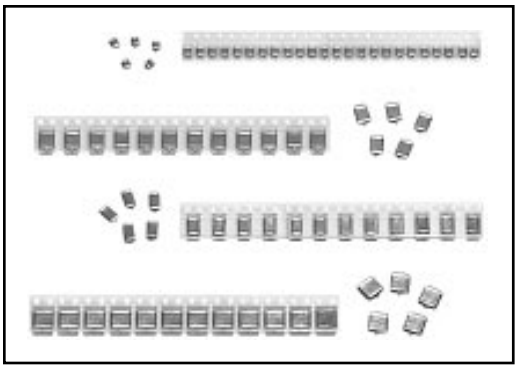
# TYPE 592D
# Solid Tantalum Chip Capacitors
## TANTAMOUNT®, Low Profile, Conformal Terminals
## Maximum C/V



### FEATURES

- Low profile .047" [1.2mm] height (nominal)
- Compatible with 293D molded chip mounting pad layout
- 12mm tape available per EIA-481-1 and reeling per IEC 286-3. 7" [178mm] standard. 13" [330mm] available.
- Terminations: 60/40 Tin Lead (2) standard
- Operating temperature: - 55°C to + 125°C
- Low leakage current
- Low impedance and inductance
- Case code compatibility with EIA 535BAAC and CECC 30801 molded chips for length and width

### PERFORMANCE CHARACTERISTICS

**Operating Temperature:** - 55°C to + 85°C. (To + 125°C with voltage derating.)

**Capacitance Tolerance:** At 120Hz, + 25°C. ± 20% standard. ± 10% available.

**Dissipation Factor:** At 120Hz, + 25°C. Dissipation factor, as determined from the expression 2πfRC, shall not exceed the values listed in the Standard Ratings Tables.

**DC Leakage Current (DCL Max.):**

**At + 25°C:** Leakage current shall not exceed the values listed in the Standard Ratings Tables.

**At + 85°C:** Leakage current shall not exceed 10 times the values listed in the Standard Ratings Tables.

**At + 125°C:** Leakage current shall not exceed 12 times the values listed in the Standard Ratings Tables.

**Life Test:** Capacitors shall withstand rated DC voltage applied at + 85°C for 2000 hours or derated DC voltage applied at + 125°C for 1000 hours.

Following the life test:

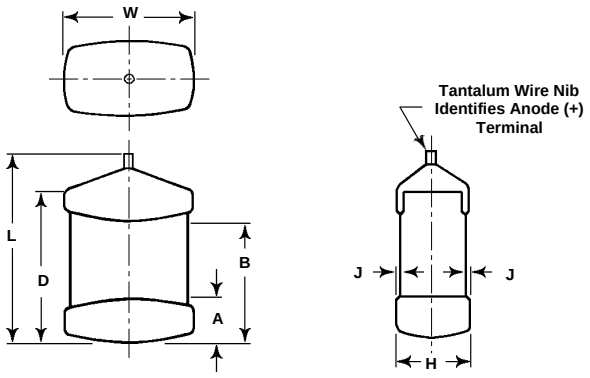
1. DCL shall meet the original requirement.
2. Dissipation Factor and ESR shall meet the initial requirement.
3. Change in capacitance shall not exceed ± 10%.

### ELECTRICAL CHARACTERISTICS @ + 25°C

**DCL:** .01µA/CV or .5µA whichever is greater.

**DF:** 4% ≤ 1µF. 6% > 1µF < 100µF. 8% ≥ 100µF.

### DIMENSIONAL CONFIGURATIONS [Numbers in brackets indicate millimeters]




| CASE CODE | L (Max.) | W | H | A | B | D (Ref.) | J (Max.) |
|---|---|---|---|---|---|---|---|
| B | .158 [4.0] | .104 ± .010 [2.6 ± 0.3] | .047 ± .012 [1.2 ± 0.3] | .023 ± .010 [.6 ± 0.3] | .097 ± .015 [2.5 ± 0.4] | .127 [3.2] | .004 [0.1] |
| C | .281 [7.1] | .126 ± .010 [3.2 ± 0.3] | .047 ± .012 [1.2 ± 0.3] | .040 ± .015 [1.0 ± 0.4] | .200 ± .025 [5.1 ± 0.6] | .236 [6.0] | .004 [0.1] |
| D | .293 [7.5] | .170 ± .010 [4.3 ± 0.3] | .047 ± .012 [1.2 ± 0.3] | .050 ± .015 [1.3 ± 0.4] | .200 ± .025 [5.1 ± 0.6] | .253 [6.4] | .004 [0.1] |
| R | .285 [7.2] | .235 ± .010 [6.0 ± 0.3] | .047 ± .012 [1.2 ± 0.3] | .050 ± .015 [1.3 ± 0.4] | .190 ± .025 [4.8 ± 0.6] | .243 [6.2] | .004 [0.1] |

