KEMET Organic Capacitor (KO-CAP®) – Miniature

T529 Small Case Substrate Terminal Polymer Electrolytic (2012 and 3216 Case Sizes)

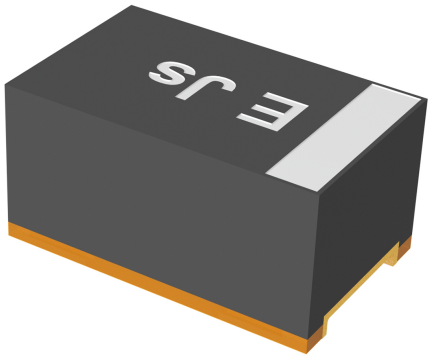
Overview

The KEMET Organic Capacitor (KO-CAP) is a solid electrolytic capacitor with a conductive polymer cathode capable of delivering very low ESR and improved capacitance retention at high frequencies. KO-CAP combines the low ESR of multilayer ceramic, the high capacitance of aluminum electrolytic and the volumetric efficiency of tantalum into a single surface mount package. Unlike liquid electrolyte-based capacitors, KO-CAP has a very long operational life and high ripple current capabilities.

The T529 Small Case Substrate Terminal Polymer Electrolytic design results in the most volumetrically efficient packaging technology available today in polymer electrolytic chip capacitors. This series offers high capacitance values in a small 2012–10 (2.0 mm (L) x 1.2 mm (W) x 1.0 mm (H)) package size. The T529 Series is ideal for use in densely populated circuits such as smart phones and digital cameras where space restrictions do not allow for larger and more commonly available case sizes.

Benefits

- Substrate Termination
- EIA Case Size: 2012 (0805 MLCC Equivalent)
- Low Profile: 1.0 mm maximum
- Improved volumetric efficiency
- Halogen-free Epoxy/RoHS Compliant
- Lead free 260°C reflow capable



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Applications

Typical applications include densely populated circuits where space restrictions do not allow for larger and more commonly available case sizes such as smart phones, digital cameras, MP3 players, GPS navigation systems, WiFi modules, analytical and test equipment, and audio/sound circuits.

Environmental Compliance

RoHS Compliant (6/6) according to Directive 2002/95/EC. Halogen-free.

Ordering Information

T	529	P	476	M	006	A	A	E200
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate/ Design	Termination Finish	ESR Code
T = Tantalum	529 = Substrate Terminal Polymer	P = 2012-10 I = 3216-10	First two digits represent significant figures. Third digit specifies number of zeros. ex. 476 = 47 µF	M = ±20%	006 = 6.3 010 = 10	A = N/A	A = Ni – Au	E = ESR Last three digits specify ESR in mΩ (200 = 200 mΩ)

Performance Characteristics

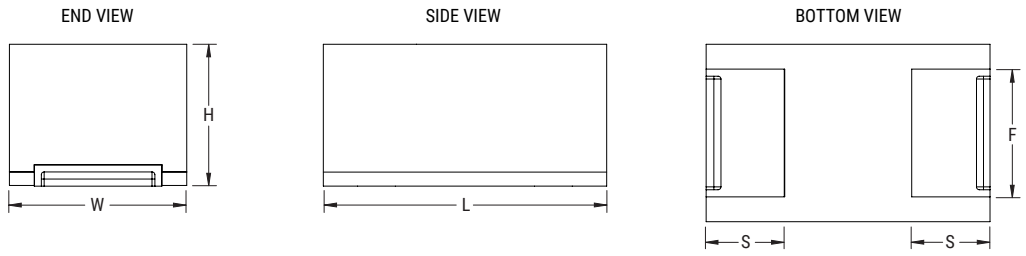
Item	Specifications
Operating Temperature	–55°C to 105°C
Rated Capacitance Range	10 µF to 150 µF at 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	6.3 V and 10 V
DF (120 Hz)	Refer to Part Number Electrical Specification Table
ESR (100 kHz)	Refer to Part Number Electrical Specification Table
Leakage Current	Refer to Part Number Electrical Specification Table

