

T591 High Performance Automotive Grade Polymer Electrolytic, 2.5 – 50 VDC

Overview

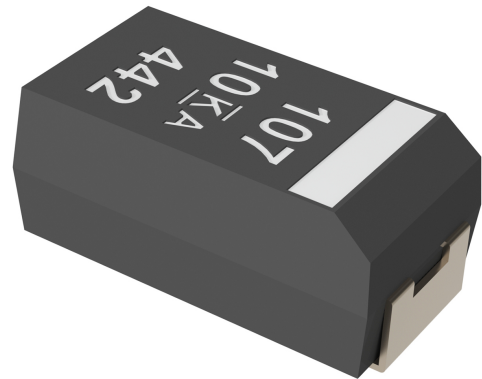
The KEMET Organic Capacitor (KO-CAP) is a solid electrolytic capacitor with a conductive polymer cathode capable of delivering very low ESR and improved capacitance retention at high frequencies. KO-CAP combines the low ESR of multilayer ceramic, the high capacitance of aluminum electrolytic and the 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.

KOCAP Polymer Capacitors

The T591 High Performance Automotive Grade Polymer Electrolytic delivers higher capacitance and ESR stability under harsh environmental conditions. Enhancements to the design and selected material upgrades render this the first KO-CAP capable of stable performance after 500 hours at 85°C/85% RH/VR. The T591 is manufactured in a ISO TS 16949 certified plant. Parts are available with PPAP/PSW and change control.

Benefits

- Ultra-low ESR
- Qualification package based on AEC-Q200
- High reliability up to 500 hours with 85°C/85% RH load
- TS 16949 certified plant
- Meets or exceeds EIA standard 535BAAC
- Taped and reeled per EIA 481



Applications

Typical applications include decoupling and filtering in a variety of market segments, with special emphasis in automotive applications such as infotainment and input/output in DC/DC converters where harsh conditions such as high humidity and temperature are a concern.

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 www.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	591	D	107	M	010	A	T	E025
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate/ Design	Termination Finish	ESR
T = Tantalum	591 = Automotive Grade Polymer	B, D, V	First two digits represent significant figures. Third digit specifies number of zeros.	M = ±20%	2R5 = 2.5 006 = 6.3 010 = 10 016 = 16 020 = 20 025 = 25 035 = 35 050 = 50	A = N/A	T = 100% Tin (Sn)	Maximum ESR in mΩ, 025 = 25 mΩ

Performance Characteristics

Item	Performance Characteristics
Operating Temperature	-55°C to 105°C / 125°C
Rated Capacitance Range	33 – 330 μF at 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	2.5 – 50 V
DF (120 Hz)	Refer to Part Number Electrical Specification Table
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** 125°C at 2/3 rated voltage, 1,000 hours**	Δ C/C	Within -20%/+10% of initial value			
		DF	Within 2 x Initial Limits			
		DCL	Within 2 x Initial Limit			
		ESR	Within 2 x Initial Limit			
Storage Life	105°C at 0 volts, 2,000 hours** 125°C at 0 volts, 1,000 hours	Δ C/C	Within -20%/+10% of initial value			
		DF	Within 2 x Initial Limits			
		DCL	Within 2 x Initial Limit			
		ESR	Within 2 x Initial Limit			
Humidity	85°C, 85% RH, Load, 500 hours	Δ C/C	Within -5%/+35% of initial value			
		DF	Within 1.5 x Initial Limits			
		DCL	Within Initial Limit			
		ESR	Within 2 x Initial Limit			
Thermal Shock	MIL-STD-202, Method 107, Condition B, mounted, -55°C to 105°C / 125°C, 1,000 cycles	Δ C/C	Within -20%/+10% of initial value			
		DF	Within Initial Limits			
		DCL	Within Initial Limit			
		ESR	Within 2 x Initial Limits			
Surge Voltage	105°C, 1.32 x rated voltage, 1,000 cycles, 33 Ω in series 125°C, 1.32 x rated voltage, 1,000 cycles, 33 Ω in series	Δ C/C	Within -20%/+10% of initial value			
		DF	Within initial limits			
		DCL	Within initial limits			
		ESR	Within initial limits			
Temperature Stability	Extreme temperature exposure at a succession of continuous steps at +25°C, -55°C, +25°C, +85°C, +105°C/+125°C***, +25°C	+25°C	-55°C	+85°C	+105°C/+125°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
Mechanical Shock/Vibration	AEC-Q200 (MIL-STD-202, Method 213, Figure 1, Condition F)	Δ C/C	Within ±10% of initial value			
		DF	Within initial limits			
	AEC-Q200 (MIL-STD-202, Method 204, 5 gs for 20 min/12 cycles each of 3 orientations. Test from 10 – 2, 000 Hz).	ESR	Within initial limits			
		DCL	Within initial limits			

