PRELIMINARY

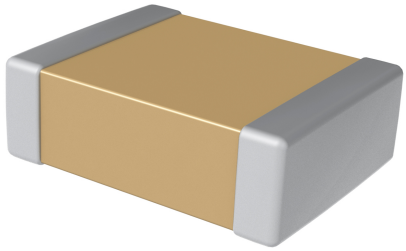
Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

KC-Link for Fast Switching Semiconductor Applications DC-Link, Snubber, Resonator Capacitor (Commercial & Automotive Grade)

Overview

KEMET's KC-Link surface mount capacitors are designed to meet the growing demand for fast switching semiconductors that operate at higher voltages, temperatures, and frequencies. By utilizing KEMET's robust and proprietary C0G/NPO 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 extremely low effective series resistance (ESR) and very low thermal resistance, KC-Link capacitors can operate at very high ripple currents with no change in capacitance versus DC voltage and negligible change in capacitance versus temperature. With an operating temperature of 150°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications which require minimal cooling. KC-Link C0G dielectric technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of lead frames. This provides extremely low effective series inductance (ESL) increasing the operating frequency range allowing for further miniaturization.

In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC–Q200 qualification requirements.



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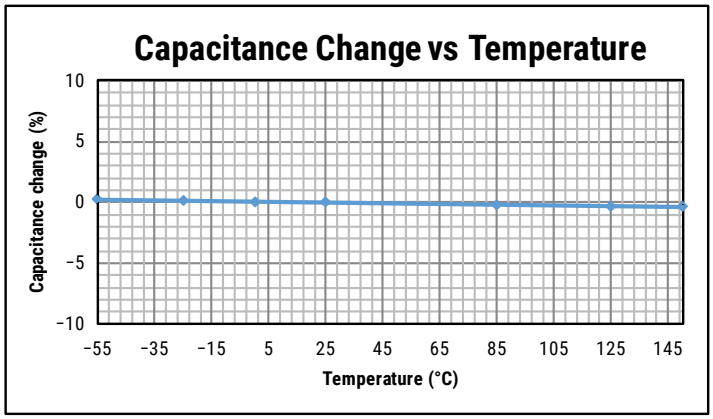
Benefits

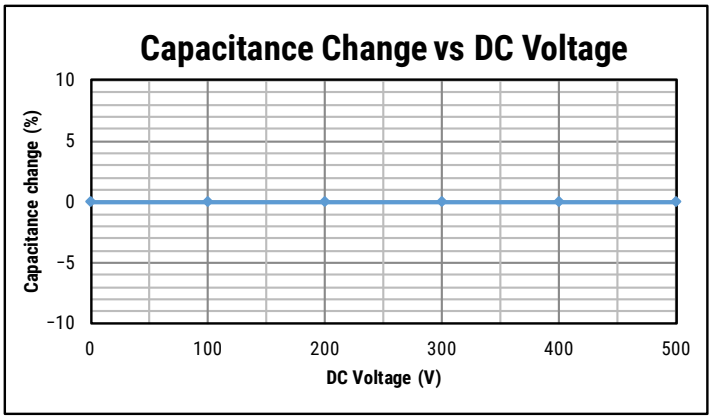
- Very high ripple current capability
- Extremely low Effective Series Resistance (ESR)
- Extremely low Effective Series Inductance (ESL)
- Operating temperature range of −55°C to +150°C
- High frequency operation (>10 MHz)
- No capacitance shift with voltage
- No piezoelectric noise
- High thermal stability
- RoHS Pb-free

