KEMET Organic Capacitor (KO-CAP®) – Miniature

T528 Low ESL Polymer Electrolytic for CPU/GPU Decoupling

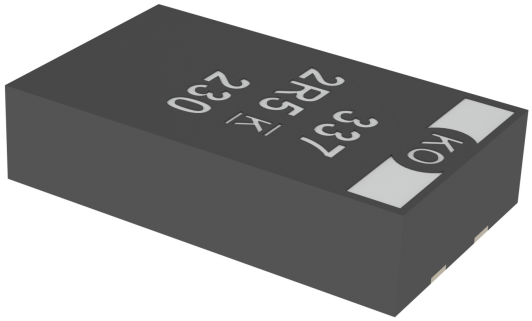
Overview

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 T528 Low ESL Facedown Terminal Polymer Electrolytic combines ultra-low ESR and high capacitance in a package design that offers the lowest ESL in the market. This series offers exceptional performance for high-speed microprocessor, FPGA or ASIC decoupling designs. The T528 Series utilizes a unique termination design that allows for a reduction in the inductance loop area and comes in a low profile 1.7 mm case height. This capacitor series offers improved capacitance retention at frequencies of up to 1 MHz.

Benefits

- Low ESL <0.7 nH at 20 MHz
- Improved volumetric efficiency
- High frequency capacitance retention
- 100% accelerated steady state aging
- 100% surge current tested
- EIA standard case sizes
- Halogen-free Epoxy/RoHS Compliant
- Lead free 260°C reflow capable



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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 or Ni-Pd-Au.

K-SIM

For a detailed analysis of specific part numbers, please visit ksim.kemet.com to access KEMET's K-SIM software. KEMET K-SIM is designed to simulate behavior of components with respect to frequency, ambient temperature, and DC bias levels.

Ordering Information

T	528	Z	337	M	2R5	A	T	E009	
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate/ Design	Termination Finish	ESR Code	Packaging (C-Spec)
T = Tantalum	528 = Low ESL Facedown Terminal Polymer	B W Z	First two digits represent significant figures. Third digit specifies number of zeros.	M = ±20%	002 = 2 2R5 = 2.5 004 = 4 006 = 6.3	A = N/A	T = 100% Matte Tin (Sn) plated P = Ni-Pd-Au plated	E = ESR Last three digits specify ESR in mΩ (009 = 9 mΩ)	Blank = 7" Reel 7280 = 13" Reel

Performance Characteristics

Item	Performance Characteristics
Operating Temperature	−55°C to 105°C
Rated Capacitance Range	33 – 470 µF at 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	2 – 6.3 V
DF (120 Hz)	≤ 10%
ESR (100 kHz)	Refer to Part Number Electrical Specification Table
Leakage Current	≤ 0.1 CV (µA) at rated voltage after 5 minutes

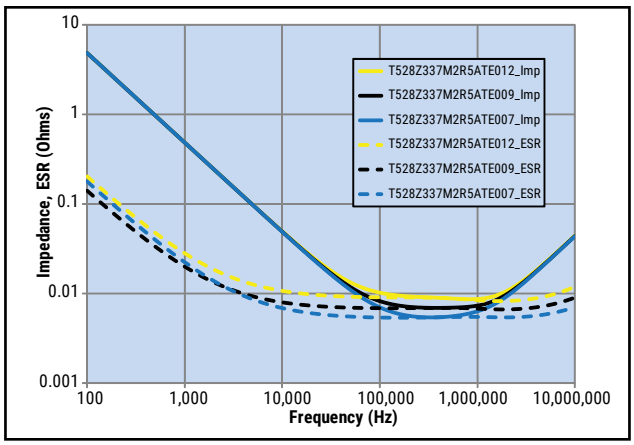
Qualification

Test	Condition		Characteristics			
Endurance	105°C at rated voltage, 2,000 hours		Δ C/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 at 0 volts, 2,000 hours		Δ C/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 hours		Δ C/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
		Δ C/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 1,000 cycles		Δ C/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, Method 213, Condition I, 100 G peak MIL–STD–202, Method 204, Condition D, 10 Hz to 2,000 Hz, 20 G peak		Δ C/C	Within ±10% of initial value		
			DF	Within initial limits		
			DCL	Within initial limits		

