

## 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.

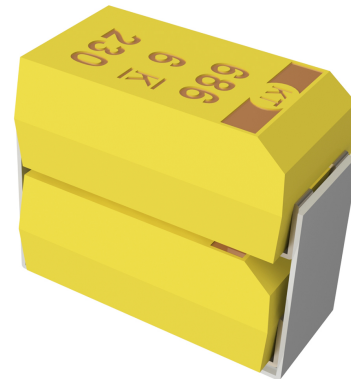
## KO-CAP Polymer Capacitors

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](http://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  $\mu$ F
- Capacitance can be custom specified
- Voltage ratings of 3 – 63 VDC
- High volumetric efficiency
- Ultra low ESR
- Surge capability
- Operating temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Laser-marked case
- Use up to 90% of rated voltage for part types  $\leq 10$  V
- Use up to 80% of rated voltage for part types  $> 10$  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](http://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 Components Series |
| T = Tantalum    | Stacks Polymer Cathode | 2B<br>3B<br>4B<br>6B<br>2C<br>3C<br>4C<br>6C<br>2D<br>3D<br>4D<br>6D<br>20<br>30<br>40<br>60<br>2X<br>3X<br>4X<br>6X | First two digits represent significant figures. Third digit specifies number of zeros. | K = ±10%<br>M = ±20%  | 003 = 3<br>004 = 4<br>006 = 6.3<br>010 = 10<br>016 = 16<br>025 = 25<br>035 = 35<br>050 = 50<br>063 = 63 | A = N/A<br>B = 0.1%/Khrs<br>C = 0.01%/Khrs<br>D = 0.001%/Khrs | H = Standard solder coated (SnPb 5% Pb minimum)<br><br>T = 100% Matte Tin (Sn)-plated | 65 = 4 cycles at 25°C ±5°C<br>66 = 10 cycles at 25°C<br>67 = 10 cycles at -55°C +0°C/-5°C and 85°C<br><br>85 = 4 cycles at 25°C ±5°C and improved humidity capability<br>86 = 10 cycles at 25°C ±5°C and improved humidity capability<br>87 = 10 cycles at -55°C +0°C/-5°C and +85°C ±5°C and improved humidity capability<br><br>*** E = None<br>** S = 10 cycles at 25°C<br>** W = 10 cycles at -55°C and 85°C | 05 = ESR - High<br>10 = ESR - Standard<br>20 = ESR-Low | D = Silver-plated (Ag)<br>H = Solder-plated (SnPb 5% Pb minimum)<br>T = 100% Tin (Sn) | 540 = T540<br>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 Components Series |
| T = Tantalum    | Stacks Polymer Cathode | 2B<br>3B<br>4B<br>6B<br>2C<br>3C<br>4C<br>6C<br>2D<br>3D<br>4D<br>6D<br>20<br>30<br>40<br>60<br>2X<br>3X<br>4X<br>6X | First two digits represent significant figures. Third digit specifies number of zeros. | K = ±10%<br>M = ±20%  | 003 = 3<br>004 = 4<br>006 = 6.3<br>010 = 10<br>016 = 16<br>025 = 25<br>035 = 35<br>050 = 50<br>063 = 63 | A = N/A                 | H = Standard solder coated (SnPb 5% Pb minimum)<br><br>T = 100% Matte Tin (Sn)-plated | E = None<br>S = 10 cycles at 25°C<br>W = 10 cycles -55°C and 85°C | ESR in mΩ   | D = Silver-plated (Ag)<br>H = Solder-plated (SnPb 5% Pb minimum)<br>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 Components Series   |
| T = Tantalum    | Stacks Polymer Cathode | 2B<br>3B<br>4B<br>6B<br>2C<br>3C<br>4C<br>6C<br>2D<br>3D<br>4D<br>6D<br>20<br>30<br>40<br>60<br>2X<br>3X<br>4X<br>6X | First two digits represent significant figures. Third digit specifies number of zeros. | K = ±10%<br>M = ±20%  | 003 = 3<br>004 = 4<br>006 = 6.3<br>010 = 10<br>016 = 16<br>025 = 25<br>035 = 35<br>050 = 50<br>063 = 63 | A = N/A                 | H = Standard solder coated (SnPb 5% Pb minimum)<br><br>T = 100% Matte Tin (Sn)-plated | E = None         | ESR in mΩ   | D = Silver-plated (Ag)<br>H = Solder-plated (SnPb 5% Pb minimum)<br>T = 100% Tin (Sn) | 520 = T520<br>521 = T521<br>525 = T525<br>530 = T530<br>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<br>125°C at 2/3 rated voltage, 2,000 hours | $\Delta C/C$    | Within -20/+10% of initial value   |
|                      |  | DF              | $\leq$ 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,<br>5 cycles                     | $\Delta C/C$    | Within $\pm 5\%$ 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  | $\Delta C/C$    | Within $\pm 5\%$ 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                                       | $\Delta C/C$    | Within $\pm 5\%$ of initial value  |
|                      |  | DF              | Within initial limits              |
|                      |  | DCL             | Within initial limits              |
|                      |  | ESR             | Within initial limits              |
| Mechanical Vibration | MIL-STD-202, Method 204, Condition D,<br>10 Hz to 2,000 Hz, 20 G peak          | $\Delta C/C$    | Within $\pm 10\%$ 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 ( $T_R$ ) /<br>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 ( $T_R$ ) /<br>105°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 ( $T_R$ ) /<br>125°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 ( $U_C$ ) | 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  $T_C$

