Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

U2J with KONNEKT™ Technology, 10V - 100V (Commercial & Automotive Grade)

Overview

KEMET's U2J with KONNEKT™ Technology surface mount capacitors are designed for high-efficiency and high-density power applications. KONNEKT utilizes an innovative Transient Liquid Phase Sintering (TLPS) material to create a leadless multi-chip solution. When combined with KEMET's ultra-stable U2J dielectric, KONNEKT enables a low-loss, low-inductance package capable of handling extremely high ripple currents in the hundreds of kilohertz.

U2J is an extremely stable Class I dielectric material that exhibits a negligible shift in capacitance with respect to voltage and a predictable and linear change in capacitance with reference to ambient temperature, with minimal aging effect. Capacitance change is limited to −750 ±120 ppm/°C from −55°C to +125°C.

U2J with KONNEKT™ Technology can also be mounted in a low-loss orientation to further increasing its power handling capability. The low-loss orientation lowers ESR (Effective Series Resistance) and ESL (Effective Series Inductance) which increases ripple current handling capability.

Benefits

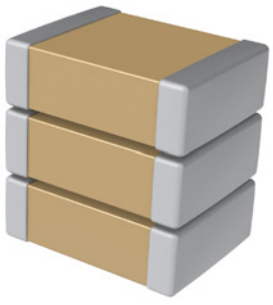
- Extremely high-power density and ripple current capability[1]
- Extremely low equivalent series resistance (ESR)[1]
- Extremely low equivalent series inductance (ESL)[1]
- Capacitance offerings ranging from 300 nF – 1.4 uF
- Up to 120% more capacitance compared to C0G with KONNEKT
- DC voltage ratings from 10 – 100 V
- EIA sizes 1206, 1210, and 1812
- Operating temperature range of −55°C to +125°C
- Retains over 99% of nominal capacitance at full rated voltage
- Low noise
- Surface mountable using standard MLCC reflow profiles
- RoHS compliant and Pb-free

Applications

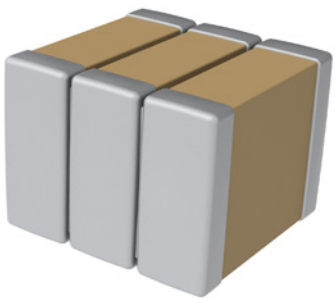
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- LLC resonant converters
- Switched tank converters
- Wireless charging systems
- Photovoltaic systems
- Power converters
- Inverters
- DC link
- Snubber

[1] When mounted in low-loss orientation.
[2] 1812 case size only available in Commercial Grade.