**Note:** The anode termination (D less B) will be a minimum of .010" [0.3].

## RATINGS AND CASE CODES

| µF | 4 V | 6.3 V | 10 V | 16 V | 20 V | 25 V | 35 V |
|---|---|---|---|---|---|---|---|
| 1.0 | | | | | | | B |
| 2.2 | | | | | | B | C |
| 3.3 | | | | | | C | D |
| 4.7 | | | | | B | C | R |
| 6.8 | | | | B | C | D | R |
| 10 | | | B | C | D | R | |
| 15 | | B | | D | R | | |
| 22 | B | | C | D | R | | |
| 33 | | C | D | R | | | |
| 47 | C | D | R | | | | |
| 68 | D | R | R | | | | |
| 100 | R | R | | | | | |

## STANDARD RATINGS

| CAPACITANCE (µF) | CASE CODE | PART NUMBER* | Max. DCL @ + 25°C (µA) | Max. DF @ + 25°C 120Hz (%) | Max. ESR @ + 25°C 100kHz (Ohms) | Max. RIPPLE 100kHz Irms (Amps) |
|---|---|---|---|---|---|---|
| **4 WVDC @ + 85°C, SURGE = 5.2 V . . . 2.7 WVDC @ + 125°C, SURGE = 3.4 V** | | | | | | |
| 22.0 | B | 592D226X0004B2T | 0.9 | 6 | 2.20 | 0.20 |
| 47.0 | C | 592D476X0004C2T | 1.9 | 6 | 1.80 | 0.24 |
| 68.0 | D | 592D686X0004D2T | 2.7 | 6 | 1.60 | 0.28 |
| 100.0 | R | 592D107X0004R2T | 4.0 | 8 | 0.70 | 0.46 |
| **6.3 WVDC @ + 85°C, SURGE = 8 V . . . 4 WVDC @ + 125°C, SURGE = 5 V** | | | | | | |
| 15.0 | B | 592D156X06R3B2T | 0.9 | 6 | 2.70 | 0.18 |
| 33.0 | C | 592D336X06R3C2T | 2.1 | 6 | 2.10 | 0.22 |
| 47.0 | D | 592D476X06R3D2T | 3.0 | 6 | 1.70 | 0.27 |
| 68.0 | R | 592D686X06R3R2T | 4.3 | 6 | 0.75 | 0.45 |
| 100.0 | R | 592D107X06R3R2T | 6.3 | 8 | 0.70 | 0.46 |
| **10 WVDC @ + 85°C, SURGE = 13 V . . . 7 WVDC @ + 125°C, SURGE = 8 V** | | | | | | |
| 10.0 | B | 592D106X0010B2T | 1.0 | 6 | 3.10 | 0.17 |
| 22.0 | C | 592D226X0010C2T | 2.2 | 6 | 2.30 | 0.21 |
| 33.0 | D | 592D336X0010D2T | 3.3 | 6 | 1.80 | 0.26 |
| 47.0 | R | 592D476X0010R2T | 4.7 | 6 | 0.80 | 0.43 |
| 68.0 | R | 592D686X0010R2T | 6.8 | 6 | 0.75 | 0.45 |
| **16 WVDC @ + 85°C, SURGE = 20 V . . . 10 WVDC @ + 125°C, SURGE = 12 V** | | | | | | |
| 6.8 | B | 592D685X0016B2T | 1.1 | 6 | 3.20 | 0.17 |
| 10.0 | C | 592D106X0016C2T | 1.6 | 6 | 2.50 | 0.20 |
| 15.0 | D | 592D156X0016D2T | 2.4 | 6 | 1.90 | 0.26 |
| 22.0 | D | 592D226X0016D2T | 3.5 | 6 | 1.85 | 0.26 |
| 33.0 | R | 592D336X0016R2T | 5.3 | 6 | 0.90 | 0.41 |
| **20 WVDC @ + 85°C, SURGE = 26 V . . . 13 WVDC @ + 125°C, SURGE = 16 V** | | | | | | |
| 4.7 | B | 592D475X0020B2T | 0.9 | 6 | 3.50 | 0.16 |
| 6.8 | C | 592D685X0020C2T | 1.4 | 6 | 2.60 | 0.20 |
| 10.0 | D | 592D106X0020D2T | 2.0 | 6 | 1.95 | 0.25 |
| 15.0 | R | 592D156X0020R2T | 3.0 | 6 | 1.10 | 0.37 |
| 22.0 | R | 592D226X0020R2T | 4.4 | 6 | 1.00 | 0.39 |