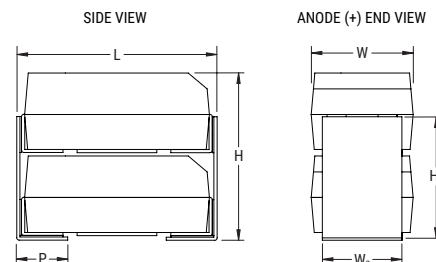
Rated Temperature,  $T_R$ : Maximum recommended operating temperature without voltage derating;  $T_R$  is equal to or lower than  $T_C$

## Dimensions – Millimeters (Inches)

Metric will govern

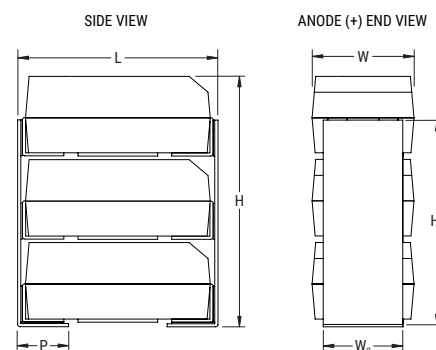
### TSP2

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



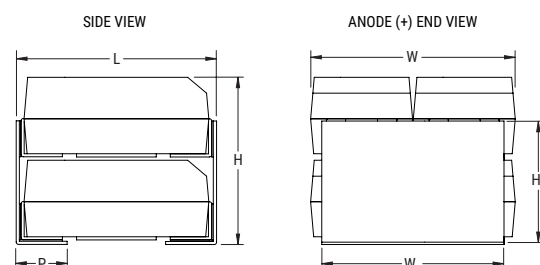
### TSP3

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



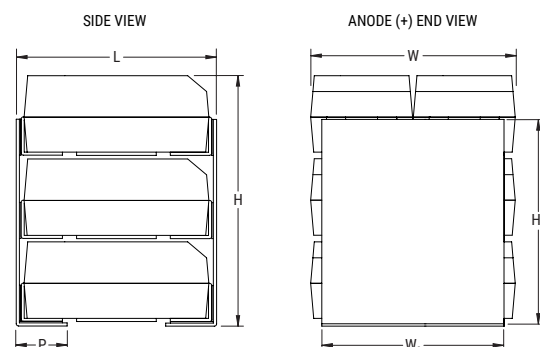
### TSP4

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



### TSP6

| KEMET 6 Component Stack Dimensions |                             |                            |                              |                            |                              |                              |
|------------------------------------|-----------------------------|----------------------------|------------------------------|----------------------------|------------------------------|------------------------------|
| Case Code                          | L                           | W                          | H                            | W <sub>2</sub>             | H <sub>2</sub>               | P                            |
| 6B                                 | 4.1 ±0.38<br>(0.162 ±0.015) | 6.1 ±0.2<br>(0.242 ±0.008) | 6.3 ±0.38<br>(0.248 ±0.015)  | 5.3 ±0.2<br>(0.210 ±0.008) | 5.3 ±0.38<br>(0.210 ±0.015)  | 0.76 ±0.38<br>(0.030 ±0.015) |
| 6D                                 | 8.0 ±0.38<br>(0.315 ±0.015) | 8.9 ±0.2<br>(0.350 ±0.008) | 9.2 ±0.38<br>(0.365 ±0.015)  | 7.4 ±0.2<br>(0.292 ±0.008) | 7.7 ±0.38<br>(0.304 ±0.015)  | 1.9 ±0.38<br>(0.075 ±0.015)  |
