

Overview

The KEMET Tantalum Stack Polymer (TSP) Electrolytic Capacitor is designed to provide the highest CV (capacitance/voltage) ratings in a surface mount configuration. All of KEMET's Polymer Electrolytic Solutions are available in a stack configuration. The only exceptions are the facedown series (T523, T527, T528, and T529). These capacitors are utilized in stacks of 2, 3, 4, and 6 components to achieve a broad range of capacitance, ESR, and voltage ratings. The TSP series may be operated at steady state voltages up to 90% of rated voltage for part types with rated voltage less than or equal to 10 volts and up to 80% of rated voltage for part types greater than 10 volts. Stacking configurations allow for custom capacitance/voltage solutions and very low ESR options.

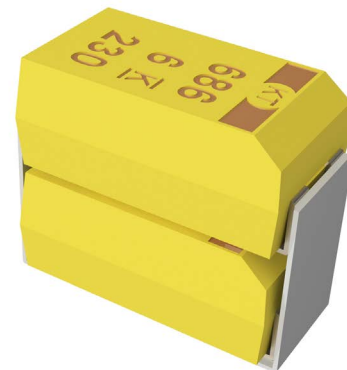
KO-CAP Polymer Capacitors

The TSP series is the first polymer electrolytic capacitor available with failure rate options when utilizing KEMET's T540 and T541 Series. The failure rate is determined by utilizing accelerated conditions (voltage and temperature) applied to board mounted samples to assess long term device reliability. The failure rates available are B (0.1% per 1,000 hours), C (0.01% per 1,000 hours), and D (0.001% per 1,000 hours). This method was developed based on over ten (10) years of research and is described in numerous papers available on www.kemet.com.

Note: Custom stacking solutions are also available with other KEMET Polymer Electrolytic Surface Mount products. Please contact KEMET Sales for availability.

Benefits

- Polymer cathode technology
- High capacitance
- Surface mountable
- Capacitance values of 20 – 6,000 μ F
- Capacitance can be custom specified
- Voltage ratings of 3 – 63 VDC
- High volumetric efficiency
- Ultra low ESR
- Surge capability
- Operating temperature range of -55°C to $+125^{\circ}\text{C}$
- Laser-marked case
- Use up to 90% of rated voltage for part types $\leq 10\text{ V}$
- Use up to 80% of rated voltage for part types $> 10\text{ V}$
- KEMET's PERA method testing



Applications

Typical applications include decoupling and filtering in a variety of market segments. The T540 Polymer COTS stack devices can be utilized in defense and aerospace applications. Other KEMET series can be utilized in filtering and decoupling applications to service various market segments.

Environmental Compliance

RoHS Compliant (6/6) according to Directive 2002/95/EC when ordered with 100% Sn solder.

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

T540/T541 Discrete Component

T	SP	2D	207	M	010	A	H	65	20	D	540
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate (Discrete)	Termination Finish (Discrete)	Surge (Discrete)	ESR (Stack)	Termination Finish (Stack)	Discrete Component's Series
T = Tantalum	Stacks Polymer Cathode	2B 3B 4B 6B 2C 3C 4C 6C 2D 3D 4D 6D 20 30 40 60 2X 3X 4X 6X	First two digits represent significant figures. Third digit specifies number of zeros.	K = ±10% M = ±20%"	003 = 3 004 = 4 006 = 6.3 010 = 10 016 = 16 025 = 25 035 = 35 050 = 50 063 = 63	A = N/A B = 0.1%/Khrs C = 0.01%/Khrs D = 0.001%/Khrs"	H = Standard solder coated (SnPb 5% Pb minimum) T = 100% Matte Tin (Sn)-plated	65 = 4 cycles at 25°C ±5°C 66 = 10 cycles at 25°C 67 = 10 cycles at -55°C +0°C/-5°C and 85°C 85 = 4 cycles at 25°C ±5°C and improved humidity capability 86 = 10 cycles at 25°C ±5°C and improved humidity capability 87 = 10 cycles at -55°C +0°C/-5°C and +85°C ±5°C and improved humidity capability *** E = None ** S = 10 cycles at 25°C ** W = 10 cycles at -55°C and 85°C	05 = ESR - High 10 = ESR - Standard 20 = ESR - Low	D = Silver-plated (Ag) H = Solder-plated (SnPb 5% Pb minimum) T = 100% Tin (Sn)	540 = T540 541 = T541

T543 Discrete Component

T	SP	6X	207	M	050	A	H	E	040	D	543
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate (Discrete)	Termination Finish (Discrete)	Surge (Discrete)	ESR (Stack)	Termination Finish (Stack)	Discrete Component's Series
T = Tantalum	Stacks Polymer Cathode		First two digits represent significant figures. Third digit specifies number of zeros.	K = ±10% M = ±20%	003 = 3 004 = 4 006 = 6.3 010 = 10 016 = 16 025 = 25 035 = 35 050 = 50 063 = 63	A = N/A	H = Standard solder coated (SnPb 5% Pb minimum) T = 100% Matte Tin (Sn)-plated	E = None S = 10cycles @ 25°C W = 10 cycles -55°C and 85°C	ESR in mΩ	D = Silver-plated (Ag) H = Solder-plated (SnPb 5% Pb minimum) T = 100% Tin (Sn)	543 = T543

Ordering Information (cont.)

T520, T521, T525, T530, T545 Discrete Component

T	SP	2X	667	M	10	A	T	E	002	D	530
Capacitor Class	Series	Case Size	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Failure Rate (Discrete)	Termination Finish (Discrete)	Surge (Discrete)	ESR (Stack)	Termination Finish (Stack)	Discrete Component's Series
T = Tantalum	Stacks Polymer Cathode		First two digits represent significant figures. Third digit specifies number of zeros.	K = ±10% M = ±20%	003 = 3 004 = 4 006 = 6.3 010 = 10 016 = 16 025 = 25 035 = 35 050 = 50 063 = 63	A = N/A	H = Standard solder coated (SnPb 5% Pb minimum) T = 100% Matte Tin (Sn)-plated	E = None	ESR in mΩ	D = Silver-plated (Ag) H = Solder-plated (SnPb 5% Pb minimum) T = 100% Tin (Sn)	520 = T520 521 = T521 525 = T525 530 = T530 545 = T545

Note: Custom discrete component stacking solutions are also available with other KEMET Polymer Electrolytic Surface Mount series/products. Please contact KEMET Sales for availability.

