

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 affected 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 a major importance. Class II capacitors have temperature characteristics of  $\pm 15\%$  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  $\pm 15\%$ . 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  $0 \pm 30$  ppm per degree C over an operating temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  (Also known as "NP0").

**X7R:** Class II, with a maximum capacitance change of  $\pm 15\%$  over an operating temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

**Z5U:** Class III, with a maximum capacitance change of  $+22\% - 56\%$  over an operating temperature range of  $+10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

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 $\leq$ 1000 pF X7R — 1 kHz and 1 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 M $\Omega$ - $\mu\text{F}$ or 100 G $\Omega$	1,000 M $\Omega$ - $\mu\text{F}$ or 100 G $\Omega$	1,000 M $\Omega$ - $\mu\text{F}$ or 10 G $\Omega$
Temperature Characteristics: Range, $^{\circ}\text{C}$ Capacitance Change without DC voltage	-55 to 125 $0 \pm 30$ ppm/ $^{\circ}\text{C}$	-55 to 125 $\pm 15\%$	+10 to 85 $+22\%, -56\%$

\* 1 MHz and 1 vrms if capacitance  $\leq$  100 pF on military product.

Table 1

**GENERAL SPECIFICATIONS**

<b>Working Voltage:</b>	<b>Axial</b>	<b>Radial</b>
C0G	50 & 100 volts	100 & 200 volts
X7R	50 & 100 volts	50, 100 & 200 volts
Z5U	50 & 100 volts	50 & 100 volts

**Temperature Characteristics:**

C0G	0 ± 30 PPM/°C from - 55°C to + 125°C <sup>(1)</sup>
X7R	± 15% from - 55°C to + 125°C
Z5U	+ 22%; - 56% from + 10°C to + 85°C

**Capacitance Tolerance:**

C0G	± 5%, ± 10%, ± 20%
X7R	± 10%, ± 20%
Z5U	± 20%, - 20 + 80%, - 0 + 100%

**Construction:**

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

**Lead Material:**

Solder Coated Copper Clad Steel

**Solderability:**

EIA RS-198D, Method 302, Solder temperature - 230° ± 5°C. Dwell time in solder - 7 ± 1/2 seconds.

**Terminal Strength:**

EIA RS-198D, Method 303, Condition A (2.2 kg)

**ELECTRICAL @ 25°C**

**Capacitance:**

Within specified tolerance at 25°C and following test conditions.  
C0G - Greater than 1000 pF with 1.0 vrms at 1 kHz.  
- 1000 pF and less with 1.0 vrms at 1 MHz.  
X7R - with 1.0 vrms at 1 kHz.  
Z5U - with 0.5 vrms at 1 kHz.

**Dissipation Factor:**

At 25°C - same test conditions as capacitance.  
C0G - 0.15% maximum  
X7R - 2.5% maximum  
Z5U - 4.0% maximum

**Insulation Resistance:**

EIA RS-198D, Method 104, Condition A  
C0G - 100 gigohms or 1000 megohm x µF, whichever is less.  
X7R - 100 gigohms or 1000 megohm x µF, whichever is less.  
Z5U - 10 gigohms or 1000 megohm x µF, whichever is less.

**Dielectric Withstanding Voltage:**

EIA RS-198D, Method 103 (250% of rated voltage for 5 seconds, with current limited to 50mA)

**ENVIRONMENTAL**

**Vibration:**

EIA RS-198D, Method 304, Condition D (10-2000 Hz; 20g)

**Shock:**

EIA RS-198D, Method 305, Condition I (100g)

**Life Test:**

EIA RS-198D, Method 201, Condition D. Test Potential and Temperature.  
C0G - 200% of rated voltage at + 125°C  
X7R - 200% of rated voltage at + 125°C  
Z5U - 200% of rated voltage at + 85°C  
Post-Test Limits at + 25°C are:

**Capacitance Change:**

C0G - ± 3%, or 0.25 pF, whichever is greater.  
X7R - ± 20% of initial value. <sup>(2)</sup>  
Z5U - ± 30% of initial value. <sup>(2)</sup>

**Dissipation Factor:**

C0G - 0.25% maximum  
X7R - 3.0% maximum  
Z5U - 4.0% maximum

**Insulation Resistance:**

C0G - 10 gigohms or 100 megohm x µF, whichever is less.  
X7R - 10 gigohms or 100 megohm x µF, whichever is less.  
Z5U - 1 gigohm or 100 megohm x µF, whichever is less.