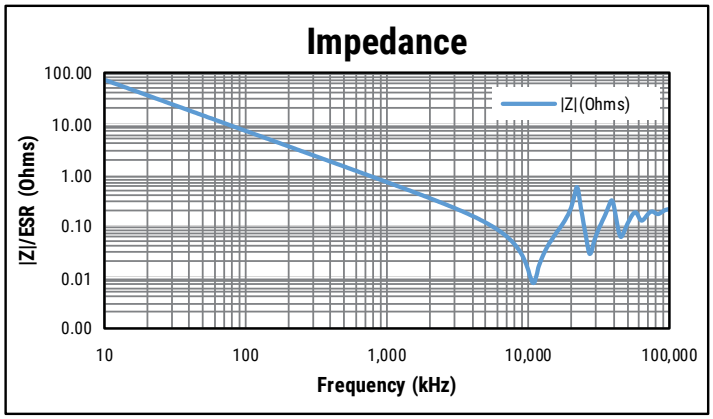
Applications

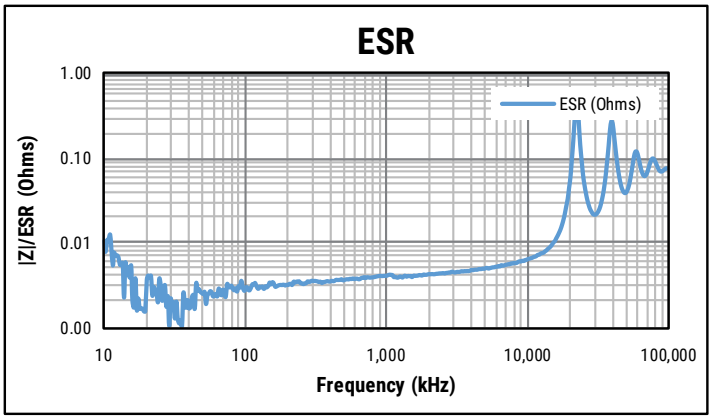
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Hybrid electrical vehicles (drive systems, charging)
- Photovoltaic systems
- Power conversion
- Inverters
- DC link
- LLC resonators
- Snubber

Typical Performance - 3640, 220 nF, 500 V









				Typical Ripple Current (A_{rms}) [1]		
Frequency	**Typical ESR at 25°C**	**Typical ESL at 25°C**	**Rth[2]**	**T_A=85°C**	**T_A=105°C**	**T_A=125°C**
50 kHz	< 4.0 mΩ	1 nH	15°C/W	24.4	20.6	15.4
100 kHz				23.2	19.3	14.4
200 kHz				21.6	17.9	13.4
300 kHz				20.7	17.2	12.8

1 T_A = Ambient temperature during ripple current measurements. Ripple current measurements performed at 0 VDC bias with a peak capacitor temperature of 150°C. Samples mounted to heat sink with no forced air cooling.
2 Rth = Thermal resistance of KC-Link 3640 224nF 500 V capacitor.

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating temperature range	−55°C to +150°C
Capacitance change with reference to +25°C and 0 VDC applied (TCC)	±30 PPM/°C
Aging rate (maximum % capacitance loss/decade hour)	0%
[1]Dielectric Withstanding Voltage (DWV)	800 VDC
[2]Dissipation Factor (DF) Maximum Limit at 25°C	0.15%
[3]Insulation Resistance (IR) Minimum Limit at 25°C	1,000 - MΩ - µF or 100 GΩ (500 VDC applied for 120 ±5 seconds at 25°C)

1 DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

2 Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance ≤ 1,000 pF

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance > 1,000 pF

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

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Ordering Information

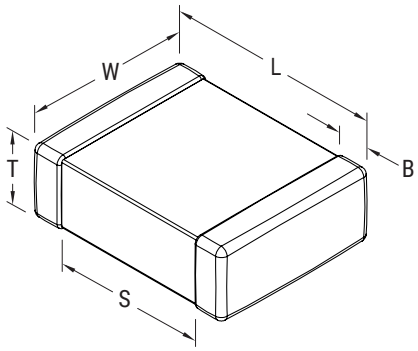
CKC	33	C	224	K	C	G	A	C	TU
Series	Case Size (L"x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (V)	Dielectric	Subclass Designation	Termination Finish	Packaging (Suffix/C-Spec)
CKC = KC-LINK	33 = 3640	C = Standard	Two single digits and number of zeros. Use 9 for 1.0 – 9.9 pF e.g. 2.2 pF = 229	F = ±1% G = ±2% J = ±5% K = ±10%	C = 500 V	G = C0G	A = N/A	C = 100% matte Sn	See "Packaging C-Spec Ordering Options Table" below

Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
Commercial Grade	
7" Reel/Unmarked	TU
13" Reel (Embossed Plastic Tape)/ Unmarked	7210
Automotive Grade[1]	
7" Reel	AUTO
13" Reel (Embossed Plastic Tape)/ Unmarked	AUTO7210

1 For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
3640	9210	9.10 (0.358) ±0.40 (0.016)	10.20 (0.402) ±0.40 (0.016)	2.5 (0.098) ±0.2 (0.008)	1.27 (0.050) ±0.40 (0.016)	N/A	Solder Reflow Only

