

## Overview

The KEMET Low ESR Polymer Series is a tantalum capacitor with a Ta anode and Ta<sub>2</sub>O<sub>5</sub> dielectric. A conductive organic polymer replaces the traditionally used MnO<sub>2</sub> as the cathode plate of the capacitor. This results in very low ESR and improved capacitance retention at high frequency. The KO-CAP also exhibits a benign failure mode which eliminates the ignition failures that can occur in standard MnO<sub>2</sub> tantalum types. KO-CAPs may also be operated at voltages up to 90% of rated voltage for part types with rated voltages of ≤ 10 volts and up to 80% of rated voltage for part types > 10 volts with equivalent or better reliability than traditional MnO<sub>2</sub> tantalum capacitors operated at 50% of rated voltage.

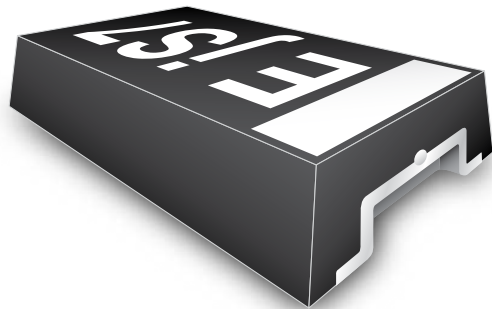
The T527 Series KO-CAP combines improved packaging efficiency with a low profile design through the use of facedown terminal technology. This series offers high capacitance in a 3216-10 (3.2 mm (L) x 1.6 mm (W) x 1.0 mm (H)) package size. The T527 Series is ideal for use in densely populated circuits such as smart phones and digital cameras where space restrictions do not allow for larger and more commonly available case sizes.

## Benefits

- Polymer cathode technology
- EIA Case Size: 3216 (1206 MLCC Equivalent)
- Low Profile: 1.0 mm maximum
- Non-ignition failure mode
- Improved volumetric efficiency
- Self-healing mechanism
- Capacitance: 22 – 100 µF
- Use up to 90% of rated voltage (10% derating)
- Voltage: 4 V – 10 V
- RoHS Compliant and Halogen Free
- 105°C maximum temperature capability
- Lead free 260°C reflow capable

## 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.



RoHS Compliant



Halogen Free

## Ordering Information

T	527	I	476	M	006	A	T	E200	
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Voltage	Failure Rate/Design	Lead Material	ESR Code	Packaging (C-Spec)
T = Tantalum	527 = Facedown Terminal Polymer	I = 3216	First two digits represent significant figures. Third digit specifies number of zeros. e.g., 476 = 47 $\mu$ F	M = $\pm$ 20%	004 = 4 V 006 = 6.3 V 010 = 10 V	A = N/A	T = 100% Tin (Sn)	E = ESR Last three digits specify ESR in m $\Omega$ (200 = 200 m $\Omega$ )	Blank = 7" Reel

## Performance Characteristics

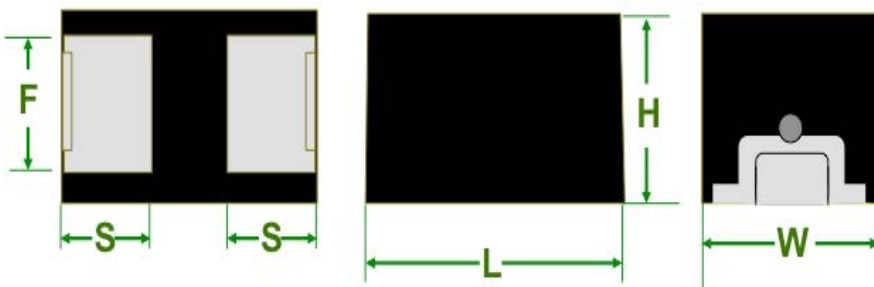
Item	Specifications
Operating Temperature	-55°C to 105°C
Rated Capacitance Range	22 $\mu$ F to 100 $\mu$ F @ 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	4 – 10 V
DF (120 Hz)	Refer to Part Number Electrical Specification Table
ESR (100 kHz)	Refer to Part Number Electrical Specification Table
Leakage Current	Refer to Part Number Electrical Specification Table