* Part Numbers shown for units with ± 20% capacitance tolerance. For ± 10% units, change "X0" to "X9".

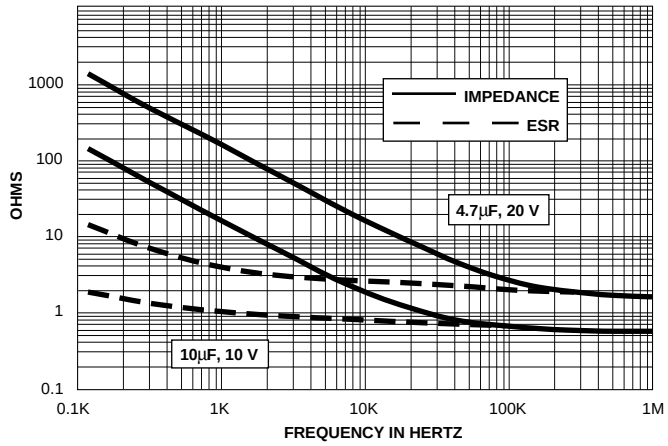
## STANDARD RATINGS

| CAPACITANCE (µF) | CASE CODE | PART NUMBER* | Max. DCL @ + 25°C (µA) | Max. DF @ + 25°C 120Hz (%) | Max. ESR @ + 25°C 100kHz (Ohms) | Max. RIPPLE 100kHz Irms (Amps) |
|---|---|---|---|---|---|---|
| **25 WVDC @ + 85°C, SURGE = 32 V . . . 17 WVDC @ + 125°C, SURGE = 20 V** | | | | | | |
| 2.2 | B | 592D225X0025B2T | 0.6 | 6 | 3.70 | 0.16 |
| 3.3 | C | 592D335X0025C2T | 0.8 | 6 | 2.80 | 0.19 |
| 4.7 | C | 592D475X0025C2T | 1.2 | 6 | 2.90 | 0.19 |
| 6.8 | D | 592D685X0025D2T | 1.7 | 6 | 2.00 | 0.25 |
| 10.0 | R | 592D106X0025R2T | 2.5 | 6 | 1.20 | 0.35 |
| **35 WVDC @ + 85°C, SURGE = 46 V . . . 23 WVDC @ + 125°C, SURGE = 26 V** | | | | | | |
| 1.0 | B | 592D105X0035B2T | 0.5 | 4 | 4.50 | 0.14 |
| 2.2 | C | 592D225X0035C2T | 0.8 | 6 | 3.50 | 0.17 |
| 3.3 | D | 592D335X0035D2T | 1.2 | 6 | 2.10 | 0.24 |
| 4.7 | R | 592D475X0035R2T | 1.6 | 6 | 1.40 | 0.33 |
| 6.8 | R | 592D685X0035R2T | 2.4 | 6 | 1.30 | 0.34 |

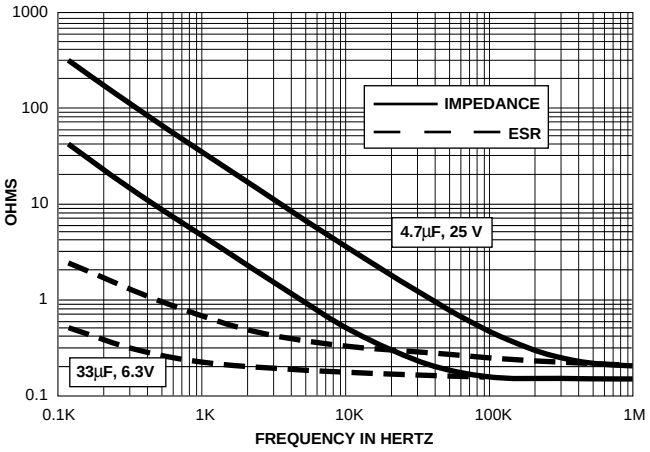
* Part Numbers shown for units with ± 20% capacitance tolerance. For ± 10% units, change "X0" to "X9".

