

## Overview

The KEMET Organic Capacitor (KO-CAP) 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 steady state 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 T528 Series KO-CAP combines ultra-low ESR and high capacitance in a package design that offers the lowest ESL in the market for this type of product. This series offers exceptional performance for high-speed server and microprocessor decoupling — designs that are driving the demand for low inductance chips. The T528 uses a different termination design that allows for a reduction in the inductance loop area and comes in a low profile 1.7mm case height. These product features offer the advantage of improved capacitance retention at frequencies of up to 1 MHz.

## Benefits

- Polymer cathode technology
- 100% accelerated steady state aging
- Low ESL <0.7nH @ 20MHz
- 100% surge current tested
- High frequency capacitance retention
- Non-ignition failure mode
- Improved volumetric efficiency
- Self-healing mechanism
- Capacitance: 150µF to 470µF
- Use up to 90% of rated voltage (10% derating)
- Voltage: 2.5V to 6.3V
- RoHS compliant and Halogen Free
- 105°C maximum temperature capability
- Lead free 260°C reflow capable

## Applications

Typical applications include high speed server, microprocessor decoupling and high ripple current applications.



## Environmental Compliance

RoHS Compliant (6/6)\* according to Directive 2002/95/EC

\*When ordered with 100% Sn Solder

## SPICE

For a detailed analysis of specific part numbers, please visit [kemet.com](http://kemet.com) for a free download of KEMET's SPICE software. The KEMET SPICE program is freeware intended to aid design engineers in analyzing the performance of these capacitors over frequency, temperature, ripple, and DC bias conditions.

## Ordering Information

T	528	Z	337	M	2R5	A	T	E009	
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Voltage	Failure Rate/Design	Lead Material	ESR Code	Packaging (C-Spec)
T = Tantalum	528 = Low ESL Facedown Terminal Polymer	K = 3528-10 W = 7343-15 Z = 7343-17	First two digits represent significant figures. Third digit specifies number of zeros.	M = ±20%	2R5 = 2.5V 003 = 3V 004 = 4V 006 = 6.3V 010 = 10V	A = N/A	T = 100% Matte Tin (Sn) Plated	E = ESR Last three digits specify ESR in mOhms. (009 = 9mOhms)	Blank = 7" Reel 7280 = 13" Reel

## Performance Characteristics

Item	Performance Characteristics
Operating Temperature	-55°C to 105°C
Rated Capacitance Range	150µF - 470µF @ 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	2.5V - 10V
DF(120Hz)	≤ 10%
ESR (100kHz)	Refer to Part Number Electrical Specification Table
Leakage Current	≤ 0.1CV (µA) at Rated Voltage after 5 minutes