Standard



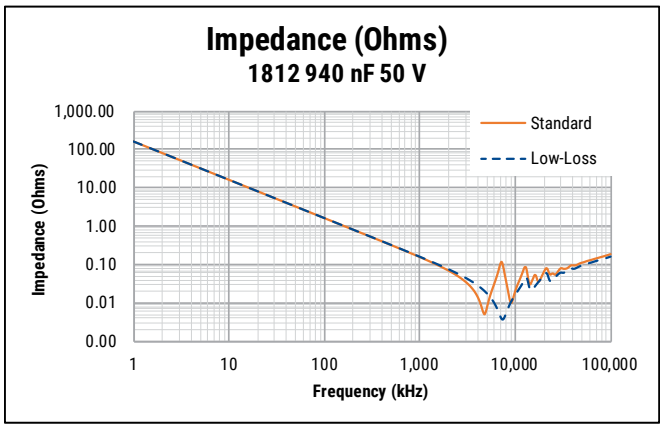
Low Loss

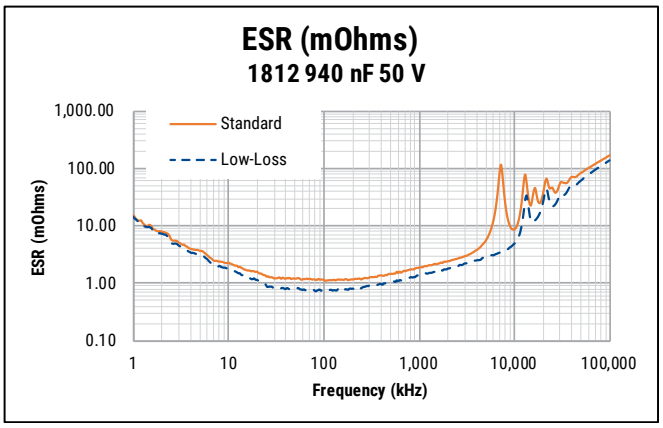


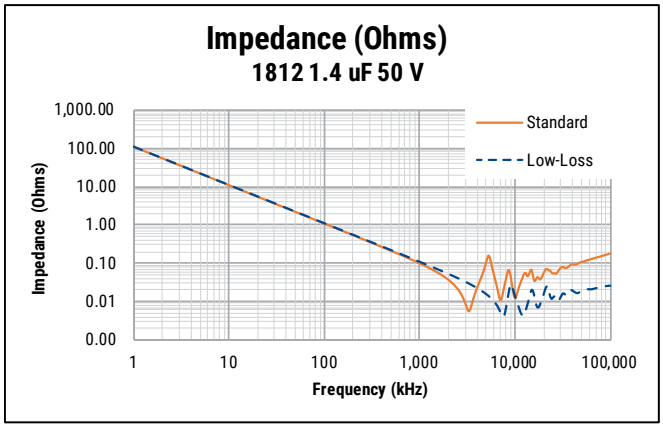
Typical Performance

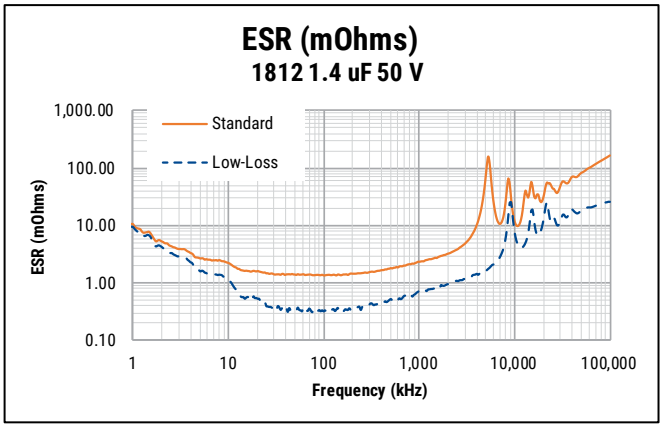
				Typical Ripple Current (A_{rms})[1]		
Part Type	**Mounting Configuration**	**Typical ESR at 25°C, 100 kHz**	**Typical ESL at 25°C**	**100 kHz**	**200 kHz**	**300 kHz**
1812 940 nF	Standard	1.15 mΩ	1.1 nH	12.0	12.0	11.5
	Low Loss	0.77 mΩ	0.45 nH	18.0	18.0	16.0
1812 1.4 uF	Standard	1.3 mΩ	1.6 nH	11.0	10.0	10.0
	Low Loss	0.35 mΩ	0.4 nH	20.0	34.0	31.0

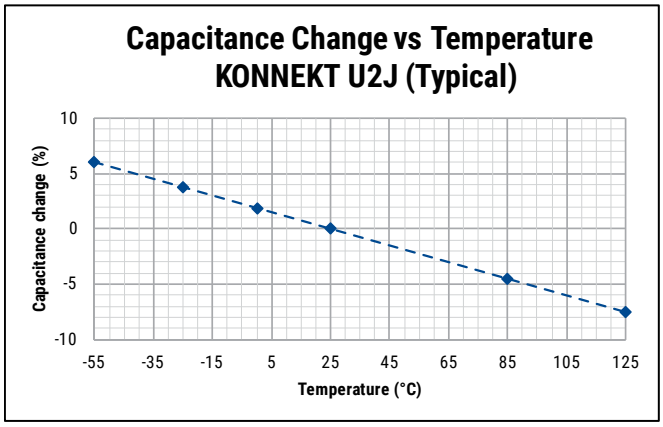
[1] Ripple current measurements performed at 85°C with a peak capacitor temperature of 95°C. Samples mounted to heat sink with no forced air cooling. Maximum ambient and self heating cannot exceed 125°C.

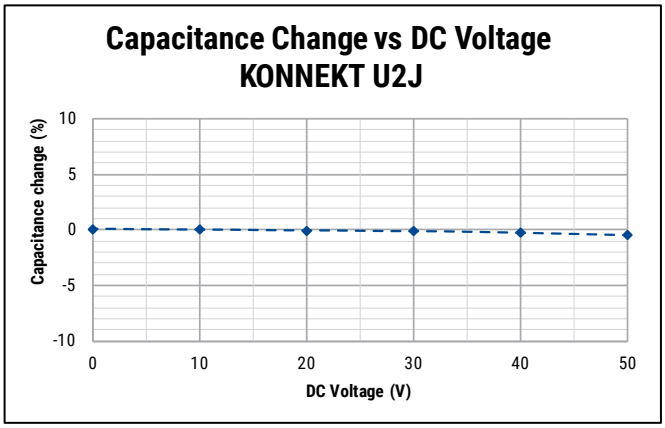




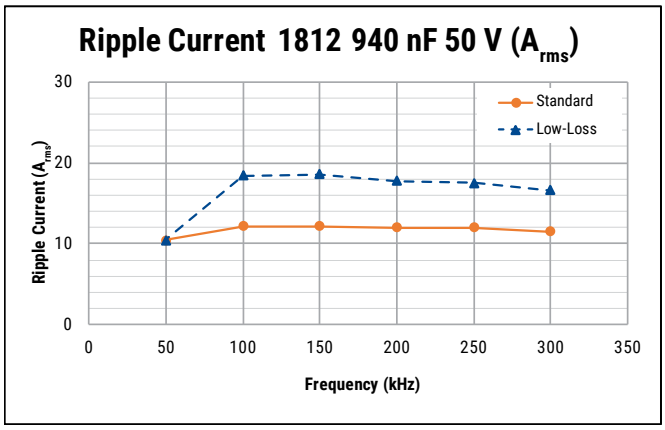


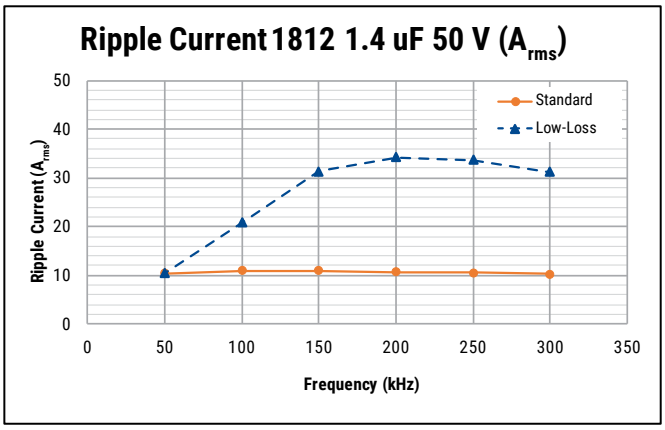






Typical Performance cont.