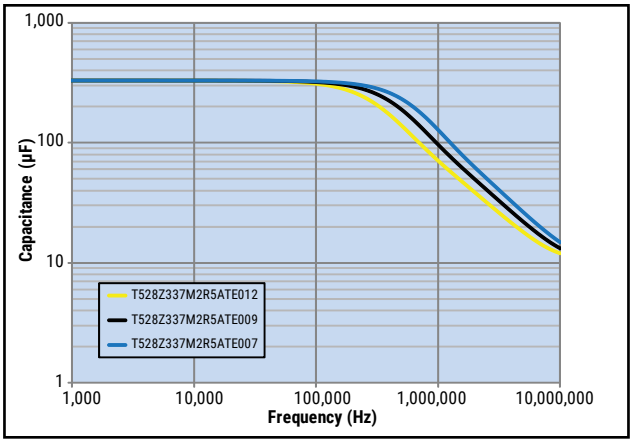
**IL = Initial limit*

Electrical Characteristics

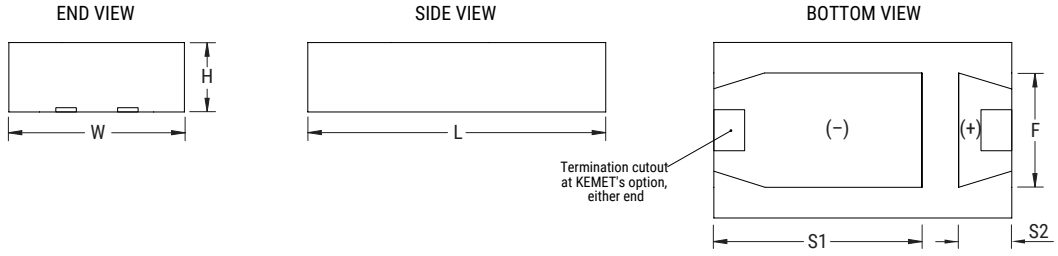
ESR vs. Frequency



Capacitance vs. Frequency



Dimensions – Millimeters



Case Size		Component Dimensions						Total Weight
KEMET	EIA	L	W	H	F ±0.2	S1 ±0.4	S2 ±0.2	(mg)
B	3528–20	3.5±0.2	2.8±0.2	2.0 Maximum	2.2	0.8	0.8	94.85
W	7343–15	7.3±0.4	4.3±0.3	1.5 Maximum	2.8	5.0	1.3	222.95
Z	7343–17	7.3±0.4	4.3±0.3	1.7 Maximum	2.8	5.0	1.3	206.33

These weights are provided as reference. If exact weights are needed, please contact your KEMET Sales Representative