Performance Characteristics

Item	Performance Characteristics
Operating Temperature	-55°C to 125°C
Rated Capacitance Range	20 – 6,000 µF at 120 Hz/25°C
Capacitance Tolerance	M Tolerance (20%)
Rated Voltage Range	3 – 63 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, 2,000 hours	Δ C/C	Within -20/+10% of initial value
		DF	≤ initial limit
		DCL	1.25 x IL at 125°C
		ESR	2 x initial limit
Thermal Shock	KEMET specified test, mounted, -55°C to 125°C, 5 cycles	Δ C/C	Within ±5% of initial value
		DF	Within initial limits
		DCL	Within 1.25 x initial limit
		ESR	Within initial limits
Surge Voltage	85°C, 1.15 x rated voltage 1,000 cycles	Δ C/C	Within ±5% of initial value
		DF	Within initial limits
		DCL	Within initial limits
		ESR	Within initial limits
Surge Voltage	125°C, 0.77 x rated voltage 1,000 cycles	Δ C/C	Within ±5% of initial value
		DF	Within initial limits
		DCL	Within initial limits
		ESR	Within initial limits
Mechanical Vibration	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

Reliability

KO-CAP capacitors have an average failure rate of 0.5 %/1,000 hours at category voltage, U_C , and category temperature, T_C . These capacitors are qualified using industry test standards at U_C and T_C . The minimum test time (1,000 or 2,000 hours) is dependent on the product.

The actual life expectancy of KO-CAP capacitors increases when application voltage, U_A , and application temperature, T_A , are lower than U_C and T_C . As a general guideline, when $U_A < 0.9 * U_C$ and $T_A < 85^\circ\text{C}$, the life expectancy will typically exceed the useful lifetime of most hardware (> 10 years).

The lifetime of a KO-CAP capacitor at a specific application voltage and temperature can be modeled using the equations below. A failure is defined as passing enough current to blow a 1-Amp fuse. The calculation is an estimation based on empirical results and is not a guarantee.

$$VAF = \left(\frac{U_C}{U_A}\right)^n$$

where:

VAF = acceleration factor due to voltage, unitless

U_C = category voltage, volt

U_A = application voltage, volt

n = exponent, 16

$$TAF = e^{\left[\frac{E_a}{k} \left(\frac{1}{273+T_A} - \frac{1}{273+T_C}\right)\right]}$$

where:

TAF = acceleration factor due to temperature, unitless

E_a = activation energy, 1.4 eV

k = Boltzmann's constant, 8.617E-5 eV/K

T_A = application temperature, °C

T_C = category temperature, °C

$$AF = VAF * TAF$$

where:

AF = acceleration factor, unitless

TAF = acceleration factor due to temperature, unitless

VAF = acceleration factor due to voltage, unitless

$$Life_{U_A, T_A} = Life_{U_C, T_C} * AF$$

where:

$Life_{U_A, T_A}$ = guaranteed life application voltage and temperature, years

$Life_{U_C, T_C}$ = guaranteed life category voltage and temperature, years

AF = acceleration factor, unitless

Reliability Table 1 – Common temperature range classifications

85°C (T_R) / 85°C (T_C)	Rated Voltage (U_R)	2.5	4.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0	35.0	50.0	63.0	75.0
	Category Voltage (U_C)	2.5	4.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0	35.0	50.0	63.0	75.0
105°C (T_R) / 105°C (T_C)	Rated Voltage (T_R)	2.5	4.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0	35.0	50.0	63.0	75.0
	Category Voltage (U_C)	2.5	4.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0	35.0	50.0	63.0	75.0
105°C (T_R) / 125°C (T_C)	Rated Voltage (T_R)	2.5	4.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0	35.0	50.0	63.0	75.0
	Category Voltage (U_C)	1.7	2.7	4.2	5.4	6.7	8.4	10.7	13.4	16.8	23.5	33.5	42.2	50.3

Terms:

Category Voltage, U_C : Maximum recommended peak DC operating voltage for continuous operation at the category temperature, T_C

Rated Voltage, U_R : Maximum recommended peak DC operating voltage for continuous operation up to the rated temperature, T_R

Category Temperature, T_C : Maximum recommended operating temperature; voltage derating may be required at T_C

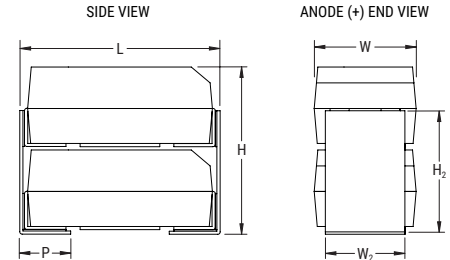
Rated Temperature, T_R : Maximum recommended operating temperature without voltage derating; T_R is equal to or lower than T_C

Dimensions – Millimeters (Inches)

