VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE
data book

LEADED SOLID ELECTROLYTE TANTALEX® CAPACITORS

VISHAY

VSE-DB0029-0805

Notes:

1. To navigate:
   a) Click on the Vishay logo on any datasheet to go to the Contents page for that section. Click on the Vishay logo on any Contents page to go to the main Table of Contents page.
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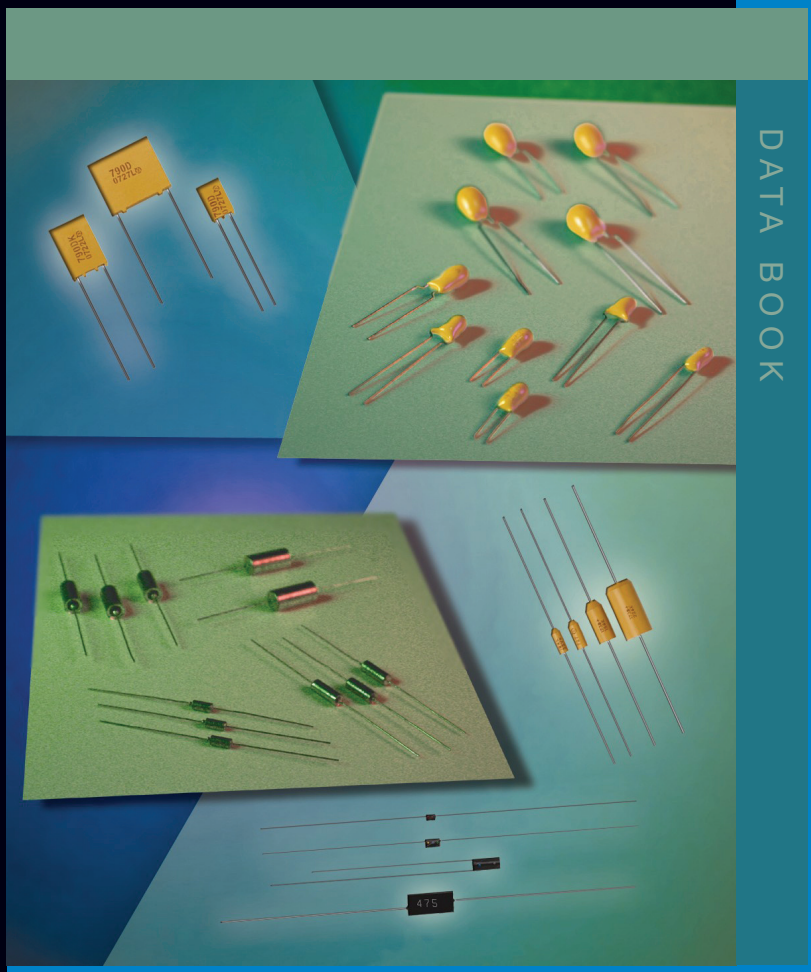

DATA BOOK

LEADED SOLID ELECTROLYTE TANTALEX® CAPACITORS

Hermetic Seal, Axial Leaded

Molded Case, Radial and Axial Leaded

Resin Coated, Radial and Tripole Leaded

CECC 30201 Qualified Styles

Military MIL-PRF-39003 Qualified Styles

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- Chip Fuses
- Variable Resistors
  - Cermet Variable Resistors
  - Wirewound Variable Resistors
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  - PTC Thermistors
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  - Molded Chip Tantalum Capacitors
  - Coated Chip Tantalum Capacitors
  - Solid Through-Hole Tantalum Capacitors
  - Wet Tantalum Capacitors
- Ceramic Capacitors
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Leaded Solid Electrolyte
TANTALEX® Capacitors

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Leaded Solid Electrolyte TANTALEX® Capacitors

All Military Products are manufactured with DSCC approved designs, processes and testing. Commercial products are manufactured to be in compliance with EIA Industry Standards

Military Style to Commercial Equivalent Product Index

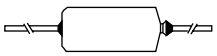
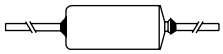
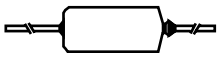
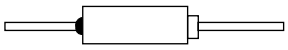
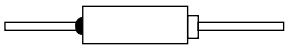
SOLID TANTALUM LEADED CAPACITORS

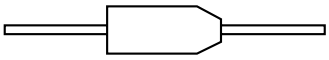
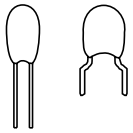
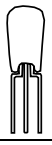
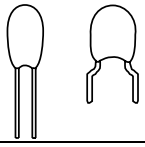
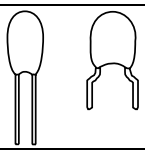
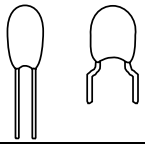
MILITARY STYLE	COMMERCIAL TYPE EQUIVALENT	

Note:

* Military Style CX-MIL-C-49137 not available

All Military Products are manufactured with DSCC approved designs, processes and testing. Commercial products are manufactured to be in compliance with EIA Industry Standards

SOLID TANTALUM LEADED CAPACITORS - HERMETIC SEAL, METAL CASE						
MODEL	**MIL SPEC/ TYPE**	**OUTLINE DRAWING**	**CAPACITANCE RANGE (µF)**	**WORKING VOLTAGES AT 85 °C**	**CASE SIZES**	**PAGE**
150D - Polar	MIL-PRF-39003/01 (CSR13)		0.056 - 330	6 - 125 VDC	A, B, R, S	18
152D - Polar	MIL-PRF-39003/03 (CSR23)		1.2 - 1000	6 - 50 VDC	A, B, R, S	27
550D - Polar	MIL-PRF-39003/09 (CSR21)		5.6 - 330	6 - 50 VDC	R, S	31
Military Parts CSR13 - Metal Case Axial CSR21 - Metal Case Axial CSR23 - Metal Case Axial	MIL-PRF-39003/01 MIL-PRF-39003/09 MIL-PRF-39003/03		0.056 - 330	6 - 100 VDC 6 - 50 VDC 6 - 50 VDC	A, B, C, D C, D A, B, C, D	39
To CECC 30201 CTS1 - Metal Case Axial CTS13 - Metal Case Axial 749DX - Metal Case Axial	30201 - 002 30201 - 005 30201 - 001/ 011/012/029		0.1 - 330 0.1 - 330 0.068 - 1000	6 - 125 VDC 6 - 63 VDC 6 - 63 VDC	A, B, C, D A, B, C, D A, B, C, D	54

SOLID TANTALUM LEADED CAPACITORS - NON-HERMETIC SEAL, MOLDED CASE, RESIN COATED						
MODEL	**MIL SPEC/ TYPE**	**OUTLINE DRAWING**	**CAPACITANCE RANGE (µF)**	**WORKING VOLTAGES AT 85 °C**	**CASE SIZES**	**PAGE**
173D - Molded Axial			0.10 - 330	2 - 50 VDC	U, V, W, X, Y	98
199D - Dipped Radial			0.1 - 680	3 - 50 VDC	A, B, C, D, E, F	111
299D - Dipped Radial			0.1 - 680	3 - 50 VDC	A, B, C, D, E, F	117
489D, 499D - Dipped Radial			0.1 - 680	3 - 50 VDC	A, B, C, D, E, F, H, M, N, R	123
790D - Molded Radial			0.1 - 330	6 - 50 VDC	A, B, C, D	104
ETPW - Dipped Radial Vishay Roederstein Type			0.1 - 330	3 - 50 VDC	P1A to P6R	131
ETQW - Dipped Radial Vishay Roederstein Type, High Reliability			0.1 - 330	3 - 50 VDC	Q1A to Q6R	138

Notes:

- All Axial Polar capacitors are available tape and reeled per EIA RS-296
- Model 199D/299D capacitors are available tape and reeled per EIA RS-468

Solid Tantalum Capacitors

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.

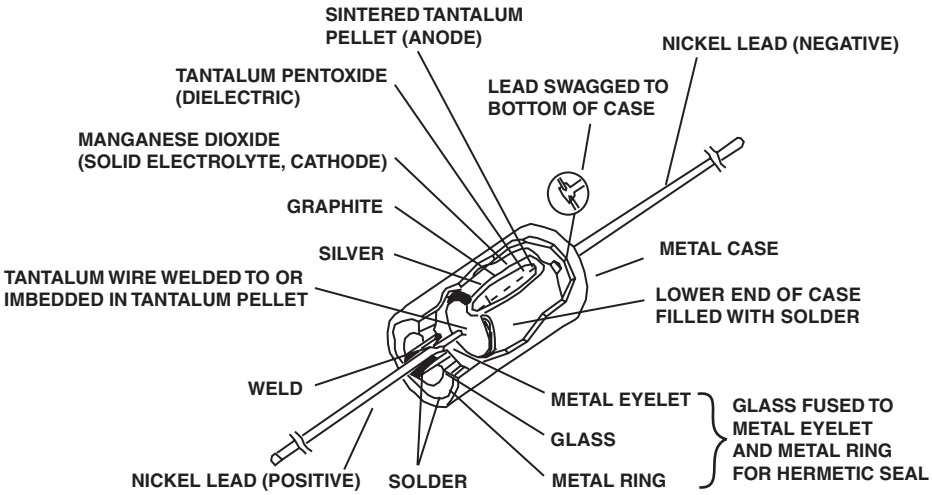
Rating for rating, tantalum capacitors tend to have as much as three times better capacitance/volume efficiency than aluminum electrolytic capacitors. An approximation of the capacitance/volume efficiency of other types of capacitors may be inferred from the following table, which shows the dielectric 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	K DIELECTRIC CONSTANT
Air or Vacuum	1.0
Paper	2.0 - 6.0
Plastic	2.1 - 6.0
Mineral Oil	2.2 - 2.3
Silicone Oil	2.7 - 2.8
Quartz	3.8 - 4.4
Glass	4.8 - 8.0
Porcelain	5.1 - 5.9
Mica	5.4 - 8.7
Aluminum Oxide	8.4
Tantalum Pentoxide	**26**
Ceramic	12 - 400 000

150D AND MIL STYLE CSR13

HERMETICALLY-SEALED, SOLID ELECTROLYTE
(MILITARY SPECIFICATION NO. MIL-PRF-39003)



Voltage Range:
6 WVDC to 125 WVDC
Capacitance Range:
0.056 µF to 330 µF
Size Range:
0.125" [3.175 mm] Ø x 0.250" [6.350 mm] long to
0.341" [8.661 mm] Ø x 0.750" [19.050 mm] long
Primary Applications:
Industrial and military equipment where reliability, low leakage current, low dissipation factor and stability with time and temperature are required.

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. The liquid electrolyte in wet slug capacitors - generally sulfuric acid - forms the cathode (negative) plate.

In solid electrolyte capacitors, a dry material, manganese dioxide, forms the cathode plate. The anode lead wire from the tantalum pellet consists of two pieces. A tantalum lead embedded in, or welded to the pellet, which is in turn connected to a termination or lead wire. The drawings clearly show the construction details of the frequently used types of tantalum capacitors.

VISHAY'S LINE OF HIGH QUALITY LEADED TANTALUM CAPACITORS

Vishay manufactures two categories of leaded tantalum capacitors:

1. Solid electrolyte, sintered anode leaded tantalum capacitors as shown in this data book

2. Wet electrolyte, sintered anode leaded tantalum capacitors - see Vishay data book, Wet Tantalum Capacitors (VSE-DB0030)

SOLID ELECTROLYTE TANTALUM CAPACITORS

Solid electrolyte, sintered anode tantalum capacitors in their original hermetically-sealed designs differ from the wet versions in their electrolyte. Here, the electrolyte is manganese dioxide, which is formed on the tantalum pentoxide dielectric layer by impregnating the pellet with a solution of manganous nitrate. The pellets are 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 solderable surface between the pellet and the can in which it will be enclosed.

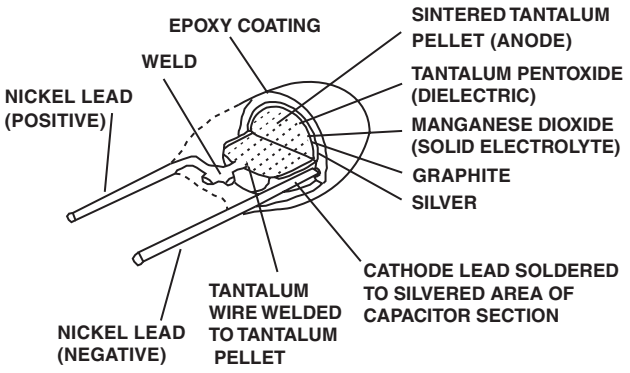
The pellets, with lead wire and header attached, are inserted into the can where the pellet is held in place by solder. The can cover is also soldered into place.

After assembly, the capacitors are tested and inspected to assure long life and reliability. Another variation of the solid electrolyte tantalum capacitor encases the element in plastic resins, such as epoxy materials. 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 leadframes or leadframeless designs as shown in the accompanying drawings.

199D

EPOXY-DIPPED, SOLID ELECTROLYTE



Voltage Range:
3 WVDC to 50 WVDC
Capacitance Range:
0.10 µF to 680 µF
Size Range:
0.177" [4.496 mm] diameter x 0.340" [8.636 mm] high to
0.380" [9.652 mm] diameter x 0.710" [18.034 mm] high
Primary Applications:
On printed circuit boards in entertainment, commercial and industrial equipment where low cost, small size, high stability, low DC leakage and low dissipation factor are important.

TANTALUM CAPACITORS FOR ALL DESIGN CONSIDERATIONS

In choosing between the two basic types of tantalum capacitors, the circuit designer customarily uses wet sintered anode capacitors, or wet “slug” tantalum capacitors, where the lowest DC leakage is required. The conventional silver can design will not tolerate any reverse voltages. However, in military or aerospace applications, tantalum cases are used in place of silver cases where utmost reliability is desired. The tantalum cased wet slug units will withstand reverse voltages up to 3 V, will operate under higher ripple currents and can be used at temperatures up to + 392 °F (+ 200 °C).

Solid electrolyte designs, which are the least expensive for a given rating, are used in many applications where their very small size for a given unit of capacitance is of importance.

They will typically withstand up to about 10 % of the rated DC working voltage in a reverse direction. Also important are their good low temperature performance characteristics and freedom from corrosive electrolytes.

Vishay Sprague patented the original solid electrolyte capacitors and was the first to market them in 1956. (Vishay has the broadest line of tantalum capacitors and has continued its position of leadership in this field.) Datasheets covering the various types and styles of Vishay tantalum capacitors for consumer and entertainment electronics, for industrial and for military applications are available where detailed performance characteristics must be specified.

AC Ripple Current Calculations

INTRODUCTION

Solid tantalum capacitors are preferred for filtering applications in small power supplies and DC/DC converters in a broad range of military, industrial and commercial systems including computers, telecommunications, instruments and controls and automotive equipment. Solid tantalum capacitors are preferred for their high reliability, long life, extended shelf life, exceptional stability with temperature and their small size. Their voltage range is 4 to 50 V for the most common types. Tantalum chip capacitors for surface mount applications are manufactured in very small sizes and are compatible with standard pick-and-place equipment.

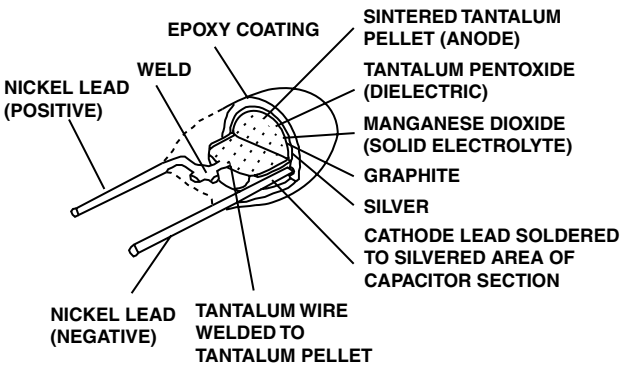
The electronics industry has moved to smaller and smaller power supplies and higher switching frequencies, with an increased requirement for capacitors with smaller size and operating characteristics better suited to high frequencies. This application note briefly describes the construction of solid tantalum capacitors, the concept of Equivalent Series Resistance (ESR) and presents calculations for power dissipation and voltage limitations for both low and high frequency applications.

CONSTRUCTION

The solid tantalum capacitor consists of a sintered tantalum pellet, the anode, on which a tantalum oxide dielectric is formed by electrolysis. The pellet is then coated with manganese dioxide for the cathode. Positive and negative terminations are attached to this pellet and the assembly may be conformally coated, molded or sealed in a metal case.

SOLID DIPPED TANTALUM CAPACITOR

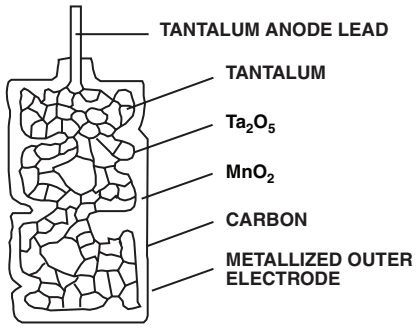
CROSS SECTION



Looking closely at the internal structure of the pellet, we see that it is made of grains of tantalum powder sintered to each other. A solid tantalum capacitor is equivalent to many small capacitors in parallel, one for each grain of powder. This configuration produces a very large surface area, therefore a large capacitance in a relatively small volume.

TANTALUM PELLET

SIMPLIFIED VIEW



EQUIVALENT SERIES RESISTANCE (ESR)

A capacitor offers internal resistance to AC current, called the Equivalent Series Resistance (ESR). At lower frequencies, this is mainly the resistance of the dielectric. At higher frequencies, the resistance of the manganese dioxide in the voids between the grains is predominant. Because the resistivity of manganese dioxide is inversely proportional to temperature, the ESR of solid tantalum capacitors at high frequencies decreases as temperature increases.

POWER DISSIPATION LIMITATION

When AC current is applied to a solid tantalum capacitor, the resistance (ESR) that opposes the flow of current results in heat generation, according to the formula:

$$(1) \quad P = I^2 \times ESR$$

The power (P) dissipated in the capacitor results in an elevation of temperature. The allowable temperature rise of a capacitor due to power dissipation is determined by experience. For example, this value is + 20 °C maximum for molded chip capacitors. This in turn limits the power that the capacitor can dissipate.

VOLTAGE LIMITATION

The power a capacitor can dissipate is also limited by the applied DC voltage. The operating voltage should not be allowed to rise above the rated voltage (nor should it drop below zero, since the solid tantalum capacitor is a polarized component). Assuming the capacitor is biased at half the rated voltage, which is the optimum use condition, the limiting value of the voltage is, for a sinusoidal waveform:

(2) $V_{rms} = V_{pp}/2\sqrt{2} = R_V/2\sqrt{2}$

V_{rms} for each value of R_V (Rated voltage) are:

RATED VOLTAGE	V_{rms} MAXIMUM
4	1.42
10	5.30
20	7.07
25	8.84
35	12.37
40	14.14
50	17.68

CURRENT LIMITATION (LOW FREQUENCY)

To find the limiting current I_{rms}, we divide V_{rms} by the impedance at the desired frequency.

(3) $I_{rms} = V_{rms}/Z$

using the formula:

(4) $Z = \sqrt{X^2 + ESR^2}$

where X is 1/Cw + Lw (w = 2πf)

Since inductance of a solid tantalum capacitor is usually in the nanohenry range, the Lw factor becomes important only when the frequency is higher than a few megahertz. For filtering applications at 100 kHz and lower, the inductance factor will generally be ignored in the calculation. At 120 Hz, the impedance can be determined by calculation.

(5) $Z = \sqrt{(1/2\pi fC)^2 + (DF/2\pi fC)^2} = (1/2\pi fC)\sqrt{(1 + DF^2)}$

At 120 Hz, DF2 is relatively small compared with 1 and the formula can be simplified to:

(6) $Z = 1/2\pi fC$

More generally, DF values of less than 10 % will not affect the final result by more than 1 %. It is important to use the lowest value for C, including the capacitance tolerance. At 120 Hz, the formula can be simplified to:

(7) $I_{rms} = 0.266 \times CV$

where I_{rms} is the maximum permissible rms current in milliamperes, C the capacitance minus the capacitance tolerance in microfarads and V the rated voltage in volts. All above calculations assume the capacitor is properly biased at half the rated voltage. If this is not the case, V_{rms} becomes

(8) $V_P/\sqrt{2}$

where $V_P = V_{rated} - V_{bias}$ or V_{bias}, whichever is lower.

CURRENT LIMITATION (HIGH FREQUENCY)

At frequencies in the 10 kHz to several 100 kHz range, the power dissipation becomes the limiting factor. The following formula gives the maximum permissible ripple current for a sinusoidal wave form:

(9) $I_{rms} = \sqrt{P_{max.}/ESR}$

$P_{max.}$ is the maximum power dissipation the capacitor can tolerate. The ESR value in the formula is the maximum ESR of the capacitor at the required frequency. This can be determined by measuring capacitors and determining a maximum value by using the mean value and adding 3 or more standard deviations. Some manufacturers specify the maximum impedance at 100 kHz or 1 MHz. Either value may be used in ripple current calculations.

Power dissipation limits calculated for the most popular surface mount types of solid tantalum capacitors are:

1. Hermetic Axial (150D, CSR13):

CASE SIZE	MAXIMUM POWER AT + 25 °C (W)
A	0.115
B	0.145
C	0.185
D	0.225

2. Dipped Tantalum (199D, 299D):

CASE SIZE	MAXIMUM POWER AT + 25 °C (W)	
	199D	299D
A	0.080	0.140
B	0.090	0.160
C	0.100	0.180
D	0.120	0.210
E	0.140	0.240
F	0.180	0.270

3. Molded Case Chip (293D):

As a general guideline, it is also worth mentioning that rectangular pellets for large case size ratings have lower ESR than cylindrical ones. Since cylindrical pellets are widely used in leaded capacitors and rectangular pellets for surface mount chips, it is safe to assume that a tantalum chip will have the same or lower ESR than the same capacitance/voltage capacitor in a leaded package.

ESR SCREENING

For parallel operation, the ESR spread can be minimized by screening. This reduces the risk of excess ripple current exposure to any one of the capacitors.

Some equipment will only measure impedance. An impedance limit can be caluclated to insure that the ESR stays in the required range. Use the formula:

$$(10)\ Z_{max.} = \sqrt{Xc^2 / ESR^2}$$

$$Xc = 1 / C\omega$$

Impedance can be measured using an impedance meter and a fixture that is appropriate for the task. With the most sophisticated fixtures, several capacitors may be tested at the same time, reducing the test cycle time.

CORRECTIVE FACTORS

The calculations for high frequency ripple current are shown in formula (9) for a sinusoidal waveform and an ambient temperature of + 25 °C. If the waveform is not sinusoidal, the ripple current limitations may differ. Generally speaking, the ripple current limit calculated by formula (9) can be divided by the duty cycle of the signal. If the temperature is higher than + 25 °C, the ripple current limit should also be multiplied by the factors shown:

TEMPERATURE °C	MULTIPLYING FACTOR
+ 55 °C	0.9
+ 85 °C	0.8
+ 125 °C	0.4

RIPPLE CURRENT/VOLTAGE CALCULATIONS EXAMPLE

As an example, we will determine the ripple voltage and power dissipation capability for a 1 µF, ± 20 % tolerance, 35 V, dipped tantalum capacitor.

At 120 Hz:

$$V_{rms} = R_V / 2\sqrt{2} = 12.37\ V$$

$$I_{rms} = V_{rms} / Z$$

$$= 12.37 \times 2 \times 3.14 \times 120 \times 0.8 \times 10^{-6} = 0.007\ A$$

If we used

$$I_{rms} = \sqrt{P_{max.} / ESR}$$

With $ESR = DF / 2\pi fC$

$$= 04 / 2 \times 3.14 \times 120 \times 0.8 \times 10^{-6} = 66\ \Omega$$

$$I_{rms} = \sqrt{P_{max.} / ESR} = \sqrt{0.080 / 66} = \sqrt{0.035\ A}$$

At 120 Hz, the voltage is the limiting factor.

At 100 kHz:

$$I_{rms} = \sqrt{P_{max.} / ESR}$$

At 100 kHz, the typical ESR for a 1 µF/35 V tantalum is:

$$ESR = \sqrt{1.5\ \Omega}\ (Z = 3\ \Omega)$$

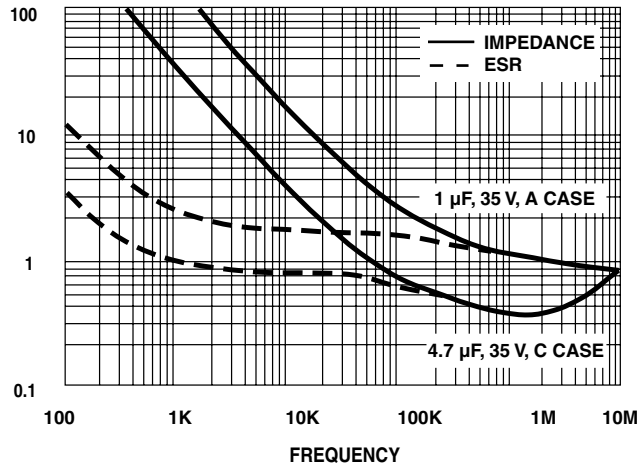
$$I_{rms} = 0.080 / 1.5 = 0.231\ A$$

If we now look at the maximum ripple voltage, the above limitation translates into:

$$V_{rms} = Z \times I_{rms} = 3 \times 0.231 = 0.69\ V$$

At 100 kHz, the power dissipation is the limiting factor.

TYPICAL CURVES OF IMPEDANCE AND ESR VS. FREQUENCY



CONCLUSIONS

The industry is moving towards smaller and smaller power supplies and DC/DC converters operating at higher frequencies. The three factors shown become more and more important in capacitor selection.

1. Higher Switching Frequencies: The switching frequency of power supplies has increased from the 10 kHz range a decade ago to the 100 kHz range and up today. The ESR of solid tantalum capacitors is either the same or lower at higher frequencies and impedance is at a minimum in the 100 kHz to megahertz range. Higher switching frequencies and the need for smaller sizes will increase the use of solid tantalum capacitors.
2. Surface Mount Technology: The application of surface mount technology not only reduces the size of power supplies and converters but also uses the substrate on which the components are mounted to dissipate some of the heat generated by the switching elements. Solid tantalum chip capacitors are well suited for this application. They have superior operating characteristics, do not leak electrolyte and are compatible with common automated surface assembly equipment.
3. Tighter High Frequency Parameters: The reduction of the maximum ESR of a solid tantalum capacitor may produce tradeoffs in size or DC characteristics. Rather than looking at lower ESR in terms of process average, it may be advisable to try to reduce ESR variation, producing a lower maximum ESR with a tighter distribution. This improvement may be achieved by using statistical process control, an approach already being implemented at Vishay Sprague Solid Tantalum manufacturing facilities.

Mounting for Through-Hole Components

General

All through-hole or leaded styles fall into two general classes. The first is provided with leads extending from opposite ends of the body, generally along the principle axis of the body (“axial leads”). The second is provided with parallel leads extending from one side or face of the body (“radial leads”). With both type, mounting points are normally provided by the leads themselves.

Axial leads may be used for point-to-point wiring, but usually, the wires are bent at 90° from the capacitor axis for insertion through printed circuit (PC) boards. Axial capacitors supplied on reels for machine insertion will withstand the mechanical stresses of bending and inserting. The Vishay axial series may be supplied on reels to feed such machines. Radial leads are intended to plug directly into holes of PC boards. Auto-insertion machines will insert compatible radial capacitor designs, and most Vishay capacitors may be supplied in appropriate reeled forms.

With either axial or radial types, attention should be paid to treatment of the capacitors during mounting and afterward under service conditions. Difficulty during mounting usuall y arises from lead damage or from overheating. The hand soldering technique or more often, wave-soldering machines can cause overheating. The internal cathode connection on most solid tantalum through-hole series is made between solder and a silver-pigmented paint. If too much heat is applied, this solder may reflow and degrade the silver-solder interface or cause a direct short circuit.

Vishay’s hermetically-sealed series has an internal space into which molten cathode solder may run, depriving the cathode connection and possibly flowing across the terminals to short circuit the capacitor from the inside. It is also possible to remelt or reflow the solder which bonds the rim of the glass-metal seal, causing loss of hermeticity and possibly a short circuit. Finally, solder at the exit point of the positive wire may be re-melted withsimilar effect. This solder however, is a high-temperature alloy, and it is much less likely to be melted. Redipping of leadwires is practiced by some users, introducing another hazard of re-melting this solder. Vishay recommends that redipping or hot solder dipping of any tantalum capacitor be performed by our factories under controlled conditions.

Molded series have only one site of solder, the internal cathode connection. The rate of heat transfer through the plastic is lower than through the metal can of our hermetic styles. However the opportunity for temperature transfer or conduction along the negative lead-wire to re-melt this solder is very similar. There is little internal void within molded cased capacitors, so re-melted solder tends to remain in its original location and solidify when heat is removed. Short circuiting is very unlikely, but reliability of the internal connection may be compromised by leaching of silver from the paint into the molten solder. The latter effect degrades the cathode connection in hermetic parts as well.

Lead Forming

While we will provide some general guidelines for bending leads, more specific details are outlined in J-STD-001. The positive or anode lead bend must be a minimum of 0.050" from the case or from the external weld connection. If the part has a hermetic (glass-to-metal) seal, do not bend, cut, or disturb the tube between the weld and the glass seal. The cathode lead bend must be a minimum of 0.050" from the case.

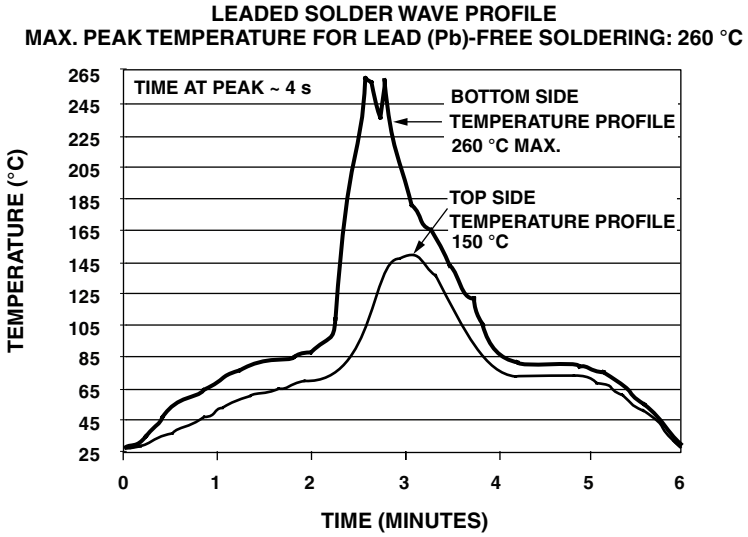
Solder Heat Test

All through-hole capacitors will pass the Resistance to Soldering Heat Test of MIL-STD-202, Method 210, Condition B. This test dips each lead-wire into molten solder at + 260 °C for 10 s while the capacitor body is held vertically above the solder. Vishay capacitors will pass this test when the depth of immersion brings the capacitor body (or closest external solder joint, if it is closer as in some hermetic styles) to a minimum distance of 0.100" from the solder surface. This demonstration of resistance to solder heat is in accordance with what is believed to be the industry standard. More severe treatment must be considered reflective of an improper soldering process.

Mounting for Through-Hole Components

Solder Profile

Shown below is a recommended solder wave profile for both axial and radial through-hole solid tantalum capacitors.



"We are dedicated to partnership with our customers... assuring continuously improved quality of the products and services we offer..."

About the manufacture of tantalum capacitors at Vishay ...

Attention to customer requirements-to your requirements keeps us on the leading edge of the quality revolution. We maintain total quality commitments throughout our operations.

The scope of our Quality System encompasses:

1. Product and Materials Development
2. Process Control
3. Training
4. Outgoing Quality Improvement
5. Customer Partnerships
6. Ship-To-Stock Programs.
7. Our Quality System is Registered to ISO/QS 9000

PRODUCT AND MATERIALS DEVELOPMENT

The work in our research and development facilities is focused on new materials and designs. Our scientists and engineers are recognized for their experience in this technology. Vishay Sprague, a pioneer in the field of tantalum capacitors, has introduced many important advances over the years.

SUPPLIER PARTNERSHIPS

We are continuously working with suppliers to assure a thorough understanding of our quality requirements and the use of statistical methods as a tool for process control. We expect our suppliers to be dedicated to the improvement of quality of our incoming materials, taking rigorous action to investigate and correct non-conformance whenever required.

Our suppliers are considered extensions of our tantalum processes.

PROCESS CONTROL

Vishay ships millions of tantalum capacitors each month for aerospace and defense electronics, for computers and communications as well as for a virtually unlimited range of high-performance military, industrial and commercial equipment.

We are dedicated to defect prevention in all aspects of design and manufacturing. Rigorous action is taken to investigate the root cause of non-conformances and/or variation and to correct such situations.

Vishay is committed to the use of statistical techniques to reduce variation, independent of specification limit. This is one of the tools used to improve performance.

We perform a thorough analysis of critical process elements using statistical methods at key points. More and more process steps are being automated to assure consistency in manufacturing and conformance to design specifications.

TRAINING

A disciplined procedures approach is an essential part of our quality improvement program. This requires a commitment to provide all personnel with the skills and tools necessary to produce quality at the source. Employees are trained in company philosophy, statistical process control, capability studies, application of procedures and equipment operation.

Our training includes the analysis of statistical data from our processes to help us understand and control variations. As we train our operators in SPC and automate our processes, the rate of quality improvement accelerates accordingly.

PARTS PER MILLION (PPM) PROGRAMS

The collection of quality data and reporting of outgoing quality in PPM is not new to Vishay Sprague. In fact, Vishay Sprague provided leadership for the committee developing the EIA Standard for PPM measurement. And long before reporting outgoing quality in "Parts Per Million" was fashionable, Vishay Sprague had defined a program, was collecting data and reporting internally to assure quality improvement.

PPM performance, by product, is calculated by Quality Assurance from end-of-the-line electrical performance data. These data include all variations, whether minor or catastrophic, from internal standards that are stricter than those used by our customers. The result is that our customers' measurement of as-received quality in PPM is always more favorable than our own measurement.

Today, not all suppliers are using a standard method of PPM calculation. Consequently, when comparing reported PPM levels, it is essential that the method of calculation be understood. For example, calculations that include only catastrophic failures may produce very low reported PPM levels.

CUSTOMER PARTNERSHIPS

We are currently involved with many major Ship-to-Stock programs. These programs rely on our history of providing materials that meet customer quality expectations, are delivered on time and at competitive prices.

This history, plus our proven dedication to continuous quality improvement and the use of statistical techniques to identify and reduce variation in our processes, provides customer confidence to eliminate incoming inspection, thereby reducing costs.

Our partnership also extends to in-depth applications engineering support. Our engineers work with customers to review their designs and in the selection of the most appropriate Vishay Sprague tantalum capacitors.

SHIP-TO-STOCK PROGRAMS

Vishay Sprague provides a program for those customers who may not have identified their own Ship-to-Stock program. This program may be modified to suit specific needs.

QUARTERLY PPM REPORTS

These reports express outgoing quality of each product type purchased and may be used for monitoring quality improvement.