* IL = Initial Limit

** Minimum temperature test condition at 85°C

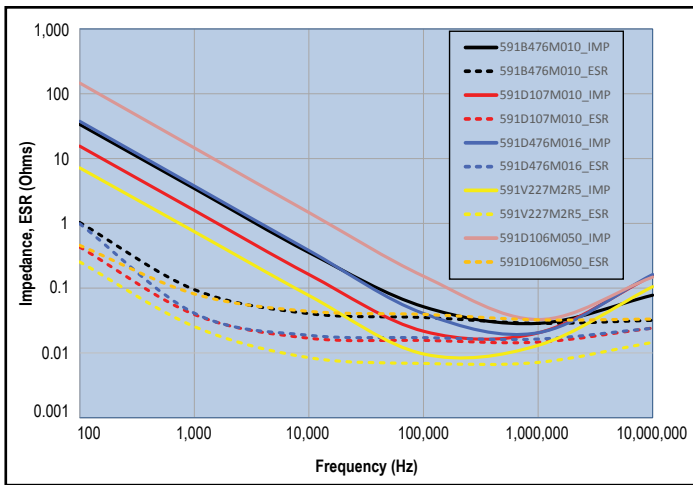
*** Refer to part number specifications for individual temperature classification

Certification

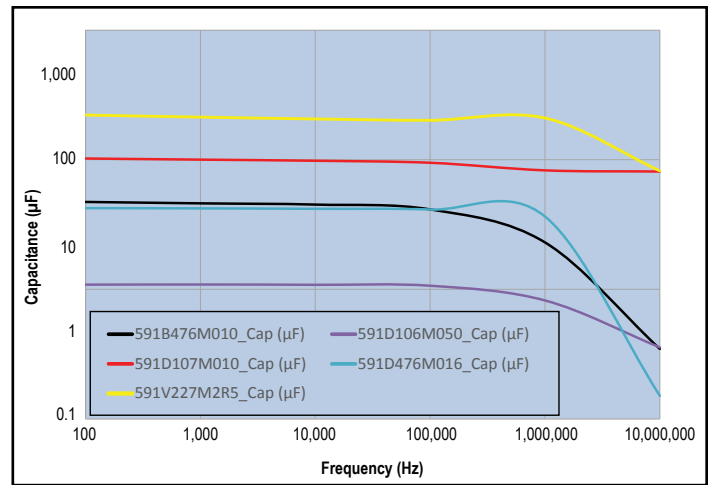
KEMET's Internal Qualification Plan for this tantalum series of capacitors follows AEC-Q200 guidelines. The humidity bias is limited to a maximum of 500 hours.