Metric will govern

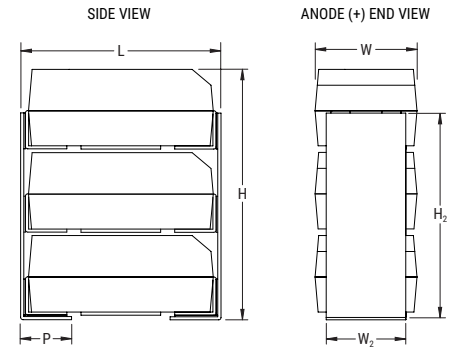
TSP2

KEMET 2 Component Stack Dimensions						
Case Code	L	W	H	W ₂	H ₂	P
2C	6.5 ± 0.38 (0.258 ± 0.015)	3.3 ± 0.2 (0.130 ± 0.008)	5.3 ± 0.38 (0.210 ± 0.015)	2.5 ± 0.2 (0.100 ± 0.008)	4.5 ± 0.38 (0.176 ± 0.015)	1.4 ± 0.38 (0.055 ± 0.015)
2B	4.1 ± 0.38 (0.162 ± 0.015)	3.1 ± 0.2 (0.122 ± 0.008)	4.3 ± 0.38 (0.170 ± 0.015)	2.3 ± 0.2 (0.090 ± 0.008)	3.1 ± 0.38 (0.124 ± 0.015)	0.76 ± 0.38 (0.030 ± 0.015)
2D	8.0 ± 0.38 (0.315 ± 0.015)	4.4 ± 0.2 (0.174 ± 0.008)	6.2 ± 0.38 (0.245 ± 0.015)	3.0 ± 0.2 (0.120 ± 0.008)	4.8 ± 0.38 (0.192 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)
2X	8.0 ± 0.38 (0.315 ± 0.015)	4.4 ± 0.2 (0.174 ± 0.008)	8.9 ± 0.38 (0.352 ± 0.015)	3.0 ± 0.2 (0.120 ± 0.008)	6.9 ± 0.38 (0.272 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)



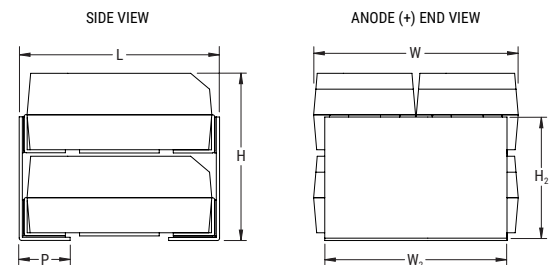
TSP3

KEMET 3 Component Stack Dimensions						
Case Code	L	W	H	W ₂	H ₂	P
3B	4.1 ± 0.38 (0.162 ± 0.015)	3.1 ± 0.2 (0.122 ± 0.008)	6.3 ± 0.38 (0.248 ± 0.015)	2.3 ± 0.2 (0.090 ± 0.008)	5.3 ± 0.38 (0.210 ± 0.015)	0.76 ± 0.38 (0.030 ± 0.015)
3D	8.0 ± 0.38 (0.315 ± 0.015)	4.4 ± 0.2 (0.174 ± 0.008)	9.2 ± 0.38 (0.365 ± 0.015)	3.0 ± 0.2 (0.120 ± 0.008)	7.7 ± 0.38 (0.304 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)
3X	8.0 ± 0.38 (0.315 ± 0.015)	4.4 ± 0.2 (0.174 ± 0.008)	13.3 ± 0.38 (0.525 ± 0.015)	3.0 ± 0.2 (0.120 ± 0.008)	11.0 ± 0.38 (0.436 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)



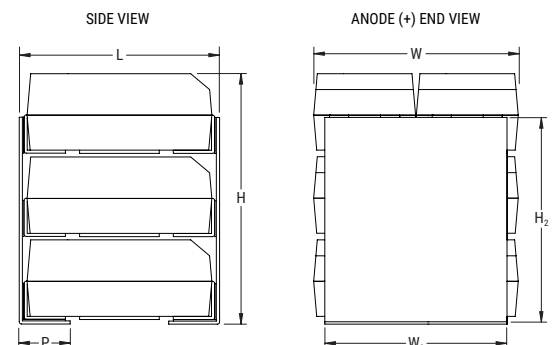
TSP4

KEMET 4 Component Stack Dimensions						
Case Code	L	W	H	W ₂	H ₂	P
4B	4.1 ± 0.38 (0.162 ± 0.015)	6.1 ± 0.2 (0.242 ± 0.008)	4.3 ± 0.38 (0.170 ± 0.015)	5.3 ± 0.2 (0.210 ± 0.008)	3.1 ± 0.38 (0.124 ± 0.015)	0.76 ± 0.38 (0.030 ± 0.015)
4D	8.0 ± 0.38 (0.315 ± 0.015)	8.9 ± 0.2 (0.350 ± 0.008)	6.2 ± 0.38 (0.245 ± 0.015)	7.4 ± 0.2 (0.292 ± 0.008)	4.8 ± 0.38 (0.192 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)
4X	8.0 ± 0.38 (0.315 ± 0.015)	8.9 ± 0.2 (0.350 ± 0.008)	8.9 ± 0.38 (0.352 ± 0.015)	7.4 ± 0.2 (0.292 ± 0.008)	6.9 ± 0.38 (0.272 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)



TSP6

KEMET 6 Component Stack Dimensions						
Case Code	L	W	H	W ₂	H ₂	P
6B	4.1 ± 0.38 (0.162 ± 0.015)	6.1 ± 0.2 (0.242 ± 0.008)	6.3 ± 0.38 (0.248 ± 0.015)	5.3 ± 0.2 (0.210 ± 0.008)	5.3 ± 0.38 (0.210 ± 0.015)	0.76 ± 0.38 (0.030 ± 0.015)
6D	8.0 ± 0.38 (0.315 ± 0.015)	8.9 ± 0.2 (0.350 ± 0.008)	9.2 ± 0.38 (0.365 ± 0.015)	7.4 ± 0.2 (0.292 ± 0.008)	7.7 ± 0.38 (0.304 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)
6X	8.0 ± 0.38 (0.315 ± 0.015)	8.9 ± 0.2 (0.350 ± 0.008)	13.3 ± 0.38 (0.525 ± 0.015)	7.4 ± 0.2 (0.292 ± 0.008)	11.0 ± 0.38 (0.436 ± 0.015)	1.9 ± 0.38 (0.075 ± 0.015)