Qualification

Test	Condition/Characteristics				
Endurance	105°C at rated voltage, 1,000 hours		Δ C/C	Within initial Δ C/C limits	
			DF	Within 1.5 x initial limits	
			DCL	Within 3.0 x initial limits	
Damp Heat Steady State	60°C, 90 to 95% RH, 500 hours		Δ C/C	−20% to +30% of initial Δ C/C limit	
			DF	Within 1.5 x initial limits	
			DCL	Within 3.0 x initial limits	
Temperature Stability	Extreme temperature exposure at −55°C and +105°C		+25°C	−55°C	+105°C
		Δ C/C	IL*	−20% to 0% of Δ C/C	0% to +50% of Δ C/C
		DF	IL	IL	IL
		DCL	IL	IL	1.25 CV
Surge Voltage	1.3 Vr, 85°C, 1,000 Ω resistor, 1,000 cycles		Δ C/C	Within initial Δ C/C limits	
			DF	Within initial limit	
			DCL	Within initial limit	
Mechanical Shock	100 G, Saw-Tooth wave		Δ C/C	Within initial Δ C/C limits	
			DF	Within initial limit	
			DCL	Within initial limit	
Vibration	Frequency: 10 to 2 kHz, Sweep: 1 minute, Amplitude of vibration: 1.5 mm, Vibration Time: Each plane shall be 2 hours for a total of 4 hours.		Δ C/C	Within initial Δ C/C limits	
			DF	Within initial limit	
			DCL	Within initial limit	
Terminal strength	Strength: 4.9 N, Time: 10±0.5 seconds (two directions)		Visual	No evidence of mechanical damage	

**IL = Initial limit*

Dimensions – Millimeters



Case Size		Component Dimensions					Weight
KEMET	EIA	L	W	H	F	S	(mg)
P	2012–10	2.0±0.1	1.25±0.1	1.0 maximum	0.9±0.1	0.55±0.1	No data
I	3216–10	3.2±0.2	1.6±0.2	1.0 maximum	1.2±0.1	0.8±0.1	70.12

Table 1 – Ratings & Part Number Reference

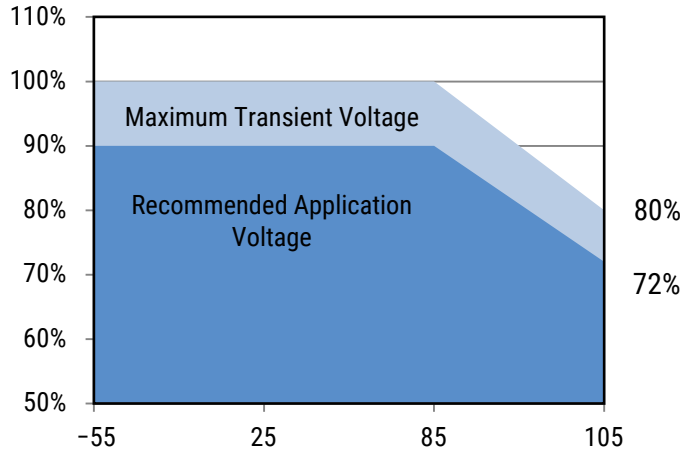
Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	MSL	Maximum Operating Temp
VDC at 85°C	µF	KEMET/EIA	(See below for part options)	µA at +25°C Maximum/ 5 Minutes	% at +25°C 120 Hz Maximum	mΩ at +25°C 100 kHz Maximum	mA at +45°C 100 kHz	Reflow Temp ≤ 260°C	°C
6.3	22	P/2012-10	T529P226M006AAE200	22.0	6	200	510	3	105
6.3	47	P/2012-10	T529P476M006AAE200	29.6	6	200	510	3	105
6.3	47	P/2012-10	T529P476M006AAE150	29.6	6	150	408	3	105
6.3	150	I/3216-10	T529I157M006AAE200	283.5	10	200	548	3	105
10	10	P/2012-10	T529P106M010AAE200	30.0	6	200	510	3	105
10	22	P/2012-10	T529P226M010AAE200	33.0	6	200	510	3	105
10	47	P/2012-10	T529P476M010AAE200*	141.0	6	200	510	3	105

