

## Overview

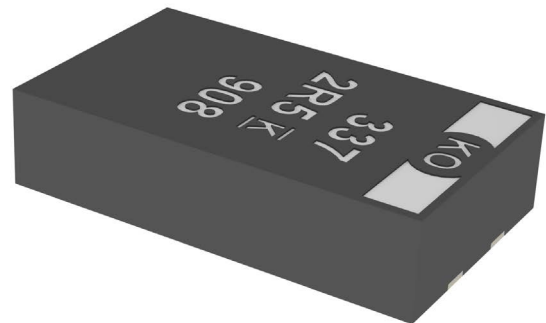
The KEMET Organic Capacitor (KO-CAP) is a solid electrolytic capacitor with a conductive polymer cathode capable of delivering very low ESR and improved capacitance retention at high frequencies. KO-CAP combines the low ESR of multilayer ceramic, the high capacitance of aluminum electrolytic, and the volumetric efficiency of tantalum into a single surface mount package. Unlike liquid electrolyte-based capacitors, KO-CAP has a very long operational life and high ripple current capabilities.

## KO-CAP Polymer Capacitors

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

## Benefits

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



## Applications

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

## Environmental Compliance

RoHS Compliant when ordered with 100% Sn or Ni-Pd-Au.

- Halogen-free
- Epoxy compliant with UL94 V-0
- Molded Epoxy complies for outgassing testing under ASTM E 595.

## 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

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

## Performance Characteristics

| Item                    | Performance Characteristics                                 |
|-------------------------|---|
| Operating Temperature   | -55°C to 105°C  |
| Rated Capacitance Range | 150 – 470 µF at 120 Hz/25°C                                 |
| Capacitance Tolerance   | M Tolerance (20%)   |
| Rated Voltage Range     | 2 – 6.3 V   |
| DF (120 Hz)             | ≤ 10% - 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  | Δ C/C           | Within -20/+10% of initial value |       |          |          |
|                                |  | DF              | ≤ Initial Limit                  |       |          |          |
|                                |  | DCL             | Within 1.25 x initial limit      |       |          |          |
|                                |  | ESR             | Within 2.0 x initial limit       |       |          |          |
| Storage Life                   | 105°C at 0 volts, 2,000 hours  | Δ C/C           | Within -20/+10% of initial value |       |          |          |
|                                |  | DF              | Within initial limits            |       |          |          |
|                                |  | DCL             | Within 1.25 x initial limit      |       |          |          |
|                                |  | ESR             | Within 2.0 x initial limit       |       |          |          |
| Humidity                       | 60°C, 90% RH, No Load, 500 hours   | Δ C/C           | Within -5/+35% of initial value  |       |          |          |
|                                |  | DF              | ≤ Initial limit                  |       |          |          |
|                                |  | DCL             | Within 5.0 x initial limit       |       |          |          |
|                                |  | ESR             | Within 2.0 x initial limit       |       |          |          |
| Temperature Stability          | Extreme temperature exposure at a succession of continuous steps at -55°C, +25°C, +85°C, +105°C                        |                 | +25°C                            | -55°C | +85°C    | +105°C   |
|                                |  | Δ C/C           | IL*                              | ±20%  | ±20%     | ±30%     |
|                                |  | DF              | IL                               | IL    | 1.2 x IL | 1.5 x IL |
|                                |  | DCL             | IL                               | N/A   | 10 x IL  | 10 x IL  |
| Surge Voltage                  | 105°C, 1.32 x rated voltage 1,000 cycles   | Δ C/C           | Within -20/+10% of initial value |       |          |          |
|                                |  | DF              | Within initial limits            |       |          |          |
|                                |  | DCL             | Within initial limits            |       |          |          |
|                                |  | ESR             | Within initial limits            |       |          |          |
| Mechanical Shock/<br>Vibration | MIL-STD-202, Method 213, Condition I, 100 G peak<br>MIL-STD-202, Method 204, Condition D, 10 Hz to 2,000 Hz, 20 G peak | Δ C/C           | Within ±10% of initial value     |       |          |          |
|                                |  | DF              | Within initial limits            |       |          |          |
|                                |  | DCL             | Within initial limits            |       |          |          |

\*IL = Initial limit

## 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:

$Life_{U_A, T_A}$  = estimated 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,  $T_C$

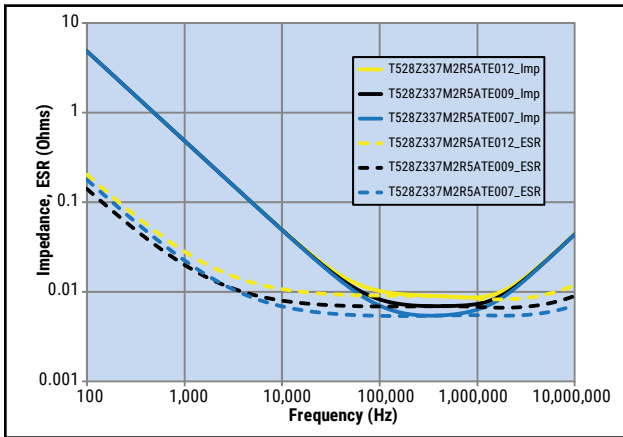
Rated Voltage,  $U_R$ : Maximum recommended peak DC operating voltage for continuous operation up to the rated temperature,  $T_R$