Electrical Characteristics

ESR vs. Frequency



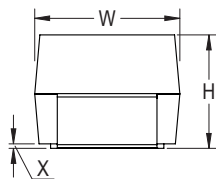
Capacitance vs. Frequency



Dimensions – Millimeters (Inches)

Metric will govern

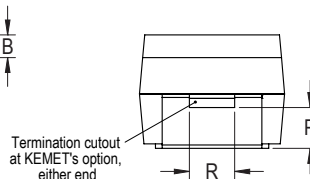
CATHODE (-) END VIEW



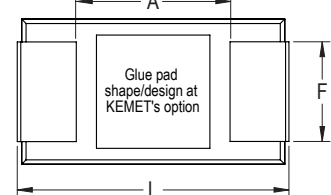
SIDE VIEW



ANODE (+) END VIEW



BOTTOM VIEW



Case Size		Component Dimensions											Weight
KEMET	EIA	L*	W*	H*	F* ±0.1 ±(0.004)	S* ±0.3 ±(0.012)	B* ±0.15 (Ref) ±0.006	X (Ref)	P (Ref)	R (Ref)	T (Ref)	A (Minimum)	(mg)
B*	3528-21	3.5 ±0.2 (0.138 ±0.008)	2.8 ±0.2 (0.110 ±0.008)	1.9 ±0.1 (0.075 ±0.004)	2.2 (0.087)	0.8 (0.031)	0.4 (0.016)	0.10 ±0.10 (0.004 ±0.004)	0.5 (0.020)	1.0 (0.039)	0.13 (0.005)	1.1 (0.043)	94.85
D*	7343-31	7.3 ±0.3 (0.287 ±0.012)	4.3 ±0.3 (0.169 ±0.012)	2.8 ±0.3 (0.110 ±0.012)	2.4 (0.094)	1.3 (0.051)	0.5 (0.020)	0.10 ±0.10 (0.004 ±0.004)	0.9 (0.035)	1.0 (0.039)	0.13 (0.005)	3.8 (0.150)	434.83
V	7343-19	7.3 ±0.3 (0.287 ±0.012)	4.3 ±0.3 (0.169 ±0.012)	1.9 ±0.1 (0.075 ±0.004)	2.4 (0.094)	1.3 (0.051)	N/A	0.05 (0.002)	N/A	N/A	0.13 (0.005)	3.8 (0.150)	274.30

Notes: (Ref) – Dimensions provided for reference only. For low profile cases, no dimensions are provided for B, P or R because these cases do not have a bevel or a notch.

* MIL-PRF-55365/8 specified dimensions

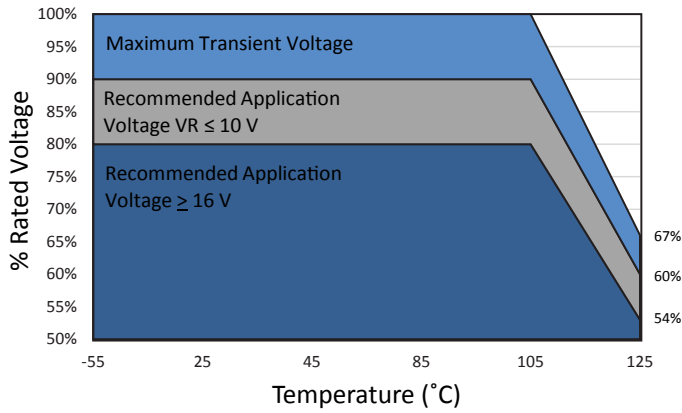
Table 1 – Ratings & Part Number Reference

