

Pulse Discharge, High Voltage, High Temperature 200°C COG Dielectric, 1,000 VDC – 3,500 VDC (Industrial Grade)

Overview

KEMET's Industrial Grade Pulse Discharge Series surface mount capacitors in COG Dielectric deliver reliable high voltage and high temperature performance required for operation in harsh environments, specifically discharge circuitry. Constructed of a robust and proprietary base metal electrode (BME) dielectric system, these devices offer industry-leading performance relative to capacitance and case size. KEMET Pulse Discharge capacitors average greater than 30% higher breakdown voltage than competitive precious metal electrode (PME) devices with similar capacitance & voltage ratings.

Designed for down-hole oil exploration and perforation, these devices feature a 200°C maximum operating temperature. The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I material.

Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. Pulse Discharge series capacitors in COG dielectric exhibit no change in capacitance with respect to time and voltage and boast a negligible change in capacitance with reference to ambient temperature. These devices retain high insulation resistance with low dissipation factor at elevated temperatures up to 200°C.

KEMET's Pulse Discharge surface mount MLCCs are manufactured in state-of-the-art ISO/TS 16949:2009 certified facilities and are proven to function reliably in harsh, high temperature and high humidity, down-hole environments.



Ordering Information

C	2824	H	393	K	U	G	W	C	TU
Ceramic	Case Size (L" x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance	Dielectric Withstanding Voltage (VDC) ¹	Dielectric	Failure Rate/ Design	Termination Finish ²	Packaging/ Grade (C-Spec) ³
	2824 3040 3640 4540	H = High temperature (200°C)	Two significant digits and number of zeros	J = ±5% K = ±10% M = ±20%	D = 1,000 U = 1,250 G = 2,000 H = 3,000 V = 3,500	G = COG	W = Pulse discharge	C = 100% Matte Sn L = SnPb (5% Pb minimum)	See "Packaging C-Spec Ordering Options Table"

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. See waterfall table for working voltage.

² Additional termination finish options may be available. Contact KEMET for details.

³ Additional reeling or packaging options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

Packaging Type/Options ¹	Packaging Ordering Code (C-Spec) ²
7" Reel (Embossed Plastic Tape)/Unmarked	TU
13" Reel (Embossed Plastic Tape)/Unmarked	7210
Reel (Embossed Plastic Tape)/Unmarked – 50 pieces	T050
Reel (Embossed Plastic Tape)/Unmarked – 100 pieces	T100
Reel (Embossed Plastic Tape)/Unmarked – 250 pieces	T250
Reel (Embossed Plastic Tape)/Unmarked – 500 pieces	T500
Reel (Embossed Plastic Tape)/Unmarked – 1,000 pieces	T1K0

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

² Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "Txxx" packaging ordering codes (C-Specs) outlined above, product may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

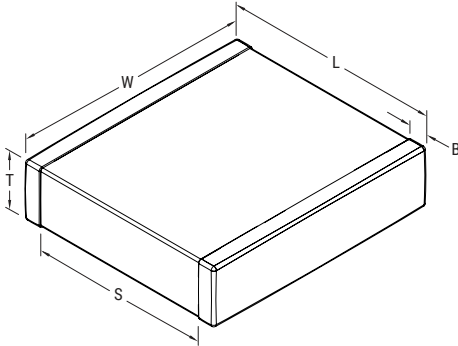
Benefits

- Operating temperature range of -55°C to +200°C
- Lead (Pb)-free, RoHS and REACH compliant
- Base metal technology
- Higher UVBD capability than competitive dielectric technologies
- Capacitance offerings ranging from 2.2 nF up to 150 nF
- Available capacitance tolerances of ±5%, ±10% or ±20%
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +200°C
- No capacitance decay with time
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include high temperature discharge circuits for munitions and down-hole oil exploration/perforation.