## TYPICAL CURVES @ + 25°C, IMPEDANCE AND ESR vs FREQUENCY

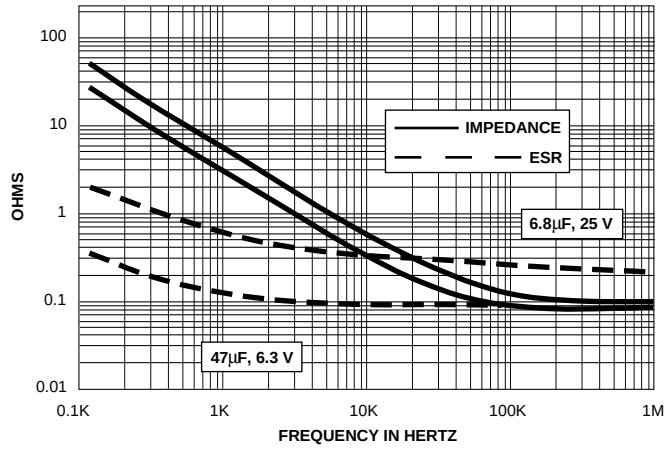
"B" Case



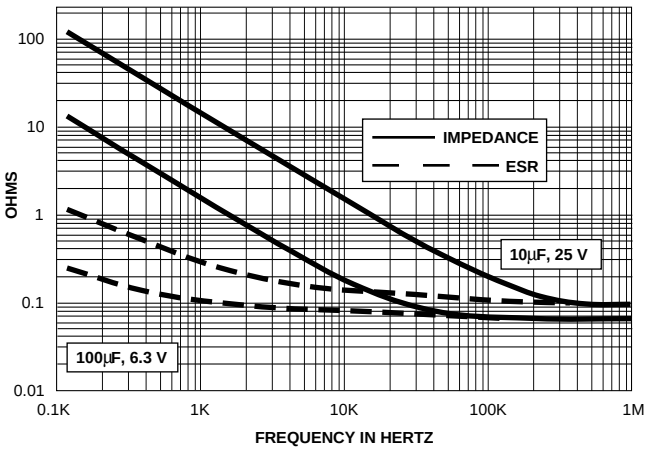

"C" Case




"D" Case




"R" Case



## PERFORMANCE CHARACTERISTICS

1. **Operating Temperature:** Capacitors are designed to operate over the temperature range of - 55°C to + 85°C.

1.1 Capacitors may be operated to + 125°C with voltage derating to two-thirds the + 85°C rating.

| + 85°C Rating | | + 125°C Rating | |
|---|---|---|---|
| Working Voltage (V) | Surge Voltage (V) | Working Voltage (V) | Surge Voltage (V) |
| 4.0 | 5.2 | 2.7 | 3.4 |
| 6.3 | 8.0 | 4.0 | 5.0 |
| 10.0 | 13.0 | 7.0 | 8.0 |
| 16.0 | 20.0 | 10.0 | 12.0 |
| 20.0 | 26.0 | 13.0 | 16.0 |
| 25.0 | 32.0 | 17.0 | 20.0 |
| 35.0 | 46.0 | 23.0 | 26.0 |

2. **DC Working Voltage:** The DC working voltage is the maximum operating voltage for continuous duty at the rated temperature.

3. **Surge Voltage:** The surge DC rating is the maximum voltage to which the capacitors may be subjected under any conditions, including transients and peak ripple at the highest line voltage.

3.1 **Surge Voltage Test:** Capacitors shall withstand the surge voltage applied in series with a 33 ohm ± 5% resistor at the rate of one-half minute on, one-half minute off, at + 85°C, for 1000 successive test cycles.

3.2 Following the surge voltage test, the dissipation factor, ESR and the leakage current shall meet the initial requirements; the capacitance shall not have changed more than ± 10%.

4. **Capacitance Tolerance:** The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

4.1 Capacitance measurements shall be made by means of a polarized capacitance bridge. The polarizing voltage shall be of such magnitude that there shall be no reversal of polarity due to the AC component. The maximum voltage applied to capacitors during measurements shall be 2 volts rms at 120Hz at + 25°C. If the AC voltage applied is less than one-half volt rms, no DC bias is required. Accuracy of the bridge shall be within ± 2%.