**Moisture Resistance:**

EIA RS-198D, Method 204, Condition A (10 cycles without applied voltage).  
Post-Test Limits at + 25°C are:

**Capacitance Change:**

C0G - 3%, or 0.25 pF, whichever is greater.  
X7R - ± 20% of initial value. <sup>(2)</sup>  
Z5U - ± 30% of initial value. <sup>(2)</sup>

**Dissipation Factor:**

C0G - 0.25% maximum  
X7R - 3.0% maximum  
Z5U - 4.0% maximum

**Insulation Resistance:**

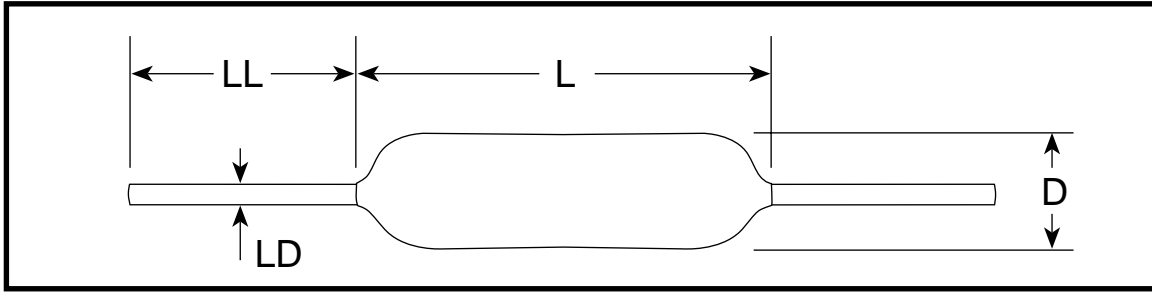
C0G - 10 gigohms or 100 megohm x µF, whichever is less.  
X7R - 10 gigohms or 100 megohm x µF, whichever is less.  
Z5U - 1 gigohm or 100 megohm x µF, whichever is less.

**Thermal Shock:**

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

- (1) +53 ppm -30 ppm/°C from + 25°C to - 55°C, ± 60 ppm below 10 pF.
- (2) X7R & 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.

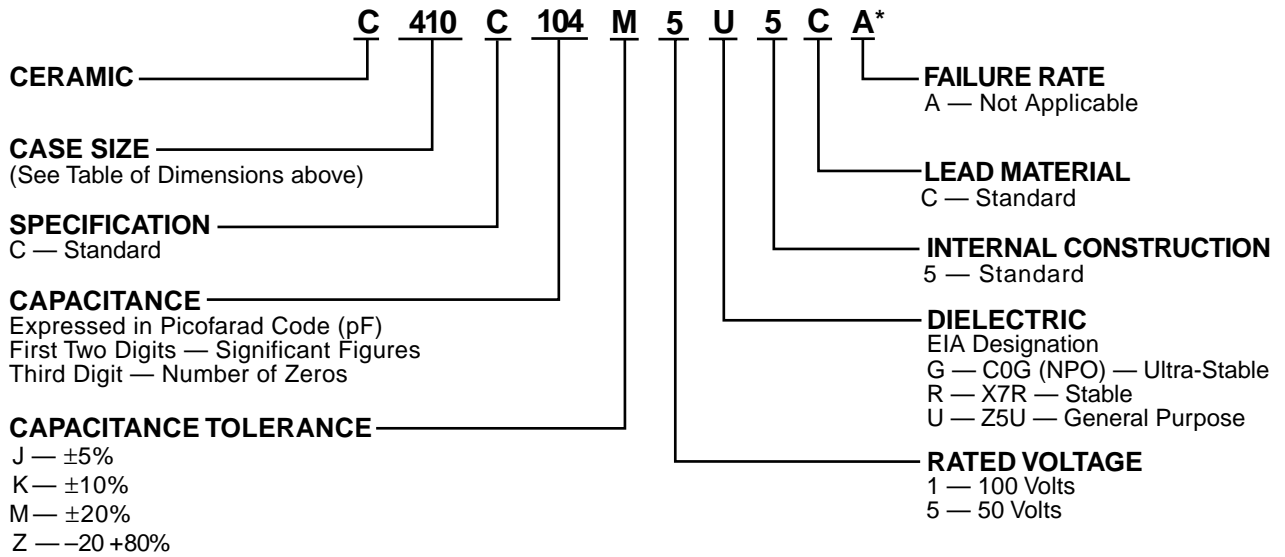
CAPACITANCE OUTLINE DRAWING



MAXIMUM DIMENSIONS—INCHES & (MILLIMETERS)