** Part numbers with an asterisk are not recommended for new designs. Please use the T521 version of these part numbers.*

Derating Guidelines

Voltage Rating	-55°C to 85°C		85°C to 105°C	
	Maximum Recommended Steady State Voltage	Maximum Recommended Transient Voltage (1 ms – 1 µs)	Maximum Recommended Steady State Voltage	Maximum Recommended Transient Voltage (1 ms – 1 µs)
≤ 10 V	90% of V_R	V_R	See Chart	See Chart

V_R = Rated Voltage



Ripple Current/Ripple Voltage

Permissible AC ripple voltage and current are related to equivalent series resistance (ESR) and the power dissipation capabilities of the device. Permissible AC ripple voltage which may be applied is limited by two criteria:

1. The positive peak AC voltage plus the DC bias voltage, if any, must not exceed the DC voltage rating of the capacitor.
2. The negative peak AC voltage in combination with bias voltage, if any, must not exceed the allowable limits specified for reverse voltage. See the Reverse Voltage section for allowable limits.

The maximum power dissipation by case size can be determined using the table at right. The maximum power dissipation rating stated in the table must be reduced with increasing environmental operating temperatures. Refer to the table below for temperature compensation requirements.

Temperature Compensation Multipliers for Maximum Ripple Current		
T ≤ 45°C	45°C < T ≤ 85°C	85°C < T ≤ 105°C
1.00	0.90	0.40

T= Environmental Temperature

The maximum power dissipation rating must be reduced with increasing environmental operating temperatures. Refer to the Temperature Compensation Multiplier table for details.

Case Code	EIA Case Code	Maximum Power Dissipation (P max) mWatts at 45°C with +30°C Rise
I	3216	60
P	2012	25

Using the P max of the device, the maximum allowable rms ripple current or voltage may be determined.

$I(max) = \sqrt{P\ max/R}$
$E(max) = Z\sqrt{P\ max/R}$

I = rms ripple current (amperes)
E = rms ripple voltage (volts)
P max = maximum power dissipation(watts)
R = ESR at specified frequency (ohms)
Z = Impedance at specified frequency (ohms)

Reverse Voltage

Polymer electrolytic capacitors are polar devices and may be permanently damaged or destroyed if connected in the wrong polarity. These devices will withstand a small degree of transient voltage reversal for short periods as shown in the below table.

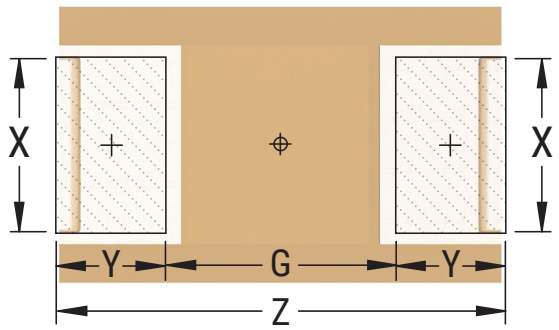
Temperature	Permissible Transient Reverse Voltage
25°C	15% of Rated Voltage
55°C	10% of Rated Voltage
85°C	5% of Rated Voltage
105°C	3% of Rated Voltage
125°C*	1% of Rated Voltage

**For Series Rated to 125°C*

Table 2 – Land Dimensions/Courtyard

KEMET	Metric Size Code	Dimensions (mm) Minimum – Maximum			
Case	EIA	G	Z	X	Y
I	3216–10	1.00 – 1.65	3.25 – 3.80	1.1 – 1.30	0.8 – 1.40
P	2012–10	0.40 – 1.05	2.05 – 2.60	0.80 – 1.00	0.5 – 1.1

(JEITA RC-2371 is recommended for reference)