5. **Capacitance Change With Temperature:** The capacitance change with temperature shall not exceed the following percentage of the capacitance measured at + 25°C:

| - 55°C | + 85°C | + 125°C |
|---|---|---|
| - 10% | + 10% | + 12% |

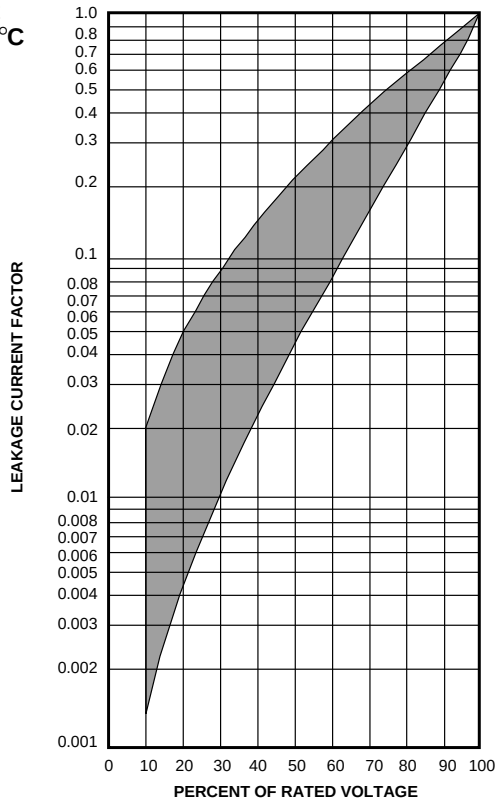
6. **Dissipation Factor:** The dissipation factor, determined from the expression $2\pi fRC$, shall not exceed values listed in the Standard Ratings Table.

6.1 Measurements shall be made by the bridge method at, or referred to, a frequency of 120Hz and a temperature of + 25°C.

7. **Leakage Current:** Capacitors shall be stabilized at the rated temperature for 30 minutes. Rated voltage shall be applied to capacitors for 5 minutes using a steady source of power (such as a regulated power supply) with a 1000 ohm resistor connected in series with the capacitor under test to limit the charging current. Leakage current shall then be measured.

*Note that leakage current varies with applied voltage. See graph below for the appropriate adjustment factor.*

**TYPICAL LEAKAGE CURRENT FACTOR RANGE**




7.1 **At + 25°C,** the leakage current shall not exceed the value listed in the Standard Ratings Table.

7.2 **At + 85°C,** the leakage current shall not exceed 10 times the value listed in the Standard Ratings Table.

7.3 **At + 125°C,** the leakage current shall not exceed 12 times the value listed in the Standard Ratings Table.

8. **Life Test:** Capacitors shall withstand rated DC voltage applied at + 85°C for 2000 hours or derated DC voltage applied at + 125°C for 1000 hours.

8.1 Following the life test, the dissipation factor and leakage current shall meet the initial requirement; the capacitance change shall not exceed ± 10% of initial value.

9. **Humidity Test:** Capacitors shall withstand 1000 hours at + 40°C, 90% to 95% relative humidity, with no voltage applied.

9.1 Following the humidity test, capacitance change shall be within 10% of initial value; the dissipation factor and ESR shall not exceed 150% of the initial requirement; the leakage current shall not exceed 200% of the initial requirement at + 25°C.

## PERFORMANCE CHARACTERISTICS (Continued)

10. **Soldering Testing:** Capacitors shall be checked by the following method: Terminations are immersed in non-activated flux and dipped in 60/40 Sn/Pb solder for 5 seconds at + 245°C. Wetting must occur on at least 95% of the external surface of the terminations.
11. **Resistance to Soldering Heat:** Capacitors mounted on a substrate will withstand exposure to + 260°C for 5 seconds.

11.1 Following the resistance to soldering heat test, capacitance shall be within initial tolerance; dissipation factor shall be within 120% of initial requirements at + 25°C; the leakage current shall be within initial requirement at + 25°C.

12. **Marking:** The small body area of these capacitors does not allow elaborate marking schemes. All required information is present on the carton or package in which the parts are shipped; in addition, part number, quantity and date code are indicated on the reels.