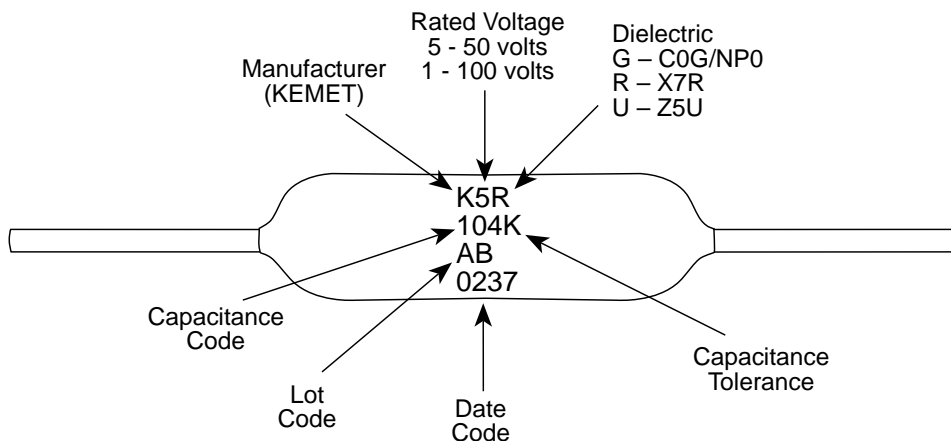
STYLE	L MAX	D MAX	LD +.001, -.003 (+.025, -.076)	LL MIN
C410	.170 (4.32)	.100 (2.54)	.020 (.51)	1.0 (25.4)
C412	.170 (4.32)	.120 (3.05)	.020 (.51)	1.0 (25.4)
C420	.260 (6.60)	.100 (2.54)	.020 (.51)	1.0 (25.4)
C430	.290 (7.37)	.150 (3.81)	.020 (.51)	1.0 (25.4)
C440	.400 (10.16)	.150 (3.81)	.020 (.51)	1.0 (25.4)

ORDERING INFORMATION



\*Part Number Example: C410C104M5U5CA (14 digits – no spaces)

MARKING INFORMATION



RATINGS & PART NUMBER REFERENCE

ULTRA-STABLE TEMPERATURE CHARACTERISTIC—C0G/NPO

CAPACITANCE pF	KEMET PART NUMBER
<b>100 VOLT - C0G</b>	
10	C410C100(1)1G5CA
12	C410C120(1)1G5CA
15	C410C150(1)1G5CA
18	C410C180(1)1G5CA
22	C410C220(1)1G5CA
27	C410C270(1)1G5CA
33	C410C330(1)1G5CA
39	C410C390(1)1G5CA
47	C410C470(1)1G5CA
56	C410C560(1)1G5CA
68	C410C680(1)1G5CA
82	C410C820(1)1G5CA
100	C410C101(1)1G5CA
120	C410C121(1)1G5CA
150	C410C151(1)1G5CA
180	C410C181(1)1G5CA
220	C410C221(1)1G5CA
270	C410C271(1)1G5CA
330	C410C331(1)1G5CA
390	C410C391(1)1G5CA
470	C410C471(1)1G5CA
560	C410C561(1)1G5CA
680	C410C681(1)1G5CA
820	C410C821(1)1G5CA
1,000	C410C102(1)1G5CA
1,200	C420C122(1)1G5CA
1,500	C420C152(1)1G5CA
1,800	C420C182(1)1G5CA
2,200	C420C222(1)1G5CA
2,700	C430C272(1)1G5CA
3,300	C430C332(1)1G5CA
3,900	C430C392(1)1G5CA
4,700	C430C472(1)1G5CA
5,600	C430C562(1)1G5CA
6,800	C430C682(1)1G5CA
8,200	C430C822(1)1G5CA
10,000	C440C103(1)1G5CA
12,000	C440C123(1)1G5CA
15,000	C440C153(1)1G5CA
<b>50 VOLT - C0G</b>	
560	C410C561(1)5G5CA
680	C410C681(1)5G5CA
820	C410C821(1)5G5CA
1,000	C410C102(1)5G5CA
1,200	C412C122(1)5G5CA
1,500	C412C152(1)5G5CA
1,800	C412C182(1)5G5CA
2,200	C412C222(1)5G5CA
2,700	C412C272(1)5G5CA
1,200	C420C122(1)5G5CA
1,500	C420C152(1)5G5CA
1,800	C420C182(1)5G5CA
2,200	C420C222(1)5G5CA
2,700	C430C272(1)5G5CA
3,300	C430C332(1)5G5CA
3,900	C430C392(1)5G5CA
4,700	C430C472(1)5G5CA
5,600	C430C562(1)5G5CA
6,800	C430C682(1)5G5CA
8,200	C430C822(1)5G5CA
10,000	C440C103(1)5G5CA
12,000	C440C123(1)5G5CA
15,000	C440C153(1)5G5CA