Dimensions – Millimeters (Inches)



Size Code	L Length	W Width	T Thickness Maximum	B Bandwidth	S Separation Minimum	Mounting Technique
2824	7.10±0.40 (0.280±0.016)	6.10±0.40 (0.240±0.016)	See Table 2	1.27±0.40 (0.050±0.016)	N/A	Solder Reflow Only
3040	7.60±0.40 (0.300±0.016)	10.20±0.40 (0.402±0.016)				
3640	9.10±0.40 (0.358±0.016)	10.20±0.40 (0.402±0.016)				
4540	11.40±0.40 (0.449±0.016)	10.20±0.40 (0.402±0.016)				

Qualification/Certification

Industrial grade pulse discharge products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range	-55°C to +200°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)	See product selection table (product waterfall) for available ratings
² Dissipation Factor (DF) Maximum Limit at 25°C	0.1%
³ Insulation Resistance (IR) Minimum Limit at 25°C	1,000 megohm microfarads 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 Vrms ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ± 50 Hz and 1.0 Vrms ±0.2 V 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.

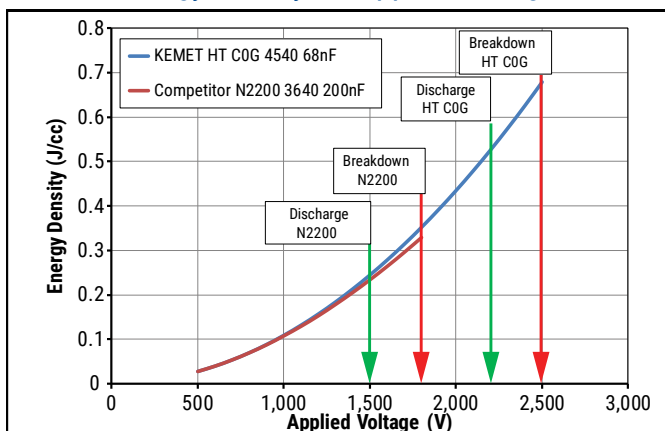
Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
COG	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Electrical Characteristics

Energy Density vs. Applied Voltage



Discharge Current vs. Applied Voltage

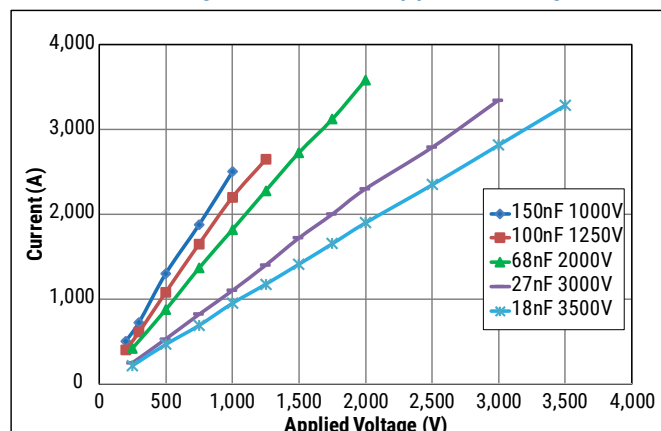


Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
TA	2824	1.40 ± 0.15	0	0	750	2,500
TB	2824	2.00 ± 0.20	0	0	300	2,000
TC	2824	2.50 ± 0.20	0	0	300	2,000
QB	3040	1.40 ± 0.15	0	0	500	1,650
QC	3040	2.00 ± 0.20	0	0	500	1,650
QD	3040	2.50 ± 0.20	0	0	350	1,400
MA	3640	1.40 ± 0.15	0	0	250	1,550
MB	3640	2.00 ± 0.20	0	0	250	1,550
MC	3640	2.50 ± 0.20	0	0	250	1,000
SA	4540	1.40 ± 0.15	0	0	200	1,500
SB	4540	2.00 ± 0.20	0	0	200	1,500
SC	4540	2.50 ± 0.20	0	0	200	1,500
Thickness Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity		Plastic Quantity	

Package quantity based on finished chip thickness specifications.

