# Solid Tantalum Surface Mount Chip Capacitors, Molded Case, Ultra Flat Low Profile




## FEATURES

- Small size, low profile
- Terminations:
  Case UA: 100 % matte tin
  Case UB: Ni / Pd / Au
- Qualified to EIA-717
- MSL level: 1 (UA case size), 3 (UB case size)
- Compatible with “high volume” automatic pick and place equipment
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

HALOGEN FREE Available

GREEN (5-2008) Available

## PERFORMANCE / ELECTRICAL CHARACTERISTICS

**Operating Temperature:** -55 °C to +125 °C (above 85 °C, voltage derating is required)

**Capacitance Range:** 0.1 µF to 220 µF

**Capacitance Tolerance:** ± 10 %, ± 20 %

**Voltage Rating:** 2.5 $V_{DC}$ to 35 $V_{DC}$

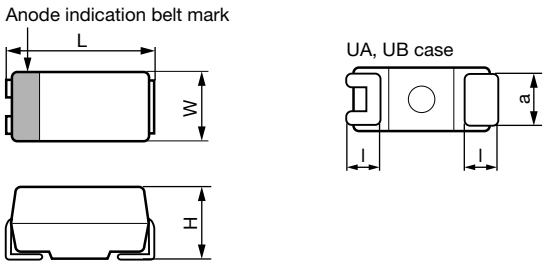
## APPLICATIONS

- Industrial
- General purpose

## ORDERING INFORMATION

| TMCU | A | 1G | 107 | M | TR | (2) | F |
|---|---|---|---|---|---|---|---|
| TYPE | CASE CODE | DC VOLTAGE RATING AT +85 °C | CAPACITANCE (µF) | CAPACITANCE TOLERANCE | PACKAGING POLARITY | (OPTIONAL) | TERMINAL CODE |
| | See Ratings and Case Codes table. | 0E = 2.5 V<br>0G = 4 V<br>0J = 6.3 V (7 V)<br>1A = 10 V<br>1C = 16 V<br>1D = 20 V<br>1E = 25 V<br>1V = 35 V | This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow. | K = ± 10 %<br>M = ± 20 % | TR = 7" reel, cathodes close to perforation side | Halogen-free (special order) | F = lead (Pb)-free terminations |

## DIMENSIONS in inches [millimeters]




| CASE CODE | EIA SIZE | L | W | H | l | a |
|---|---|---|---|---|---|---|
| UA | 3216-12 | 0.126 ± 0.008 [3.2 ± 0.2] | 0.063 ± 0.008 [1.6 ± 0.2] | 0.047 max. [1.2 max.] | 0.030 ± 0.012 [0.8 ± 0.3] | 0.047 ± 0.008 [1.2 ± 0.2] |
| UB | 3528-12 | 0.138 ± 0.008 [3.5 ± 0.2] | 0.110 ± 0.008 [2.8 ± 0.2] | 0.047 max. [1.2 max.] | 0.030 ± 0.012 [0.8 ± 0.3] | 0.071 ± 0.008 [1.8 ± 0.2] |



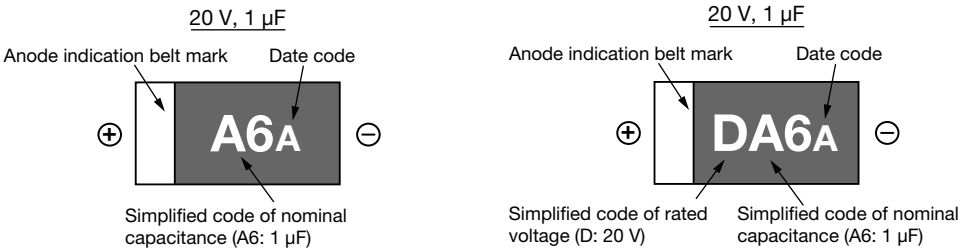
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## RATINGS AND CASE CODES

| µF | 2.5 V | 4 V | 6.3 V (7 V) | 10 V | 16 V | 20 V | 25 V | 35 V |
|---|---|---|---|---|---|---|---|---|
| 0.10 | | | | | | | | UA |
| 0.15 | | | | | | | | UA |
| 0.22 | | | | | | | | UA |
| 0.33 | | | | | | | UA | |
| 0.47 | | | | | | | UA | |
| 0.68 | | | | | | UA | UA | |
| 1.0 | | | | | | UA / UB | UA | UA / UB |
| 1.5 | | | | | UA | UA / UB | UB | UB |
| 2.2 | | | | | UA / UB | UA / UB | UB | UB |
| 3.3 | | | | | UA / UB | UA / UB | UB | |
| 4.7 | | | | UA | UA / UB | UA / UB | UB | |
| 6.8 | | | | UA | UA / UB | UB | | |
| 10 | | | UA | UA | UA / UB | | | |
| 15 | UA | UA | UA | UA / UB | UB | | | |
| 22 | UA | UA | UA / UB | UA / UB | UB | | | |
| 33 | UA / UB | UA / UB | UA / UB | UB | | | | |
| 47 | UA / UB | UA / UB | UA / UB | UB | | | | |
| 68 | UB | UB | UB | | | | | |
| 100 | UB | UB | UB | | | | | |
| 150 | UB | UB | | | | | | |
| 220 | UB | UB | | | | | | |