(1) Insert proper letter for capacitance tolerance desired:  
 J = ±5%  
 K = ±10%  
 M = ±20%

SINGLE TEMPERATURE CHARACTERISTIC—X7R

CAPACITANCE pF	KEMET PART NUMBER
<b>100 VOLT - X7R</b>	
470	C410C471(1)1R5CA
560	C410C561(1)1R5CA
680	C410C681(1)1R5CA
820	C410C821(1)1R5CA
1,000	C410C102(1)1R5CA
1,200	C410C122(1)1R5CA
1,500	C410C152(1)1R5CA
1,800	C410C182(1)1R5CA
2,200	C410C222(1)1R5CA
2,700	C410C272(1)1R5CA
3,300	C410C332(1)1R5CA
3,900	C410C392(1)1R5CA
4,700	C410C472(1)1R5CA
5,600	C410C562(1)1R5CA
6,800	C410C682(1)1R5CA
8,200	C410C822(1)1R5CA
10,000	C410C103(1)1R5CA
12,000	C410C123(1)1R5CA
15,000	C412C153(1)1R5CA
18,000	C412C183(1)1R5CA
22,000	C412C223(1)1R5CA
27,000	C412C273(1)1R5CA
15,000	C420C153(1)1R5CA
18,000	C420C183(1)1R5CA
22,000	C420C223(1)1R5CA
27,000	C420C273(1)1R5CA
39,000	C430C393(1)1R5CA
47,000	C430C473(1)1R5CA
56,000	C430C563(1)1R5CA
68,000	C430C683(1)1R5CA
82,000	C430C823(1)1R5CA
100,000	C430C104(1)1R5CA
120,000	C440C124(1)1R5CA
150,000	C440C154(1)1R5CA
<b>50 VOLT - X7R</b>	
8,200	C410C822(1)5R5CA
10,000	C410C103(1)5R5CA
12,000	C410C123(1)5R5CA
15,000	C410C153(1)5R5CA
18,000	C410C183(1)5R5CA
22,000	C410C223(1)5R5CA
27,000	C410C273(1)5R5CA
33,000	C410C333(1)5R5CA
39,000	C410C393(1)5R5CA
47,000	C410C473(1)5R5CA
56,000	C412C563(1)5R5CA
68,000	C412C683(1)5R5CA
82,000	C412C823(1)5R5CA
100,000	C412C104(1)5R5CA
56,000	C420C563(1)5R5CA
68,000	C420C683(1)5R5CA
82,000	C420C823(1)5R5CA
100,000	C420C104(1)5R5CA
120,000	C430C124(1)5R5CA
150,000	C430C154(1)5R5CA
180,000	C430C184(1)5R5CA
220,000	C430C224(1)5R5CA
270,000	C430C274(1)5R5CA
330,000	C440C334(1)5R5CA
390,000	C440C394(1)5R5CA
470,000	C440C474(1)5R5CA

(1) Insert proper letter for capacitance tolerance desired:  
 K = ±10%, M = ±20%