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

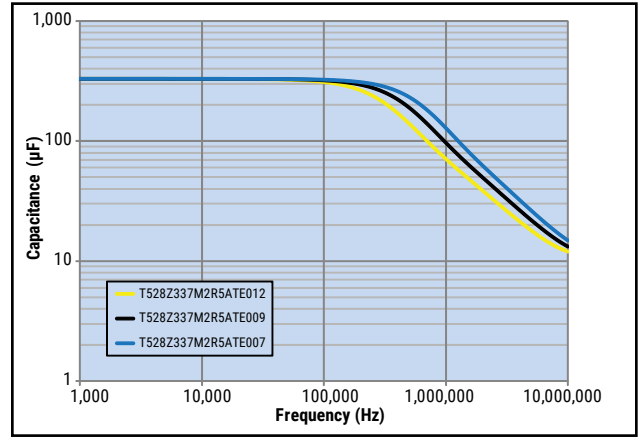
Rated Temperature,  $T_R$ : Maximum recommended operating temperature without voltage derating;  $T_R$  is equal to or lower than  $T_C$

## Electrical Characteristics

ESR vs. Frequency

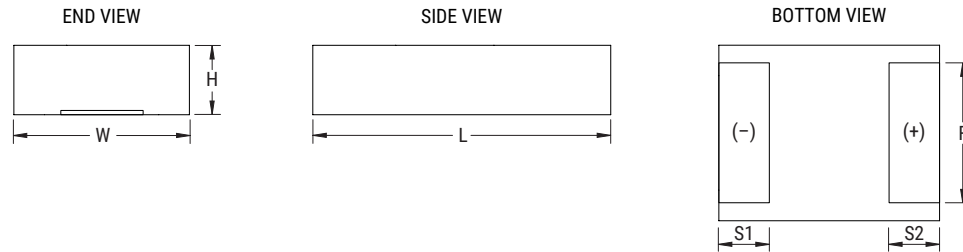


Capacitance vs. Frequency

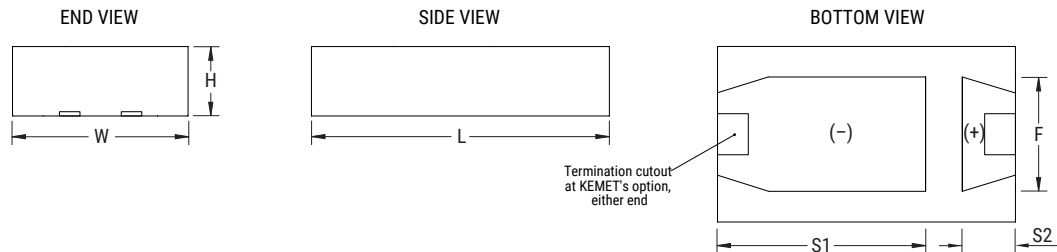


## Dimensions – Millimeters

### B Case



### W and Z Cases



| Case Size |         | Component Dimensions |          |          |        |          |          | Typical Weight |
|-----------|---------|----------------------|----------|----------|--------|----------|----------|----------------|
| KEMET     | EIA     | L                    | W        | H        | F ±0.2 | S1       | S2       | (mg)           |
| B         | 3528-20 | 3.5 ±0.2             | 2.8 ±0.2 | 1.9 ±0.1 | 2.2    | 0.8 ±0.3 | 0.8 ±0.3 | 94.85          |
| W         | 7343-15 | 7.3 ±0.4             | 4.3 ±0.3 | 1.4 ±0.1 | 2.8    | 5.0 ±0.4 | 1.3 ±0.2 | 222.95         |
| Z         | 7343-17 | 7.3 ±0.4             | 4.3 ±0.3 | 1.6 ±0.1 | 2.8    | 5.0 ±0.4 | 1.3 ±0.2 | 206.33         |