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

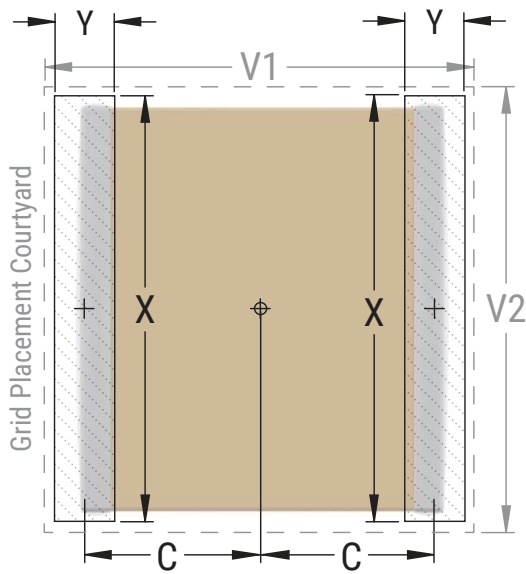
Size Code (In.)	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)					Density Level B: Median (Nominal) Land Protrusion (mm)					Density Level C: Minimum (Least) Land Protrusion (mm)				
		C	Y	X	V1	V2	C	Y	X	V1	V2	C	Y	X	V1	V2
2824	7260	3.45	1.70	6.60	9.60	7.60	3.35	1.50	6.50	8.70	7.00	3.25	1.30	6.40	8.00	6.70
3040	7610	3.70	1.70	10.70	10.10	11.70	3.60	1.50	10.60	9.20	11.10	3.50	1.30	10.50	8.50	10.80
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
4540	-	5.60	1.70	10.70	13.90	11.70	5.50	1.50	10.60	13.00	11.10	5.40	1.30	10.50	12.30	10.80

Density Level A: For low-density product applications. Provides a wider process window for reflow solder processes.

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 a 3640 case size.



Soldering Process

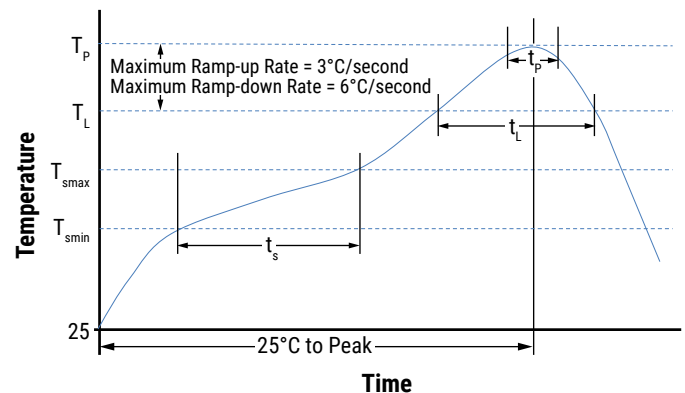
Recommended Soldering Technique:

- Solder reflow only

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	
	SnPb	100% Matte Sn
Preheat/Soak		
Temperature Minimum (T_{Smin})	100°C	150°C
Temperature Maximum (T_{Smax})	150°C	200°C
Time (t_s) from T_{Smin} to T_{Smax}	60 – 120 seconds	60 – 120 seconds
Ramp-Up Rate (T_L to T_p)	3°C/second maximum	3°C/second maximum
Liquidous Temperature (T_L)	183°C	217°C
Time Above Liquidous (t_L)	60 – 150 seconds	60 – 150 seconds
Peak Temperature (T_p)	235°C	260°C
Time Within 5°C of Maximum Peak Temperature (t_p)	20 seconds maximum	30 seconds maximum
Ramp-Down Rate (T_p to T_L)	6°C/second maximum	6°C/second maximum
Time 25°C to Peak Temperature	6 minutes maximum	8 minutes maximum



Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

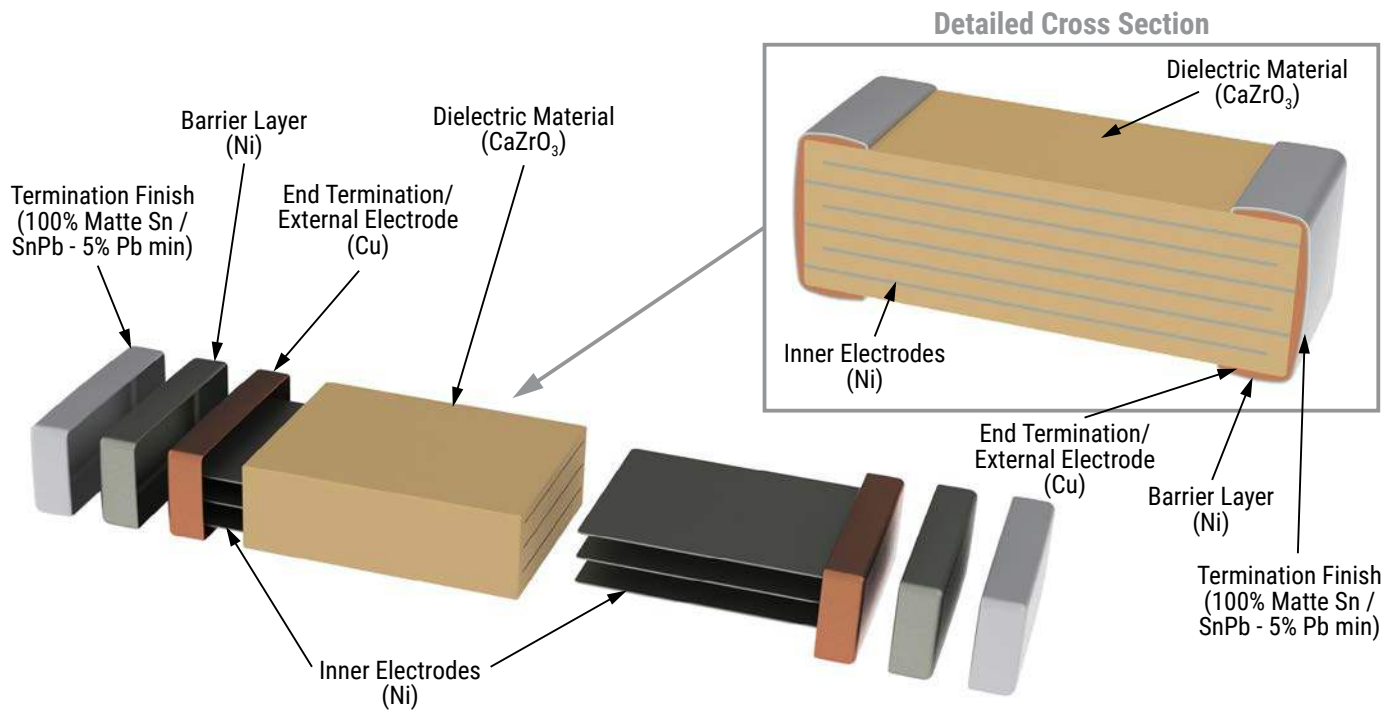
Table 4 – Performance & Reliability: Test Methods and Conditions

Product Qualification Test Plan	
Reliability/Environmental Tests per MIL-STD-202//JESD22	
Load Humidity	85°C/85%RH and 200 VDC maximum, 1,000 Hours
Low Voltage Humidity	85°C/85%RH, 1.5V, 1,000 Hours
Temperature Cycling	-55°C to +200°C, 50 Cycles
Thermal Shock	-55°C to +150°C, 20 seconds transfer, 15 minute dwell, 300 Cycles
Moisture Resistance	Cycled Temp/RH 0 V, 10 cycles at 24 hours each
Physical, Mechanical & Process Tests per MIL-STD 202/JIS-C-6429	
Resistance to Solvents	Include Aqueous wash chemical – OKEM Clean or equivalent
Mechanical Shock and Vibration	Method 213: Figure 1, Condition F Method 204: 5 gs for 20 minutes, 12 cycles
Resistance to Soldering Heat	Condition B, no per-heat of samples, Single Wave Solder
Terminal Strength	Force of 1.8 kg for 60 seconds
Board Flex	Appendix 2, Note: 3.0 mm (minimum)

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°C and maximum storage humidity not exceed 70% relative humidity. 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.

Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.

Packaging

Please contact kemet for details regarding available packaging options.

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.