Soldering Process

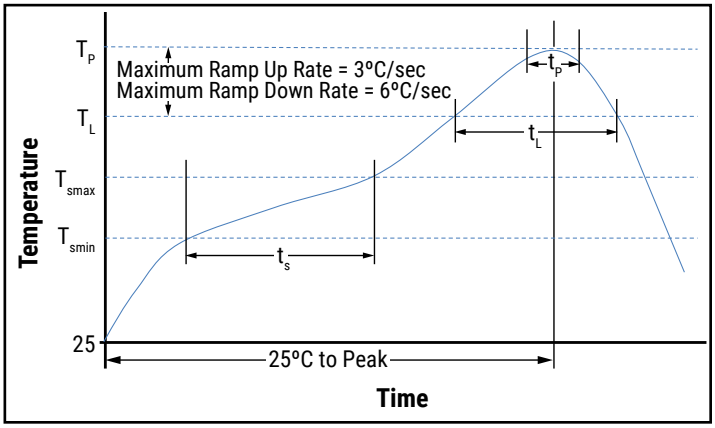
KEMET's families of surface mount capacitors are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J–STD–020D standard for moisture sensitivity testing. The devices can safely withstand a maximum of three reflow passes at these conditions.

Please note that although the X/7343–43 case size can withstand wave soldering, the tall profile (4.3 mm maximum) dictates care in wave process development.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the molded case. The iron should be used to heat the solder pad, applying solder between the pad and the termination, until reflow occurs. Once reflow occurs, the iron should be removed immediately. "Wiping" the edges of a chip and heating the top surface is not recommended.

Profile Feature	SnPb Assembly	Pb-Free Assembly
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/seconds maximum	3°C/seconds maximum
Liquidous Temperature (T_L)	183°C	217°C
Time Above Liquidous (t_L)	60 – 150 seconds	60 – 150 seconds
Peak Temperature (T_P)	220°C* 235°C**	250°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/seconds maximum	6°C/seconds maximum
Time 25°C to Peak Temperature	6 minutes maximum	8 minutes maximum

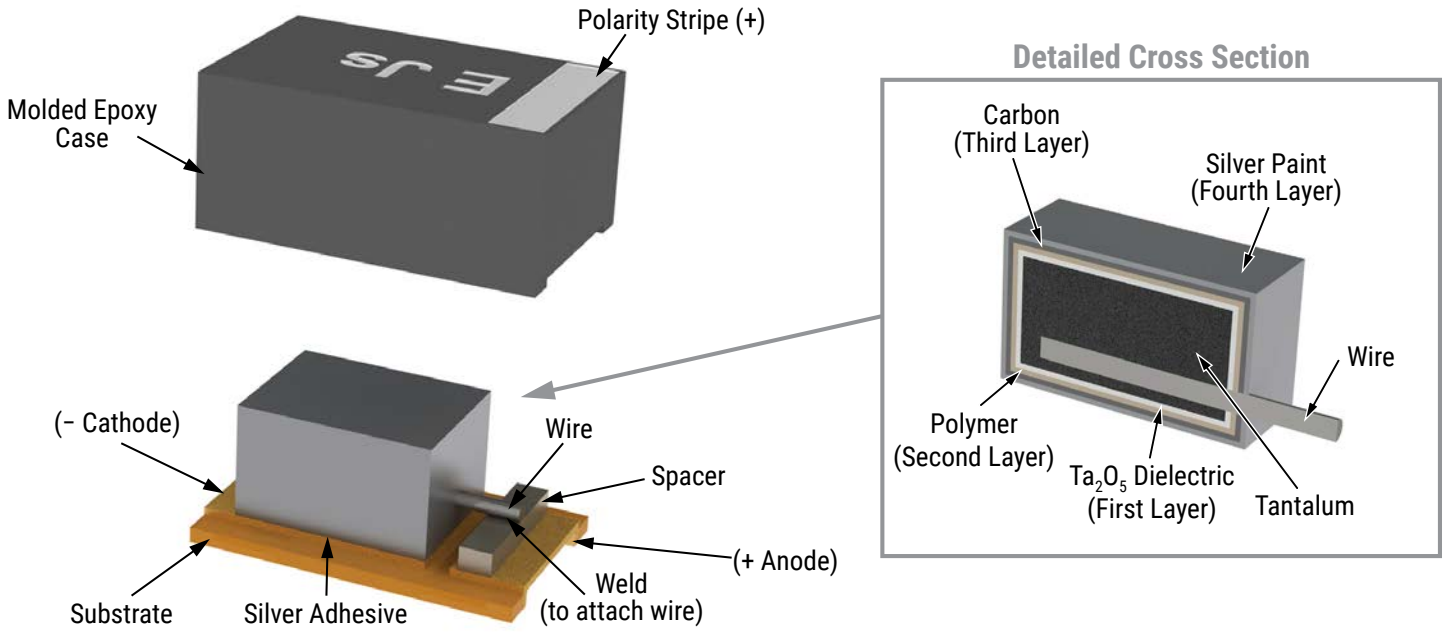
Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.
**Case Size D, E, P, Y, and X*
***Case Size A, B, C, H, I, K, M, R, S, T, U, V, W, and Z*