Capacitance and Rated Voltage Chart

Capacitance		Rated Voltage								
µf	Code	3V	4V	6.3V	10	16	25	35	50	63
20	206									2X
30	306									2X, 3X
40	406									4X
44	446								2X	
45	456									3X
60	606									4X, 6X
66	666				2B			2X	2X, 3X	
88	886								4X	
90	906									6X
94	946					2D		2X		
99	996				3B					
100	107							3X	3X	
130	137			2B	4B		2X	4X	4X, 6X	
140	147					3D		3X		
190	197					4D		4X		
198	207				6B					
200	207		2B	3B	2D		3X	6X	6X	
260	267						4X			
272	277			4B						
280	287					6D		6X		
300	307		3B		2D	2X				
400	407		4B	6B	4D		6X			
440	447		2D		2D	2X				
450	457	3B				3X				
600	607	4B	6B			4X				
660	667	2D		2D	3D, 2X	2X, 3X				
880	887		4D		4D	4X				
900	907	6B			6D	6X				
940	947		2D	2X						
990	997			3D	3X	3X				
1300	138		2X	4D	6D, 4X	4X, 6X				
1360	148	2D								
1400	148		3D	3X						
1900	198		4D	4X						
1980	208			6D						
2000	208	3D	2X, 3X		6X	6X				
2700	278	4D	4X							
2800	288		6D	6X						
3000	308		3X							
4000	408	6D	4X, 6X							
6000	608		6X							

Table 1A – TSP2 Ratings & Part Number Reference

Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	Standard ESR	Low ESR	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	mΩ at +25°C 100 kHz Max	°C
4	200	2B	TSP2B207(4)004(6)(3)(1)(2)(5)540	80	8	40	N/A	125
6.3	130	2B	TSP2B137(4)006(6)(3)(1)(2)(5)540	86	8	40	N/A	125
10	66	2B	TSP2B666(4)010(6)(3)(1)(2)(5)540	66	8	40	N/A	125
3	660	2D	TSP2D667(4)003(6)(3)(1)(2)(5)540	198	10	13	N/A	125
3	1400	2D	TSP2D148(4)003(6)(3)(1)(2)(5)540	408	10	13	N/A	125
4	440	2D	TSP2D447(4)004(6)(3)(1)(2)(5)540	176	10	13	N/A	125
4	940	2D	TSP2D947(4)004(6)(3)(1)(2)(5)540	376	10	20	13	125
6.3	660	2D	TSP2D667(4)006(6)(3)(1)(2)(5)540	416	10	20	13	125
10	200	2D	TSP2D207(4)010(6)(3)(1)(2)(5)540	200	10	28	13	125
10	300	2D	TSP2D307(4)010(6)(3)(1)(2)(5)540	300	10	28	13	125
10	440	2D	TSP2D447(4)010(6)(3)(1)(2)(5)540	440	10	13	N/A	125
16	94	2D	TSP2D946(4)016(6)(3)(1)(2)(5)540	152	10	33	18	125
4	1300	2X	TSP2X138(4)004(6)(3)(1)(2)(5)541	520	10	5	3	125
4	2000	2X	TSP2X208(4)004(6)(3)(1)(2)(5)541	800	10	5	3	125
6.3	940	2X	TSP2X947(4)006(6)(3)(1)(2)(5)541	564	10	5	3	125
10	660	2X	TSP2X667(4)010(6)(3)(1)(2)(5)541	660	10	5	3	125
16	300	2X	TSP2X307(4)016(6)(3)(1)(2)(5)541	480	10	20	12	125
16	440	2X	TSP2X447(4)016(6)(3)(1)(2)(5)541	704	10	20	12	125
16	660	2X	TSP2X667(4)016(6)(3)(1)(2)(5)541	1056	10	25	12	125
25	130	2X	TSP2X137(4)025(6)(3)(1)(2)(5)541	325	10	25	N/A	125
35	66	2X	TSP2X666(4)035(6)(3)(1)(2)(5)541	231	10	30	N/A	125
35	94	2X	TSP2X946(4)035(6)(3)(1)(2)(5)541	329	10	30	N/A	125
50	44	2X	TSP2X446(4)050(6)(3)(1)(2)(5)541	220	10	40	N/A	125
50	66	2X	TSP2X666(4)050(6)(3)(1)(2)(5)541	330	10	40	N/A	125
63	20	2X	TSP2X206(4)063(6)(3)(1)(2)(5)541	126	10	75	50	125
63	30	2X	TSP2X306(4)063(6)(3)(1)(2)(5)541	189	10	25	N/A	125

(1) To complete KEMET part number, insert 65 = None, 66 = 10 cycles +25°C, 67 = 10 cycles -55°C +85°C. Designates surge current option.

(2) To complete KEMET part number, insert 10 = Standard ESR, 20 = Low ESR. Designates ESR option.

(3) To complete KEMET part number, insert H = Standard solder coated or T = 100% Tin

(4) To complete KEMET part number, insert M for ±20%, K for ±10%. Designates Capacitance tolerance.

(5) To complete KEMET part number, insert D = Silver-plated (Ag), H = Solder-plated, or T = 100% Tin (Sn). Designates Termination Finish (stack)

(6) To complete KEMET part number, insert D (0.001%/1,000 hours), C (0.01%/1,000 hours), B (0.1%/1,000 hours), or A = N/A. Designates Reliability Level.

Refer to Ordering Information for additional detail.