SHIPPING CONTAINER ID

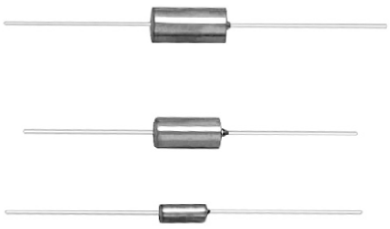
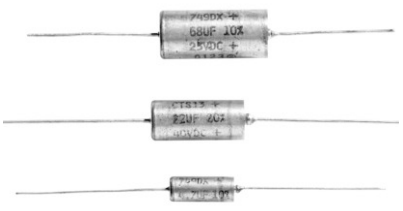
We identify each container to assure that material proceeds directly to your stockroom and is not inspected when received.

Vishay Sprague is responsible for its quality.

VISHAY SPRAGUE
SHIP TO
STOCK
INSP. BY DATE

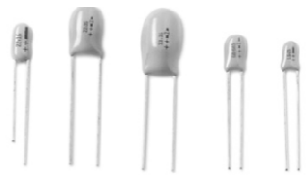
SOLID TANTALUM CAPACITORS HERMETIC SEAL, METAL CASE

SOLID TANTALUM LEADED CAPACITORS

PICTORIAL	MODEL	CASE CODES	DESCRIPTION	PAGE
	150D	A, B, R, S	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Axial lead, hermetically sealed, high performance, high capacitance, low DCL, lLow dissipation factor. Excellent operating stability/reliability. Supplied with plastic film insulation. Terminals are solid, tinned nickel wire leads. Commercial, industrial and military applications.	18
	152D	A, B, R, S	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Axial lead, hermetically sealed, extended capacitance, small size, low leakage current, low dissipation factor, Exceptional operating stability. Proven reliability in a wide variety of high performance commercial, industrial and military applications.	27
	550D	R, S	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Axial lead, hermetically sealed, small size, long life. Designed for power supply filtering applications at above 100 kHz. Extremely low equivalent series resistance with the capability to handle high ripple currents in switching regulators and high frequency power supplies.	31
	**MIL-PRF-39003** CSR13 M39003/01 CSR21 M39003/09 CSR23 M39003/03	A, B, C, D C, D A, B, C, D	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Axial lead, tubular, hermetically sealed. Capacitors are qualified to MIL-PRF-39003 - Exponential and Weibull distribution. Capacitors are furnished to the requirements of the military specification, including marking, testing and inspection. Also, MIL-PRF-39003 establishes failure rates (expressed in percent per 1000 h) based on exponential and Weibull distribution. Exponential failure rates are identified as levels M, P, R and S. Weibull failure rates are B, C and D. Levels M, P, R and S are inactive for new designs.	39
	**CECC30201** CTS1 CTS13 749DX	A, B, C, D	The CTS1, CTS13, and 749DX series are qualified to the European standard CECC30201. These are hermetically sealed, metal case, axial leaded capacitors with long life and high performance. They have high capacitance, with low DF (dissipation factor), and low DCL (DC Leakage). The CTS1, CTS13, and 749DX have excellent operating stability and reliability. All units are supplied with plastic film isolation. The standard terminations are tin/lead plated nickel wire, but 100 % tin (RoHS compliant) terminations are available.	54

SOLID TANTALUM CAPACITORS
NON-HERMETIC SEAL, MOLDED CASE AND RESIN COATED

SOLID TANTALUM LEADED CAPACITORS

PICTORIAL	MODEL	CASE CODES	DESCRIPTION	PAGE
	173D	U, V, W, X, Y	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Axial lead, miniature, molded case, precision molded in gold colored, flame retardant, thermosetting epoxy resin. Units are laser marked for improved legibility. The tapered end of the case provides easy identification of the positive terminal. Tape and reel	98
	199D	A, B, C, D, E, F	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Radial lead, resin-coated, miniature, rugged and reliable. High performance, economical, low leakage current and dissipation factor. Two lead styles. Tape and reel packaging. Suitable for a broad range of commercial and industrial equipment applications.	111
	299D	A, B, C, D, E, F	Solid Tantalum Capacitor - Solid-Electrolyte TANTALEX®: Tripole®, triple lead, resin-coated - conformal coating, miniature, high performance. The anole lead is in the center while both outside leads are cathode leads. The three-lead design makes backwards insertion impossible. Tape and reel packaging per EIA-468.	117
	489D 499D	A, B, C, D	The 489D and 499D are solid tantalum resin coated radial leaded capacitors built to conform to the European standards for ratings and case sizes. They are available in many ratings, sizes and lead configurations. They are the economical choice for a variety of applications, with low DF (disspation factor) and low DCL (DC Leakage). The units are laser marked for improved marking legibility. Standard terminations are tin/lead plated, but they are now also available with 100 % tin (RoHS compliant) terminations. Tape and reel packaging is available.	123
	790D	A, B, C, D	Solid Tantalum Capacitor - precisely molded with a flame retardant expoxy resin coating. Four case sizes with stand-off leads. Low leakage current, low impedance and extended value ranges available	104
	ETPW	1A, 1B, 2C, 2D, 2E, 3F, 3G, 4H, 5J, 5K, 5L, 6M, 6N, 6P, 6R	Solid Tantalum Capacitor - resin coated with flame retardant encapsulation, practically without expoxy run down. Radial lead. Improved humidity class and low leakage current. Very high CV product, low failure rate and high operational stability.	131
	ETQW	1, 2, 3, 4, 5, 6	Solid Tantalum Capacitor - resin coated with flame retardant encapsulation, practically without expoxy run down. Radial lead. Improved humidity class and low leakage current. Very high CV product, low failure rate and high operational stability.	138

Metal Case

Contents

Solid-Electrolyte TANTALEX® Capacitors Hermetically-Sealed, Axial-Lead

FEATURES

- Terminations: Tin/lead (SnPb), 100 % Tin (RoHS compliant)
- These high performance, hermetically-sealed TANTALEX® capacitors have set the standard for solid-electrolyte tantalum capacitors for more than three decades.
- High capacitance, low DCL, low dissipation factor and exceptional operating stability.
- Performance and reliability have been proven in commercial, industrial and military applications.
- Available in four case codes and capacitors and are supplied with plastic-film insulation.
- Terminals are solid, tinned nickel wire leads.
- The Military equivalent to the 150D is the CSR13 which is qualified to MIL-C-39003/01.

Available

RoHS* COMPLIANT

PERFORMANCE CHARACTERISTICS

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

Capacitance Tolerance: At 120 Hz, + 25 °C. ± 20 %, ± 10 % standard. ± 5 % available as special.

Dissipation Factor: At 120 Hz, + 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.):

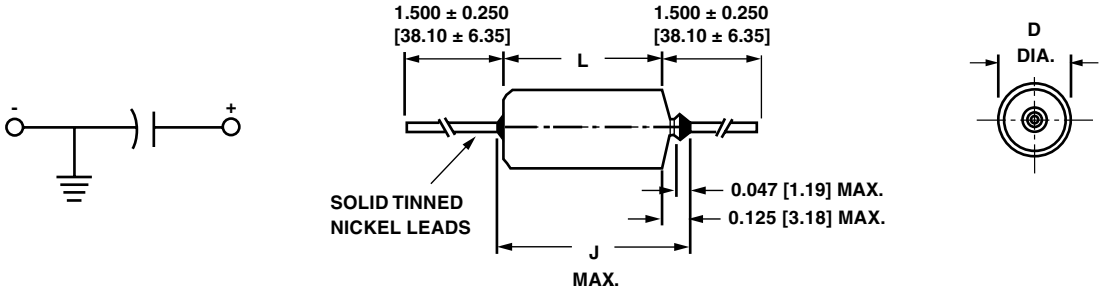
At + 25 °C: Leakage current shall not exceed the values listed in the Standard Ratings Tables.

At + 85 °C: Leakage current shall not exceed 10 times the values listed in the Standard Ratings Tables.
At +125 °C: Leakage shall not exceed 15 times the values listed in the Standard Ratings Tables.

Life Test: Capacitors shall withstand rated DC voltage applied at + 85 °C for 2000 h or derated DC voltage applied at + 125 °C for 1000 h
Following the life test:

1. DCL shall not exceed 125 % of the initial requirement
2. Dissipation Factor shall meet the initial requirement
3. Change in capacitance shall not exceed ± 5 %

DIMENSIONS in inches [millimeters]



CASE CODE	WITH INSULATING SLEEVE (1)		J (MAXIMUM)	LEAD SIZE	
	D	L		AWG NO.	NOMINAL DIAMETER
A	0.135 ± 0.016 [3.43 ± 0.41]	0.286 ± 0.031 [7.26 ± 0.79]	0.422 [10.720]	24	0.020 [0.51]
B	0.185 ± 0.016 [4.70 ± 0.41]	0.474 ± 0.031 [12.04 ± 0.79]	0.610 [15.490]	24	0.020 [0.51]
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	0.822 [20.880]	22	0.025 [0.64]
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	0.922 [23.420]	22	0.025 [0.64]

Note:
(1) When a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body

* Pb containing terminations are not RoHs compliant, exemptions may apply

ORDERING INFORMATION

150D	224	X0	006	A	2	T	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING	CASE CODE	STYLE NUMBER	PACKAGING	ROHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 % X9 = ± 10 % *X5 = ± 5 % *Special Order	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating.	See Ratings and Case Codes Table.	0 = No Sleeve 2 = Insulated sleeve	B = Bulk T = Tape and Reel	E3 = 100 % Tin termination (RoHS compliant) Blank = SnPb termination

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER CAP. TOL. ± 20 %	PART NUMBER CAP. TOL. ± 10 %	MAX. DCL AT + 25 °C (µA)	MAX. DF AT + 25 °C 120 Hz (%)
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V					
0.22	A	150D224X0006A2	150D224X9006A2	0.5	2
0.27	A	-	150D274X9006A2	0.5	2
0.33	A	150D334X0006A2	150D334X9006A2	0.5	2
0.39	A	-	150D394X9006A2	0.5	2
0.47	A	150D474X0006A2	150D474X9006A2	0.5	2
0.56	A	-	150D564X9006A2	0.5	2
0.68	A	150D684X0006A2	150D684X9006A2	0.5	2
0.82	A	-	150D824X9006A2	0.5	2
1.0	A	150D105X0006A2	150D105X9006A2	0.5	2
1.2	A	-	150D125X9006A2	0.5	4
1.5	A	150D155X0006A2	150D155X9006A2	0.5	4
1.8	A	-	150D185X9006A2	0.5	4
2.2	A	150D225X0006A2	150D225X9006A2	0.5	4
2.7	A	-	150D275X9006A2	0.5	4
3.3	A	150D335X0006A2	150D335X9006A2	0.5	4
3.9	A	-	150D395X9006A2	0.5	4
4.7	A	150D475X0006A2	150D475X9006A2	0.5	4
5.6	A	-	150D565X9006A2	0.5	4
6.8	A	150D685X0006A2	150D685X9006A2	0.5	6
8.2	B	-	150D825X9006B2	0.5	6
10.0	B	150D106X0006B2	150D106X9006B2	0.5	6
12.0	B	-	150D126X9006B2	0.5	6
15.0	B	150D156X0006B2	150D156X9006B2	1.0	6
18.0	B	-	150D186X9006B2	1.0	6
22.0	B	150D226X0006B2	150D226X9006B2	1.0	6
27.0	B	-	150D276X9006B2	1.0	6
33.0	B	150D336X0006B2	150D336X9006B2	1.0	6
39.0	B	-	150D396X9006B2	1.0	6
47.0	B	150D476X0006B2	150D476X9006B2	2.0	6
56.0	B	-	150D566X9006B2	2.0	6
68.0	R	150D686X0006R2	150D686X9006R2	3.0	6
82.0	R	-	150D826X9006R2	3.0	6
100.0	R	150D107X0006R2	150D107X9006R2	3.0	6
120.0	R	150D127X0006R2	150D127X9006R2	3.0	6
150.0	R	150D157X0006R2	150D157X9006R2	6.0	6
180.0	R	150D187X0006R2	150D187X9006R2	6.0	6
220.0	S	150D227X0006S2	150D227X9006S2	6.0	8
270.0	S	150D277X0006S2	150D277X9006S2	6.0	8
330.0	S	150D337X0006S2	150D337X9006S2	10.0	8

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT+ 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V					
0.22	A	150D224X0010A2	150D224X9010A2	0.5	2
0.27	A	-	150D274X9010A2	0.5	2
0.33	A	150D334X0010A2	150D334X9010A2	0.5	2
0.39	A	-	150D394X9010A2	0.5	2
0.47	A	150D474X0010A2	150D474X9010A2	0.5	2
0.56	A	-	150D564X9010A2	0.5	2
0.68	A	150D684X0010A2	150D684X9010A2	0.5	2
0.82	A	-	150D824X9010A2	0.5	2
1.0	A	150D105X0010A2	150D105X9010A2	0.5	2
1.2	A	-	150D125X9010A2	0.5	4
1.5	A	150D155X0010A2	150D155X9010A2	0.5	4
1.8	A	-	150D185X9010A2	0.5	4
2.2	A	150D225X0010A2	150D225X9010A2	0.5	4
2.7	A	-	150D275X9010A2	0.5	4
3.3	A	150D335X0010A2	150D335X9010A2	0.5	4
3.9	A	-	150D395X9010A2	0.5	4
4.7	A	150D475X0010A2	150D475X9010A2	0.5	4
5.6	B	-	150D565X9010B2	0.5	4
6.8	B	150D685X0010B2	150D685X9010B2	1.0	6
8.2	B	-	150D825X9010B2	1.0	6
10.0	B	150D106X0010B2	150D106X9010B2	1.0	6
12.0	B	-	150D126X9010B2	1.0	6
15.0	B	150D156X0010B2	150D156X9010B2	1.0	6
18.0	B	-	150D186X9010B2	1.0	6
22.0	B	150D226X0010B2	150D226X9010B2	2.0	6
27.0	B	-	150D276X9010B2	2.0	6
33.0	B	150D336X0010B2	150D336X9010B2	2.0	6
39.0	B	-	150D396X9010B2	2.0	6
47.0	R	150D476X0010R2	150D476X9010R2	3.0	6
56.0	R	-	150D566X9010R2	3.0	6
68.0	R	150D686X0010R2	150D686X9010R2	3.0	6
82.0	R	-	150D826X9010R2	3.0	6
100.0	R	150D107X0010R2	150D107X9010R2	6.0	6
120.0	R	150D127X0010R2	150D127X9010R2	6.0	6
150.0	S	150D157X0010S2	150D157X9010S2	10.0	6
180.0	S	150D187X0010S2	150D187X9010S2	10.0	6
220.0	S	150D227X0010S2	150D227X9010S2	10.0	8
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V					
0.22	A	150D224X0015A2	150D224X9015A2	0.5	2
0.27	A	-	150D274X9015A2	0.5	2
0.33	A	150D334X0015A2	150D334X9015A2	0.5	2
0.39	A	-	150D394X9015A2	0.5	2
0.47	A	150D474X0015A2	150D474X9015A2	0.5	2
0.56	A	-	150D564X9015A2	0.5	2
0.68	A	150D684X0015A2	150D684X9015A2	0.5	2
0.82	A	-	150D824X9015A2	0.5	2
1.0	A	150D105X0015A2	150D105X9015A2	0.5	2
1.2	A	-	150D125X9015A2	0.5	4
1.5	A	150D155X0015A2	150D155X9015A2	0.5	4
1.8	A	-	150D185X9015A2	0.5	4
2.2	A	150D225X0015A2	150D225X9015A2	0.5	4
2.7	A	-	150D275X9015A2	0.5	4
3.3	A	150D335X0015A2	150D335X9015A2	0.5	4
3.9	B	-	150D395X9015B2	0.5	4
4.7	B	150D475X0015B2	150D475X9015B2	1.0	4

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V					
5.6	B	-	150D565X9015B2	1.0	4
6.8	B	150D685X0015B2	150D685X9015B2	1.0	6
8.2	B	-	150D825X9015B2	1.0	6
10.0	B	150D106X0015B2	150D106X9015B2	1.0	6
12.0	B	-	150D126X9015B2	1.0	6
15.0	B	150D156X0015B2	150D156X9015B2	2.0	6
18.0	B	-	150D186X9015B2	2.0	6
22.0	B	150D226X0015B2	150D226X9015B2	3.0	6
27.0	R	-	150D276X9015R2	3.0	6
33.0	R	150D336X0015R2	150D336X9015R2	3.0	6
39.0	R	-	150D396X9015R2	3.0	6
47.0	R	150D476X0015R2	150D476X9015R2	6.0	6
56.0	R	-	150D566X9015R2	6.0	6
68.0	R	150D686X0015R2	150D686X9015R2	6.0	6
82.0	S	-	150D826X9015S2	6.0	6
100.0	S	150D107X0015S2	150D107X9015S2	6.0	6
120.0	S	150D127X0015S2	150D127X9015S2	6.0	6
150.0	S	150D157X0015S2	150D157X9015S2	10.0	6
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V					
0.027	A	-	150D273X9020A2	0.1	2
0.033	A	150D333X0020A2	150D333X9020A2	0.1	2
0.039	A	-	150D393X9020A2	0.1	2
0.047	A	150D473X0020A2	150D473X9020A2	0.1	2
0.056	A	-	150D563X9020A2	0.1	2
0.068	A	150D683X0020A2	150D683X9020A2	0.1	2
0.082	A	-	150D823X9020A2	0.1	2
0.10	A	150D104X0020A2	150D104X9020A2	0.5	2
0.12	A	-	150D124X9020A2	0.5	2
0.15	A	150D154X0020A2	150D154X9020A2	0.5	2
0.18	A	-	150D184X9020A2	0.5	2
0.22	A	150D224X0020A2	150D224X9020A2	0.5	2
0.27	A	-	150D274X9020A2	0.5	2
0.33	A	150D334X0020A2	150D334X9020A2	0.5	2
0.39	A	-	150D394X9020A2	0.5	2
0.47	A	150D474X0020A2	150D474X9020A2	0.5	2
0.56	A	-	150D564X9020A2	0.5	2
0.68	A	150D684X0020A2	150D684X9020A2	0.5	2
0.82	A	-	150D824X9020A2	0.5	2
1.0	A	150D105X0020A2	150D105X9020A2	0.5	2
1.2	A	-	150D125X9020A2	0.5	4
1.5	A	150D155X0020A2	150D155X9020A2	0.5	4
1.8	A	-	150D185X9020A2	0.5	4
2.2	A	150D225X0020A2	150D225X9020A2	0.5	4
2.7	B	-	150D275X9020B2	0.5	4
3.3	B	150D335X0020B2	150D335X9020B2	0.5	4
3.9	B	-	150D395X9020B2	1.0	4
4.7	B	150D475X0020B2	150D475X9020B2	1.0	4
5.6	B	-	150D565X9020B2	1.0	4
6.8	B	150D685X0020B2	150D685X9020B2	1.0	6
8.2	B	-	150D825X9020B2	1.0	6
10.0	B	150D106X0020B2	150D106X9020B2	1.0	6
12.0	B	-	150D126X9020B2	1.0	6
15.0	B	150D156X0020B2	150D156X9020B2	2.0	6

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V					
18.0	R	-	150D186X9020R2	3.0	6
22.0	R	150D226X0020R2	150D226X9020R2	3.0	6
27.0	R	-	150D276X9020R2	3.0	6
33.0	R	150D336X0020R2	150D336X9020R2	3.0	6
39.0	R	-	150D396X9020R2	3.0	6
47.0	R	150D476X0020R2	150D476X9020R2	6.0	6
56.0	S	-	150D566X9020S2	6.0	6
68.0	S	150D686X0020S2	150D686X9020S2	6.0	6
82.0	S	-	150D826X9020S2	6.0	6
100.0	S	150D107X0020S2	150D107X9020S2	10.0	6
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V					
0.027	A	-	150D273X9035A2	0.1	2
0.033	A	150D333X0035A2	150D333X9035A2	0.1	2
0.039	A	-	150D393X9035A2	0.1	2
0.047	A	150D473X0035A2	150D473X9035A2	0.1	2
0.056	A	-	150D563X9035A2	0.1	2
0.068	A	150D683X0035A2	150D683X9035A2	0.1	2
0.082	A	-	150D823X9035A2	0.1	2
0.10	A	150D104X0035A2	150D104X9035A2	0.5	2
0.12	A	-	150D124X9035A2	0.5	2
0.15	A	150D154X0035A2	150D154X9035A2	0.5	2
0.18	A	-	150D184X9035A2	0.5	2
0.22	A	150D224X0035A2	150D224X9035A2	0.5	2
0.27	A	-	150D274X9035A2	0.5	2
0.33	A	150D334X0035A2	150D334X9035A2	0.5	2
0.39	A	-	150D394X9035A2	0.5	2
0.47	A	150D474X0035A2	150D474X9035A2	0.5	2
0.56	A	-	150D564X9035A2	0.5	2
0.68	A	150D684X0035A2	150D684X9035A2	0.5	2
0.82	A	-	150D824X9035A2	0.5	2
1.0	A	150D105X0035A2	150D105X9035A2	0.5	2
1.2	B	-	150D125X9035B2	0.5	4
1.5	B	150D155X0035B2	150D155X9035B2	0.5	4
1.8	B	-	150D185X9035B2	0.5	4
2.2	B	150D225X0035B2	150D225X9035B2	1.0	4
2.7	B	-	150D275X9035B2	1.0	4
3.3	B	150D335X0035B2	150D335X9035B2	1.0	4
3.9	B	-	150D395X9035B2	1.0	4
4.7	B	150D475X0035B2	150D475X9035B2	1.0	4
5.6	B	-	150D565X9035B2	1.0	4
6.8	B	150D685X0035B2	150D685X9035B2	2.0	4
8.2	R	-	150D825X9035R2	3.0	4
10.0	R	150D106X0035R2	150D106X9035R2	3.0	4
12.0	R	-	150D126X9035R2	3.0	4
15.0	R	150D156X0035R2	150D156X9035R2	3.0	4
18.0	R	-	150D186X9035R2	3.0	4
22.0	R	150D226X0035R2	150D226X9035R2	6.0	4
27.0	S	-	150D276X9035S2	6.0	4
33.0	S	150D336X0035S2	150D336X9035S2	6.0	4
39.0	S	-	150D396X9035S2	6.0	4
47.0	S	150D476X0035S2	150D476X9035S2	10.0	4

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C	Max. DF AT + 25 °C
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V					
0.056	A	-	150D563X9050A2	0.1	2
0.068	A	150D683X0050A2	150D683X9050A2	0.1	2
0.082	A	-	150D823X9050A2	0.1	2
0.10	A	150D104X0050A2	150D104X9050A2	0.5	2
0.12	A	-	150D124X9050A2	0.5	2
0.15	A	150D154X0050A2	150D154X9050A2	0.5	2
0.18	A	-	150D184X9050A2	0.5	2
0.22	A	150D224X0050A2	150D224X9050A2	0.5	2
0.27	A	-	150D274X9050A2	0.5	2
0.33	A	150D334X0050A2	150D334X9050A2	0.5	2
0.39	A	-	150D394X9050A2	0.5	2
0.47	A	150D474X0050A2	150D474X9050A2	0.5	2
0.56	A	-	150D564X9050A2	0.5	2
0.68	A	150D684X0050A2	150D684X9050A2	0.5	2
0.82	A	-	150D824X9050A2	0.5	2
1.0	A	150D105X0050A2	150D105X9050A2	0.5	2
1.2	B	-	150D125X9050B2	0.5	4
1.5	B	150D155X0050B2	150D155X9050B2	0.5	4
1.8	B	-	150D185X9050B2	0.5	4
2.2	B	150D225X0050B2	150D225X9050B2	1.0	4
2.7	B	-	150D275X9050B2	1.0	4
3.3	B	150D335X0050B2	150D335X9050B2	2.0	4
3.9	B	-	150D395X9050B2	2.0	4
4.7	B	150D475X0050B2	150D475X9050B2	3.0	4
5.6	R	-	150D565X9050R2	3.0	4
6.8	R	150D685X0050R2	150D685X9050R2	3.0	4
8.2	R	-	150D825X9050R2	3.0	4
10.0	R	150D106X0050R2	150D106X9050R2	3.0	4
12.0	R	-	150D126X9050R2	3.0	4
15.0	R	150D156X0050R2	150D156X9050R2	6.0	4
18.0	R	-	150D186X9050R2	6.0	4
22.0	S	150D226X0050S2	150D226X9050S2	6.0	4
60 WVDC AT + 85 °C, SURGE = 78 V … 40 WVDC AT +125 °C, SURGE = 49 V					
0.1	A	150D104X0060A2	150D104X9060A2	0.5	4.0
0.12	A	150D124X0060A2	150D124X9060A2	0.5	4.0
0.15	A	150D154X0060A2	150D154X9060A2	0.5	4.0
0.18	A	150D184X0060A2	150D184X9060A2	0.5	4.0
0.22	A	150D224X0060A2	150D224X9060A2	0.5	4.0
0.27	A	150D274X0060A2	150D274X9060A2	0.5	4.0
0.33	A	150D334X0060A2	150D334X9060A2	0.5	4.0
0.39	A	150D394X0060A2	150D394X9060A2	0.5	4.0
0.47	A	150D474X0060A2	150D474X9060A2	0.5	4.0
0.56	A	150D564X0060A2	150D564X9060A2	0.5	4.0
0.68	A	150D684X0060A2	150D684X9060A2	0.5	4.0
1.0	B	150D105X0060A2	150D105X9060A2	0.5	4.0
2.2	B	150D225X0060A2	150D225X9060A2	1.0	4.0
4.7	R	150D475X0060A2	150D475X9060A2	3.0	6.0
5.6	R	150D565X0060A2	150D565X9060A2	3.0	6.0
6.8	R	150D685X0060A2	150D685X9060A2	4.0	6.0
8.2	R	150D825X0060A2	150D825X9060A2	5.0	6.0
10	R	150D106X0060A2	150D106X9060A2	6.0	6.0
12	S	150D126X0060A2	150D126X9060A2	6.0	6.0
15	S	150D156X0060A2	150D156X9060A2	9.0	6.0
18	S	150D186X0060A2	150D186X9060A2	10.0	6.0
22	S	150D226X0060A2	150D226X9060A2	12.0	6.0

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
75 WVDC AT + 85 °C, SURGE = 98 V . . . 50 WVDC AT + 125 °C, SURGE = 64 V					
0.033	A	150D333X0075A2	150D333X9075A2	0.5	2
0.039	A	-	150D393X9075A2	0.5	2
0.047	A	150D473X0075A2	150D473X9075A2	0.5	2
0.056	A	-	150D563X9075A2	0.5	2
0.068	A	150D683X0075A2	150D683X9075A2	0.5	2
0.082	A	-	150D823X9075A2	0.5	2
0.10	A	150D104X0075A2	150D104X9075A2	0.5	2
0.12	A	-	150D124X9075A2	0.5	2
0.15	A	150D154X0075A2	150D154X9075A2	0.5	2
0.18	A	-	150D184X9075A2	0.5	2
0.22	A	150D224X0075A2	150D224X9075A2	0.5	2
0.27	A	-	150D274X9075A2	0.5	2
0.33	A	150D334X0075A2	150D334X9075A2	0.5	2
0.39	A	-	150D394X9075A2	0.5	2
0.47	A	150D474X0075A2	150D474X9075A2	0.5	2
0.56	A	-	150D564X9075A2	0.5	2
0.68	A	150D684X0075A2	150D684X9075A2	0.5	2
0.82	B	-	150D824X9075B2	0.5	2
1.0	B	150D105X0075B2	150D105X9075B2	0.5	2
1.2	B	-	150D125X9075B2	0.5	4
1.5	B	150D155X0075B2	150D155X9075B2	1.0	4
1.8	B	-	150D185X9075B2	1.0	4
2.2	B	150D225X0075B2	150D225X9075B2	1.0	4
2.7	B	-	150D275X9075B2	1.0	4
3.3	B	150D335X0075B2	150D335X9075B2	2.0	4
3.9	B	-	150D395X9075B2	2.0	4
4.7	R	150D475X0075R2	150D475X9075R2	4.0	4
5.6	R	-	150D565X9075R2	4.0	4
6.8	R	150D685X0075R2	150D685X9075R2	6.0	4
8.2	R	-	150D825X9075R2	6.0	4
10.0	R	150D106X0075R2	150D106X9075R2	8.0	4
12.0	S	-	150D126X9075S2	10.0	4
15.0	S	150D156X0075S2	150D156X9075S2	12.0	4
100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V					
0.033	A	150D333X0100A2	150D333X9100A2	0.5	2
0.039	A	-	150D393X9100A2	0.5	2
0.047	A	150D473X0100A2	150D473X9100A2	0.5	2
0.056	A	-	150D563X9100A2	0.5	2
0.068	A	150D683X0100A2	150D683X9100A2	0.5	2
0.082	A	-	150D823X9100A2	0.5	2
0.10	A	150D104X0100A2	150D104X9100A2	0.5	2
0.12	A	-	150D124X9100A2	0.5	2
0.15	A	150D154X0100A2	150D154X9100A2	0.5	2
0.18	A	-	150D184X9100A2	0.5	2
0.22	A	150D224X0100A2	150D224X9100A2	0.5	2
0.27	A	-	150D274X9100A2	0.5	2
0.33	A	150D334X0100A2	150D334X9100A2	0.5	2
0.39	A	-	150D394X9100A2	0.5	2
0.47	A	150D474X0100A2	150D474X9100A2	0.5	2
0.56	A	-	150D564X9100A2	0.5	2
0.68	B	150D684X0100B2	150D684X9100B2	0.5	2
0.82	B	-	150D824X9100B2	0.5	2

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order)

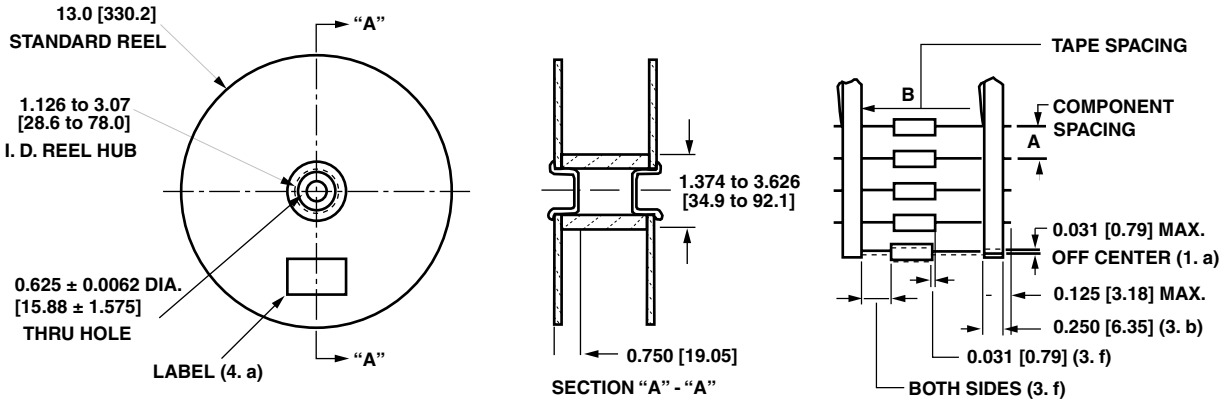
STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V					
1.0	B	150D105X0100B2	150D105X9100B2	0.5	2
1.2	B	-	150D125X9100B2	0.5	3
1.5	B	150D155X0100B2	150D155X9100B2	0.6	3
1.8	B	-	150D185X9100B2	0.6	3
2.2	B	150D225X0100B2	150D225X9100B2	0.6	3
2.7	B	-	150D275X9100B2	0.6	3
3.3	R	150D335X0100R2	150D335X9100R2	2.5	3
3.9	R	-	150D395X9100R2	3.0	3
4.7	R	150D475X0100R2	150D475X9100R2	4.0	3
5.6	R	-	150D565X9100R2	4.0	3
6.8	R	150D685X0100R2	150D685X9100R2	6.0	3
8.2	S	150D825X0100S2	150D825X9100S2	6.0	3
10	S	150D106X0100S2	150D106X9100S2	6.0	3
125 WVDC AT + 85 °C, SURGE = 140 V . . . 82 WVDC AT + 125 °C, SURGE = 94 V					
0.027	A	-	150D273X9125A2	1.0	2
0.033	A	150D333X0125A2	150D333X9125A2	1.0	2
0.039	A	-	150D393X9125A2	1.0	2
0.047	A	150D473X0125A2	150D473X9125A2	1.0	2
0.056	A	-	150D563X9125A2	1.0	2
0.068	A	150D683X0125A2	150D683X9125A2	1.0	2
0.082	A	-	150D823X9125A2	1.0	2
0.10	A	150D104X0125A2	150D104X9125A2	1.0	2
0.12	A	-	150D124X9125A2	1.0	2
0.15	A	150D154X0125A2	150D154X9125A2	1.0	2
0.18	A	-	150D184X9125A2	1.0	2
0.22	A	150D224X0125A2	150D224X9125A2	1.0	2
0.27	A	-	150D274X9125A2	1.0	2
0.33	A	150D334X0125A2	150D334X9125A2	1.0	2
0.39	A	-	150D394X9125A2	1.5	2
0.47	A	150D474X0125A2	150D474X9125A2	1.5	2
0.56	B	-	150D564X9125B2	1.6	2
0.68	B	150D684X0125B2	150D684X9125B2	1.8	2
0.82	B	-	150D824X9125B2	2.0	2
1.0	B	150D105X0125B2	150D105X9125B2	2.0	2
1.2	B	-	150D125X9125B2	2.0	3
1.5	B	150D155X0125B2	150D155X9125B2	2.0	3
1.8	B	-	150D185X9125B2	2.0	3
2.2	B	150D225X0125B2	150D225X9125B2	2.0	3

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order).

STANDARD REEL PACKAGING SPECIFICATIONS - MEETS EIA STANDARD RS-296 in inches [millimeters]



CASE CODE	TYPE 150D UNITS WITH INSULATING SLEEVE		LEAD SIZE		COMPONENT SPACING	TAPE SPACING	UNITS PER REEL
	D	L	AWG NO.	NOM. DIA.	A	B	
A	0.135 ± 0.016 [3.43 ± 0.41]	0.286 ± 0.031 [7.26 ± 0.79]	24	0.020 [0.51]	0.200 ± 0.015 [5.08 ± 0.38]	2.500 ± 0.062 [63.5 ± 1.57]	1000
B	0.185 ± 0.016 [4.70 ± 0.41]	0.474 ± 0.031 [12.04 ± 0.79]	24	0.020 [0.51]	0.200 ± 0.015 [5.08 ± 0.38]	2.500 ± 0.062 [63.5 ± 1.57]	1000
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ± 0.062 [73.03 ± 1.57]	500
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ±0.062 [73.03 ± 1.57]	500

STANDARD REEL PACKAGING INFORMATION

1. Component Leads:

a. Component leads shall not be bent beyond 0.047" [1.19 mm] maximum from their nominal position when measured from the leading edge of the component lead at the inside tape edge and at the lead egress from the component.

b. The "C" dimension shall be governed by the overall length of the reel packaged component. The distance between flanges shall be 0.125" to 0.250" [3.18 mm to 6.35 mm] greater than the overall component length.

2. Orientation:

All polarized components must be oriented to one direction. The cathode lead tape shall be a color and the anode lead tape shall be white.