Table 1 – Ratings & Part Number Reference

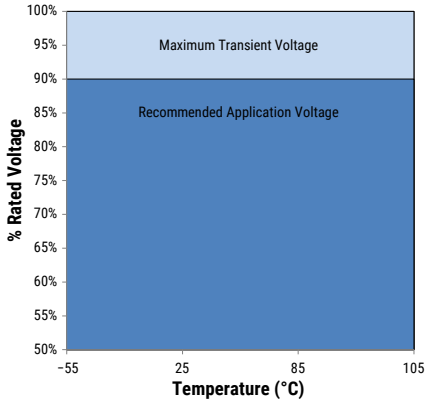
Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	MSL	Maximum Operating Temp
VDC at 105°C	µF	KEMET/EIA	(See below for part options)	µA at +25°C Maximum/ 5 Minutes	% at +25°C 120 Hz Maximum	mΩ at +25°C 100 kHz Maximum	mA at +45°C 100 kHz	Reflow Temp ≤ 260°C	°C
2	270	B/3528-20	T528B277M002APE006	54.0	8	6	3900	3	105
2	270	B/3528-20	T528B277M002APE009	54.0	8	9	3200	3	105
2.5	220	Z/7343-17	T528Z227M2R5ATE006	55.0	10	6	7400	3	105
2.5	270	B/3528-20	T528B277M2R5APE006	67.5	10	6	3900	3	105
2.5	270	B/3528-20	T528B277M2R5APE009	67.5	10	9	3200	3	105
2.5	330	W/7343-15	T528W337M2R5ATE009	82.5	10	9	6000	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE005	82.5	10	5	8100	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE006	82.5	10	6	7400	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE007	82.5	10	7	6800	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE008	82.5	10	8	6400	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE009	82.5	10	9	6000	3	105
2.5	330	Z/7343-17	T528Z337M2R5ATE012	82.5	10	12	5200	3	105
2.5	470	Z/7343-17	T528Z477M2R5ATE005	117.5	10	5	8100	3	105
2.5	470	Z/7343-17	T528Z477M2R5ATE006	117.5	10	6	7400	3	105
2.5	470	Z/7343-17	T528Z477M2R5ATE008	117.5	10	8	6400	3	105
2.5	470	Z/7343-17	T528Z477M2R5ATE009	117.5	10	9	6000	3	105
2.5	470	Z/7343-17	T528Z477M2R5ATE012	117.5	10	12	5200	3	105
4	220	Z/7343-17	T528Z227M004ATE007	88.0	10	7	6800	3	105
4	220	Z/7343-17	T528Z227M004ATE008	88.0	10	8	6400	3	105
4	220	Z/7343-17	T528Z227M004ATE009	88.0	10	9	6000	3	105
4	220	Z/7343-17	T528Z227M004ATE012	88.0	10	12	5200	3	105
4	330	Z/7343-17	T528Z337M004ATE009	132.0	10	9	6000	3	105
4	330	Z/7343-17	T528Z337M004ATE012	132.0	10	12	5200	3	105
6.3	150	Z/7343-17	T528Z157M006ATE007	94.5	10	7	6800	3	105
6.3	150	Z/7343-17	T528Z157M006ATE008	94.5	10	8	6400	3	105
6.3	150	Z/7343-17	T528Z157M006ATE009	94.5	10	9	6000	3	105
6.3	150	Z/7343-17	T528Z157M006ATE012	94.5	10	12	5200	3	105
6.3	220	Z/7343-17	T528Z227M006ATE009	138.6	10	9	6000	3	105
6.3	220	Z/7343-17	T528Z227M006ATE012	138.6	10	12	5200	3	105
VDC at 105°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 +45°C 100 kHz	Reflow Temp ≤ 260°C	°C
Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	MSL	Maximum Operating 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	Maximum Recommended Steady State Voltage	Maximum Recommended Transient Voltage (1 ms – 1 µs)
−55°C to 105°C		
2 V ≤ V_R ≤ 6.3 V	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:

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.

KEMET Case Code	EIA Case Code	Maximum Power Dissipation (P max) mWatts at 45°C with +30°C Rise
B	3528-20	127
W	7343-15	325
Z	7343-17	325

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)

Temperature Compensation Multipliers for Maximum Ripple Current		
T ≤ 45°C	45° C < T ≤ 85°C	85°C < T ≤ 125°C
1.00	0.70	0.25

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.