Table 1B – TSP3 Ratings & Part Number Reference

Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	Standard ESR	Low ESR	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	mΩ at +25°C 100 kHz Max	°C
3	450	3B	TSP3B457(4)003(6)(3)(1)(2)(5)540	135	8	27	N/A	125
4	300	3B	TSP3B307(4)004(6)(3)(1)(2)(5)540	120	8	27	N/A	125
6.3	200	3B	TSP3B207(4)006(6)(3)(1)(2)(5)540	129	8	27	N/A	125
10	99	3B	TSP3B996(4)010(6)(3)(1)(2)(5)540	99	8	27	N/A	125
3	2000	3D	TSP3D208(4)003(6)(3)(1)(2)(5)540	612	10	9	N/A	125
4	1400	3D	TSP3D148(4)004(6)(3)(1)(2)(5)540	564	10	14	9	125
6.3	990	3D	TSP3D997(4)006(6)(3)(1)(2)(5)540	624	10	14	9	125
10	660	3D	TSP3D667(4)010(6)(3)(1)(2)(5)540	660	10	9	N/A	125
16	140	3D	TSP3D147(4)016(6)(3)(1)(2)(5)540	226	10	22	12	125
4	2000	3X	TSP3X208(4)004(6)(3)(1)(2)(5)541	800	10	3	2	125
4	3000	3X	TSP3X308(4)004(6)(3)(1)(2)(5)541	1200	10	3	2	125
6.3	1400	3X	TSP3X148(4)006(6)(3)(1)(2)(5)541	840	10	3	2	125
10	990	3X	TSP3X997(4)010(6)(3)(1)(2)(5)541	990	10	3	2	125
16	450	3X	TSP3X457(4)016(6)(3)(1)(2)(5)541	720	10	15	9	125
16	660	3X	TSP3X667(4)016(6)(3)(1)(2)(5)541	1056	10	15	9	125
16	990	3X	TSP3X997(4)016(6)(3)(1)(2)(5)541	1584	10	18	9	125
25	200	3X	TSP3X207(4)025(6)(3)(1)(2)(5)541	500	10	18	N/A	125
35	100	3X	TSP3X107(4)035(6)(3)(1)(2)(5)541	350	10	20	N/A	125
35	140	3X	TSP3X147(4)035(6)(3)(1)(2)(5)541	490	10	20	N/A	125
50	66	3X	TSP3X666(4)050(6)(3)(1)(2)(5)541	330	10	25	N/A	125
50	100	3X	TSP3X107(4)050(6)(3)(1)(2)(5)541	500	10	25	N/A	125
63	30	3X	TSP3X306(4)063(6)(3)(1)(2)(5)541	189	10	50	35	125
63	45	3X	TSP3X456(4)063(6)(3)(1)(2)(5)541	283.5	10	18	N/A	125

(1) To complete KEMET part number, insert 65 = None, 66 = 10 cycles +25°C, 67 = 10 cycles -55°C +85°C. Designates surge current option.

(2) To complete KEMET part number, insert 10 = Standard ESR, 20 = Low ESR. Designates ESR option.

(3) To complete KEMET part number, insert H = Standard solder coated or T = 100% Tin

(4) To complete KEMET part number, insert M for ±20%, K for ±10%. Designates Capacitance tolerance.

(5) To complete KEMET part number, insert D = Silver-plated (Ag), H = Solder-plated, or T = 100% Tin (Sn). Designates Termination Finish (stack)

(6) To complete KEMET part number, insert D (0.001%/1,000 hours), C (0.01%/1,000 hours), B (0.1%/1,000 hours), or A = N/A. Designates Reliability Level.

Refer to Ordering Information for additional detail.

Table 1C – TSP4 Ratings & Part Number Reference

Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	Standard ESR	Low ESR	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	mΩ at +25°C 100 kHz Max	°C
3	600	4B	TSP4B607(4)003(6)(3)(1)(2)(5)540	180	8	20	N/A	125
4	400	4B	TSP4B407(4)004(6)(3)(1)(2)(5)540	160	8	20	N/A	125
6.3	270	4B	TSP4B277(4)006(6)(3)(1)(2)(5)540	172	8	20	N/A	125
10	130	4B	TSP4B137(4)010(6)(3)(1)(2)(5)540	132	8	20	N/A	125
3	2700	4D	TSP4D278(4)003(6)(3)(1)(2)(5)540	816	10	7	N/A	125
4	880	4D	TSP4D887(4)004(6)(3)(1)(2)(5)540	352	10	7	N/A	125
4	1900	4D	TSP4D198(4)004(6)(3)(1)(2)(5)540	752	10	10	7	125
6.3	1300	4D	TSP4D138(4)006(6)(3)(1)(2)(5)540	832	10	10	7	125
10	400	4D	TSP4D407(4)010(6)(3)(1)(2)(5)540	400	10	14	7	125
10	880	4D	TSP4D887(4)010(6)(3)(1)(2)(5)540	880	10	7	N/A	125
16	190	4D	TSP4D197(4)016(6)(3)(1)(2)(5)540	301	10	17	9	125
4	2700	4X	TSP4X278(4)004(6)(3)(1)(2)(5)541	1080	10	3	2	125
4	4000	4X	TSP4X408(4)004(6)(3)(1)(2)(5)541	1600	10	3	2	125
6.3	1900	4X	TSP4X198(4)006(6)(3)(1)(2)(5)541	1140	10	3	2	125
10	1300	4X	TSP4X138(4)010(6)(3)(1)(2)(5)541	1300	10	3	2	125
16	600	4X	TSP4X607(4)016(6)(3)(1)(2)(5)541	960	10	10	8	125
16	880	4X	TSP4X887(4)016(6)(3)(1)(2)(5)541	1408	10	10	8	125
16	1300	4X	TSP4X138(4)016(6)(3)(1)(2)(5)541	2080	10	12	8	125
25	260	4X	TSP4X267(4)025(6)(3)(1)(2)(5)541	650	10	12	N/A	125
35	130	4X	TSP4X137(4)035(6)(3)(1)(2)(5)541	455	10	15	N/A	125
35	190	4X	TSP4X197(4)035(6)(3)(1)(2)(5)541	665	10	15	N/A	125
50	88	4X	TSP4X886(4)050(6)(3)(1)(2)(5)541	440	10	20	N/A	125
50	130	4X	TSP4X137(4)050(6)(3)(1)(2)(5)541	650	10	20	N/A	125
63	40	4X	TSP4X406(4)063(6)(3)(1)(2)(5)541	252	10	40	25	125
63	60	4X	TSP4X606(4)063(6)(3)(1)(2)(5)541	378	10	12	N/A	125

(1) To complete KEMET part number, insert 65 = None, 66 = 10 cycles +25°C, 67 = 10 cycles -55°C +85°C. Designates surge current option.

(2) To complete KEMET part number, insert 10 = Standard ESR, 20 = Low ESR. Designates ESR option.

(3) To complete KEMET part number, insert H = Standard solder coated or T = 100% Tin

(4) To complete KEMET part number, insert M for ±20%, K for ±10%. Designates Capacitance tolerance.