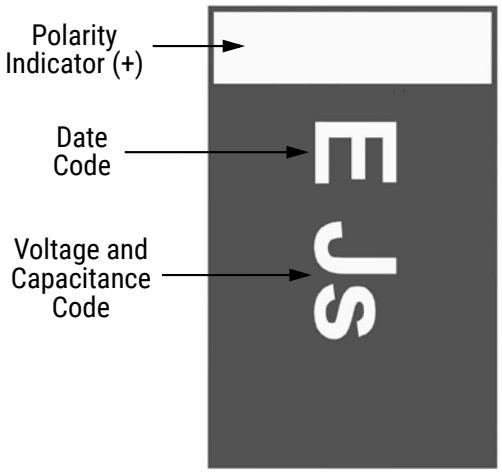
Storage

All KO-CAP Series are shipped in moisture barrier bags with a desiccant and moisture indicator card. These series are classified as MSL3 (Moisture Sensitivity Level 3). Product contained within the moisture barrier bags should be stored in normal working environments with temperatures not to exceed 30°C and humidity not in excess of 60% RH.

Construction



Capacitor Marking



Code	J	A
Rated Voltage	6 V	10 V

Code	j	s	a
Capacitance	22	47	100

Date Code *												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	A	B	C	D	E	F	G	H	J	K	L	M
2014	N	P	Q	R	S	T	U	V	W	X	Y	Z
2015	a	b	c	d	e	f	g	h	j	k	l	m
2016	n	p	q	r	s	t	u	v	w	x	y	z

Tape & Reel Packaging Information

KEMET's molded chip capacitor families are packaged in 8 and 12 mm plastic tape on 7" and 13" reels in accordance with *EIA Standard 481*: Embossed Carrier Taping of Surface Mount Components for Automatic Handling. This packaging system is compatible with all tape-fed automatic pick-and-place systems.