Rated Voltage	Rated Cap	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	ESR	Maximum Allowable Ripple Current	MSL	Maximum Operating Temp
VDC at 105°C	µF	KEMET/EIA	(See below for part options)	µA at +25°C Max/5 Min	% at +25°C 120 Hz Max	mΩ at +25°C 100 kHz Max	mA at +45°C 100 kHz	Reflow Temp ≤ 260°C	°C
2.5	220	V/7343-20	T591V227M2R5ATE009	55	10	9	4558	3	105
2.5	220	V/7343-20	T591V227M2R5ATE012	55	10	12	3947	3	105
2.5	220	V/7343-20	T591V227M2R5ATE015	55	10	15	3531	3	105
2.5	330	V/7343-20	T591V337M2R5ATE012	83	10	12	3947	3	105
2.5	330	V/7343-20	T591V337M2R5ATE025	83	10	25	2735	3	105
6.3	33	B/3528-21	T591B336M006ATE080	20.8	8	80	1260	3	125
6.3	47	B/3528-21	T591B476M006ATE070	29.6	8	70	1347	3	125
6.3	150	V/7343-20	T591V157M006ATE025	95	10	25	2735	3	125
6.3	150	V/7343-20	T591V157M006ATE045	95	10	45	2039	3	125
6.3	330	D/7343-31	T591D337M006ATE025	208	10	25	3000	3	125
6.3	330	D/7343-31	T591D337M006ATE040	208	10	40	2372	3	125
6.3	330	D/7343-31	T591D337M006ATE080	208	10	80	1677	3	125
10	33	B/3528-21	T591B336M010ATE080	33	8	80	1260	3	125
10	47	B/3528-21	T591B476M010ATE070	47	8	70	1347	3	125
10	100	D/7343-31	T591D107M010ATE025	100	10	25	3000	3	125
10	100	D/7343-31	T591D107M010ATE040	100	10	40	2372	3	125
10	100	D/7343-31	T591D107M010ATE080	100	10	80	1677	3	125
10	100	V/7343-20	T591V107M010ATE025	100	10	25	2735	3	125
10	100	V/7343-20	T591V107M010ATE045	100	10	45	2039	3	125
10	220	D/7343-31	T591D227M010ATE025	220	10	25	3000	3	125
10	220	D/7343-31	T591D227M010ATE040	220	10	40	2372	3	125
10	220	D/7343-31	T591D227M010ATE080	220	10	80	1677	3	125
16	47	D/7343-31	T591D476M016ATE070	75.2	10	70	1793	3	125
16	100	D/7343-31	T591D107M016ATE050	160	10	50	2121	3	125
20	47	D/7343-31	T591D476M020ATE060	94	10	60	1936	3	125
25	22	D/7343-31	T591D226M025ATE060	55	10	60	1936	3	125
25	33	D/7343-31	T591D336M025ATE060	82.5	10	60	1936	3	125
35	10	D/7343-31	T591D106M035ATE120	35	10	120	1369	3	125
35	10	V/7343-20	T591V106M035ATE120	35	10	120	1248	3	125
50	10	D/7343-31	T591D106M050ATE090	50	10	90	1581	3	125

Refer to Ordering Information for additional detail.

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

Derating Guidelines



Voltage Rating	Maximum Recommended Steady State Voltage		Maximum Recommended Transient Voltage (1 ms – 1 μ s)	
	-55°C to 105°C		105°C to 125°C	
$2.5 \text{ V} \leq V_R \leq 10 \text{ V}$	90% of V_R		V_R	60% of V_R
$V_R \geq 16 \text{ V}$	80% of V_R		V_R	54% of 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.

Case Code	EIA Case Code	Maximum Power Dissipation (P max) mWatts at 45°C with +30°C Rise
B	3528-21	127
D	7343-31	225
V	7343-20	187

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

Temperature Compensation Multipliers for Maximum Ripple Current			
T ≤ 45°C	45°C < T ≤ 85°C	85°C < T ≤ 105°C	T ≤ 125°C
1.00	0.90	0.40	0.25

T = Environmental Temperature

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

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

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

I = rms ripple current (amperes)

R = ESR at specified frequency (ohms)

E = rms ripple voltage (volts)

Z = Impedance at specified frequency (ohms)

P max = maximum power dissipation (watts)