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

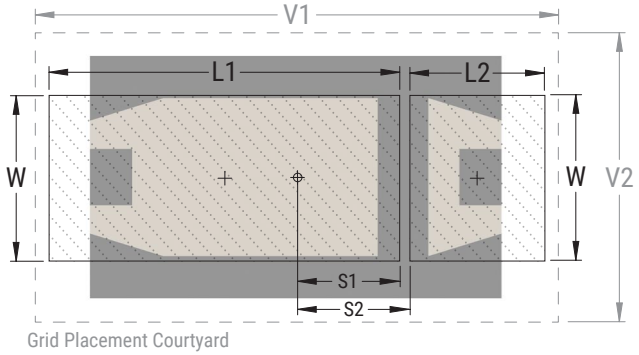
**For Series Rated to 125°C*

Table 2 – Land Dimensions/Courtyard

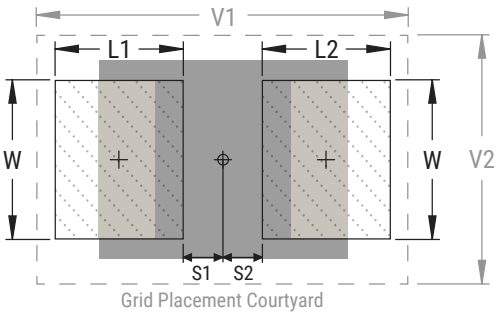
KEMET	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)							Density Level B: Median (Nominal) Land Protrusion (mm)							Density Level C: Minimum (Least) Land Protrusion (mm)						
Case	EIA	L1	L2	W	S1	S2	V1	V2	L1	L2	W	S1	S2	V1	V2	L1	L2	W	S1	S2	V1	V2
B	3528-20	2.20	2.20	2.35	0.46	0.46	6.32	4.00	1.80	1.80	2.23	0.56	0.56	5.22	3.50	1.42	1.42	2.13	0.64	0.64	4.36	3.24
W[1]	7343-15	6.48	2.68	3.04	−1.82	1.98	10.32	5.60	6.18	2.38	2.92	−1.82	1.98	9.22	5.10	5.82	2.02	2.82	−1.76	2.04	8.36	4.84
Z[1]	7343-17	6.48	2.68	3.04	−1.82	1.98	10.32	5.60	6.18	2.38	2.92	−1.82	1.98	9.22	5.10	5.82	2.02	2.82	−1.76	2.04	8.36	4.84

Density Level A: *For low-density product applications. Recommended for wave solder applications and 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).*
[1] *Negative values of S1 mean that pad lies at the center's right side.*

W, Z Case



B Case



Soldering Process

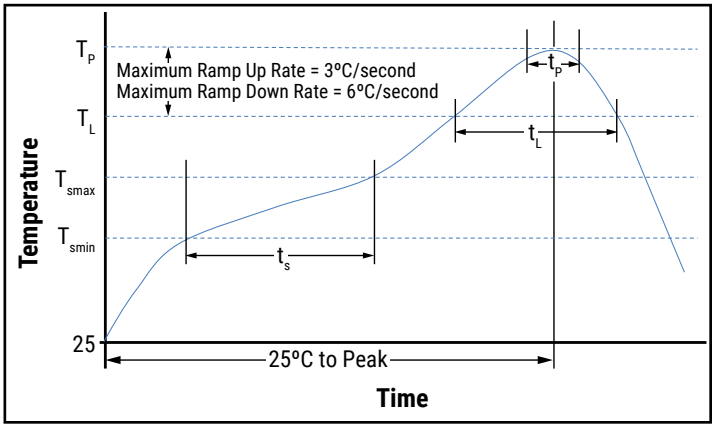
KEMET's families of surface mount capacitors are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile 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