3. Reeling:

a. Components on any reel shall not represent more than two date codes when date code identification is required.

b. Component leads shall be positioned between pairs of 0.250" [6.35 mm] tape.

c. The disposable reels have hubs and corrugated fibreboard flanges and core or equivalent.

d. A minimum of 12.0" [304.8 mm] leader of tape shall be provided before the first and after the last component on the reel.

e. 50 or 60 lb. Kraft paper must be wound between layer of components as far as necessary for component protection. Width of paper to be 0.062" to 0.250" [1.57 mm to 6.35 mm] less than the "C" dimension of the reel. Solid-Electrolyte TANTALEX® Capacitors Hermetically- Sealed, Axial-Lead.

f. A row of components must be centered between tapes ± 0.047" [1.19 mm]. In addition, individual components may deviate from center of component row ± 0.031" [0.79 mm].

g. Staples shall not be used for splicing. Not more than 4 layers of tape shall be used in any splice area and no tape shall be offset from another by more than 0.031" [0.79 mm] non-cumulative. Tape splices shall overlap at least 6.0" [152.4 mm] for butt joints and at least 3.0" [76.2 mm] for lap joints and shall not be weaker than unspliced tape. Universal splicing clips may also be used.

h. Quantity per reel shall be controlled so that tape components and cover shall not extend beyond the smallest dimension of the flange (either across flats or diameter). Once the quantity per reel for each part number has been established, future orders for that part number shall be packaged in that quantity. When order or release quantity is less than the established quantity, a standard commercial pack is to be used.

i. A maximum of 0.25 % of the components per reel quantity may be missing without consecutive missing components.

j. Adequate protection must be provided to prevent physical damage to both reel and components during shipment and storage.

4. Marking:

Minimum reel and carton marking shall consist of the following: Customer Part Number, Purchase Order No., Quantity, Package Date, Manufacturer's Name, Electrical Value, Date Code, Vishay Sprague Part Number and Country of Origin.

Solid-Electrolyte TANTALEX® Capacitors Extended Capacitance Values, Hermetically-Sealed

FEATURES

- Terminatons: Tin/lead (SnPb), 100 % Tin (RoHS compliant)
- High capacitance and small size
- Low leakage current and low dissipation factor
- Exceptional operating stability
- Hermetically-sealed, cylindrical, metal-case
- The military equivalent to the 152D is the CSR23 which is qualified to MIL-C-39003/03
- Provide proven reliability in a wide variety of high performance military, industrial and commercial markets

Pb Available

RoHS* COMPLIANT

PERFORMANCE CHARACTERISTICS

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

Capacitance Tolerance: At 120 Hz, + 25 °C ± 20 % and ± 10 % standard, ± 5 % available as special

Dissipation Factor: At 120 Hz, + 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 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 h or derated DC voltage applied at + 125 °C for 1000 h.

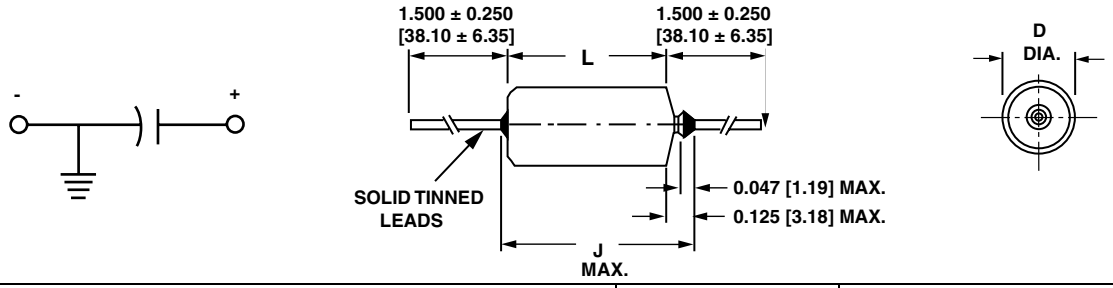
Following the life test:

1. DCL shall not exceed 125 % of the initial requirements. In no case need the leakage current be less than 2 µA.
2. Dissipation Factor shall meet the initial requirement
3. Change in capacitance shall not exceed ± 5 %

ORDERING INFORMATION

152D	106	X0	006	A	2	T	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	STYLE NUMBER	PACKAGING	ROHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 % X9 = ± 10 % *X5 = ± 5 % *Special Order	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating.	See Ratings and Case Codes Table.	2 = Insulated sleeve.	T = Tape and Reel	E3 = 100 % tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in inches [millimeters]



CASE CODE	WITH INSULATING SLEEVE (1)		J (MAXIMUM)	LEAD SIZE	
	D	L		AWG NO.	NOMINAL DIA.
A	0.135 ± 0.016 [3.43 ± 0.41]	0.286 ± 0.031 [7.26 ± 0.79]	0.422 [10.72]	24	0.020 [0.51]
B	0.185 ± 0.016 [4.70 ± 0.41]	0.474 ± 0.031 [12.04 ± 0.79]	0.610 [15.49]	24	0.020 [0.51]
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	0.822 [20.88]	22	0.025 [0.64]
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	0.922 [23.42]	22	0.025 [0.64]

Notes:

(1) When a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body

* Pb containing terminations are not RoHS compliant, exemptions may apply

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT+ 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V					
10	A	152D106X0006A2	152D106X9006A2	1.0	6
12	A	-	152D126X9006A2	1.0	6
15	A	152D156X0006A2	152D156X9006A2	1.0	6
68	B	152D686X0006B2	152D686X9006B2	3.0	6
82	B	-	152D826X9006B2	3.0	6
100	B	152D107X0006B2	152D107X9006B2	6.0	6
330	R	152D337X0006R2	152D337X9006R2	10.0	8
390	R	-	152D397X9006R2	10.0	8
470	R	152D477X0006R2	152D477X9006R2	10.0	8
560	S	-	152D567X9006S2	20.0	10
680	S	152D687X0006S2	152D687X9006S2	20.0	10
820	S	-	152D827X9006S2	20.0	10
1000	S	152D108X0006S2	152D108X9006S2	20.0	10
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V					
5.6	A	-	152D565X9010A2	1.0	4
6.8	A	152D685X0010A2	152D685X9010A2	1.0	6
8.2	A	-	152D825X9010A2	1.2	6
10	A	152D106X0010A2	152D106X9010A2	1.2	6
47	B	152D476X0010B2	152D476X9010B2	4.0	6
56	B	-	152D566X9010B2	5.0	6
68	B	152D686X0010B2	152D686X9010B2	6.0	6
82	B	-	152D826X9010B2	7.0	6
150	R	152D157X0010R2	152D157X9010R2	8.0	8
180	R	-	152D187X9010R2	8.0	8
220	R	152D227X0010R2	152D227X9010R2	12.0	8
270	R	-	152D277X9010R2	13.0	8
330	S	152D337X0010S2	152D337X9010S2	16.0	8
390	S	-	152D397X9010S2	16.0	10
470	S	152D477X0010S2	152D477X9010S2	16.0	10
560	S	-	152D567X9010S2	20.0	10
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V					
3.9	A	-	152D395X9015A2	1.0	4
4.7	A	152D475X0015A2	152D475X9015A2	1.0	4
5.6	A	-	152D565X9015A2	1.3	4
6.8	A	152D685X0015A2	152D685X9015A2	1.3	6
27	B	-	152D276X9015B2	3.0	6
33	B	152D336X0015B2	152D336X9015B2	5.0	6
39	B	-	152D396X9015B2	5.0	6
82	R	-	152D826X9015R2	8.0	6
100	R	152D107X0015R2	152D107X9015R2	10.0	8
120	R	-	152D127X9015R2	10.0	8
150	R	152D157X0015R2	152D157X9015R2	15.0	8
180	R	-	152D187X9015R2	15.0	8
220	S	152D227X0015S2	152D227X9015S2	20.0	8
270	S	-	152D277X9015S2	20.0	8
330	S	152D337X0015S2	152D337X9015S2	20.0	8

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order).

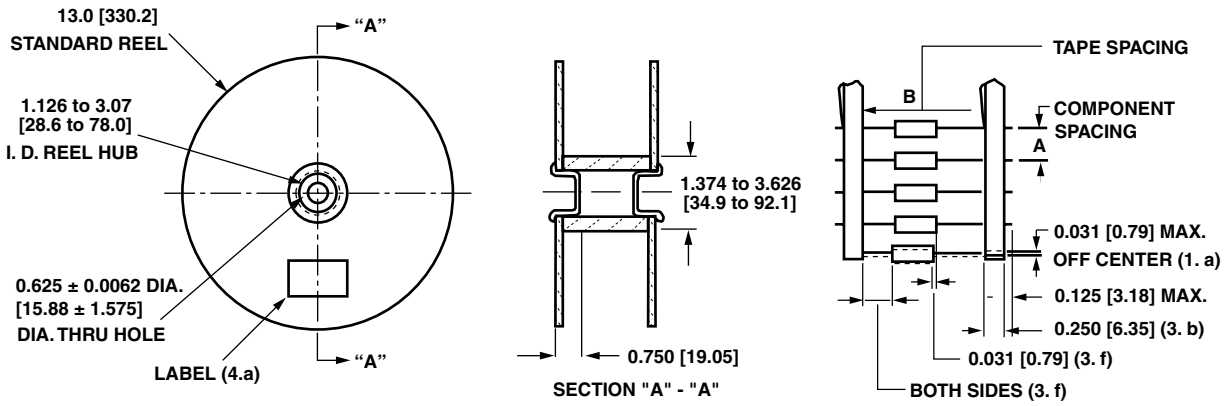
STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL AT + 25 °C (µA)	Max. DF AT + 25 °C 120 Hz (%)
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V					
2.7	A	-	152D275X9020A2	0.8	4
3.3	A	152D335X0020A2	152D335X9020A2	1.0	4
3.9	A	-	152D395X9020A2	1.2	4
4.7	A	152D475X0020A2	152D475X9020A2	1.2	4
18	B	-	152D186X9020B2	3.0	4
22	B	152D226X0020B2	152D226X9020B2	3.0	4
27	B	-	152D276X9020B2	4.0	4
56	R	-	152D566X9020R2	7.0	6
68	R	152D686X0020R2	152D686X9020R2	8.0	6
82	R	-	152D826X9020R2	10.0	6
100	R	152D107X0020R2	152D107X9020R2	12.0	6
120	R	-	152D127X9020R2	12.0	6
150	S	152D157X0020S2	152D157X9020S2	15.0	8
180	S	-	152D187X9020S2	15.0	8
220	S	152D227X0020S2	152D227X9020S2	15.0	8
30 WVDC AT + 85 °C, SURGE = 39 V . . . 20 WVDC AT + 125 °C, SURGE = 26 V					
2.2	A	152D225X0030A2	152D225X9030A2	1.0	4
2.7	A	-	152D275X9030A2	1.0	4
12	B	-	152D126X9030B2	3.0	4
15	B	152D156X0030B2	152D156X9030B2	3.0	4
18	B	-	152D186X9030B2	3.0	4
56	R	-	152D566X9030R2	7.0	6
68	R	152D686X0030R2	152D686X9030R2	7.0	6
82	S	-	152D826X9030S2	10.0	8
100	S	152D107X0030S2	152D107X9030S2	10.0	8
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V					
1.2	A	-	152D125X9035A2	0.6	4
1.5	A	152D155X0035A2	152D155X9035A2	0.8	4
1.8	A	-	152D185X9035A2	1.0	4
8.2	B	-	152D825X9035B2	3.0	4
10	B	152D106X0035B2	152D106X9035B2	3.0	4
27	R	-	152D276X9035R2	7.0	6
33	R	152D336X0035R2	152D336X9035R2	8.0	6
39	R	-	152D396X9035R2	10.0	6
47	R	152D476X0035R2	152D476X9035R2	10.0	6
56	S	-	152D566X9035S2	12.0	6
68	S	152D686X0035S2	152D686X9035S2	12.0	6
82	S	-	152D826X9035S2	30.0	8
100	S	152D107X0035S2	152D107X9035S2	30.0	8
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V					
1.2	A	-	152D125X9050A2	0.6	4
1.5	A	152D155X0050A2	152D155X9050A2	0.8	4
5.6	B	-	152D565X9050B2	2.5	4
6.8	B	152D685X0050B2	152D685X9050B2	2.5	4
22	R	152D226X0050R2	152D226X9050R2	7.0	6
27	R	-	152D276X9050R2	8.0	6
33	S	152D336X0050S2	152D336X9050S2	10.0	6
39	S	-	152D396X9050S2	10.0	6
47	S	152D476X0050S2	152D476X9050S2	10.0	6
60 WVDC AT + 85 °C, SURGE = 78 V . . . 39 WVDC AT + 125 °C, SURGE = 49 V					
22	R	152D226X0060R2	-	7	6

Note:

(1) Insert capacitance tolerance code “X5” for ± 5 % units (special order).

STANDARD REEL PACKAGING SPECIFICATIONS - MEETS EIA STANDARD RS-296 in inches [millimeters]



CASE CODE	TYPE 152D UNITS WITH INSULATING SLEEVE		J (MAX.)	LEAD SIZE		COMPONENT SPACING	TAPE SPACING	UNITS PER REEL
	D	L		AWG NO.	NOM. DIA.	A	B	
A	0.135 ± 0.016 [3.43 ± 0.41]	0.286 ± 0.031 [7.26 ± 0.79]	0.422 [10.72]	24	0.020 [0.51]	0.200 ± 0.015 [5.08 ± 0.38]	2.500 ± 0.062 [63.5 ± 1.57]	1000
B	0.185 ± 0.016 [4.70 ± 0.41]	0.474 ± 0.031 [12.04 ± 0.79]	0.610 [15.49]	24	0.020 [0.51]	0.200 ± 0.015 [5.08 ± 0.38]	2.500 ± 0.062 [63.5 ± 1.57]	1000
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	0.822 [20.88]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ± 0.062 [73.03 ± 1.57]	500
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	0.922 [23.42]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ±0.062 [73.03 ± 1.57]	500

STANDARD REEL PACKAGING INFORMATION

1. **Component Leads:**

a. Component leads shall not be bent beyond 0.047" [1.19 mm] maximum from their nominal position when measured from the leading edge of the component lead at the lead egress from the component.

b. The "C" dimension shall be governed by the overall length of the reel packaged component. The distance between flanges shall be 0.125" to 0.250" [3.18 mm to 6.35 mm] greater than the overall component length.

2. Orientation:

a. All polarized components must be oriented to one direction. The cathode lead tape shall be a color and the anode lead tape shall be white.

3. Reeling:

a. Components on any reel shall not represent more than two date codes when date code identification is required.

b. Component leads shall be positioned between pairs of 0.250" [6.35 mm] tape.

c. The disposable reels have hubs and corrugated fibreboard flanges and core or equivalent.

d. A minimum of 12" [304.8 mm] leader of tape shall be provided before the first and after the last component on the reel.

e. 50 or 60 lb. Kraft paper must be wound between layer of components as far as necessary for component protection. Width of paper to be 0.062" to 0.250" [1.57 mm to 6.35 mm] less than the "C" dimension of the reel.

f. A row of components must be centered between tapes ± 0.047" [1.19 mm]. In addition, individual components may deviate from center of component row ± 0.031" [0.79 mm].

g. Staples shall not be used for splicing. Not more than 4 layers of tape shall be used in any splice area and no tape shall be offset from another by more than 0.031" [0.79 mm] non-cumulative. Tape splices shall overlap at least 6" [152.4 mm] for butt joints and at least 3"[76.2 mm] for lap joints and shall not be weaker than unspliced tape. Universal splicing clips may also be used.

h. Quantity per reel shall be controlled so that tape components and cover shall not extend beyond the smallest dimension of the flange (either across flats or diameter). Once the quantity per reel for each part number has been established, future orders for that part number shall be packaged in that quantity. When order or release quantity is less than the established quantity, a standard commercial pack is to be used.

i. A maximum of 0.25 % of the components per reel quantity may be missing without consecutive missing components.

j. Adequate protection must be provided to prevent physical damage to both reel and components during shipment and storage.

4. Marking:

Minimum reel and carton marking shall consist of the following: Customer Part Number, Purchase Order No., Quantity, Package Date, Manufacturer's Name, Electrical Value, Date Code, Vishay Sprague Part Number and Country of Origin.

Solid-Electrolyte TANTALEX® Capacitors for High Frequency Power Supplies

FEATURES

- Terminatons: Tin/lead (SnPb), 100 % Tin (RoHS compliant)
- Hermetically-sealed, axial-lead solid tantalum capacitors
- Small size and long life
- Exceptional capacitance stability and excellent resistance to severe environmental conditions
- The military equivalent is the CSR21 which is qualified to MIL-C-39003/09

Pb Available

RoHS* COMPLIANT

APPLICATIONS

Designed for power supply filtering applications at above 100 kHz

PERFORMANCE CHARACTERISTICS

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

Capacitance Tolerance: At 120 Hz, + 25 °C. ± 20 %, ± 10 % standard. ± 5 % available as special

Dissipation Factor: At 120 Hz, + 25 °C. Dissipation factor, as determined from the expression 2πRC, 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 he 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 shall not exceed 15 times the values listed in the Standard Ratings Tables.

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

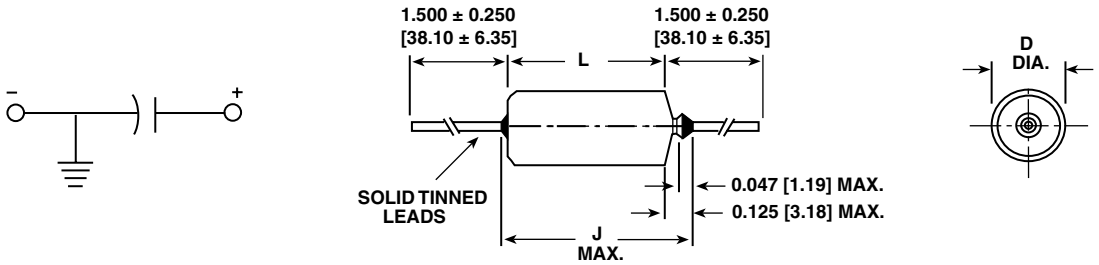
Following the life test:

1. DCL shall not exceed 125 % of the initial requirements.
2. Dissipation Factor shall meet the initial requirement.
3. Change in capacitance shall not exceed ± 5 %

ORDERING INFORMATION

550D	157	X0	006	R	2	T	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	STYLE NUMBER	PACKAGING	ROHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow. Standard capacitance ratings are in accordance with EIA preferred number series wherever possible.	X0 = ± 20 % X9 = ± 10 % X5 = ± 5 % * Special order	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating.	See Ratings and Case Codes Table.	2 = Insulated sleeve	T = Tape and Reel	E3 = 100 % tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in inches [millimeters]



CASE CODE	WITH INSULATING SLEEVE (1)		J (MAX.)	LEAD SIZE	
	D	L		AWG NO.	NOMINAL DIA.
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	0.822 [20.880]	22	0.025 [0.64]
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	0.922 [23.420]	22	0.025 [0.64]

Notes:

(1) When a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body

* Pb containing terminations are not RoHS compliant, exemptions may apply

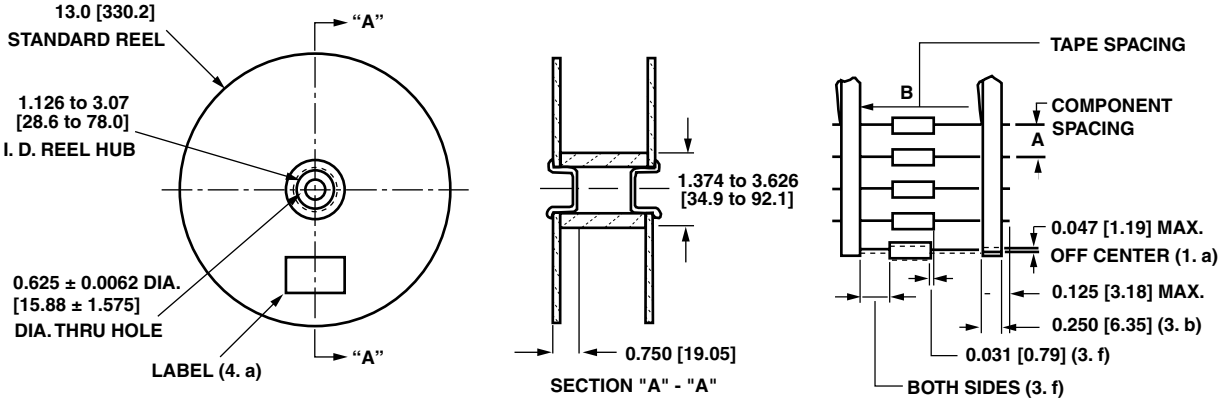
STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	Max. DCL at + 25 °C (µA)	Max. DF at + 25 °C 120 Hz (%)	Max. ESR at + 25 °C 100 kHz (Ω)
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V						
150	R	550D157X0006R2	550D157X9006R2	9	10	0.065
180	R	550D187X0006R2	550D187X9006R2	11	10	0.060
220	S	550D227X0006S2	550D227X9006S2	12	10	0.055
270	S	550D277X0006S2	550D277X9006S2	13	10	0.050
330	S	550D337X0006S2	550D337X9006S2	15	12	0.045
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V						
82	R	550D826X0010R2	550D826X9010R2	8	8	0.085
100	R	550D107X0010R2	550D107X9010R2	10	8	0.075
120	R	550D127X0010R2	550D127X9010R2	12	8	0.070
150	S	550D157X0010S2	550D157X9010S2	15	8	0.065
180	S	550D187X0010S2	550D187X9010S2	18	8	0.060
220	S	550D227X0010S2	550D227X9010S2	20	10	0.055
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V						
56	R	550D566X0015R2	550D566X9015R2	8	6	0.100
68	R	550D686X0015R2	550D686X9015R2	10	6	0.095
82	S	550D826X0015S2	550D826X9015S2	12	6	0.085
100	S	550D107X0015S2	550D107X9015S2	15	8	0.075
120	S	550D127X0015S2	550D127X9015S2	18	8	0.070
150	S	550D157X0015S2	550D157X9015S2	20	8	0.065
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V						
27	R	550D276X0020R2	550D276X9020R2	5	5	0.145
33	R	550D336X0020R2	550D336X9020R2	7	5	0.130
39	R	550D396X0020R2	550D396X9020R2	8	5	0.120
47	R	550D476X0020R2	550D476X9020R2	9	6	0.110
56	S	550D566X0020S2	550D566X9020S2	11	6	0.100
68	S	550D686X0020S2	550D686X9020S2	14	6	0.095
82	S	550D826X0020S2	550D826X9020S2	16	6	0.085
100	S	550D107X0020S2	550D107X9020S2	20	8	0.075
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V						
8.2	R	550D825X0035R2	550D825X9035R2	3	4	0.250
10	R	550D106X0035R2	550D106X9035R2	4	4	0.230
12	R	550D126X0035R2	550D126X9035R2	4	4	0.210
15	R	550D156X0035R2	550D156X9035R2	5	4	0.190
18	R	550D186X0035R2	550D186X9035R2	6	4	0.175
22	R	550D226X0035R2	550D226X9035R2	8	4	0.160
27	S	550D276X0035S2	550D276X9035S2	9	4	0.145
33	S	550D336X0035S2	550D336X9035S2	11	5	0.130
39	S	550D396X0035S2	550D396X9035S2	14	5	0.120
47	S	550D476X0035S2	550D476X9035S2	16	5	0.110
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V						
5.6	R	550D565X0050R2	550D565X9050R2	4	3	0.300
6.8	R	550D685X0050R2	550D685X9050R2	4	3	0.275
8.2	R	550D825X0050R2	550D825X9050R2	5	3	0.250
10.0	R	550D106X0050R2	550D106X9050R2	5	3	0.230
12.0	R	550D126X0050R2	550D126X9050R2	6	3	0.210
15.0	R	550D156X0050R2	550D156X9050R2	8	3	0.190
18.0	R	550D186X0050R2	550D186X9050R2	9	4	0.175
22.0	S	550D226X0050S2	550D226X9050S2	11	4	0.160

Note:

(1) Insert capacitance tolerance code “X5”; for ± 5 % units (special order).

TAPE AND REEL PACKAGING in inches [millimeters]



CASE CODE	TYPE 550D UNITS WITH INSULATING SLEEVE		J (MAX.)	LEAD SIZE		COMPONENT SPACING	TAPE SPACING	UNITS PER REEL
	D	L		AWG NO.	NOM. DIA.	A	B	
R	0.289 ± 0.016 [7.34 ± 0.41]	0.686 ± 0.031 [17.42 ± 0.79]	0.822 [20.88]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ± 0.062 [73.03 ± 1.57]	500
S	0.351 ± 0.016 [8.92 ± 0.41]	0.786 ± 0.031 [19.96 ± 0.79]	0.922 [23.42]	22	0.025 [0.64]	0.400 ± 0.015 [10.16 ± 0.38]	2.875 ±0.062 [73.03 ± 1.57]	500

STANDARD REEL PACKAGING INFORMATION

1. **Component Leads:**

a. Component leads shall not be bent beyond 0.047" [1.19 mm] maximum from their nominal position when measured from the leading edge of the component lead at the inside tape edge and at the lead egress from the component.

b. The "C" dimension shall be governed by the overall length of the reel packaged component. The distance between flanges shall be 0.125" to 0.250" [3.18 mm to 6.35 mm] greater than the overall component length.

2. Orientation:

a. All polarized components must be oriented to one direction. The cathode lead tape shall be a color and the anode lead tape shall be white.

3. Reeling:

a. Components on any reel shall not represent more than two date codes when date code identification is required.

b. Component leads shall be positioned between pairs of 0.250" [6.35 mm] tape.

c. The disposable reels have hubs with corrugated fibreboard flanges and core or equivalent.

d. A minimum of 12" [304.8 mm] leader of tape shall be provided before the first and after the last component on the reel.

e. 50 or 60 lb. Kraft paper must be wound between layer of components as far as necessary for component protection. Width of paper to be 0.062" to 0.250" [1.57 mm to 6.35 mm] less than the "C" dimension of the reel.

f. A row of components must be centered between tapes ± 0.047" [1.19 mm]. In addition, individual components may deviate from center of component row ± 0.031" [0.79 mm].

g. Staples shall not be used for splicing. Not more than 4 layers of tape shall be used in any splice area and no tape shall be offset from another by more than 0.031" [0.79 mm] non-cumulative. Tape splices shall overlap at least 6" [152.4 mm] for butt joints and at least 3" [76.2 mm] for lap joints and shall not be weaker than unspliced tape. Universal splicing clips may also be used.

h. Quantity per reel shall be controlled so that tape components and cover shall not extend beyond the smallest dimension of the flange (either across flats or diameter). Once the quantity per reel for each part number has been established, future orders for that part number shall be packaged in that quantity. When order or release quantity is less than the established quantity, a standard commercial pack is to be used.

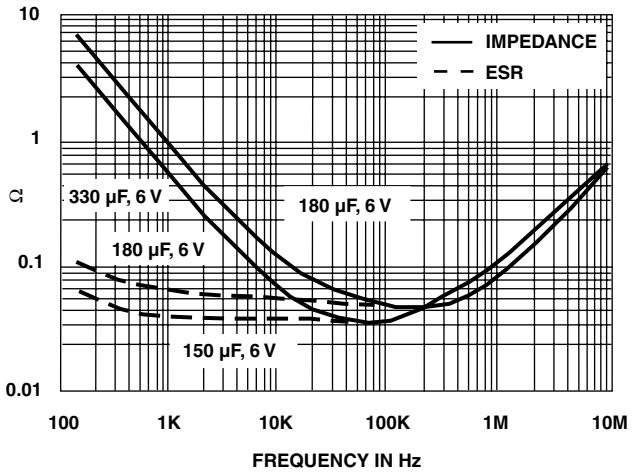
i. A maximum of 0.25 % of the components per reel quantity may be missing without consecutive missing components.

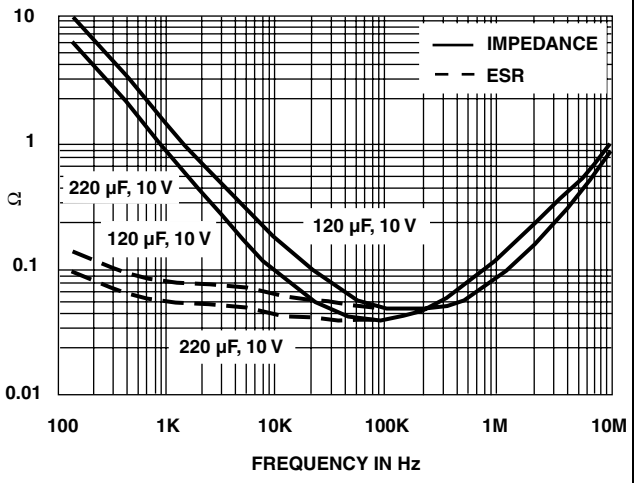
j. Adequate protection must be provided to prevent physical damage to both reel and components during shipment and storage.

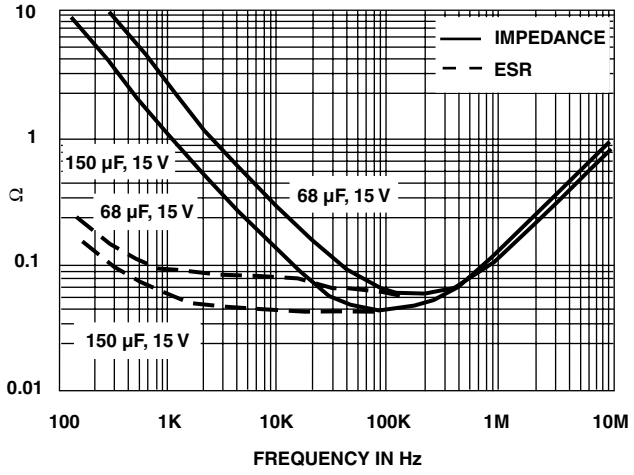
4. **Marking:**

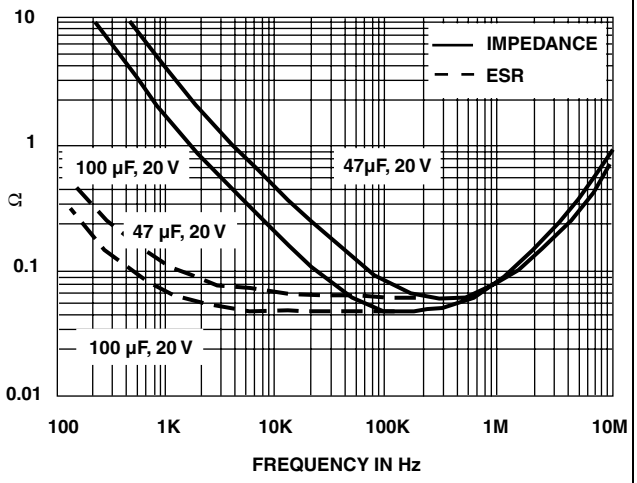
a. Minimum reel and carton marking shall consist of the following: Customer Part Number, Purchase Order No., Quantity, Package Date, Manufacturer's name, Electrical Value, Date Code, Vishay Sprague Part Number and Country of Origin.

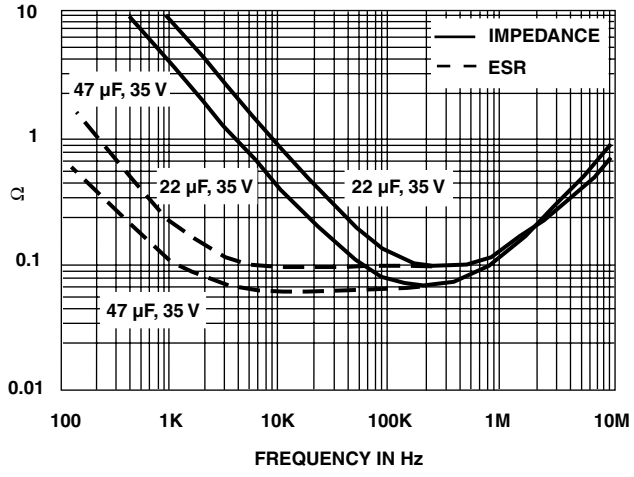
TYPICAL CURVES AT + 25 °C, IMPEDANCE AND ESR VS. FREQUENCY

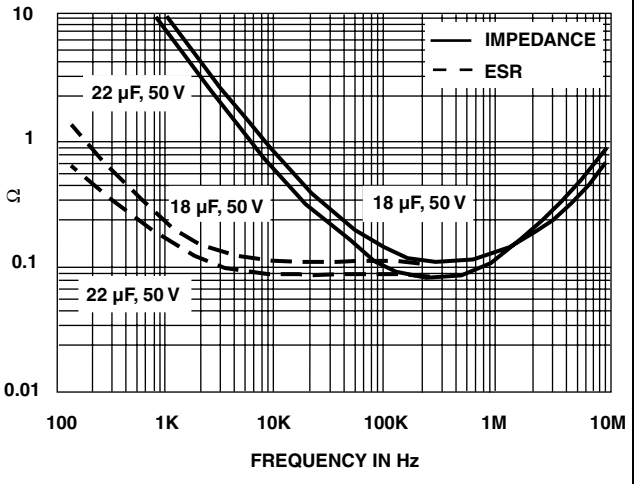












PERFORMANCE CHARACTERISTICS

- **Operating Temperature:** Capacitors are designed to operate over the temperature range of - 55 °C to + 85 °C with no derating.
- Capacitors may be operated up 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)
6	8	4	5
10	13	7	9
15	20	10	12
20	26	13	16
35	46	23	28
50	65	33	40

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 Ω ± 5 % resistor at the rate of 1.5 min on, 1.5 min off at + 85 °C, for 1000 successive test cycles.

3.2 Following the surge voltage test, the dissipation factor 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 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 measurement shall be 2 V_{rms} at 1000 Hz at + 25 °C. If the AC voltage applied is less than one-half volt rms, no DC bias is required. Measurement 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 %

- 55 °C	+ 85 °C	+ 125 °C
- 10 %	+ 8 %	+ 12 %

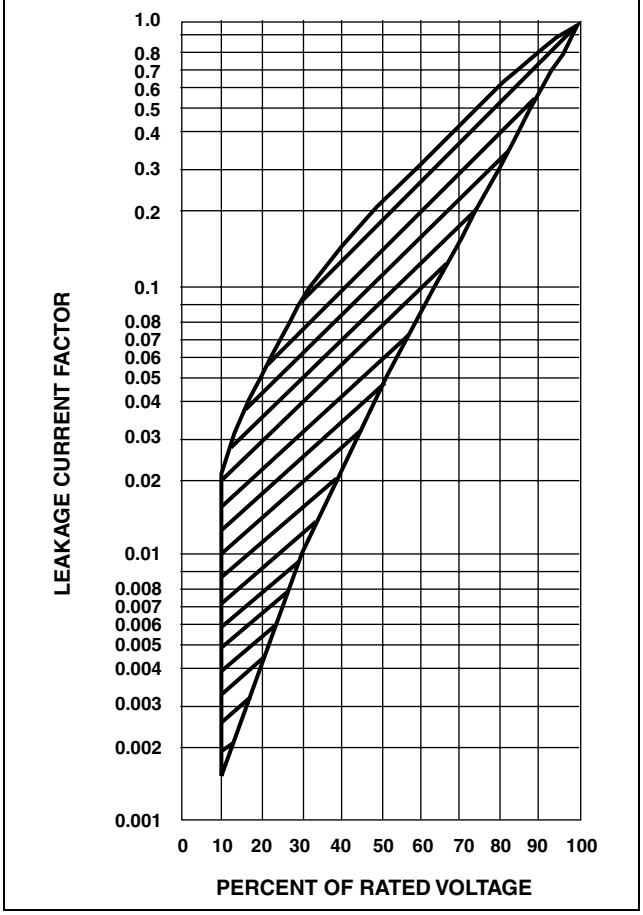
6. **Dissipation Factor:** The dissipation factor, determined from the expression 2πfRC, shall not exceed values listed in the Standard Ratings Table.