GENERAL PURPOSE TEMPERATURE CHARACTERISTIC—Z5U

CAPACITANCE pF	KEMET PART NUMBER
<b>100 VOLT - Z5U</b>	
10,000	C410C103(1)1U5CA
12,000	C410C123(1)1U5CA
15,000	C410C153(1)1U5CA
18,000	C410C183(1)1U5CA
22,000	C410C223(1)1U5CA
27,000	C420C273(1)1U5CA
33,000	C420C333(1)1U5CA
39,000	C420C393(1)1U5CA
47,000	C420C473(1)1U5CA
56,000	C430C563(1)1U5CA
68,000	C430C683(1)1U5CA
82,000	C430C823(1)1U5CA
100,000	C430C104(1)1U5CA
120,000	C430C124(1)1U5CA
150,000	C430C154(1)1U5CA
180,000	C440C184(1)1U5CA
220,000	C440C224(1)1U5CA
<b>50 VOLT - Z5U</b>	
27,000	C410C273(1)5U5CA
33,000	C410C333(1)5U5CA
39,000	C410C393(1)5U5CA
47,000	C410C473(1)5U5CA
56,000	C410C563(1)5U5CA
68,000	C410C683(1)5U5CA
82,000	C410C823(1)5U5CA
100,000	C410C104(1)5U5CA
120,000	C410C124(1)5U5CA
150,000	C410C154(1)5U5CA
180,000	C410C184(1)5U5CA
220,000	C410C224(1)5U5CA
270,000	C412C274(1)5U5CA
330,000	C412C334(1)5U5CA
270,000	C420C274(1)5U5CA
330,000	C420C334(1)5U5CA
390,000	C430C394(1)5U5CA
470,000	C430C474(1)5U5CA
560,000	C430C564(1)5U5CA
680,000	C430C684(1)5U5CA
820,000	C440C824(1)5U5CA
1,000,000	C440C105(1)5U5CA

(1) Insert proper letter for capacitance tolerance desired:  
 M = ±20%, Z = +80, -20%

**NOTE:** Certain NPO and X7R dielectric capacitance values are available upon request in 200 volts. Contact your local KEMET sales representative for exact values, price and delivery.

For packaging information, see pages 32 and 34.

**Ceramic Axial**  
Lead Tape and Reel Packaging

KEMET offers standard reeling of Molded and Conformally Coated Axial Leaded Ceramic Capacitors for automatic insertion or lead forming machines per EIA specification RS-296. KEMET'S internal specification four-digit suffix, 7200, is placed at the end of the part number to designate tape and reel packaging, ie: C410C104Z5U5CA7200.

Paper (50 lb.) test minimum is inserted between the layers of capacitors wound on reels for component pitch  $\leq 0.400"$ . Capacitor lead length may extend only a maximum of  $.0625"$  (1.59mm) beyond the tapes' edges. Capacitors are centered in a row between the two tapes and will deviate only  $\pm 0.031$  (0.79mm) from the row center. A minimum of  $36"$  (91.5 cm) leader tape is provided at each end of the reel capacitors. Universal splicing clips are used to connect the tape. Standard reel quantities are shown on page 34.