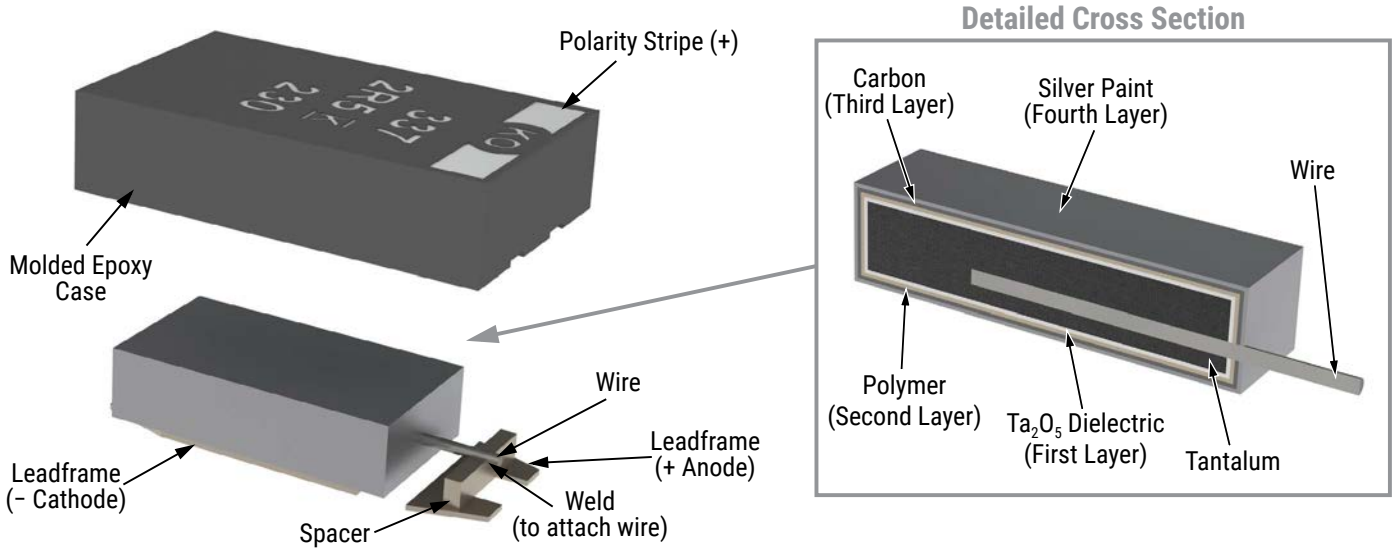
Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.
**Case Size D, E, P, Y, and X*
***Case Size A, B, C, H, I, K, M, R, S, T, U, V, W, and Z*



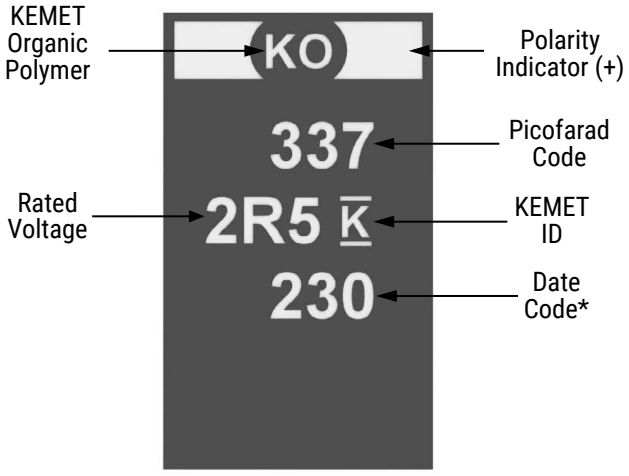
Storage

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 40°C and humidity not in excess of 90% RH.

Construction



Capacitor Marking



* 230 = 30th week of 2012

Date Code *	
1st digit = Last number of Year	2 = 2012 3 = 2013 4 = 2014 5 = 2015 6 = 2016 7 = 2017
2nd and 3rd digit = Week of the Year	01 = 1st week of the Year to 52 = 52nd week of the Year

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.