| 6X                                 | 8.0 ±0.38<br>(0.315 ±0.015) | 8.9 ±0.2<br>(0.350 ±0.008) | 13.3 ±0.38<br>(0.525 ±0.015) | 7.4 ±0.2<br>(0.292 ±0.008) | 11.0 ±0.38<br>(0.436 ±0.015) | 1.9 ±0.38<br>(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/<br>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<br>Max/5 Min | % at +25°C<br>120 Hz Max | mΩ at +25°C<br>100 kHz Max | mΩ at +25°C<br>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/<br>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<br>Max/5 Min | % at +25°C<br>120 Hz Max | mΩ at +25°C<br>100 kHz Max | mΩ at +25°C<br>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/<br>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<br>Max/5 Min | % at +25°C<br>120 Hz Max | mΩ at +25°C<br>100 kHz Max | mΩ at +25°C<br>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/<br>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<br>Max/5 Min | % at +25°C<br>120 Hz Max | mΩ at +25°C<br>100 kHz Max | mΩ at +25°C<br>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

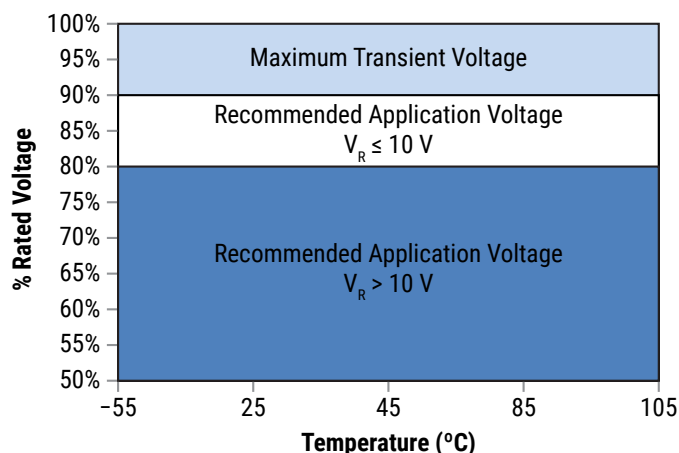
(4) To complete KEMET part number, insert M for ±20%, K for ±10%. Designates Capacitance tolerance.

(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**

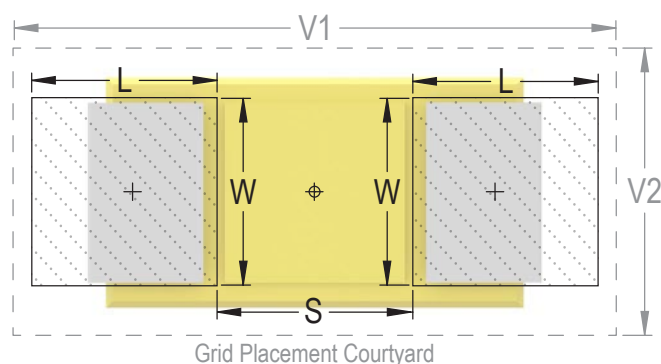
| KEMET | Density Level A:<br>Maximum (Most) Land Protrusion<br>(mm) |      |      |       |       | Density Level B:<br>Median (Nominal) Land Protrusion<br>(mm) |      |      |      |      | Density Level C:<br>Minimum (Least) Land Protrusion<br>(mm) |      |      |      |      |
|-------|--|------|------|-------|-------|--|------|------|------|------|---|------|------|------|------|
|       | 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).

