INTRODUCTION

Ceramic chips consist of formulated ceramic dielectric materials which have been fabricated into thin layers, interspersed with metal electrodes alternately exposed on opposite edges of the laminated structure. The entire structure is then 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. Standard end terminations use a nickel barrier layer and a tin overplate to provide excellent solderability for the customer.

KEMET multilayer ceramic chip capacitors are produced in plants designed specifically for chip capacitor manufacture. The process features a high degree of mechanization as well as precise controls over raw materials and process conditions. Manufacturing is supplemented by extensive Technology, Engineering and Quality Assurance programs.

KEMET ceramic chip capacitors are offered in the five most popular temperature characteristics. These are designated by the Electronics Industies Association (EIA) as the ultra-stable C0G (also known as NP0, military version BP), the stable X7R (military BX or BR), the stable X5R, and the general purpose Z5U and Y5V. A wide range of sizes are available. KEMET multilayer ceramic chip capacitors are available in KEMET's tape and reel packaging, compatible with automatic placement equipment. Bulk cassette packaging is also available (0805,0603 and 0402 only) for those pick and place machines requiring its use.

ELECTRICAL CHARACTERISTICS

1. Working Voltage:

Refers to the maximum continuous DC working voltage permissible across the entire operating temperature range. The reliability of multilayer ceramic capacitors is not extremely sensitive to voltage, and brief applications of voltage above rated will not result in immediate failure. However, reliability will be degraded by sustained exposure to voltages above rated.

2. Temperature Characteristics:

Within the EIA classifications, various temperature characteristics are identified by a three-symbol code; for example: C0G, X7R, X5R, Z5U and Y5V.

For Class I temperature compensating dielectrics (includes C0G), the first symbol designates the significant figures of the temperature coefficient in PPM per degree Celsius, the second designates the multiplier to be applied, and the third designates the tolerance in PPM per degrees Celsius. EIA temperature characteristic codes for Class I dielectrics are shown in Table 1.

Table 1 – EIA Temperature Characteristic Codes for Class I Dielectrics

Significant Figure of Temperature Coefficient		Multiplier Applied to Temperature Coefficient		Tolerance of Temperature Coefficient	
PPM per Degree C	Letter Symbol	Multiplier	Number Symbol	PPM per Degree C	Letter Symbol
0.0	C	-1	0	± 30	G
0.3	B	-10	1	± 60	H
0.9	A	-100	2	± 120	J
1.0	M	-1000	3	± 250	K
1.5	P	-10000	4	± 500	L

KEMET supplies the C0G characteristic.

For Class II and III dielectrics (including X7R, X5R, Z5U & Y5V), the first symbol indicates the lower limit of the operating temperature range, the second indicates the upper limit of the operating temperature range, and the third indicates the maximum capacitance change allowed over the operating temperature range. EIA type designation codes for Class II and III dielectrics are shown in Table 2.

Table 2 – EIA Temperature Characteristic Codes for Class II & III Dielectrics

Low Temperature Rating		High Temperature Rating		Maximum Capacitance Shift		
Degree Celsius	Letter Symbol	Degree Celsius	Number Symbol	Percent	Letter Symbol	EIA Class
+10C	Z	+45C	2	± 1.0%	A	II
-30C	Y	+65C	4	± 1.5%	B	II
-55C	X	+85C	5	± 2.2%	C	II
		+105C	6	± 3.3%	D	II
		+125C	7	± 4.7%	E	II
		+150C	8	± 7.5%	F	II
		+200C	9	± 10.0%	P	II
				± 15.0%	R	II
				± 22.0%	S	III
				+ 22/-33%	T	III
				+22/-56%	U	III
				+22/-82%	V	III

KEMET supplies the X7R, X5R, Z5U and Y5V characteristics.

3. Capacitance Tolerance:

See tables on pages 47-50.

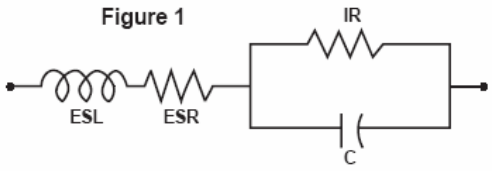
4. Capacitance:

Within specified tolerance when measured per Table 3.

The standard unit of capacitance is the farad. For practical capacitors, capacitance is usually expressed in microfarads (10^{-6} farad), nanofarads (10^{-9} farad), or picofarads (10^{-12} farad). Standard measurement conditions are listed in Table 3 - Specified Electrical Limits.

Like all other practical capacitors, multilayer ceramic capacitors also have resistance and inductance. A simplified schematic for the single frequency equivalent circuit is shown in Figure 1. At high frequency more complex models apply - see KEMET SPICE models at www.kemet.com for details.

Figure 1



C = Capacitance ESR = Equivalent Series Resistance

ESL = Equivalent Series Inductance IR = Insulation Resistance

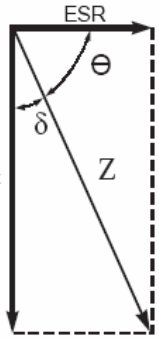
5. Dissipation Factor:
Measured under same conditions as capacitance. (See Table 3)

Dissipation factor (DF) is a measure of the losses in a capacitor under AC application. It is the ratio of the equivalent series resistance to the capacitive reactance, and is usually expressed in percent. It is normally measured simultaneously with capacitance, and under the same conditions. The vector diagram below illustrates the relationship between DF, ESR and impedance. The reciprocal of the dissipation factor is called the "Q" or quality factor. For convenience, the "Q" factor is often used for very low values of dissipation factor especially when measured at high frequencies. DF is sometimes called the "loss tangent" or "tangent δ", as shown in Figure 2.