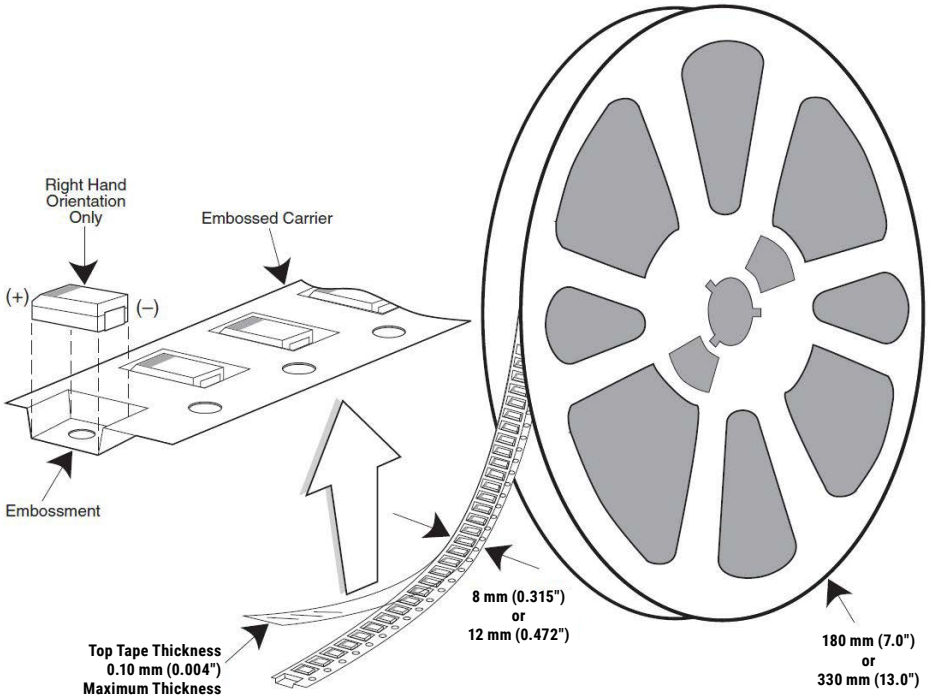


Table 3 – Packaging Quantity

Case Code		Tape Width (mm)	7" Reel*	13" Reel*
KEMET	EIA			
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	3,000
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
Q	7343-12	12	1,000	3,000
Y	7343-40	12	500	2,000
X	7343-43	12	500	2,000
E/T428P	7360-38	12	500	2,000
H	7360-20	12	1,000	2,500

** No C-Spec required for 7" reel packaging. C-7280 required for 13" reel packaging.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