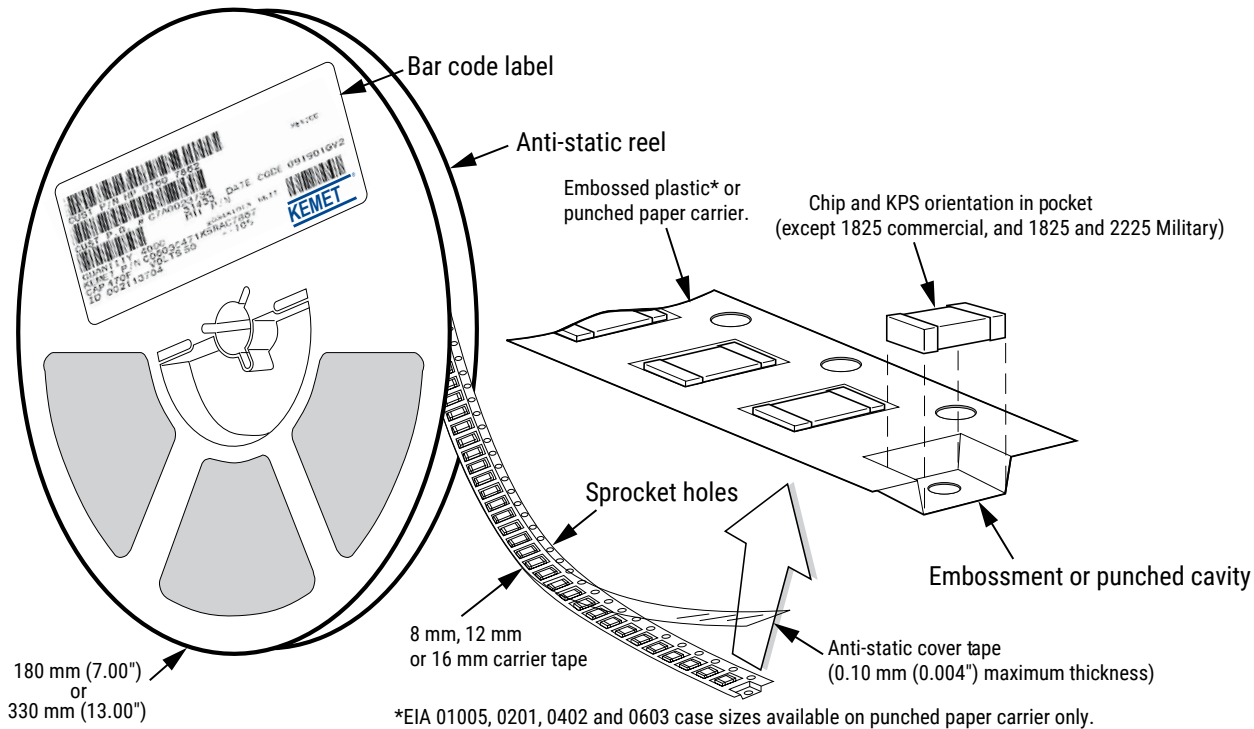


Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		7" Reel	13" Reel	7" Reel	13" Reel
		Pitch (P ₁)*		Pitch (P ₁)*	
01005 – 0402	8			2	2
0603	8			2/4	2/4
0805	8	4	4	4	4
1206 – 1210	8	4	4	4	4
1805 – 1808	12	4	4		
≥ 1812	12	8	8		
2824	16	12	12		
3040 – 4540	24	16	16		
KPS 1210	12	8	8		
KPS 1812 & 2220	16	12	12		
Array 0508 & 0612	8	4	4		

New 2 mm Pitch Reel Options*

Packaging Ordering Code (C-Spec)	Packaging Type/Options
C-3190	Automotive grade 7" reel unmarked
C-3191	Automotive grade 13" reel unmarked
C-7081	Commercial grade 7" reel unmarked
C-7082	Commercial grade 13" reel unmarked

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations.