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

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

| Rated Voltage | Rated Capacitance | Case Code/<br>Case Size | KEMET Part Number            | DC Leakage                        | DF                        | ESR                         | Maximum Allowable Ripple Current | MSL                 | Maximum Operating Temp |
|---------------|-------------------|-------------------------|------------------------------|-----------------------------------|---------------------------|-----------------------------|----------------------------------|---------------------|------------------------|
| VDC at 105°C  | µF                | KEMET/EIA               | (See below for part options) | µA at +25°C Maximum/<br>5 Minutes | % at +25°C 120 Hz Maximum | mΩ at +25°C 100 kHz Maximum | (rms) mA at +45°C 100 kHz        | Reflow Temp ≤ 260°C | °C                     |
| 2             | 270               | B/3528-20               | T528B277M002APE006           | 54.0                              | 8                         | 6                           | 3,900                            | 3                   | 105                    |
| 2             | 270               | B/3528-20               | T528B277M002APE009           | 54.0                              | 8                         | 9                           | 3,200                            | 3                   | 105                    |
| 2.5           | 220               | Z/7343-17               | T528Z227M2R5ATE006           | 55.0                              | 10                        | 6                           | 7,400                            | 3                   | 105                    |
| 2.5           | 270               | B/3528-20               | T528B277M2R5APE006           | 67.5                              | 10                        | 6                           | 3,900                            | 3                   | 105                    |
| 2.5           | 270               | B/3528-20               | T528B277M2R5APE009           | 67.5                              | 10                        | 9                           | 3,200                            | 3                   | 105                    |
| 2.5           | 330               | W/7343-15               | T528W337M2R5ATE009           | 82.5                              | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE005           | 82.5                              | 10                        | 5                           | 8,100                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE006           | 82.5                              | 10                        | 6                           | 7,400                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE007           | 82.5                              | 10                        | 7                           | 6,800                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE008           | 82.5                              | 10                        | 8                           | 6,400                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE009           | 82.5                              | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 2.5           | 330               | Z/7343-17               | T528Z337M2R5ATE012           | 82.5                              | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| 2.5           | 470               | Z/7343-17               | T528Z477M2R5ATE005           | 117.5                             | 10                        | 5                           | 8,100                            | 3                   | 105                    |
| 2.5           | 470               | Z/7343-17               | T528Z477M2R5ATE006           | 117.5                             | 10                        | 6                           | 7,400                            | 3                   | 105                    |
| 2.5           | 470               | Z/7343-17               | T528Z477M2R5ATE008           | 117.5                             | 10                        | 8                           | 6,400                            | 3                   | 105                    |
| 2.5           | 470               | Z/7343-17               | T528Z477M2R5ATE009           | 117.5                             | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 2.5           | 470               | Z/7343-17               | T528Z477M2R5ATE012           | 117.5                             | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| 4             | 220               | Z/7343-17               | T528Z227M004ATE007           | 88.0                              | 10                        | 7                           | 6,800                            | 3                   | 105                    |
| 4             | 220               | Z/7343-17               | T528Z227M004ATE008           | 88.0                              | 10                        | 8                           | 6,400                            | 3                   | 105                    |
| 4             | 220               | Z/7343-17               | T528Z227M004ATE009           | 88.0                              | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 4             | 220               | Z/7343-17               | T528Z227M004ATE012           | 88.0                              | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| 4             | 330               | Z/7343-17               | T528Z337M004ATE009           | 132.0                             | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 4             | 330               | Z/7343-17               | T528Z337M004ATE012           | 132.0                             | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| 6.3           | 150               | Z/7343-17               | T528Z157M006ATE007           | 94.5                              | 10                        | 7                           | 6,800                            | 3                   | 105                    |
| 6.3           | 150               | Z/7343-17               | T528Z157M006ATE008           | 94.5                              | 10                        | 8                           | 6,400                            | 3                   | 105                    |
| 6.3           | 150               | Z/7343-17               | T528Z157M006ATE009           | 94.5                              | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 6.3           | 150               | Z/7343-17               | T528Z157M006ATE012           | 94.5                              | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| 6.3           | 220               | Z/7343-17               | T528Z227M006ATE009           | 138.6                             | 10                        | 9                           | 6,000                            | 3                   | 105                    |
| 6.3           | 220               | Z/7343-17               | T528Z227M006ATE012           | 138.6                             | 10                        | 12                          | 5,200                            | 3                   | 105                    |
| VDC at 105°C  | µF                | KEMET/EIA               | (See below for part options) | µA at +25°C Maximum/<br>5 Minutes | % at +25°C 120 Hz Maximum | mΩ at +25°C 100 kHz Maximum | (rms) mA at +45°C 100 kHz        | Reflow Temp ≤ 260°C | °C                     |
| Rated Voltage | Rated Capacitance | Case Code/<br>Case Size | KEMET Part Number            | DC Leakage                        | DF                        | ESR                         | Maximum Allowable Ripple Current | MSL                 | Maximum Operating Temp |

Other part number options:

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

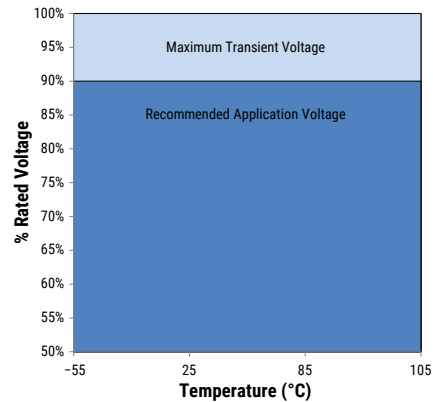
Also available on large (13 inch) reels. Add 7280 to the end of the part number.