## MARKING




### CAPACITANCE AND VOLTAGE MARKING

| µF | 2.5 V | 4 V | 6.3 V | 10 V | 16 V | 20 V | 25 V | 35 V |
|---|---|---|---|---|---|---|---|---|
| 0.10 | | | | | | | | VA5 |
| 0.15 | | | | | | | | VE5 |
| 0.22 | | | | | | | | VJ5 |
| 0.33 | | | | | | | EN5 | |
| 0.47 | | | | | | | ES5 | |
| 0.68 | | | | | | DW5 | EW5 | |
| 1.0 | | | | | | DA6 (1) / A6 (2) | EA6 | VA6 |
| 1.5 | | | | | CE6 | DE6 (1) / E6 (2) | EE6 | VE6 |
| 2.2 | | | | | CJ6 (1) / J6 (2) | DJ6 | EJ6 | VJ6 |
| 3.3 | | | | | CN6 | DN6 | EN6 | |
| 4.7 | | | | AS6 | CS6 | DS6 | ES6 | |
| 6.8 | | | | AW6 | CW6 | DW6 | | |
| 10 | | | JA7 | AA7 | CA7 | | | |
| 15 | eE7 | GE7 | JE7 | AE7 | CE7 | | | |
| 22 | eJ7 | GJ7 | JJ7 | AJ7 | CJ7 | | | |
| 33 | eN7 | GN7 | JN7 | AN7 | | | | |
| 47 | eS7 | GS7 | JS7 | AS7 | | | | |
| 68 | eW7 | GW7 | JW7 | | | | | |
| 100 | eA8 | GA8 | JA8 | | | | | |
| 150 | eE8 | GE8 | | | | | | |
| 220 | eJ8 | GJ8 | | | | | | |

**Notes**

(1) Marking on UA case
(2) Marking on UB case


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## DATE CODE

| YEAR | MONTH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2017 | A | B | C | D | E | F | G | H | J | K | L | M |
| 2018 | N | P | Q | R | S | T | U | V | W | X | Y | Z |
| 2019 | a | b | c | d | e | f | g | h | j | k | l | m |
| 2020 | n | p | q | r | s | t | u | v | w | x | y | z |
| 2021 | A | B | C | D | E | F | G | H | J | K | L | M |
| 2022 | N | P | Q | R | S | T | U | V | W | X | Y | Z |
| 2023 | a | b | c | d | e | f | g | h | j | k | l | m |
| 2024 | n | p | q | r | s | t | u | v | w | x | y | z |

**Note**

- Marking code repeats every four years in alphabetical order (letter of I, i, O, and o are excluded)

## STANDARD RATINGS

| CAPACITANCE (µF) | CASE CODE | PART NUMBER | MAX. DCL AT +25 °C (µA) | MAX. DF AT +25 °C, 120 Hz (%) | MAX. ESR AT +25 °C, 100 kHz (Ω) | MAX. RIPPLE, 100 kHz $I_{RMS}$ (A) |
|---|---|---|---|---|---|---|
| **2.5 $V_{DC}$ AT +85 °C; 1.6 $V_{DC}$ AT +125 °C** | | | | | | |
| 15 | UA | TMCUA0E156(1)TRF | 0.5 | 8 | 3.0 | 0.161 |
| 22 | UA | TMCUA0E226(1)TRF | 0.6 | 8 | 1.8 | 0.208 |
| 33 | UA | TMCUA0E336(1)TRF | 1.7 | 12 | 1.8 | 0.208 |
| 33 | UB | TMCUB0E336(1)TRF | 0.8 | 12 | 1.7 | 0.238 |
| 47 | UA | TMCUA0E476(1)TRF | 2.4 | 18 | 1.8 | 0.208 |
| 47 | UB | TMCUB0E476(1)TRF | 1.2 | 12 | 1.7 | 0.238 |
| 68 | UB | TMCUB0E686(1)TRF | 1.7 | 15 | 1.7 | 0.238 |
| 100 | UB | TMCUB0E107(1)TRF | 5.0 | 20 | 1.1 | 0.295 |
| 150 | UB | TMCUB0E157(1)TRF | 7.5 | 30 | 1.1 | 0.295 |
| 220 | UB | TMCUB0E227(1)TRF | 11.0 | 30 | 1.1 | 0.295 |
| **4 $V_{DC}$ AT +85 °C; 2.5 $V_{DC}$ AT +125 °C** | | | | | | |
| 15 | UA | TMCUA0G156(1)TRF | 0.6 | 8 | 3.0 | 0.161 |
| 22 | UA | TMCUA0G226(1)TRF | 0.9 | 8 | 1.8 | 0.208 |
| 33 | UA | TMCUA0G336(1)TRF | 2.6 | 12 | 1.8 | 0.208 |
| 33 | UB | TMCUB0G336(1)TRF | 1.3 | 12 | 1.7 | 0.238 |
| 47 | UA | TMCUA0G476(1)TRF | 3.8 | 18 | 1.8 | 0.208 |
| 47 | UB | TMCUB0G476(1)TRF | 1.9 | 12 | 1.7 | 0.238 |
| 68 | UB | TMCUB0G686(1)TRF | 2.7 | 15 | 1.7 | 0.238 |
| 100 | UB | TMCUB0G107(1)TRF | 8.0 | 20 | 1.1 | 0.295 |
| 150 | UB | TMCUB0G157(1)TRF | 12.0 | 30 | 1.1 | 0.295 |
| 220 | UB | TMCUB0G227MTRF | 17.6 | 30 | 1.1 | 0.295 |
| **6.3 $V_{DC}$ (7 $V_{DC}$) AT +85 °C; 4 $V_{DC}$ AT +125 °C** | | | | | | |
| 10 | UA | TMCUA0J106(1)TRF | 0.7 | 8 | 4.0 | 0.140 |
| 15 | UA | TMCUA0J156(1)TRF | 1.1 | 8 | 2.9 | 0.164 |
| 22 | UA | TMCUA0J226(1)TRF | 2.8 | 12 | 2.9 | 0.164 |
| 22 | UB | TMCUB0J226(1)TRF | 1.4 | 10 | 1.7 | 0.238 |
| 33 | UA | TMCUA0J336(1)TRF | 4.2 | 20 | 2.9 | 0.164 |
| 33 | UB | TMCUB0J336(1)TRF | 2.3 | 10 | 1.7 | 0.238 |
| 47 | UA | TMCUA0J476MTRF | 5.9 | 20 | 2.9 | 0.164 |
| 47 | UB | TMCUB0J476(1)TRF | 3.3 | 12 | 1.7 | 0.238 |
| 68 | UB | TMCUB0J686(1)TRF | 8.6 | 20 | 1.7 | 0.238 |
| 100 | UB | TMCUB0J107MTRF | 12.6 | 20 | 1.1 | 0.295 |