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	W	L	S	V1	V2	W	L	S	V1	V2	W	L	S	V1
	B	3528-21	2.35	2.21	0.92	6.32	4.00	2.23	1.80	1.12	5.22	3.50	2.13	1.42	1.28	4.36	3.24
	D	7343-31	2.55	2.77	3.67	10.22	5.60	2.43	2.37	3.87	9.12	5.10	2.33	1.99	4.03	8.26	4.84
	V	7343-20	2.55	2.77	3.67	10.22	5.60	2.43	2.37	3.87	9.12	5.10	2.33	1.99	4.03	8.26	4.84

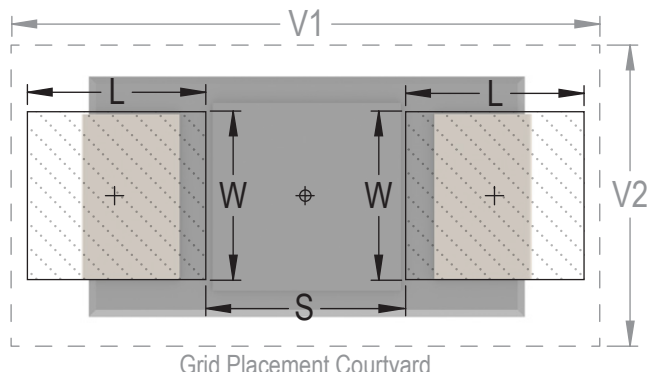
Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes.

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 Height of these chips may create problems in wave soldering.

² Land pattern geometry is too small for silkscreen outline.



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

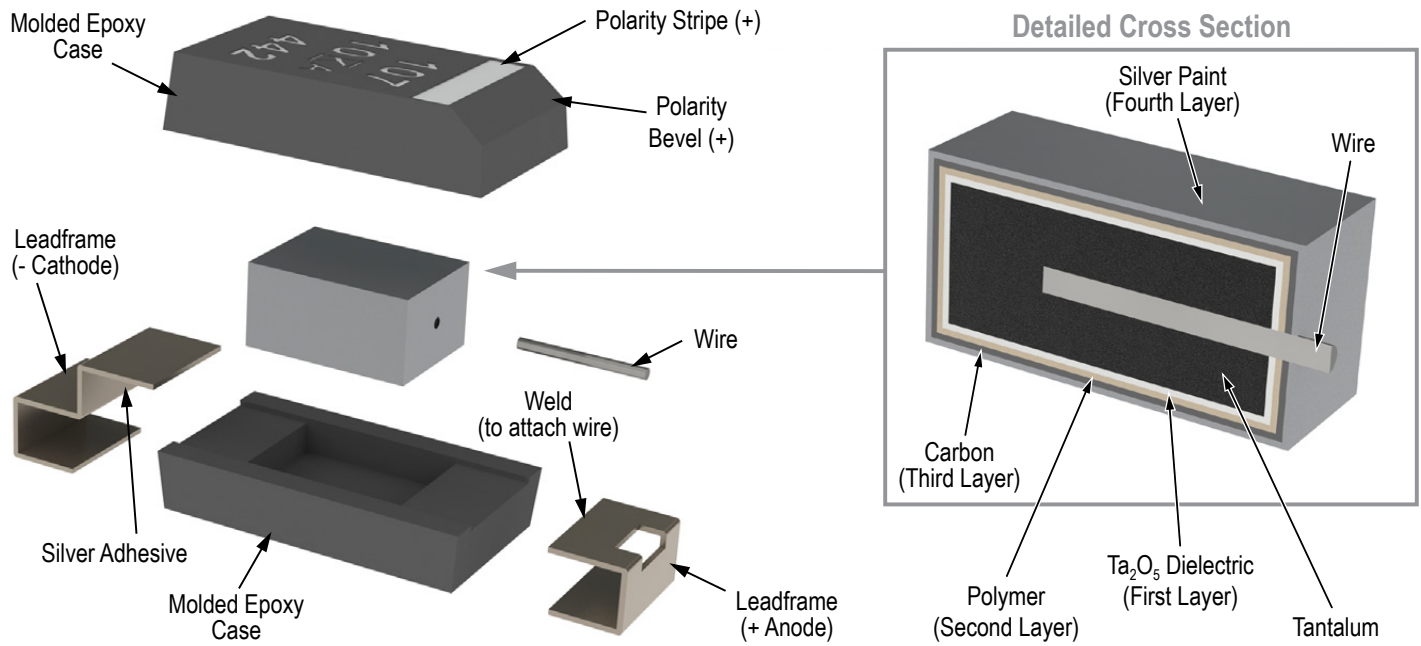
**Case Size A, B, C, H, I, K, M, R, S, T, U, V, W, and Z