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

## Derating Guidelines

| Voltage Rating                          | Maximum Recommended Steady State Voltage |
|---|--|
| -55°C to 105°C                          |  |
| $2\text{ V} \leq V_R \leq 6.3\text{ V}$ | 90% of $V_R$                             |

$V_R$  = Rated Voltage



## Ripple Current/Ripple Voltage

Permissible AC ripple voltage and current are related to equivalent series resistance (ESR) and the power dissipation capabilities of the device. Permissible AC ripple voltage which may be applied is limited by two criteria:

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

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

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

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

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

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

$I$  = rms ripple current (amperes)

$E$  = rms ripple voltage (volts)

$P_{max}$  = maximum power dissipation (watts)

$R$  = ESR at specified frequency (ohms)

$Z$  = Impedance at specified frequency (ohms)

| Temperature Compensation Multipliers for Maximum Ripple Current |  |   |
|---|--|---|
| $T \leq 45^\circ\text{C}$                                       | $45^\circ\text{C} < T \leq 85^\circ\text{C}$ | $85^\circ\text{C} < T \leq 125^\circ\text{C}$ |
| 1.00  | 0.70   | 0.25  |

$T$  = Environmental Temperature

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

## Reverse Voltage

Polymer electrolytic capacitors are polar devices and may be permanently damaged or destroyed if connected in the wrong polarity. These devices will withstand a small degree of transient voltage reversal for short periods as shown in the below table.

| Temperature | Permissible Transient Reverse Voltage |
|-------------|---------------------------------------|
| 25°C        | 15% of Rated Voltage                  |
| 55°C        | 10% of Rated Voltage                  |
| 85°C        | 5% of Rated Voltage                   |
| 105°C       | 3% of Rated Voltage                   |
| 125°C*      | 1% of Rated Voltage                   |

\*For Series Rated to 125°C

### Table 2 – Land Dimensions/Courtyard

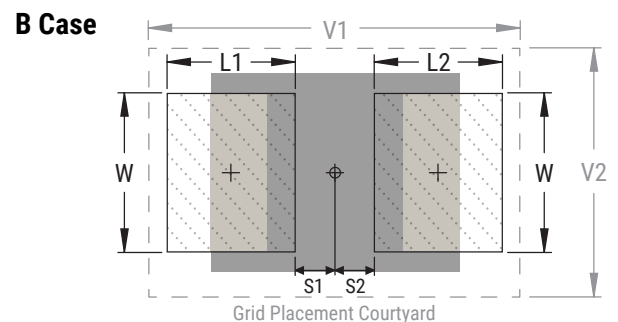
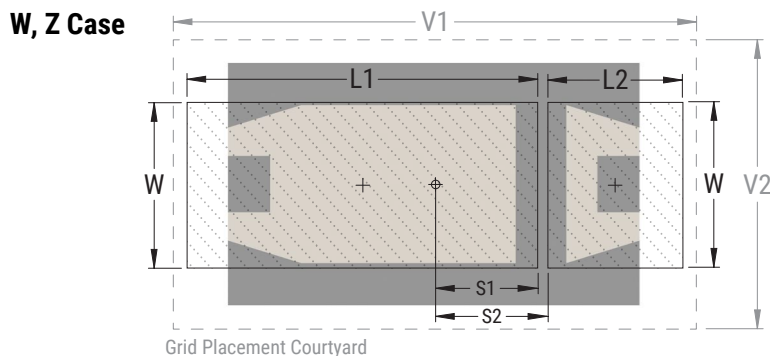
| KEMET          | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) |      |      |       |      |       |      | Density Level B: Median (Nominal) Land Protrusion (mm) |      |      |       |      |      |      | Density Level C: Minimum (Least) Land Protrusion (mm) |      | 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

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

**Density Level B:** For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.

**Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC standard 7351 (IPC-7351).

<sup>1</sup> Negative values of S1 mean that pad lies at the center's right side.