(5) To complete KEMET part number, insert D = Silver-plated (Ag), H = Solder-plated, or T = 100% Tin (Sn). Designates Termination Finish (stack)

(6) To complete KEMET part number, insert D (0.001%/1,000 hours), C (0.01%/1,000 hours), B (0.1%/1,000 hours), or A = N/A. Designates Reliability Level.

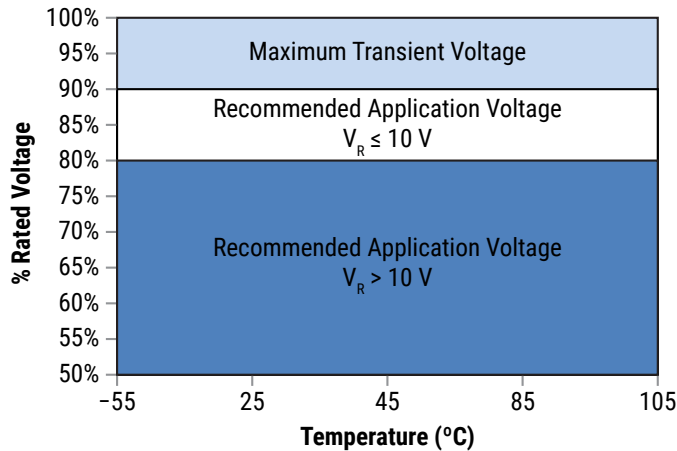
Refer to Ordering Information for additional detail.

Table 1D – TSP6 Ratings & Part Number Reference

Rated Voltage	Rated Capacitance	Case Code/ Case Size	KEMET Part Number	DC Leakage	DF	Standard ESR	Low ESR	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	mΩ at +25°C 100 kHz Max	°C
3	900	6B	TSP6B907(4)003(6)(3)(1)(2)(5)540	270	8	14	N/A	125
4	600	6B	TSP6B607(4)004(6)(3)(1)(2)(5)540	240	8	14	N/A	125
6.3	400	6B	TSP6B407(4)006(6)(3)(1)(2)(5)540	258	8	14	N/A	125
10	200	6B	TSP6B207(4)010(6)(3)(1)(2)(5)540	198	8	14	N/A	125
3	4100	6D	TSP6D418(4)003(6)(3)(1)(2)(5)540	1224	10	5	N/A	125
4	2800	6D	TSP6D288(4)004(6)(3)(1)(2)(5)540	1128	10	7	5	125
6.3	2000	6D	TSP6D208(4)006(6)(3)(1)(2)(5)540	1248	10	7	5	125
10	900	6D	TSP6D907(4)010(6)(3)(1)(2)(5)540	900	10	10	5	125
10	1300	6D	TSP6D138(4)010(6)(3)(1)(2)(5)540	1320	10	5	N/A	125
16	280	6D	TSP6D287(4)016(6)(3)(1)(2)(5)540	452	10	11	6	125
4	4000	6X	TSP6X408(4)004(6)(3)(1)(2)(5)541	1600	10	2	1	125
4	6000	6X	TSP6X608(4)004(6)(3)(1)(2)(5)541	2400	10	2	1	125
6.3	2800	6X	TSP6X288(4)006(6)(3)(1)(2)(5)541	1680	10	2	1	125
10	2000	6X	TSP6X208(4)010(6)(3)(1)(2)(5)541	2000	10	2	1	125
16	900	6X	TSP6X907(4)016(6)(3)(1)(2)(5)541	1440	10	8	5	125
16	1300	6X	TSP6X138(4)016(6)(3)(1)(2)(5)541	2080	10	8	5	125
16	2000	6X	TSP6X208(4)016(6)(3)(1)(2)(5)541	3200	10	9	5	125
25	400	6X	TSP6X407(4)025(6)(3)(1)(2)(5)541	1000	10	9	N/A	125
35	200	6X	TSP6X207(4)035(6)(3)(1)(2)(5)541	700	10	10	N/A	125
35	280	6X	TSP6X287(4)035(6)(3)(1)(2)(5)541	980	10	10	N/A	125
50	130	6X	TSP6X137(4)050(6)(3)(1)(2)(5)541	650	10	12	N/A	125
50	200	6X	TSP6X207(4)050(6)(3)(1)(2)(5)541	1000	10	12	N/A	125
63	60	6X	TSP6X606(4)063(6)(3)(1)(2)(5)541	378	10	25	20	125
63	90	6X	TSP6X906(4)063(6)(3)(1)(2)(5)541	567	10	9	N/A	125

- (1) To complete KEMET part number, insert 65 = None, 66 = 10 cycles +25°C, 67 = 10 cycles -55°C +85°C. Designates surge current option.
(2) To complete KEMET part number, insert 10 = Standard ESR, 20 = Low ESR. Designates ESR option.
(3) To complete KEMET part number, insert H = Standard solder coated or T = 100% Tin
(4) To complete KEMET part number, insert M for ±20%, K for ±10%. Designates Capacitance tolerance.
(5) To complete KEMET part number, insert D = Silver-plated (Ag), H = Solder-plated, or T = 100% Tin (Sn). Designates Termination Finish (stack)
(6) To complete KEMET part number, insert D (0.001%/1,000 hours), C (0.01%/1,000 hours), B (0.1%/1,000 hours), or A = N/A. Designates Reliability Level.
Refer to Ordering Information for additional detail.

Derating Guidelines



Recommended Application Voltage

KO-CAPs are solid state capacitors that demonstrate no wearout mechanism when operated within their recommended guidelines. While the KO-CAP can be operated at full rated voltage, most circuit designers seek a minimum level of assurance in long term reliability, which should be demonstrated with data. A voltage derating can provide the desired level of demonstrated reliability based on industry accepted acceleration models. Since most applications do require long term reliability, KEMET recommends that designers consider a voltage derating, according the graphic above, for the maximum steady state voltage.

Voltage Rating	Maximum Recommended Steady State Voltage
-55°C to 105°C	
$10\text{ V} \leq V_R$	90% of V_R
$V_R > 10$	80% of V_R

V_R = Rated Voltage

Reverse Voltage

Solid electrolytic capacitors are polar devices and may be permanently damaged or destroyed if connected with the wrong polarity. The positive terminal is identified on the capacitor body by a stripe plus in some cases a beveled edge. A small degree of transient reverse voltage is permissible for short periods per the table. The capacitors should not be operated continuously in reverse mode, even within these limits.