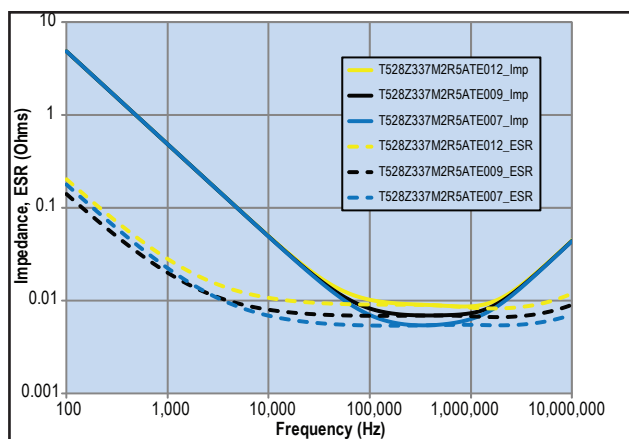
## Qualification

Test	Condition	Characteristics				
Endurance	105°C @ Rated Voltage, 2000 Hrs.	ΔC/C	Within -20/+10% of initial value			
		DF	≤ Initial Limit			
		DCL	Within 1.25 x initial limit			
		ESR	Within 2.0 x initial limit			
Storage Life	105°C @ 0 Volts, 2000 Hrs.	ΔC/C	Within -20/+10% of initial value			
		DF	Within initial limits			
		DCL	Within 1.25 x initial limit			
		ESR	Within 2.0 x initial limit			
Humidity	60°C, 90% RH, 500 Hrs.	ΔC/C	Within -5%/+35% of initial value			
		DF	≤ Initial Limit			
		DCL	Within 5.0 x initial limit			
		ESR	Within 2.0 x initial limit			
Temperature Stability	Extreme temperature exposure at a succession of continuous steps at +25°C, -55°C, +25°C, +85°C, +105°C, +25°C.	+25°C	-55°C	+85°C	+105°C	
		ΔC/C	IL*	±20%	±20%	±30%
		DF	IL	IL	1.2 x IL	1.5 x IL
		DCL	IL	n/a	10 x IL	10 x IL
Surge Voltage	105°C, 1.32 x Rated Voltage, 33Ω Resistance, 1000 cycles	ΔC/C	Within -20/+10% of initial value			
		DF	Within initial limits			
		DCL	Within initial limits			
		ESR	Within initial limits			
Mechanical Shock/Vibration	Mil-Std-202, Meth. 213, Cond. I, 100G Peak Mil-Std-202, Meth. 204, Cond. D, 10Hz to 2000Hz, 20G Peak	ΔC/C	Within ±10% of initial value			
		DF	Within initial limits			
		DCL	Within initial limits			

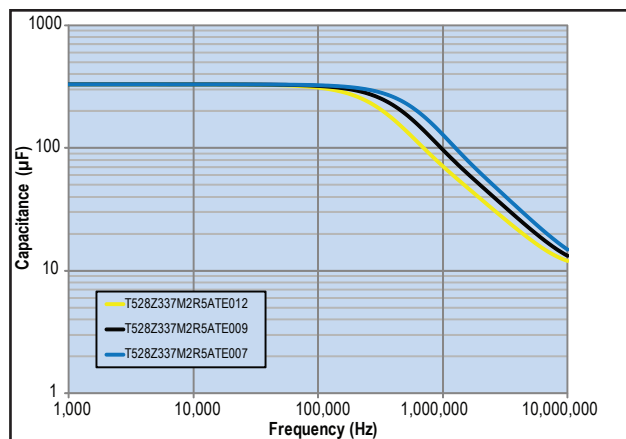
\*IL = Initial Limit

## Electrical Characteristics

ESR vs. Frequency



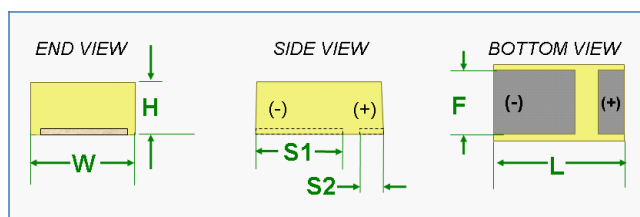
Capacitance vs. Frequency



## Dimensions – Millimeters (Inches)

Metric will govern

Case Size		Component					
KEMET	EIA	L	W	H	F ±0.2	S1 ±0.2	S2 ±0.2
K	3528-10	3.5 ± 0.3	2.8 ± 0.3	1.0 max	2	1.2	0.6
W	7343-15	7.3 ± 0.4	4.3 ± 0.3	1.5 max	2.8	5.1	1.3
Z	7343-17	7.3 ± 0.4	4.3 ± 0.3	1.7 max	2.8	5.1	1.3