## 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.

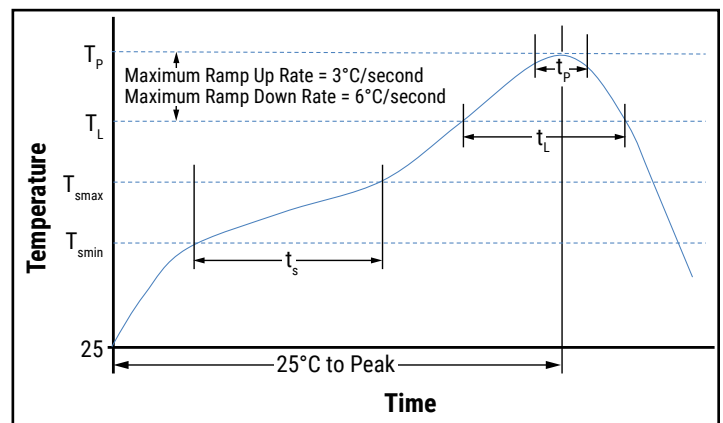
Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the molded case. The iron should be used to heat the solder pad, applying solder between the pad and the termination, until reflow occurs. 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/second maximum | 3°C/second 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*<br>235°C**  | 250°C*<br>260°C**  |
| Time within 5°C of Maximum Peak Temperature ( $t_p$ ) | 20 seconds maximum | 30 seconds maximum |
| Ramp-down Rate ( $T_P$ to $T_L$ )                     | 6°C/second maximum | 6°C/second 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.

\* For Case Size height > 2.5 mm

\*\* For Case Size height ≤ 2.5 mm



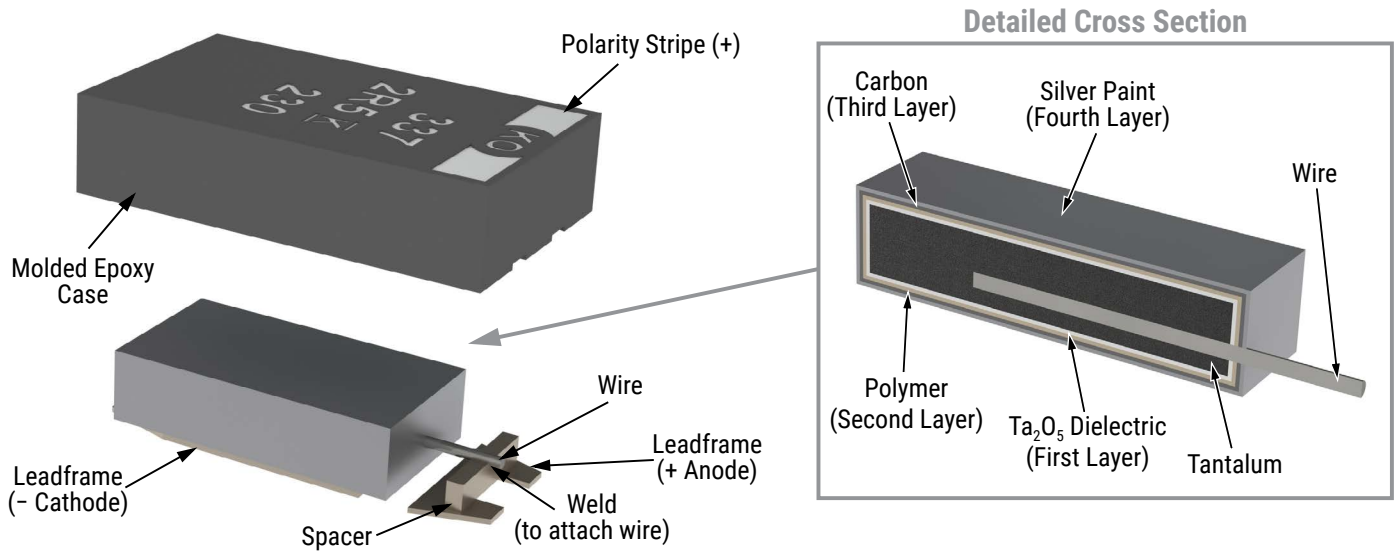
## Storage

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

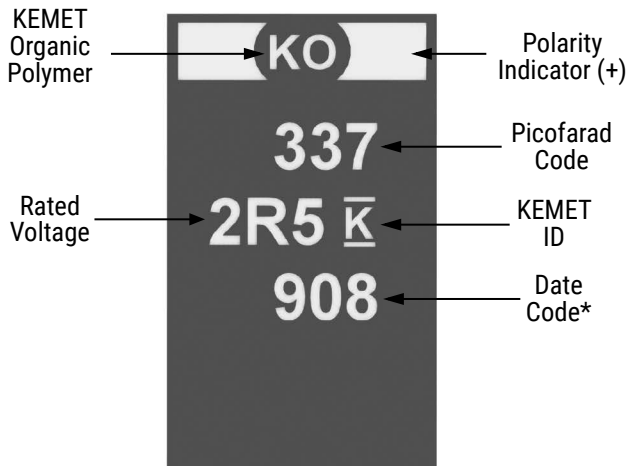
The calculated shelf life in a sealed bag would be 12 months from a bag seal date in a storage environment of < 40°C and humidity < 90% RH. It should be 24 months from a bag seal date in a storage environment of < 30°C and humidity < 70% RH.