Temperature	Permissible Transient Reverse Voltage
25°C	15% of Rated Voltage
85°C	5% of Rated Voltage
125°C	1% of Rated Voltage

Table 2 – Land Dimensions/Courtyard

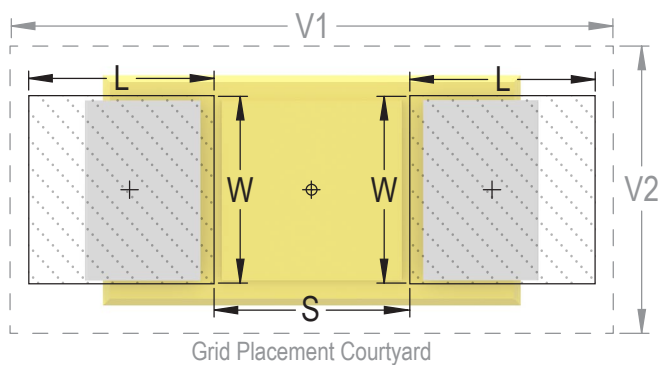
KEMET	Density Level A: Maximum (Most) Land Protrusion (mm)					Density Level B: Median (Nominal) Land Protrusion (mm)					Density Level C: Minimum (Least) Land Protrusion (mm)				
	L	W	S	V1	V2	L	W	S	V1	V2	L	W	S	V1	V2
TSP2B	2.34	2.54	1.41	7.10	4.30	1.94	2.42	1.61	6.00	3.80	1.56	2.32	1.77	5.14	3.54
TSP2C	2.98	2.74	2.53	9.50	4.50	2.58	2.62	2.73	8.40	4.00	2.20	2.52	2.89	7.54	3.74
TSP2D	3.48	3.24	3.03	11.00	5.60	3.08	3.12	3.23	9.90	5.10	2.70	3.02	3.39	9.04	4.84
TSP2X	3.48	3.24	3.03	11.00	5.60	3.08	3.12	3.23	9.90	5.10	2.70	3.02	3.39	9.04	4.84
TSP3B	2.34	2.54	1.41	7.10	4.30	1.94	2.42	1.61	6.00	3.80	1.56	2.32	1.77	5.14	3.54
TSP3D	3.48	3.24	3.03	11.00	5.60	3.08	3.12	3.23	9.90	5.10	2.70	3.02	3.39	9.04	4.84
TSP3X	3.48	3.24	3.03	11.00	5.60	3.08	3.12	3.23	9.90	5.10	2.70	3.02	3.39	9.04	4.84
TSP4B	2.34	5.54	1.41	7.10	7.30	1.94	5.42	1.61	6.00	6.80	1.56	5.32	1.77	5.14	6.54
TSP4D	3.48	7.64	3.03	11.00	10.10	3.08	7.52	3.23	9.90	9.60	2.70	7.42	3.39	9.04	9.34
TSP4X	3.48	7.64	3.03	11.00	10.10	3.08	7.52	3.23	9.90	9.60	2.70	7.42	3.39	9.04	9.34
TSP6B	2.34	5.54	1.41	7.10	7.30	1.94	5.42	1.61	6.00	6.80	1.56	5.32	1.77	5.14	6.54
TSP6D	3.48	7.64	3.03	11.00	10.10	3.08	7.52	3.23	9.90	9.60	2.70	7.42	3.39	9.04	9.34
TSP6X	3.48	7.64	3.03	11.00	10.10	3.08	7.52	3.23	9.90	9.60	2.70	7.42	3.39	9.04	9.34

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.



Soldering Process

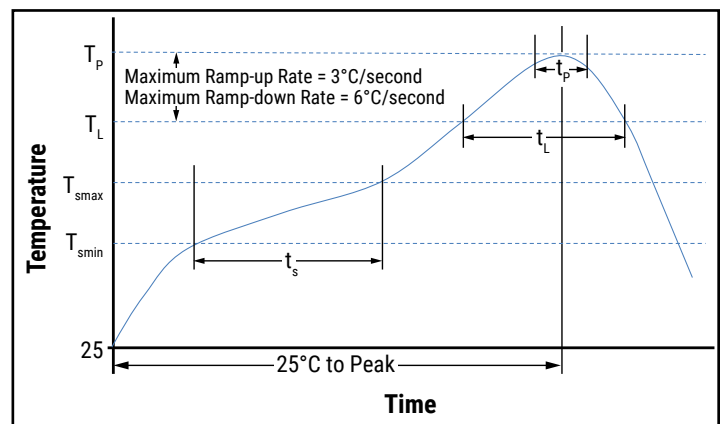
KEMET’s families of surface mount capacitors are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET’s recommended profile conditions for convection and IR reflow reflect the profile 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	250°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.



Storage

All KO-Cap Series are shipped in moisture barrier bags (MBBs) with desiccant and humidity indicator card (HIC). These parts are classified as MSL3 (Moisture Sensitivity Level 3) per IPC/JEDEC J–STD–020 and packaged per IPC/JEDEC J–STD–033