*Refer to Tables 6 and 7 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

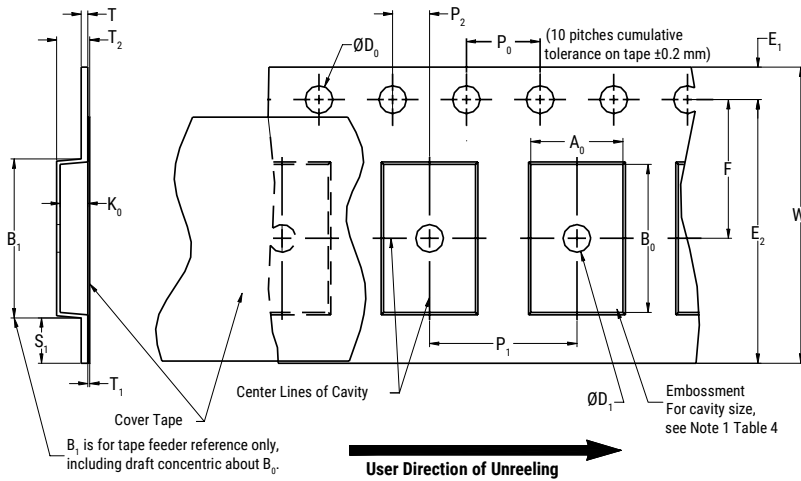


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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
8 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±0.05 (0.079±0.002)	25.0 (0.984)	0.600 (0.024)	0.600 (0.024)	0.100 (0.004)
12 mm					30 (1.181)			
16 mm								
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	
8 mm	Single (4 mm)	6.25 (0.246)	3.5±0.05 (0.138±0.002)	4.0±0.10 (0.157±0.004)	2.5 (0.098)	8.3 (0.327)	Note 5	
12 mm	Single (4 mm) & Double (8 mm)	10.25 (0.404)	5.5±0.05 (0.217±0.002)	8.0±0.10 (0.315±0.004)	4.6 (0.181)	12.3 (0.484)		
16 mm	Triple (12 mm)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.157±0.004)	4.6 (0.181)	16.3 (0.642)		
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)		

- 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.
- The tape with or without components shall pass around R without damage (see Figure 6).
- If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).
- B₁ dimension is a reference dimension for tape feeder clearance only.
- The cavity defined by A₀, B₀ and K₀ shall surround the component with sufficient clearance that:
 - the component does not protrude above the top surface of the carrier tape.
 - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
 - 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).
 - lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).
 - for KPS Series product, A₀ and B₀ are measured on a plane 0.3 mm above the bottom of the pocket.
 - see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

Figure 2 – Punched (Paper) Carrier Tape Dimensions

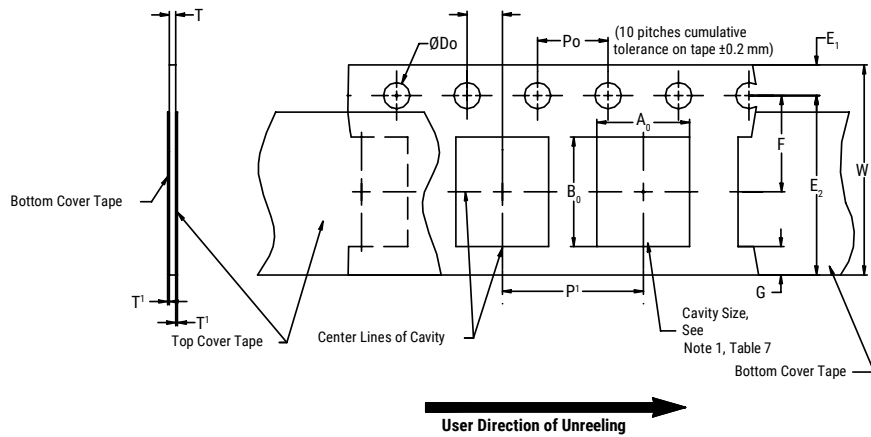


Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

Constant Dimensions – Millimeters (Inches)							
Tape Size	D_0	E_1	P_0	P_2	T_1 Maximum	G Minimum	R Reference Note 2
8 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±0.05 (0.079±0.002)	0.10 (0.004) Maximum	0.75 (0.030)	2 (0.984)
Variable Dimensions – Millimeters (Inches)							
Tape Size	Pitch	E2 Minimum	F	P_1	T Maximum	W Maximum	$A_0 B_0$
8 mm	Half (2 mm)	6.25 (0.246)	3.5±0.05 (0.138±0.002)	2.0±0.05 (0.079±0.002)	1.1 (0.098)	8.3 (0.327)	Note 1
8 mm	Single (4 mm)			4.0±0.10 (0.157±0.004)			

- The cavity defined by A_0 , B_0 and T shall surround the component with sufficient clearance that:
 - the component does not protrude beyond either surface of the carrier tape.
 - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
 - rotation of the component is limited to 20° maximum (see Figure 3).
 - lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).
 - see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.
- The tape with or without components shall pass around R without damage (see Figure 6).

Packaging Information Performance Notes

- Cover Tape Break Force:** 1.0 Kg minimum.
- 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.