## GUIDE TO APPLICATION

1. **A-C Ripple Current:** The maximum allowable ripple current shall be determined from the formula:

$$I_{rms} = \sqrt{\frac{P}{R_{ESR}}}$$

where,

P = Power Dissipation in Watts @ + 25°C as given in the table in Paragraph Number 5 (Power Dissipation).

$R_{ESR}$ = The capacitor Equivalent Series Resistance at the specified frequency.

2. **A-C Ripple Voltage:** The maximum allowable ripple voltage shall be determined from the formula:

$$V_{rms} = Z\sqrt{\frac{P}{R_{ESR}}}$$

or, from the formula:

$$V_{rms} = I_{rms} \times Z$$

where,

P = Power Dissipation in Watts @ + 25°C as given in the table in Paragraph Number 5 (Power Dissipation).

$R_{ESR}$ = The capacitor Equivalent Series Resistance at the specified frequency.

Z = The capacitor Impedance at the specified frequency.

2.1 The sum of the peak AC voltage plus the DC voltage shall not exceed the DC voltage rating of the capacitor.

2.2 The sum of the negative peak AC voltage plus the applied DC voltage shall not allow a voltage reversal exceeding 10% of the DC working voltage at + 25°C.

3. **Reverse Voltage:** These capacitors are capable of withstanding peak voltages in the reverse direction equal to 10% of the DC rating at + 25°C and 5% of the DC rating at + 85°C.

4. **Temperature Derating:** If these capacitors are to be operated at temperatures above + 25°C, the permissible rms ripple current or voltage shall be calculated using the derating factors as shown:

| Temperature | Derating Factor |
|---|---|
| + 25°C | 1.0 |
| + 55°C | 0.9 |
| + 85°C | 0.8 |
| + 125°C | 0.4 |

5. **Power Dissipation:** Power dissipation will be affected by the heat sinking capability of the mounting surface. Non-sinusoidal ripple current may produce heating effects which differ from those shown. It is important that the equivalent *Irms* value be established when calculating permissible operating levels. (Power dissipation calculated using + 25°C temperature rise.)

| Case Code | Maximum Permissible Power Dissipation @ + 25°C (Watts) in free air |
|---|---|
| B | 0.090 |
| C | 0.100 |
| D | 0.125 |
| R | 0.150 |

6. **Printed Circuit Board Materials:** The 592D is compatible with most commonly used printed circuit board materials (alumina substrates, FR4, FR5, G10, PTFE-fluorocarbon and porcelainized steel). If your desired board material is not shown here please contact the Tantalum Marketing Department for assistance in determining compatibility.
7. **Attachment:**

7.1 **Solder Paste:** The recommended thickness of the solder paste after application is .007" ± .001" [.178 ± .025]. Care should be exercised in selecting the solder paste. The metal purity should be as high as practical. The flux (in the paste) must be active enough to remove the oxides formed on the metallization prior to the exposure to soldering heat. In practice this can be aided by extending the solder preheat time at temperatures below the liquidous state of the solder.

7.2 **Soldering:** Capacitors can be attached by conventional soldering techniques - vapor phase, infrared reflow, wave soldering and hot plate methods. The solder temperature/soldering time chart shows maximum recommended time/temperature conditions for soldering. Attachment with a soldering iron is not recommended due to the difficulty of controlling temperature and time at temperature.

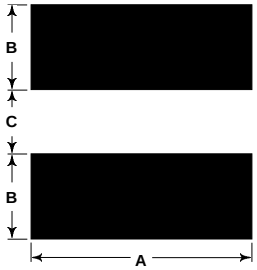
8. **Cleaning (Flux Removal) After Soldering:** The 592D is compatible with all commonly used solvents such as TES, TMS, Prelete and Chlorethane. Solvents containing methylene chloride or other epoxy solvents should be avoided since these will attack the epoxy encapsulation material.

## GUIDE TO APPLICATION (Continued)

9. **Recommended Mounting Pad Geometries:** The area under the tantalum wire nib should not be metallized on the PC board. The nib must have sufficient clearance to avoid electrical contact with other components. The width dimension indicated is the same as the maximum width of the capacitor. This is to minimize lateral movement.