6.1 Measurements shall be made by the bridge method at, or referred to, a frequency of 1000 Hz and a temperature of + 25 °C.

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

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

TYPICAL LEAKAGE CURRENT FACTOR RANGE AT + 25 °C



PERFORMANCE CHARACTERISTICS (Continued)

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 15 times the value listed in the Standard Ratings Table.

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

8.1 Following the life test, the dissipation factor shall meet the initial requirement; the capacitance change shall not exceed ± 2 %; the leakage current shall not exceed 125 % of the original requirement.

9. **Shelf Test:** Capacitors shall withstand a shelf test for 5000 h at a temperature of + 85 °C, with no voltage applied.

9.1 Following the shelf test, the leakage current shall meet the initial requirement; the dissipation factor shall not exceed 150 % of the initial requirement; the capacitance change shall not exceed ± 5 %.

10 **Vibration Tests:** Capacitors shall be subjected to vibration tests in accordance with the following criteria.

10.1 Capacitors shall be secured for test by means of a rigid mounting using suitable brackets.

10.2 **Low Frequency Vibration:** Vibration shall consist of a simple harmonic motion having an amplitude of 0.03" [0.76] and a maximum total excursion of 0.06" [1.52], in a direction perpendicular to the major axis of the capacitor.

10.2.1 Vibration frequency shall be varied uniformly between the approximate limits of 10 Hz to 55 Hz during a period of approximately one minute, continuously for 1 and 1.5 h.

10.2.2 A cathode ray oscilloscope or other comparable means shall be used in determining electrical intermittency during the final 30 minutes of the test. The AC voltage applied shall not exceed 2 volts rms.

10.2.3 Electrical tests shall show no evidence of intermittent contacts, open circuits or short circuits during these tests.

10.2.4 Following the low frequency vibration test, capacitors shall meet the original requirements for leakage current and dissipation factor; capacitance change shall not exceed ± 5 % of the original measured value.

10.3 **High Frequency Vibration:** Vibration shall consist of a simple harmonic motion having an amplitude of 0.06" [1.52] ± 10 % maximum total excursion or 20 g peak, whichever is less.

10.3.1 Vibration Frequency shall be varied logarithmically from 50 Hz to 2000 Hz and return to 50 Hz during a cycle period of 20 minutes.

10.3.2 The vibration shall be applied for 4 h in each of 2 directions, parallel and perpendicular to the major axis of the capacitors.

10.3.3 Rated DC voltage shall be applied during the vibration cycling.

10.3.4 A cathode ray oscilloscope or other comparable means shall be used in determining electrical intermittency during test. The AC voltage applied shall not exceed 2 V_{rms}.

10.3.5 Electrical tests shall show no evidence of intermittent contacts, open circuits or short circuits during these tests.

10.3.6 There shall be no mechanical damage to these capacitors as a result of these tests.

10.3.7 Following the high frequency vibration test, capacitors shall meet the original limits for capacitance, dissipation factor and leakage current.

11. **Acceleration Test:**

11.1 Capacitors shall be rigidly mounted by means of suitable brackets.

11.2 Capacitors shall be subjected to a constant acceleration of 100 g for a period of 10 s in each of 2 mutually perpendicular planes.

11.2.1 The direction of motion shall be parallel to and perpendicular to the cylindrical axis of the capacitors.

11.3 Rated DC voltage shall be applied during acceleration test.

11.3.1 A cathode ray oscilloscope or other comparable means shall be used in determining electrical intermittency during test. The AC voltage applied shall not exceed 2 V_{rms}.

11.4 Electrical tests shall show no evidence of intermittent contacts, open circuits or short circuits during these tests.

11.5 There shall be no mechanical damage to these capacitors as a result of these tests.

11.6 Following the acceleration test, capacitors shall meet the original limits for capacitance, dissipation factor and leakage current.

12. **Shock Test:**

12.1 Capacitors shall be rigidly mounted by means of suitable brackets. The test load shall be distributed uniformly on the test platform to minimize the effects of unbalanced loads.

PERFORMANCE CHARACTERISTICS (Continued)

12.1.1 Test equipment shall be adjusted to produce a shock of 100 g peak with a duration of 6 ms and a sawtooth waveform at a velocity change of 9.7 ft./s.

12.2 Capacitors shall be subjected to 3 shocks applied in each of 3 directions corresponding to the 3 mutually perpendicular axes of the capacitors.

12.3 Rated DC voltage shall be applied to capacitors during test.

12.3.1 A cathode ray oscilloscope or other comparable means shall be used in determining electrical intermittency during test. The AC voltage applied shall not exceed 2 V_{rms}.

12.4 Electrical tests shall show no evidence of intermittent contacts, open circuits or short circuits during these tests.

12.5 There shall be no mechanical damage to these capacitors as a result of these tests.

12.6 Following the shock test, capacitors shall meet the original limits for capacitance, dissipation factor and leakage current.

13. **Moisture Resistance:**

13.1 Capacitors shall be subjected to temperature cycling at 90 % to 98 % relative humidity, in a test chamber constructed of non-reactive materials (non-resiniferous and containing no formaldehyde or phenol). Steam or distilled, demineralized or deionized water having a pH value between 6.0 and 7.2 at + 23 °C shall be used to obtain the required humidity. No rust, corrosive contaminants or dripping condensate shall be imposed on test specimens.

13.1.1 Capacitors shall be mounted by their normal mounting means in a normal mounting position and placed in a test chamber so that uniform and thorough exposure is obtained.

13.1.2 No conditioning or initial measurements will be performed prior to temperature cycling. Polarization and load voltages are not applicable.

13.1.3 Capacitors shall be subjected to temperature cycling from + 25 °C to + 65 °C to + 25 °C (+ 10 °C, - 2 °C) over a period of 8 h, at 90 % to 98 % relative humidity, for 20 cycles.

13.1.4 Temperature cycling shall be stopped after an even number of cycles 5 times during the first 18 cycles, and the capacitor shall be alloweed to stabilize at high humidity for 1 to 4 h.

13.1.5 After stabilization, capacitors shall be removed from the humidity chamber and shall be conditioned for 3 h at - 10 °C ± 2 °C.

13.1.6 After cold conditioning, capacitors shall be subjected to vibration cycling consisting of a simple harmonic vibration having an amplitude of 0.03" [0.76] and a maximum total excursion of 0.06" [1.52] varied uniformly from 10 Hz to 55 Hz to 10 Hz over a period of 1 min, for 15 cycles.

13.1.7 Capacitors shall then be returned to temperature/ humidity cycling.

13.2 After completion of temperature cycling, capacitors shall be removed from the test chamber and stabilized at room temperature for 2 to 6 h.

13.3 Capacitors shall show no evidence of harmful or extensive corrosion, obliteration or marking or other visible damage.

13.4 Following the moisture resistance test, capacitors shall meet the original limits for capacitance, dissipation factor and leakage current.

14. **Insulating Sleeves:**

14.1 Capacitors with insulating sleeves shall withstand a 2000 V_{DC} potential applied for 1 min between the case and a metal “V” block in intimate contact with the insulating sleeve.

14.2 Capacitors with insulating sleeves shall have the insulation resistance measured between the case and a metal “V” block in intimate contact with the insulating sleeve. The insulation resistance shall be at least 1000 MΩ

15. **Thermal Shock And Immersion Cycling:**

15.1 Capacitors shall be conditioned prior to temperature cycling for 15 min at + 25 °C, at less than 50 % relative humidity and a barometric pressure at 28 to 31".

15.2 Capacitors shall be subjected to thermal shock in a cycle of exposure to ambient air at
- 65 °C (+ 0 °C, - 5 °C) for 30 min, then,
+ 25 °C (+ 10 °C, - 5 °C) for 5 min, then
+ 125 °C (+ 3 °C, - 0 °C) for 30 min, then
+ 25 °C (+ 10 °C, - 5 °C) for 5 min, for 5 cycles.

15.3 Between 4 and 24 h after temperature cycling, capacitors shall be subjected to immersion in a bath of fresh tap water with the non-corrosive dye Rhodamine B added, at + 65 °C (+ 5 °C, - 0 °C) for 15 min, then, within 3 s, immersed in a saturated solution of sodium chloride and water with Rhodamine B added, at a temperature of + 25 °C (+ 10 °C, - 5 °C) for 15 min, for 2 cycles.

15.3.1 Capacitors shall be thoroughly rinsed and wiped or air-blasted dry immediately upon removal from immersion cycling.

15.4 Capacitors shall show no evidence of harmful or extensive corrosion, obliteration of marking or other visible damage.

PERFORMANCE CHARACTERISTICS (Continued)

15.5 Following the thermal shock immersion cycling test, capacitors shall meet the original requirements for leakage current and dissipation factor; capacitance change shall not exceed ± 5 % of the original measured value.

15.6 Capacitors shall be opened and examined. There shall be no evidence of dye penetration.

16. **Reduced Pressure Test:**

16.1 Capacitors shall be stabilized at a reduced pressure of 0.315" [8.0] of mercury, equivalent to an altitude of 100 000 feet [30.480 m], for a period of 5 min.

16.2 Rated DC voltage shall be applied for 1 min.

16.3 Capacitors shall not flash over nor shall end seals be damaged.

16.4 Following the reduced pressure test, the capacitance, equivalent series resistance and leakage current shall meet the original requirements.

17. **Lead Pull Test:** Leads shall withstand a tensile stress of 3 pounds (1.4 kg) applied in any direction for 30 s.

18. **Marking:** Capacitors shall be marked with Sprague or (2); the type number 550D; rated capacitance and tolerance, rated DC working voltage and the standard EIA date code.

18.1 Capacitors shall be marked on one end with a plus sign (+) to identify the positive terminal.

18.2 Vishay Sprague reserves the right to furnish capacitors of higher working voltages than those ordered, where the physical size of the higher voltage units is identical to that of the units ordered.

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 W at + 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 W at + 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 15 % 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 15 % of the DC rating at + 25 °C, 10 % of the DC rating at + 55 °C; 5 % of the DC rating at + 85 °C.

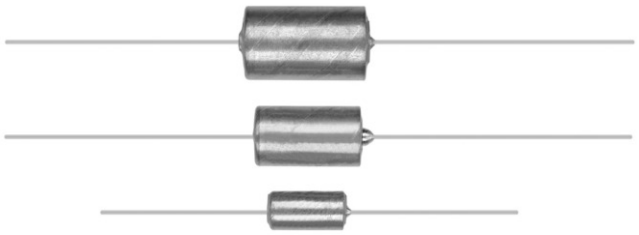
4. **Temperature Derating:** If these capacitors are to be operated at temperatures above + 25 °C, the permissible rms ripple current or voltage shall be calculated using the derating factors as shown:

Temperature	Derating Factor
+ 25 °C	1.0
+ 55 °C	0.8
+ 85 °C	0.6
+ 125 °C	0.4

5. **Power Dissipation:** The figures shown relate to an approximate + 20 °C rise in case temperature measured in free air. 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 permissable operating levels.

Case Code	Maximum Permissible Power Dissipation at + 25 °C (W in free air)
R	0.185
S	0.225

Solid-Electrolyte TANTALEX® Capacitors, Military MIL-PRF-39003 Qualified, Styles CSR13, 21, 23



FEATURES

- Hermetically sealed
- Metal cased
- Axial lead
- Tubular

STYLE, DOCUMENT/DETAIL SPEC.

Style CSR13, M39003/01

Style CSR23, M39003/03

Style CSR21, M39003/09

Solid-Electrolyte TANTALEX® Capacitors to Military Specification MIL-PRF-39003 - Exponential and Weibull Distribution: Hermetically sealed, metal cased, axial leaded tubular capacitors manufactured as Military Styles CSR13, CSR21 and CSR23. These capacitors are furnished to the requirements of the military specification, including marking, testing and inspection.

In accordance with the specification, all capacitors are marked with the Military Part Number (M39003/xx-xxxx) rather than the older Style designation (CSRxxxxxxxx) and should be ordered as such. All capacitors covered by MIL-PRF-39003 are now ordered with the Military Part Number as illustrated in the Part Numbering System chart. Capacitors must not be ordered using the Style number identification.

MIL-PRF-39003 establishes failure rates (expressed in percent per 1000 h) based on exponential and Weibull distribution. Care must be exercised in ordering to insure the part number correctly identifies the desired failure rate level.

Exponential failure rates are identified as levels M, P, R and S; Weibull failure rates are B, C and D. Failure rate levels M, P, R and S are inactive for new designs.

In addition, each order for Military Style CSR13, CSR23 capacitors requiring government inspection must state whether inspection is to be at the destination or at the Vishay Sprague Plant. Orders requiring source inspection cannot be shipped until this has been accomplished.

Style CS13 capacitors previously shown in MIL-C-26655 are directly replaced by Style CSR13 and Style CSR23 capacitors are extended capacitance range versions of Military Style CSR13.

For information on the performance characteristics of these capacitors, please refer to the latest issue of the military specification.

MILITARY SPECIFICATION MIL-PRF-39003 PART NUMBERING SYSTEM INFORMATION

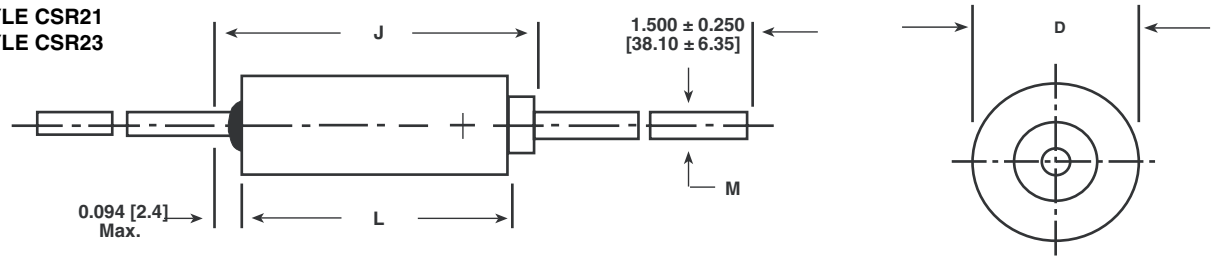
M39003	/01	-2254	A (1)
BASIC DOCUMENT NUMBER	DETAIL SPECIFICATION	DASH NUMBER	SURGE CURRENT OPTION CODE
Indicates the Basic Specification; in this case MIL-PRF-39003	Indicates the Detail Specification of the Basic Military Specification	Taken from Standard/ Extended Ratings Tables	Blank = Standard (no surge current) A = + 25 °C, after Weibull B = - 55 °C and + 85 °C, before Weibull C = - 55 °C and + 85 °C, before Weibull D = + 25 °C, after Weibull, High Temperature solder E = - 55 °C and + 85 °C, after Weibull, High Temperature solder F = - 55 °C and + 85 °C, after Weibull, High Temperature solder H = High Temperature solder only (no surge)

Note:

(1) The material in this section has been abstracted from MIL-PRF-39003. If questions about optional surge current testing or high temperature solder, please see MIL-PRF-39003, paragraph 1.2, table II.

DIMENSIONS in inches [millimeters]

STYLE CSR13
STYLE CSR21
STYLE CSR23



CASE CODE	L ± 0.031 [0.79]	D + 0.016 [0.41] - 0.015 [0.38]	M ± 0.002 [0.05]	J (MAX.)
A	0.286 [7.26]	0.135 [3.43]	0.020 [0.51]	0.422 [10.72]
B	0.474 [12.04]	0.185 [4.70]	0.020 [0.51]	0.610 [15.49]
C	0.686 [17.42]	0.289 [7.34]	0.025 [0.64]	0.822 [20.88]
D	0.786 [19.96]	0.351 [8.92]	0.025 [0.64]	0.922 [23.42]

Notes:

(1) The case insulation shall extend 0.015" [0.38 mm] minimum beyond each end. However, when a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body.

(2) A minimum lead length of 1.0" [2.54 mm] for use with tape and reel automatic insertion equipment is available upon request.

(3) Failure Rate levels M, P, R and S are inactive for new design. Insulation is used, it shall lap over the ends of the capacitor body.

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V														
5.6	A	5	5001	5201	5401	5601	6001	7001	8001	0.3	6.0	7.5	4	4
5.6	A	10	2241	2481	2721	2961	6002	7002	8002	0.3	6.0	7.5	4	4
6.8	A	5	5002	5202	5402	5602	6003	7003	8003	0.3	6.0	7.5	6	6
6.8	A	10	2242	2482	2722	2962	6004	7004	8004	0.3	6.0	7.5	6	6
6.8	A	20	2243	2843	2723	2963	6005	7005	8005	0.3	6.0	7.5	6	6
47.0	B	5	5003	5203	5403	5603	6006	7006	8006	1.5	24.0	30.0	6	6
47.0	B	10	2244	2484	2724	2964	6007	7007	8007	1.5	24.0	30.0	6	6
47.0	B	20	2245	2485	2725	2965	6008	7008	8008	1.5	24.0	30.0	6	6
56.0	B	5	5004	5204	5404	5604	6009	7009	8009	1.5	24.0	30.0	6	6
56.0	B	10	2246	2486	2726	2966	6010	7010	8010	1.5	24.0	30.0	6	6
150.0	C	5	5005	5205	5405	5605	6011	7011	8011	4.5	90.0	113.0	8	8
150.0	C	10	2247	2487	2727	2967	6012	7012	8012	4.5	90.0	113.0	8	8
150.0	C	20	2248	2488	2728	2968	6013	7013	8013	4.5	90.0	113.0	8	8
180.0	C	5	5006	5206	5406	5606	6014	7014	8014	5.5	110.0	138.0	8	8
180.0	C	10	2249	2489	2729	2969	6015	7015	8015	5.5	110.0	138.0	8	8
270.0	D	5	5007	5207	5407	5607	6016	7016	8016	6.5	130.0	163.0	8	8
270.0	D	10	2250	2490	2730	2970	6017	7017	8017	6.5	130.0	163.0	8	8
330.0	D	5	5008	5208	5408	5608	6018	7018	8018	7.5	150.0	188.0	8	8
330.0	D	10	2251	2491	2731	2971	6019	7019	8019	7.5	150.0	188.0	8	8
330.0	D	20	2252	2492	2732	2972	6020	7020	8020	7.5	150.0	188.0	8	8

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V														
3.9	A	5	5009	5209	5409	5609	6021	7021	8021	0.3	6.0	7.5	4	4
3.9	A	10	2253	2493	2733	2973	6022	7022	8022	0.3	6.0	7.5	4	4
4.7	A	5	5010	5210	5410	5610	6023	7023	8023	0.4	7.0	8.8	4	4
4.7	A	10	2254	2494	2734	2974	6024	7024	8024	0.4	7.0	8.8	4	4
4.7	A	20	2255	2495	2735	2975	6025	7025	8025	0.4	7.0	8.8	4	4
27.0	B	5	5011	5211	5411	5611	6026	7026	8026	2.0	40.0	50.0	6	6
27.0	B	10	2256	2496	2736	2976	6027	7027	8027	2.0	40.0	50.0	6	6
33.0	B	5	5012	5212	5412	5612	6028	7028	8028	2.5	50.0	63.0	6	6
33.0	B	10	2257	2497	2737	2977	6029	7029	8029	2.5	50.0	63.0	6	6
33.0	B	20	2258	2498	2738	2978	6030	7030	8030	2.5	50.0	63.0	6	6
39.0	B	5	5013	5213	5413	5613	6031	7031	8031	2.5	50.0	63.0	6	6
39.0	B	10	2259	2499	2739	2979	6032	7032	8032	2.5	50.0	63.0	6	6
82.0	C	5	5014	5214	5414	5614	6033	7033	8033	4.0	80.0	100.0	6	6
82.0	C	10	2260	2500	2740	2980	6034	7034	8034	4.0	80.0	100.0	6	6
100.0	C	5	5015	5215	5415	5615	6035	7035	8035	5.0	100.0	125.0	8	8
100.0	C	10	2261	2501	2741	2981	6036	7036	8036	5.0	100.0	125.0	8	8
100.0	C	20	2262	2502	2742	2982	6037	7037	8037	5.0	100.0	125.0	8	8
120.0	C	5	5016	5216	5416	5616	6038	7038	8038	6.0	120.0	150.0	8	8
120.0	C	10	2263	2503	2743	2983	6039	7039	8039	6.0	120.0	150.0	8	8
180.0	D	5	5017	5217	5417	5617	6040	7040	8040	9.0	180.0	226.0	8	8
180.0	D	10	2264	2504	2744	2984	6041	7041	8041	9.0	180.0	226.0	8	8
220.0	D	5	5018	5218	5418	5618	6042	7042	8042	10.0	200.0	250.0	8	8
220.0	D	10	2265	2505	2745	2985	6043	7043	8043	10.0	200.0	250.0	8	8
220.0	D	20	2266	2506	2746	2986	6044	7044	8044	10.0	200.0	250.0	8	8
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V														
2.7	A	5	5019	5219	5419	5619	6045	7045	8045	0.3	6.0	7.5	4	4
2.7	A	10	2267	2507	2747	2987	6046	7046	8046	0.3	6.0	7.5	4	4
3.3	A	5	5020	5220	5420	5620	6047	7047	8047	0.4	8.0	10.0	4	4
3.3	A	10	2268	2508	2748	2988	6048	7048	8048	0.4	8.0	10.0	4	4
3.3	A	20	2269	2509	2749	2989	6049	7049	8049	0.4	8.0	10.0	4	4
18.0	B	5	5021	5221	5421	5621	6050	7050	8050	2.0	35.0	44.0	6	6
18.0	B	10	2270	2510	2750	2990	6051	7051	8051	2.0	35.0	44.0	6	6
22.0	B	5	5022	5222	5422	5622	6052	7052	8052	2.0	40.0	50.0	6	6
22.0	B	10	2271	2511	2751	2991	6053	7053	8053	2.0	40.0	50.0	6	6
22.0	B	20	2272	2512	2752	2992	6054	7054	8054	2.0	40.0	50.0	6	6
56.0	C	5	5023	5223	5423	5623	6055	7055	8055	4.0	80.0	100.0	6	6
56.0	C	10	2273	2513	2753	2993	6056	7056	8056	4.0	80.0	100.0	6	6
68.0	C	5	5024	5224	5424	5624	6057	7057	8057	5.0	100.0	125.0	6	6
68.0	C	10	2274	2514	2754	2994	6058	7058	8058	5.0	100.0	125.0	6	6
68.0	C	20	2275	2515	2755	2995	6059	7059	8059	5.0	100.0	125.0	6	6
120.0	D	5	5025	5225	5425	5625	6060	7060	8060	9.0	180.0	226.0	8	8
120.0	D	10	2276	2516	2756	2996	6061	7061	8061	9.0	180.0	226.0	8	8
150.0	D	5	5026	5226	5426	5626	6062	7062	8062	10.0	200.0	250.0	8	8
150.0	D	10	2277	2517	2757	2997	6063	7063	8063	10.0	200.0	250.0	8	8
150.0	D	20	2278	2518	2758	2998	6064	7064	8064	10.0	200.0	250.0	8	8
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V														
1.2	A	5	5027	5227	5427	5627	6065	7065	8065	0.3	6.0	7.5	4	4
1.2	A	10	2279	2519	2759	2999	6066	7066	8066	0.3	6.0	7.5	4	4
1.5	A	5	5028	5228	5428	5628	6067	7067	8067	0.3	6.0	7.5	4	4
1.5	A	10	2280	2520	2760	3000	6068	7068	8068	0.3	6.0	7.5	4	4
1.5	A	20	2281	2521	2761	3001	6069	7069	8069	0.3	6.0	7.5	4	4
1.5	A	5	5029	5229	5429	5629	6070	7070	8070	0.3	6.0	7.5	4	4
1.8	A	10	2282	2522	2762	3002	6071	7071	8071	0.3	6.0	7.5	4	4

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V														
2.2	A	5	5030	5230	5430	5630	6072	7072	8072	0.4	8.0	10.0	4	4
2.2	A	10	2283	2523	2763	3003	6073	7073	8073	0.4	8.0	10.0	4	4
2.2	A	20	2284	2524	2764	3004	6074	7074	8074	0.4	8.0	10.0	4	4
8.2	B	5	5031	5231	5431	5631	6075	7075	8075	1.0	20.0	25.0	6	6
8.2	B	10	2285	2525	2765	3005	6076	7076	8076	1.0	20.0	25.0	6	6
10.0	B	5	5032	5232	5432	5632	6077	7077	8077	1.5	30.0	38.0	6	6
10.0	B	10	2286	2526	2766	3006	6078	7078	8078	1.5	30.0	38.0	6	6
10.0	B	20	2287	2527	2767	3007	6079	7079	8079	1.5	30.0	38.0	6	6
12.0	B	5	5033	5233	5433	5633	6080	7080	8080	1.8	35.0	44.0	6	6
12.0	B	10	2288	2528	2768	3008	6081	7081	8081	1.8	35.0	44.0	6	6
15.0	B	5	5034	5234	5434	5634	6082	7082	8082	2.0	40.0	50.0	6	6
15.0	B	10	2289	2529	2769	3009	6083	7083	8083	2.0	40.0	50.0	6	6
15.0	B	20	2290	2530	2770	3010	6084	7084	8084	2.0	40.0	50.0	6	6
27.0	C	5	5035	5235	5435	5635	6085	7085	8085	2.5	50.0	63.0	6	6
27.0	C	10	2291	2531	2771	3011	6086	7086	8086	2.5	50.0	63.0	6	6
33.0	C	5	5036	5236	5436	5636	6087	7087	8087	3.5	70.0	88.0	6	6
33.0	C	10	2292	2532	2772	3012	6088	7088	8088	3.5	70.0	88.0	6	6
33.0	C	20	2293	2533	2773	3013	6089	7089	8089	3.5	70.0	88.0	6	6
39.0	C	5	5037	5237	5437	5637	6090	7090	8090	4.0	80.0	100.0	6	6
39.0	C	10	2294	2534	2774	3014	6091	7091	8091	4.0	80.0	100.0	6	6
47.0	C	5	5038	5238	5438	5368	6092	7092	8092	4.5	90.0	113.0	6	6
47.0	C	10	2295	2535	2775	3015	6093	7093	8093	4.5	90.0	113.0	6	6
47.0	C	20	2296	2536	2776	3016	6094	7094	8094	4.5	90.0	113.0	6	6
56.0	D	5	5039	5239	5439	5639	6095	7095	8095	5.5	110.0	138.0	6	6
56.0	D	10	2297	2537	2777	3017	6096	7096	8096	5.5	110.0	138.0	6	6
68.0	D	5	5040	5240	5440	5640	6097	7097	8097	7.0	140.0	175.0	6	6
68.0	D	10	2298	2538	2778	3018	6098	7098	8098	7.0	140.0	175.0	6	6
68.0	D	20	2299	2539	2779	3019	6099	7099	8099	7.0	140.0	175.0	6	6
82.0	D	5	5041	5241	5441	5641	6100	7100	8100	8.0	160.0	200.0	6	6
82.0	D	10	2300	2540	2780	3020	6101	7101	8101	8.0	160.0	200.0	6	6
100.0	D	5	5042	5242	5442	5642	6102	7102	8102	10.0	200.0	250.0	8	8
100.0	D	10	2301	2541	2781	3021	6103	7103	8103	10.0	200.0	250.0	8	8
100.0	D	20	2302	2542	2782	3022	6104	7104	8104	10.0	200.0	250.0	8	8
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V														
5.6	B	5	5043	5243	5443	5643	6105	7105	8105	1.3	25.0	32.0	4	4
5.6	B	10	2303	2543	2783	3023	6106	7106	8106	1.3	25.0	32.0	4	4
6.8	B	5	5044	5244	5444	5644	6107	7107	8107	1.5	30.0	38.0	6	6
6.8	B	10	2304	2544	2784	3024	6108	7108	8108	1.5	30.0	38.0	6	6
6.8	B	20	2305	2545	2785	3025	6109	7109	8109	1.5	30.0	38.0	6	6
22.0	C	5	5045	5245	5445	5645	6110	7110	8110	4.0	80.0	100.0	6	6
22.0	C	10	2306	2546	2786	3026	6111	7111	8111	4.0	80.0	100.0	6	6
22.0	C	20	2307	2547	2787	3027	6112	7112	8112	4.0	80.0	100.0	6	6
27.0	D	5	5046	5246	5446	5646	6113	7113	8113	4.5	90.0	113.0	6	6
27.0	D	10	2308	2548	2788	3028	6114	7114	8114	4.5	90.0	113.0	6	6
33.0	D	5	5047	5247	5447	5647	6115	7115	8115	5.5	110.0	138.0	6	6
33.0	D	10	2309	2549	2789	3029	6116	7116	8116	5.5	110.0	138.0	6	6
33.0	D	20	2310	2550	2790	3030	6117	7117	8117	5.5	110.0	138.0	6	6
39.0	D	5	5048	5248	5448	5648	6118	7118	8118	7.0	140.0	175.0	6	6
39.0	D	10	2311	2551	2791	3031	6119	7119	8119	7.0	140.0	175.0	6	6
47.0	D	5	5049	5249	5449	5649	6120	7120	8120	8.0	160.0	200.0	6	6
47.0	D	10	2312	2552	2792	3032	6121	7121	8121	8.0	160.0	200.0	6	6
47.0	D	20	2313	2553	2793	3033	6122	7122	8122	8.0	160.0	200.0	6	6

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V														
0.056	A	5	5063	5263	5463	5663	6156	7156	8156	0.3	5.0	6.3	2	4
0.056	A	10	2334	2574	2814	3054	6157	7157	8157	0.3	5.0	6.3	2	4
0.068	A	5	5064	5264	5464	5664	6158	7158	8158	0.3	5.0	6.3	2	4
0.068	A	10	2335	2575	2815	3055	6159	7159	8159	0.3	5.0	6.3	2	4
0.068	A	20	2336	2576	2816	3056	6160	7160	8160	0.3	5.0	6.3	2	4
0.082	A	5	5065	5265	5465	5665	6161	7161	8161	0.3	5.0	6.3	2	4
0.082	A	10	2337	2577	2817	3057	6162	7162	8162	0.3	5.0	6.3	2	4
0.10	A	5	5066	5266	5466	5666	6163	7163	8163	0.3	5.0	6.3	2	4
0.10	A	10	2338	2578	2818	3058	6164	7164	8164	0.3	5.0	6.3	2	4
0.10	A	20	2339	2579	3819	3059	6165	7165	8165	0.3	5.0	6.3	2	4
0.12	A	5	5067	5267	5467	5667	6166	7166	8166	0.3	5.0	6.3	2	4
0.12	A	10	2340	2580	2820	3060	6167	7167	8167	0.3	5.0	6.3	2	4
0.15	A	5	5068	5268	5468	5668	6168	7168	8168	0.3	5.0	6.3	2	4
0.15	A	10	2341	2581	2821	3061	6169	7169	8169	0.3	5.0	6.3	2	4
0.15	A	20	2342	2582	2822	3062	6170	7170	8170	0.3	5.0	6.3	2	4
0.18	A	5	5069	5269	5469	5669	6171	7171	8171	0.3	5.0	6.3	2	4
0.18	A	10	2343	2583	2823	3063	6172	7172	8172	0.3	5.0	6.3	2	4
0.22	A	5	5070	5270	5470	5670	6173	7173	8173	0.3	5.0	6.3	2	4
0.22	A	10	2344	2584	2824	3064	6174	7174	8174	0.3	5.0	6.3	2	4
0.22	A	20	2345	2585	2825	3065	6175	7175	8175	0.3	5.0	6.3	2	4
0.27	A	5	5071	5271	5471	5671	6176	7176	8176	0.3	5.0	6.3	2	4
0.27	A	10	2346	2586	2826	3066	6177	7177	8177	0.3	5.0	6.3	2	4
0.33	A	5	5072	5272	5472	5672	6178	7178	8178	0.3	5.0	6.3	2	4
0.33	A	10	2347	2587	2827	3067	6179	7179	8179	0.3	5.0	6.3	2	4
0.33	A	20	2348	2588	2828	3068	6180	7180	8180	0.3	5.0	6.3	2	4
0.39	A	5	5073	5273	5473	5673	6181	7181	8181	0.3	5.0	6.3	2	4
0.39	A	10	2349	2589	2829	3069	6182	7182	8182	0.3	5.0	6.3	2	4
0.47	A	5	5074	5274	5474	5674	6183	7183	8183	0.3	5.0	6.3	2	4
0.47	A	10	2350	2590	2830	3070	6184	7184	8184	0.3	5.0	6.3	2	4
0.47	A	20	2351	2591	2831	3071	6185	7185	8185	0.3	5.0	6.3	2	4
0.56	A	5	5075	5275	5475	5675	6186	7186	8186	0.3	5.0	6.3	2	4
0.56	A	10	2352	2592	2832	3072	6187	7187	8187	0.3	5.0	6.3	2	4
0.68	A	5	5076	5276	5476	5676	6188	7188	8188	0.3	5.0	6.3	2	4
0.68	A	10	2353	2593	2833	3073	6189	7189	8189	0.3	5.0	6.3	2	4
0.68	A	20	2354	2594	2834	3074	6190	7190	8190	0.3	5.0	6.3	2	4
0.82	A	5	5077	5277	5477	5677	6191	7191	8191	0.3	5.0	6.3	2	4
0.82	A	10	2355	2595	2835	3075	6192	7192	8192	0.3	5.0	6.3	2	4
1.0	A	5	5078	5278	5478	5678	6193	7193	8193	0.4	8.0	10.0	4	4
1.0	A	10	2356	2596	2836	3076	6194	7194	8194	0.4	8.0	10.0	4	4
1.0	A	20	2357	2597	2837	3077	6195	7195	8195	0.4	8.0	10.0	4	4
1.2	B	5	5079	5279	5479	5679	6196	7196	8196	0.4	9.0	11.0	4	4
1.2	B	10	2358	2598	2838	3078	6197	7197	8197	0.4	9.0	11.0	4	4
1.5	B	5	5080	5280	5480	5680	6198	7198	8198	0.6	12.0	15.0	4	4
1.5	B	10	2359	2599	2839	3079	6199	7199	8199	0.6	12.0	15.0	4	4
1.5	B	20	2360	2600	2840	3080	6200	7200	8200	0.6	12.0	15.0	4	4
1.8	B	5	5081	5281	5481	5681	6201	7201	8201	0.7	14.0	18.0	4	4
1.8	B	10	2361	2601	2841	3081	6202	7202	8202	0.7	14.0	18.0	4	4
2.2	B	5	5082	5282	5482	5682	6203	7203	8203	0.8	17.0	22.0	4	4
2.2	B	10	2362	2602	2842	3082	6204	7204	8204	0.8	17.0	22.0	4	4
2.2	B	20	2363	2603	2843	3083	6205	7205	8205	0.8	17.0	22.0	4	4
2.7	B	5	5083	5283	5483	5683	6206	7206	8206	1.0	20.0	25.0	4	4
2.7	B	10	2364	2604	2844	3084	6207	7207	8207	1.0	20.0	25.0	4	4
3.3	B	5	5084	5284	5484	5684	6208	7208	8208	1.2	25.0	32.0	4	4
3.3	B	10	2365	2605	2845	3085	6209	7209	8209	1.2	25.0	32.0	4	4