**Notes**

- Part number definition:
  (1) Tolerance: For 10 % tolerance, specify “K”; for 20 % tolerance, change to “M”
- Termination code “F”:
  Case UA: 100 % tin; case UB: Ni / Pd / Au


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## STANDARD RATINGS

| CAPACITANCE (µF) | CASE CODE | PART NUMBER | MAX. DCL AT +25 °C (µA) | MAX. DF AT +25 °C, 120 Hz (%) | MAX. ESR AT +25 °C, 100 kHz (Ω) | MAX. RIPPLE, 100 kHz $I_{RMS}$ (A) |
|---|---|---|---|---|---|---|
| **10 $V_{DC}$ AT +85 °C; 6.3 $V_{DC}$ AT +125 °C** | | | | | | |
| 4.7 | UA | TMCUA1A475(1)TRF | 0.5 | 6 | 4.0 | 0.140 |
| 6.8 | UA | TMCUA1A685(1)TRF | 0.7 | 6 | 4.0 | 0.140 |
| 10 | UA | TMCUA1A106(1)TRF | 1.0 | 8 | 4.0 | 0.140 |
| 15 | UA | TMCUA1A156(1)TRF | 3.0 | 12 | 2.9 | 0.164 |
| 15 | UB | TMCUB1A156(1)TRF | 1.5 | 10 | 2.8 | 0.185 |
| 22 | UA | TMCUA1A226MTRF | 4.4 | 18 | 2.9 | 0.164 |
| 22 | UB | TMCUB1A226(1)TRF | 2.2 | 10 | 1.7 | 0.238 |
| 33 | UB | TMCUB1A336(1)TRF | 6.6 | 12 | 1.7 | 0.238 |
| 47 | UB | TMCUB1A476MTRF | 9.4 | 30 | 1.7 | 0.238 |
| **16 $V_{DC}$ AT +85 °C; 10 $V_{DC}$ AT +125 °C** | | | | | | |
| 1.5 | UA | TMCUA1C155(1)TRF | 0.5 | 6 | 8.8 | 0.094 |
| 2.2 | UA | TMCUA1C225(1)TRF | 0.5 | 6 | 7.7 | 0.101 |
| 2.2 | UB | TMCUB1C225(1)TRF | 0.5 | 6 | 6.6 | 0.121 |
| 3.3 | UA | TMCUA1C335(1)TRF | 0.5 | 6 | 7.7 | 0.101 |
| 3.3 | UB | TMCUB1C335(1)TRF | 0.5 | 6 | 4.0 | 0.155 |
| 4.7 | UA | TMCUA1C475(1)TRF | 0.8 | 8 | 4.0 | 0.140 |
| 4.7 | UB | TMCUB1C475(1)TRF | 0.8 | 6 | 4.0 | 0.155 |
| 6.8 | UA | TMCUA1C685(1)TRF | 1.1 | 12 | 4.0 | 0.140 |
| 6.8 | UB | TMCUB1C685(1)TRF | 1.1 | 6 | 4.0 | 0.155 |
| 10 | UA | TMCUA1C106MTRF | 1.6 | 18 | 3.3 | 0.154 |
| 10 | UB | TMCUB1C106(1)TRF | 1.6 | 8 | 2.8 | 0.185 |
| 15 | UB | TMCUB1C156(1)TRF | 4.8 | 12 | 2.8 | 0.185 |
| 22 | UB | TMCUB1C226MTRF | 7.0 | 18 | 1.7 | 0.238 |
| **20 $V_{DC}$ AT +85 °C; 13 $V_{DC}$ AT +125 °C** | | | | | | |
| 0.68 | UA | TMCUA1D684(1)TRF | 0.5 | 4 | 19.8 | 0.063 |
| 1.0 | UA | TMCUA1D105(1)TRF | 0.5 | 4 | 16.5 | 0.069 |
| 1.0 | UB | TMCUB1D105(1)TRF | 0.5 | 4 | 8.8 | 0.104 |
| 1.5 | UA | TMCUA1D155(1)TRF | 0.5 | 6 | 16.5 | 0.069 |
| 1.5 | UB | TMCUB1D155(1)TRF | 0.5 | 6 | 8.8 | 0.104 |
| 2.2 | UA | TMCUA1D225(1)TRF | 0.5 | 6 | 7.7 | 0.101 |
| 2.2 | UB | TMCUB1D225(1)TRF | 0.5 | 6 | 6.6 | 0.121 |
| 3.3 | UA | TMCUA1D335MTRF | 0.7 | 6 | 7.7 | 0.101 |
| 3.3 | UB | TMCUB1D335(1)TRF | 0.7 | 6 | 4.0 | 0.155 |
| 4.7 | UA | TMCUA1D475MTRF | 0.9 | 8 | 4.0 | 0.140 |
| 4.7 | UB | TMCUB1D475(1)TRF | 0.9 | 6 | 4.0 | 0.155 |
| 6.8 | UB | TMCUB1D685MTRF | 1.4 | 6 | 2.8 | 0.185 |
| **25 $V_{DC}$ AT +85 °C; 16 $V_{DC}$ AT +125 °C** | | | | | | |
| 0.33 | UA | TMCUA1E334(1)TRF | 0.5 | 4 | 26.4 | 0.054 |
| 0.47 | UA | TMCUA1E474(1)TRF | 0.5 | 4 | 22.0 | 0.060 |
| 0.68 | UA | TMCUA1E684(1)TRF | 0.5 | 8 | 19.8 | 0.063 |
| 1.0 | UA | TMCUA1E105(1)TRF | 0.5 | 8 | 16.5 | 0.069 |
| 1.5 | UB | TMCUB1E155(1)TRF | 0.5 | 6 | 8.8 | 0.104 |
| 2.2 | UB | TMCUB1E225(1)TRF | 0.6 | 6 | 6.6 | 0.121 |
| 3.3 | UB | TMCUB1E335(1)TRF | 0.8 | 6 | 4.0 | 0.155 |
| 4.7 | UB | TMCUB1E475MTRF | 1.2 | 6 | 4.0 | 0.155 |