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

Rated Voltage	Rated Cap	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	Moisture Sensitivity	Rated Temp
VDC	120Hz	KEMET/EIA	(See below for part options)	+20°C	+20°C 120Hz	+20°C 100kHz	+45°C 100kHz	Temp≤260°C	(°C)
	µF			µAmps	% Max	mOhms	mAmps	J-STD-020D	
2.5	330	W/7343-15	T528W337M2R5ATE009	82.5	10	9	6000.0	3	105
2.5	330	Z/7343-18	T528Z337M2R5ATE005	82.5	10	5	8100.0	3	105
2.5	330	Z/7343-18	T528Z337M2R5ATE007	82.5	10	7	6800.0	3	105
2.5	330	Z/7343-18	T528Z337M2R5ATE008	82.5	10	8	6400.0	3	105
2.5	330	Z/7343-18	T528Z337M2R5ATE009	82.5	10	9	6000.0	3	105
2.5	330	Z/7343-18	T528Z337M2R5ATE012	82.5	10	12	5200.0	3	105
2.5	470	Z/7343-18	T528Z477M2R5ATE005	117.5	10	5	8100.0	3	105
2.5	470	Z/7343-18	T528Z477M2R5ATE008	117.5	10	8	6400.0	3	105
2.5	470	Z/7343-18	T528Z477M2R5ATE009	117.5	10	9	6000.0	3	105
2.5	470	Z/7343-18	T528Z477M2R5ATE012	117.5	10	12	5200.0	3	105
4	220	Z/7343-18	T528Z227M004ATE007	88.0	10	7	6800.0	3	105
4	220	Z/7343-18	T528Z227M004ATE008	88.0	10	8	6400.0	3	105
4	220	Z/7343-18	T528Z227M004ATE009	88.0	10	9	6000.0	3	105
4	220	Z/7343-18	T528Z227M004ATE012	88.0	10	12	5200.0	3	105
4	330	Z/7343-18	T528Z337M004ATE009	132.0	10	9	6000.0	3	105
4	330	Z/7343-18	T528Z337M004ATE012	132.0	10	12	5200.0	3	105
6.3	150	K/3528-21	T528K157M006ATE200	94.5	10	200	900.0	3	105
6.3	150	Z/7343-18	T528Z157M006ATE007	94.5	10	7	6800.0	3	105
6.3	150	Z/7343-18	T528Z157M006ATE008	94.5	10	8	6400.0	3	105
6.3	150	Z/7343-18	T528Z157M006ATE009	94.5	10	9	6000.0	3	105
6.3	150	Z/7343-18	T528Z157M006ATE012	94.5	10	12	5200.0	3	105
6.3	220	Z/7343-18	T528Z227M006ATE009	138.6	10	9	6000.0	3	105
6.3	220	Z/7343-18	T528Z227M006ATE012	138.6	10	12	5200.0	3	105
VDC	µF	KEMET/EIA	(see below for part options)	µAmps	% Max	mOhms	mAmps	J-STD-020D	(°C)
	120Hz			+20°C	+20°C 120Hz	+20°C 100kHz	+45°C 100kHz	Temp≤260°C	
Rated Voltage	Rated Cap	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum allowable ripple current	Moisture Sensitivity	Rated Temp

Other part number options:

1- Standard with tin terminations (14th character = T). Tin/lead terminations is also available (14th character = H)

Also available on large (13 inch) reels. Add 7280 to the end of the part number.

Higher voltage ratings and tighter tolerance product including ESR may be substituted within the same size at KEMET's option. Voltage substitutions will be marked with the higher voltage rating. Substitutions can include better than series.

## Derating Guidelines

Voltage Rating	Max Recommended Steady State Voltage	Max Recommended Transient Voltage (1ms - 1μs)
-55°C to 105°C		
$2.5V \leq V_r \leq 10V$	90% of $V_r$	$V_r$

$V_r$  = 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:

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

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

Case Code		Maximum Power Dissipation (Pmax) mWatts @ 45°C w/+30°C Rise
KEMET	EIA	
T520/525T	3528-12	105
T520M	3528-15	120
T520A	3216-18	112
T520/525B	3538-21	127
T520U	6032-15	135
T520L	3528-19	150
T520C	6032-28	165
T520W	6032-15	180
T520V	7343-20	187
T520/525D	7343-31	225
T520Y	7343-40	241
T520X	7343-43	247
T528Z	7343-17	325
T530D	7343-31	255
T530Y	7343-40	263
T530X	7443-43	270

Temperature Compensation Multipliers for Maximum Power Dissipation		
≤45°C	45°C < T ≤ 85°C	85°C < T ≤ 105°C
1.00	0.70	0.25

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)

Pmax = maximum power dissipation (watts)

R = ESR at specified frequency (ohms)