Ordering Information

C	1812	C	145	J	5	J	L	C	7XXX
Series	Case Size (L"x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance[1]	Rated Voltage (V)	Dielectric	Subclass Designation	Termination Finish[2]	Packaging (Suffix/C-Spec)
C = Ceramic	1206 1210 1812	C = Standard	Two single digits and number of zeros.	J = ±5% K = ±10%	8 = 10 V 4 = 16 V 3 =25 V 5 = 50 V 1 = 100 V	J = U2J	L = KONNEKT	C = 100% matte Sn	See "Packaging C-Spec Ordering Options Table"

[1] Tolerance J available in 1812 case size only.

[2] Additional termination finish options may be available. Contact KEMET for details. See Table 1A for available capacitance and voltage ratings.

[3] 1812 case size only available in Commercial Grade

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

1206, 2-Chip Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number	Capacitance	Cap Code	Voltage	Number of Chips	Orientation	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
								7" Tape & Reel	13" Tape & Reel
C1206C444K8JLC(a)	440 nF	444	10 V	2	Standard	3.20 (0.126) ±0.40 (0.016)	0.22	500	1900
C1206C444K4JLC(a)	440 nF	444	16 V			3.20 (0.126) ±0.40 (0.016)		500	1900
C1206C444K3JLC(a)	440 nF	444	25 V			3.20 (0.126) ±0.4 0(0.016)		500	1900
C1206C304K5JLC(a)	300 nF	304	50 V			3.20 (0.126) ±0.40 (0.016)		500	1900

(a) C-Spec for Product Grade, Reeling and Mounting Orientation.

1210, 2-Chip Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number	Capacitance	Cap Code	Voltage	Number of Chips	Orientation	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
								7" Tape & Reel	13" Tape & Reel
C1210C664K8JLC(a)	660 nF	664	10 V	2	Standard	4.30 (0.169) ±0.40 (0.016)	0.15	450	1800
C1210C664K4JLC(a)	660 nF	664	16 V			4.30 (0.169) ±0.40 (0.016)		450	1800
C1210C664K3JLC(a)	660 nF	664	25 V			4.30 (0.169) ±0.40 (0.016)		450	1800
C1210C544K5JLC(a)	540 nF	544	50 V			3.40 (0.134) ±0.40 (0.016)		450	1800
C1210C364K1JLC(a)	360 nF	364	100 V			3.40 (0.134) ±0.40 (0.016)		375	1500

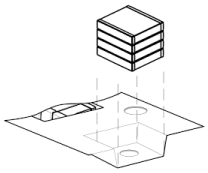
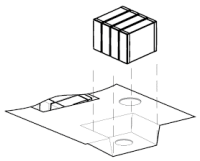
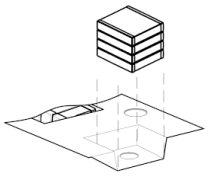
(a) C-Spec for Product Grade, Reeling and Mounting Orientation.

1812, 2-Chip and 3-Chip Product Ordering Codes, Ratings, and Package Quantities (Commercial Grade Only)

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Orientation	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
								7" Tape & Reel	13" Tape & Reel
C1812C944(b)5JLC(a)	940 nF	944	50 V	2	Standard	3.50 (0.137) ±0.40 (0.016)	0.22	500	2,000
					Low Loss	3.20 (0.126) ±0.30 (0.012)		500	2,200
C1812C145(b)5JLC(a)	1.4 uF	145	50 V	3	Standard	5.30 (0.208) ±0.60 (0.024)	0.33	200	900
					Low Loss	3.20 (0.126) ±0.30 (0.012)		500	2,200

(a) C-Spec for Product Grade, Reeling and Mounting Orientation.
(b) Capacitance tolerance character "J" or "K"

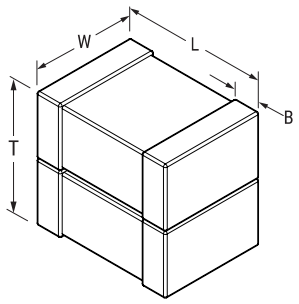
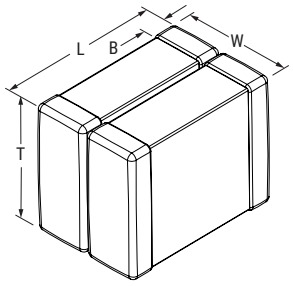
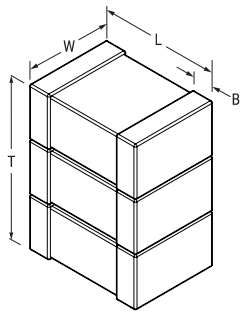
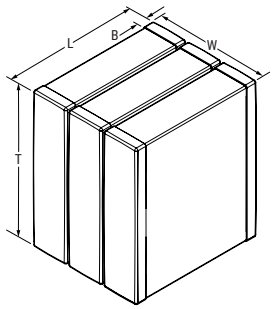
Table 1B - Packaging C-Spec Ordering Options Table

