Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

C0G with KONNEKT™ Technology, 50 – 3,000 VDC (Commercial & Automotive Grade)

KEMET a YAGEO company

RoHS Lead-free REACH COMPLIANT

KONNEKT™ High Density Packaging

Overview

KEMET's C0G with KONNEKT™ technology surface mount capacitors are designed for high-efficiency and high-density power applications. KONNEKT high density packaging technology uses an innovative Transient Liquid Phase Sintering (TLPS) material to create a surface mount multi-chip solution for high density packaging. By utilizing KEMET's robust and proprietary C0G base metal electrode (BME) dielectric system, these capacitors are well suited for power converters, inverters, snubbers, and resonators where high efficiency is a primary concern.

With an operating temperature range up to 125°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications, which require minimal cooling. C0G with KONNEKT technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of metal frames.

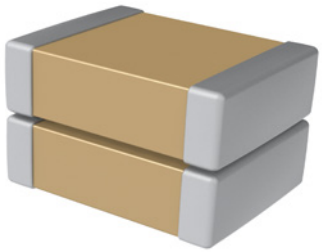
C0G with KONNEKT series compliments the KC-LINK with KONNEKT series by offering a wider voltage range and operating temperature range up to 125°C

Benefits

- Extremely high-power density and ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Capacitance offerings ranging from 0.78 nF – 940 nF
- DC voltage ratings from 50 – 3,000 V
- EIA sizes 1812 and 2220
- Operating temperature range of −55°C to +125°C
- No capacitance shift with voltage
- No piezoelectric noise
- High thermal stability
- Surface mountable using standard MLCC reflow profiles

Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- EV/HEV (drive systems, charging)
- LLC resonant converters
- Switched tank converters
- Wireless charging systems
- Photovoltaic systems
- Power converters
- Inverters
- DC link
- Snubber

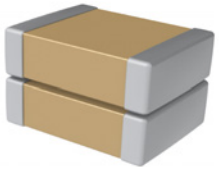
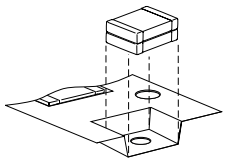
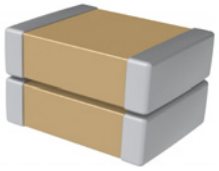
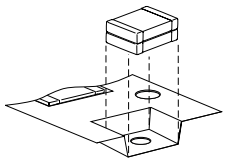


Ordering Information

C	1812	C	943	K	C	G	L	C	XXXX
Ceramic	Case Size (L"x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (V)	Dielectric	Subclass Designation	Termination Finish	Orientation and Packaging (Suffix/C-Spec)
C	1812 2220	C = Standard	Two single digits + number of zeros.	K = ±10%	5 = 50 V 1 = 100 V 2 = 200 V A = 250 V C = 500 V B = 630 V D = 1,000 V F = 1,500 V G = 2,000 V Z = 2,500 V H = 3,000 V	G = C0G	L = KONNEKT	C = 100% matte Sn	See "Packaging and Orientation C-Spec Ordering Options Table"

Additional termination finish options may be available. Contact KEMET for details.

Orientation and Packaging (Suffix/C-Spec) Options Table

Mounting Orientation[1]	Tape and Reel Illustration	Packaging Type	Packaging/Grade Ordering Code (C-Spec)
Commercial Grade			
Standard 		7" Reel/Unmarked	TU
		13" Reel/Unmarked	7210
Automotive Grade			
Standard 		7" Reel/Unmarked	AUTO
		13" Reel/Unmarked	AUTO7210

1 Orientation refers to the positioning of the KONNEKT capacitors in the Tape and Reel pockets. This allows pick and place machines to place capacitors on the PCB in the correct orientation.

Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC–Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

KEMET Automotive C-Spec	Customer Notification Due To:		Days Prior To Implementation
	Process/Product change	Obsolescence*	
KEMET assigned[1]	Yes (with approval and sign off)	Yes	180 days minimum
AUTO	Yes (without approval)	Yes	90 days minimum

[1] *KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.*

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

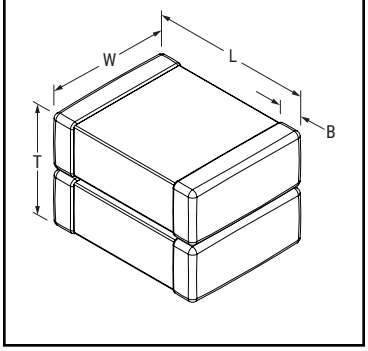
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

[1] *KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.*

● Part number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

Standard Mounting 2 Chips



EIA SIZE CODE	METRIC SIZE CODE	Number of Chips	Mounting	L LENGTH	W WIDTH	T THICKNESS	B BANDWIDTH	Mounting Technique	Typical Average Piece Weight (g)
1812	4532	2	Standard	4.50 (0.177) ±0.30 (0.012)	3.20 (0.126) ±0.30 (0.012)	See Table 1A and 1B for Thickness	0.60 (0.024) ±0.35 (0.014)	Solder Reflow Only	See Table 1A and 1B for Weights
2220	5750	2	Standard	5.70 (0.224) ±0.40 (0.016)	5.00 (0.197) ±0.40 (0.016				

Table 1A - 1812 Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C1812(a)444(b)5GLC(c)	440 nF	444	50 V	2	3.3 (0.130) ±0.4 (0.016)	0.19	500	2,000
C1812(a)304(b)1GLC(c)	300 nF	304	100 V		3.5 (0.138) ±0.4 (0.016)	0.19	500	2,000
C1812(a)204(b)2GLC(c)	200 nF	204	200 V		4.1 (0.161) ±0.4 (0.016)	0.24	275	1,050
C1812(a)204(b)AGLC(c)	200 nF	204	250 V		4.1 (0.161) ±0.4 (0.016)	0.24	275	1,050
C1812(a)943(b)CGLC(c)	94 nF	943	500 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)943(b)BGLC(c)	94 nF	943	630 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)303(b)DGLC(c)	30 nF	303	1,000 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)542(b)FGLC(c)	5.4 nF	542	1,500 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)302(b)GGLC(c)	3 nF	302	2,000 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)142(b)ZGLC(c)	1.4 nF	142	2,500 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850
C1812(a)781b)HGLC(c)	0.78 nF	781	3,000 V		5.1 (0.200) ±0.4 (0.016)	0.30	200	850

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade.
For each numbered position, available options are as follows:
(a) End Termination "C".
(b) Capacitance tolerance character "K".
(c) C-Spec for Product Grade, Reeling and Mounting Orientation.

Table 1B - 2220 Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C2220(a)944(b)5GLC(c)	940 nF	944	50 V	2	3.5 (0.138) ±0.4 (0.016)	0.45	475	1825
C2220(a)664(b)1GLC(c)	660 nF	664	100 V		3.5 (0.138) ±0.4 (0.016)	0.45	475	1825
C2220(a)444(b)2GLC(c)	440 nF	444	200 V		4.1 (0.161) ±0.4 (0.016)	0.45	225	950
C2220(a)204(b)CGLC(c)	200 nF	204	500 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)204(b)BGLC(c)	200 nF	204	630 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)663(b)DGLC(c)	66 nF	663	1,000 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)143(b)FGLC(c)	14 nF	143	1,500 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)782(b)GGLC(c)	7.8 nF	782	2,000 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)362(b)ZGLC(c)	3.6 nF	362	2,500 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250
C2220(a)202(b)HGLC(c)	2 nF	202	3,000 V		5.1 (0.200) ±0.4 (0.016)	0.65	300	1,250

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:
(a) End Termination "C".
(b) Capacitance tolerance character "K".
(c) C-Spec for Product Grade, Reeling and Mounting Orientation.

Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only)

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} of capacitance

Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms}</td><td>Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>For < 500 VDC:
Rated voltage applied for 120 ±5 seconds at 25°C

For ≥ 500 VDC:
500 V applied for 120 ±5 seconds at 25°C</td><td>Within Specification

To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

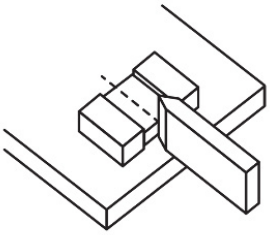
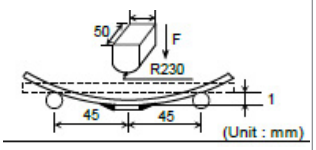
1,000 MΩ-µF or 100 GΩ</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Frequency: 1 kHz ±50 Hz
Capacitance change with reference to +25°C and 0 VDC applied

* See part number specification sheet for voltage

<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C
(Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>±30 PPM/°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td><table><tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr><tr><td>< 500</td><td>250%</td></tr><tr><td>500</td><td>150%</td></tr><tr><td>630</td><td>130%</td></tr><tr><td>≥ 1,000</td><td>120%</td></tr></table>
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>1812</td><td rowspan="2">18N</td></tr><tr><td>2220</td></tr></table>  </td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 3.0 mm
Test time: 60± 5 seconds
Ramp time: 1 mm/second
  </td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Magnification 10X. Conditions:
Category 2 (Dry Bake 155°C/4 hours ±15 minutes)
a) Method B, 245°C, SnPb
b) Method B1 at 245°C, Pb-Free
c) Method D, at 260°C, SnPb or Pb-Free</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>Load Humidity:
1,000 hours 85°C/85% RH and 200 VDC. Add 100 KΩ resistor.

Low Volt Humidity:
1,000 hours 85°C/85% RH and 1.5 V. Add 100 KΩ resistor.</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Within Post Environmental Limits
Cap: ±0.3% or ±0.25 pF shift
IR: 10% of Initial Limit
DF Limits Maximum: 0.5%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202 Method 106</td><td>Number of cycles required 10, 24 hours per cycle.
Steps 7a and 7b not required.</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Within Post Environmental Limits
Cap: ±0.3% or ±0.25 pF shift
IR: 10% of Initial Limit
DF Limits Maximum: 0.5%</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

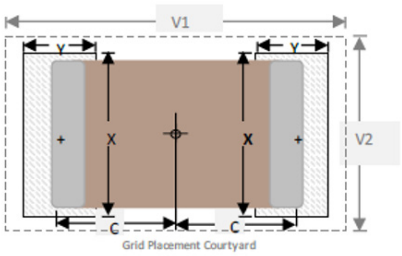
Test	Reference	Test Condition	Limits
Thermal Shock	MIL-STD-202 Method 107	Number of cycles required 5, (−55°C to 125°C) Dwell time 15 minutes.	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.0 X rated voltage applied	Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 125°C, Unpowered	
Vibration	MIL-STD-202 Method 204	5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
Mechanical Shock	MIL-STD-202 Method 213	1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F)	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
Resistance to Solvents	MIL-STD-202 Method 215	Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents.	Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Table 3 – KONNEKT Land Pattern Design Recommendations per IPC-7351 (mm)

Chip Number	Mounting	EIA SIZE CODE	METRIC SIZE CODE	Median (Nominal) Land Protrusion				
				C	Y	X	V1	V2
2	Standard	1812	4532	2.05	1.40	3.50	6.00	4.00
2	Standard	2220	5750	2.65	1.50	5.40	7.30	5.90



Storage & 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°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 upon receipt.

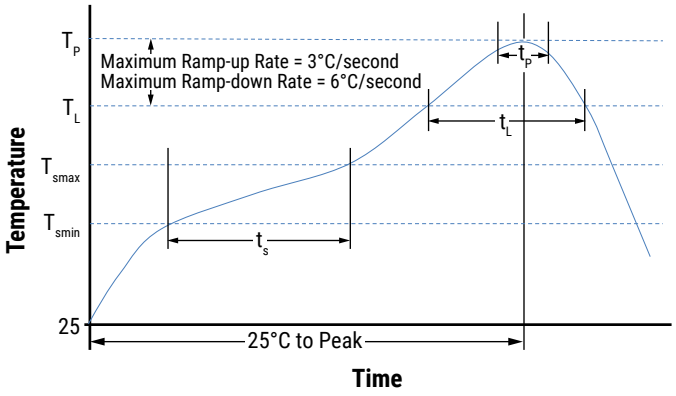
Soldering Process

Recommended Reflow Soldering Profile

KEMET's KONNEKT family of high density surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