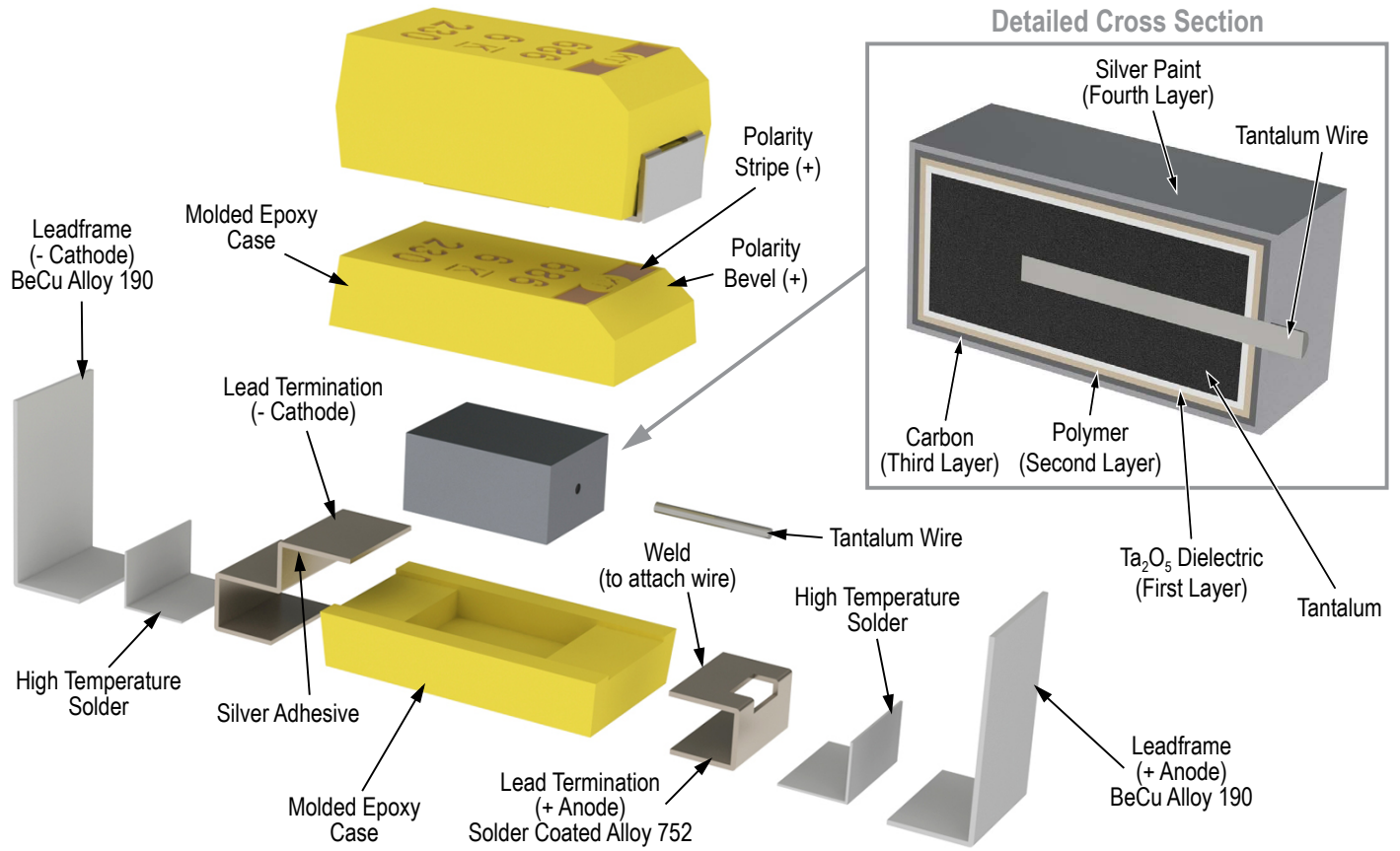
MSL3 specifies a floor time of 168H at 30°C maximum temperature and 60% relative humidity
Unused capacitors should be sealed in a MBB with fresh desiccant.

Calculated shelf life in sealed bag:

- 12 months from bag seal date in a storage environment of <40°C and humidity <90% RH
- 24 months from bag seal date in a storage environment of <30°C and humidity <70% RH

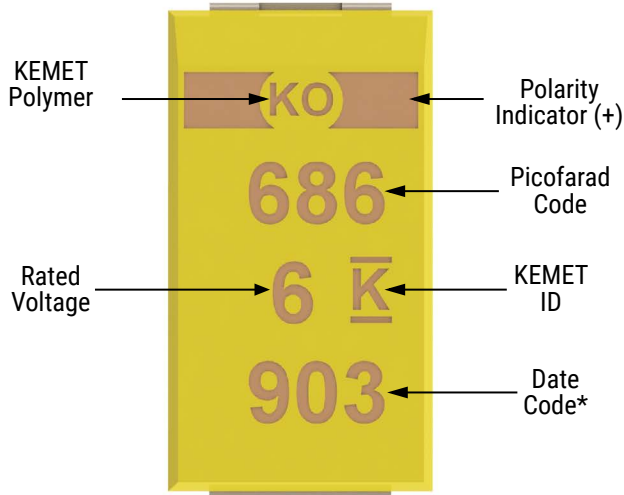
If baking is required, refer to IPC/JEDEC J–STD–033 for bake procedure

Construction



Capacitor Marking

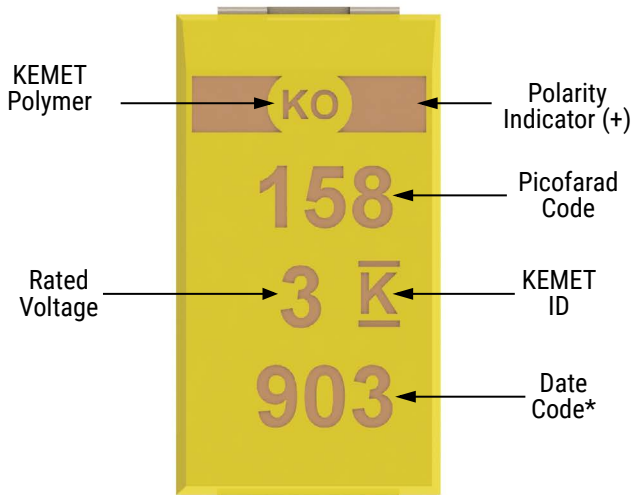
T540



* 903 = 3rd week of 2019

Date Code *	
1 st digit = Last number of Year	2 = 2012 3 = 2013 4 = 2014 5 = 2015 6 = 2016 7 = 2017
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

T541



* 903 = 3rd week of 2019

Date Code *	
1 st digit = Last number of Year	2 = 2012 3 = 2013 4 = 2014 5 = 2015 6 = 2016 7 = 2017
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

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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.

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