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
Low Loss			7" Reel/Unmarked	7805
			13" Reel/Unmarked	7810
Automotive Grade[2]				
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.*

[2] *Low loss orientation for U2J with KONNEKT not available in Automotive grade or 1206 and 1210 case sizes.*

Dimensions – Millimeters (Inches)

Standard Mounting 2 Chips	Low Loss Mounting 2 Chips	Standard Mounting 3 Chips	Low Loss Mounting 3 Chips
			

EIA SIZE CODE	METRIC SIZE CODE	Number of Chips	Mounting	L LENGTH	W WIDTH	T THICKNESS	B BANDWIDTH	Mounting Technique
1206	3216	2	Standard	3.20 (0.126) ±0.20 (0.008)	1.60 (0.063) ±0.20 (0.008)	See Ordering Code Table	0.50 (0.02) ±0.25 (0.010)	Solder Reflow Only
1210	3225	2	Standard		2.50 (0.098) ±0.20 (0.008)			
1812	4532	2	Standard	4.50 (0.177) ± 0.30 (0.012)	3.20 (0.126) ± 0.30 (0.012)		0.60 (0.024) ± 0.35 (0.014)	
			Low Loss		3.5 (0.137) ±0.4 (0.016)			
		3	Standard		3.20 (0.126) ± 0.30 (0.012)			
			Low Loss		5.3 (0.208) ±0.6 (0.024)			

Table 2 - Performance and Reliability: Test Methods and Conditions

<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}

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>Apply rated voltage for 120 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

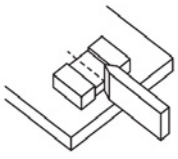
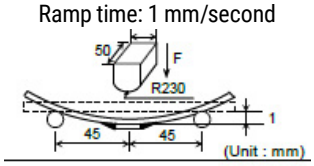
* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>−750 ±120 ppm/°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>250% of rated voltage
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>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>Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. Please refer to a part number specific datasheet for referee time details.</td><td>0.1% Loss/Decade Hour</td></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>18N</td></tr>
</table>
 </td><td>No evidence of mechanical damage</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions cont.

Test	Reference	Test Condition	Limits
Board Flex	AEC-Q200-005	Standard Termination system 2.0 mm Test time: 60± 5 seconds Ramp time: 1 mm/second  	No evidence of mechanical damage
Solderability	KEMET Custom Test	1. Board shear – SAC305 solder. Shear force of 1.8 kg (minimum) 2. Wetting balance – IEC 60068–2–69	Visual Inspection. 95% coverage on termination. No leaching.
Temperature Cycling	JESD22 Method JA-104	1,000 cycles (–55°C to +125°C) 2-3 cycles per hour Soak Time 1 or 5 minute	Measurement at 24 hours ±4 hours after test conclusion. Cap: ±20% shift DF: Initial Limit IR: Initial Limit
Biased Humidity	MIL-STD-202 Method 103	Load Humidity: 1,000 hours 85°C / 85% RH and rated voltage, or 200 VDC maximum. Low Volt Humidity: 1,000 hours 85C°/85% RH and 1.5 V.	Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits: Cap: ±0.3% or ±0.25pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Thermal Shock	MIL-STD-202 Method 107	Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes.	Cap: ±20% shift 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.	Within Post Environmental Limits Cap: ±0.3% or ±0.25pF 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: ±20% shift DF: Initial Limit IR: Initial Limit

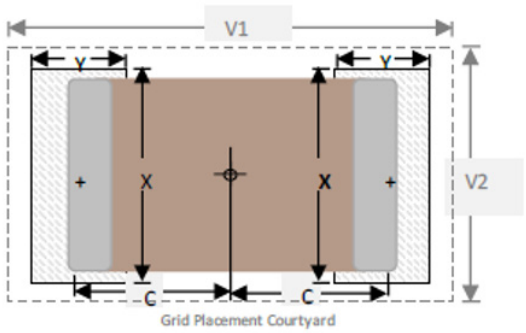
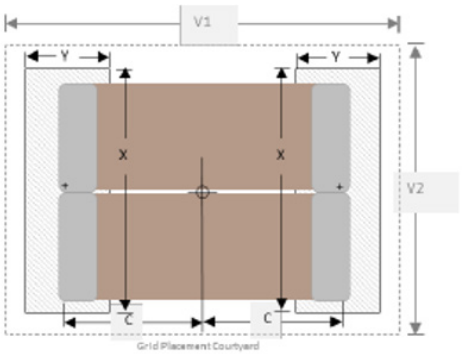
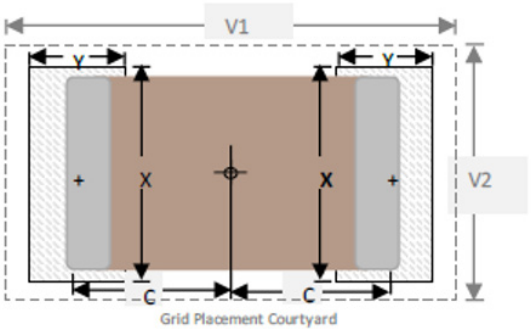
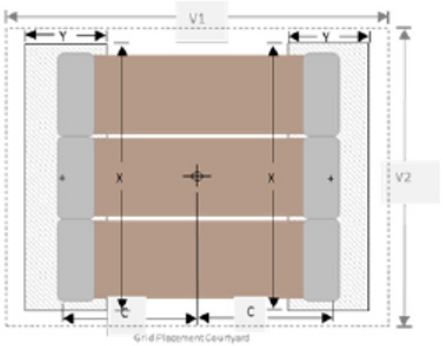
Environmental Compliance