Environmental Compliance

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

Table 1 – Product Ordering Codes & Ratings

Capacitance	Capacitance Code	Case Size				3640
		Voltage Code				C
		Rated Voltage (VDC)				500
		Capacitance Tolerance				
220 nF	224	F	G	J	K	•

Table 2 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test or Inspection Method
Terminal Strength	JIS-C-6429	Appendix 1, Note: Force of 1.8kg for 60 seconds.
Board Flex	JIS-C-6429	Appendix 2, Note: 3.0 mm (minimum).
Solderability	J-STD-002	Magnification 50X. Conditions:
		a) Method B, 4 hours at 155°C, dry heat at 235°C
		b) Method B at 215°C category 3
		c) Method D, category 3 at 260°C
Temperature Cycling	JESD22 Method JA-104	1,000 Cycles (–55°C to +125°C), Measurement at 24 hours ±4 hours after test conclusion.
Biased Humidity	MIL-STD-202 Method 103	Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.
		Low Volt Humidity: 1,000 hours 85C°/85%RH and 1.5V. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.
Moisture Resistance	MIL-STD-202 Method 106	t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion.
Thermal Shock	MIL-STD-202 Method 107	–55°C/+150°C. Note: Number of cycles required - 300, Maximum transfer time - 20 seconds, Dwell time - 15 minutes. Air - Air.
High Temperature Life	MIL-STD-202 Method 108/EIA-198	1,000 hours at 150°C with 1.0 X rated voltage applied.
Storage Life	MIL-STD-202 Method 108	150°C, 0 VDC, for 1,000 Hours.
Vibration	MIL-STD-202 Method 204	5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz
Mechanical Shock	MIL-STD-202 Method 213	Figure 1 of Method 213, Condition F.
Resistance to Solvents	MIL-STD-202 Method 215	Add Aqueous wash chemical, OKEM Clean or equivalent.

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's 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 record 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.*

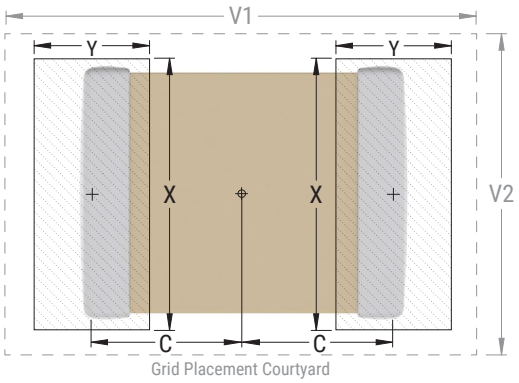
● Part number specific PPAP available
○ Product family PPAP only

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351

EIA Size Code	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)					Density Level B: Median (Nominal) Land Protrusion (mm)					Density Level C: Minimum (Least) Land Protrusion (mm)				
		C	Y	X	V1	V2	C	Y	X	V1	V2	C	Y	X	V1	V2
3640	9210	4.45	1.70	10.70	11.60	11.70	4.35	1.50	10.60	10.70	11.10	4.25	1.30	10.50	10.00	10.80

Density Level A: *For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.*
Density Level B: *For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.*
Density Level C: *For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).*

Image below based on Density Level B for an EIA 1210 case size.

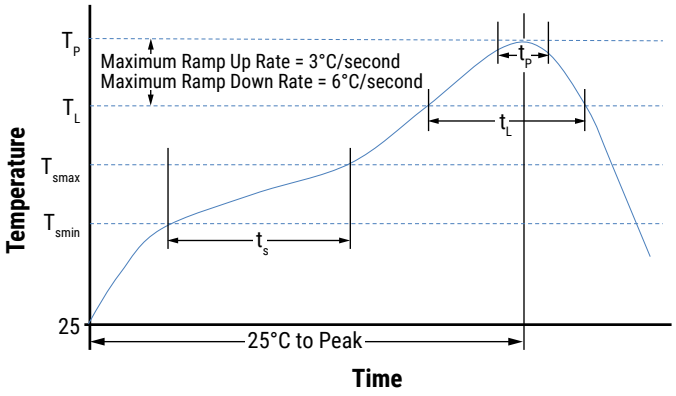


Soldering Process

Recommended Reflow Soldering Profile:
KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase 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