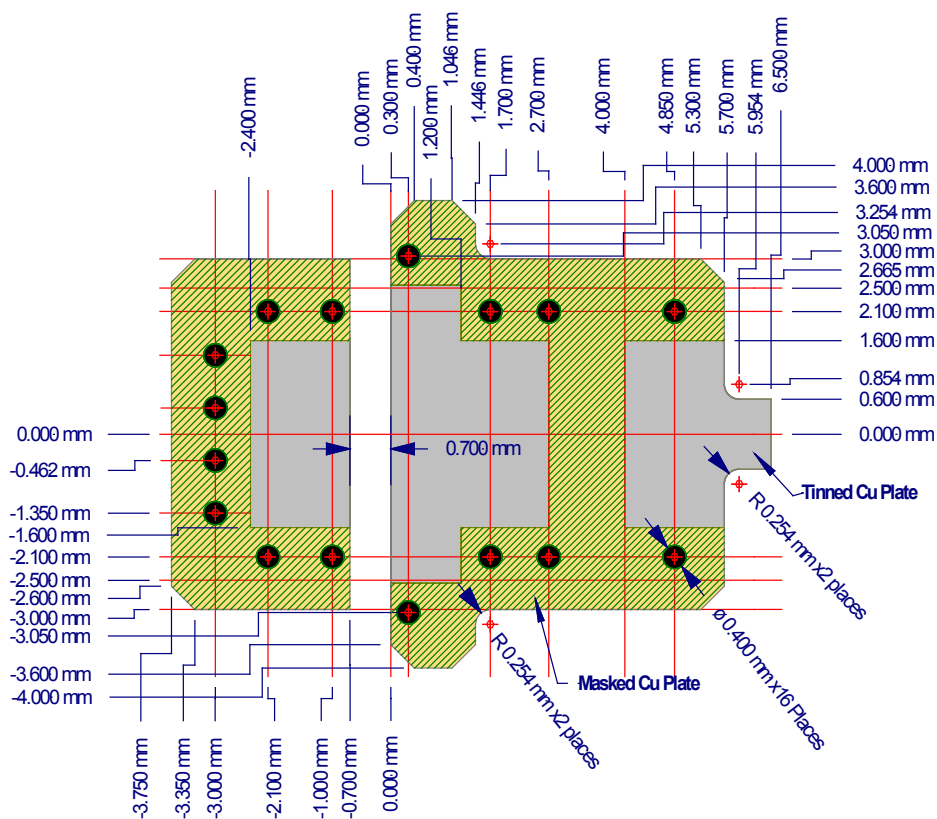
## Reverse Voltage

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

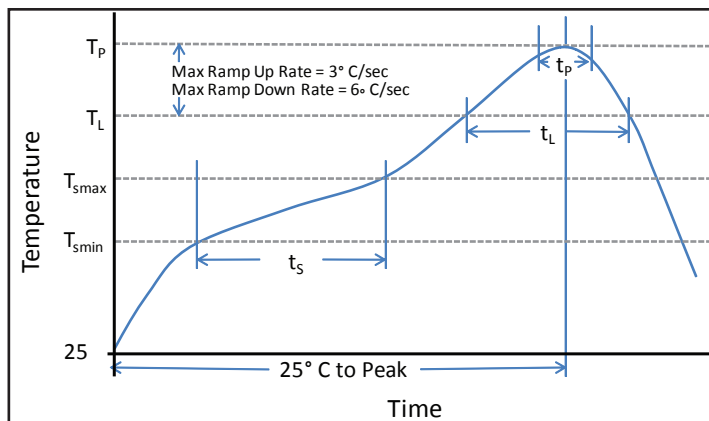
**Table 2 – Land Dimensions/Courtyard**



## Soldering Process

KEMET's families of surface mount tantalum 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.