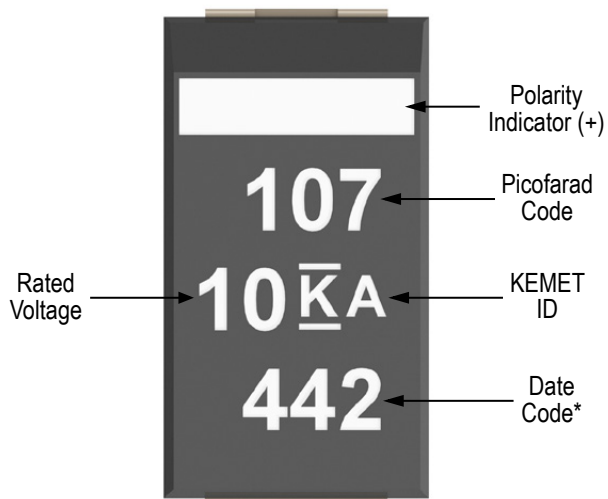
Storage

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



* 442 = 42nd week of 2014

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

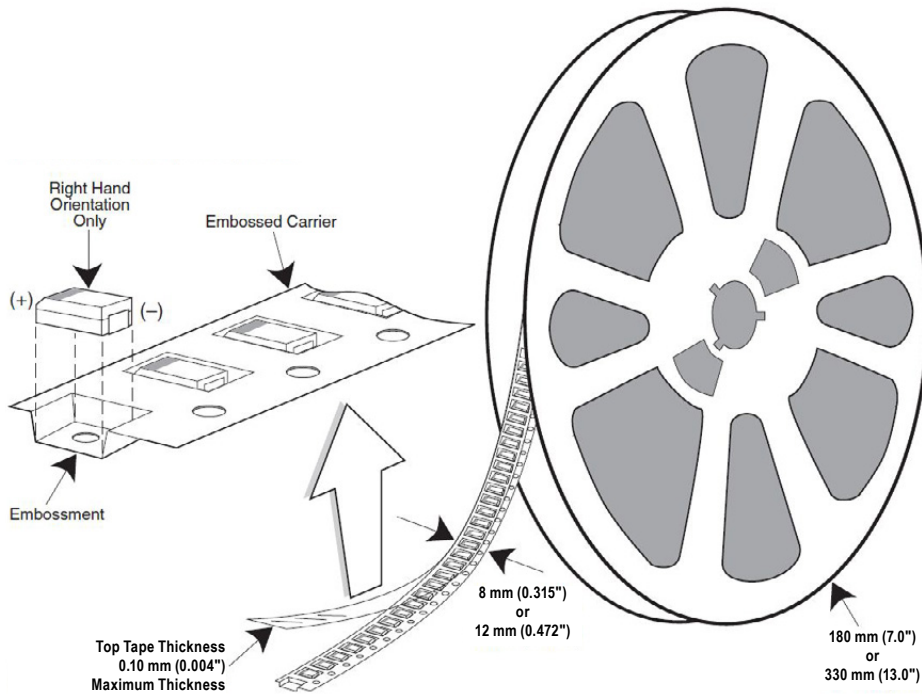


Table 3 – Packaging Quantity

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)			2.0 ±0.1 (0.079 ±0.059)				
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)	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)		

- 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 4).
- If S₁ < 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).
- B₁ dimension is a reference dimension for tape feeder clearance only.
- The cavity defined by A₀, B₀ and K₀ 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

- Cover Tape Break Force:** 1.0 Kg minimum.
- 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.