Figure 1

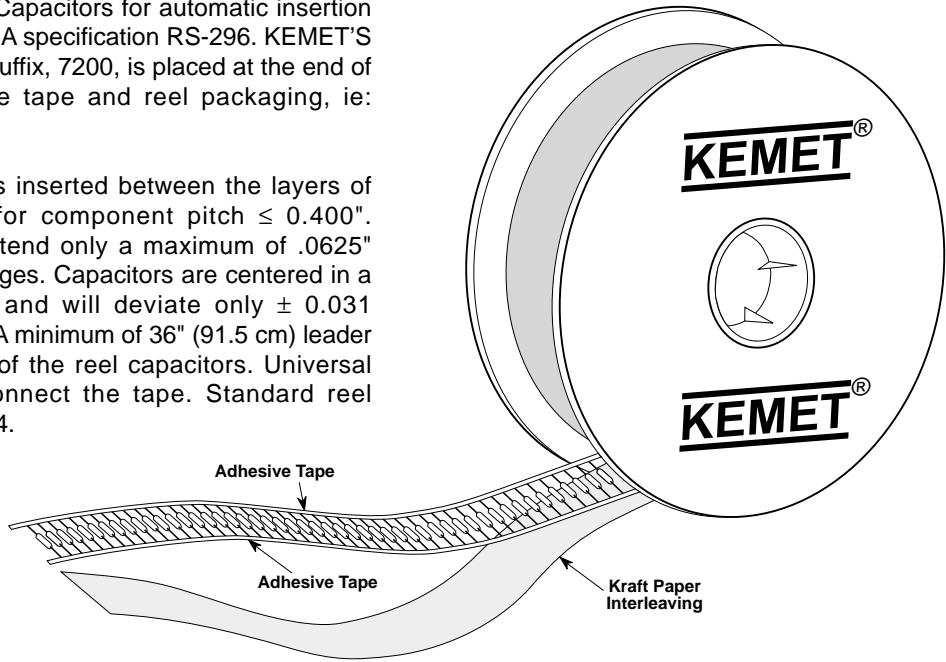


Figure 2

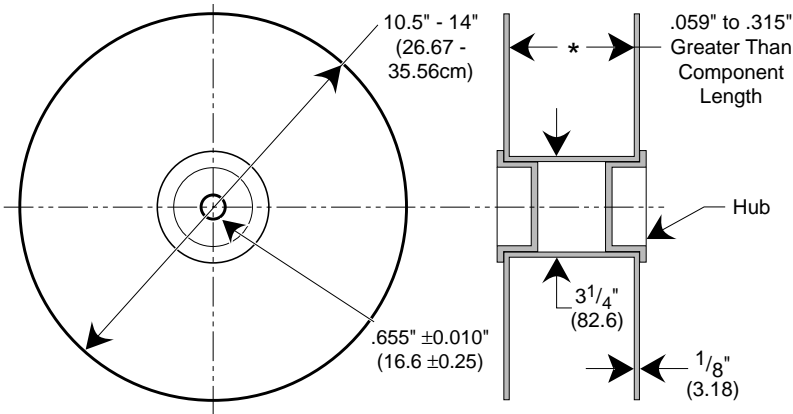


Figure 3

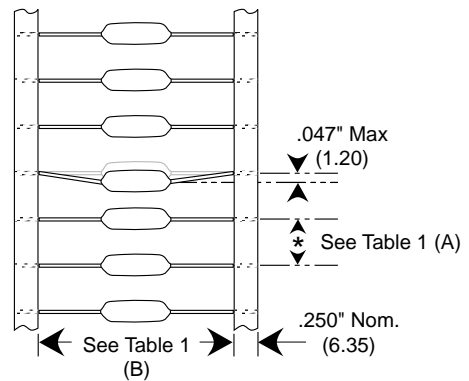


Table 1 Dimensions in Inches & (Millimeters)

Component Body Diameter	Component Pitch "A"	Inside Tape Spacing "B" $\pm 1.5\text{mm}$ (0.059")	
	0.020" or ( $\pm 0.5\text{mm}$ )	I	III*
0" (0mm) to 0.197" (5mm)	0.197" or (5mm)	2.062" (52.4mm)	
0.197" (5.01mm) to 0.394" (10mm)	0.394" or (10mm)		2.874" (73mm)

\* Not Available for Conformally Coated Parts.

CERAMIC PACKAGING					
KEMET Number	Military Style	Military Specification	Standard (1) Bulk Quantity	Standard Reel Quantity	Reel Size
C114C-K-G	CK12, CC75	MIL-C-11015/	200/Box	5000	12"
C124C-K-G	CK13, CC76	MIL-PRF-20	200/Box	5000	12"
C192C-K-G	CK14, CC77		100/Box	3000	12"
C202C-K	CK15		25/Box	500	12"
C222C-K	CK16		10/Tray	300	12"
C052C-K-G	CK05, CC05		100/Bag	2000	12"
C062C-K-G	CK06, CC06		100/Bag	1500	12"
C114G	CCR75	MIL-PRF-20	200/Box	5000	12"
C124G	CCR76		200/Box	5000	12"
C192G	CCR77		100/Box	3000	12"
C202G	CC78-CCR78		25/Box	500	12"
C222G	CC79-CCR79		10/Tray	300	12"
C052/56G	CCR05		100/Bag	1700	12"
C062/66G	CCR06		100/Bag	1500	12"
C512G	CC07-CCR07		Footnote (2)	N/A	N/A
C522G	CC08-CCR08		Footnote (2)	N/A	N/A
C114T	CKR11	MIL-PRF-39014	200/Box	5000	12"
C124T	CKR12		200/Box	5000	12"
C192T	CKR14		100/Box	3000	12"
C202T	CKR15		25/Box	500	12"
C222T	CKR16		10/Tray	300	12"
C052/56T	CKR05		100/Bag	1700	12"
C062/66T	CKR06		100/Bag	1500	12"
C31X			500/Bag	2500	12"
C32X			500/Bag	2500	12"
C33X			250/Bag	1500	12"
C340			100/Bag	1000	12"
C350			50/Bag	N/A	N/A
C410			300/Box	5000	12"
C412			200/Box	5000	12"
C420			300/Box	5000	12"
C430			200/Box	2500	12"
C440			200/Box	2500	12"
C512	N/A	N/A	Footnote (2)	N/A	N/A
C522	N/A	N/A	Footnote (2)	N/A	N/A

NOTE: (1) Standard packaging refers to number of pieces per bag, box, tray or vial.

(2) Quantity varies. For further details, please consult the factory.