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



Time/Temperature Soldering Profile

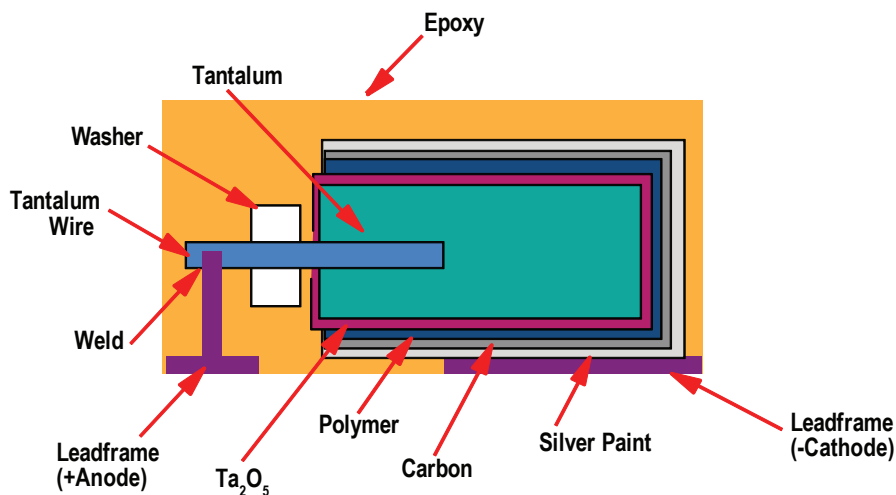
Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Preheat/Soak		
Temperature Min ( $T_{smin}$ )	100°C	150°C
Temperature Max ( $T_{smax}$ )	150°C	200°C
Time ( $t_s$ ) from $T_{smin}$ to $T_{smax}$	60-120 sec	60-120 sec
Ramp-up rate ( $T_L$ to $T_p$ )	3°C/sec max	3°C/sec max
Liquidous temperature ( $T_L$ )	183°C	217°C
Time above liquidous ( $t_L$ )	60-150 sec	60-150 sec
Peak Temperature ( $T_p$ )	220°C* 235°C**	250°C* 260°C**
Time within 5°C of max peak temperature ( $t_p$ )	20 sec max	30 sec max
Ramp-down rate ( $T_p$ to $T_L$ )	6°C/sec max	6°C/sec max
Time 25°C to peak temperature	6 minutes max	8 minutes max

Note 1: 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

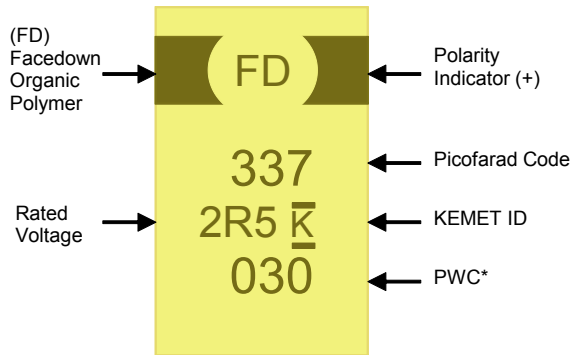
\*\*Case Size A, B, C, H, I, K, M, R, S, T, U, V, W and Z

## Construction





## Capacitor Marking



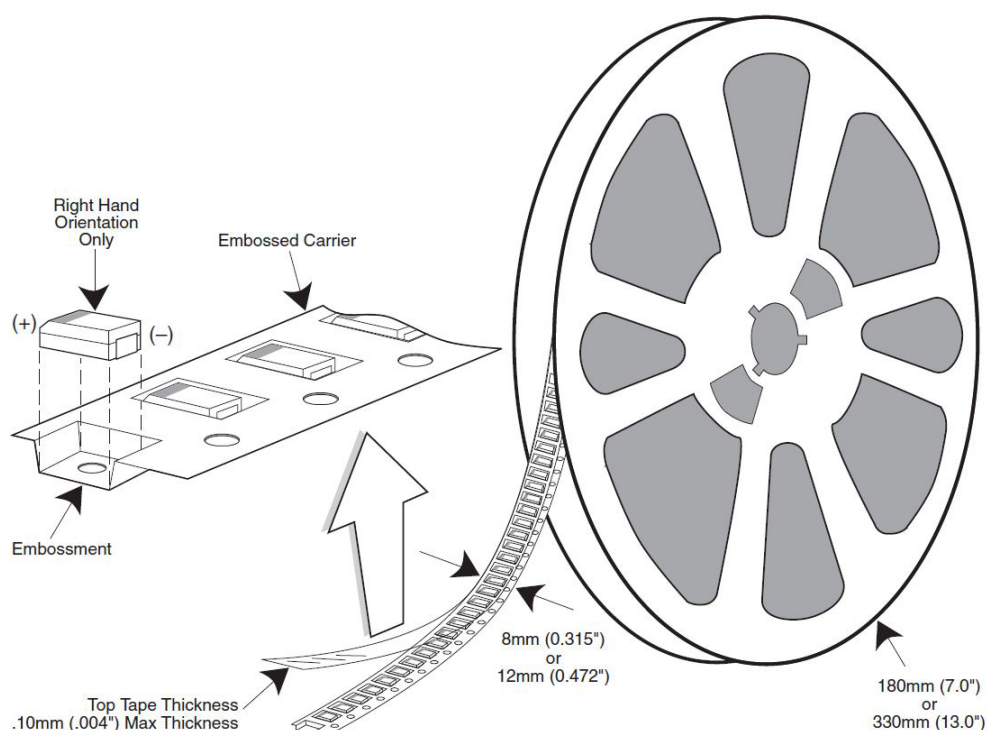
\* 030 = 30<sup>th</sup> week of 2010

## 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 40°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 mm and 12 mm plastic tape on 7" and 13" reels, in accordance with EIA Standard 481-1: Taping of Surface Mount Components for Automatic Handling. This packaging system is compatible with all tape fed automatic pick and place systems.