Figure 2

$$DF(\%) = \frac{ESR \times 100}{X_C}$$

$$X_C = \frac{1}{2\pi fC}$$



6. Impedance:

Since the parallel resistance (IR) is normally very high, the total impedance of the capacitor can be approximated by:

Figure 3

$$Z = \sqrt{ESR^2 + (X_L - X_C)^2}$$

Where: **Z = Total Impedance**

ESR = Equivalent Series Resistance

X_C = Capacitive Reactance = $1/(2\pi fC)$

X_L = Inductive Reactance = $(2\pi f)(ESL)$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications. At high frequency more detailed models apply - see KEMET SPICE models for such instances.

7. Insulation Resistance:
Measured after 2 minutes electrification at 25°C and rated voltage: Limits per Table 3.

Insulation Resistance is the measure of a capacitor to resist the flow of DC leakage current. It is sometimes referred to as "leakage resistance". Insulation resistance (IR) is the DC resistance measured across the terminals of a capacitor, represented by the parallel resistance (IR) shown in Figure 1. For a given dielectric type, electrode area increases with capacitance, resulting in a decrease in the insulation resistance. Consequently, insulation resistance limits are usually specified as the "RC" (IR x C) product, in terms of ohm-farads or megohm-micro-farads. The insulation resistance for a specific capacitance value is determined by dividing this product by the capacitance. However, as the nominal capacitance values become small, the insulation resistance calculated from the RC product

Table 3 – Specified Electrical Limits

Parameter	Temperature Characteristics			
	C0G	X7R/X5R	Z5U	Y5V
Capacitance & Dissipation Factor: Measured at following conditions: C0G – 1kHz and 1 vrms if capacitance >1000 pF 1MHz and 1 vrms if capacitance ≤1000 pF X7R/X5R/Y5V – 1kHz and 1 vrms* if capacitance ≤ 10 µF X7R/X5R/Y5V – 120Hz and 0.5 vrms if capacitance > 10 µF Z5U – 1kHz and 0.5 vrms Y5V – 1kHz and 1 vrms DF Limits: 50 - 200 volts – 25 volts – 16 volts – 6.3/10 volts –	 0.10% 0.10% -------- --------	 2.5% 3.5% 3.5% 5.0%	 4.0% 4.0% -------	 5.0% 7.0% 7.0% 10.0%
Dielectric Strength: At 2.5 times rated DC voltage	Pass Subsequent IR Test			
Insulation Resistance (IR): At rated DC voltage, whichever of the two is smaller. To get IR limit, divide MΩ–µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.	1,000 MΩ – µF or 100 GΩ (100,000 MΩ)	1,000 MΩ – µF or 100 GΩ (100,000 MΩ)	100 MΩ – µF or 10 GΩ (10,000 MΩ)	100 MΩ – µF or 10 G (≥16 volt) 50 MΩ – µF or 10G (≤10v) (10,000 MΩ)
Temperature: Range, °C Capacitance Change (without DC voltage)	-55 to +125 0 ± 30 ppm/°C	X7R: -55 to +125 ±15% X5R: -55 to +85 ±15%	+10 to +85 +22% -56%	-30 to +85 +22% -82%

***Note: Some values measured at ½ volt, see X7R Table for specific details on pages 48 and 49.**

impedance consists of the ESR only. At high frequency more detailed models apply - See KEMET SPICE models for such instances.

Typical impedance versus frequency curves for KEMET multilayer ceramic capacitors are shown in Figures 4, 5 and 6.

ENVIRONMENTAL AND PHYSICAL

13. **Thermal Shock:**
EIA-198, Method 202, Condition B (5 cycles -55° to + 125°C).

14. **Life Test:**
EIA-198, Method 201, 1000 hours at 200% of rated voltage at 125°C. (Except 85°C for Z5U and Y5V).
See Table 4 on page 44 for limits.

15. **Humidity Test:**
EIA-198, Method 206, (Except 1000 hours,85°C, 85% RH, Rated Voltage).
See Table 4 on page 44 for limits.

16. **Moisture Resistance:**
EIA-198, Method 204, Condition B (20 cycles with 50 volts applied.
See Table 4 on page 44 for limits.

17. **Solderability:**
EIA-198, Method 301 (245°, 5 secs, Sn62 solder) 95% smooth solder on terminations.

18. **Resistance to Soldering Heat:**
EIA-198, Method 302, Condition B (260°C, 10 seconds) no leaching of nickel barrier.

19. **Terminal Strength:**
EIA-198, Method 303, Condition D .

RELIABILITY

20. A well constructed multilayer ceramic capacitor chip is extremely reliable and, for all practical purposes, has no wearout mechanism when used within the maximum voltage and temperature ratings. Most failures occur as a result of mechanical or thermal damage during mounting on the board, or during subsequent testing. Capacitor failure may also be induced by sustained operation at voltages that exceed the rated DC voltage, voltage spikes or transients that exceed the dielectric's voltage capability, sustained operation at temperatures above the maximum rated temperature, internal defects, or excessive temperature rise due to power dissipation. As with any practical device, multilayer ceramic capacitors also possess an inherent, although low, failure rate when operated within rated conditions. The primary failure mode is by short-circuit or low insulation resistance, resulting from cracks or from dielectric breakdown at a defect site. KEMET monitors reliability with a periodic sampling program for selected values. Results are available in our FIT (Failure in Time) report for commercial chips.

21. **Storage and Handling:**
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40 degrees C, and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts, and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years of receipt.

MISAPPLICATION

22. Ceramic capacitors, like any other capacitors, may fail if they are misapplied. Some misapplications include mechanical damage, such as impact or excessive flexing of the circuit board. Others include severe mounting or rework cycles that may also introduce thermal shock. Still others include exposure to excessive voltage, current or temperature. If the dielectric layer of the capacitor is damaged by misapplication, the circuit may fail. The electrical energy of the circuit can be released as heat, which may damage the circuit board and other components as well.

ADDITIONAL INFORMATION

23. Detailed application information can be found in KEMET Engineering Bulletins.

F-2100	Surface Mount-Mounting Pad Dimensions and Considerations
F-2102	Reflow Soldering Process
F-2105	Wave Solder Process
F-2103	Surface Mount Repair
F-2110	Capacitance Monitoring while Flex Testing

For analysis of high frequency applications, KEMET has SPICE models of most chip capacitors. Models may be downloaded from KEMET's website www.kemet.com.