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h)							MAX. DCL (µA) AT			MAX. DF (%) AT	
			M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	+ 25 °C	+ 85 °C	+ 125 °C	- 55 °C + 25 °C	+ 85 °C + 125 °C
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V														
3.3	B	20	2366	2606	2846	3086	6210	7210	8210	1.2	25.0	32.0	4	4
3.9	B	5	5085	5285	5485	5685	6211	7211	8211	1.5	30.0	38.0	4	4
3.9	B	10	2367	2607	2847	3087	6212	7212	8212	1.5	30.0	38.0	4	4
4.7	B	5	5086	5286	5486	5686	6213	7213	8213	1.7	35.0	44.0	4	4
4.7	B	10	2368	2608	2848	3088	6214	7214	8214	1.7	35.0	44.0	4	4
4.7	B	20	2369	2609	2849	3089	6215	7215	8215	1.7	35.0	44.0	4	4
5.6	C	5	5087	5287	5487	5687	6216	7216	8216	2.2	45.0	56.0	4	4
5.6	C	10	2370	2610	2850	3090	6217	7217	8217	2.2	45.0	56.0	4	4
6.8	C	5	5088	5288	5488	5688	6218	7218	8218	2.2	45.0	56.0	6	6
6.8	C	10	2371	2611	2851	3091	6219	7219	8219	2.2	45.0	56.0	6	6
6.8	C	20	2372	2612	2852	3092	6220	7220	8220	2.2	45.0	56.0	6	6
8.2	C	5	5089	5289	5489	5689	6221	7221	8221	2.5	50.0	63.0	6	6
8.2	C	10	2373	2613	2853	3093	6222	7222	8222	2.5	50.0	63.0	6	6
10.0	C	5	5090	5290	5490	5690	6223	7223	8223	2.5	50.0	63.0	6	6
10.0	C	10	2374	2614	2854	3094	6224	7224	8224	2.5	50.0	63.0	6	6
10.0	C	20	2375	2615	2855	3095	6225	7225	8225	2.5	50.0	63.0	6	6
12.0	C	5	5091	5291	5491	5691	6226	7226	8226	3.0	60.0	75.0	6	6
12.0	C	10	2376	2616	2856	3096	6227	7227	8227	3.0	60.0	75.0	6	6
15.0	C	5	5092	5292	5492	5692	6228	7228	8228	4.0	80.0	100.0	6	6
15.0	C	10	2377	2617	2857	3097	6229	7229	8229	4.0	80.0	100.0	6	6
15.0	C	20	2378	2618	2858	3098	6230	7230	8230	4.0	80.0	100.0	6	6
18.0	C	5	5093	5293	5493	5693	6231	7231	8231	4.5	90.0	113.0	6	6
18.0	C	10	2379	2619	2859	3099	6232	7232	8232	4.5	90.0	113.0	6	6
22.0	D	5	5094	5294	5494	5694	6233	7233	8233	5.5	110.0	138.0	6	6
22.0	D	10	2380	2620	2860	3100	6234	7234	8234	5.5	110.0	138.0	6	6
22.0	D	20	2381	2621	2861	3101	6235	7235	8235	5.5	110.0	138.0	6	6
75 WVDC AT + 85 °C, SURGE = 98 V . . . 50 WVDC AT + 125 °C, SURGE = 64 V														
0.1	A	5	5095	5295	5495	5695	6236	7236	8236	0.3	5.0	6.3	2	4
0.1	A	10	2382	2622	2862	3102	6237	7237	8237	0.3	5.0	6.3	2	4
0.1	A	20	2383	2623	2863	3103	6238	7238	8238	0.3	5.0	6.3	2	4
0.12	A	5	5096	5296	5496	5696	6239	7239	8239	0.3	5.0	6.3	2	4
0.12	A	10	2384	2624	2864	3104	6240	7240	8240	0.3	5.0	6.3	2	4
0.15	A	5	5097	5297	5497	5697	6241	7241	8241	0.3	5.0	6.3	2	4
0.15	A	10	2385	2625	2865	3105	6242	7242	8242	0.3	5.0	6.3	2	4
0.15	A	20	2386	2626	2866	3106	6243	7243	8243	0.3	5.0	6.3	2	4
0.18	A	5	5098	5298	5498	5698	6244	7244	8244	0.3	5.0	6.3	2	4
0.18	A	10	2387	2627	2867	3107	6245	7245	8245	0.3	5.0	6.3	2	4
0.22	A	5	5099	5299	5499	5699	6246	7246	8246	0.3	5.0	6.3	2	4
0.22	A	10	2388	2628	2868	3108	6247	7247	8247	0.3	5.0	6.3	2	4
0.22	A	20	2389	2629	2869	3109	6248	7248	8248	0.3	5.0	6.3	2	4
0.27	A	5	5100	5300	5500	5700	6249	7249	8249	0.3	5.0	6.3	2	4
0.27	A	10	2390	2630	2870	3110	6250	7250	8250	0.3	5.0	6.3	2	4
0.33	A	5	5101	5301	5501	5701	6251	7251	8251	0.3	5.0	6.3	2	4
0.33	A	10	2391	2631	2871	3111	6252	7252	8252	0.3	5.0	6.3	2	4
0.33	A	20	2392	2632	2872	3112	6253	7253	8253	0.3	5.0	6.3	2	4
0.39	A	5	5102	5302	5502	5702	6254	7254	8254	0.3	5.0	6.3	2	4
0.39	A	10	2393	2633	2873	3113	6255	7255	8255	0.3	5.0	6.3	2	4
0.47	A	5	5103	5303	5503	5703	6256	7256	8256	0.3	5.0	6.3	2	4
0.47	A	10	2394	2634	2874	3114	6257	7257	8257	0.3	5.0	6.3	2	4
0.47	A	20	2395	2635	2875	3115	6258	7258	8258	0.3	5.0	6.3	2	4
0.56	A	5	5104	5304	5504	5704	6259	7259	8259	0.3	5.0	6.3	2	4
0.56	A	10	2396	2636	2876	3116	6260	7260	8260	0.3	5.0	6.3	2	4

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h)							MAX. DCL (µA) AT			MAX. DF (%) AT	
			M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	+ 25 °C	+ 85 °C	+ 125 °C	- 55 °C + 25 °C	+ 85 °C + 125 °C
75 WVDC AT + 85 °C, SURGE = 98 V . . . 50 WVDC AT + 125 °C, SURGE = 64 V														
0.68	A	5	5105	5305	5505	5705	6261	7261	8261	0.3	5.0	6.3	2	4
0.68	A	10	2397	2637	2877	3117	6262	7262	8262	0.3	5.0	6.3	2	4
0.68	A	20	2398	2638	2878	3118	6263	7263	8263	0.3	5.0	6.3	2	4
0.82	B	5	5106	5306	5506	5706	6264	7264	8264	0.3	5.0	6.3	2	4
0.82	B	10	2399	2879	2879	3119	6265	7265	8265	0.3	5.0	6.3	2	4
1.0	B	5	5107	5307	5507	5707	6266	7266	8266	0.3	5.0	6.3	2	4
1.0	B	10	2400	2410	2880	3120	6267	7267	8267	0.3	5.0	6.3	2	4
1.0	B	20	2401	2641	2881	3121	6268	7268	8268	0.3	5.0	6.3	2	4
1.2	B	5	5108	5308	5508	5708	6269	7269	8269	0.3	5.0	6.3	4	4
1.2	B	10	2402	2642	2882	3122	6270	7270	8270	0.3	5.0	6.3	4	4
1.5	B	5	5109	5309	5509	5709	6271	7271	8271	0.6	10.0	13.0	4	4
1.5	B	10	2403	2643	2883	3123	6272	7272	8272	0.6	10.0	13.0	4	4
1.5	B	20	2404	2664	2884	3124	6273	7273	8273	0.6	10.0	13.0	4	4
1.8	B	5	5110	5310	5510	5710	6274	7274	8274	0.7	10.0	13.0	4	4
1.8	B	10	2405	2645	2885	3125	6275	7275	8275	0.7	10.0	13.0	4	4
1.8	B	10	2405	2645	2885	3125	6275	7275	8275	0.7	10.0	13.0	4	4
2.2	B	5	5111	5311	5511	5711	6276	7276	8276	0.8	15.0	19.0	4	4
2.2	B	10	2406	2646	2886	3126	6277	7277	8277	0.8	15.0	19.0	4	4
2.2	B	20	2407	2647	2887	3127	6278	7278	8278	1.0	15.0	19.0	4	4
2.7	B	5	5112	5312	5512	5712	6279	7279	8279	1.0	15.0	19.0	4	4
2.7	B	10	2408	2648	2888	3128	6280	7280	8280	1.2	15.0	19.0	4	4
3.3	B	5	5113	5313	5513	5713	6281	7281	8281	1.2	20.0	25.0	4	4
3.3	B	10	2409	2649	2889	3129	6282	7282	8282	1.2	20.0	25.0	4	4
3.3	B	20	2410	2650	2890	3130	6283	7283	8283	1.5	20.0	25.0	4	4
3.9	B	5	5114	5314	5514	5714	6284	7284	8284	1.5	20.0	25.0	4	4
3.9	B	10	2411	2651	2891	3131	6285	7285	8285	3.0	20.0	25.0	4	4
4.7	C	5	5115	5315	5515	5715	6286	7286	8286	3.0	60.0	75.0	4	4
4.7	C	10	2412	2652	2892	3132	6287	7287	8287	3.0	60.0	75.0	4	4
4.7	C	20	2413	2653	2893	3133	6288	7288	8288	3.0	60.0	75.0	4	4
5.6	C	5	5116	5316	5513	5716	6289	7289	8289	3.0	60.0	75.0	4	4
5.6	C	10	2414	2654	2894	3134	6290	7290	8290	5.0	60.0	75.0	4	4
6.8	C	5	5117	5317	5517	5717	6291	7291	8291	5.0	100.0	125.0	6	6
6.8	C	10	2415	2655	2895	3135	6292	7292	8292	5.0	100.0	125.0	6	6
6.8	C	20	2416	2656	2896	3136	6293	7293	8293	5.0	100.0	125.0	6	6
8.2	C	5	5118	5318	5518	5718	6294	7294	8294	5.0	100.0	125.0	6	6
8.2	C	10	2417	2657	2897	3137	6295	7295	8295	5.0	100.0	125.0	6	6
10.0	C	5	5119	5319	5519	5719	6296	7296	8296	5.0	100.0	125.0	6	6
10.0	C	10	2418	2658	2898	3138	6297	7297	8297	5.0	100.0	125.0	6	6
10.0	C	20	2419	2659	2899	3139	6298	7298	8295	5.0	100.0	125.0	6	6
12.0	D	5	5120	5320	5520	5720	6299	7299	8299	5.0	100.0	125.0	6	6
12.0	D	10	2420	2660	2900	3140	6300	7300	8300	5.0	100.0	125.0	6	6
15.0	D	5	5121	5321	5521	5721	6301	7301	8301	7.0	140.0	175.0	6	6
15.0	D	10	2421	2661	2901	3141	6302	7302	8302	7.0	140.0	175.0	6	6
15.0	D	20	2422	2662	2902	3142	6303	7303	8303	7.0	140.0	175.0	6	6

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V														
0.056	A	5	5135	5335	5535	5735	6337	7337	8337	0.3	5.0	6.3	2	4
0.056	A	10	2443	2683	2923	3163	6338	7338	8338	0.3	5.0	6.3	2	4
0.068	A	5	5136	5336	5536	5736	6339	7339	8339	0.3	5.0	6.3	2	4
0.068	A	10	2444	2684	2924	3164	6340	7340	8340	0.3	5.0	6.3	2	4
0.068	A	20	2445	2685	2925	3165	6341	7341	8341	0.3	5.0	6.3	2	4
0.082	A	5	5137	5337	5537	5737	6342	7342	8342	0.3	5.0	6.3	2	4
0.082	A	10	2446	2686	2926	3166	6343	7343	8343	0.3	5.0	6.3	2	4
0.1	A	5	5138	5338	5538	5738	6344	7344	8344	0.3	5.0	6.3	2	4
0.1	A	10	2447	2687	2927	3167	6345	7345	8345	0.3	5.0	6.3	2	4
0.1	A	20	2448	2688	2928	3168	6346	7346	8346	0.3	5.0	6.3	2	4
0.12	A	5	5139	5339	5539	5739	6347	7347	8347	0.3	5.0	6.3	2	4
0.12	A	10	2449	2689	2929	3169	6348	7348	8348	0.3	5.0	6.3	2	4
0.15	A	5	5140	5340	5540	5740	6349	7349	8349	0.3	5.0	6.3	2	4
0.15	A	10	2450	2690	2930	3170	6350	7350	8350	0.3	5.0	6.3	2	4
0.15	A	20	2451	2691	2931	3171	6351	7351	8351	0.3	5.0	6.3	2	4
0.18	A	5	5141	5341	5541	5741	6352	7352	8352	0.3	5.0	6.3	2	4
0.18	A	10	2452	2692	2932	3172	6353	7353	8353	0.3	5.0	6.3	2	4
0.22	A	5	5142	5342	5542	5742	6354	7354	8354	0.3	5.0	6.3	2	4
0.22	A	10	2453	2693	2933	3173	6355	7355	8355	0.3	5.0	6.3	2	4
0.22	A	20	2454	2694	2934	3174	6356	7356	8356	0.3	5.0	6.3	2	4
0.27	A	5	5143	5343	5543	5743	6357	7357	8357	0.3	5.0	6.3	2	4
0.27	A	10	2455	2695	2935	3175	6358	7358	8358	0.3	5.0	6.3	2	4
0.33	A	5	5144	5344	5544	5744	6359	7359	8359	0.3	5.0	6.3	2	4
0.33	A	10	2456	2696	2936	3176	6360	7360	8360	0.3	5.0	6.3	2	4
0.33	A	20	2457	2697	2937	3177	6361	7361	8361	0.3	5.0	6.3	2	4
0.39	A	5	5145	5345	5545	5745	6362	7362	8362	0.3	5.0	6.3	2	4
0.39	A	10	2458	2698	2938	3178	6363	7363	8363	0.3	5.0	6.3	2	4
0.47	A	5	5146	5436	5546	5746	6364	7364	8364	0.3	5.0	6.3	2	4
0.47	A	10	2459	2699	2939	3179	6365	7365	8365	0.3	5.0	6.3	2	4
0.47	A	20	2460	2700	2940	3180	6366	7366	8366	0.3	5.0	6.3	2	4
0.56	A	5	5147	5347	5547	5747	6367	7367	8367	0.3	5.0	6.3	2	4
0.56	A	10	2461	2701	2941	3181	6368	7368	8368	0.3	5.0	6.3	2	4
0.68	B	5	5148	5348	5548	5748	6369	7369	8369	0.3	5.0	6.3	2	4
0.68	B	10	2462	2702	2942	3182	6370	7370	8370	0.3	5.0	6.3	2	4
0.68	B	20	2463	2703	2943	3183	6371	7371	8371	0.3	5.0	6.3	2	4
0.82	B	5	5149	5349	5549	5749	6372	7372	8372	0.4	5.0	6.3	2	4
0.82	B	10	2464	2704	2944	3184	6373	7373	8373	0.4	5.0	6.3	2	4

STANDARD RATINGS: CSR13, M39003/01-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/01- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V														
1.0	B	5	5150	5350	5550	5750	6374	7374	8374	0.5	5.0	6.3	2	4
1.0	B	10	2465	2705	2945	3185	6375	7375	8375	0.5	5.0	6.3	2	4
1.0	B	20	2466	2706	2946	3186	6376	7376	8376	0.5	5.0	6.3	2	4
1.2	B	5	5151	5351	5551	5751	6377	7377	8377	0.5	5.0	6.3	4	4
1.2	B	10	2467	2707	2947	3187	6378	7378	8378	0.5	5.0	6.3	4	4
1.5	B	5	5152	5352	5552	5752	6379	7379	8379	0.7	10.0	13.0	4	4
1.5	B	10	2468	2708	2948	3188	6380	7380	8380	0.7	10.0	13.0	4	4
1.5	B	20	2469	2709	2949	3189	6381	7381	8381	0.7	10.0	13.0	4	4
1.8	B	5	5153	5353	5553	5753	6382	7382	8382	0.7	10.0	13.0	4	4
1.8	B	10	2470	2710	2950	3190	6383	7383	8383	0.7	10.0	13.0	4	4
2.2	B	5	5154	5354	5554	5754	6384	7384	8384	0.9	15.0	19.0	4	4
2.2	B	10	2471	2711	2951	3191	6385	7385	8385	0.9	15.0	19.0	4	4
2.2	B	20	2472	2712	2952	3192	6386	7386	8386	0.9	15.0	19.0	4	4
2.7	B	5	5155	5355	5555	5755	6387	7387	8387	1.1	15.0	19.0	4	4
2.7	B	10	2473	2713	2953	3193	6388	7388	8388	1.1	15.0	19.0	4	4
3.3	C	5	5156	5356	5556	5756	6389	7389	8389	1.5	30.0	38.0	6	6
3.3	C	10	5157	5357	5557	5757	6390	7390	8390	1.5	30.0	38.0	6	6
3.3	C	20	5158	5358	5558	5758	6391	7391	8391	1.5	30.0	38.0	6	6
3.9	C	5	5159	5359	5559	5759	6392	7392	8392	1.5	30.0	38.0	6	6
3.9	C	10	5160	5360	5560	5760	6393	7393	8393	1.5	30.0	38.0	6	6
4.7	C	5	5161	5361	5561	5761	6394	7394	8394	2.5	50.0	63.0	6	6
4.7	C	10	5162	5362	5562	5762	6395	7395	8395	2.5	50.0	63.0	6	6
4.7	C	20	5163	5363	5563	5763	6396	7396	8396	2.5	50.0	63.0	6	6
5.6	C	5	5164	5364	5564	5764	6397	7397	8397	2.5	50.0	63.0	6	6
5.6	C	10	5165	5365	5565	5765	6398	7398	8398	2.5	50.0	63.0	6	6
6.8	C	5	5166	5366	5566	5766	6399	7399	8399	2.5	50.0	63.0	6	6
6.8	C	10	5167	5367	5567	5767	6400	7400	8400	2.5	50.0	63.0	6	6
6.8	C	20	5168	5368	5568	5768	6401	7401	8401	2.5	50.0	63.0	6	6

STANDARD RATINGS: CSR21, M39003/09-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/09- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF AT + 25 °C 1 kHz (%)	MAX. ESR AT + 25 °C 100 kHz (Ω)	DERATED MAX. RIPPLE CURRENT AT + 25 °C (A) 40 kHz	1 kHz
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V																
150.0	C	5	0001	0101	0201	0301	2001	3001	4001	4.5	90.0	113.0	10	0.065	3.3	2.0
150.0	C	10	0002	0102	0202	0302	2002	3002	4002	4.5	90.0	113.0	10	0.065	3.3	2.0
150.0	C	20	0003	0103	0203	0303	2003	3003	4003	4.5	90.0	113.0	10	0.065	3.3	2.0
180.0	C	5	0004	0104	0204	0304	2004	3004	4004	5.5	110.0	138.0	10	0.060	3.4	2.4
180.0	C	10	0005	0105	0205	0305	2005	3005	4005	5.5	110.0	138.0	10	0.060	3.4	2.4
270.0	D	5	0006	0106	0206	0306	2006	3006	4006	6.5	130.0	163.0	10	0.050	4.1	3.4
270.0	D	10	0007	0107	0207	0307	2007	3007	4007	6.5	130.0	163.0	10	0.050	4.1	3.4
330.0	D	5	0008	0108	0208	0308	2008	3008	4008	7.5	150.0	188.0	12	0.045	4.3	3.8
330.0	D	10	0009	0109	0209	0309	2009	3009	4009	7.5	150.0	188.0	12	0.045	4.3	3.8
330.0	D	20	0010	0110	0210	0310	2010	3010	4010	7.5	150.0	188.0	12	0.045	4.3	3.8
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V																
82.0	C	5	0011	0111	0211	0311	2011	3011	4011	4.0	80.0	100.0	8	0.085	2.9	1.8
82.0	C	10	0012	0112	0212	0312	2012	3012	4012	4.0	80.0	100.0	8	0.085	2.9	1.8
100.0	C	5	0013	0113	0213	0313	2013	3013	4013	5.0	100.0	125.0	8	0.075	3.0	2.2
100.0	C	10	0014	0114	0214	0314	2014	3014	4014	5.0	100.0	125.0	8	0.075	3.0	2.2
100.0	C	20	0015	0115	0215	0315	2015	3015	4015	5.0	100.0	125.0	8	0.075	3.0	2.2
120.0	C	5	0016	0116	0216	0136	2016	3016	4016	6.0	120.0	150.0	8	0.070	3.2	2.5
120.0	C	10	0017	0117	0217	0317	2017	3017	4017	6.0	120.0	150.0	8	0.070	3.2	2.5
180.0	D	5	0018	0118	0218	0318	2018	3018	4018	9.0	180.0	226.0	8	0.060	3.7	3.4
180.0	D	10	0019	0119	0219	0319	2019	3019	4019	9.0	180.0	226.0	8	0.060	3.7	3.4
220.0	D	5	0020	0120	0220	0320	2020	3020	4020	10.0	200.0	250.0	10	0.055	3.9	3.4
220.0	D	10	0021	0121	0221	0321	2021	3021	4021	10.0	200.0	250.0	10	0.055	3.9	3.4
220.0	D	20	0022	0122	0222	0322	2022	3022	4022	10.0	200.0	250.0	10	0.055	3.9	3.4
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V																
56.0	C	5	0023	0123	0223	0323	2023	3023	4023	4.0	80.0	100.0	6	0.100	2.6	1.8
56.0	C	10	0024	0124	0224	0324	2024	3024	4024	4.0	80.0	100.0	6	0.100	2.6	1.8
68.0	C	5	0025	0125	0225	0325	2025	3025	4025	5.0	100.0	125.0	6	0.095	2.7	2.2
68.0	C	10	0026	0126	0226	0326	2026	3026	4026	5.0	100.0	125.0	6	0.095	2.7	2.2
68.0	C	20	0027	0127	0227	0327	2027	3027	4027	5.0	100.0	125.0	6	0.095	2.7	2.2
120.0	D	5	0028	0128	0228	0328	2028	3028	4028	9.0	180.0	226.0	8	0.070	3.5	2.8
120.0	D	10	0029	0129	0229	0329	2029	3029	4029	9.0	180.0	226.0	8	0.070	3.5	2.8
150.0	D	5	0030	0130	0230	0330	2030	3030	4030	10.0	200.0	250.0	8	0.065	3.6	3.1
150.0	D	10	0031	0131	0231	0331	2031	3031	4031	10.0	200.0	250.0	8	0.065	3.6	3.1
150.0	D	20	0032	0132	0232	0332	2032	3032	4032	10.0	200.0	250.0	8	0.065	3.6	3.1
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V																
27.0	C	5	0033	0133	0233	0333	2033	3033	4033	2.5	50.0	63.0	5	0.145	2.2	1.2
27.0	C	10	0034	0134	0234	0334	2034	3034	4034	2.5	50.0	63.0	5	0.145	2.2	1.2
33.0	C	5	0035	0135	0235	0335	2035	3035	4035	3.5	70.0	88.0	5	0.130	2.3	1.4
33.0	C	10	0036	0136	0236	0336	2036	3036	4036	3.5	70.0	88.0	5	0.130	2.3	1.4
33.0	C	20	0037	0137	0237	0337	2037	3037	4037	3.5	70.0	88.0	5	0.130	2.3	1.4
39.0	C	5	0038	0138	0238	0338	2038	3038	4038	4.0	80.0	100.0	5	0.120	2.4	1.7
39.0	C	10	0039	0139	0239	0339	2039	3039	4039	4.0	80.0	100.0	5	0.120	2.4	1.7
47.0	C	5	0040	0140	0240	0340	2040	3040	4040	4.5	90.0	113.0	6	0.110	2.5	1.8
47.0	C	10	0041	0141	0241	0341	2041	3041	4041	4.5	90.0	113.0	6	0.110	2.5	1.8
47.0	C	20	0042	0142	0242	0342	2042	3042	4042	4.5	90.0	113.0	6	0.110	2.5	1.8
56.0	D	5	0043	0143	0243	0343	2043	3043	4043	5.5	110.0	138.0	6	0.100	2.9	2.2
56.0	D	10	0044	0144	0244	0344	2044	3044	4044	5.5	110.0	138.0	6	0.100	2.9	2.2

STANDARD RATINGS: CSR21, M39003/09-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/09- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF AT + 25 °C 1 kHz (%)	MAX. ESR AT + 25 °C 100 kHz (Ω)	DERATED MAX. RIPPLE CURRENT AT + 25 °C (A) 40 kHz	1 kHz
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V																
68.0	D	5	0045	0145	0245	0345	2045	3045	4045	7.0	140.0	175.0	6	0.095	3.0	2.4
68.0	D	10	0046	0146	0246	0346	2046	3046	4046	7.0	140.0	175.0	6	0.095	3.0	2.4
68.0	D	20	0047	0147	0247	0347	2047	3047	4047	7.0	140.0	175.0	6	0.095	3.0	2.4
82.0	D	5	0048	0148	0248	0348	2048	3048	4048	8.0	160.0	200.0	6	0.085	3.1	2.5
82.0	D	10	0049	0149	0249	0349	2049	3049	4049	8.0	160.0	200.0	6	0.085	3.1	2.5
100.0	D	5	0050	0150	0250	0350	2050	3050	4050	10.0	200.0	250.0	8	0.075	3.3	2.5
100.0	D	10	0051	0151	0251	0351	2051	3051	4051	10.0	200.0	250.0	8	0.075	3.3	2.5
100.0	D	20	0052	0152	0252	0352	2052	3052	4052	10.0	200.0	250.0	8	0.075	3.3	2.5
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V																
22.0	C	5	0053	0153	0253	0353	2053	3053	4053	4.0	80.0	100.0	4	0.160	2.1	1.5
22.0	C	10	0054	0154	0254	0354	2054	3054	4054	4.0	80.0	100.0	4	0.160	2.1	1.5
22.0	C	20	0055	0155	0255	0355	2055	3055	4055	4.0	80.0	100.0	4	0.160	2.1	1.5
27.0	D	5	0056	0156	0256	0356	2056	3056	4056	4.5	90.0	113.0	4	0.145	2.4	1.9
27.0	D	10	0057	0157	0257	0357	2057	3057	4057	4.5	90.0	113.0	4	0.145	2.4	1.9
33.0	D	5	0058	0158	0258	0358	2058	3058	4058	5.5	110.0	138.0	5	0.130	2.5	1.9
33.0	D	10	0059	0159	0259	0359	2059	3059	4059	5.5	110.0	138.0	5	0.130	2.5	1.9
33.0	D	20	0060	0160	0260	0360	2060	3060	4060	5.5	110.0	138.0	5	0.130	2.5	1.9
39.0	D	5	0061	0161	0261	0361	2061	3061	4061	7.0	140.0	175.0	5	0.120	2.6	2.0
39.0	D	10	0062	0162	0262	0362	2062	3062	4062	7.0	140.0	175.0	5	0.120	2.6	2.0
47.0	D	5	0063	0163	0263	0363	2063	3063	4063	8.0	160.0	200.0	5	0.110	2.7	2.2
47.0	D	10	0064	0164	0264	0364	2064	3064	4064	8.0	160.0	200.0	5	0.110	2.7	2.2
47.0	D	20	0065	0165	0265	0365	2065	3065	4065	8.0	160.0	200.0	5	0.110	2.7	2.2
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V																
5.6	C	5	0066	0166	0266	0366	2066	3066	4066	2.2	45.0	56.0	3	0.300	1.5	0.6
5.6	C	10	0067	0167	0267	0367	2067	3067	4067	2.2	45.0	56.0	3	0.300	1.5	0.6
6.8	C	5	0068	0168	0268	0368	2068	3068	4068	2.2	45.0	56.0	3	0.275	1.6	0.7
6.8	C	10	0069	0169	0269	0369	2069	3069	4069	2.2	45.0	56.0	3	0.275	1.6	0.7
6.8	C	20	0070	0170	0270	0370	2070	3070	4070	2.2	45.0	56.0	3	0.275	1.6	0.7
8.2	C	5	0071	0171	0271	0371	2071	3071	4071	2.5	50.0	63.0	3	0.250	1.6	0.9
8.2	C	10	0072	0172	0272	0372	2072	3072	4072	2.5	50.0	63.0	3	0.250	1.6	0.9
10.0	C	5	0073	0173	0273	0373	2073	3073	4073	2.5	50.0	63.0	3	0.230	1.7	1.1
10.0	C	10	0074	0174	0274	0374	2074	3074	4074	2.5	50.0	63.0	3	0.230	1.7	1.1
10.0	C	20	0075	0175	0275	0375	2075	3075	4075	2.5	50.0	63.0	3	0.230	1.7	1.1
12.0	C	5	0076	0176	0276	0376	2076	3076	4076	3.0	60.0	75.0	3	0.210	1.8	1.3
12.0	C	10	0077	0177	0277	0377	2077	3077	4077	3.0	60.0	75.0	3	0.210	1.8	1.3
15.0	C	5	0078	0178	0278	0378	2078	3078	4078	4.0	80.0	100.0	3	0.190	1.9	1.4
15.0	C	10	0079	0179	0279	0379	2079	3079	4079	4.0	80.0	100.0	3	0.190	1.9	1.4
15.0	C	20	0080	0180	0280	0380	2080	3080	4080	4.0	80.0	100.0	3	0.190	1.9	1.4
18.0	C	5	0081	0181	0281	0381	2081	3081	4081	4.5	90.0	113.0	4	0.175	2.0	1.4
18.0	C	10	0082	0182	0282	0382	2082	3082	4082	4.5	90.0	113.0	4	0.175	2.0	1.4
22.0	D	5	0083	0183	0283	0383	2083	3083	4083	5.5	110.0	138.0	4	0.160	2.3	1.7
22.0	D	10	0084	0184	0284	0384	2084	3084	4084	5.5	110.0	138.0	4	0.160	2.3	1.7
22.0	D	20	0085	0185	0285	0385	2085	3085	4085	5.5	110.0	138.0	4	0.160	2.3	1.7

STANDARD RATINGS: CSR23, M39003/03-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/03- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V														
10.0	A	10	0101	0201	0301	0401	2001	3001	4001	0.9	9.0	11.0	6	6
10.0	A	20	0102	0202	0302	0402	2002	3002	4002	0.9	9.0	11.0	6	6
12.0	A	10	0103	0203	0303	0403	2003	3003	4003	1.0	10.0	12.5	6	6
100.0	B	10	0104	0204	0304	0404	2004	3004	4004	6.0	60.0	75.0	8	8
100.0	B	20	0105	0205	0305	0405	2005	3005	4005	6.0	60.0	75.0	8	8
330.0	C	10	0106	0206	0306	0406	2006	3006	4006	15.0	150.0	188.0	8	8
330.0	C	20	0107	0207	0307	0407	2007	3007	4007	15.0	150.0	188.0	8	8
390.0	C	10	0108	0208	0308	0408	2008	3008	4008	15.0	150.0	188.0	10	10
470.0	C	10	0109	0209	0309	0409	2009	3009	4009	15.0	150.0	188.0	10	10
470.0	C	20	0110	0210	0310	0410	2010	3010	4010	15.0	150.0	188.0	10	10
680.0	D	10	0111	0211	0311	0411	2011	3011	4011	20.0	200.0	250.0	10	10
680.0	D	20	0112	0212	0312	0412	2012	3012	4012	20.0	200.0	250.0	10	10
820.0	D	10	0113	0213	0313	0413	2013	3013	4013	20.0	200.0	250.0	10	10
1000.0	D	10	0114	0214	0314	0414	2014	3014	4014	30.0	300.0	375.0	10	10
1000.0	D	20	0115	0215	0315	0415	2015	3015	4015	30.0	300.0	375.0	10	10
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V														
6.8	A	10	0116	0216	0316	0416	2016	3016	4016	1.0	10.0	12.5	6	6
6.8	A	20	0117	0217	0317	0417	2017	3017	4017	1.0	10.0	12.5	6	6
8.2	A	10	0118	0218	0318	0418	2018	3018	4018	1.2	12.0	15.0	6	6
47.0	B	10	0119	0219	0319	0419	2019	3019	4019	5.0	50.0	63.0	6	6
47.0	B	20	0120	0220	0320	0420	2020	3020	4020	5.0	50.0	63.0	6	6
56.0	B	10	0121	0221	0321	0421	2021	3021	4021	6.0	60.0	75.0	6	6
68.0	B	10	0122	0222	0322	0422	2022	3022	4022	7.0	70.0	88.0	6	6
68.0	B	20	0123	0223	0323	0423	2023	3023	4023	7.0	70.0	88.0	6	6
82.0	B	10	0124	0224	0324	0424	2024	3024	4024	8.0	80.0	100.0	6	6
220.0	C	10	0125	0225	0325	0425	2025	3025	4025	15.0	150.0	188.0	8	8
220.0	C	20	0126	0226	0326	0426	2026	3026	4026	15.0	150.0	188.0	8	8
270.0	C	10	0127	0227	0327	0427	2027	3027	4027	15.0	150.0	188.0	8	8
390.0	D	10	0128	0228	0328	0428	2028	3028	4028	20.0	200.0	250.0	10	10
470.0	D	10	0129	0229	0329	0429	2029	3029	4029	20.0	200.0	250.0	10	10
470.0	D	20	0130	0230	0330	0430	2030	3030	4030	20.0	200.0	250.0	10	10
560.0	D	10	0131	0231	0331	0431	2031	3031	4031	30.0	300.0	375.0	10	10
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V														
4.7	A	10	0132	0232	0332	0432	2032	3032	4032	1.0	10.0	12.5	4	4
4.7	A	20	0133	0233	0333	0433	2033	3033	4033	1.0	10.0	12.5	4	4
5.6	A	10	0134	0234	0334	0434	2034	3034	4034	1.3	13.0	16.5	4	4
33.0	B	10	0135	0235	0335	0435	2035	3035	4035	6.0	60.0	75.0	6	6
33.0	B	20	0136	0236	0336	0436	2036	3036	4036	6.0	60.0	75.0	6	6
39.0	B	10	0137	0237	0337	0437	2037	3037	4037	6.0	60.0	75.0	6	6
150.0	C	10	0138	0238	0338	0438	2038	3038	4038	15.0	150.0	188.0	8	8
150.0	C	20	0139	0239	0339	0439	2039	3039	4039	15.0	150.0	188.0	8	8
180.0	C	10	0140	0240	0340	0440	2040	3040	4040	15.0	150.0	188.0	8	8
220.0	D	10	0141	0241	0341	0441	2041	3041	4041	20.0	200.0	250.0	8	8
220.0	D	20	0142	0242	0342	0442	2042	3042	4042	20.0	200.0	250.0	8	8
270.0	D	10	0143	0243	0343	0443	2043	3043	4043	20.0	200.0	250.0	8	8
330.0	D	10	0144	0244	0344	0444	2044	3044	4044	20.0	200.0	250.0	8	8
330.0	D	20	0145	0245	0345	0445	2045	3045	4045	20.0	200.0	250.0	8	8