Profile Feature	Termination Finish
	100% matte Sn
Preheat/Soak	
Temperature Minimum (T_{Smin})	150°C
Temperature Maximum (T_{Smax})	200°C
Time (t_S) from T_{Smin} to T_{Smax}	60 – 120 seconds
Ramp-Up Rate (T_L to T_P)	3°C/second maximum
Liquidous Temperature (T_L)	217°C
Time Above Liquidous (t_L)	60 – 150 seconds
Peak Temperature (T_P)	260°C
Time Within 5°C of Maximum Peak Temperature (t_P)	30 seconds maximum
Ramp-Down Rate (T_P to T_L)	6°C/second maximum
Time 25°C to Peak Temperature	8 minutes maximum

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



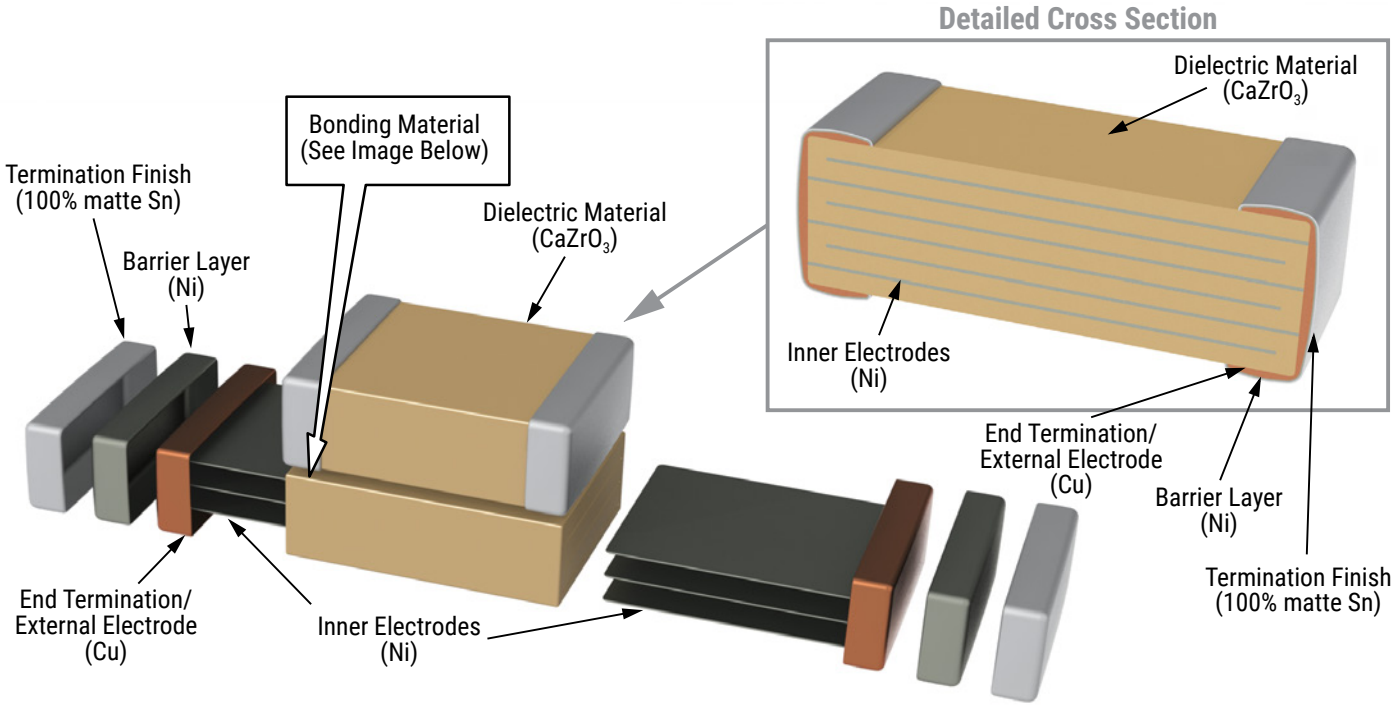
Hand Soldering and Removal of KONNEKT Capacitors