## Qualification

Test	Condition/Characteristics				
Endurance	85°C @ rated voltage, 1,000 hours	$\Delta C/C$	Within initial $\Delta C/C$ limits		
		DF	Within 1.5 x initial limits		
		DCL	Within initial limits		
Damp Heat Steady State	40°C, 90 to 95% RH, 500 hours	$\Delta C/C$	-30% to +20% of initial $\Delta C/C$ limit		
		DF	Within 1.5 x initial limits		
		DCL	Within initial limits		
Temperature Stability	Extreme temperature exposure at -55°C and +105°C	$\Delta C/C$	+25°C	-55°C	+105°C
		DF	IL*	-20% to 0% of $\Delta C/C$	-50% - 0% of $\Delta C/C$
		DCL	IL	IL	IL
Surge Voltage	1.3 Vr, 85°C, 1,000 $\Omega$ resistor, 1,000 cycles	$\Delta C/C$	Within initial $\Delta C/C$ limits		
		DF	Within initial limit		
		DCL	Within initial limit		
Mechanical Shock	100 G, Saw-Tooth wave	$\Delta C/C$	Within initial $\Delta C/C$ 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.	$\Delta C/C$	Within initial $\Delta C/C$ limits		
		DF	Within initial limit		
		DCL	Within initial limit		
Terminal strength	Strength: 4.9 N, Time: 10 $\pm$ 0.5 seconds (two directions)	Visual	No evidence of mechanical damage		

\*IL = Initial limit

## Dimensions – Millimeters



Case Size		Component				
KEMET	EIA	L	W	H	F	S
I	3216-10	3.2 $\pm$ 0.2	1.6 $\pm$ 0.2	1.0 Maximum	1.2 $\pm$ 0.1	0.8 $\pm$ 0.2

**Table 1 – Ratings & Part Number Reference**

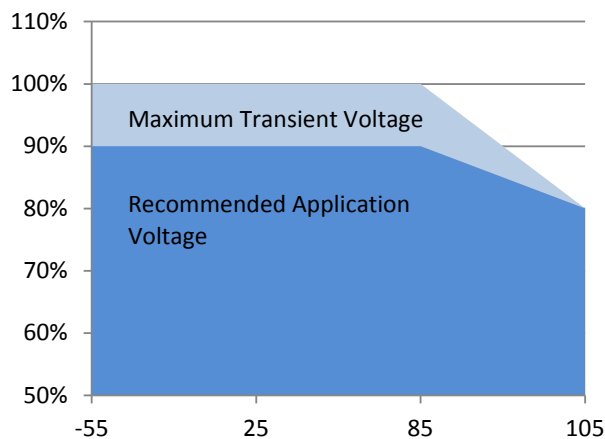
Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	Moisture Sensitivity	Rated Temp.
VDC	μF	KEMET/EIA	(See below for part options)	μA @ +25°C Maximum/ 5 Minutes	% @ +25°C 120 Hz Maximum	mΩ @ +25°C 100 kHz Maximum	(mA) +45°C 100 kHz	Temp ≤ 260°C	°C
4	100	I/3216-10	T5271107M004ATE200	40.0	8	200	775	3	105
6	47	I/3216-10	T5271476M006ATE200	29.6	6	200	632	3	105
10	22	I/3216-10	T5271226M010ATE200	22.0	8	200	548	3	105
10	33	I/3216-10	T5271336M010ATE200	33.0	6	200	548	3	105
10	47	I/3216-10	T5271476M010ATE200	47.0	6	200	548	3	105

Refer to Ordering Information for additional detail.

### 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	$V_R$

$V_R$  = 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 Power Dissipation		
≤ 45°C	45°C < T ≤ 85°C	85°C < T ≤ 105°C
1.00	0.90	0.40

*T* = Environmental Temperature

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

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

$$E(\max) = \sqrt{P \max \cdot R}$$

*I* = rms ripple current (amperes)

*E* = rms ripple voltage (volts)

*P max* = maximum power dissipation (watts)

*R* = ESR at specified frequency (ohms)

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

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

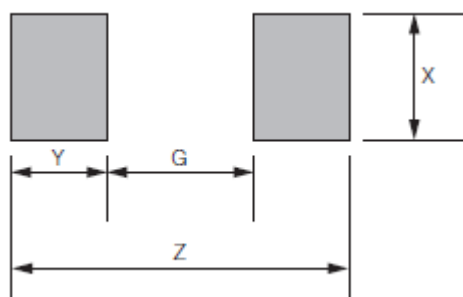
## Reverse Voltage

Polymer tantalum 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 in mm			
		G Maximum	Z Minimum	X Minimum	Y ref
Case	EIA				
I	3216-10	1.65	3.25	1.10	0.80
P	2012-10	1.05	2.05	0.80	0.50