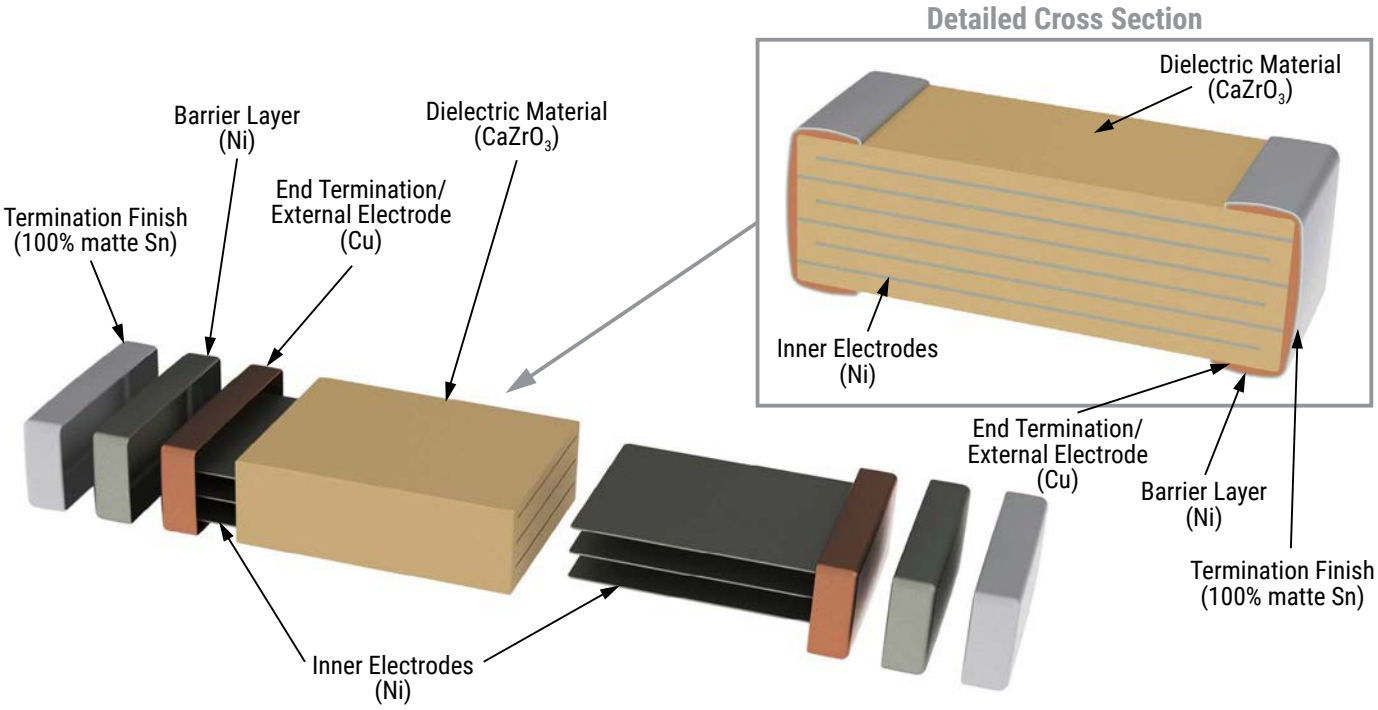
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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.

Construction



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 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. See Table 2 for details on reeling quantities for commercial chips.