- 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

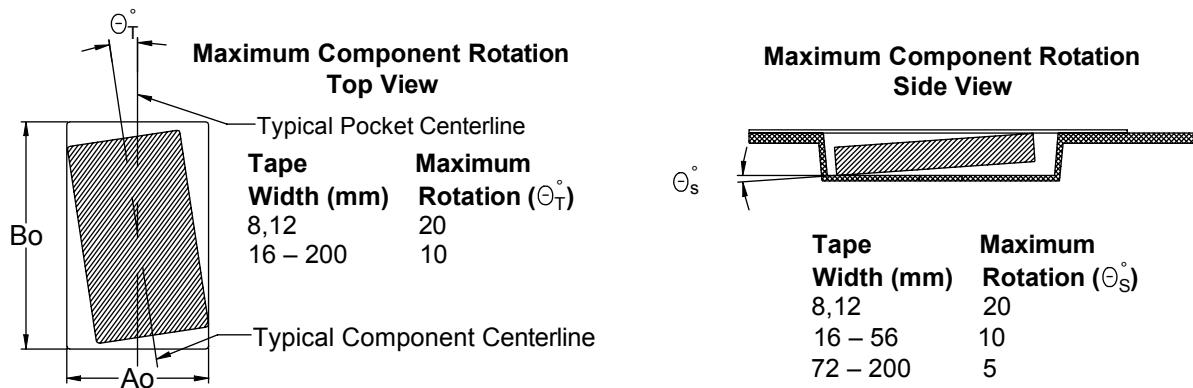


Figure 3 – Maximum Lateral Movement

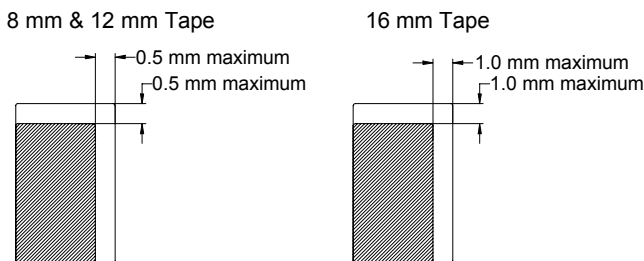


Figure 4 – Bending Radius

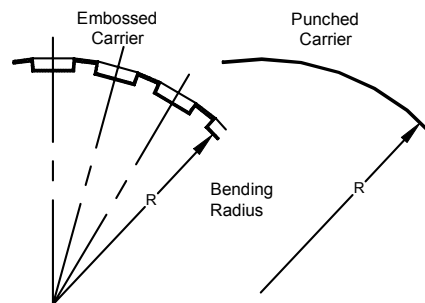
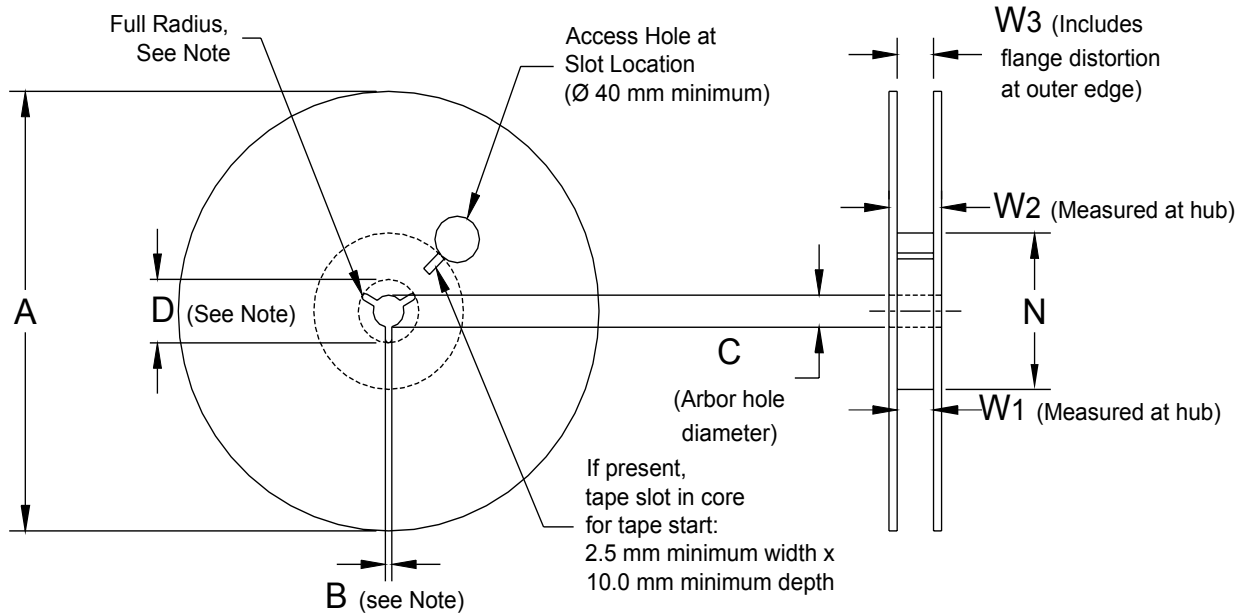