## 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.

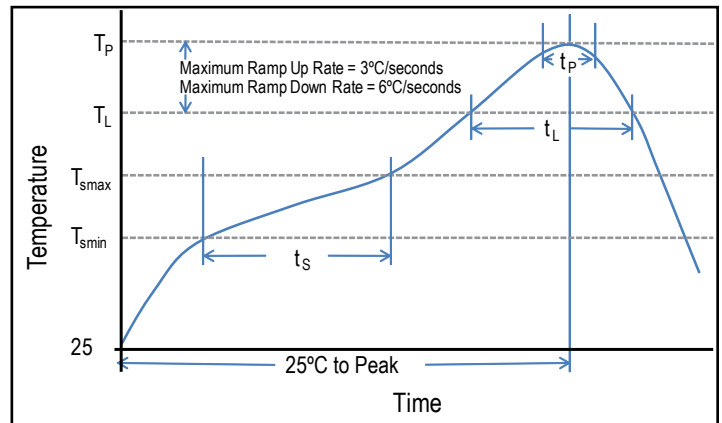
During typical reflow operations, a slight darkening of the gold-colored epoxy may be observed. This slight darkening is normal and not harmful to the product. Marking permanency is not affected by this change.

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

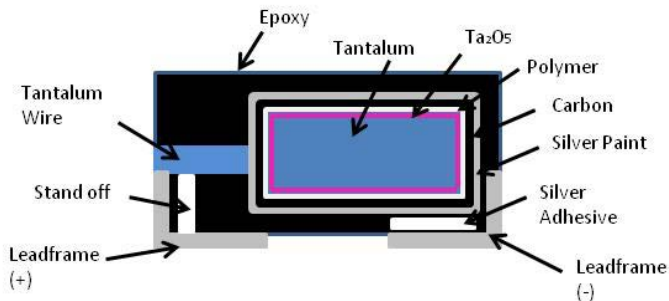
Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.

\*Case Size D, E, P, Y, and X

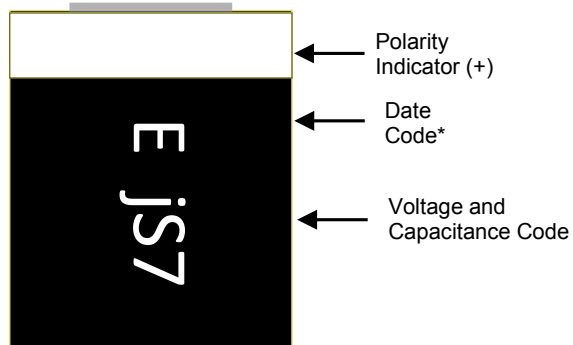
\*\*Case Size A, B, C, H, I, K, M, R, S, T, U, V, W, and Z