**Notes**

- Part number definition:
  (1) Tolerance: For 10 % tolerance, specify “K”; for 20 % tolerance, change to “M”
- Termination code “F”:
  Case UA: 100 % tin; case UB: Ni / Pd / Au


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## STANDARD RATINGS

| CAPACITANCE (µF) | CASE CODE | PART NUMBER | MAX. DCL AT +25 °C (µA) | MAX. DF AT +25 °C, 120 Hz (%) | MAX. ESR AT +25 °C, 100 kHz (Ω) | MAX. RIPPLE, 100 kHz $I_{RMS}$ (A) |
|---|---|---|---|---|---|---|
| 35 $V_{DC}$ AT +85 °C; 22 $V_{DC}$ AT +125 °C | | | | | | |
| 0.10 | UA | TMCUA1V104(1)TRF | 0.5 | 4 | 40.0 | 0.044 |
| 0.15 | UA | TMCUA1V154(1)TRF | 0.5 | 4 | 40.0 | 0.044 |
| 0.22 | UA | TMCUA1V224(1)TRF | 0.5 | 4 | 40.0 | 0.044 |
| 1.0 | UA | TMCUA1V105MTRF | 0.5 | 8 | 16.5 | 0.069 |
| 1.0 | UB | TMCUB1V105(1)TRF | 0.5 | 6 | 8.8 | 0.104 |
| 1.5 | UB | TMCUB1V155(1)TRF | 0.5 | 6 | 8.8 | 0.104 |
| 2.2 | UB | TMCUB1V225MTRF | 0.8 | 6 | 6.6 | 0.121 |

**Notes**

- Part number definition:
  (1) Tolerance: For 10 % tolerance, specify “K”; for 20 % tolerance, change to “M”
- Termination code “F”:
  Case UA: 100 % tin; case UB: Ni / Pd / Au

## RECOMMENDED VOLTAGE DERATING GUIDELINES (for temperature below +85 °C)

| CAPACITOR VOLTAGE RATING | OPERATING VOLTAGE |
|---|---|
| 2.5 | 1.2 |
| 4.0 | 2.0 |
| 6.3 (7.0) | 3.1 (3.5) |
| 10 | 5.0 |
| 16 | 8.0 |
| 20 | 10.0 |
| 25 | 12.5 |
| 35 | 17.5 |

**Note**

- For more information about recommended voltage derating see technical note www.vishay.com/doc?40246

## POWER DISSIPATION

| CASE CODE | MAXIMUM PERMISSIBLE POWER DISSIPATION AT +25 °C (W) IN FREE AIR |
|---|---|
| UA | 0.078 |
| UB | 0.096 |

## STANDARD PACKAGING QUANTITY

| CASE CODE | UNITS PER 7" REEL |
|---|---|
| UA | 3000 |
| UB | 3000 |


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| PERFORMANCE CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **CONDITION** | **POST TEST PERFORMANCE** | | | | |
| Temperature characteristics | Measure the specified characteristics in each stage | | Specified initial value | -55 °C | +85 °C | +125 °C |
| | | Capacitance change | - | -12 % to 0 % | 0 % to 10 % | 0 % to 12 % |
| | | Dissipation factor (%), maximum | 4 | 5 | 4 | 5 |
| | | | 6 | 8 | 6 | 6 |
| | | | 8 | 12 | 10 | 12 |
| | | | 10 | 14 | 12 | 14 |
| | | | 12 | 16 | 14 | 16 |
| | | | 18 | 34 | 20 | 22 |
| | | | 20 | 38 | 22 | 24 |
| | | | 30 | 60 | 30 | 40 |
| | | Leakage current | Refer to Standard Ratings table | - | 1000 % specified initial value or less | 1250 % specified initial value or less |
| Solder heat resistance | Solder Dip<br>260 °C ± 5 °C, 10 s ± 1 s<br>Reflow<br>260 °C, 10 s ± 1 s | Capacitance change | Within ± 5 % of initial value | | | |
| | | Dissipation factor | Initial specified value or less | | | |
| | | Leakage current | Initial specified value or less | | | |
| Moisture resistance no load | Leave at 40 °C and 90 % to 95 % RH for 500 h | Capacitance change | Within ± 10 % of initial value | | | |
| | | Dissipation factor | Initial specified value or less | | | |
| | | Leakage current | Initial specified value or less | | | |
| High temperature load | 85 °C. The rated voltage is applied for 2000 h | Capacitance change | Within ± 10 % of initial value | | | |
| | | Dissipation factor | Initial specified value or less | | | |
| | | Leakage current | Shall not exceed 125 % of initial specified value | | | |
| Thermal shock | Leave at -55 °C, normal temperature, 125 °C, and normal temperature for 30 min., 3 min, 30 min, and 3 min. Repeat this operation 5 times running. | Capacitance change | Within ± 5 % of initial value | | | |
| | | Dissipation factor | Initial specified value or less | | | |
| | | Leakage current | Initial specified value or less | | | |
| Moisture resistance load | Leave at 40 °C and 90 % to 95 % RH. The rated voltage applied for 500 h | Capacitance change | Within ± 10 % of initial value | | | |
| | | Dissipation factor | Shall not exceed 150 % of initial specified value | | | |
| | | Leakage current | Shall not exceed 200 % of initial specified value | | | |
| Failure rate | 85 °C. The rated voltage is applied through a protective resistor of 1 Ω/V. | 1 % / 1000 h | | | | |

**Note**

- Test conditions per JIS C5101-1


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# Guide for Tantalum Solid Electrolyte Chip Capacitors

## INTRODUCTION

Tantalum electrolytic capacitors are the preferred choice in applications where volumetric efficiency, stable electrical parameters, high reliability, and long service life are primary considerations. The stability and resistance to elevated temperatures of the tantalum / tantalum oxide / manganese dioxide system make solid tantalum capacitors an appropriate choice for today's surface mount assembly technology.