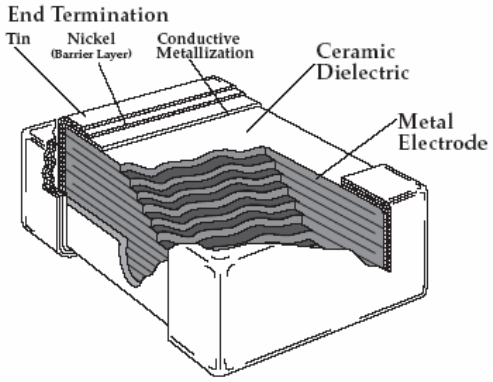
Additional information is also available - See your KEMET representative for details or post your questions to KEMET's homepage on the web http://www.kemet.com.

TABLE 4 – ENVIRONMENTAL LIMITS

Body	Rated DC Voltage	Initial DF (%)	IR (GΩ or ΩF) whichever is less	DF (%) Post Life/ Hum/Moisture Resistance	Cap Shift (% or pf, whichever is greater) Post Life/ Hum/Moisture Resistance	IR (GΩ or ΩF) whichever is less Post Life/ Hum/Moisture Resistance
C0G	200*	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	100	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	50	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	25	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	16	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
X7R/X5R	200*	2.5	100/1000	3.0	± 20%	10/100
	100	2.5	100/1000	3.0	± 20%	10/100
	50	2.5	100/1000	3.0	± 20%	10/100
	25	3.5	100/1000	5.0	± 20%	10/100
	16	3.5	100/1000	5.0	± 20%	10/100
	6.3/10	5.0	100/1000	7.5	± 20%	10/100
Z5U	100	4.0	10/100	5.0	± 30%	1/10
	50	4.0	10/100	5.0	± 30%	1/10
	25	4.0	10/100	7.5	± 30%	1/10
Y5V	100	5.0	10/100	7.5	± 30%	1/10
	50	5.0	10/100	7.5	± 30%	1/10
	25	7.0	10/100	10.0	± 30%	1/10
	16	7.0	10/100	10.0	± 30%	1/10
	6.3/10	10.0	10/50	15.0	± 30%	1/5

*200 Volt limits not currently included in EIA-198.

CONSTRUCTION



TYPICAL PERFORMANCE CURVES
(See SPICE models for specific ratings.)