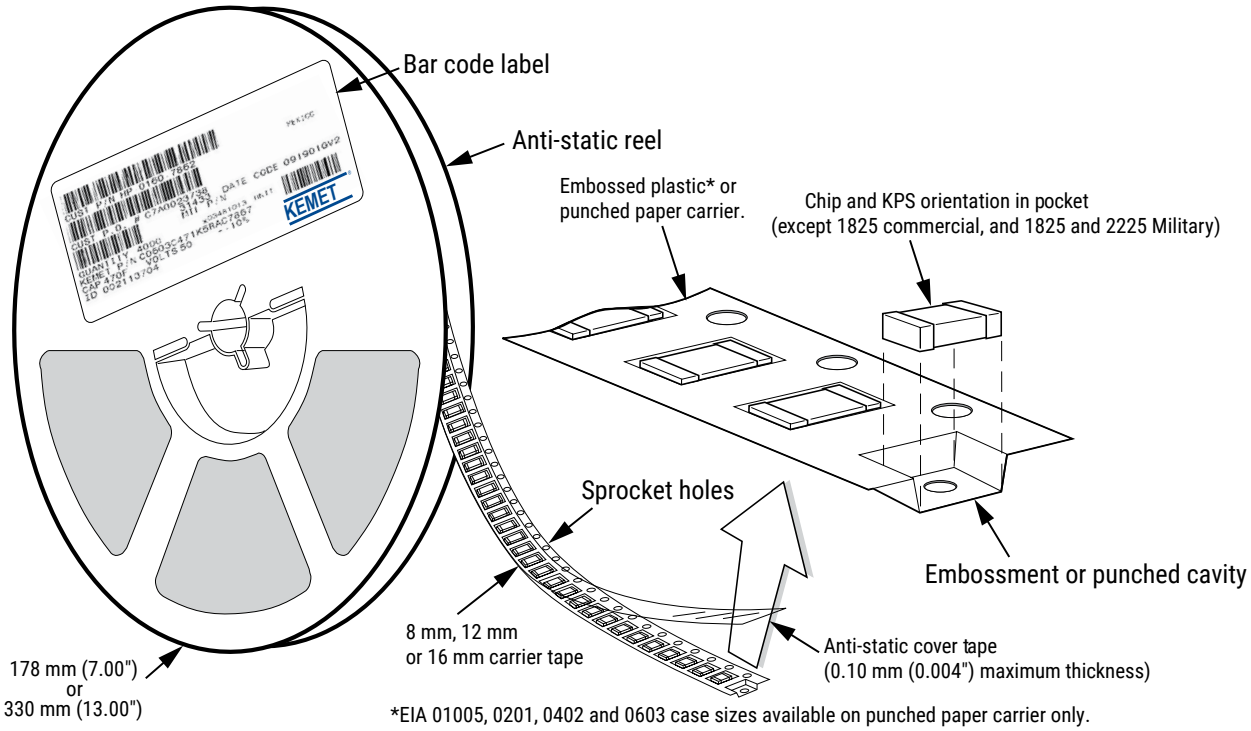


Table 3 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic	
		7" Reel	13" Reel
		Pitch (P_1)*	
3640	24	16	16

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

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

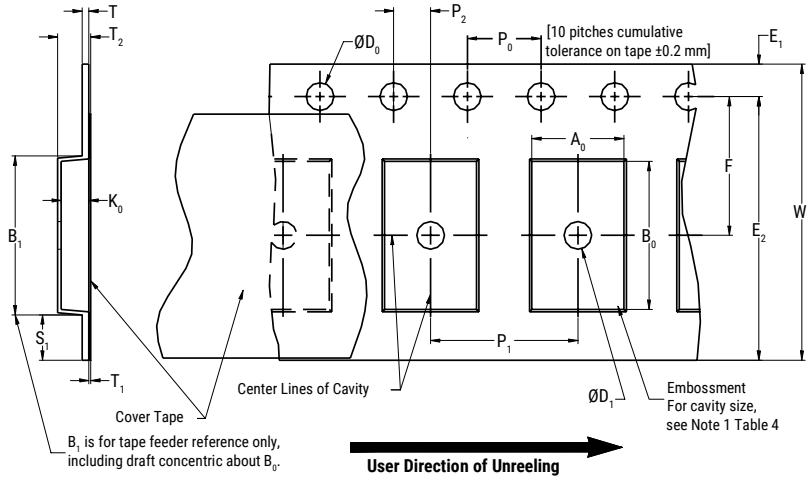


Table 4 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)								
Tape Size	D_0	E_1	P_0	P_2	R Reference Note 2	S_1 Minimum Note 3	T Maximum	T1 Maximum
24 mm	1.5 +0.10/−0.0 (0.059 +0.004/−0.0)	1.75 ±0.10 (0.069 ±0.004)	4.0 ±0.10 (0.157 ±0.004)	2.0 ±0.10 (0.078 ±0.003)	30 (1.181)	5 (0.196)	0.250 (0.009)	0.350 (0.013)
Variable Dimensions — Millimeters (Inches)								
Tape Size	Pitch	E_2 Minimum	F	P_1	T_2 Maximum	W Maximum	A_0, B_0 & K_0	
24 mm	16 mm	22.25 (0.875)	11.5 ±0.10 (0.452 ±0.003)	16.0 ±0.10 (0.629 ±0.004)	3 (0.118)	24.3 (0.956)		