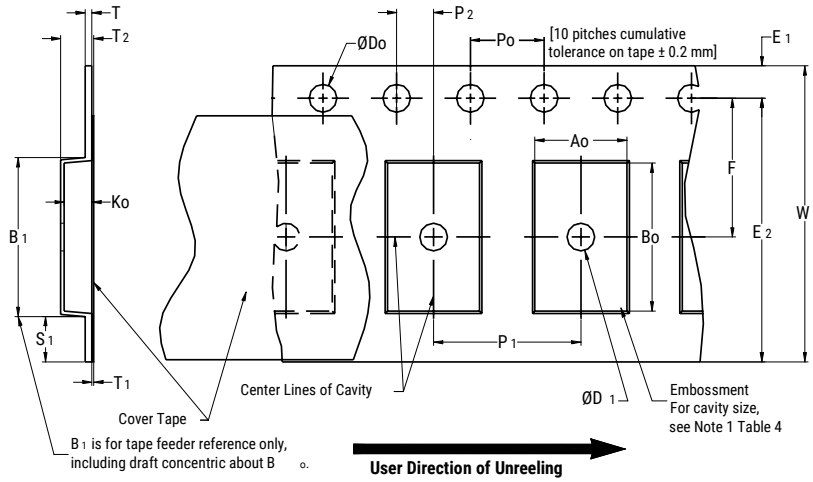


Table 4 – Embossed (Plastic) Carrier Tape Dimensions

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

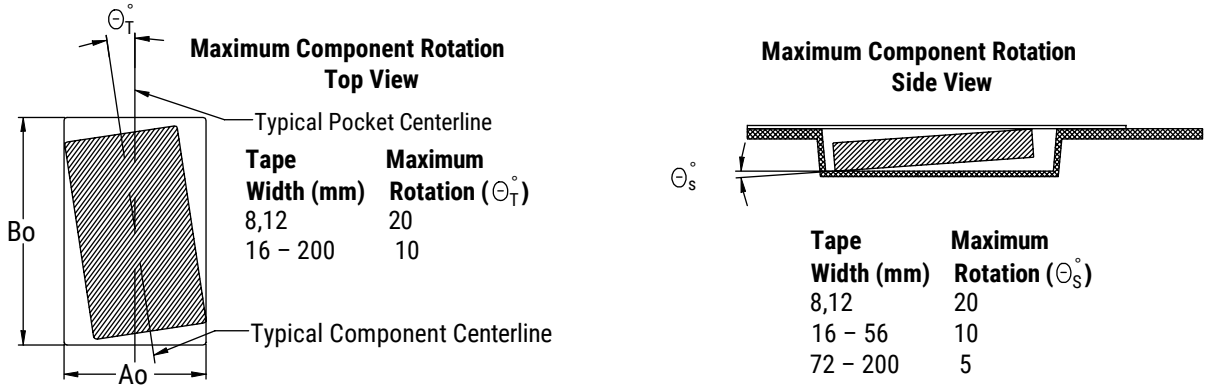


Figure 3 – Maximum Lateral Movement

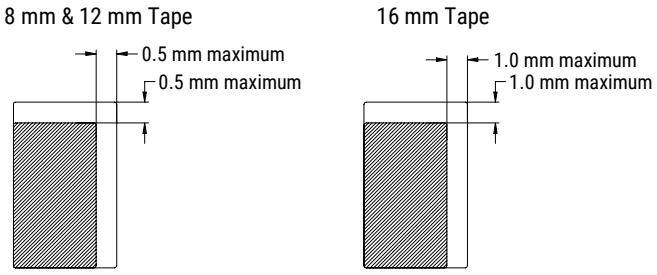


Figure 4 – Bending Radius

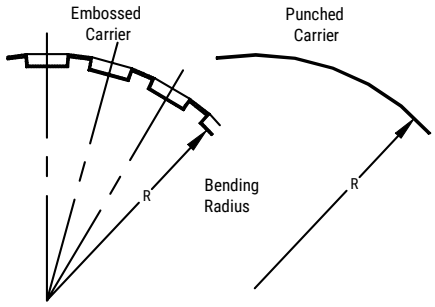
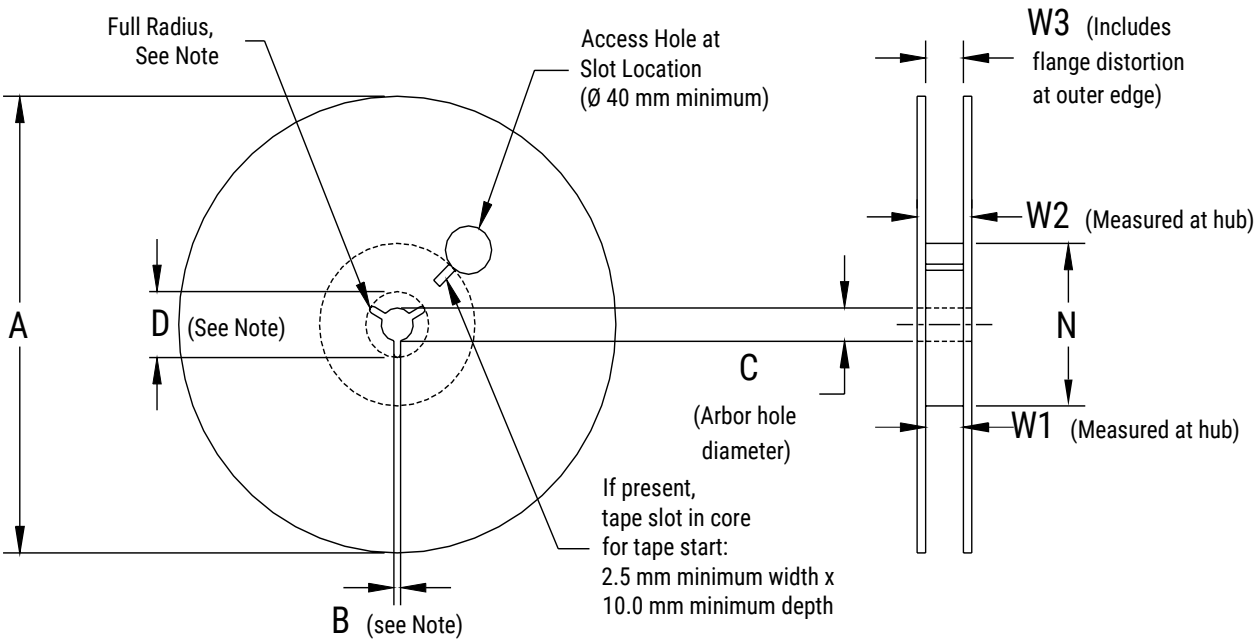