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

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

EIA SIZE CODE	METRIC SIZE CODE	Number of Chips	Mounting	Median (Nominal) Land Protrusion				
				C	Y	X	V1	V2
1206	3216	2	Standard	1.50	1.15	1.80	4.70	2.30
1210	3225	2	Standard	1.50	1.15	2.70	4.70	3.20
1812	4532	2	Standard	2.05	1.40	3.50	6.00	4.00
			Low Loss	2.05	1.40	3.50	6.00	4.00
		3	Standard	2.05	1.40	3.50	6.00	4.00
			Low Loss	2.05	1.40	5.90	6.00	6.40

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

2 Chips	
Standard	**Low Loss**
(Land Pattern Design Recommendations per IPC-7351, top view)	
	
3 Chips	
Standard	**Low Loss**
(Land Pattern Design Recommendations per IPC-7351, top view)	
	

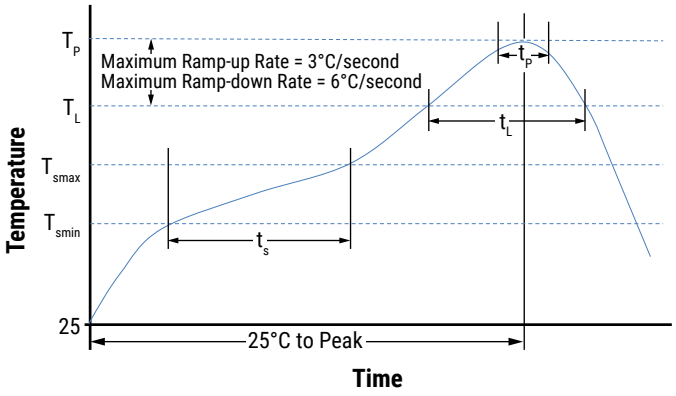
Soldering Process

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.

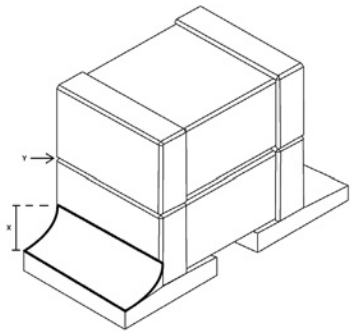
Profile Feature	Termination Finish
	100% matte Sn
Preheat/Soak	
Temperature Minimum (T_{Smin})	150°C
Temperature Maximum (T_{Smax})	200°C
Time (t_S) from T_{Smin} to T_{Smax}	60 – 120 seconds
Ramp-Up Rate (T_L to T_P)	3°C/second maximum
Liquidous Temperature (T_L)	217°C
Time Above Liquidous (t_L)	60 – 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.



Solder Fillet Height for Standard Orientation

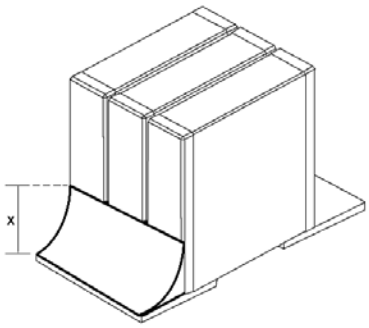
When mounting a KONNEKT capacitor in standard orientation, KEMET recommends using the typical solder volume for a single chip of equivalent case size while not exceeding a fillet height (Y). It is crucial to maintain a solder fillet height (X) that does not contact the TLPS joint (Y). This ensures that the solder contacts and wicks only to the bottom chip in the assembly and that the TLPS joint remains unaffected, thereby guaranteeing a reliable mechanical and electrical connection to the PCB or substrate.



Soldering Process cont.

Solder Fillet Height for Low-Loss Orientation

When mounting in low-loss orientation, KEMET recommends a solder filet height (X) no greater than 1mm and no less than 0.5mm. This ensures the solder contacts and wicks to all the chips in the KONNEKT stack, and ensures all chips are mechanically and electrically connected to the PCB.