Vishay Sprague has been a pioneer and leader in this field, producing a large variety of tantalum capacitor types for consumer, industrial, automotive, military, and aerospace electronic applications.

Tantalum is not found in its pure state. Rather, it is commonly found in a number of oxide minerals, often in combination with Columbium ore. This combination is known as “tantalite” when its contents are more than one-half tantalum. Important sources of tantalite include Australia, Brazil, Canada, China, and several African countries. Synthetic tantalite concentrates produced from tin slags in Thailand, Malaysia, and Brazil are also a significant raw material for tantalum production.

Electronic applications, and particularly capacitors, consume the largest share of world tantalum production. Other important applications for tantalum include cutting tools (tantalum carbide), high temperature super alloys, chemical processing equipment, medical implants, and military ordnance.

Vishay Sprague is a major user of tantalum materials in the form of powder and wire for capacitor elements and rod and sheet for high temperature vacuum processing.

## THE BASICS OF TANTALUM CAPACITORS

Most metals form crystalline oxides which are non-protecting, such as rust on iron or black oxide on copper. A few metals form dense, stable, tightly adhering, electrically insulating oxides. These are the so-called “valve” metals and include titanium, zirconium, niobium, tantalum, hafnium, and aluminum. Only a few of these permit the accurate control of oxide thickness by electrochemical means. Of these, the most valuable for the electronics industry are aluminum and tantalum.

Capacitors are basic to all kinds of electrical equipment, from radios and television sets to missile controls and automobile ignitions. Their function is to store an electrical charge for later use.

Capacitors consist of two conducting surfaces, usually metal plates, whose function is to conduct electricity. They are separated by an insulating material or dielectric. The dielectric used in all tantalum electrolytic capacitors is tantalum pentoxide.

Tantalum pentoxide compound possesses high-dielectric strength and a high-dielectric constant. As capacitors are being manufactured, a film of tantalum pentoxide is applied to their electrodes by means of an electrolytic process. The film is applied in various thicknesses and at various voltages and although transparent to begin with, it takes on different colors as light refracts through it. This coloring occurs on the tantalum electrodes of all types of tantalum capacitors.

Rating for rating, tantalum capacitors tend to have as much as three times better capacitance / volume efficiency than aluminum electrolytic capacitors. An approximation of the capacitance / volume efficiency of other types of capacitors may be inferred from the following table, which shows the dielectric constant ranges of the various materials used in each type. Note that tantalum pentoxide has a dielectric constant of 26, some three times greater than that of aluminum oxide. This, in addition to the fact that extremely thin films can be deposited during the electrolytic process mentioned earlier, makes the tantalum capacitor extremely efficient with respect to the number of microfarads available per unit volume. The capacitance of any capacitor is determined by the surface area of the two conducting plates, the distance between the plates, and the dielectric constant of the insulating material between the plates.

**COMPARISON OF CAPACITOR DIELECTRIC CONSTANTS**

| DIELECTRIC | e<br>DIELECTRIC CONSTANT |
|---|---|
| Air or vacuum | 1.0 |
| Paper | 2.0 to 6.0 |
| Plastic | 2.1 to 6.0 |
| Mineral oil | 2.2 to 2.3 |
| Silicone oil | 2.7 to 2.8 |
| Quartz | 3.8 to 4.4 |
| Glass | 4.8 to 8.0 |
| Porcelain | 5.1 to 5.9 |
| Mica | 5.4 to 8.7 |
| Aluminum oxide | 8.4 |
| **Tantalum pentoxide** | **26** |
| Ceramic | 12 to 400K |

In the tantalum electrolytic capacitor, the distance between the plates is very small since it is only the thickness of the tantalum pentoxide film. As the dielectric constant of the tantalum pentoxide is high, the capacitance of a tantalum capacitor is high if the area of the plates is large:

$$C = \frac{eA}{t}$$

where

C = capacitance

e = dielectric constant

A = surface area of the dielectric

t = thickness of the dielectric

Tantalum capacitors contain either liquid or solid electrolytes. In solid electrolyte capacitors, a dry material (manganese dioxide) forms the cathode plate. A tantalum lead is embedded in or welded to the pellet, which is in turn connected to a termination or lead wire. The drawings show the construction details of the surface mount types of tantalum capacitors shown in this catalog.



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## SOLID ELECTROLYTE TANTALUM CAPACITORS

Solid electrolyte capacitors contain manganese dioxide, which is formed on the tantalum pentoxide dielectric layer by impregnating the pellet with a solution of manganous nitrate. The pellet is then heated in an oven, and the manganous nitrate is converted to manganese dioxide.

The pellet is next coated with graphite, followed by a layer of metallic silver, which provides a conductive surface between the pellet and the leadframe.

Molded chip tantalum capacitor encases the element in plastic resins, such as epoxy materials. After assembly, the capacitors are tested and inspected to ensure long life and reliability. It offers excellent reliability and high stability for consumer and commercial electronics with the added feature of low cost.