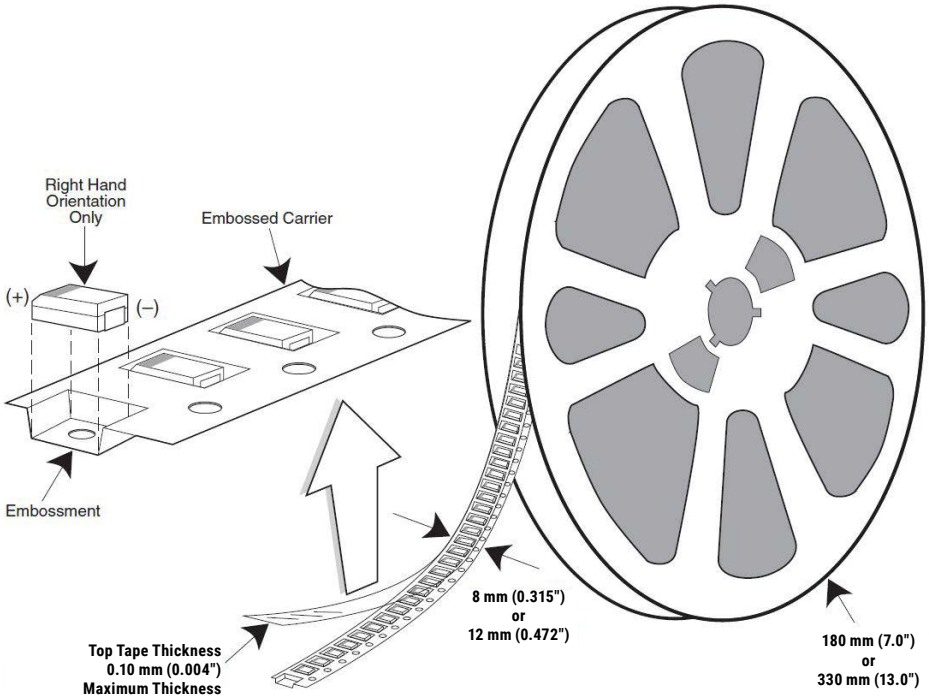


Table 3 – Packaging Quantity

KEMET Case Codes		Tape and Reel Dimensions	
		Tape Width (mm)	180 mm (7" diameter)
I	3216	8	3,000
P	2012	8	3,000

(Quantity per reel)

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

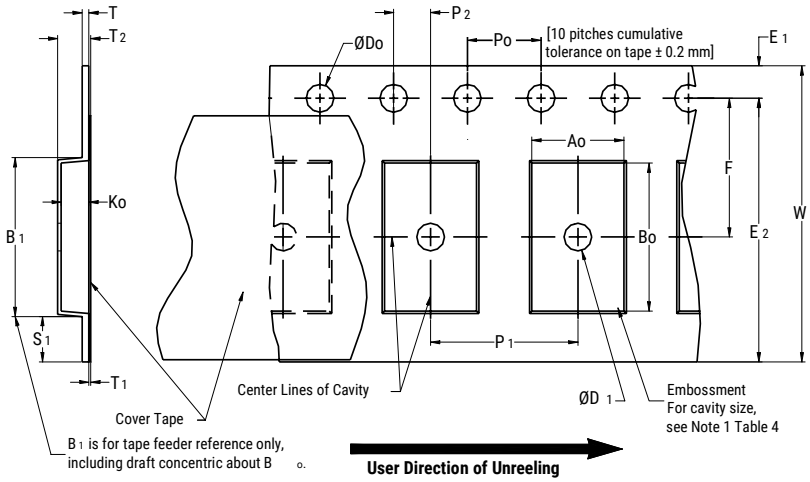


Table 4 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D_0	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
8 mm	1.5+0.10/−0.0 (0.059+0.004/−0.0)	1.0 (0.039)	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		1.5 (0.059)				30 (1.181)			
16 mm					2.0±0.1 (0.079±0.059)				

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
8 mm	Single (4 mm)	4.35 (0.171)	6.25 (0.246)	3.5±0.05 (0.138±0.002)	2.0±0.05 or 4.0±0.10 (0.079±0.002 or 0.157±0.004)	2.5 (0.098)	8.3 (0.327)	Note 5
12 mm	Single (4 mm) & Double (8 mm)	8.2 (0.323)	10.25 (0.404)	5.5±0.05 (0.217±0.002)	2.0±0.05 (0.079±0.002) or 4.0±0.10 (0.157±0.004) or 8.0±0.10 (0.315 ±0.004)	4.6 (0.181)	12.3 (0.484)	
16 mm	Triple (12 mm)	12.1 (0.476)	14.25 (0.561)	7.5±0.10 (0.295±0.004)	4.0±0.10 (0.157±0.004) to 12.0±0.10 (0.472±0.004)	8.0 (0.315)	16.3 (0.642)	