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

## Construction



## Capacitor Marking



\* 908 = 8<sup>th</sup> week of 2019

| Date Code *  |  |
|--|--|
| 1 <sup>st</sup> digit = last number of year                  | 6 = 2016<br>7 = 2017<br>8 = 2018<br>9 = 2019<br>0 = 2020                           |
| 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 |

## Tape & Reel Packaging Information

KEMET’s molded chip capacitor families are packaged in 8 and 12 mm plastic tape on 7" and 13" reels in accordance with *EIA Standard 481: Embossed Carrier Taping of Surface Mount Components for Automatic Handling*. This packaging system is compatible with all tape-fed automatic pick-and-place systems.

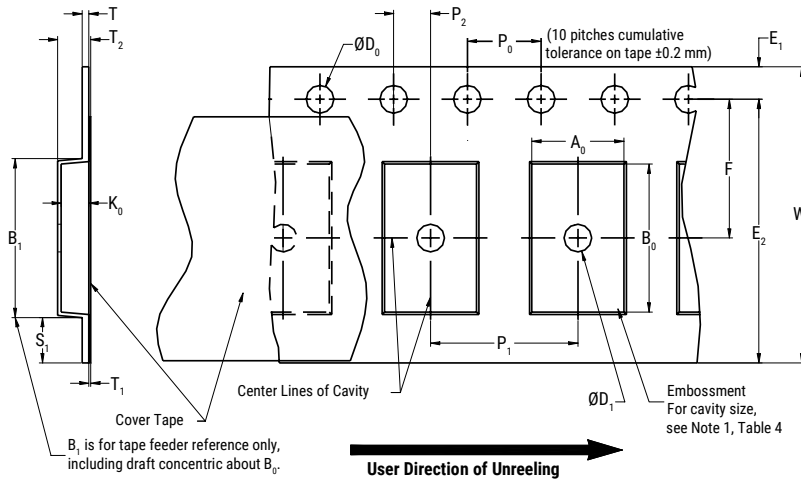


**Table 3 – Packaging Quantity**

| Case Code |         | Tape Width (mm) | 7" Reel* | 13" Reel* |
|-----------|---------|-----------------|----------|-----------|
| KEMET     | EIA     |                 |          |           |
| P         | 2012-10 | 8               | 3,000    | N/A       |
| R         | 2012-12 | 8               | 2,500    | 10,000    |
| I         | 3216-10 | 8               | 3,000    | N/A       |
| S         | 3216-12 | 8               | 2,500    | 10,000    |
| A         | 3216-18 | 8               | 2,000    | N/A       |
| T         | 3528-12 | 8               | 3,000    | 10,000    |
| M         | 3528-15 | 8               | 2,500    | 8,000     |
| B         | 3528-21 | 8               | 2,000    | 8,000     |
| U         | 6032-15 | 12              | 1,000    | 5,000     |
| L         | 6032-19 | 12              | 1,000    | 3,000     |
| C         | 6032-28 | 12              | 500      | 3,000     |
| Q         | 7343-12 | 12              | 1,000    | 3,000     |
| W         | 7343-15 | 12              | 1,000    | 3,000     |
| Z         | 7343-17 | 12              | 1,000    | 3,000     |
| V         | 7343-19 | 12              | 1,000    | 3,000     |
| D         | 7343-31 | 12              | 500      | 2,500     |
| Y         | 7343-40 | 12              | 500      | 2,000     |
| X         | 7343-43 | 12              | 500      | 2,000     |
| J         | 7360-15 | 12              | 1,000    | 3,000     |
| H         | 7360-20 | 12              | 1,000    | 3,000     |
| O         | 7360-43 | 12              | 250      | 1,000     |

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

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



**Table 4 – Embossed (Plastic) Carrier Tape Dimensions**

Metric will govern

| Constant Dimensions – Millimeters (Inches) |   |                         |                                    |                                   |                                   |                       |                         |                  |                  |
|--|---|-------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------|-------------------------|------------------|------------------|
| Tape Size                                  | $D_0$   | $D_1$ Minimum<br>Note 1 | $E_1$                              | $P_0$                             | $P_2$                             | R Reference<br>Note 2 | $S_1$ Minimum<br>Note 3 | T Maximum        | $T_1$<br>Maximum |
| 8 mm                                       | $1.5 \pm 0.10 / -0.0$<br>(0.059 + 0.004 / -0.0) | 1.0<br>(0.039)          | $1.75 \pm 0.10$<br>(0.069 ± 0.004) | $4.0 \pm 0.10$<br>(0.157 ± 0.004) | $2.0 \pm 0.05$<br>(0.079 ± 0.002) | 25.0<br>(0.984)       | 0.600<br>(0.024)        | 0.600<br>(0.024) | 0.100<br>(0.004) |
| 12 mm                                      |   | 1.5<br>(0.059)          |                                    |                                   |                                   |                       |                         |                  |                  |