EFFECT OF FREQUENCY

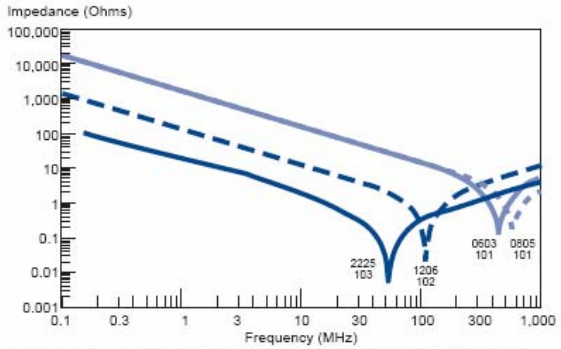


FIGURE 4. Impedance versus Frequency C0G Dielectric

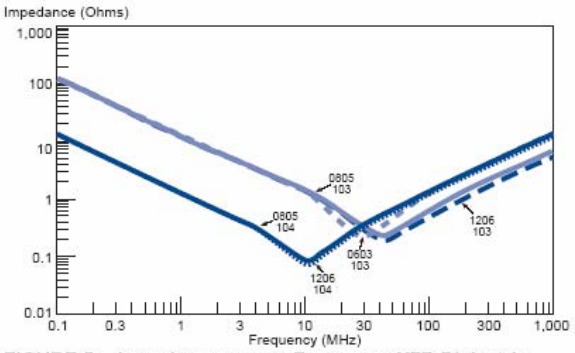


FIGURE 5 Impedance versus Frequency X7R Dielectric

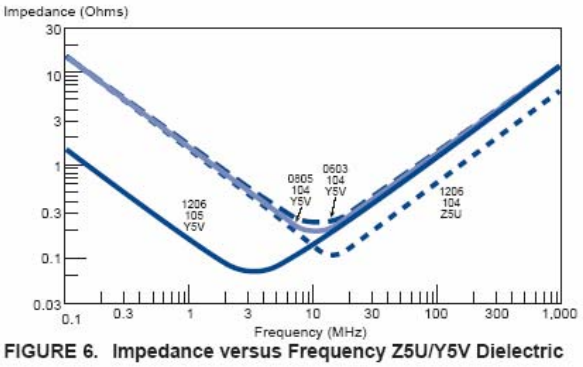


FIGURE 6. Impedance versus Frequency Z5U/Y5V Dielectric

EFFECT OF VOLTAGE

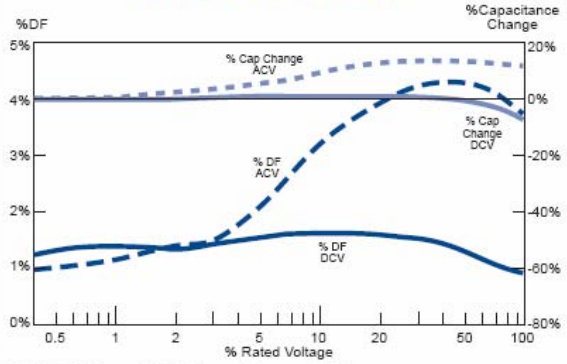


FIGURE 7. X7R Capacitance & DF versus Applied AC/DC Voltages

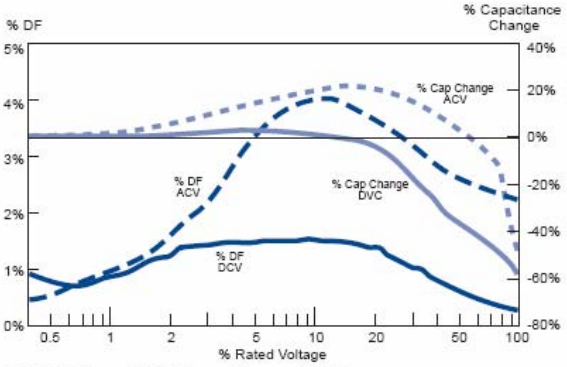
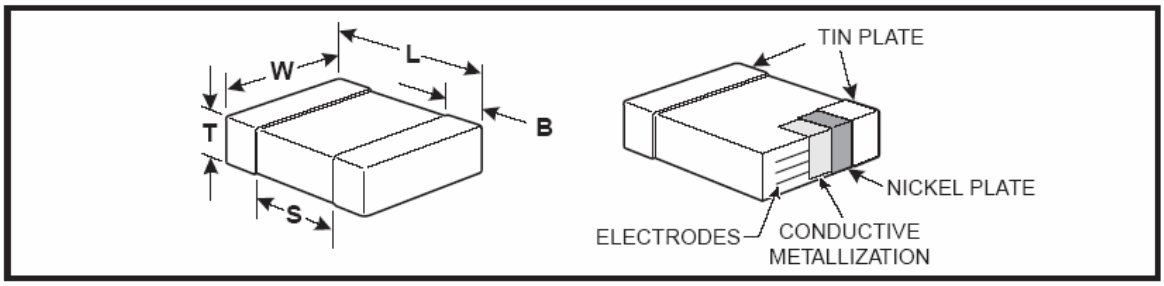


FIGURE 8. Z5U Capacitance & DF versus Applied AC/DC Voltages

FEATURES

- C0G (NP0), X7R, X5R, Z5U and Y5V Dielectrics
- 10, 16, 25, 50, 100 and 200 Volts
- Standard End Metalization: Tin-plate over nickel barrier
- Available Capacitance Tolerances: ±0.10 pF; ±0.25 pF; ±0.5 pF; ±1%; ±2%; ±5%; ±10%; ±20%; and +80%-20%
- Tape and reel packaging per EIA481-1. (See page 59 for specific tape and reel information.) Bulk Cassette packaging (0402, 0603, 0805 only) per IEC60286-6 and EIAJ 7201.

CAPACITOR OUTLINE DRAWINGS



DIMENSIONS—MILLIMETERS AND (INCHES)

EIA SIZE CODE	METRIC SIZE CODE (Ref only)	L # LENGTH	W # WIDTH	T (EIA) # THICKNESS MAX.	B BANDWIDTH	S MIN. SEPARATION	MOUNTING TECHNIQUE
0402*	1005	1.0 (.04) ± .05(.002)	0.5 (.02) ± .05 (.002)	0.55 (.022)	0.20 (0.008)-0.40 (0.016)	0.3 (.012)	Solder Reflow
0603*	1608	1.6 (.063) ± 0.15 (.006)	0.8 (.032) ± 0.15 (.006)	0.9 (.035)	0.35 (.014) ±0.15 (.006)	0.7 (.028)	Solder Wave † or Solder Reflow
0805*	2012	2.0 (.079) ± 0.2 (.008)	1.25 (.049) ± 0.2 (.008)	1.3 (.051)	0.5 (.02) ±.25 (.010)	0.75 (.030)	
1206*	3216	3.2 (.126) ± 0.2 (.008)	1.6 (.063) ± 0.2 (.008)	1.5 (.059)	0.5 (.02) ±.25 (.010)	N/A	
1210*	3225	3.2 (.126) ± 0.2 (.008)	2.5 (.098) ± 0.2 (.008)	1.7 (.067)	0.5 (.02) ±.25 (.010)	N/A	
1812	4532	4.5 (.177) ± 0.3 (.012)	3.2 (.126) ± 0.3 (.012)	1.7 (.067)	0.6 (.024) ±.35 (.014)	N/A	Solder Reflow
1825*	4564	4.5 (.177) ± 0.3 (.012)	6.4 (.252) ± 0.4 (.016)	1.7 (.067)	0.6 (.024) ±.35 (.014)	N/A	
2220	5650	5.6 (.220) ± 0.4 (.016)	5.0 (.197) ± 0.4 (.016)	1.8 (.071)	0.6 (.024) ±.35 (.014)	N/A	
2225	5664	5.6 (.220) ± 0.4 (.016)	6.3 (.248) ± 0.4 (.016)	2.0 (.079)	0.6 (.024) ±.35 (.014)	N/A	

* Note: Indicates EIA Preferred Case Sizes (Tightened tolerances apply for 0402, 0603, and 0805 packaged in bulk cassette, see page 63.)
#Note: These thicknesses are EIA maximums. Most chips are considerably thinner. Consult factory for details. Also, some extended values may be slightly thicker than EIA maximums.
† For extended value 1210 case size – solder reflow only.

CAPACITOR ORDERING INFORMATION (Standard Chips - For Military see page 53)

C 0805 C 103 K 5 R A C*

CERAMIC

SIZE CODE

SPECIFICATION
C - Standard

CAPACITANCE CODE
Expressed in Picofarads (pF)
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 through 9.9pF. Use 8 for 0.5 through 0.99pF)
(Example: 2.2pF = 229 or 0.50 pF = 508)

CAPACITANCE TOLERANCE

B – ±0.10pF	J – ±5%
C – ±0.25pF	K – ±10%
D – ±0.5pF	M – ±20%
F – ±1%	P – (GMV) – special order only
G – ±2%	Z – +80%, -20%

END METALLIZATION
C-Standard
(Tin-plated nickel barrier)

FAILURE RATE LEVEL
A- Not Applicable

TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G – C0G (NP0) (±30 PPM/°C)
R – X7R (±15%) (-55°C + 125°C)
P– X5R (±15%) (-55°C + 85°C)
U – Z5U (+22%, -56%) (+10°C + 85°C)
V – Y5V (+22%, -82%) (-30°C + 85°C)