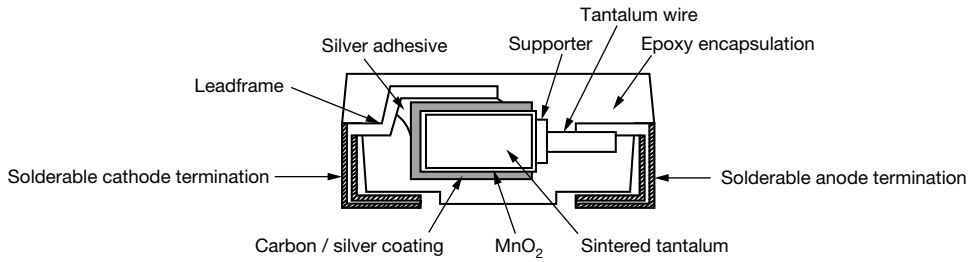
Surface mount designs of “Solid Tantalum” capacitors use lead frames as shown in the accompanying drawings.

## TANTALUM CAPACITORS FOR ALL DESIGN CONSIDERATIONS

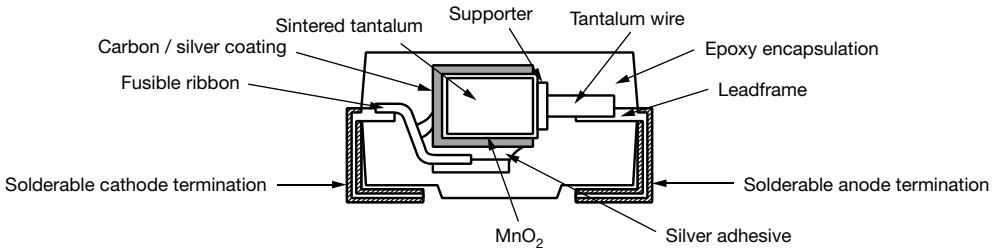
Solid electrolyte designs are the least expensive for a given rating and are used in many applications where their very small size for a given unit of capacitance is of importance. Also important are their good low temperature performance characteristics and freedom from corrosive electrolytes.

Datasheets covering the various types and styles of capacitors for consumer and entertainment electronics and industry applications are available where detailed performance characteristics must be specified.

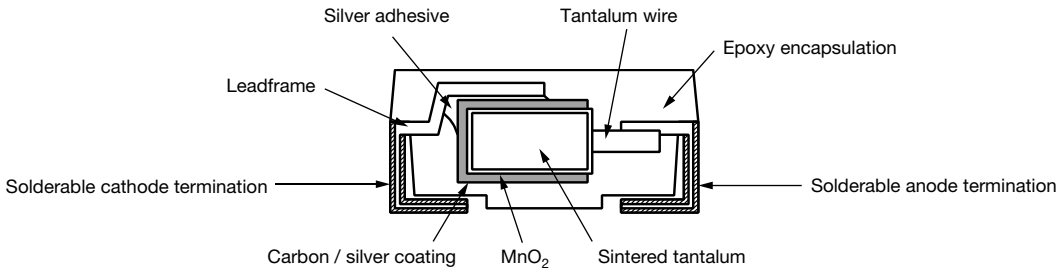
## MOLDED CHIP CAPACITOR, ALL TYPES EXCEPT TMCTX / TMCJ




## MOLDED CHIP CAPACITOR WITH BUILT-IN FUSE, TYPE TMCTX



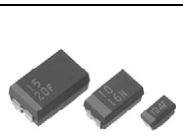

## MOLDED CHIP CAPACITOR 0603 SIZE, TYPE TMCJ






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| SOLID TANTALUM CAPACITORS - MOLDED CASE | | | | | | |
|---|---|---|---|---|---|---|
| **SERIES** | **TMCS** | **TMCM** | **TMCR** | **TMCU** | **TMCP** | **TMCJ** |
| **PRODUCT IMAGE** |  |  |  |  |  |  |
| **TYPE** | Solid tantalum surface mount chip capacitors, molded case | | | | | |
| **FEATURES** | Standard industrial grade | Standard industrial grade extended range | Low ESR | Low profile | 0805 size | 0603 size |
| **TEMPERATURE RANGE** | -55 °C to +125 °C | | | | | |
| **CAPACITANCE RANGE** | 0.1 µF to 68 µF | 0.47 µF to 470 µF | 10 µF to 330 µF | 0.1 µF to 220 µF | 0.1 µF to 47 µF | 0.68 µF to 22 µF |
| **VOLTAGE RANGE** | 4 V to 35 V | 2.5 V to 35 V | 7 V to 35 V | 2.5 V to 35 V | 2.5 V to 25 V | 2.5 V to 20 V |
| **CAPACITANCE TOLERANCE** | ± 10 %, ± 20 % | | | | | ± 20 % |
| **LEAKAGE CURRENT** | 0.01 CV or 0.5 µA, whichever is greater | | | | | |
| **DISSIPATION FACTOR** | 4 % to 6 % | 4 % to 30 % | 6 % to 30 % | 4 % to 30 % | 6 % to 30 % | 20 % |
| **CASE SIZES** | A, B, C, E | A, B, C, E | B, C, E | UA, UB | P | J |
| **TERMINATION FINISH** | 100 % tin | | | Case UA: 100 % tin<br>Case UB: Ni / Pd / Au | 100 % tin | |