## Construction



## Capacitor Marking



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

Code	g	j	A
Rated Voltage	4 V	6 V	10 V

Code	J7	N7	S7	W7	A8
Capacitance	22	33	47	68	100

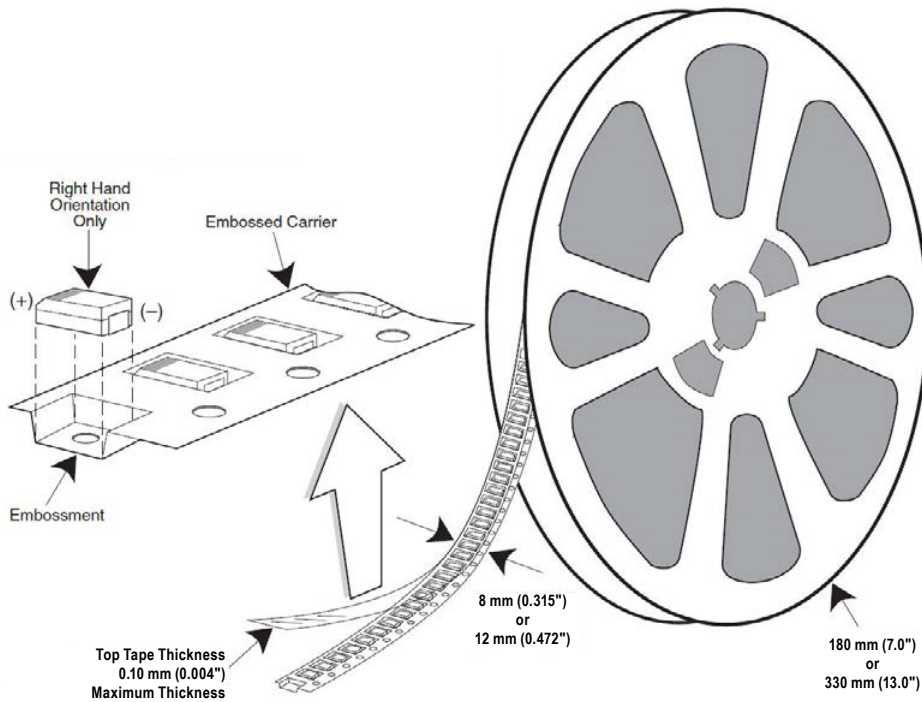
## Storage

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.



## Tape & Reel Packaging Information

KEMET’s molded tantalum and aluminum chip capacitor families are packaged in 8 and 12 mm plastic tape on 7" and 13" reels in accordance with *EIA Standard 481-1*: Embossed Carrier Taping of Surface Mount Components for Automatic Handling. This packaging system is compatible with all tape-fed automatic pick-and-place systems.

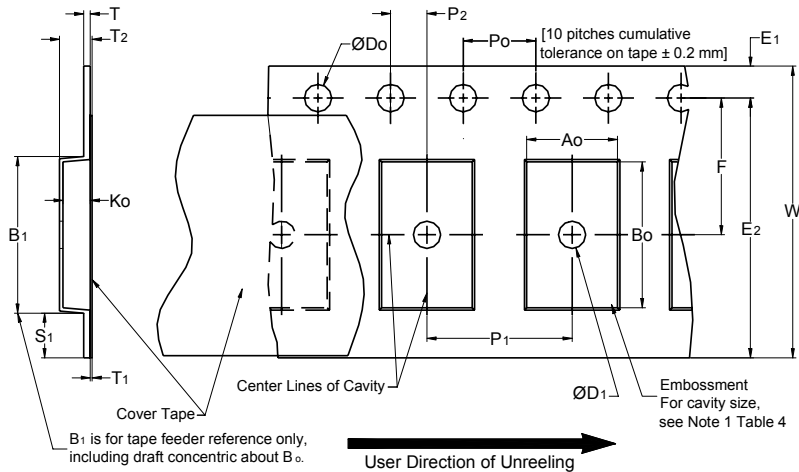


**Table 3 – Packaging Quantity**

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

(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									
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)	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)	8.2 (0.323)	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)	12.1 (0.476)	14.25 (0.561)	5.5 ±0.05 (0.217 ±0.002)	8.0 ±0.10 (0.315 ±0.004)	4.6 (0.181)	16.3 (0.642)		

- 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 5).
- 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).
- $B_1$  dimension is a reference dimension for tape feeder clearance only.
- The cavity defined by  $A_0$ ,  $B_0$  and  $K_0$  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 2).
  - 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).
  - see Addendum in EIA Standard 481–D for standards relating to more precise taping requirements.

## Packaging Information Performance Notes

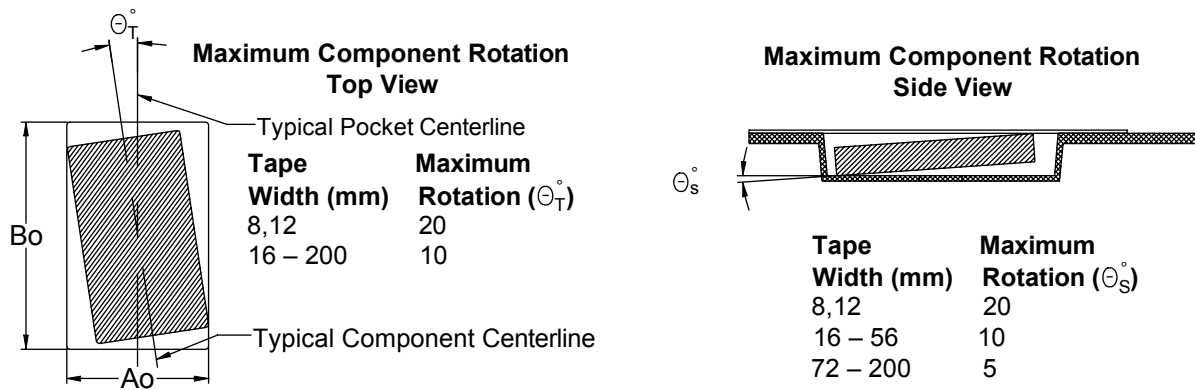
- 1. Cover Tape Break Force:** 1.0 Kg minimum.
- 2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