| Variable Dimensions – Millimeters (Inches) |                                       |                         |                  |                                   |  |                |                 |                    |  |
|--|---------------------------------------|-------------------------|------------------|-----------------------------------|--|----------------|-----------------|--------------------|--|
| Tape Size                                  | Pitch                                 | $B_1$ Maximum<br>Note 4 | $E_2$ Minimum    | F                                 | $P_1$  | $T_2$ Maximum  | W Maximum       | $A_0, B_0$ & $K_0$ |  |
| 8 mm                                       | Single (4 mm)                         | 4.35<br>(0.171)         | 6.25<br>(0.246)  | $3.5 \pm 0.05$<br>(0.138 ± 0.002) | $2.0 \pm 0.05$ or $4.0 \pm 0.10$<br>(0.079 ± 0.002 or 0.157 ± 0.004)                                     | 2.5<br>(0.098) | 8.3<br>(0.327)  | Note 5             |  |
| 12 mm                                      | Single (4 mm)<br>and Double<br>(8 mm) | 8.2<br>(0.323)          | 10.25<br>(0.404) | $5.5 \pm 0.05$<br>(0.217 ± 0.002) | $2.0 \pm 0.05$ (0.079 ± 0.002) or<br>$4.0 \pm 0.10$ (0.157 ± 0.004) or<br>$8.0 \pm 0.10$ (0.315 ± 0.004) | 4.6<br>(0.181) | 12.3<br>(0.484) |                    |  |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
2. The tape, with or without components, shall pass around R without damage (see Figure 4).
3. If  $S_1 < 1.0$  mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481–D, paragraph 4.3, section b).
4.  $B_1$  dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by  $A_0, B_0$  and  $K_0$  shall surround the component with sufficient clearance that:
  - (a) the component does not protrude above the top surface of the carrier tape.
  - (b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
  - (c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes (see Figure 2).
  - (d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape (see Figure 3).
  - (e) see Addendum in EIA Standard 481–D for standards relating to more precise taping requirements.

## Packaging Information Performance Notes

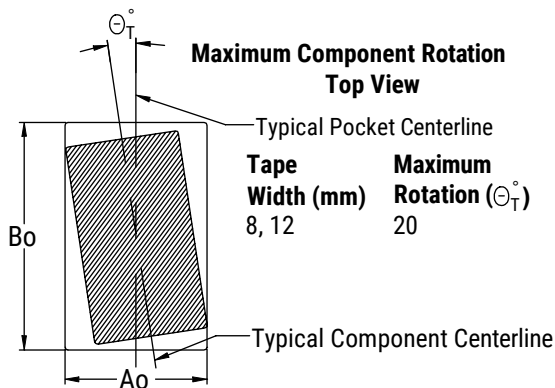
- 1. Cover tape break force:** 1.0 kg minimum.
- 2. Cover tape peel strength:** The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength                    |
|------------|----------------------------------|
| 8 mm       | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 mm      | 0.1 to 1.3 newton (10 to 130 gf) |