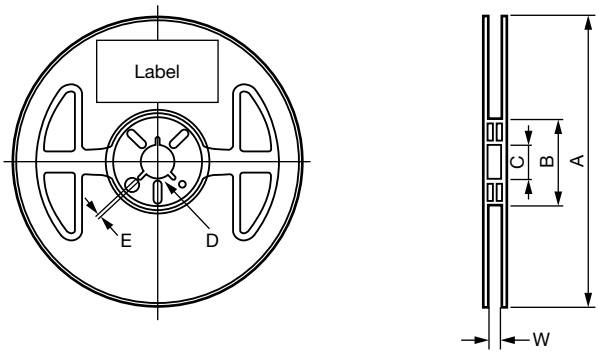
| SOLID TANTALUM CAPACITORS - MOLDED CASE | | | |
|---|---|---|---|
| **SERIES** | **TMCTX** | **TMCH** | **THC** |
| **PRODUCT IMAGE** |  |  |  |
| **TYPE** | Solid tantalum surface mount chip capacitors, molded case | | |
| **FEATURES** | Built-in fuse | High reliability | High reliability, high temperature +150 °C |
| **TEMPERATURE RANGE** | -55 °C to +125 °C | | -55 °C to +150 °C |
| **CAPACITANCE RANGE** | 1.0 µF to 68 µF | 0.1 µF to 100 µF | 0.33 µF to 47 µF |
| **VOLTAGE RANGE** | 10 V to 35 V | 4 V to 35 V | 10 V to 35 V |
| **CAPACITANCE TOLERANCE** | ± 10 %, ± 20 % | | |
| **LEAKAGE CURRENT** | 0.01 CV or 0.5 µA, whichever is greater | 0.005 CV or 0.25 µA, whichever is greater | |
| **DISSIPATION FACTOR** | 4 % to 6 % | 4 % to 8 % | 4 % to 6 % |
| **CASE SIZES** | B, C, E, F | A, B, C, E, P | A, B, C, E |
| **TERMINATION FINISH** | 100 % tin | | |



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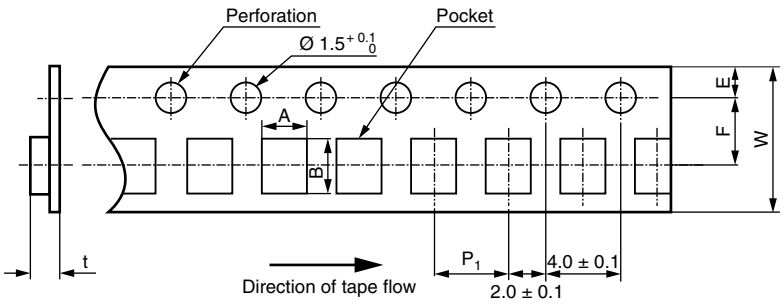
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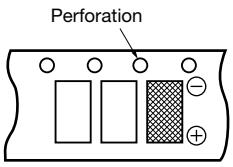
## PLASTIC TAPE AND REEL PACKAGING DIMENSIONS in millimeters

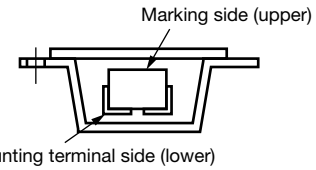



| CASE CODE | J, P, A, UA, B, UB | C, E, F |
|---|---|---|
| TAPE WIDTH | 8 | 12 |
| A + 0 / - 3 | Ø 180 | |
| B + 1 / 0 | Ø 60 | |
| C ± 0.2 | Ø 13 | |
| D ± 0.5 | Ø 21 | |
| E ± 0.5 | 2.0 | |
| W ± 0.3 | 9.0 | 13.0 |

## TAPE SIZE in millimeters




| CASE CODE | A ± 0.2 | B ± 0.2 | W ± 0.3 | F ± 0.1 | E ± 0.1 | $P_1$ ± 0.1 | $t_{max.}$ |
|---|---|---|---|---|---|---|---|
| J | 1.0 | 1.8 | 8.0 | 3.5 | 1.75 | 4.0 | 1.3 |
| P | 1.4 | 2.2 | 8.0 | 3.5 | 1.75 | 4.0 | 1.6 |
| A | 1.9 | 3.5 | 8.0 | 3.5 | 1.75 | 4.0 | 2.5 |
| UA | 1.9 | 3.5 | 8.0 | 3.5 | 1.75 | 4.0 | 1.7 |
| B | 3.1 | 3.8 | 8.0 | 3.5 | 1.75 | 4.0 | 2.5 |
| UB | 3.1 | 3.8 | 8.0 | 3.5 | 1.75 | 4.0 | 1.7 |
| C | 3.7 | 6.3 | 12.0 | 5.5 | 1.75 | 8.0 | 3.1 |
| E | 4.8 | 7.7 | 12.0 | 5.5 | 1.75 | 8.0 | 3.4 |
| F | 6.2 | 7.5 | 12.0 | 5.5 | 1.75 | 8.0 | 4.1 |

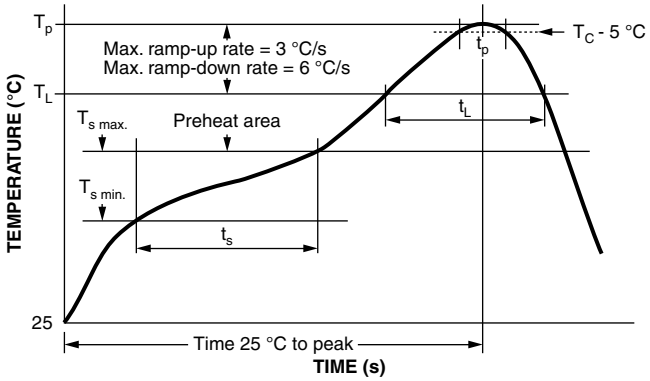


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## RECOMMENDED REFLOW PROFILES