The preferred method of attachment for KEMET's KONNEKT Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

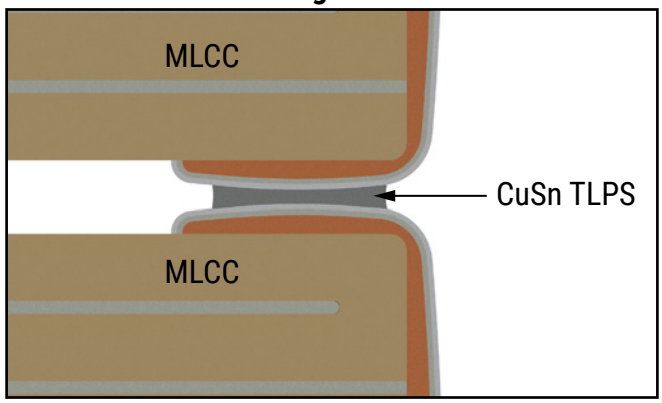
However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.

Please see KEMET's KONNEKT Soldering Guidelines here.

Construction – Standard Termination



Bonding Material



Tape & Reel Packaging Information

KEMET offers X7R with KONNEKT technology capacitors packaged in 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.

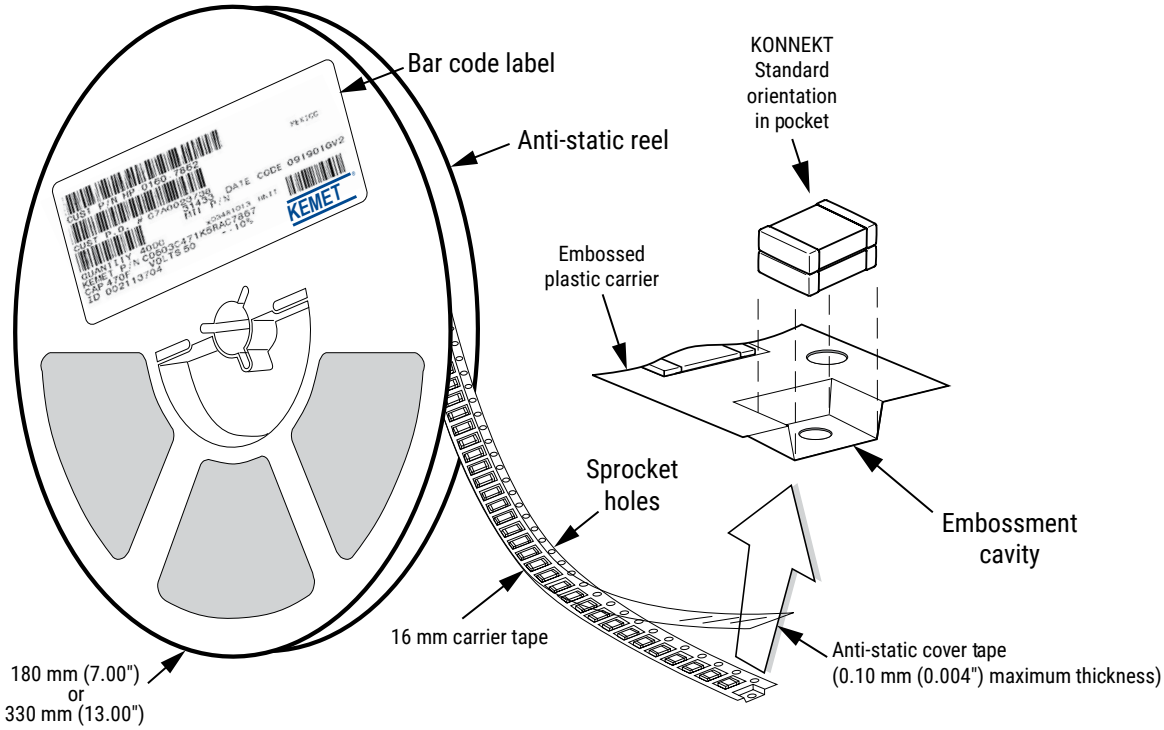


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Number of Chips	Chip Thickness	Tape Size (W)[1]	Embossed Plastic	
				7" Reel	13" Reel
				Pitch (P_1)[2]	
KONNEKT 1812	2	≤ 3.5 mm	16	8	8
		> 3.5 mm		12	12
KONNEKT 2220	2	≤ 3.5 mm >5.0 mm & ≤ 5.3 mm	16	8	8
		> 3.5 mm ≤ 5.0		12	12

1. Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations.
2. Refer to Tables 4 and 5 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

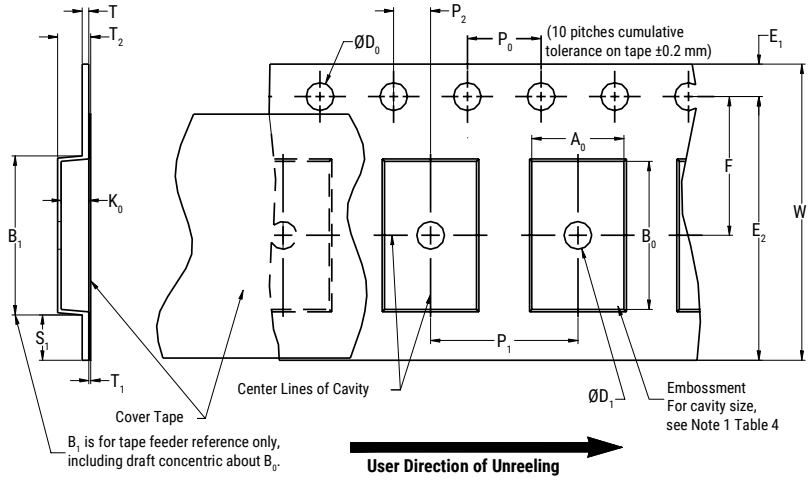


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D_0	D_1 Minimum Note 1	E_1	P_0	P_2	R Reference Note 2	S_1 Minimum Note 3	T Maximum	T_1 Maximum
16 mm	1.5 +0.10/−0.0 (0.059 +0.004/−0.0)	1.5 (0.059)	1.75±0.10 (0.069±0.004)	4.0±0.10 (0.157±0.004)	2.0±0.05 (0.079±0.002)	30 (1.181)	0.600 (0.024)	0.600 (0.024)	0.100 (0.004)

Variable Dimensions — Millimeters (Inches)										
Case Size	Number of Chips	Tape Size	Pitch	B_1 Maximum Note 4	E_2 Minimum	F	P_1	T_2 Maximum	W Maximum	A_0,B_0 & K_0
1812	2	16 mm	Triple (12mm)	7.9 (0.311)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	7.5 (0.295)			8.0±0.10 (0.315±0.004)			
2220	2	16 mm	Triple (12mm)	8.5 (0.335)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	9.2 (0.363)			8.0±0.10 (0.315±0.004)			

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
2. The tape with or without components shall pass around R without damage (see Figure 6).
3. If S_1 < 1.0 mm, there may not be enough area for cover tape to be properly applied. See EIA Document 481, Paragraph 4.3 (b).
4. B_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 shall surround the component with sufficient clearance that:
(a) the component does not protrude above the top 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 for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).
(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).
(e) For KPS product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.
(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.

Packaging Information Performance Notes

1. Cover Tape Break Force: 1.0 kg minimum.
2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

Tape Width	Peel Strength
16 mm	0.1 to 1.3 newton (10 to 130 gf)

Table 6 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	B Minimum	C	D Minimum
16 mm	178±0.20 (7.008±0.008) or 330±0.20 (13.000±0.008)	1.5 (0.059)	13.0 +0.5/−0.2 (0.521 +0.02/−0.008)	20.2 (0.795)
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum See Note 2, Tables 2-3	W_1	W_2 Maximum	W_3
16 mm	50 (1.969)	16.4 +2.0/−0.0 (0.646 +0.078/−0.0)	22.4 (0.882)	Shall accommodate tape width without interference

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