STANDARD RATINGS: CSR23, M39003/03-XXXX

CAPACITANCE (µF)	CASE CODE	CAP. TOL. (± %)	PART NO. M39003/03- FAILURE RATE LEVEL (%/1000 h) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001	MAX. DCL (µA) AT + 25 °C	+ 85 °C	+ 125 °C	MAX. DF (%) AT - 55 °C + 25 °C	+ 85 °C + 125 °C
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V														
2.7	A	10	0146	0246	0346	0446	2046	3046	4046	0.8	8.0	10.0	4	4
3.3	A	10	0147	0247	0347	0447	2047	3047	4047	1.0	10.0	12.5	4	4
3.3	A	20	0148	0248	0348	0448	2048	3048	4048	1.0	10.0	12.5	4	4
3.9	A	10	0149	0249	0349	0449	2049	3049	4049	1.2	12.0	15.0	4	4
18.0	B	10	0150	0250	0350	0450	2050	3050	4050	4.0	40.0	50.0	6	6
22.0	B	10	0151	0251	0351	0451	2051	3051	4051	4.0	40.0	50.0	6	6
22.0	B	20	0152	0252	0352	0452	2052	3052	4052	4.0	40.0	50.0	6	6
27.0	B	10	0153	0253	0353	0453	2053	3053	4053	5.0	50.0	63.0	6	6
56.0	C	10	0154	0254	0354	0454	2054	3054	4054	9.0	90.0	110.0	6	6
68.0	C	10	0155	0255	0355	0455	2055	3055	4055	10.0	100.0	125.0	6	6
68.0	C	20	0156	0256	0356	0456	2056	3056	4056	10.0	100.0	125.0	6	6
82.0	C	10	0157	0257	0357	0457	2057	3057	4057	10.0	100.0	125.0	6	6
100.0	C	10	0158	0258	0358	0458	2058	3058	4058	15.0	150.0	188.0	6	6
100.0	C	20	0159	0259	0359	0459	2059	3059	4059	15.0	150.0	188.0	6	6
120.0	C	10	0160	0260	0360	0460	2060	3060	4060	15.0	150.0	188.0	6	6
150.0	D	10	0161	0261	0361	0461	2061	3061	4061	20.0	200.0	250.0	8	8
150.0	D	20	0162	0262	0362	0462	2062	3062	4062	20.0	200.0	250.0	8	8
180.0	D	10	0163	0263	0363	0463	2063	3063	4063	20.0	200.0	250.0	8	8
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V														
1.8	A	10	0164	0264	0364	0464	2064	3064	4064	1.0	10.0	12.5	4	4
8.2	B	10	0165	0265	0365	0465	2065	3065	4065	3.5	35.0	44.0	6	6
10.0	B	10	0166	0266	0366	0466	2066	3066	4066	4.0	40.0	50.0	6	6
10.0	B	20	0167	0267	0367	0467	2067	3067	4067	4.0	40.0	50.0	6	6
33.0	C	10	0168	0268	0368	0468	2068	3068	4068	10.0	100.0	125.0	6	6
33.0	C	20	0169	0269	0369	0469	2069	3069	4069	10.0	100.0	125.0	6	6
39.0	C	10	0170	0270	0370	0470	2070	3070	4070	10.0	100.0	125.0	6	6
47.0	C	10	0171	0271	0371	0471	2071	3071	4071	10.0	100.0	125.0	6	6
47.0	C	20	0172	0272	0372	0472	2072	3072	4072	10.0	100.0	125.0	6	6
56.0	D	10	0173	0273	0373	0473	2073	3073	4073	15.0	150.0	188.0	6	6
68.0	D	10	0174	0274	0374	0474	2074	3074	4074	15.0	150.0	188.0	6	6
68.0	D	20	0175	0275	0375	0475	2075	3075	4075	15.0	150.0	188.0	6	6
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V														
1.2	A	10	0176	0276	0376	0476	2076	3076	4076	0.9	9.0	11.0	4	4
1.5	A	10	0177	0277	0377	0477	2077	3077	4077	1.2	12.0	15.0	4	4
1.5	A	20	0178	0278	0378	0478	2078	3078	4078	1.2	12.0	15.0	4	4
5.6	B	10	0179	0279	0379	0479	2079	3079	4079	4.5	45.0	56.0	4	4
6.8	B	10	0180	0280	0380	0480	2080	3080	4080	4.5	45.0	56.0	6	6
6.8	B	20	0181	0281	0381	0481	2081	3081	4081	4.5	45.0	56.0	6	6
22.0	C	10	0182	0282	0382	0482	2082	3082	4082	10.0	100.0	125.0	6	6
22.0	C	20	0183	0283	0383	0483	2083	3083	4083	10.0	100.0	125.0	6	6
27.0	C	10	0184	0284	0384	0484	2084	3084	4084	10.0	100.0	125.0	6	6
33.0	D	10	0185	0285	0385	0485	2085	3085	4085	10.0	100.0	125.0	6	6
33.0	D	20	0186	0286	0386	0486	2086	3086	4086	10.0	100.0	125.0	6	6
39.0	D	10	0187	0287	0387	0487	2087	3087	4087	10.0	100.0	125.0	6	6

WEIBULL DISTRIBUTION METHOD FOR DETERMINING FAILURE RATE, MIL-PRF-39003

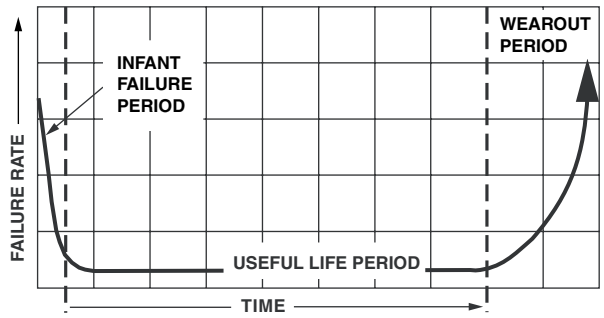
The current issue of Military Specification MIL-PRF-39003 incorporates Weibull distribution techniques as a means for calculating failure rates for solid tantalum capacitors. The exponential failure rates (M, P, R and S) are inactive for new designs. Weibull graded failure rate level "B" capacitors supersede exponential failure rates M, P, R and S.

Increasingly, more stringent quality measurement systems are being used in the electronics industry. AQL sample plans are being replaced by programs measuring component quality in PPM (Parts Per Million). Product quality specifications seemingly approach perfection. Procedures used to calculate PPM quality levels are based on manufacturers in-process controls and final inspection results and by users data at incoming inspection and equipment assembly.

Initial quality requirements are only part of a good product specification. Reliability and useful life should be considered as well - to fit the reliability and useful life requirements of end equipment.

Reliability is a measure of the expected failure rate during the useful life of the capacitor. When plotted the failure rate follows a characteristic "bathtub" curve, covering three periods in the typical capacitor life cycle.
The bathtub curve shows the early time period called infant failure period, the uniform failure rate period or useful life and a period of increasing failure rate due to wearout.

RELIABILITY LIFE CYCLE - TYPICAL "BATHTUB" CURVE



The Weibull shape parameter beta (β) is shown as less than one ($\beta < 1$) during infant mortality, one ($\beta = 1$) during the useful life and greater than one ($\beta > 1$) during the wearout period. Since Weibull distribution works well on units with a beta less than 1, solid tantalum capacitors can use this method for determining failure rates. Solid tantalum capacitors fail early in life (normally during the aging or burnin cycles) and show a slightly decreasing failure rate with time - however, there is no known wearout failure mode.

The processing of solid tantalum capacitors is not "perfectly clean". Impurities in the tantalum powders along with microscopic dust particles can cause flaws in the dielectric tantalum oxide. These flaws in the dielectric can cause failure sites which are normally found during the in-process aging or burn-in cycles. A very large percentage of failures occur during these burn-ins. Since the worst flaws are presumed to fail first, we eventually arrive at flaw sizes which are presumably too small to cause further degradation.

Weibull states that the failure rate of a component that shows a decreasing failure rate with time can be predicted within a short period of time under accelerated conditions.

Accelerated conditions for solid tantalum capacitors can be imposed by means of either voltage or temperature stress.

Since temperatures above + 125 °C can cause degradation of the solid manganese dioxide electrolyte, voltage acceleration is performed instead.

The Navy's Crane NAD facility completed testing on solid tantalum capacitors from several manufacturers in late 1981. During testing, acceleration factors (A.F.) were derived from life test results and the following formula used:

$A.F. = 7.034 \times 10\text{-}9\ e\ (18.7724\ V_s/V_r)$

V_s = Voltage stress

V_r = Rated voltage of unit under test

The acceleration factors used in MIL-C-39003 are as shown:

V_s/V_r	A.F.
1.0	1.0
1.1	6.53
1.2	42.7
1.3	279.0
1.4	1824.0
1.5	-
1.527	11 923.0
FOR EXAMPLE:	20 000.00

If a 15 µF, 20 V part is placed on test for 1 h at + 85 °C and 26 V ($V_s/V_r = 1.3$), this is equivalent to 279 hours of testing at + 85 °C and 20 V (exponential grading).

To explain the Weibull analysis, several formulas must be shown. The basic Weibull formula is as shown:

$$F(x) = 1 - e^{\left(\frac{t\beta}{\alpha}\right)}$$

F(x) = Cumulative fraction failed (P) at time (t)

t = Actual test time

β = Weibull shape parameter (beta)

α = Weibull scale parameter (alpha)

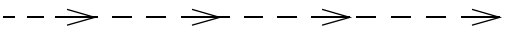
To calculate Weibull failure rates, special burn-in ovens must be used which will record an actual time to failure for each of the units on test.

To perform the test, 100 % of the units (or 500 pieces whichever is less) are placed in the Weibull oven and taken to test conditions (+ 85 °C and voltage stress per the acceleration factors chosen). For lots over 500 pieces, the balance of the lot is placed in a standard burn-in oven at the same Weibull conditions. Failures that occur during the start-up are not used in the calculation. After test conditions are reached (< 5 min), the start time is considered to be t_0.

A count of good pieces is taken at no later than 15 minutes after t_0. This will be the sample size. At least two hours after t_0, the number of failures are counted. If no failures occur, the lot must be put back on test and recounted after 10 h.

WEIBULL DISTRIBUTION METHOD FOR DETERMINING FAILURE RATE, MIL-PRF-39003 (Cont'd)

If no failures occur, the lot can be re-started at a higher stress level only once. If no failures occur at the higher stress level, the lot is not suitable for Weibull analysis.



t_0 15 min 2 h ≤ t_1 ≤ 10 h 40 h

After a minimum of 40 h, the failure count is again taken. If no further failures occur, one is added to the count. Failure rate is calculated by the following:

$$Z(t) = [-\beta\ 1n\ (1 - P2)105]/t_2\ A.F.$$

Where

Z(t) = Failure Rate

β = Weibull shape parameter (slope of the line between t_1 and t_2 graphed on paper with a 1n (t) abscissa and 1n 1n (1/(1-P)) ordinate

P = Ratio of failures to units on test at stop time

t_2 = Number of hours on test

A.F. = Acceleration Factor

The failure rate can be calculated from the previous formula as follows:

$Z(t) = [-\beta\ 1n\ (1 - P)105]/t\ A.F.$

$Z(t) = [-\ 0.2119\ 1n\ (1 - 0.0326)\ 105]/40\ (17356)$

$Z(t) = [-\ 0.2119\ (-\ 0.0331)\ 105]/6.9424\ (105)$

$Z(t) = [0.0070/6.9424]$

$Z(t) = 0.0010\ \%/1000\ h$

ACTUAL WEIBULL TEST ANALYSIS FOR THE VISHAY SPRAGUE EQUIPMENT

SPRAGUE ELECTRIC COMPANY
SANFORD MAINE

WEIBULL TEST ANALYSIS
(TWO POINT)

OVEN NUMBER: 4 ZONE NUMBER: 10

LOT NUMBER : H5398-02
OPERATOR : B KIMBALL
FAMILY : 576D DTN
RATING : 220-10
CASE : S
TOTAL PARTS ON TEST : 468
POWDER LOT : 9468

START DATE : 17 Nov 1997
START TIME : 18:45:00
END DATE : 19 Nov 1997
END TIME : 10:45:00
APPLIED VOLTAGE : 15.3
ACCELERATION FACTOR : 20000

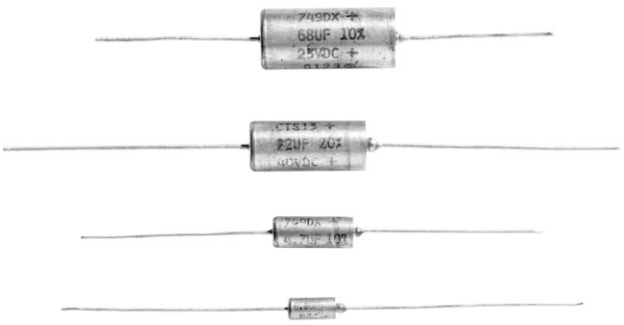
HOURS ON TEST	# OF FAILURES	CUM % FAIL
0.00	0	0.00
..17	0	0.00
2.00	2	.43
40.00	7	1.50
Total # of failures	7	1.50

THE CURRENT FAILURE RATE IS .00079 D Level

ALPHA= 312.4013
BETA = .41998

OPERATOR B. Kimball mell Q.A.R./ENG. Rita Thibeault

Hermetically Sealed, Axial-Lead, to CECC Specifications



FEATURES

- Terminations: Tin/lead (SnPb), 100 % Tin (RoHS compliant)
- Hermetically sealed metal case with plastic film insulation
- Extended capacitance range (type 749DX)
- High operational stability with both time and temperature
- Low leakage current
- Low dissipation factor

Available

RoHS* COMPLIANT

APPLICATIONS

Performance and reliability has been proven in a wide range of applications such as: filtering, by-pass, coupling, energy storage, timing circuits.

PERFORMANCE CHARACTERISTICS

Operating Temperature:

- 55 °C to + 85 °C (types CTS13)
- 55 °C to + 125 °C (types CTS1, 749DX)

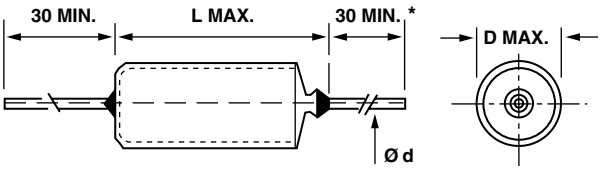
SPECIFICATIONS

CECC		BS	
30201-001	749DX	9073-N001	749DX
30201-002	CTS1		
30201-005	CTS13		
30201-011/012	749DX	**IECQ**	
30201-029	749DX		

ORDERING INFORMATION

CTS13	105	X0	040	A	2	P	E3
TYPE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	STYLE NUMBER	PACKAGING	ROHS COMPLIANT
Identifies the Basic Capacitor Design CTS1 = CECC 30201-002 CTS13 = CECC 30201-005 749DX = CECC 30201-001/011/012/029	Expressed in picofarads. First two digits are significant. Third digit is the number of zeros following.	X0 = ± 20 % X9 = ± 10 % X5 = ± 5 % (Special Order)	Expressed in volts. Where necessary, zeros precede the voltage rating to complete the 3 digit block 6R3 = 6.3 V	See Table Ratings and Case Codes.	0 = Bare Case 2 = Plastic-Film Insulation	See Taping and Packaging	E3 = 100 % Tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in millimeters



*** 23 mm MAX. FOR TAPED CAPACITORS**

CASE CODE	BS D MAX.	NF D MAX.	L MAX.	+ 10 % Ø d - 0.05
A	3.6	3.8	10.2	0.5
B	4.9	5.1	15.0	0.5
C	7.5	7.7	20.5	0.6
D	9.1	9.3	24.0	0.6

* Pb containing terminations are not RoHS compliant, exemptions may apply

TYPE CTS1: STANDARD RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R (+ 85 °C)									
	6.3 V	10 V	16 V	25 V	40 V	50 V	53 V	80 V	100 V	125 V
	CATEGORY VOLTAGE U_C (+ 125 °C)									
	4 V	6.3 V	10 V	13 V	25 V	33 V	40 V	50 V	67 V	82 V
0.10							**A**	**A**	**A**	**A**
0.12							A	A	A	A
0.15							**A**	**A**	**A**	**A**
0.18							A	A	A	A
0.22							**A**	**A**	**A**	**A**
0.27						A	A	A	A	A
0.33						**A**	**A**	**A**	**A**	**A**
0.39						A	A	A	A	B
0.47					**A**	**A**	**A**	**A**	**A**	**B**
0.56					A	A	A	A	A	B
0.68					**A**	**A**	**A**	**A**	**B**	**B**
0.82					A	A	B	B	B	B
1.0					**A**	**A**	**B**	**B**	**B**	**B**
1.2					A	B	B	B	B	B
1.5				**A**	**B**	**B**	**B**	**B**	**B**	**B**
1.8			A		B	B	B	B	B	B
2.2			**A**		**B**	**B**	**B**	**B**	**B**	**B**
2.7			A		B	B	B	B	B	
3.3			**A**		**B**	**B**	**B**	**B**	**C**	
3.9		A			B	B	B	B	C	
4.7		**A**			**B**	**B**	**C**	**C**	**C**	
5.6	A				B	C	C	C	C	
6.8	**A**				**B**	**C**	**C**	**C**	**C**	
8.2				B	C	C	C	C		
10				**B**	**C**	**C**	**C**	**C**		
12			B		C	C	D	D		
15			**B**		**C**	**C**	**D**	**D**		
18			B		C	C	D			
22			**B**		**C**	**D**				
27		B		C	D					
33		**B**		**C**	**D**					
39	B		C		D					
47	**B**		**C**		**D**					
56	B		C	D						
68			**C**	**D**						
82		C	D							
100		**C**	**D**							
120	C		D							
150	**C**		**D**							
180		D								
220		**D**								
270	D									
330	**D**									

Note:
Preferred ratings are in bold characters. Non-preferred ratings are available only with a capacitance tolerance of ± 10 % or ± 5 % (special order).

TYPE CTS13: STANDARD RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R (+ 85 °C)							
	6.3 V	10 V	16 V	20 V	25V	40 V	50 V	63 V
0.10						**A**	**A**	**A**
0.12						A	A	A
0.15						**A**	**A**	**A**
0.18						A	A	A
0.22						**A**	**A**	**A**
0.27						A	A	A
0.33						**A**	**A**	**A**
0.39						A	A	A
0.47						**A**	**A**	**A**
0.56						A	A	A
0.68						**A**	**A**	**A**
0.82						A	A	B
1.0						**A**	**A**	**B**
1.2					A	A	B	B
1.5					**A**	**B**	**B**	**B**
1.8				A		B	B	B
2.2				**A**		**B**	**B**	**B**
2.7			A			B	B	B
3.3			**A**			**B**	**B**	**B**
3.9		A				B	B	B
4.7		**A**				**B**	**B**	**C**
5.6	A					B	C	C
6.8	**A**					**B**	**C**	**C**
8.2					B	C	C	C
10					**B**	**C**	**C**	**C**
12				B		C	C	D
15				**B**		**C**	**C**	**D**
18			B			C	C	D
22			**B**			**C**	**D**	
27		B			C	D		
33		**B**			**C**	**D**		
39	B			C		D		
47	**B**			**C**		**D**		
56	B		C		D			
68			**C**		**D**			
82		C		D				
100		**C**		**D**				
120	C		D					
150	**C**		**D**					
180		D						
220		**D**						
270	D							
330	**D**							

Note:
Preferred ratings are in bold characters. Non-preferred ratings are available only with a capacitance tolerance of ± 10 % or ± 5 % (special order).

TYPE 749DX: STANDARD RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R (+ 85 °C)								
	6.3 V	10 V	16 V	20 V	25 V	35 V	40 V	50 V	63 V
	CATEGORY VOLTAGE U_C (+ 125 °C)								
	4 V	6.3 V	10 V	13 V	16 V	23 V	25 V	33 V	40 V
0.068								A	
0.085								A	
0.10						**A**	**A**		**A**
0.12						A	A		A
0.15						**A**	**A**		**A**
0.18						A	A		A
0.22						**A**	**A**		**A**
0.27						A	A		A
0.33						**A**	**A**		**A**
0.39						A	A		A
0.47						**A**	**A**		**A**
0.56						A	A		A
0.68						**A**	**A**		**A**
0.82						A	A	A	B
1.0						**A**	**A**	**A**	**B**
1.2					A	B	B	B	B
1.5					**A**	**B**	**B**	**B**	**B**
1.8				A		B	B	B	B
2.2				**A**		**B**	**B**	**B**	**B**
2.7			A			B	B	B	B
3.3			**A**			**B**	**B**	**B**	**B**
3.9		A				B	B	B	B
4.7		**A**				**B**	**B**	(1)	**C**
5.6	A					B	B	C	C
6.8	**A**					(1)	(1)	**C**	**C**
8.2					B	C	C	C	C
10					**B**	**C**	**C**	**C**	**C**
12				B		C	C	C	D
15				**B**		**C**	**C**	**C**	**D**
18			B			C	C	C	D
22			**B**			**C**	**C**	**D**	
27		B			C	D	D		
33		**B**			**C**	**D**	**D**		
39		B		C		D	D		
47	**B**			**C**		**D**			
56	B		C		D	(1)			
68			**C**		**D**				
82		C		D					
100		**C**		**D**					
120		C	D						
150	**C**		**D**						
180	C	D							
220		**D**							
270	D								
330	**D**								

Note:
(1) See extended range page
Preferred ratings are in bold characters. Non-preferred ratings are available only with a capacitance tolerance of ± 10 % or ± 5 % (special order).

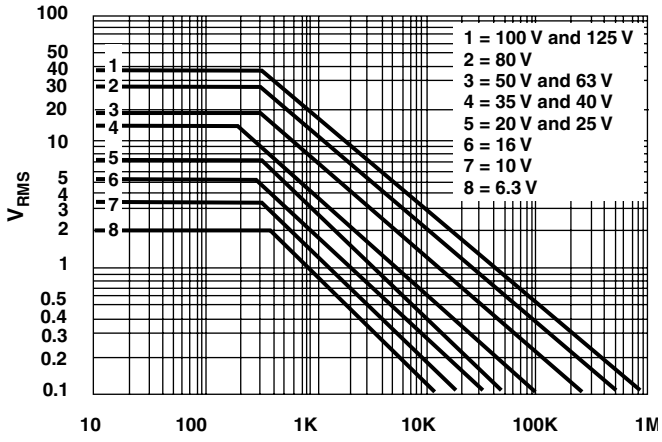
TYPE 749DX: EXTENDED RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R (+ 85 °C)						
	6.3 V	10 V	16 V	20 V	25 V	35 V	50 V
	CATEGORY VOLTAGE U_C (+ 125 °C)						
	4 V	6.3 V	10 V	13 V	16 V	23 V	32 V
1.2						A	A
1.5						**A**	**A**
1.8						A	
2.2					**A**		
2.7					A		
3.3					**A**		
3.9			A	A			
4.7			**A**	**A**			**B**
5.6			A				B
6.8			**A**			**B**	
8.2		A				B	
10		**A**					
12	A				B		
15	**A**				**B**		
18				B	B		
22				**B**			**C**
27			B			C	D
33			**B**			**C**	**D**
39			B			C	D
47		**B**				**C**	
56		B			C	D	
68		**B**			**C**	**D**	
82		B			D		
100	**B**		**C**	**C**	**D**		
120	B		C	C	D		
150			**C**		**D**		
180			C	D			
220		**C**	**D**	**D**			
270		C	D				
330	**C**	**D**	**D**				
390	C	D					
470	**C**	**D**					
560		D					
680	**D**						
820	D						
1000	**D**						

Note:
Preferred ratings are in bold characters. Non-preferred ratings are available only with a capacitance tolerance of ± 10 % or ± 5 % (special order).

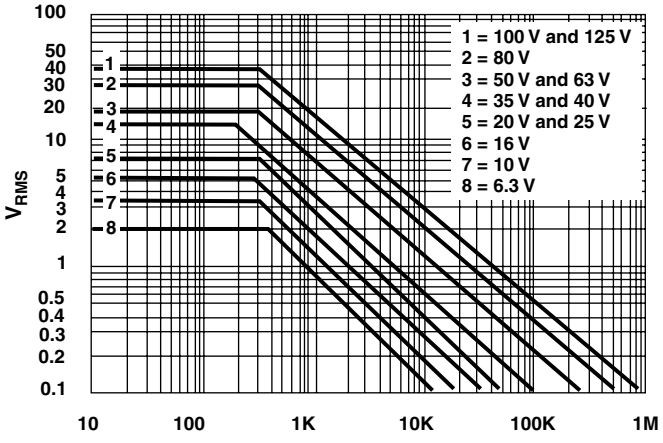
TYPICAL CURVES RIPPLE VOLTAGE AT + 25 °C

CASE "A" CAPACITORS



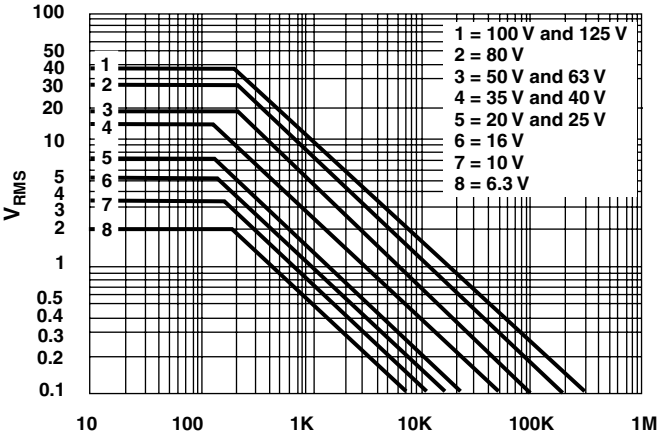
FREQUENCY IN Hz

CASE "B" CAPACITORS



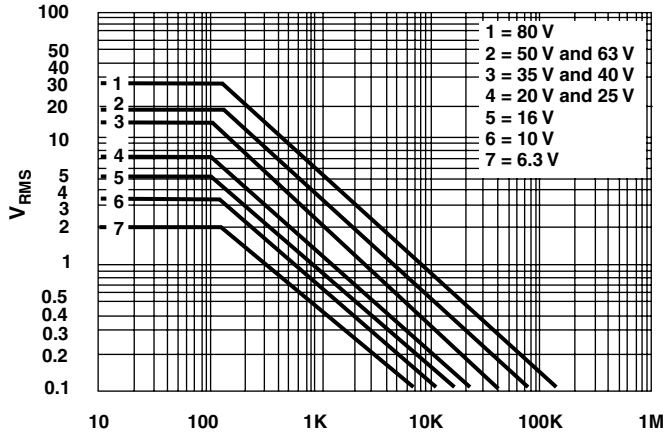
FREQUENCY IN Hz

CASE "C" CAPACITORS



FREQUENCY IN Hz

CASE "D" CAPACITORS



FREQUENCY IN Hz

PERFORMANCE CHARACTERISTICS

1. Operating Temperature:

- 55 °C to + 85 °C with rated DC voltage UR applied, + 85 °C to + 125 °C with linear voltage derating to category voltage UC (only for types CTS1, 749DX).

2. Capacitance and Tolerance:

Capacitance measured at 100 Hz and + 25 °C shall be within the specified tolerance limits of the nominal rating. Capacitance measurement shall be made by means of a polarized capacitance bridge. The polarizing voltage shall be of 2.2 V. The maximum voltage applied during measurements shall be 1.0 V_{rms} at 100 Hz and + 25 °C.

3. Reverse Voltage:

These capacitors are capable of withstanding peak voltage in the reverse direction equal to: 15 % of the rated DC voltage at + 25 °C, 5 % of the rated DC voltage at + 85 °C.

4.Surge Voltage:

Table 1

PRODUCT TYPE	SURGE VOLTAGE AT + 85 °C	SURGE VOLTAGE AT + 125 °C
CTS13	1.30 U_R	-
749DX/CTS1	1.30 U_R	1.30 U_C

Capacitors shall withstand the surge voltage applied in series with a 1000 W resistor, at the rate of 1.5 minute on, 5.5 minute off, for 1000 successive test cycles at + 85 °C or at + 125 °C. After test, dissipation factor and leakage current shall meet the initial requirements at + 25 °C (see below), capacitance change shall not exceed ± 10 % of initial value at + 25 °C.

5. Leakage current:

Rated voltage UR shall be applied to capacitors during five minutes with a resistor of 1000 Ω in series with each capacitor, before making DC leakage current measurements. The leakage current shall not exceed the following limits:

Table 2

TEMPERATURE	CTS1/CTS13/749DX
+ 25 °C	0.01 C_R x U_R or 1 µA whichever is greater
+ 85 °C	0.1 C_R x U_R or 10 µA whichever is greater
+ 125 °C	0.125 C_R x U_R or 12.5 µA whichever is greater

6. Dissipation factor:

The dissipation factor, when measured at 100 Hz, shall not exceed the values below:

Table 3

TEMP.	CTS1/CTS13		749DX	
	$C_RU_R \leq 1900$	$C_RU_R > 1900$	$C_R \leq 100$	$C_R > 100$
- 55 °C	9 %	11 %	8 %	10 %
+ 25 °C	6 %	8 %	6 %	8 %
+ 85 °C	9 %	11 %	-	-
+ 125 °C (1)	12 %	14 %	10 %	11 %

Note: (1) not applicable for CTS13

7. Stability at low and high temperature:

Capacitance change with temperature shall not exceed the limits of the following table, leakage current and dissipation factor shall be within the limits specified in Tables 2 and 3.

Table 4

TEMPERATURE	CTS1/CTS13/749DX
- 55 °C	- 10 %
+ 85 °C	+ 12 %
+ 125 °C (2)	+ 15 %

Note: (2) not applicable for CTS13

8. Impedance:

The impedance measured at 100 kHz and 25 °C shall not exceed the following values:

Table 5

CASE CODE	Z (Ω)(3)
A	10
B	5
C	2
D	1

Note: (3) not applicable for $C_R \leq 0.68$ µF

9. Life test:

After 2000 h at + 85 °C with rated DC voltage applied, or after 2000 h at + 125 °C with category DC voltage applied (for types CTS1, 749DX only) capacitors shall meet the requirements in table 6.

Table 6

PRODUCT TYPE	CAPACITANCE CHANGE	DISSIPATION FACTOR	DC LEAKAGE CURRENT
CTS1 CTS13 749DX	Within ± 10 % of initial value at + 25 °C	Within initial requirement at + 25 °C	Within 125 % of initial requirements at + 25 °C

PERFORMANCE CHARACTERISTICS

(Continued)

10. Humidity test:

After 56 days (1350 h) at + 40 °C, 90 to 95 % of relative humidity (per IEC 68-2-3) with no voltage applied, capacitors shall meet the requirements in table 7 below.

Table 7

CAPACITANCE CHANGE	Within ± 3 % of initial value
DC LEAKAGE CURRENT	Within initial requirement at + 25 °C -Table 2
DISSIPATION FACTOR	Within initial requirement at + 25 °C - Table 3

Table 8

CAPACITANCE CHANGE	Within ± 5 % of initial value at + 25 °C
DC LEAKAGE CURRENT	Within initial requirement at + 25 °C - Table 2
DISSIPATION FACTOR	Within initial requirement at + 25 °C - Table 3

Typical values of charge-discharge current (per above test conditions).

RATED VOLTAGE U_R (V)	CHARGE-DISCHARGE CURRENT (A)
6.3	13
10	20
16	32
25	50
40	80
50	100
63	126

12. Insulation test:

For capacitors with insulating sleeves, a DC voltage of 100 V shall be applied for one minute between the case of the capacitor and a metal "V" block in intimate contact with the insulating sleeve. The insulating resistance measured in these conditions shall be at least 100 MΩ.

13. Lead pull test:

Leads shall withstand the following test (IEC 68 - 2 - 2): Tensile stress of 5N (cases A and B) or 10N (cases C and D) for 10 s in any direction

One bend in each direction
Two cosecutive rotations of 180°

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 W at + 25 °C as given below
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:

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

where,
Z = The capacitor Impedance at the specified frequency.

The calculations are summarized on the graphs page 59 giving the maximum available ripple voltage as a function of frequency.

However, the sum of the peak AC voltage plus the DC voltage shall not exceed the rated DC voltage at + 85 °C of the capacitor. The sum of the negative peak AC voltage plus the DC voltage shall not allow a voltage reversal exceeding 15 % of the rated DC voltage.

3. AC Ripple Current or Voltage Derating Factor:

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 in the table below:

TEMPERATURE	DERATING FACTOR
+ 25 °C	1.0
+ 55 °C	0.8
+ 85 °C	0.6
+ 125 °C	0.4

4. Power Dissipation:

Power dissipation will be affected by the heat sinking capability of the mounting surface. Non-sinusoidial ripple current may produce heating effects which differ from those shown in the following table. It is important that the equivalent Irms value be established when calculating permissible operating levels.

CASE CODE	POWER DISSIPATION AT + 25 °C (W)
A	0.115
B	0.145
C	0.185
D	0.225

TAPE AND REEL PACKING

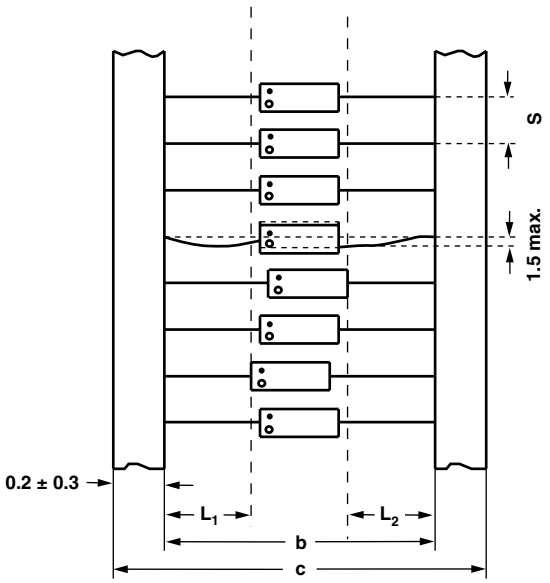
MEETS IEC 286-1

L_1 - L_2 = 1.5 mm max.

S = component spacing (cumulative tolerance on 20 units = 4 mm)

b = tape spacing

c = overall length



DIMENSIONS in millimeters

CASE SIZE	REEL AND AMMO S	REEL PACK					AMMO PACK			BULK
		OPTION P		OPTION R		QTY PER REEL	OPTION G		QTY PER BOX	QTY PER PACK
		b	c MAX.	b	c MAX.		b	c MAX.		
A	5.0 ± 0.3	63 ± 2	78	53 ± 2	68	1000	53 ± 2	68	500	100
B	5.0 ± 0.3	63 ± 2	78	53 ± 2	68	1000	53 ± 2	68	500	75
C	10.0 ± 0.3	63 ± 2	78	63 ± 2	78	500	53 ± 2	68	250	50
D	10.0 ± 0.3	63 ± 2	78	63 ± 2	78	500	53 ± 2	68	250	25
PACKAGING CODE		P		R			G			B

MARKING

Capacitors shall be marked with SPRAGUE and/or the registered trademark 2 at vendor‘s option; the type number; rated capacitance and tolerance (with a letter code, if different from ± 20 %, K = ± 10 % ; J = ± 5 %) ; rated DC voltage at + 85 °C and the date code of manufacture.