VOLTAGE

1 - 100V	3 - 25V
2 - 200V	4 - 16V
5 - 50V	8 - 10V
	9 - 6.3V

* Part Number Example: C0805C103K5RAC (14 digits - no spaces)

C0G CAPACITANCE RANGE – 0402, 0603, 0805, 1206

CAP. PF	CAP. TOL.	C0402*				C0603*						C0805*						C1206*					
		10V	16V	25V	50V	10V	16V	25V	50V	100V	200V	10V	16V	25V	50V	100V	200V	10V	16V	25V	50V	100V	200V
.50	C,D	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508						
.75	C,D	758	758	758	758	758	758	758	758	758	758	758	758	758	758	758	758						
1.0	C,D	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109
1.1	C,D	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119
1.2	C,D	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
1.3	C,D	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139
1.5	C,D	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159
1.6	C,D	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169
1.8	C,D	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189	189
2.0	C,D	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
2.2	C,D	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229
2.4	C,D	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249	249
2.7	C,D K,M	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279
3.0	C,D K,M	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309
3.3	C,D K,M	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339
3.6	C,D K,M	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369	369
3.9	C,D K,M	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399
4.3	C,D K,M	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439
4.7	C,D K,M	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479	479
5.1	C,D K,M	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519	519
5.6	C,D J,K,M	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569	569
6.2	C,D J,K,M	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629
6.8	C,D J,K,M	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689
7.5	C,D J,K,M	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759	759
8.2	C,D J,K,M	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829
9.1	C,D J,K,M	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919	919
10	C,D J,K,M	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
11	C,D J,K,M	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
12	C,D J,K,M	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
13	C,D J,K,M	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
15	C,D G,J,K,M	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
16	C,D G,J,K,M	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
18	C,D G,J,K,M	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
20	C,D G,J,K,M	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
22	C,D G,J,K,M	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
24	C,D G,J,K,M	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
27	D,F,G,J,K,M	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
30	D,F,G,J,K,M	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
33	D,F,G,J,K,M	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330
36	D,F,G,J,K,M	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
39	D,F,G,J,K,M	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390
43	D,F,G,J,K,M	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430	430
47	D,F,G,J,K,M	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470
51	D,F,G,J,K,M	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510
56	F,G,J,K,M	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
62	F,G,J,K,M	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620
68	F,G,J,K,M	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680
75	F,G,J,K,M	750	750	750		750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
82	F,G,J,K,M	820	820	820		820	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820
91	F,G,J,K,M	910	910	910		910	910	910	910	910	910	910	910	910	910	910	910	910	910	910	910	910	910
100	F,G,J,K,M	101	101	101		101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101
110	F,G,J,K,M					111	111	111	111	111		111	111	111	111	111	111	111	111	111	111	111	111
120	F,G,J,K,M					121	121	121	121	121		121	121	121	121	121	121	121	121	121	121	121	121
130	F,G,J,K,M					131	131	131	131	131		131	131	131	131	131	131	131	131	131	131	131	131
150	F,G,J,K,M					151	151	151	151	151		151	151	151	151	151	151	151	151	151	151	151	151
160	F,G,J,K,M					161	161	161	161	161		161	161	161	161	161	161	161	161	161	161	161	161
180	F,G,J,K,M					181	181	181	181	181		181	181	181	181	181	181	181	181	181	181	181	181
200	F,G,J,K,M					201	201	201	201			201	201	201	201	201	201	201	201	201	201	201	201
220	F,G,J,K,M					221	221	221	221			221	221	221	221	221	221	221	221	221	221	221	221
240	F,G,J,K,M					241	241	241	241			241	241	241	241	241	241	241	241	241	241	241	241
270	F,G,J,K,M					271	271	271	271			271	271	271	271	271	271	271	271	271	271	271	271
300	F,G,J,K,M					301	301	301	301			301	301	301	301	301	301	301	301	301	301	301	301
330	F,G,J,K,M					331	331	331	331			331	331	331	331	331	331	331	331	331	331	331	331
360	F,G,J,K,M					361	361	361	361			361	361	361	361	361	361	361	361	361	361	361	361
390	F,G,J,K,M					391	391	391	391			391	391	391	391	391	391	391	391	391	391	391	391
430	F,G,J,K,M					431	431	431	431			431	431	431	431	431	431	431	431	431	431	431	431
470	F,G,J,K,M					471	471	471	471			471	471	471	471	471	471	471	471	471	471	471	471
510	F,G,J,K,M					511	511	511	511			511	511	511	511	511		511	511	511	511	511	511
560	F,G,J,K,M					561	561	561				561	561	561	561	561		561	561	561	561	561	561
620	F,G,J,K,M					621	621	621				621	621	621	621	621		621	621	621	621	621	621
680	F,G,J,K,M					681	681	681				681	681	681	681	681		681	681	681	681	681	681
750	F,G,J,K,M					751	751	751				751	751	751	751	751		751	751	751	751	751	751
820	F,G,J,K,M					821	821	821				821	821	821	821	821		821	821	821	821	821	821
910	F,G,J,K,M					911	911	911				911	911	911	911	911		911	911	911	911	911	911
1000	F,G,J,K,M					102	102	102				102	102	102	102	102		102	102	102	102	102	102
1100	F,G,J,K,M											112	112	112	112			112	112	112	112	112	112
1200	F,G,J,K,M											122	122	122	122			122	122	122	122	122	122
1300	F,G,J,K,M											132	132	132	132			132	132	132	132	132	132
1500	F,G,J,K,M											152	152	152	152			152	152	152	152	152	152
1600	F,G,J,K,M											162	162	162	162			162	162	162	162	162	162
1800	F,G,J,K,M											182	182	182	182			182	182	182	182	182	182
2000	F,G,J,K,M											202	202	202				202	202	202	202	202	
2200	F,G,J,K,M											222	222	222				222	222	222	222	222	
2400	F,G,J,K,M											242	242	242				242	242	242	242	242	
2700	F,G,J,K,M											272	272	272				272	272	272	272	272	
3000	F,G,J,K,M											302	302	302				302	302	302	302	302	
3300	F,G,J,K,M											332	332	332				332	332	332	332	332	
3600	F,G,J,K,M											362	362	362				362	362	362	362	362	
3900	F,G,J,K,M											392	392	392				392	392	392	392	392	
4300	F,G,J,K,M																	432	432	432	432		
4700	F,G,J,K,M																	472	472	472	472		
5100	F,G,J,K,M																	512	512	512	512		
5600	F,G,J,K,M																	562	562	562	562		
6200	F,G,J,K,M																	622	622	622			
6800	F,G,J,K,M																	682	682	682			
7500	F,G,J,K,M																	752	752	752			
8200	F,G,J,K,M																	822	822	822			
9100	F,G,J,K,M																	912	912	912			
10,000	F,G,J,K,M																	103	103	103			