## REFLOW SOLDER PADS*

[Numbers in brackets indicate millimeters]

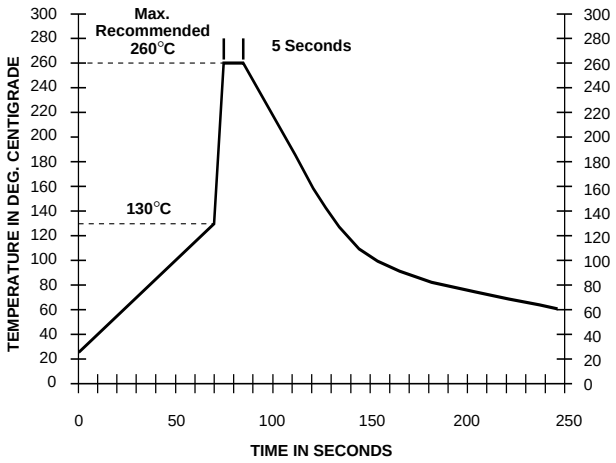



| CASE CODE | WIDTH (A) | PAD METALLIZATION (B) | SEPARATION (C) |
|---|---|---|---|
| B | .114 [3.0] | .065 [1.7] | .065 [1.7] |
| C | .136 [3.5] | .090 [2.3] | .120 [3.1] |
| D | .180 [4.6] | .090 [2.3] | .145 [3.7] |
| R | .245 [6.3] | .090 [2.3] | .145 [3.7] |

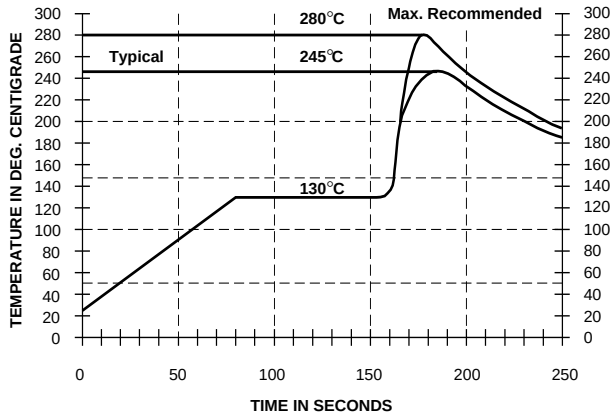
*Pads for B, C and D case codes are otherwise pad compatible with Type 293D, B, C and D case codes respectively.