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 S1 < 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. B1 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 Series product, A0 and B0 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
8 mm	0.1 to 1.0 Newton (10 to 100 gf)
12 and 16 mm	0.1 to 1.3 Newton (10 to 130 gf)
24 mm	0.1 to 1.6 Newton (10 to 160 gf)

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.
3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation

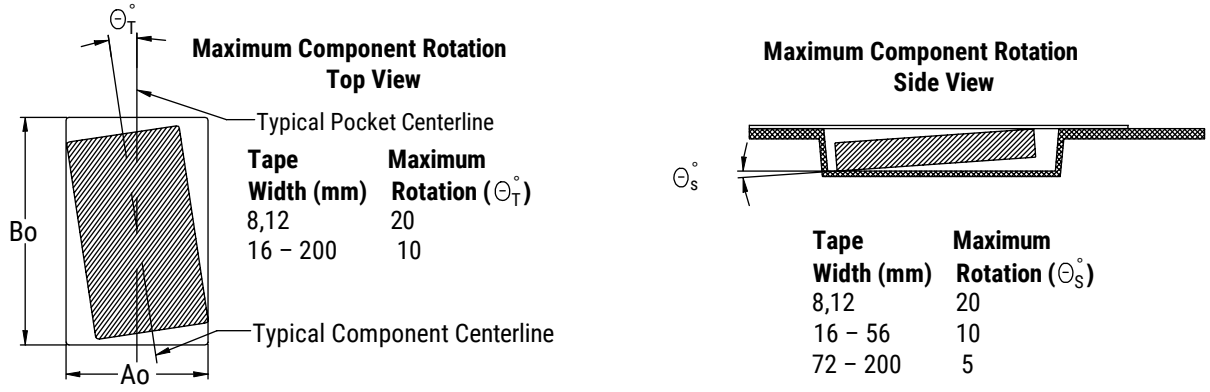


Figure 3 – Maximum Lateral Movement

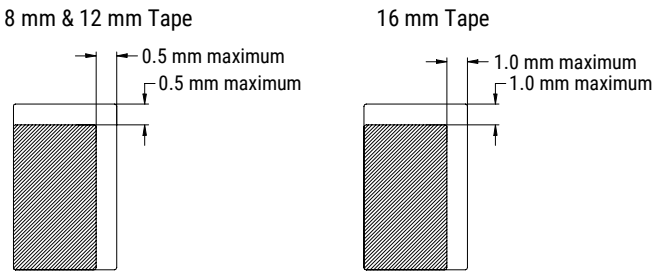


Figure 4 – Bending Radius

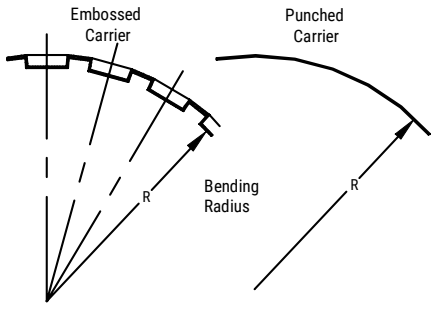
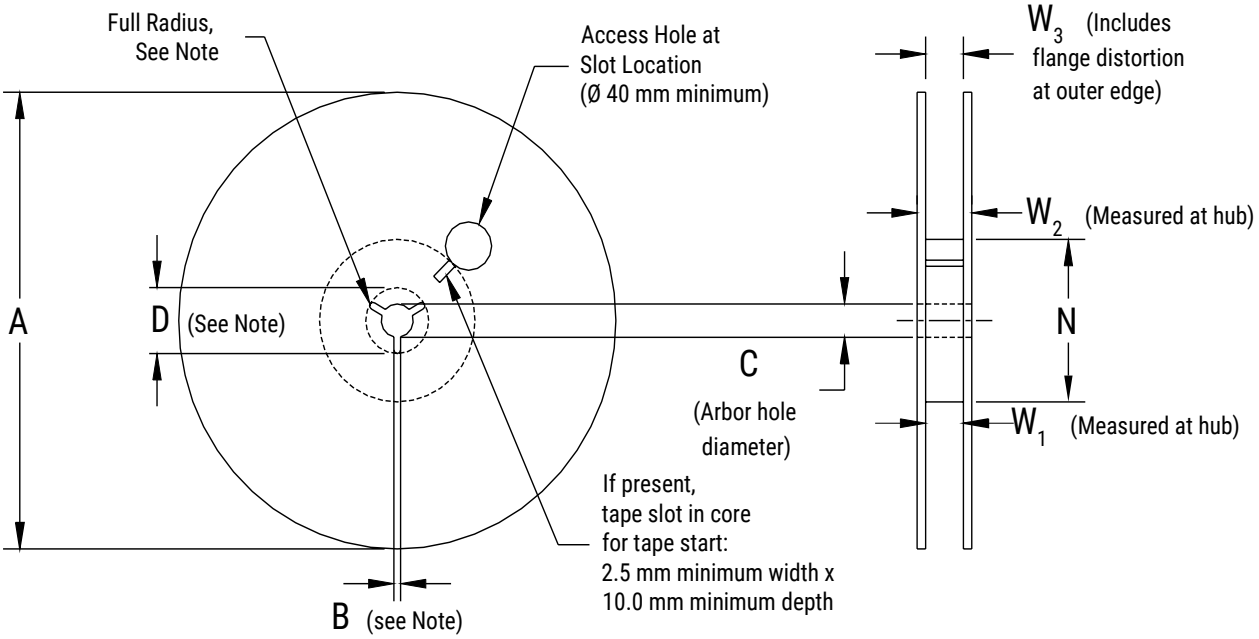


Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 5 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	B Minimum	C	D Minimum
24 mm		1.2 (0.047)	13.0 ±0.2 (0.521 ±0.008)	21 (0.826)
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum	W_1	W_2 Maximum	W_3
24 mm		25 +1.0/−0.0 (0.984 +0.039/−0.0)	27.4 ±1.0 (1.078 ±0.039)	

Figure 6 – Tape Leader & Trailer Dimensions

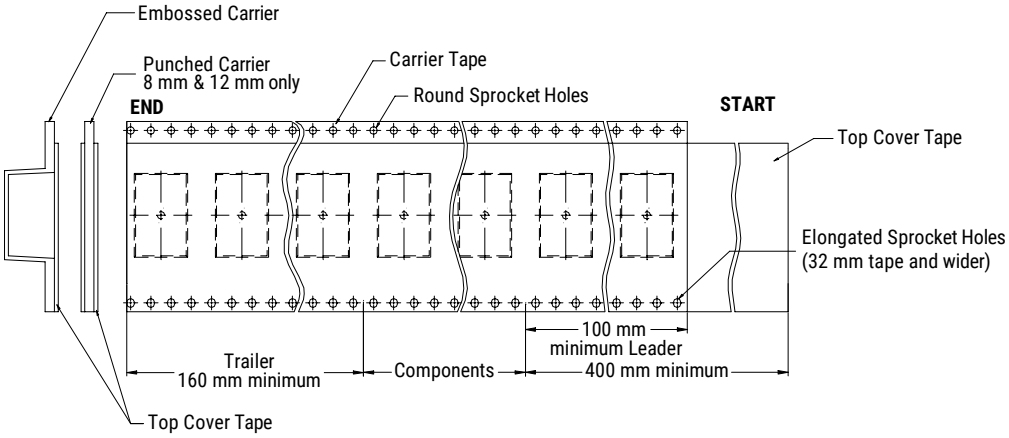
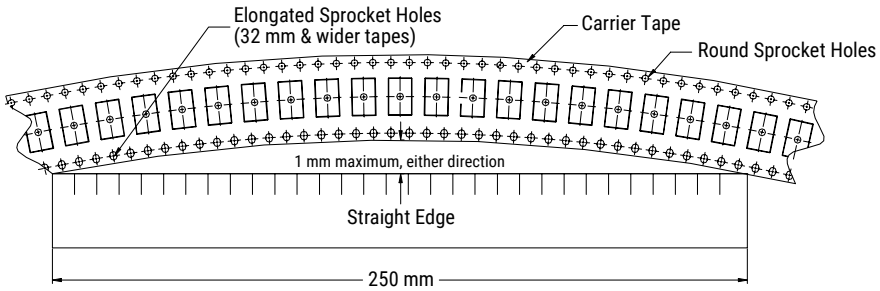


Figure 7 – Maximum Camber



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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicted or that other measures may not be required.