*** Indicates EIA preferred chip sizes.**
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used in 63 volt applications.

C0G CAPACITANCE RANGE – 1210, 1812, 1825, 2220, 2225

CAP. PF	CAP. TOL.	C1210*			C1812*			C1825*			C2220			C2225		
		50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V
10	C,D J,K,M	100	100	100												
12	C,D J,K,M	120	120	120												
15	C,D G,J,K,M	150	150	150												
18	C,D G,J,K,M	180	180	180												
22	C,D G,J,K,M	220	220	220												
27	D,F,G,J,K,M	270	270	270												
33	D,F,G,J,K,M	330	330	330												
39	D,F,G,J,K,M	390	390	390												
47	D,F,G,J,K,M	470	470	470												
56	F,G,J,K,M	560	560	560												
68	F,G,J,K,M	680	680	680												
82	F,G,J,K,M	820	820	820												
100	F,G,J,K,M	101	101	101												
120	F,G,J,K,M	121	121	121												
150	F,G,J,K,M	151	151	151												
180	F,G,J,K,M	181	181	181												
220	F,G,J,K,M	221	221	221												
270	F,G,J,K,M	271	271	271												
330	F,G,J,K,M	331	331	331												
390	F,G,J,K,M	391	391	391												
470	F,G,J,K,M	471	471	471	471	471	471									
560	F,G,J,K,M	561	561	561	561	561	561									
680	F,G,J,K,M	681	681	681	681	681	681									
820	F,G,J,K,M	821	821	821	821	821	821									
1000	F,G,J,K,M	102	102	102	102	102	102									
1200	F,G,J,K,M	122	122	122	122	122	122									
1500	F,G,J,K,M	152	152	152	152	152	152									
1800	F,G,J,K,M	182	182	182	182	182	182									
2200	F,G,J,K,M	222	222	222	222	222	222									
2700	F,G,J,K,M	272	272	272	272	272	272									
3300	F,G,J,K,M	332	332	332	332	332	332									
3900	F,G,J,K,M	392	392		392	392	392	392	392	392						
4700	F,G,J,K,M	472	472		472	472	472	472	472	472				472	472	472
5600	F,G,J,K,M	562	562		562	562	562	562	562	562				562	562	562
6800	F,G,J,K,M	682	682		682	682	682	682	682	682	682	682		682	682	682
8200	F,G,J,K,M	822			822	822		822	822	822	822	822		822	822	822
10,000	F,G,J,K,M	103			103	103		103	103	103	103	103		103	103	103
12,000	F,G,J,K,M	123						123	123	123	123	123		123	123	123
15,000	F,G,J,K,M							153	153		153	153		153	153	153
18,000	F,G,J,K,M							183	183		183	183		183	183	
22,000	F,G,J,K,M							223	223		223			223	223	
27,000	F,G,J,K,M							273	273		273			273	273	
33,000	F,G,J,K,M													333		