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)

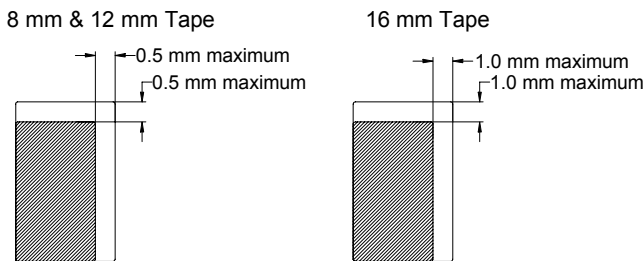
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

- 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.

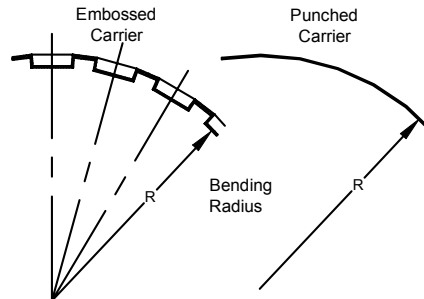
### Figure 2 – Maximum Component Rotation



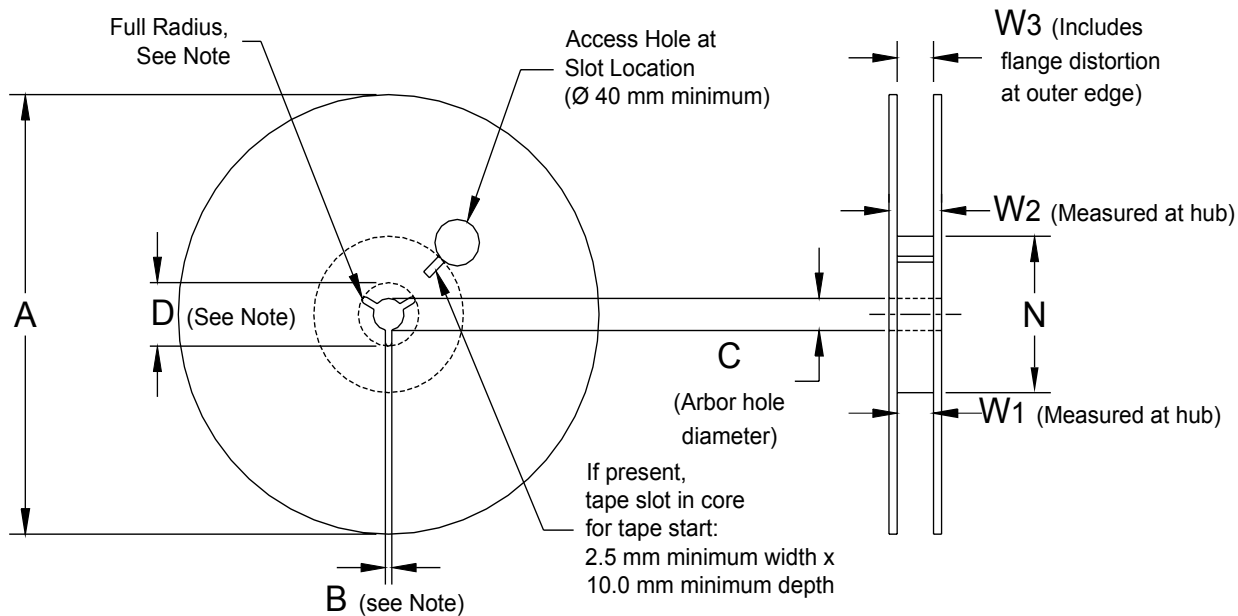
### Figure 3 – Maximum Lateral Movement



### Figure 4 – Bending Radius



**Figure 5 – Reel Dimensions**



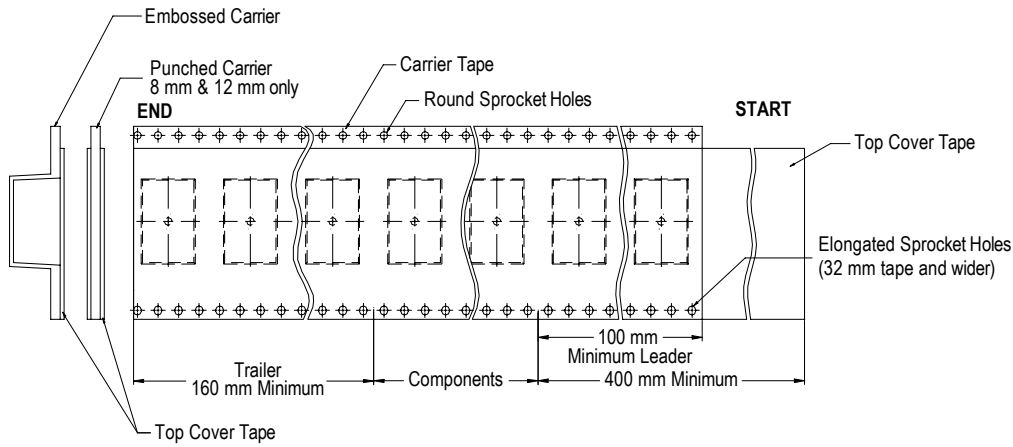
Note: Drive spokes optional; if used, dimensions B and D shall apply.

**Table 5 – Reel Dimensions**

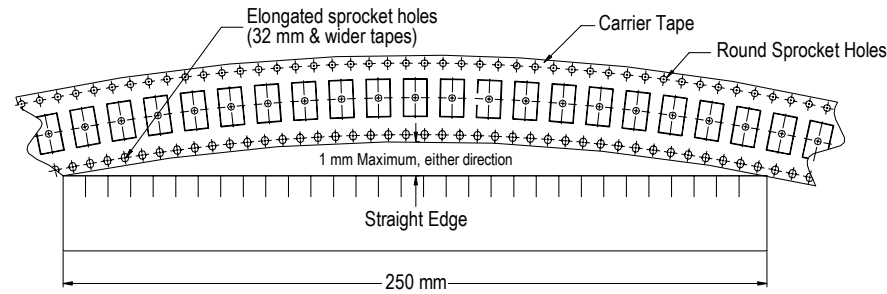
Metric will govern

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 <sub>1</sub>	W <sub>2</sub> Maximum	W <sub>3</sub>
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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Taipei, Taiwan  
Tel: 886-2-27528585

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Penang, Malaysia  
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Tel: 91-806-53-76817

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## Other KEMET Resources

Tools	
Resource	Location
Configure A Part: CapEdge	<a href="http://capacitoredge.kemet.com">http://capacitoredge.kemet.com</a>
SPICE & FIT Software	<a href="http://www.kemet.com/spice">http://www.kemet.com/spice</a>
Search Our FAQs: KnowledgeEdge	<a href="http://www.kemet.com/keask">http://www.kemet.com/keask</a>