Capacitors shall be marked on one end with a “plus” sign (+) to identify the positive terminal.

Subminiature Case

Contents

Subminiature, Leaded Solid Tantalum Capacitors

FEATURES

- Rectangular case with radial leads
- 2 to 35 VDC
- 0.1 µF to 220 µF
- Operating temperature range: - 55 °C to + 85 °C
- Qualified to MIL-PRF-49137

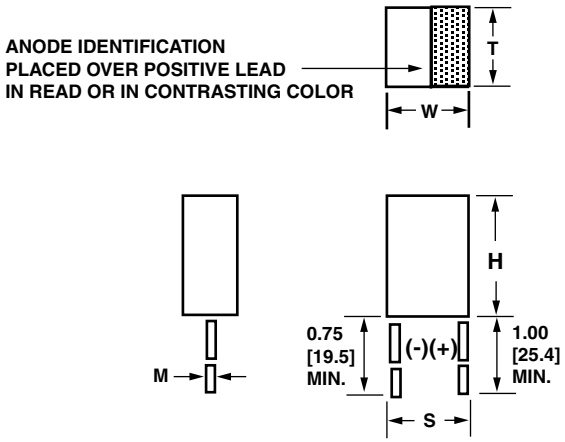
ORDERING INFORMATION

CX	06	A	474	M
MODEL	LEAD CONFIGURATION	VOLTAGE	CAPACITANCE	CAPACITANCE TOLERANCE
	0 = Radial			M = ± 20 % K = ± 10 %

Example: CX06A474M

DIMENSIONS in inches [millimeters]

RADIAL



CASE CODE	T MAX.	W MAX.	H MAX.	M ± 0.002 [± 0.051]	S
A	0.040 [1.02]	0.050 [1.27]	0.100 [2.54]	0.007 [0.18]	0.030 ± 0.015 [0.76 ± 0.38]
B	0.040 [1.02]	0.070 [1.78]	0.125 [3.18]	0.010 [0.25]	0.050 ± 0.015 [1.27 ± 0.38]
C	0.070 [1.78]	0.120 [3.05]	0.165 [4.19]	0.010 [0.25]	0.100 ± 0.020 [2.54 ± 0.51]
D	0.075 [1.91]	0.185 [4.70]	0.225 [5.72]	0.010 [0.25]	0.150 ± 0.020 [3.81 ± 0.51]
E	0.110 [2.79]	0.220 [5.59]	0.290 [7.37]	0.016 [0.41]	0.180 ± 0.025 [4.57 ± 0.64]
F	0.130 [3.30]	0.230 [5.84]	0.310 [7.87]	0.016 [0.41]	0.200 ± 0.025 [5.08 ± 0.64]
G	0.150 [3.81]	0.375 [9.53]	0.475 [12.07]	0.016 [0.41]	0.300 ± 0.025 [7.62 ± 0.64]

STANDARD RATINGS				
CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
0.47	10	0.5	A	CX06A474-(1)
2.2	10	0.5	B	CX06A225-(1)
10	10	0.5	C	CX06A106-(1)
3 WVDC AT + 85 °C				
1.5	10	0.5	B	CX06B155-(1)
6.8	10	0.5	C	CX06B685-(1)
22	10	1	D	CX06B226-(1)
220	15	9	G	CX06B227-(1)
4 WVDC AT + 85 °C				
0.33	10	0.5	A	CX06C334-(1)
1	8	0.5	B	CX06C105-(1)
4.7	8	0.5	C	CX06C475-(1)
15	8	1	D	CX06C156-(1)
47	8	2	E	CX06C476-(1)
68	8	3	F	CX06C686-(1)
6 WVDC AT + 85 °C				
0.22	10	0.5	A	CX06D224-(1)
0.68	6	0.5	B	CX06D684-(1)
3.3	6	0.5	C	CX06D335-(1)
10	6	1	D	CX06D106-(1)
33	6	2	E	CX06D336-(1)
47	6	3	F	CX06D476-(1)
150	10	9	G	CX06D157-(1)
10 WVDC AT + 85 °C				
0.15	10	0.5	A	CX06F154-(1)
0.47	6	0.5	B	CX06F474-(1)
2.2	6	0.5	C	CX06F225-(1)
6.8	6	1	D	CX06F685-(1)
22	6	2	E	CX06F226-(1)
33	6	3	F	CX06F336-(1)
100	8	9	G	CX06F107-(1)
15 WVDC AT + 85 °C				
0.10	10	0.5	A	CX06H104-(1)
0.33	6	0.5	B	CX06H334-(1)
1.5	6	0.5	C	CX06H155-(1)
15	6	2	E	CX06H156-(1)
22	6	3	F	CX06H226-(1)
68	8	9	G	CX06H686-(1)

Note:

(1) Add suffix to indicate capacitance tolerance K = ± 10 % or M = ± 20 %

STANDARD RATINGS				
CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
20 WVDC AT + 85 °C				
0.10	6	0.5	B	CX06J104-(1)
0.15	6	0.5	B	CX06J154-(1)
0.22	6	0.5	B	CX06J224-(1)
1	6	0.5	C	CX06J105-(1)
3.3	6	1	D	CX06J335-(1)
4.7	6	1	D	CX06J475-(1)
10	6	2	E	CX06J106-(1)
15	6	3	F	CX06J156-(1)
47	8	9	G	CX06J476-(1)
25 WVDC AT + 85 °C				
0.68	6	0.5	C	CX06K684-(1)
2.2	6	1	D	CX06K225-(1)
6.8	6	2	E	CX06K685-(1)
10	6	3	F	CX06K106-(1)
33	6	9	G	CX06K336-(1)
35 WVDC AT + 85 °C				
0.10	6	0.5	C	CX06M104-(1)
0.15	6	0.5	C	CX06M154-(1)
0.22	6	0.5	C	CX06M224-(1)
0.33	6	0.5	C	CX06M334-(1)
0.47	6	0.5	C	CX06M474-(1)
0.68	6	1	D	CX06M684-(1)
1	6	1	D	CX06M105-(1)
1.5	6	1	D	CX06M155-(1)
2.2	6	2	E	CX06M225-(1)
3.3	6	2	E	CX06M335-(1)
4.7	6	2	E	CX06M475-(1)
6.8	6	3	F	CX06M685-(1)
10	6	9	G	CX06M106-(1)
15	6	9	G	CX06M156-(1)
22	6	9	G	CX06M226-(1)

Note:

(1) Add suffix to indicate capacitance tolerance K = ± 10 % or M = ± 20 %

Subminiature, Leaded Solid Tantalum Capacitors

FEATURES

- Axial leads
- 2 to 35 VDC
- 0.1 µF to 220 µF
- Operating temperature range: - 55 °C to + 85 °C
- Qualified to MIL-PRF-49137

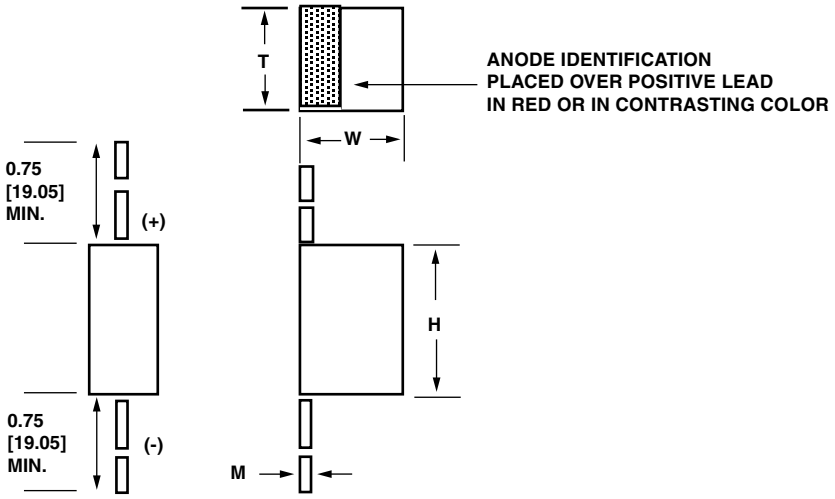
ORDERING INFORMATION

CX	06	A	474	M
MODEL	LEAD CONFIGURATION	VOLTAGE	CAPACITANCE	CAPACITANCE TOLERANCE
	1 = Axial			M = ± 20 % K = ± 10 %

Example: CX16A474M

DIMENSIONS in inches [millimeters]

AXIAL



CASE CODE	T MAX.	W MAX.	H MAX.	M ± 0.002 [± 0.051]
A	0.040 [1.02]	0.050 [1.27]	0.100 [2.54]	0.007 [0.18]
B	0.040 [1.02]	0.070 [1.78]	0.125 [3.18]	0.010 [0.25]
C	0.070 [1.78]	0.120 [3.05]	0.165 [4.19]	0.010 [0.25]
D	0.075 [1.91]	0.185 [4.70]	0.225 [5.72]	0.010 [0.25]
E	0.110 [2.79]	0.220 [5.59]	0.290 [7.37]	0.016 [0.41]
F	0.130 [3.30]	0.230 [5.84]	0.310 [7.87]	0.016 [0.41]
G	0.150 [3.81]	0.375 [9.53]	0.475 [12.07]	0.016 [0.41]

STANDARD RATINGS				
CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
0.47	10	0.5	A	CX16A474-(1)
2.2	10	0.5	B	CX16A225-(1)
10	10	0.5	C	CX16A106-(1)
3 WVDC AT + 85 °C				
1.5	10	0.5	B	CX16B155-(1)
6.8	10	0.5	C	CX16B685-(1)
22	10	1	D	CX16B226-(1)
220	15	9	G	CX16B227-(1)
4 WVDC AT + 85 °C				
0.33	10	0.5	A	CX16C334-(1)
1	8	0.5	B	CX16C105-(1)
4.7	8	0.5	C	CX16C475-(1)
15	8	1	D	CX16C156-(1)
47	8	2	E	CX16C476-(1)
68	8	3	F	CX16C686-(1)
6 WVDC AT + 85 °C				
0.22	10	0.5	A	CX16D224-(1)
0.68	6	0.5	B	CX16D684-(1)
3.3	6	0.5	C	CX16D335-(1)
10	6	1	D	CX16D106-(1)
33	6	2	E	CX16D336-(1)
47	6	3	F	CX16D476-(1)
150	10	9	G	CX16D157-(1)
10 WVDC AT + 85 °C				
0.15	10	0.5	A	CX16F154-(1)
0.47	6	0.5	B	CX16F474-(1)
2.2	6	0.5	C	CX16F225-(1)
6.8	6	1	D	CX16F685-(1)
22	6	2	E	CX16F226-(1)
33	6	3	F	CX16F336-(1)
100	8	9	G	CX16F107-(1)
15 WVDC AT + 85 °C				
0.10	10	0.5	A	CX16H104-(1)
0.33	6	0.5	B	CX16H334-(1)
1.5	6	0.5	C	CX16H155-(1)
15	6	2	E	CX16H156-(1)
22	6	3	F	CX16H226-(1)
68	8	9	G	CX16H686-(1)

Note:

(1) Add suffix to indicate capacitance tolerance K = ± 10 % or M = ± 20 %

STANDARD RATINGS				
CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
20 WVDC AT + 85 °C				
0.10	6	0.5	B	CX16J104-(1)
0.15	6	0.5	B	CX16J154-(1)
0.22	6	0.5	B	CX16J224-(1)
1	6	0.5	C	CX16J105-(1)
3.3	6	1	D	CX16J335-(1)
4.7	6	1	D	CX16J475-(1)
10	6	2	E	CX16J106-(1)
15	6	3	F	CX16J156-(1)
47	8	9	G	CX16J476-(1)
25 WVDC AT + 85 °C				
0.68	6	0.5	C	CX16K684-(1)
2.2	6	1	D	CX16K225-(1)
6.8	6	2	E	CX16K685-(1)
10	6	3	F	CX16K106-(1)
33	6	9	G	CX16K336-(1)
35 WVDC AT + 85 °C				
0.10	6	0.5	C	CX16M104-(1)
0.15	6	0.5	C	CX16M154-(1)
0.22	6	0.5	C	CX16M224-(1)
0.33	6	0.5	C	CX16M334-(1)
0.47	6	0.5	C	CX16M474-(1)
0.68	6	1	D	CX16M684-(1)
1	6	1	D	CX16M105-(1)
1.5	6	1	D	CX16M155-(1)
2.2	6	2	E	CX16M225-(1)
3.3	6	2	E	CX16M335-(1)
4.7	6	2	E	CX16M475-(1)
6.8	6	3	F	CX16M685-(1)
10	6	9	G	CX16M106-(1)
15	6	9	G	CX16M156-(1)
22	6	9	G	CX16M226-(1)

Note:

(1) Add suffix to indicate capacitance tolerance K = ± 10 % or M = ± 20 %

Subminiature, Leaded Solid Tantalum Capacitors Polar or Non-Polar

FEATURES

- Subminiature package size and light weight
- Cylindrical case with axial or radial leads
- 2 to 50 VDC
- 0.001 µF to 68 µF
- Operating temperature range: - 55 °C to + 125 °C
- High stability and reliability
- Tested in accordance with MIL-PRF-49137
- Unique and comprehensive custom design capability

ELECTRICAL CHARACTERISTICS

Operating temperature range: - 55 °C to + 125 °C

Capacitance: Measured at 120 Hz and 25 °C with a maximum of 2.2 VDC bias and 1.0 V_{rms} signal.

Capacitance Tolerance: Standard tolerance is ± 20 % for ratings 0.1 µF and above, and + 40, - 20 % for ratings below 0.1 µF. Special tolerances are also available.

Dissipation Factor: When measured simultaneously with capacitance, DF shall not exceed the value shown in the ratings tables.

DC Leakage Current (DCL Max):

When measured with DC voltage applied through a 1000 Ω resistor for 5 min, DC leakage (µA) shall not exceed:

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 and 66 % of rated voltage: Leakage current shall not exceed 15 times the values listed in the Standard Ratings Tables.

Operating Voltage: Full working voltage up to 85 °C. From 85 °C to 125 °C working voltage derates linearly to 66 % of the 85 °C working voltage.

APPLICATIONS

- Hearing aids
- Portable communications
- Space/avionics
- Laptop computers

MECHANICAL SPECIFICATIONS

Solder coated nickel leads (type N32 per MIL-STD-1276) are standard on all case sizes.

Leads are weldable and/or solderable.

Special leads are available on request (e.g. bare nickle, gold plated nickle or ribbon leads).

Lead length is 1 1/2" [38.1 mm] minimum on nonpolar parts.

On polar parts the negative lead is 1 1/4" [31.8 mm] minimum and the positive lead is 1 1/2" [38.1 mm] minimum.

ORDERING INFORMATION

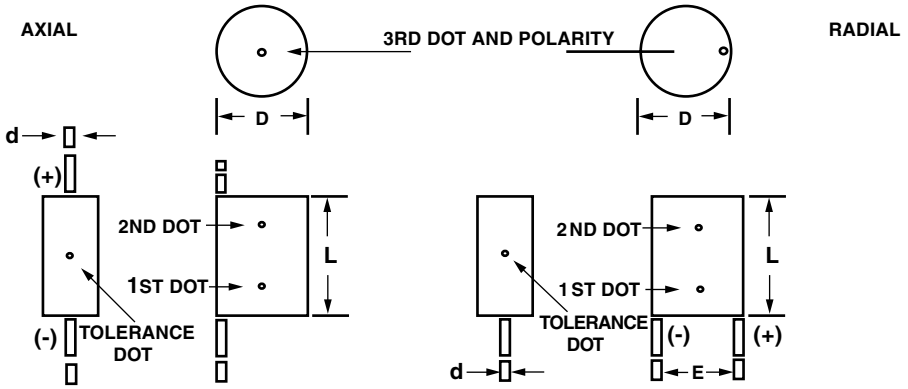
HA	1.0	35	C7	A*	M
MODEL	CAPACITANCE IN µF	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD CONFIGURATION	CAPACITANCE TOLERANCE
			C = Polar N = Non-polar	A = Axial R = Radial	E = + 40, - 20 % M = ± 20 % K = ± 10 % J = ± 5 %

Example of Part Number Code: HA1.0-35C7AM

* To complete part number in rating tables, add A or R.
Change suffix if special capacitance tolerance is required.

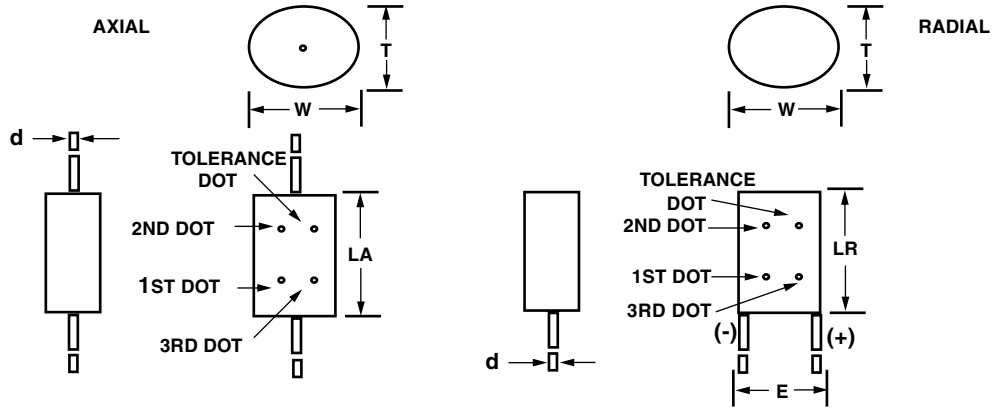
DIMENSIONS in inches [millimeters]

POLAR STYLE



CASE CODE	MAX. L	MAX. D	MAX. E	E TOL. ±	d
C0	0.100 [2.54]	0.057 [1.45]	0.030 [0.76]	0.015 [0.38]	0.007[0.18]
C1	0.110 [2.80]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C2	0.125 [3.18]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C3	0.145 [3.68]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C4	0.160 [4.06]	0.070 [1.78]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C5	0.160 [4.06]	0.077 [1.96]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C6	0.190 [4.83]	0.077 [1.96]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C7	0.200 [5.08]	0.080 [2.03]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C8	0.225 [5.72]	0.100 [2.54]	0.070 [1.78]	0.020 [0.51]	0.010 [0.25]
C9	0.250 [6.35]	0.150 [3.81]	0.120 [3.05]	0.025 [0.64]	0.016 [0.41]

NON POLAR STYLE



CASE CODE	MAX. LA	MAX. LR	MAX. W	MAX. T	E	E TOL. ±	d
N1	0.175 [4.45]	0.135 [3.43]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N2	0.210 [5.33]	0.160 [4.06]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N3	0.240 [6.10]	0.200 [5.08]	0.140 [3.56]	0.080 [2.03]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N4	0.275 [6.99]	0.235 [5.97]	0.190 [4.83]	0.105 [2.67]	0.125 [3.18]	0.020 [0.51]	0.010 [0.25]
N5	0.310 [7.87]	0.270 [6.86]	0.290 [7.37]	0.155 [3.94]	0.200 [5.08]	0.025 [0.64]	0.016 [0.41]

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
0.47	10	0.5	C0	HA.47-2C0 (1)M
1.5	10	0.5	C1	HA1.5-2C1 (1)M
2.2	10	0.5	C2	HA2.2-2C2 (1)M
3.3	10	0.5	C3	HA3.3-2C3 (1)M
4.7	10	0.5	C4	HA4.7-2C4 (1)M
6.8	10	0.5	C5	HA6.8-2C5 (1)M
10	10	0.5	C6	HA10-2C6 (1)M
15	10	0.5	C7	HA15-2C7 (1)M
22	10	1.0	C8	HA22-2C8 (1)M
68	10	1.5	C9	HA68-2C9 (1)M
3 WVDC AT + 85 °C				
1.0	10	0.5	C1	HA1.0-3C1 (1)M
1.5	10	0.5	C2	HA1.5-3C2 (1)M
2.2	10	0.5	C3	HA2.2-3C3 (1)M
3.3	10	0.5	C4	HA3.3-3C4 (1)M
4.7	10	0.5	C5	HA4.7-3C5 (1)M
6.8	10	0.5	C6	HA6.8-3C6 (1)M
10	10	0.5	C7	HA10-3C7 (1)M
15	10	1.0	C8	HA15-3C8 (1)M
47	10	1.5	C9	HA47-3C9 (1)M
4 WVDC AT + 85 °C				
0.33	10	0.5	C0	HA.33-4C0 (1)M
0.68	8	0.5	C1	HA.68-4C1 (1)M
1.0	8	0.5	C2	HA1.0-4C2 (1)M
1.5	8	0.5	C3	HA1.5-4C3 (1)M
2.2	8	0.5	C4	HA2.2-4C4 (1)M
3.3	8	0.5	C5	HA3.3-4C5 (1)M
4.7	8	0.5	C6	HA4.7-4C6 (1)M
6.8	8	0.5	C7	HA6.8-4C7 (1)M
10	8	1.0	C8	HA10-4C8 (1)M
33	8	1.5	C9	HA33-4C9 (1)M
6 WVDC AT + 85 °C				
0.22	10	0.5	C0	HA.22-6C0 (1)M
0.47	6	0.5	C1	HA.47-6C1 (1)M
0.68	6	0.5	C2	TC.68-6C2 (1)M
1.0	6	0.5	C3	HA1.0-6C3 (1)M
1.5	6	0.5	C4	HA1.5-6C4 (1)M
2.2	6	0.5	C5	HA2.2-6C5 (1)M
3.3	6	0.5	C6	HA3.3-6C6 (1)M
4.7	6	0.5	C7	HA4.7-6C7 (1)M
6.8	6	1.0	C8	HA6.8-6C8 (1)M
22	6	1.5	C9	HA22-6C9 (1)M

Note:

(1) Add for axial, R for radial

STANDARD RATINGS - POLAR CAPACITORS				
CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
10 WVDC AT + 85 °C				
0.0010	10	0.5	C0	HA.0010-10C0 (1)E
0.0010	10	0.5	C1	HA.0010-10C1 (1)E
0.0015	10	0.5	C0	HA.0015-10C0 (1)E
0.0015	10	0.5	C1	HA.0015-10C1 (1)E
0.0022	10	0.5	C0	HA.0022-10C0 (1)E
0.0022	10	0.5	C1	HA.0022-10C1 (1)E
0.0033	10	0.5	C0	HA.0033-10C0 (1)E
0.0033	10	0.5	C1	HA.0033-10C1 (1)E
0.0047	10	0.5	C0	HA.0047-10C0 (1)E
0.0047	10	0.5	C1	HA.0047-10C1 (1)E
0.15	10	0.5	C0	HA.15-10C0 (1)M
0.33	6	0.5	C1	HA.33-10C1 (1)M
0.47	6	0.5	C2	HA.47-10C2 (1)M
0.68	6	0.5	C3	HA.68-10C3 (1)M
1.0	6	0.5	C4	HA1.0-10C4 (1)M
1.5	6	0.5	C5	HA1.5-10C5 (1)M
2.2	6	0.5	C6	HA2.2-10C6 (1)M
3.3	6	0.5	C7	HA3.3-10C7 (1)M
4.7	6	1.0	C8	HA4.7-10C8 (1)M
15	6	1.5	C9	HA15-10C9 (1)M
15 WVDC AT + 85 °C				
0.10	10	0.5	C0	HA.10-15C0 (1)M
0.22	6	0.5	C1	HA.22-15C1 (1)M
0.33	6	0.5	C2	HA.33-15C2 (1)M
0.47	6	0.5	C3	HA.47-15C3 (1)M
0.68	6	0.5	C4	HA.68-15C4 (1)M
1.0	6	0.5	C5	HA1.0-15C5 (1)M
1.5	6	0.5	C6	HA1.5-15C6 (1)M
2.2	6	0.5	C7	HA2.2-15C7 (1)M
3.3	6	1.0	C8	HA3.3-15C8 (1)M
10	6	1.5	C9	HA10-15C9 (1)M
20 WVDC AT + 85 °C				
0.0068	10	0.5	C0	HA.0068-0C0 (1)E
0.0068	10	0.5	C1	HA.0068-0C1 (1)E
0.010	10	0.5	C0	HA.010-20C0 (1)E
0.015	10	0.5	C0	HA.015-20C0 (1)E
0.022	10	0.5	C0	HA.022-20C0 (1)E
0.033	10	0.5	C0	HA.033-20C0 (1)E
0.047	10	0.5	C0	HA.047-20C0 (1)E
0.068	10	0.5	C0	HA.068-20C0 (1)E
0.15	6	0.5	C1	HA.15-20C1 (1)M
0.22	6	0.5	C2	HA.22-20C2 (1)M

Note:
(1) Add for axial, R for radial

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
20 WVDC AT + 85 °C (Contd)				
0.33	6	0.5	C3	HA.33-20C3(1)M
0.47	6	0.5	C4	HA.47-20C4(1)M
0.68	6	0.5	C5	HA.68-20C5(1)M
1.0	6	0.5	C6	HA1.0-20C6(1)M
1.5	6	0.5	C7	HA1.5-20C7(1)M
2.2	6	1.0	C8	HA2.2-20C8(1)M
4.7	6	1.5	C9	HA4.7-20C9(1)M
6.8	6	1.5	C9	HA6.8-20C9(1)M
35 WVDC AT + 85 °C				
0.010	6	0.5	C1	HA.010-35C1 (1)E
0.015	6	0.5	C1	HA.015-35C1 (1)E
0.022	6	0.5	C1	HA.022-35C1 (1)E
0.033	6	0.5	C1	HA.033-35C1 (1)E
0.047	6	0.5	C1	HA.047-35C1 (1)E
0.068	6	0.5	C1	HA.068-35C1 (1)E
0.10	6	0.5	C1	HA.10-35C1 (1)M
0.15	6	0.5	C2	HA.15-35C2 (1)M
0.22	6	0.5	C3	HA.22-35C3 (1)M
0.33	6	0.5	C4	HA.33-35C4 (1)M
0.47	6	0.5	C5	HA.47-35C5 (1)M
0.68	6	0.5	C6	HA.68-35C6 (1)M
1.0	6	0.5	C7	HA1.0-35C7 (1)M
1.5	6	0.5	C8	HA1.5-35C8 (1)M
3.3	6	1.5	C9	HA3.3-35C9 (1)M
50 WVDC AT + 85 °C				
0.10	6	0.5	C2	HA.10-50C2 (1)M
0.15	6	0.5	C3	HA.15-50C3 (1)M
0.22	6	0.5	C4	HA.22-50C4 (1)M
0.33	6	0.5	C5	HA.33-50C5 (1)M
0.47	6	0.5	C6	HA.47-50C6 (1)M
0.68	6	0.5	C7	HA.68-50C7 (1)M
1.0	6	1.0	C8	HA1.0-50C8 (1)M
1.5	6	1.5	C9	HA1.5-50C9 (1)M
2.2	6	1.5	C9	HA2.2-50C9 (1)M

Note:

(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS				
CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
1.0	10	0.5	N1	HA1.0-2N1 (1)M
2.2	10	0.5	N2	HA2.2-2N2 (1)M
4.7	10	0.5	N3	HA4.7-2N3 (1)M
10	10	1.0	N4	HA10-2N4 (1)M
33	10	1.5	N5	HA33-2N5 (1)M
3 WVDC AT + 85 °C				
0.68	10	0.5	N1	HA.68-3N1 (1)M
1.5	10	0.5	N2	HA1.5-3N2 (1)M
3.3	10	0.5	N3	HA3.3-3N3 (1)M
6.8	10	1.0	N4	HA6.8-3N4 (1)M
22	10	1.5	N5	HA22-3N5 (1)M
4 WVDC AT + 85 °C				
0.47	8	0.5	N1	HA.47-4N1 (1)M
1.0	8	0.5	N2	HA1.0-4N2 (1)M
2.2	8	0.5	N3	HA2.2-4N3 (1)M
4.7	8	1.0	N4	HA4.7-4N4 (1)M
15	8	1.5	N5	HA15-4N5 (1)M
6 WVDC AT + 85 °C				
0.33	6	0.5	N1	HA.33-6N1 (1)M
0.68	6	0.5	N2	HA.68-6N2 (1)M
1.5	6	0.5	N3	HA1.5-6N3 (1)M
3.3	6	1.0	N4	HA3.3-6N4 (1)M
10	6	1.5	N5	HA10-6N5 (1)M
10 WVDC AT + 85 °C				
0.22	6	0.5	N1	HA.22-10N1 (1)M
0.47	6	0.5	N2	HA.47-10N2 (1)M
1.0	6	0.5	N3	HA1.0-10N3 (1)M
2.2	6	1.0	N4	HA2.2-10N4 (1)M
6.8	6	1.5	N5	HA6.8-10N5 (1)M
15 WVDC AT + 85 °C				
0.15	6	0.5	N1	HA.15-15N1 (1)M
0.33	6	0.5	N2	HA.33-15N2 (1)M
0.68	6	0.5	N3	HA.68-15N3 (1)M
1.5	6	1.0	N4	HA1.5-15N4 (1)M
4.7	6	1.5	N5	HA4.7-15N5 (1)M
20 WVDC AT + 85 °C				
0.010	6	0.5	N1	HA.010-20N1 (1)M
0.015	6	0.5	N1	HA.015-20N1 (1)M
0.022	6	0.5	N1	HA.022-20N1 (1)M

Note:

(1) Add for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
20 WVDC AT + 85 °C (Contd.)				
0.033	6	0.5	N2	HA.033-20N2 (1)M
0.047	6	0.5	N2	HA.047-20N2 (1)M
0.068	6	0.5	N2	HA.068-20N2 (1)M
0.10	6	0.5	N1	HA.10-20N1 (1)M
0.22	6	0.5	N2	HA.22-20N2 (1)M
0.47	6	0.5	N3	HA.47-20N3 (1)M
1.0	6	1.0	N4	HA1.0-20N4 (1)M
2.2	6	1.5	N5	H2.2-20N5 (1)M
3.3	6	1.5	N5	HA3.3-20N5 (1)M
35 WVDC AT + 85 °C				
0.10	6	0.5	N2	HA.10-35N2 (1)M
0.15	6	0.5	N2	HA.15-35N2 (1)M
0.22	6	0.5	N3	HA.22-35N3 (1)M
0.33	6	0.5	N3	HA.33-35N3 (1)M
0.47	6	1.0	N4	HA.47-35N4 (1)M
0.68	6	1.0	N4	HA.68-35N4 (1)M
1.0	6	1.5	N5	HA1.0-35N5 (1)M
1.5	6	1.5	N5	HA1.5-35N5 (1)M
50 WVDC AT + 85 °C				
0.068	6	0.5	N3	HA.068-50N3 (1)M
0.15	6	0.5	N3	HA.15-50N3 (1)M
0.33	6	1.0	N4	HA.33-50N4 (1)M
0.68	6	1.5	N5	HA.68-50N5 (1)M

Note:
(1) Add for axial, R for radial

MARKING

HA Capacitors case sizes N4 and N5 are print marked:
- Capacitance is in picofarads
- 1st and 2nd digits are significant figures
- 3rd digit indicates the number of zeros.

Capacitance Tolerance	Color	Tolerance
Is indicated by a dot on the side of the case. Black dot is omitted.	Gold	± 5 %
	Silver	± 10 %
	None	± 20 %
	None	+ 40 %/- 20 %

The positive lead is indicated by a color dot of red epoxy on the unit.

All other case sizes have color dot marking:

Capacitance	Color	Digit
In picofarads, indicated by 3 dots. 1st and 2nd dot give the significant digits. 3rd dot indicates the number of zeros. Color dot location is shown on the dimensional sketches. Black dot is omitted on black sleeve.	Black	0
	Brown	1
	Red	2
	Orange	3
	Yellow	4
	Green	5
	Blue	6
	Violet	7
	Grey	8
	White	9

e.g. Yellow-Violet-Green = 4 700 000 pf
= 4.7 µF

PERFORMANCE AND RELIABILITY

The capacitors are tested in accordance with MIL-PRF-49137, with specific requirements as follows:

Temperature Stability: When tested per MIL-PRF-49137/6, capacitance shall be within ±15 % at - 55 °C and 85 °C, and ±10 % at 25 °C after exposure to temperature extremes. DF shall be within 200 % of initial limit at - 55 °C, 150 % of initial limit at 85 °C, and meet the initial at 25 °C. DCL shall be within 10 x initial limit at 85 °C, and meet the initial limit at 25 °C.

Moisture Resistance: (per Method 106 of MIL-STD-202) After 10 cycles of 24 h at 25 °C to 65 °C and 80-98 % RH; capacitance shall be within ± 15 % of initial value, DF within 1.5 x initial limit and leakage within 3 x initial limit.

Life: (per Method 108 of MIL-STD-202) after 1000 h at 85 °C and rated voltage; capacitance shall be within ± 10 % of initial limit, DF within initial limits, and leakage within 200 % of initial limit.

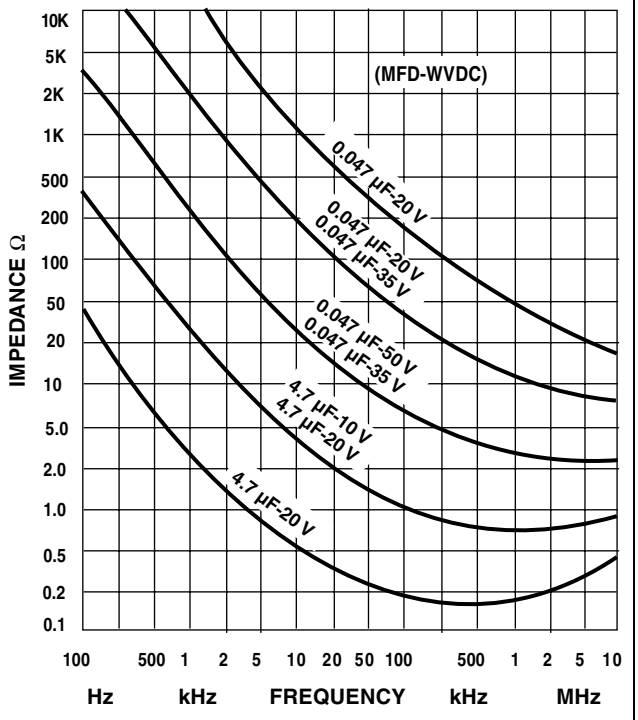
Surge Voltage: (per MIL-PRF-49317) After 1000 cycles at 85 °C and 1.3 x WVDC; capacitance shall be within ± 10 % of initial limit, DF and leakage within initial limits.

Resistance to Soldering Heat: (per Method 210 0f MIL-STD-202, Condition B) After immersion in 260 °C molten solder to within a 1/4" of the body of the unit, there shall be no evidence of mechanical or electrical degradation.