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 4).
3. If S_1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481–D, paragraph 4.3, section 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 2).
(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 3).
(e) see Addendum in EIA Standard 481–D 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)

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

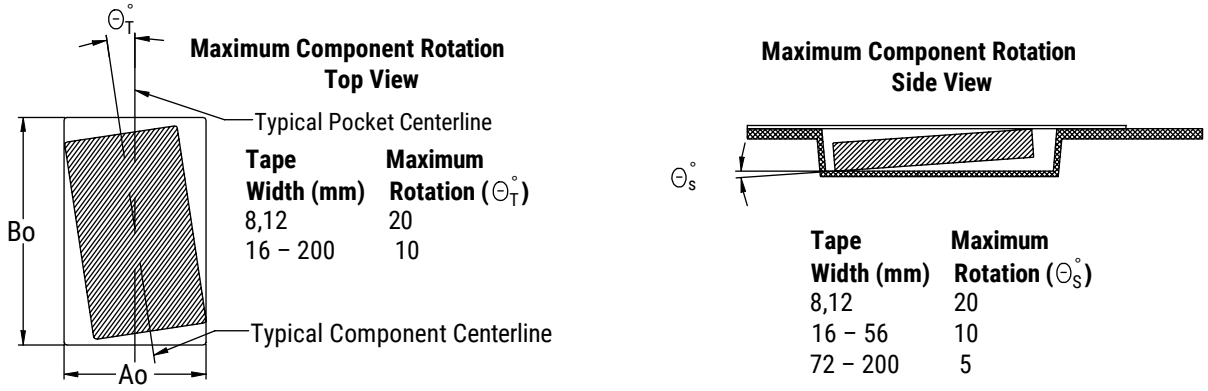


Figure 3 – Maximum Lateral Movement

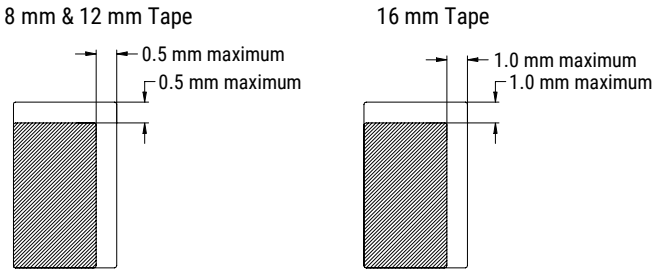


Figure 4 – Bending Radius

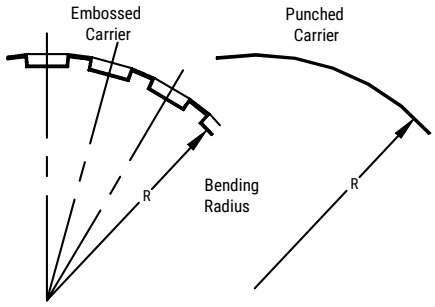
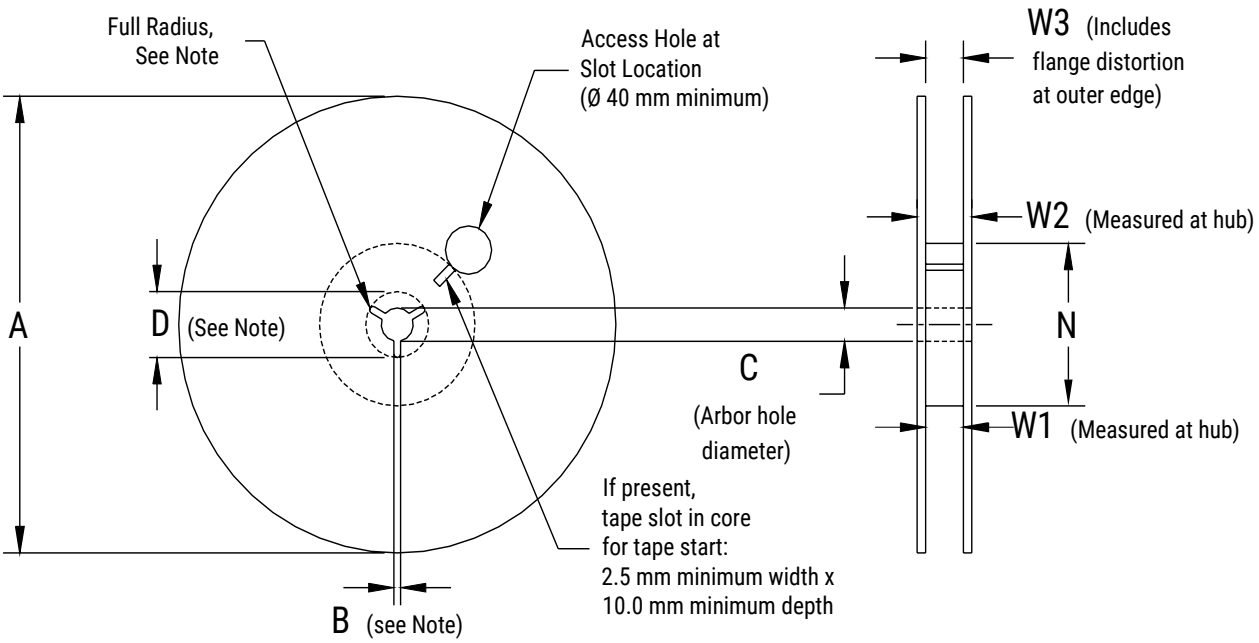