- 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 3 – Maximum Component Rotation

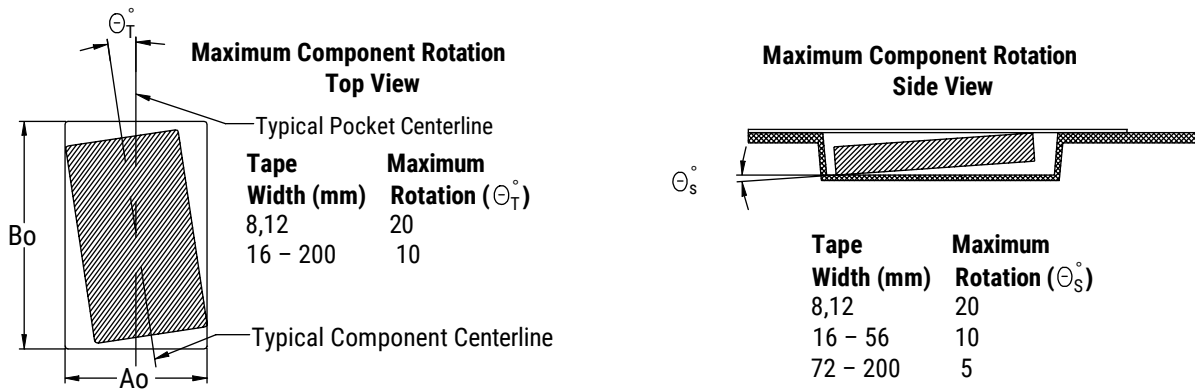


Figure 4 – Maximum Lateral Movement

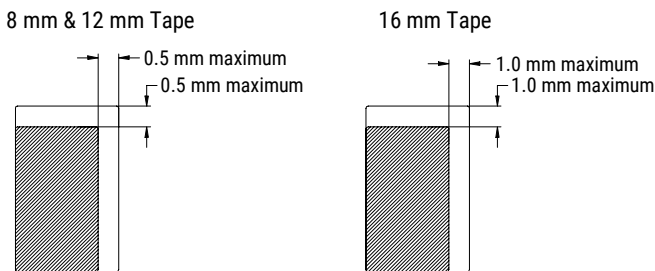


Figure 5 – Bending Radius

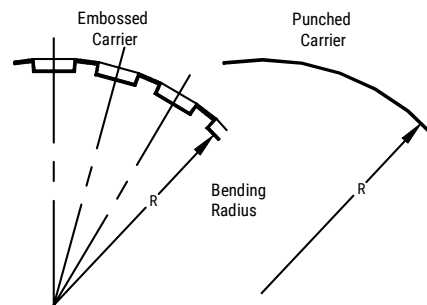


Figure 6 – Reel Dimensions

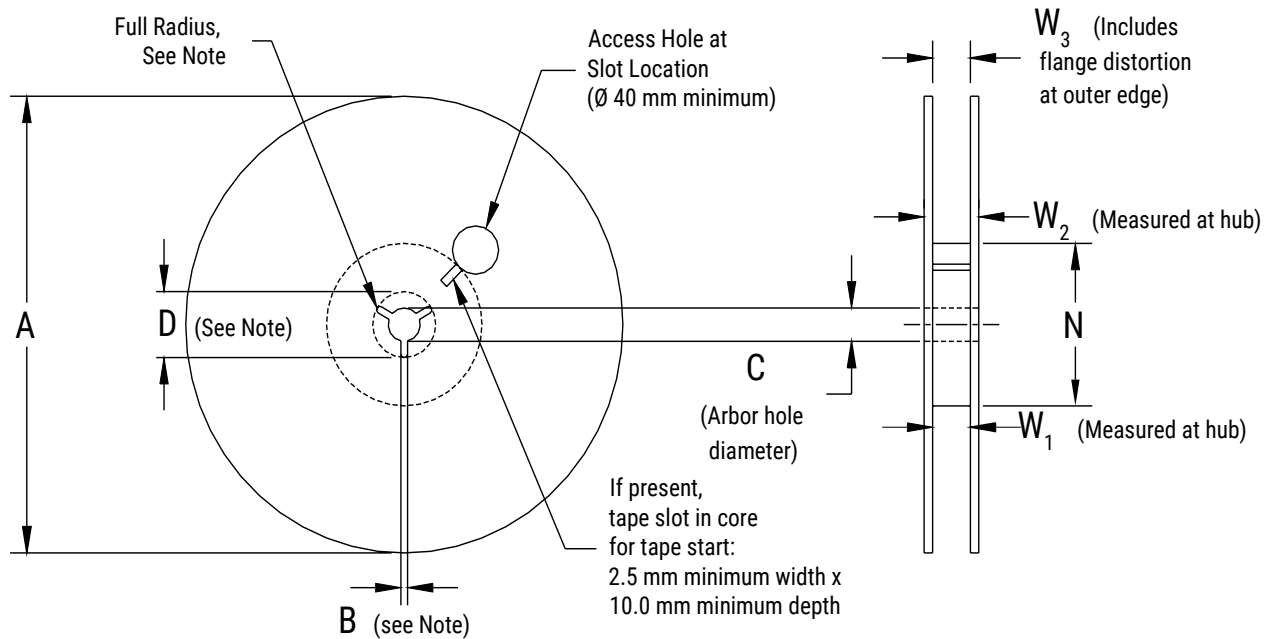


Table 8 – Reel Dimensions

Metric will govern

Constant Dimensions – Millimeters (Inches)				
Tape Size	A	B Minimum	C	D Minimum
8 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)
12 mm				
16 mm				
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