Figure 5 – Reel Dimensions



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

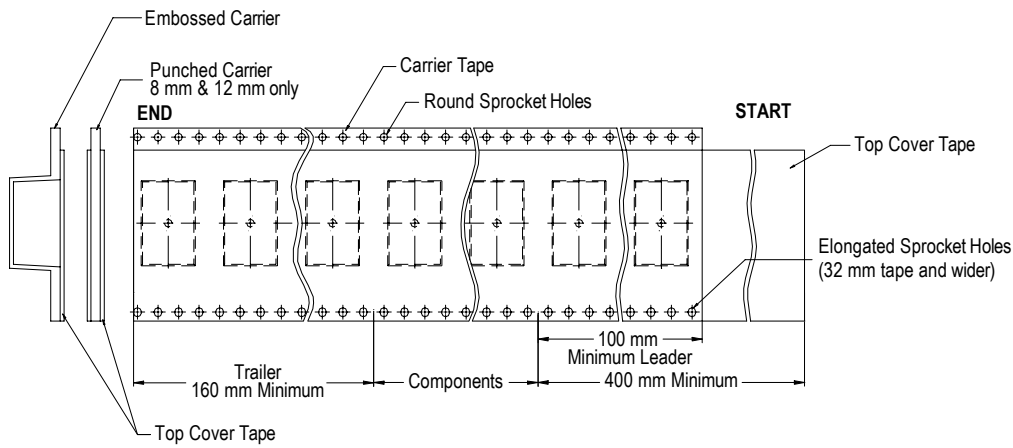
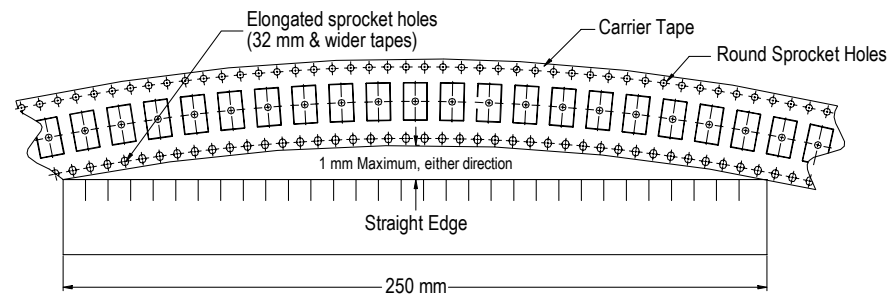


Figure 7 – Maximum Camber



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