Capacitors should withstand reflow profile as per J-STD-020 standard

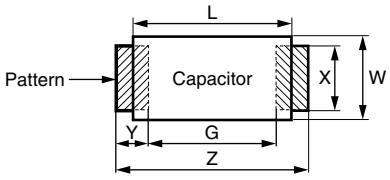



| PROFILE FEATURE | LEAD (Pb)-FREE ASSEMBLY |
|---|---|
| **Preheat / soak** | |
| Temperature min. ($T_{s\ min.}$) | 130 °C |
| Temperature max. ($T_{s\ max.}$) | 160 °C |
| Time ($t_s$) from ($T_{s\ min.}$ to $T_{s\ max.}$) | 60 s to 120 s |
| **Ramp-up** | |
| Ramp-up rate ($T_L$ to $T_p$) | 3 °C/s max. |
| Liquidus temperature ($T_L$) | 200 °C |
| Time ($t_L$) maintained above $T_L$ | 50 s max. |
| Peak package body temperature ($T_p$) max. | Depends on case size - see table below |
| Time ($t_p$) within 5 °C of the peak maximum temperature | 10 s max. |
| Ramp-down rate ($T_p$ to $T_L$) | 6 °C/s max. |
| Time from 25 °C to peak temperature | 8 min max. |

## PEAK PACKAGE BODY TEMPERATURE ($T_p$)

| CASE CODE | PEAK PACKAGE BODY TEMPERATURE ($T_p$) |
|---|---|
| | LEAD (Pb)-FREE PROCESS |
| J, P, UA, A, UB, B, C | 260 °C |
| E, F | 250 °C |

## PAD DIMENSIONS in millimeters




| CASE / DIMENSIONS | CAPACITOR SIZE | | PAD DIMENSIONS | | | |
|---|---|---|---|---|---|---|
| | L | W | G (max.) | Z (min.) | X (min.) | Y (Ref.) |
| J | 1.6 | 0.8 | 0.7 | 2.5 | 1.0 | 0.9 |
| P | 2.0 | 1.25 | 0.5 | 2.6 | 1.2 | 1.05 |
| UA, A | 3.2 | 1.6 | 1.1 | 3.8 | 1.5 | 1.35 |
| UB, B | 3.5 | 2.8 | 1.4 | 4.1 | 2.7 | 1.35 |
| C | 5.8 | 3.2 | 2.9 | 6.9 | 2.7 | 2.0 |
| E | 7.3 | 4.3 | 4.1 | 8.2 | 2.9 | 2.05 |
| F | 7.3 | 5.8 | 4.1 | 8.2 | 4.0 | 2.05 |



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## GUIDE TO APPLICATION

1. **AC 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 W at +25 °C as given in the tables in the product datasheets.

$R_{ESR}$ = the capacitor equivalent series resistance at the specified frequency.

2. **AC 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:

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

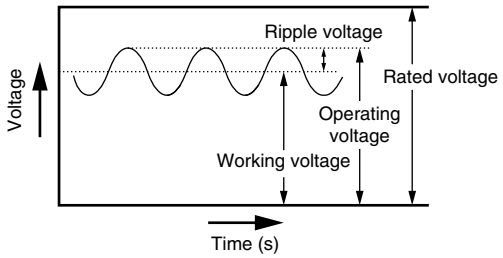
where,

P = power dissipation in W at +25 °C as given in the tables in the product datasheets.

$R_{ESR}$ = The capacitor equivalent series resistance at the specified frequency.

Z = The capacitor impedance at the specified frequency.

2.1 The tantalum capacitors must be used in such a condition that the sum of the working voltage and ripple voltage peak values does not exceed the rated voltage as shown in figure below.




3. **Temperature Derating:** power dissipation is affected by the heat sinking capability of the mounting surface. If these capacitors are to be operated at temperatures above +25 °C, the permissible ripple current (or voltage) shall be calculated using the derating coefficient as shown in the table below:

| MAXIMUM RIPPLE CURRENT TEMPERATURE DERATING FACTOR | |
|---|---|
| **TEMPERATURE** | **TMC** |
| ≤ 25 °C | 1.0 |
| 85 °C | 0.9 |
| 105 °C | 0.65 |
| 125 °C | 0.4 |

4. **Reverse Voltage:** the capacitors are not intended for use with reverse voltage applied. If the application of a reverse voltage is unavoidable, it must not exceed the following values:

At 25 °C: 10 % of the rated voltage or 1 V, whichever is smaller.

At 85 °C: 5 % of the rated voltage or 0.5 V, whichever is smaller.

5. **Mounting Precautions:**

5.1 **Limit Pressure on Capacitor Installation with Mounter:** pressure must not exceed 4.9 N with a tool end diameter of 1.5 mm when applied to the capacitors using an absorber, centering tweezers, or similar (maximum permitted pressurization time: 5 s). An excessively low absorber setting position would result in not only the application of undue force to the capacitors but capacitor and other component scattering, circuit board wiring breakage, and / or cracking as well, particularly when the capacitors are mounted together with other chips having a height of 1 mm or less.

5.2 **Flux Selection**

5.2.1 Select a flux that contains a minimum of chlorine and amine.

5.2.2 After flux use, the chlorine and amine in the flux remain must be removed.

5.3 **Cleaning After Mounting:** the following solvents are usable when cleaning the capacitors after mounting. Never use a highly active solvent.

- Halogen organic solvent (HCFC225, etc.)
- Alcoholic solvent (IPA, ethanol, etc.)
- Petroleum solvent, alkali saponifying agent, water, etc.

Circuit board cleaning must be conducted at a temperature of not higher than 50 °C and for an immersion time of not longer than 30 minutes. When an ultrasonic cleaning method is used, cleaning must be conducted at a frequency of 48 kHz or lower, at a vibrator output of 0.02 W/cm$^3$, at a temperature of not higher than 40 °C, and for a time of 5 minutes or shorter.

**Notes**

- Care must be exercised in cleaning process so that the mounted capacitor will not come into contact with any cleaned object or the like or will not get rubbed by a stiff brush or similar. If such precautions are not taken particularly when the ultrasonic cleaning method is employed, terminal breakage may occur
- When performing ultrasonic cleaning under conditions other than stated above, conduct adequate advance checkout



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