Hand Soldering and Removal of KONNEKT Capacitors

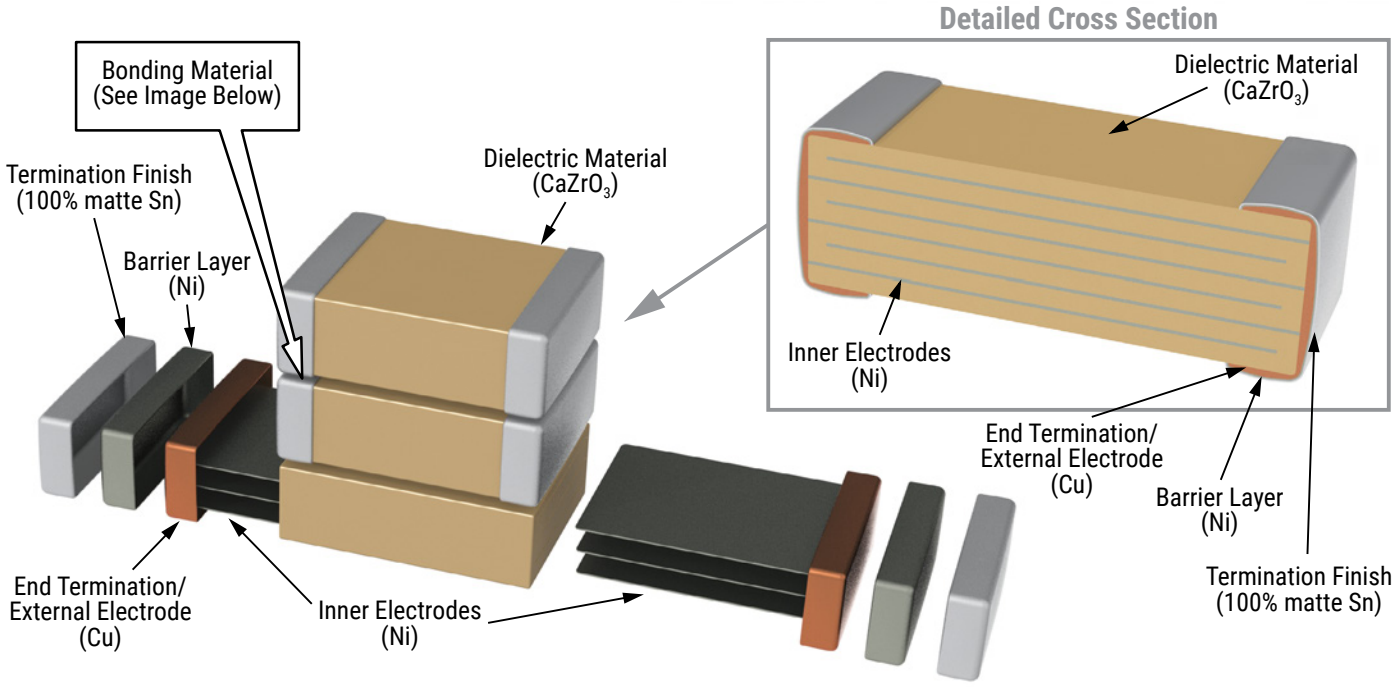
The preferred method of attachment for KEMET's KONNEKT™ Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

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.

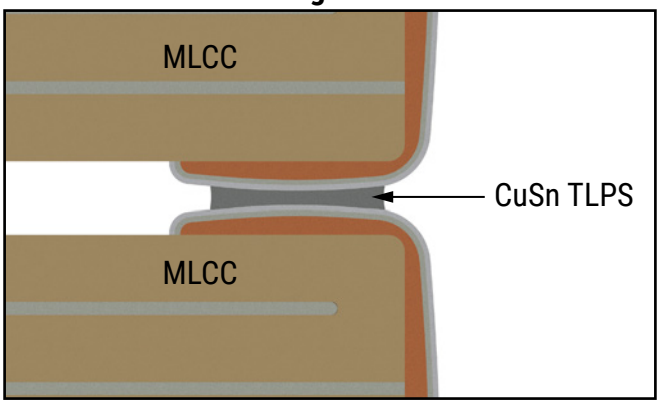
Storage & Handling

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



Bonding Material



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 1B for details on reeling quantities for commercial chips.