Figure 5 – Reel Dimensions



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
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				

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)	

Figure 6 – Tape Leader & Trailer Dimensions

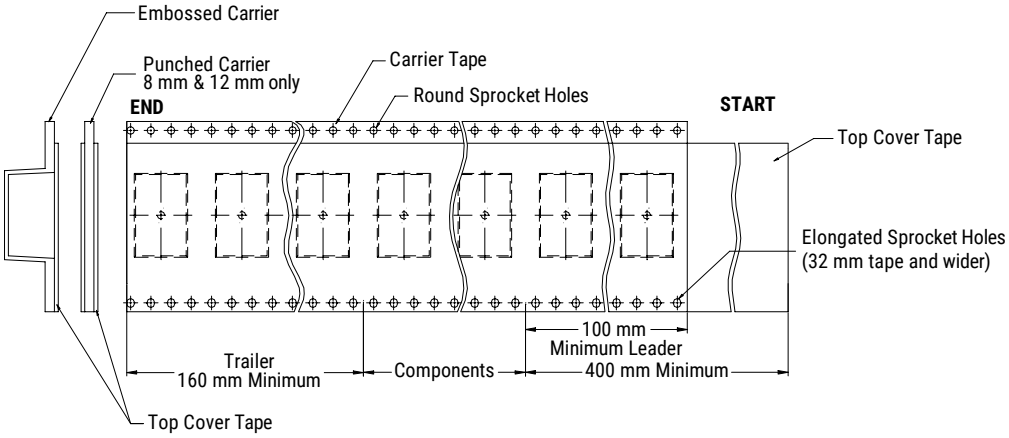
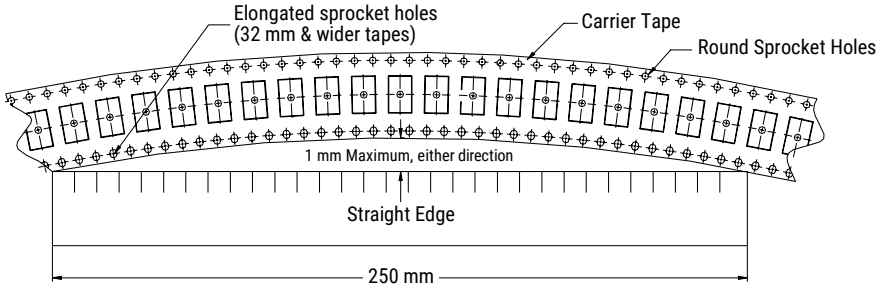


Figure 7 – Maximum Camber



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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.