X7R CAPACITANCE RANGE – 0402, 0603, 0805, 1206

CAP. PF	CAP. TOL.	C0402*					C0603*							C0805*							C1206*						
		6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V	100V	200V	6.3V	10V	16V	25V	50V	100V	200V	6.3V	10V	16V	25V	50V	100V	200V
150	K,M,J	151	151	151	151	151																					
180	K,M,J	181	181	181	181	181	181	181	181	181	181	181	181														
220	K,M,J	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221							
270	K,M,J	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271							
330	K,M,J	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331							
390	K,M,J	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391							
470	K,M,J	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471							
560	K,M,J	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561							
680	K,M,J	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681							
820	K,M,J	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821							
1000	K,M,J	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
1200	K,M,J	122	122	122	122	122	122	122	122	122	122	122		122	122	122	122	122	122	122	122	122	122	122	122	122	122
1500	K,M,J	152	152	152	152	152	152	152	152	152	152	152		152	152	152	152	152	152	152	152	152	152	152	152	152	152
1800	K,M,J	182	182	182	182		182	182	182	182	182	182		182	182	182	182	182	182	182	182	182	182	182	182	182	182
2200	K,M,J	222	222	222	222		222	222	222	222	222	222		222	222	222	222	222	222	222	222	222	222	222	222	222	222
2700	K,M,J	272	272	272	272		272	272	272	272	272	272		272	272	272	272	272	272	272	272	272	272	272	272	272	272
3300	K,M,J	332	332	332	332		332	332	332	332	332	332		332	332	332	332	332	332	332	332	332	332	332	332	332	332
3900	K,M,J	392	392	392	392		392	392	392	392	392	392		392	392	392	392	392	392	392	392	392	392	392	392	392	392
4700	K,M,J	472	472	472	472		472	472	472	472	472	472		472	472	472	472	472	472	472	472	472	472	472	472	472	472
5600	K,M,J	562	562	562	562		562	562	562	562	562			562	562	562	562	562	562	562	562	562	562	562	562	562	562
6800	K,M,J	682	682	682	682		682	682	682	682	682			682	682	682	682	682	682	682	682	682	682	682	682	682	682
8200	K,M,J	822	822	822	822		822	822	822	822	822			822	822	822	822	822	822		822	822	822	822	822	822	822
10,000	K,M,J	103	103	103	103		103	103	103	103	103			103	103	103	103	103	103		103	103	103	103	103	103	103
12,000	K,M,J						123	123	123	123	123#			123	123	123	123	123	123		123	123	123	123	123	123	123
15,000	K,M,J						153	153	153	153	153#			153	153	153	153	153	153		153	153	153	153	153	153	153
18,000	K,M,J						183	183	183	183	183#			183	183	183	183	183	183		183	183	183	183	183	183	183
22,000	K,M,J						223	223	223	223	223#			223	223	223	223	223	223		223	223	223	223	223	223	223
27,000	K,M,J						273	273	273	273				273	273	273	273	273			273	273	273	273	273		
33,000	K,M,J						333	333	333	333				333	333	333	333	333			333	333	333	333	333	333	
39,000	K,M,J						393	393	393	393				393	393	393	393	393			393	393	393	393	393	393	
47,000	K,M,J						473	473	473	473				473	473	473	473	473			473	473	473	473	473	473	
56,000	K,M,J						563	563	563	563				563	563	563	563	563#			563	563	563	563	563	563	
68,000	K,M,J						683	683	683	683				683	683	683	683	683#			683	683	683	683	683	683	
82,000	K,M,J						823	823	823	823				823	823	823	823	823#			823	823	823	823	823	823	
100,000	K,M,J						104#	104#	104#	104#				104	104	104	104	104#			104	104	104	104	104	104	
120,000	K,M,J						124#	124#	124#					124	124	124	124				124	124	124	124	124		
150,000	K,M,J						154#	154#	154#					154	154	154	154				154	154	154	154	154		
180,000	K,M,J						184#	184#	184#					184	184	184	184				184	184	184	184	184#		
220,000	K,M,J						224#	224#	224#					224	224	224	224				224	224	224	224	224#		
270,000	K,M,J													274	274	274	274				274	274	274	274			
330,000	K,M,J													334	334	334	334				334	334	334	334			
390,000	K,M,J													394	394	394	394				394	394	394	394			
470,000	K,M,J													474	474	474	474				474	474	474	474			
560,000	K,M,J													564	564	564					564	564	564	564			
680,000	K,M,J													684	684	684					684	684	684	684			
820,000	K,M,J													824	824	824					824	824	824	824			
1,000,000	K,M,J													105	105	105					105@	105@	105@	105@			
1,200,000	K,M,J																				125@	125@	125@				
1,500,000	K,M,J																				155@	155@	155@				
1,800,000	K,M,J																				185@	185@	185@				
2,200,000	K,M,J																				225@	225@	225@				

* Indicates EIA preferred chip sizes.
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
X7R dielectric - Extended Range Values - Cap and DF measured @ 0.5 Vrms.
@ maximum thickness 1.7mm

X7R CAPACITANCE RANGE – 1210, 1812, 1825, 2220, 2225

CAP.	CAP.	C1210*							C1812*			C1825*			C2220			C2225		
PF	TOL.	6.3V	10V	16V	25V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V
2200	K,M,J	222	222	222	222	222	222	222												
2700	K,M,J	272	272	272	272	272	272	272												
3300	K,M,J	332	332	332	332	332	332	332												
3900	K,M,J	392	392	392	392	392	392	392												
4700	K,M,J	472	472	472	472	472	472	472												
5600	K,M,J	562	562	562	562	562	562	562												
6800	K,M,J	682	682	682	682	682	682	682	682	682	682									
8200	K,M,J	822	822	822	822	822	822	822	822	822	822									
10,000	K,M,J	103	103	103	103	103	103	103	103	103	103									
12,000	K,M,J	123	123	123	123	123	123	123	123	123	123									
15,000	K,M,J	153	153	153	153	153	153	153	153	153	153									
18,000	K,M,J	183	183	183	183	183	183	183	183	183	183									
22,000	K,M,J	223	223	223	223	223	223	223	223	223	223	223	223	223						
27,000	K,M,J	273	273	273	273	273	273	273	273	273	273	273	273	273						
33,000	K,M,J	333	333	333	333	333	333	333	333	333	333	333	333	333						
39,000	K,M,J	393	393	393	393	393	393	393	393	393	393	393	393	393						
47,000	K,M,J	473	473	473	473	473	473	473	473	473	473	473	473	473				473	473	473
56,000	K,M,J	563	563	563	563	563	563	563	563	563	563	563	563	563				563	563	563
68,000	K,M,J	683	683	683	683	683	683	683	683	683	683	683	683	683				683	683	683
82,000	K,M,J	823	823	823	823	823	823	823	823	823	823	823	823	823				823	823	823
100,000	K,M,J	104	104	104	104	104	104	104	104	104	104	104	104	104				104	104	104
120,000	K,M,J	124	124	124	124	124	124		124	124	124	124	124	124				124	124	124
150,000	K,M,J	154	154	154	154	154	154		154	154	154	154	154	154				154	154	154
180,000	K,M,J	184	184	184	184	184			184	184	184	184	184	184				184	184	184
220,000	K,M,J	224	224	224	224	224			224	224		224	224	224				224	224	224
270,000	K,M,J	274	274	274	274	274#			274	274		274	274	274	274	274	274	274	274	274
330,000	K,M,J	334	334	334	334	334#			334	334		334	334	334	334	334	334	334	334	334
390,000	K,M,J								394			394	394	394	394	394	394	394	394	394
470,000	K,M,J								474			474	474		474	474		474	474	474
560,000	K,M,J								564			564	564		564	564		564	564	
680,000	K,M,J								684			684	684		684	684		684	684	
820,000	K,M,J								824			824			824	824		824	824	
1,000,000	K,M,J								105			105			105			105	105	
1,200,000	K,M,J											125			125			125		
1,500,000	K,M,J											155			155			155		
1,800,000	K,M,J											185			185			185		
2,200,000	K,M,J											225			225			225		

* **Indicates EIA preferred chip sizes.**
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
Extended Range Values – Cap and DF measured @ 0.5 Vrms.