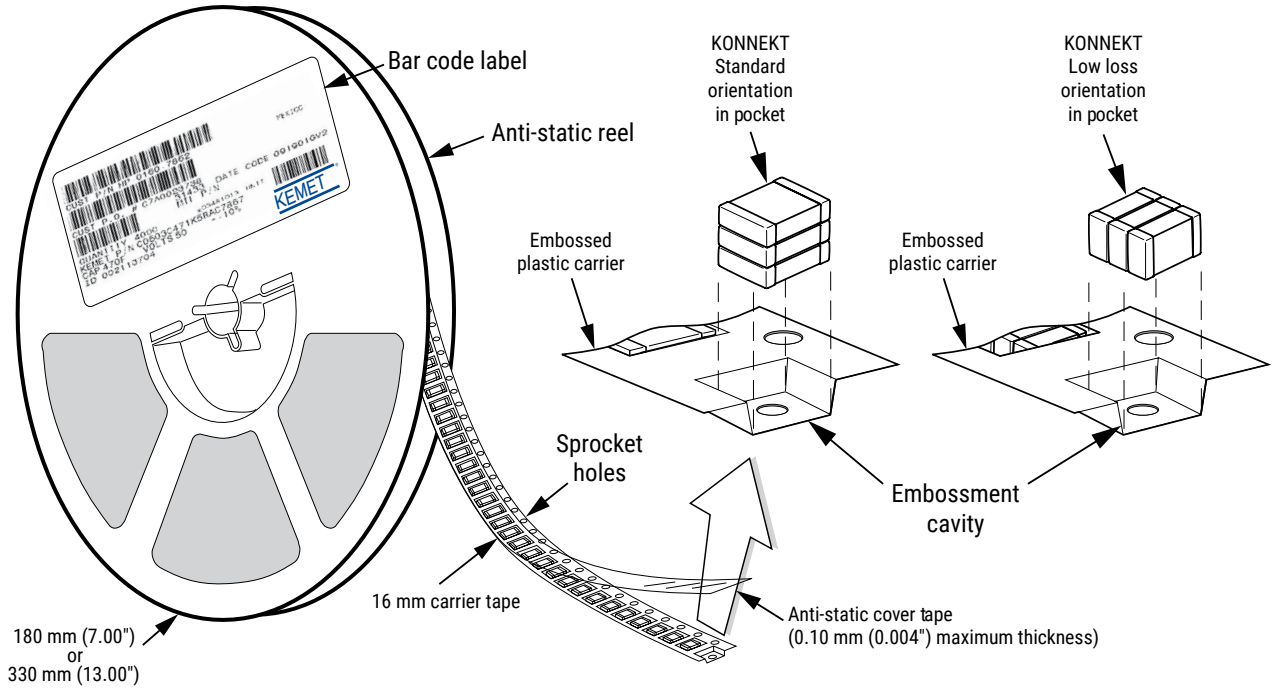


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Number of Chips	Part Orienation	Tape Size (W)*	Embossed Plastic	
				7" Reel	13" Reel
				Pitch (P_1)[2]	Pitch (P_1)[2]
1206	2	Standard	16	8	8
1210	2	Standard	16	8	8
1812	2	Standard	16	8	8
		Low Loss		8	8
	3	Standard		12	12
		Low Loss		8	8

1. Refer to Figures 1 and 2 for W and P1 carrier tape reference locations.
2. Refer to Tables 4 and 5 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

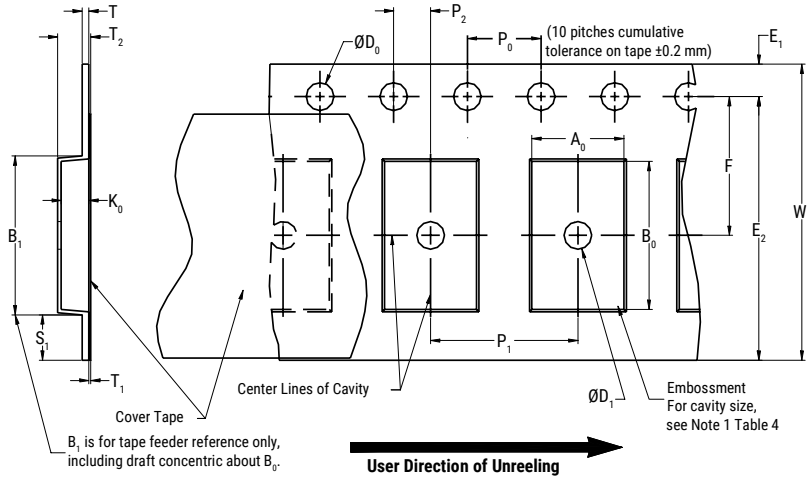


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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)									
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	
16 mm	Triple (12mm)	12.1 (0.476)	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)	Note 5	

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
16 mm	0.1 to 1.3 Newton (10 to 130 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