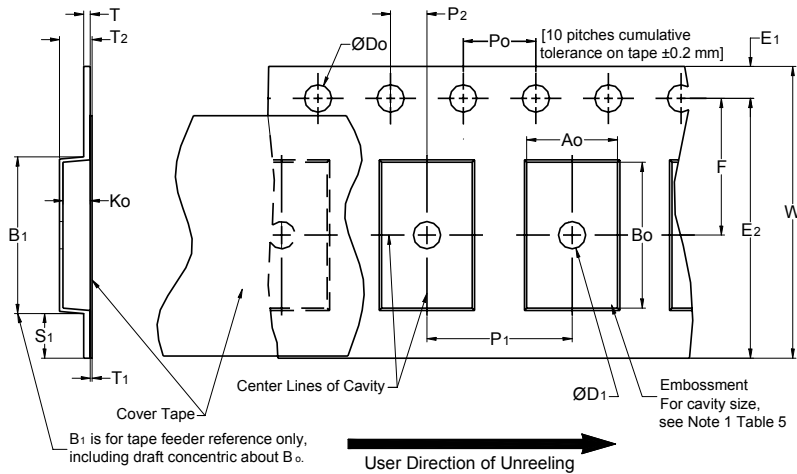


**Table 4 – Packaging Quantity**

Case Code		Tape Width-mm	7" Reel*	13" Reel*
KEMET	EIA			
R	2012-12	8	2,500	10,000
I	3216-10	8	3,000	12,000
S	3216-12	8	2,500	10,000
T	3528-12	8	2,500	10,000
M	3528-15	8	2,000	8,000
U	6032-15	12	1,000	5,000
L	6032-19	12	1,000	5,000
W	7343-15	12	1,000	3,000
Z	7343-17	12	1,000	3,000
V	7343-20	12	1,000	3,000
A	3216-18	8	2,000	9,000
B	3528-21	8	2,000	8,000
C	6032-28	12	500	3,000
D	7343-31	12	500	2,500
Y	7343-40	12	500	2,000
X	7343-43	12	500	2,000
E	7260-38	12	500	2,000

\* No c-spec required for 7" reel packaging. C-7280 required for 13" reel packaging.

**Figure 1 – Embossed (Plastic) Carrier Tape Dimensions**



**Table 5 – Embossed (Plastic) Carrier Tape Dimensions**

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	$D_0$	$D_1$ Min. Note 1	$E_1$	$P_0$	$P_2$	R Ref. Note 2	$S_1$ Min. Note 3	T Max.	$T_1$ Max.
8mm	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)
12mm		1.5 (0.059)				30 (1.181)			
16mm									
Variable Dimensions — Millimeters (Inches)									
Tape Size	Pitch	$B_1$ Max. Note 4	$E_2$ Min.	F	$P_1$	$T_2$ Max	W Max	$A_0, B_0$ & $K_0$	
8mm	Single (4mm)	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	
12mm	Single (4mm) & Double (8mm)	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)		
16mm	Triple (12mm)	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 Document 481 paragraph 4.3 (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 12mm tapes and 10° maximum for 16mm tapes (see Figure 3).
  - lateral movement of the component is restricted to 0.5 mm maximum for 8mm and 12mm wide tape and to 1.0mm maximum for 16mm tape (see Figure 4).
  - for KPS Series product  $A_0$  and  $B_0$  are measured on a plane 0.3mm above the bottom of the pocket.
  - see Addendum in EIA Document 481 for standards relating to more precise taping requirements.