X5R CAPACITANCE RANGE

Cap.	Cap.	C1206				C1210				
pF	Tol.	6.3V	10V	16V	25V	6.3V	10V	16V	25V	50V
100,000	K,M				104					
150,000	K,M				154					
180,000	K,M				184					
220,000	K,M				224					
270,000	K,M				274					
330,000	K,M				334					
470,000	K,M				474					
680,000	K,M				684					
1,000,000	K,M				105			105+	105+	105+
1,500,000	K,M	155	155	155						
1,800,000	K,M	185	185	185						
2,200,000	K,M	225	225	225						
2,700,000	K,M	275	275	275						
3,300,000	K,M	335	335	335						
4,700,000	K,M	***475***	***475***	***475***		475+	475+			
6,800,000	K,M					685+	685+			
10,000,000	K,M					106+	***106+***			

NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
+ Reflow only
Values in Bold Italics: C1206 - 1.91mm max. thickness; C1210 - 2.50mm max. thickness

Z5U CAPACITANCE RANGE

(KEMET's Z5U also meets Y5V Characteristics)

CAP. PF	CAP TOL	C0805*		C1206*		C1210*		C1812*		C1825*		C2225	
		50V	100V	50V	100V	50V	100V	50V	100V	50V	100V	50V	**100V**
6800	M,Z	682	682										
8200	M,Z	822	822										
10,000	M,Z	103	103	103	103								
12,000	M,Z	123		123	123								
15,000	M,Z	153		153	153								
18,000	M,Z	183		183	183								
22,000	M,Z	223		223	223								
27,000	M,Z	273		273	273								
33,000	M,Z	333		333	333								
39,000	M,Z	393		393	393								
47,000	M,Z	473		473	473	473	473						
56,000	M,Z	563		563	563	563	563						
68,000	M,Z	683		683	683	683	683						
82,000	M,Z	823		823	823	823	823	823	823				
100,000	M,Z	104		104	104	104	104	104	104				
120,000	M,Z			124		124	124	124	124				
150,000	M,Z			154		154	154	154	154				
180,000	M,Z			184		184		184		184	184		
220,000	M,Z			224		224		224		224	224		
270,000	M,Z					274		274		274	274		
330,000	M,Z					334		334		334	334	334	334
390,000	M,Z					394		394		394	394	394	394
470,000	M,Z					474		474		474		474	474
560,000	M,Z					564		564		564		564	
680,000	M,Z					684		684		684		684	
820,000	M,Z					824		824		824		824	
1,000,000	M,Z					105		105		105		105	
1,200,000	M,Z									125		125	
1,500,000	M,Z									155		155	
1,800,000	M,Z											185	
2,200,000	M,Z											225	

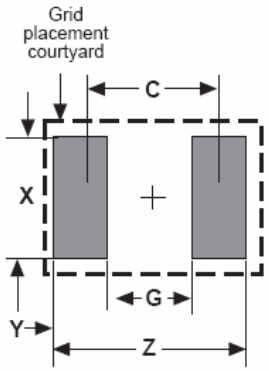
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
*** EIA preferred chip sizes**

Y5V CAPACITANCE RANGE

Cap. pF	Cap. Tol.	C0603				C0805					C1206					C1210				
		6.3V	10V	16V	25V	6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V
22,000	Z									223					223					
33,000	Z									333					333					
47,000	Z									473					473					
68,000	Z									683					683					
100,000	Z	104	104	104	104					104					104					
150,000	Z	154	154	154	154															
220,000	Z	224	224	224	224	224	224	224	224											
330,000	Z	334	334	334	334	334	334	334	334											
470,000	Z					474	474	474	474					474						
680,000	Z					684	684	684	684					684						
1,000,000	Z					105	105	105	105					105						
1,500,000	Z					***155***	***155***	***155***			155	155	155						224+	224+
2,200,000	Z					***225***	***225***	***225***			225	225	225						334+	334+
3,300,000	Z										335	335	335						474+	474+
4,700,000	Z										475	475	475			475+	475+	475+	684+	684+
6,800,000	Z										***685***	***685***				685+	685+	685+	105+	105+
10,000,000	Z										***106***	***106***				106+	106+	106+		
15,000,000	Z															***156+***	***156+***			
22,000,000	Z															***226+***	***226+***			

NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
*** EIA preferred chip sizes**
\+ Reflow only
Values in Bold Italics: C0805 - 1.40mm max. thickness; C1206 - 1.91mm max. thickness; C1210 - 2.50mm max. thickness

SURFACE MOUNT LAND DIMENSIONS - CERAMIC CHIP CAPACITORS - MM



	Reflow Solder					Wave Solder				
Dimension	**Z**	**G**	**X**	**Y(ref)**	**C(ref)**	**Z**	**G**	**X**	**Y(ref)**	**Smin**
0402	2.14	0.28	0.74	0.93	1.21	Not Recommended				
0603	2.78	0.68	1.08	1.05	1.73	3.18	0.68	0.80	1.25	1.93
0805	3.30	0.70	1.60	1.30	2.00	3.70	0.70	1.10	1.50	2.20
1206	4.50	1.50	2.00	1.50	3.00	4.90	1.50	1.40	1.70	3.20
1210	4.50	1.50	2.90	1.50	3.00	4.90	1.50	2.00	1.70	3.20
1812	5.90	2.30	3.70	1.80	4.10	6.30	2.30	2.60	2.00	4.30
1825	5.90	2.30	6.90	1.80	4.10	Not Recommended				
2220	7.00	3.30	5.50	1.85	5.15					
2225	7.00	3.30	6.80	1.85	5.15					

Calculation Formula
Z = Lmin + 2Jt + Tt
G = Smax - 2Jh -Th
X = Wmin + 2Js + Ts
Tt, Th, Ts = Combined tolerances