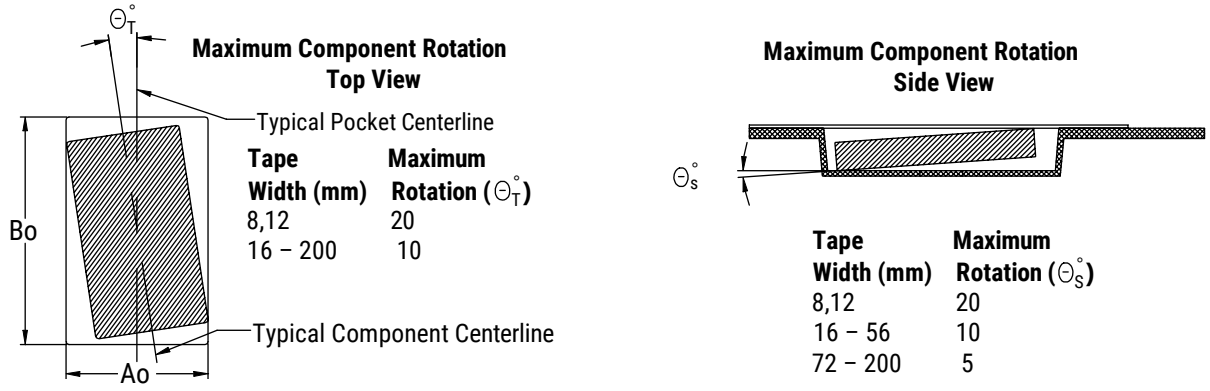


Figure 3 – Maximum Lateral Movement

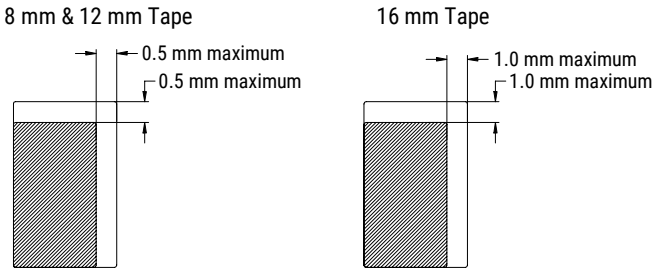


Figure 4 – Bending Radius

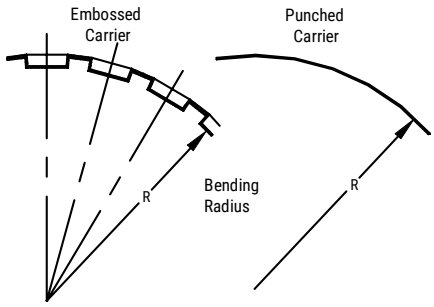
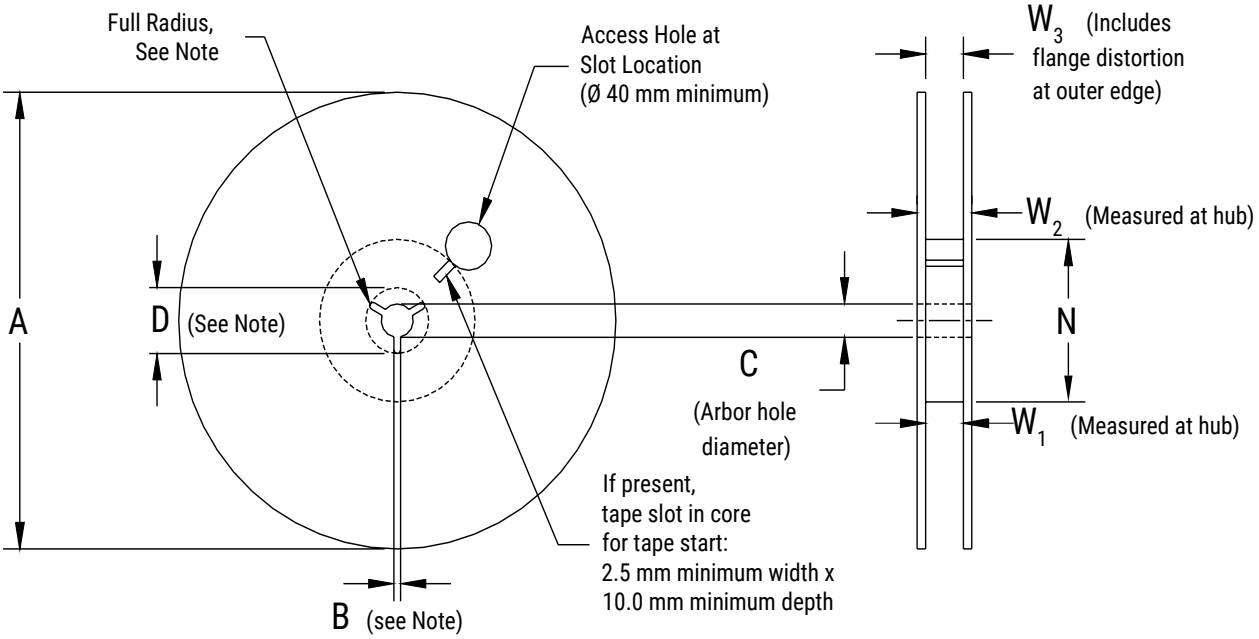


Figure 5 – Reel Dimensions



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

Table 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

Figure 6 – Tape Leader & Trailer Dimensions

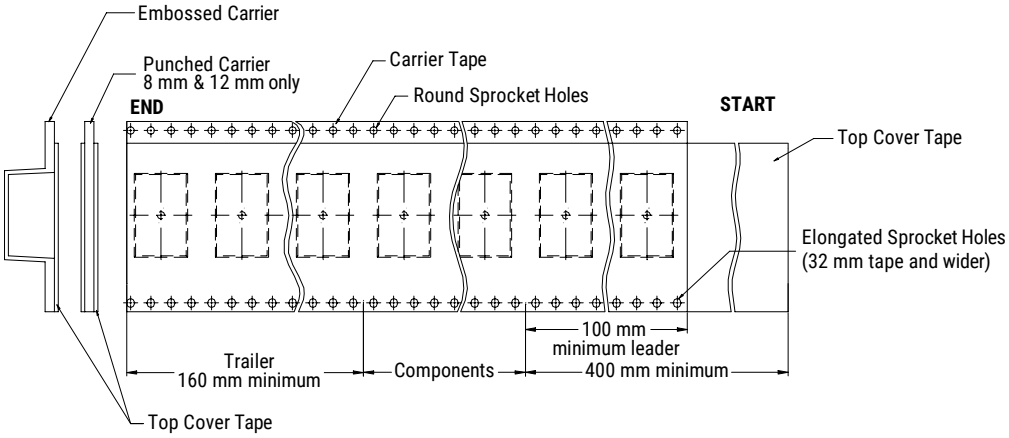
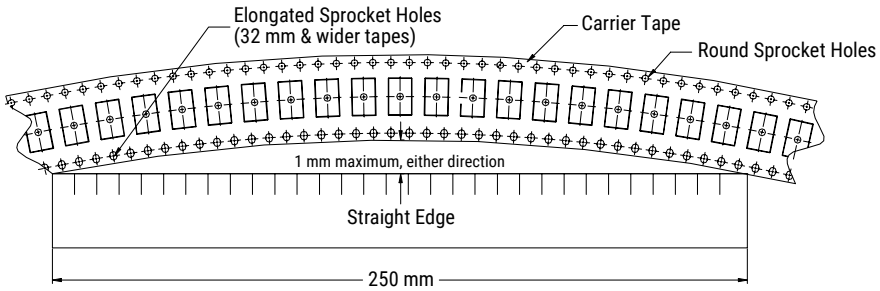


Figure 7 – Maximum Camber



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