Electrolytic LifeCalculator	<a href="http://www.kemet.com:8080/elc">http://www.kemet.com:8080/elc</a>

Product Information	
Resource	Location
Products	<a href="http://www.kemet.com/products">http://www.kemet.com/products</a>
Technical Resources (Including Soldering Techniques)	<a href="http://www.kemet.com/technicalpapers">http://www.kemet.com/technicalpapers</a>
RoHS Statement	<a href="http://www.kemet.com/rohs">http://www.kemet.com/rohs</a>
Quality Documents	<a href="http://www.kemet.com/qualitydocuments">http://www.kemet.com/qualitydocuments</a>

Product Request	
Resource	Location
Sample Request	<a href="http://www.kemet.com/sample">http://www.kemet.com/sample</a>
Engineering Kit Request	<a href="http://www.kemet.com/kits">http://www.kemet.com/kits</a>

Contact	
Resource	Location
Website	<a href="http://www.kemet.com">www.kemet.com</a>
Contact Us	<a href="http://www.kemet.com/contact">http://www.kemet.com/contact</a>
Investor Relations	<a href="http://www.kemet.com/ir">http://www.kemet.com/ir</a>
Call Us	1-877-MyKEMET
Twitter	<a href="http://twitter.com/kemetcapacitors">http://twitter.com/kemetcapacitors</a>

## Disclaimer

All product specifications, statements, information and data (collectively, the "Information") in this datasheet are subject to change. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed.

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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.