<sup>1</sup> Height of these chips may create problems in wave soldering.



## Soldering Process

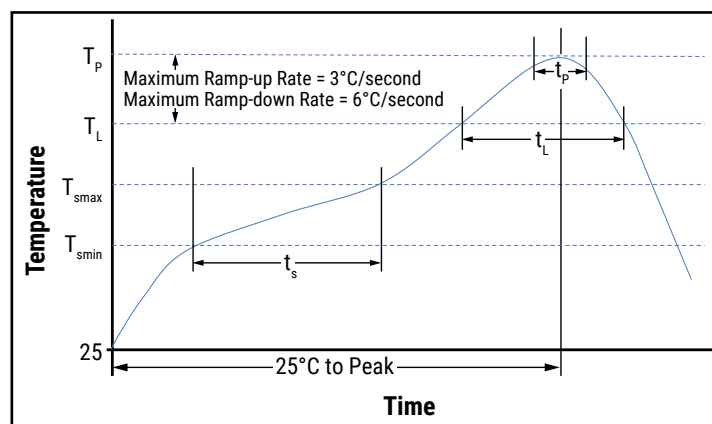
KEMET's families of surface mount capacitors are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile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

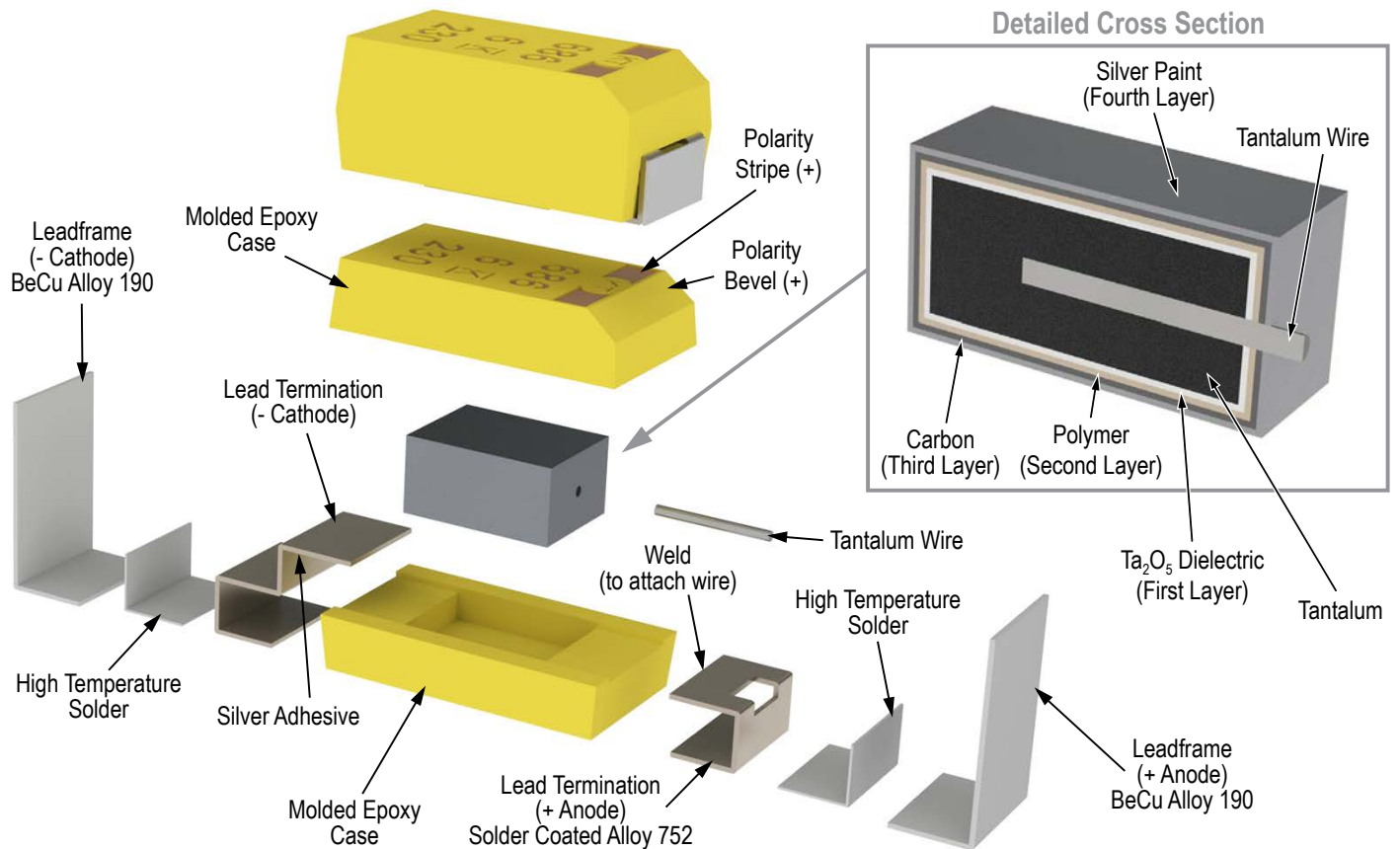
Unused capacitors should be sealed in a MBB with fresh desiccant.