## Packaging Information Performance Notes

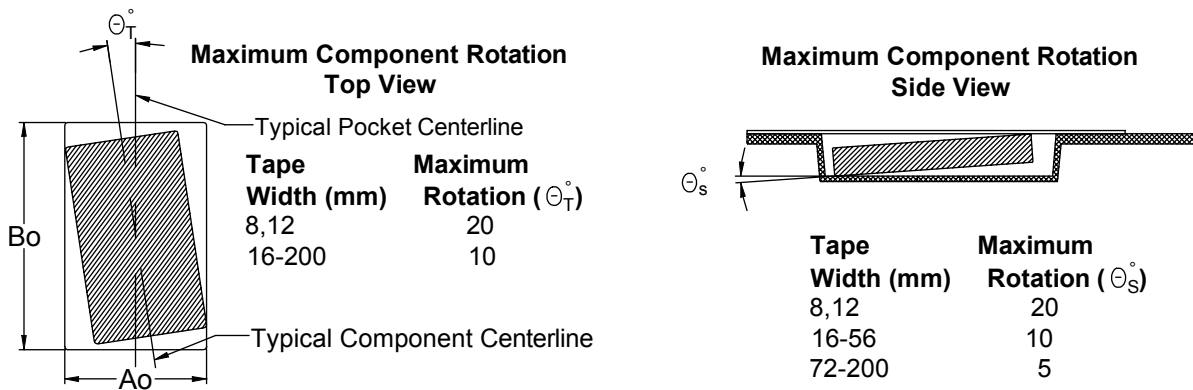
1. **Cover Tape Break Force:** 1.0 Kg Minimum.
2. **Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

Tape Width	Peel Strength
8mm	0.1 Newton to 1.0 Newton (10gf to 100gf)
12mm & 16mm	0.1 Newton to 1.3 Newton (10gf to 130gf)

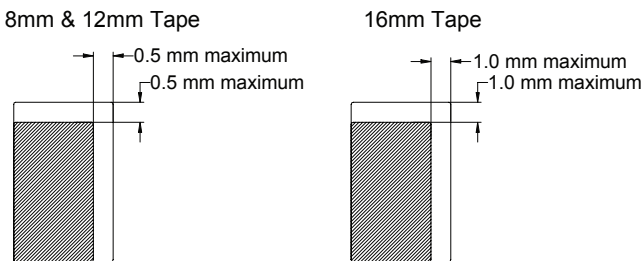
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

3. **Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556 and EIA-624.

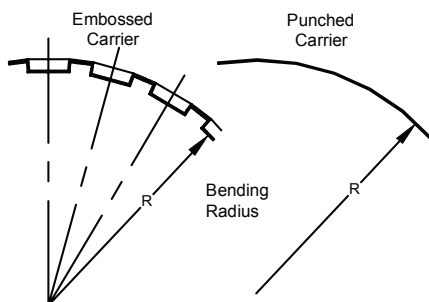
## Figure 3 – Maximum Component Rotation