Figure 5 – Reel Dimensions



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

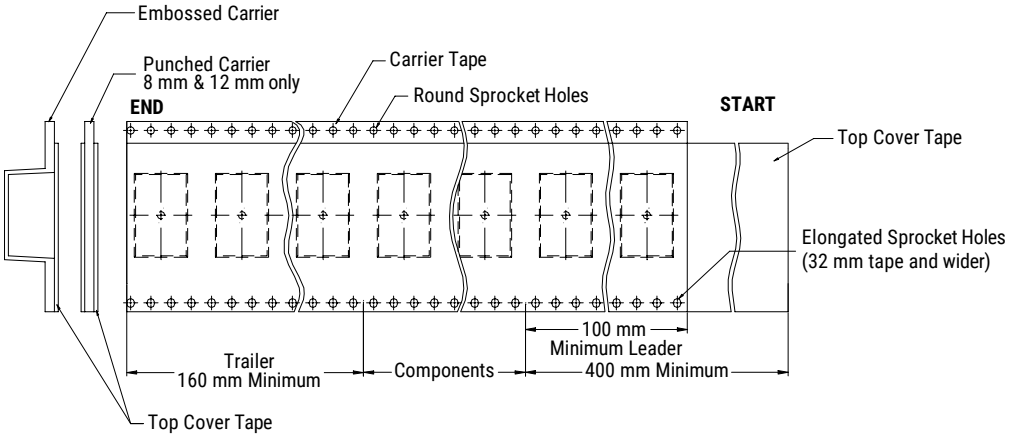
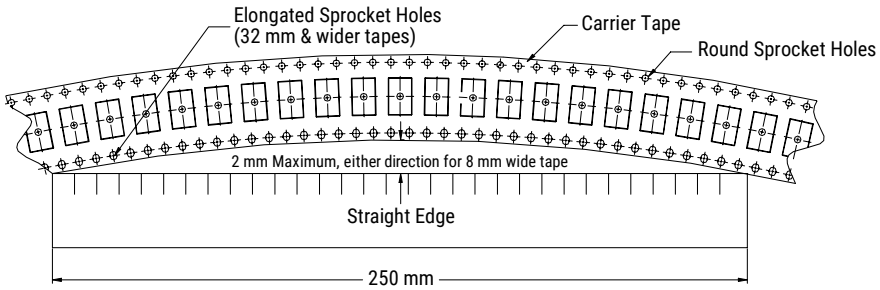


Figure 7 – Maximum Camber



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