## SOLDERING PROFILE

RECOMMENDED SOLDERING PROFILE - WAVE SOLDER




RECOMMENDED SOLDERING PROFILE - INFRARED REFLOW

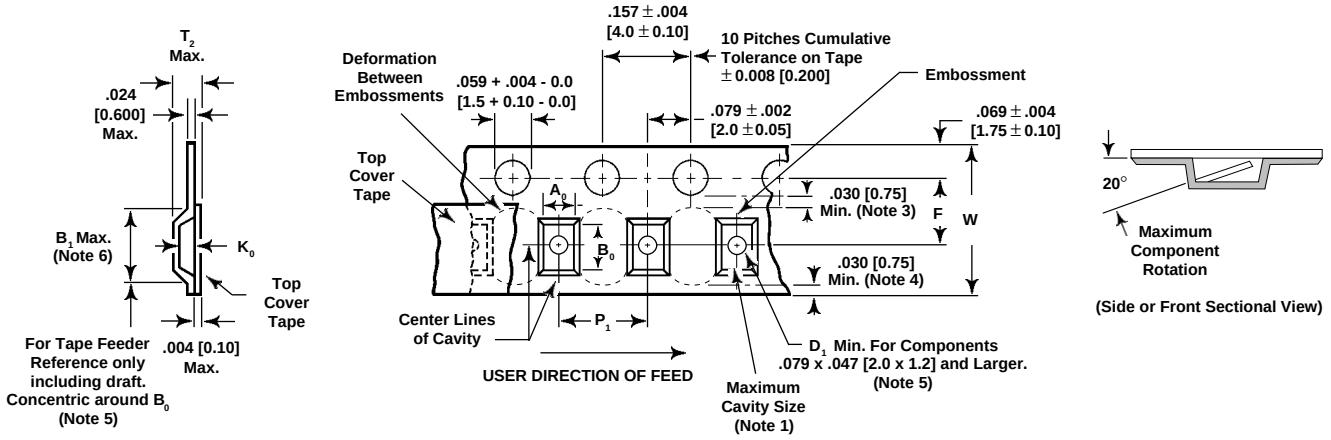


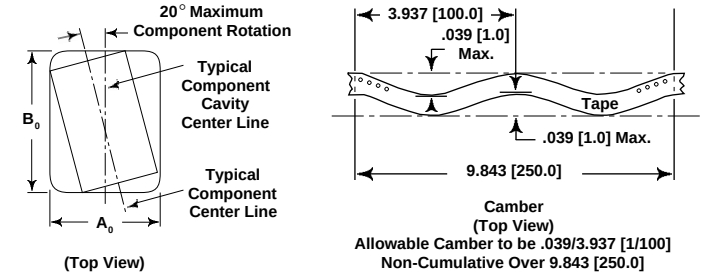

## HOW TO ORDER

| 592D | 106 | X0 | 010 | B | 2 | T |
|---|---|---|---|---|---|---|
| TYPE | CAPACITANCE | CAPACITANCE TOLERANCE | DC VOLTAGE RATING AT + 85°C | CASE CODE | TERMINATION | REEL SIZE AND PACKAGING |
| | This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow. | X0 = ± 20%<br>X9 = ± 10% | This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating. A decimal point is indicated by an "R" (6R3 = 6.3 volts). | See Ratings and Case Codes Table. | 2 = 60/40 Tin Lead. Standard. | B = Bulk Pack<br>T = Tape and Reel 7" [178] Reel (1/2 reel minimum)<br>W = 13" [330] Reel (1/2 reel minimum)<br>See Tape and Reel Specifications. |

## TAPE AND REEL PACKAGING

**Please Note:** [Numbers in brackets indicate millimeters]. Metric dimensions will govern. Dimensions in inches are rounded and for reference only.



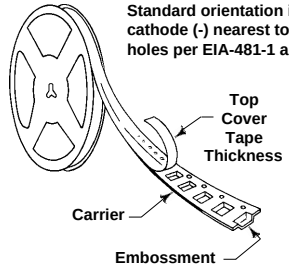

**Tape and Reel Specifications:** All case sizes are available on plastic embossed tape per EIA-481-1. Tape reeling per IEC 286-3 is also available. Standard reel diameter is 7" [178]. 13" [330] reels are available and recommended as the most cost effective packaging method.

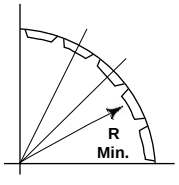
The most efficient packaging quantities are full reel increments on a given reel diameter. The quantities shown allow for the sealed empty pockets required to be in conformance with EIA-481-1. Reel size and packaging orientation must be specified in the Sprague® part number.

| TAPE SIZE | $B_1$ (Max.) (Note 6) | $D_1$ (Min.) (Note 5) | F | $P_1$ | R (Min.) (Note 2) | $T_2$ (Max.) | W | $A_0$ $B_0$ $K_0$ |
|---|---|---|---|---|---|---|---|---|
| 12mm | .323 [8.2] | .059 [1.5] | .217 ± .002 [5.5 ± 0.05] | .157 ± .004 [4.0 ± 0.10] | 1.181 [30.0] | .256 [6.5] | .472 ± .012 [12.0 ± .30] | (Note 1) |
| 12mm Double Pitch | .323 [8.2] | .059 [1.5] | .217 ± .002 [5.5 ± 0.05] | .315 ± .004 [8.0 ± 0.10] | 1.181 [30.0] | .256 [6.5] | .472 ± .012 [12.0 ± .30] | |

**Notes:**

1. $A_0B_0K_0$ are determined by the maximum dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity ($A_0B_0K_0$) must be within .002" [0.05] minimum and .020" [0.50] maximum. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees.
2. Tape with components shall pass around radius "R" without damage. The minimum trailer length may require additional length to provide R minimum for 12mm embossed tape for reels with hub diameters approaching N minimum.
3. This dimension is the flat area from the edge of the sprocket hole to either the outward deformation of the carrier tape between the embossed cavities or to the edge of the cavity whichever is less.
4. This dimension is the flat area from the edge of the carrier tape opposite the sprocket holes to either the outward deformation of the carrier tape between the embossed cavity or to the edge of the cavity whichever is less.
5. 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.
6. $B_1$ dimension is a reference dimension for tape feeder clearance only.




| Case Code | Tape Width | Component Pitch | Units Per Reel | |
|---|---|---|---|---|
| | | | 7" [178] Reel | 13" [330] Reel |
| B | 12mm | 4mm | 2000 | 8000 |
| C | 12mm | 8mm | 1000 | 4000 |
| D | 12mm | 8mm | 1000 | 4000 |
| R | 12mm | 8mm | 1000 | 4000 |