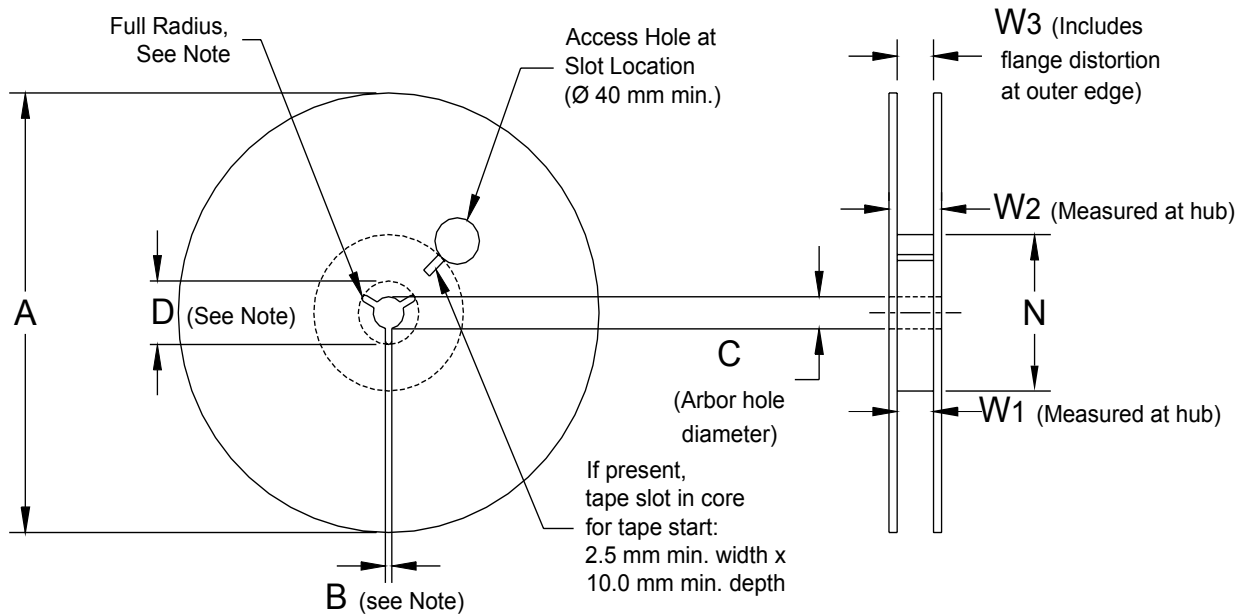
## Figure 4 – Maximum Lateral Movement



## Figure 5 – Bending Radius



**Figure 6 – Reel Dimensions**



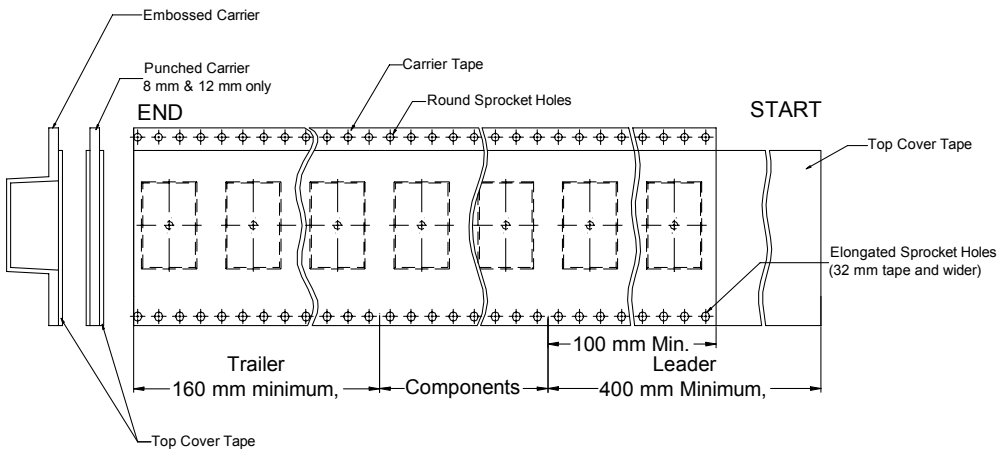
Note: Drive spokes optional; if used, dimensions B and D shall apply.

**Table 7 – Reel Dimensions**

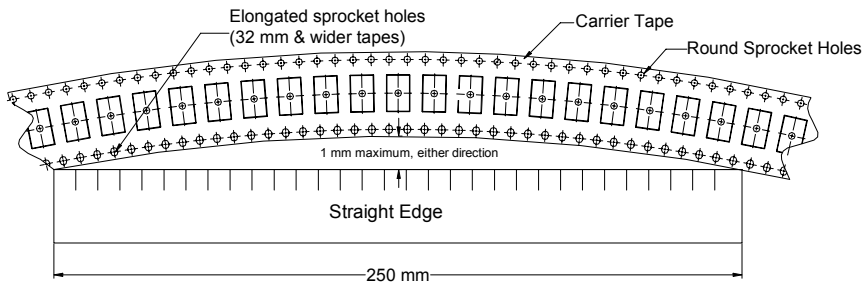
Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	B Min	C	D Min
8mm	178 ± 0.20 (7.008 ± 0.008)	1.5 (0.059)	13.0 +0.5/-0.2 (0.521 +0.02/-0.008)	20.2 (0.795)
12mm	or			
16mm	330 ± 0.20 (13.000 ± 0.008)			
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Min	W <sub>1</sub>	W <sub>2</sub> Max	W <sub>3</sub>
8mm	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
12mm		12.4 +2.0/-0.0 (0.488 +0.078/-0.0)	18.4 (0.724)	
16mm		16.4 +2.0/-0.0 (0.646 +0.078/-0.0)	22.4 (0.882)	

**Figure 7 – Tape Leader & Trailer Dimensions**



**Figure 8 – Maximum Camber**



## 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>

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
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Although we design and manufacture our 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.

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