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

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

### Figure 2 – Maximum Component Rotation



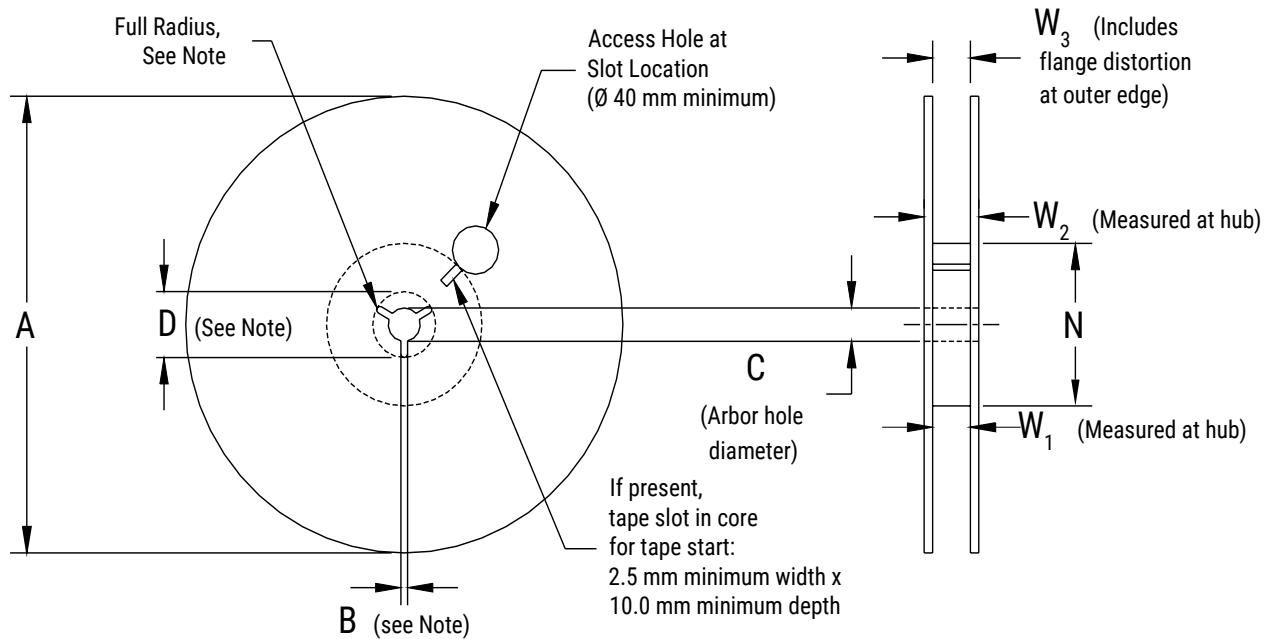
### Figure 3 – Maximum Lateral Movement



### Figure 4 – Bending Radius



## Figure 5 – Reel Dimensions



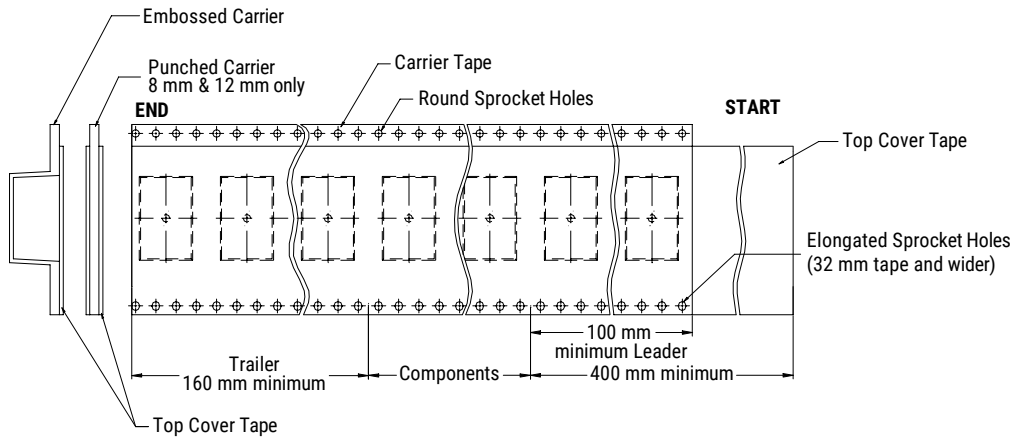
Note: Drive spokes optional; if used, dimensions B and D shall apply.

## Table 5 – Reel Dimensions

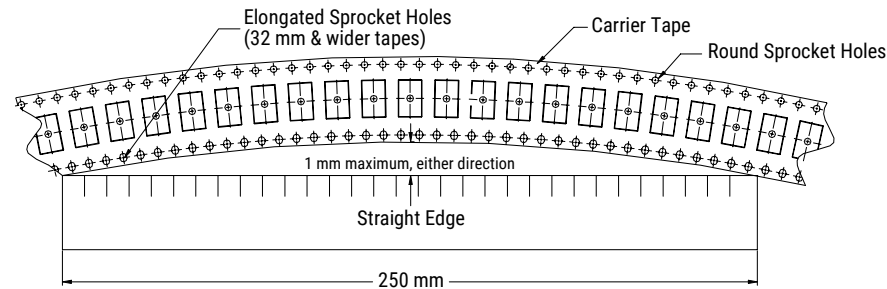
Metric will govern

| Constant Dimensions – Millimeters (Inches) |                              |                                       |  |   |
|--|------------------------------|---------------------------------------|--|---|
| Tape Size                                  | A                            | B Minimum                             | C                                      | D Minimum   |
| 8 mm                                       | 178 ±0.20<br>(7.008 ±0.008)  | 1.5<br>(0.059)                        | 13.0 +0.5/-0.2<br>(0.521 +0.02/-0.008) | 20.2<br>(0.795)                                   |
| 12 mm                                      | 330 ±0.20<br>(13.000 ±0.008) |                                       |  |   |
| Variable Dimensions – Millimeters (Inches) |                              |                                       |  |   |
| Tape Size                                  | N Minimum                    | W <sub>1</sub>                        | W <sub>2</sub> Maximum                 | W <sub>3</sub>                                    |
| 8 mm                                       | 50<br>(1.969)                | 8.4 +1.5/-0.0<br>(0.331 +0.059/-0.0)  | 14.4<br>(0.567)                        | Shall accommodate tape width without interference |
| 12 mm                                      |                              | 12.4 +2.0/-0.0<br>(0.488 +0.078/-0.0) | 18.4<br>(0.724)                        |   |

**Figure 6 – Tape Leader & Trailer Dimensions**



**Figure 7 – Maximum Camber**



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