8 mm	50 (1.969)	8.4+1.5/-0.0 (0.331+0.059/-0.0)	14.4 (0.567)	Shall accommodate tape width without interference
12 mm		12.4+2.0/-0.0 (0.488+0.078/-0.0)	18.4 (0.724)	
16 mm		16.4+2.0/-0.0 (0.646+0.078/-0.0)	22.4 (0.882)	
24 mm		25+1.0/-0.0 (0.984+0.039/-0.0)	27.4+1.0/-1.0 (1.078+0.039/-0.039)	

Figure 7 – Tape Leader & Trailer Dimensions

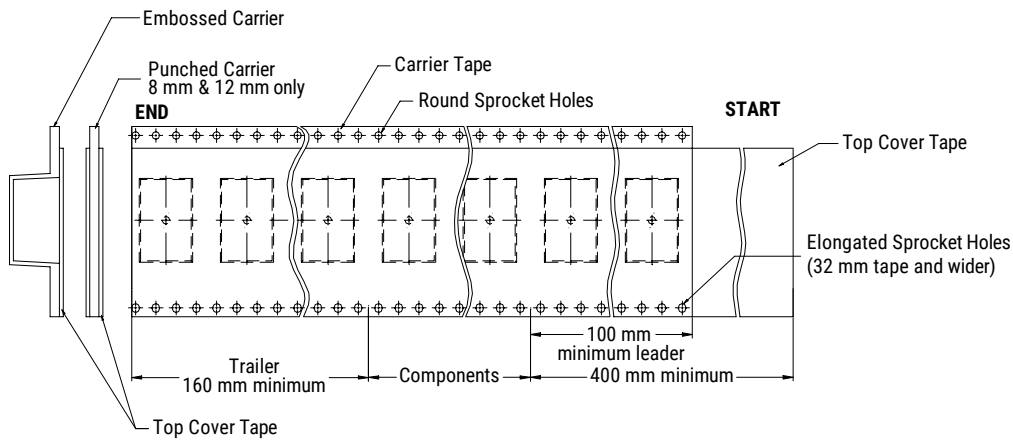
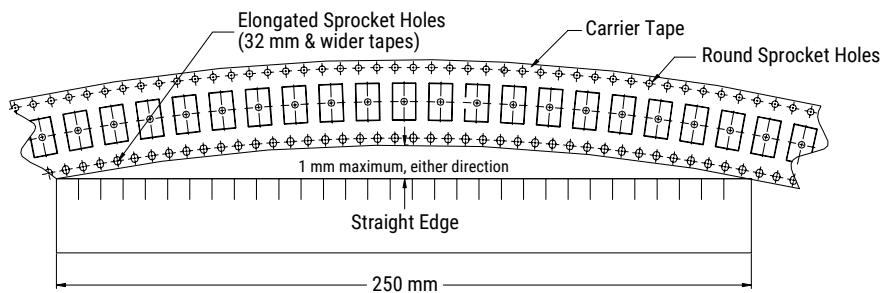


Figure 8 – Maximum Camber



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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 indicated or that other measures may not be required.