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

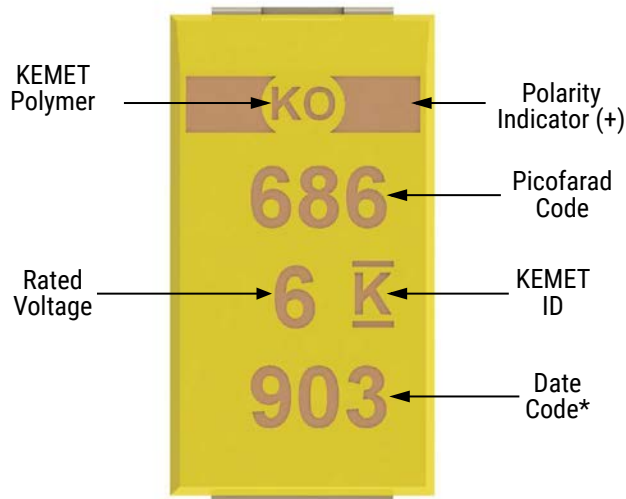
If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure

## Construction



## Capacitor Marking

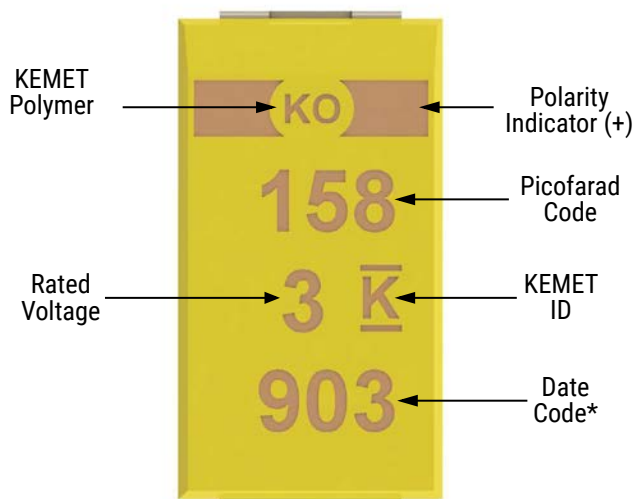
T540



\* 903 = 3<sup>rd</sup> week of 2019

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

T541



\* 903 = 3<sup>rd</sup> week of 2019

| Date Code *  |  |
|--|--|
| 1 <sup>st</sup> digit = Last number of Year                  | 2 = 2012<br>3 = 2013<br>4 = 2014<br>5 = 2015<br>6 = 2016<br>7 = 2017               |
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## KEMET Electronics Corporation Sales Offices

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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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