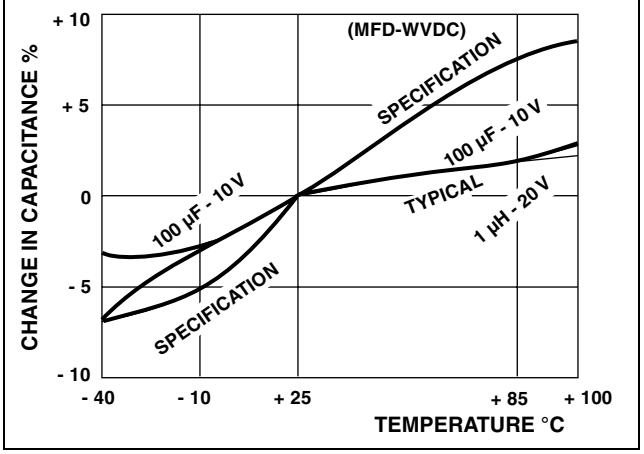
Solderability: (per Method 208 of MIL-STD-202) After dipping leads in 235 °C molten solder to within 0.125" of the body of the unit, the solder shall cover 95 % of the lead surface.

Terminal Strength: (per Method 211 of MIL-STD-202) After the following test there shall be no loosening of the terminals or permanent damage to the terminals. Test Condition A: (Pull Test) 0.010" leads withstand 1 pound, 0.016" leads 2 pounds and 0.007" leads 1/2 pound. Test Condition C: (Bend Test) All leads shall withstand 3 - 90° bends with a 1/2 pound applied force.

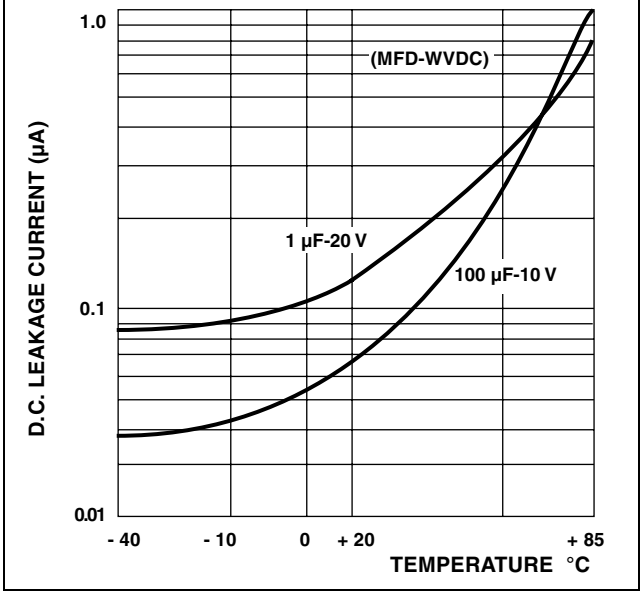
IMPEDANCE VS. FREQUENCY



CAPACITANCE VS. TEMPERATURE



LEAKAGE CURRENT - TEMPERATURE



Subminiature, Leaded Solid Tantalum Capacitors Polar or Non-Polar

FEATURES

- Subminiature package size and light weight
- Cylindrical case with axial or radial leads
- 2 to 35 VDC
- 0.22 µF to 68 µF
- Operating temperature range: - 55 °C to + 125 °C
- High stability and reliability
- Tested in accordance with MIL-PRF-49137
- Utilize high CV technology to extend the range of capacitance values in each size
- Unique and comprehensive custom design capability

ELECTRICAL CHARACTERISTICS

Operating Temperature Range: - 55 °C to + 125 °C

Capacitance: Measured at 120 Hz and 25 °C with a maximum of 2.2 V_{DC} bias and 1.0 V_{rms} signal.

Capacitance Tolerance: Standard tolerance is ± 20 % for ratings 0.1 µF and above, and + 40, - 20 % for ratings below 0.1 µF. Special tolerances are also available.

Dissipation Factor: When measured simultaneously with capacitance, DF shall not exceed the value shown in the ratings tables.

DC Leakage Current (DCL Max):

When measured with DC voltage applied through a 1000 W resistor for 5 min, DC leakage (µA) shall not exceed:

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 and 66 % of Rated Voltage: Leakage current shall not exceed 15 times the values listed in the Standard Ratings Tables.

Operating Voltage: Full working voltage up to 85 °C. From 85 °C to 125 °C working voltage derates linearly to 66 % of the 85 °C working voltage.

APPLICATIONS

- Hearing aids
- Portable communications
- Space/avionics
- Laptop computers

MECHANICAL SPECIFICATIONS

Solder coated nickel leads (type N32 per MIL-STD-1276) are standard on all case sizes.

Leads are weldable and/or solderable.

Special leads are available on request (e.g. bare nickel, gold plated nickle or ribbon leads).

Lead length is 1 1/2" [38.1 mm] minimum on non-polar parts.

On polar parts the negative lead is 1 1/4" [31.8 mm] minimum and the positive lead is 1 1/2" [38.1 mm] minimum.

ORDERING INFORMATION

SHA	1.0	35	C7	A (1)	M
MODEL	CAPACITANCE (µF)	DC VOLTAGE RATING at + 85 °C	CASE CODE	LEAD CONFIGURATION	CAPACITANCE TOLERANCE
			C = Polar N = Non-polar	A = Axial R = Radial	E = + 40, - 20 % M = ± 20 % K = ± 10 % J = ± 5 %

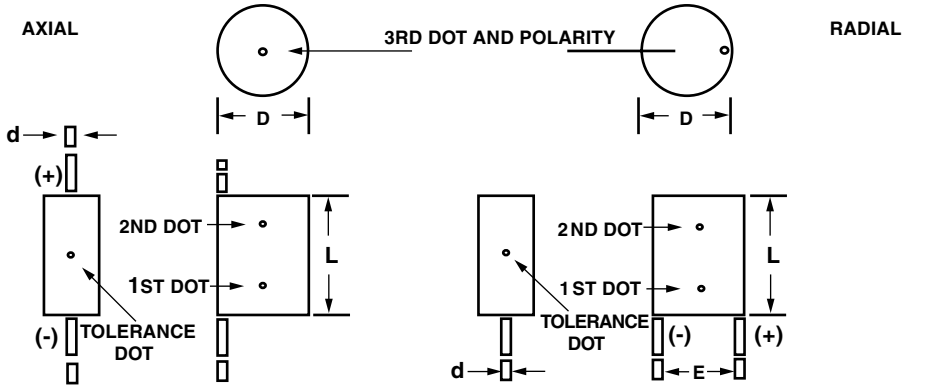
EXAMPLE OF PART NUMBER CODE: SHA1.0-35C7AM

Note:

(1) To complete part number in rating tables, add A or R.
Change suffix if special capacitance tolerance is required.

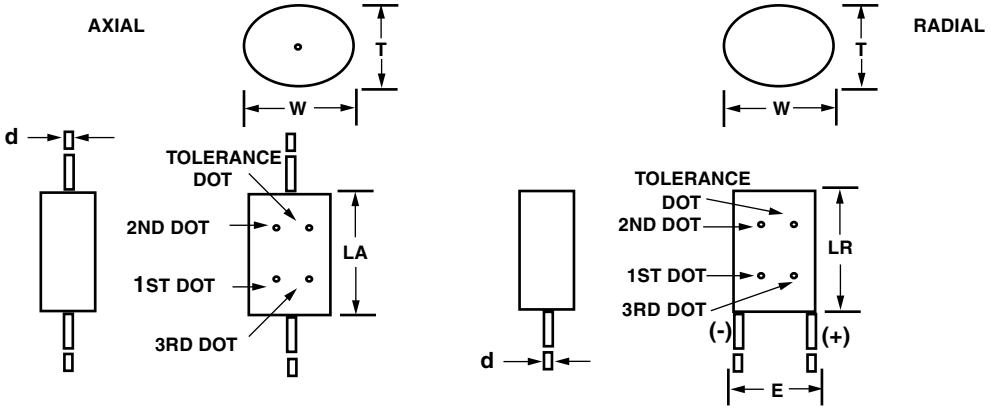
DIMENSIONS in inches [millimeters]

POLAR STYLE



CASE CODE	MAX. L	MAX. D	MAX. E	E TOL. ±	d
C0	0.100 [2.54]	0.057 [1.45]	0.030 [0.76]	0.015 [0.38]	0.007[0.18]
C1	0.110 [2.80]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C2	0.125 [3.18]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C3	0.145 [3.68]	0.067 [1.70]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C4	0.160 [4.06]	0.070 [1.78]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C5	0.160 [4.06]	0.077 [1.96]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C6	0.190 [4.83]	0.077 [1.96]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C7	0.200 [5.08]	0.080 [2.03]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C8	0.225 [5.72]	0.100 [2.54]	0.070 [1.78]	0.020 [0.51]	0.010 [0.25]
C9	0.250 [6.35]	0.150 [3.81]	0.120 [3.05]	0.025 [0.64]	0.016 [0.41]

NON POLAR STYLE



CASE CODE	MAX. LA	MAX. LR	MAX. W	MAX. T	E	E TOL. ±	d
N1	0.175 [4.45]	0.135 [3.43]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N2	0.210 [5.33]	0.160 [4.06]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N3	0.240 [6.10]	0.200 [5.08]	0.140 [3.56]	0.080 [2.03]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N4	0.275 [6.99]	0.235 [5.97]	0.190 [4.83]	0.105 [2.67]	0.125 [3.18]	0.020 [0.51]	0.010 [0.25]
N5	0.310 [7.87]	0.270 [6.86]	0.290 [7.37]	0.155 [3.94]	0.200 [5.08]	0.025 [0.64]	0.016 [0.41]

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
3.3	10	0.5	C1	SHA3.3-2C1 (1)M
15	10	0.5	C5	SHA15-2C5 (1)M
22	10	1.0	C6	SHA22-2C6 (1)M
68	10	1.5	C8	SHA68-2C8 (1)M
3 WVDC AT + 85 °C				
2.2	10	0.5	C1	SHA2.2-3C1 (1)M
3.3	10	0.5	C2	SHA3.3-3C2 (1)M
4.7	10	0.5	C3	SHA4.7-3C3 (1)M
6.8	10	0.5	C4	SHA6.8-3C4 (1)M
10	10	0.5	C5	SHA10-3C5 (1)M
15	10	1.0	C6	SHA15-3C6 (1)M
22	10	1.0	C7	SHA22-3C7 (1)M
47	10	1.5	C8	SHA47-3C8 (1)M
68	10	5.0	C9	SHA68-3C9 (1)M
4 WVDC AT + 85 °C				
1.5	8	0.5	C1	SHA1.5-4C1 (1)M
2.2	8	0.5	C2	SHA2.2-4C2 (1)M
3.3	8	0.5	C3	SHA3.3-4C3 (1)M
4.7	8	0.5	C4	SHA4.7-4C4 (1)M
6.8	8	0.5	C5	SHA6.8-4C5 (1)M
10	8	1.0	C6	SHA10-4C6 (1)M
15	8	1.0	C7	SHA15-4C7 (1)M
33	8	1.5	C8	SHA33-4C8 (1)M
47	8	5.0	C9	SHA47-4C9 (1)M
6 WVDC AT + 85 °C				
1.0	6	0.5	C1	SHA1.0-6C1 (1)M
1.5	6	0.5	C2	SHA1.5-6C2 (1)M
2.2	6	0.5	C3	SHA2.2-6C3 (1)M
3.3	6	0.5	C4	SHA3.3-6C4 (1)M
4.7	6	0.5	C5	SHA4.7-6C5 (1)M
6.8	6	1.0	C6	SHA6.8-6C6 (1)M
10	6	1.0	C7	SHA10-6C7 (1)M
22	6	1.5	C8	SHA22-6C8 (1)M
33	6	5.0	C9	SHA33-6C9 (1)M
10 WVDC AT + 85 °C				
0.68	6	0.5	C1	SHA.68-10C1 (1)M
1.0	6	0.5	C2	SHA1.0-10C2 (1)M
1.5	6	0.5	C3	SHA1.5-10C3 (1)M
2.2	6	0.5	C4	SHA2.2-10C4 (1)M
3.3	6	0.5	C5	SHA3.3-10C5 (1)M
4.7	6	1.0	C6	SHA4.7-10C6 (1)M
6.8	6	1.0	C7	SHA6.8-10C7 (1)M
15	6	1.5	C8	SHA15-10C8 (1)M
22	8	5.0	C9	SHA22-10C9 (1)M

Note:

(1) Add A for axial, R for radial

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
		15 WVDC AT + 85 °C		
0.47	6	0.5	C1	SHA.47-15C1 (1)M
0.68	6	0.5	C1	SHA.68-15C1 (1)M
1.0	6	0.5	C3	SHA1.0-15C3 (1)M
1.5	6	0.5	C4	SHA1.5-15C4 (1)M
2.2	6	0.5	C5	SHA2.2-15C5 (1)M
3.3	6	1.0	C6	SHA3.3-15C6 (1)M
4.7	6	1.0	C7	SHA4.7-15C7 (1)M
15	8	5.0	C9	SHA15-15C9 (1)M
		20 WVDC AT + 85 °C		
0.33	6	0.5	C1	SHA.33-20C1 (1)M
0.47	6	0.5	C2	SHA.47-20C2 (1)M
0.68	6	0.5	C3	SHA.68-20C3 (1)M
1.0	6	0.5	C4	SHA1.0-20C4 (1)M
1.5	6	0.5	C5	SHA1.5-20C5 (1)M
2.2	6	1.0	C6	SHA2.2-20C6 (1)M
3.3	6	1.0	C7	SHA3.3-20C7 (1)M
10	8	5.0	C9	SHA10-20C9 (1)M
		25 WVDC AT + 85 °C		
2.2	6	1.0	C7	SHA2.2-25C7 (1)M
3.3	6	1.5	C8	SHA3.3-25C8 (1)M
6.8	8	5.0	C9	SHA6.8-25C9 (1)M
		35 WVDC AT + 85 °C		
0.22	6	0.5	C1	SHA.22-35C1 (1)M
0.33	6	0.5	C2	SHA.33-35C2 (1)M
0.47	6	0.5	C3	SHA.47-35C3 (1)M
0.68	6	0.5	C4	SHA.68-35C4 (1)M
1.0	6	0.5	C5	SHA1.0-35C5 (1)M
1.5	6	0.5	C6	SHA1.5-35C6 (1)M
1.5	6	1.0	C7	SHA1.5-35C7 (1)M
2.2	6	1.5	C8	SHA2.2-35C8 (1)M

Note:

(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
		2 WVDC AT + 85 °C		
3.3	10	0.5	N2	SHA3.3-2N2 (1)M
6.8	10	0.5	N3	SHA6.8-2N3 (1)M
15	10	1.0	N4	SHA15-2N4 (1)M
47	10	2.5	N5	SHA47-2N5 (1)M
		4 WVDC AT + 85 °C		
2.2	8	0.5	N2	SHA2.2-4N2 (1)M
4.7	8	0.5	N3	SHA4.7-4N3 (1)M
10	8	1.0	N4	SHA10-4N4 (1)M
33	8	2.5	N5	SHA33-4N5 (1)M

Note

(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
6 WVDC AT + 85 °C				
1.5	6	0.5	N2	SHA1.5-6N2 (1)M
3.3	6	1.0	N3	SHA3.3-6N3 (1)M
6.8	6	1.0	N4	SHA6.8-6N4 (1)M
22	6	2.5	N5	SHA22-6N5 (1)M
10 WVDC AT + 85 °C				
1.0	6	0.5	N2	SHA1.0-10N2 (1)M
2.2	6	1.0	N3	SHA2.2-10N3 (1)M
4.7	6	1.5	N4	SHA4.7-10N4 (1)M
15	6	2.5	N5	SHA15-10N5 (1)M
15 WVDC AT + 85 °C				
0.68	6	0.5	N2	SHA.68-15N2 (1)M
1.5	6	1.0	N3	SHA1.5-15N3 (1)M
3.3	6	1.5	N4	SHA3.3-15N4 (1)M
10	6	2.5	N5	SHA10-15N5 (1)M
20 WVDC AT + 85 °C				
0.47	6	0.5	N2	SHA.47-20N2 (1)M
1.0	6	1.0	N3	SHA1.0-20N3 (1)M
2.2	6	1.5	N4	SHA2.2-20N4 (1)M
6.8	6	2.5	N5	SHA6.8-20N5 (1)M
35 WVDC AT + 85 °C				
0.33	6	0.5	N2	SHA.33-35N2 (1)M
0.68	6	1.0	N3	SHA.68-35N3 (1)M
1.5	6	1.5	N4	SHA1.5-35N4 (1)M

Note

(1) Add A for axial, R for radial

MARKING

SHA Capacitors case sizes N4 and N5 are print marked:
- Capacitance is in picofarads
- 1st and 2nd digits are significant figures
- 3rd digit indicates the number of zeros.

Capacitance Tolerance	Color	Tolerance
Is indicated by a dot on the side of the case. Black dot is omitted.	Gold	± 5 %
	Silver	± 10 %
	None	± 20 %
	None	+ 40 %/- 20 %

The positive lead is indicated by a color dot of red epoxy on the unit.
Radial lead style is marked with brown epoxy on the top.
Axial lead style is marked with brown epoxy on the cathode end

All other case sizes have color dot marking:

Capacitance	Color	Digit
In picofarads, indicated by 3 dots. 1st and 2nd dot give the significant digits. 3rd dot indicates the number of zeros. Color dot location is shown on the dimensional sketches. Black dot is omitted on black sleeve.	Black	0
	Brown	1
	Red	2
	Orange	3
	Yellow	4
	Green	5
	Blue	6
	Violet	7
	Grey	8
	White	9

e.g. Yellow-Violet-Green = 4 700 000 pf

= 4.7 µF

PERFORMANCE AND RELIABILITY

The capacitors are tested in accordance with MIL-PRF-49137, with specific requirements as follows:

Temperature Stability: When tested per MIL-PRF-49137/6, capacitance shall be within ± 15 % at - 55 °C and 85 °C, and ± 10 % at 25 °C after exposure to temperature extremes. DF shall be within 200 % of initial limit at - 55 °C, 150 % of initial limit at 85 °C, and meet the initial at 25 °C. DCL shall be within 10 x initial limit at 85 °C, and meet the initial limit at 25 °C.

Moisture Resistance: (per Method 106 of MIL-STD-202) After 10 cycles of 24 h at 25 °C to 65 °C and 80-98 % RH; capacitance shall be within ± 15 % of initial value, DF within 1.5 x initial limit and leakage within 3 x initial limit.

Life: (per Method 108 of MIL-STD-202) after 1000 h at 85 °C and rated voltage; capacitance shall be within ± 10 % of initial limit, DF within initial limits, and leakage within 200 % of initial limit.

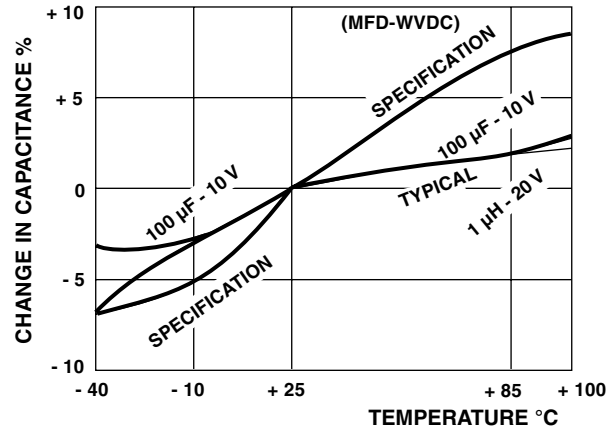
Surge Voltage: (per MIL-PRF-49317) After 1000 cycles at 85 °C and 1.3 x WVDC; capacitance shall be within ± 10 % of initial limit, DF and leakage within initial limits.

Resistance to Soldering Heat: (per Method 210 of MIL-STD-202, Condition B) After immersion in 260 °C molten solder to within a 1/4" of the body of the unit, there shall be no evidence of mechanical or electrical degradation.

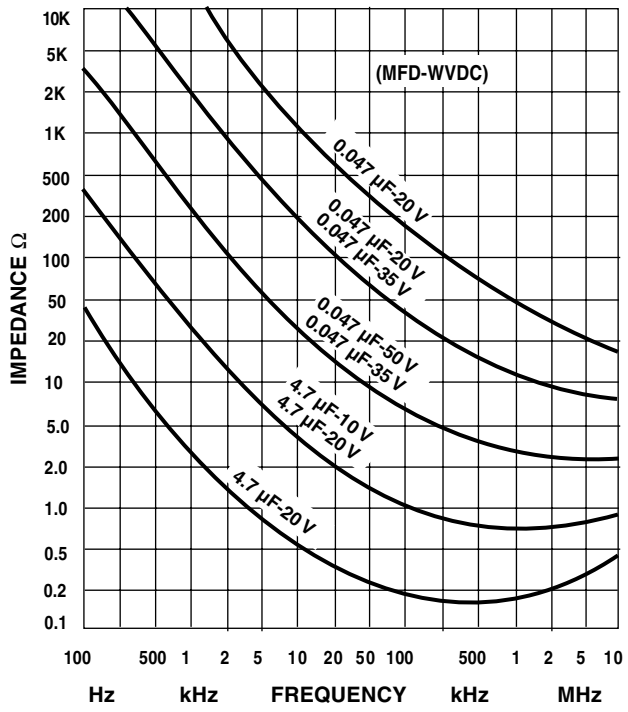
Solderability: (per Method 208 of MIL-STD-202) After dipping leads in 235 °C molten solder to within 0.125" of the body of the unit, the solder shall cover 95 % of the lead surface.

Terminal Strength: (per Method 211 of MIL-STD-202) After the following test there shall be no loosening of the terminals or permanent damage to the terminals. Test Condition A: (Pull Test) 0.010" leads withstand 1 pound, 0.016" leads 2 pounds and 0.007" leads 1/2 pound. Test Condition C: (Bend Test) All leads shall withstand 3 - 90° bends with a 1/2 pound applied force.

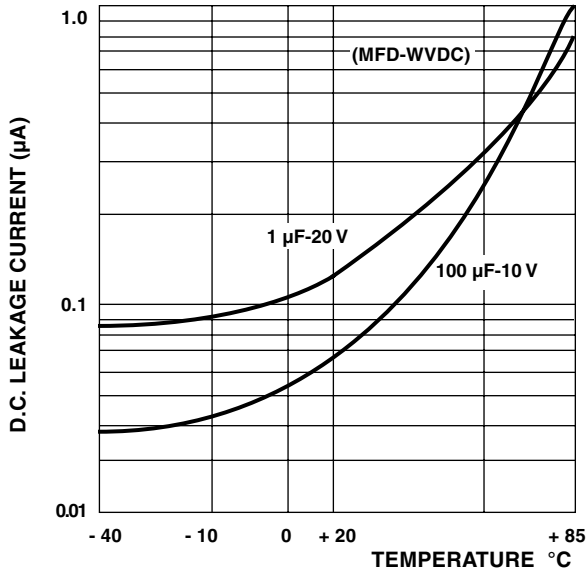
CAPACITANCE VS. TEMPERATURE



IMPEDANCE VS. FREQUENCY



LEAKAGE CURRENT - TEMPERATURE



Subminiature, Leaded Solid Tantalum Capacitors Polar or Non-Polar

FEATURES

- Subminiature package size and light weight
- Rectangular case with axial or radial leads
- 2 to 50 VDC
- 0.1 µF to 470 µF
- Operating temperature range: - 55 °C to + 125 °C
- High stability and reliability
- Tested in accordance with MIL-PRF-49137
- Unique and comprehensive custom design capability

ELECTRICAL CHARACTERISTICS

Operating temperature range: - 55 °C to + 125 °C

Capacitance: Measured at 120 Hz and 25 °C with a maximum of 2.2 V_{DC} bias and 1.0 V_{rms} signal.

Capacitance Tolerance: Standard tolerance is ± 20 % for ratings 0.1 µF and above, and + 40, - 20 % for ratings below 0.1 µF. Special tolerances are also available.

Dissipation Factor: When measured simultaneously with capacitance, DF shall not exceed the value shown in theratings tables.

DC Leakage Current (DCL Max):

When measured with DC voltage applied through a 1000 Ω resistor for 5 minutes, DC leakage (µA) shall not exceed:

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 and 66 % of Rated Voltage: Leakage current shall not exceed 15 times the values listed in the Standard Ratings Tables.

Operating Voltage: Full working voltage up to 85 °C. From 85 °C to 125 °C working voltage derates linearly to 66 % of the 85 °C working voltage.

APPLICATIONS

- Hearing aids
- Portable communications
- Space/avionics
- Laptop computers

MECHANICAL SPECIFICATIONS

Solder coated nickel leads (type N32 per MIL-STD-1276) are standard on all case sizes.

Leads are weldable and/or solderable.

Special leads are available on request (e.g. bare nickel, gold plated nickel or ribbon leads).

Lead length is 1 1/2" [38.1 mm] minimum on nonpolar parts.

On polar parts the negative lead is 1 1/4" [31.8 mm] minimum and the positive lead is 1 1/2" [38.1 mm] minimum.

ORDERING INFORMATION

TC	1.0	35	C3	A (1)	M
MODEL	CAPACITANCE IN µF	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD CONFIGURATION	CAPACITANCE TOLERANCE
			C = Polar N = Non-polar	A = Axial R = Radial	E = + 40, - 20 % M = ± 20 % K = ± 10 % J = ± 5 %

Example of Part Number Code: TC1.0-35C3AM

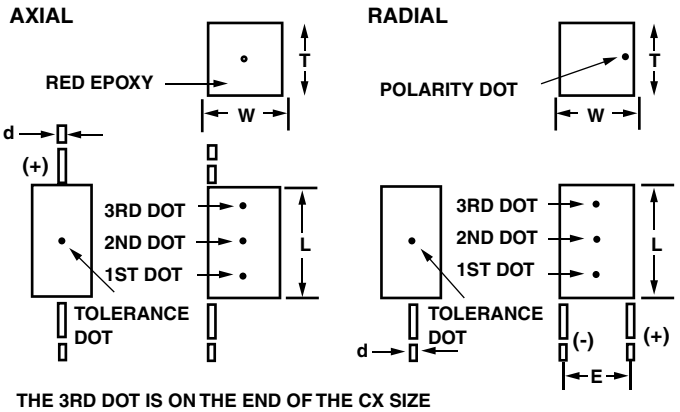
Note:

(1) To complete part number in rating tables, add A or R.
Change suffix if special capacitance tolerance is required.

Subminiature, Leaded Solid Tantalum Capacitors
Polar or Non-Polar

DIMENSIONS in inches [millimeters]

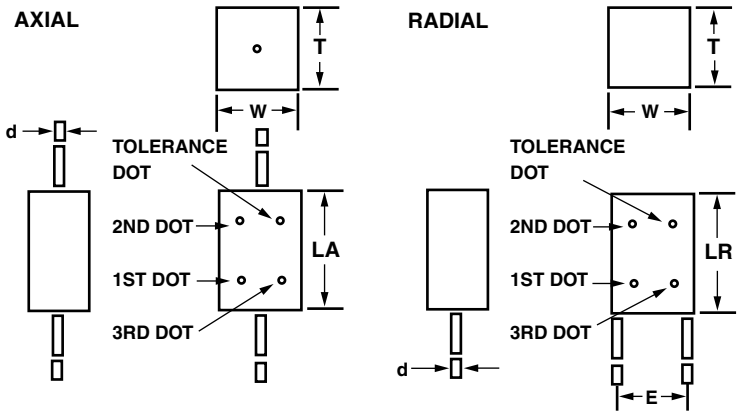
POLAR STYLE



THE 3RD DOT IS ON THE END OF THE CX SIZE

CASE CODE	L MAX.	W MAX.	T MAX.	E	E TOL. ±	d
CX	0.075 [1.91]	0.050 [1.27]	0.040 [1.02]	0.030 [0.76]	0.015 [0.38]	0.007 [0.18]
C0	0.100 [2.54]	0.050 [1.27]	0.040 [1.02]	0.030 [0.76]	0.015 [0.38]	0.007 [0.18]
C1	0.125 [3.18]	0.070 [1.78]	0.040 [1.02]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C2	0.165 [4.19]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
C3	0.225 [5.72]	0.185 [4.70]	0.075 [1.91]	0.150 [3.81]	0.020 [0.51]	0.010 [0.25]
C4	0.290 [7.37]	0.220 [5.59]	0.110 [2.79]	0.180 [4.57]	0.025 [0.64]	0.016 [0.41]
C5	0.310 [7.87]	0.230 [5.84]	0.130 [3.30]	0.200 [5.08]	0.025 [0.64]	0.016 [0.41]
C6	0.475 [12.07]	0.375 [9.53]	0.150 [3.81]	0.300 [7.62]	0.025 [0.64]	0.016 [0.41]

NON POLAR STYLE



CASE CODE	LA MAX.	LR MAX.	W MAX.	T MAX.	E MAX.	E TOL. ±	d
N1	0.220 [5.59]	0.180 [4.57]	0.125 [3.18]	0.125 [3.18]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N2	0.280 [7.11]	0.240 [6.10]	0.140 [3.56]	0.180 [4.57]	0.100 [2.54]	0.025 [0.64]	0.010 [0.25]
N3	0.370 [9.40]	0.315 [8.00]	0.180 [4.57]	0.220 [5.59]	0.150 [3.81]	0.025 [0.64]	0.016 [0.41]
N4	0.390 [9.91]	0.335 [8.51]	0.230 [5.84]	0.230 [5.84]	0.180 [4.57]	0.025 [0.64]	0.016 [0.41]

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
		2 WVDC AT + 85 °C		
0.47	10	0.5	C0	TC.47-2C0 (1)M
0.68	10	0.5	C0	TC.68-2C0 (1)M
1.0	10	0.5	C0	TC1.0-2C0 (1)M
2.2	10	0.5	C1	TC2.2-2C1 (1)M
10	10	0.5	C2	TC10-2C2 (1)M
33	10	1.0	C3	TC33-2C3 (1)M
100	15	2.0	C4	TC100-2C4 (1)M
150	15	3.0	C5	TC150-2C5 (1)M
470	20	9.0	C6	TC470-2C6 (1)M
		3 WVDC AT + 85 °C		
1.5	10	0.5	C1	TC1.5-3C1 (1)M
6.8	10	0.5	C2	TC6.8-3C2 (1)M
22	10	1.0	C3	TC22-3C3 (1)M
68	10	2.0	C4	TC68-3C4 (1)M
100	10	3.0	C5	TC100-3C5 (1)M
330	20	9.0	C6	TC330-3C6 (1)M
		4 WVDC AT + 85 °C		
0.33	10	0.5	C0	TC.33-4C0 (1)M
1.0	8	0.5	C1	TC1.0-4C1 (1)M
4.7	8	0.5	C2	TC4.7-4C2 (1)M
15	8	1.0	C3	TC15-4C3 (1)M
47	8	2.0	C4	TC47-4C4 (1)M
68	8	3.0	C5	TC68-4C5 (1)M
220	15	9.0	C6	TC220-4C6 (1)M
		6 WVDC AT + 85 °C		
0.22	10	0.5	C0	TC.22-6C0 (1)M
0.68	6	0.5	C1	TC.68-6C1 (1)M
3.3	6	0.5	C2	TC3.3-6C2 (1)M
10	6	1.0	C3	TC10-6C3 (1)M
33	6	2.0	C4	TC33-6C4 (1)M
47	6	3.0	C5	TC47-6C5 (1)M
150	10	9.0	C6	TC150-6C6 (1)M
		10 WVDC AT + 85 °C		
0.0010	10	0.5	C0	TC.0010-10C0 (1)E
0.0010	10	0.5	C1	TC.0010-10C1 (1)E
0.0015	10	0.5	C0	TC.0015-10C0 (1)E
0.0015	10	0.5	C1	TC.0015-10C1 (1)E
0.0022	10	0.5	C0	TC.0022-10C0 (1)E
0.0022	10	0.5	C1	TC.0022-10C1 (1)E
0.0033	10	0.5	C0	TC.0033-10C0 (1)E
0.0033	10	0.5	C1	TC.0033-10C1 (1)E
0.0047	10	0.5	C0	TC.0047-10C0 (1)E
0.0047	10	0.5	C1	TC.0047-10C1 (1)E
0.15	10	0.5	C0	TC.15-10C0 (1)M
0.47	6	0.5	C1	TC.47-10C1 (1)M
2.2	6	0.5	C2	TC2.2-10C2 (1)M
6.8	6	1.0	C3	TC6.8-10C3 (1)M
22	6	2.0	C4	TC22-10C4 (1)M
33	6	3.0	C5	TC33-10C5 (1)M
100	8	9.0	C6	TC100-10C6 (1)M

Note:
(1) Add A for axial, R for radial

STANDARD RATINGS - POLAR CAPACITORS				
CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
15 WVDC AT + 85 °C				
0.10	10	0.5	C0	TC.10-15C0 (1)M
0.33	6	0.5	C1	TC.33-15C1 (1)M
1.5	6	0.5	C2	TC1.5-15C2 (1)M
15	6	2.0	C4	TC15-15C4 (1)M
22	6	3.0	C5	TC22-15C5 (1)M
68	8	9.0	C6	TC68-15C6 (1)M
20 WVDC AT + 85 °C				
0.033	10	0.5	C0	TC.033-20C0 (1)E
0.033	6	0.5	C1	TC.033-20C1 (1)E
0.047	10	0.5	C0	TC.047-20C0 (1)E
0.047	6	0.5	C1	TC.047-20C1 (1)E
0.068	10	0.5	C0	TC.068-20C0 (1)E
0.068	6	0.5	C1	TC.068-20C1 (1)E
0.10	6	0.5	C1	TC.10-20C1 (1)M
0.15	6	0.5	C1	TC.15-20C1 (1)M
0.22	6	0.5	C1	TC.22-20C1 (1)M
1.0	6	0.5	C2	TC1.0-20C2 (1)M
3.3	6	1.0	C3	TC3.3-20C3 (1)M
4.7	6	1.0	C3	TC4.7-20C3 (1)M
10	6	2.0	C4	TC10-20C4 (1)M
15	6	3.0	C5	TC15-20C5 (1)M
47	8	9.0	C6	TC47-20C6 (1)M
25 WVDC AT + 85 °C				
0.68	6	0.5	C2	TC.68-25C2 (1)M
2.2	6	1.0	C3	TC2.2-25C3 (1)M
6.8	6	2.0	C4	TC6.8-25C4 (1)M
10	6	3.0	C5	TC10-25C5 (1)M
33	6	9.0	C6	TC33-25C6 (1)M
35 WVDC AT + 85 °C				
0.22	6	0.5	C2	TC.22-35C2 (1)M
0.33	6	0.5	C2	TC.33-35C2 (1)M
0.47	6	0.5	C2	TC.47-35C2 (1)M
0.68	6	1.0	C3	TC.68-35C3 (1)M
1.0	6	1.0	C3	TC1.0-35C3 (1)M
1.5	6	1.0	C3	TC1.5-35C3 (1)M
2.2	6	2.0	C4	TC2.2-35C4 (1)M
3.3	6	2.0	C4	TC3.3-35C4 (1)M
4.7	6	2.0	C4	TC4.7-35C4 (1)M
6.8	6	3.0	C5	TC6.8-35C5 (1)M
10	6	9.0	C6	TC10-35C6 (1)M
15	6	9.0	C6	TC15-35C6 (1)M
22	6	9.0	C6	TC22.35C6 (1)M
50 WVDC AT + 85 °C				
0.15	6	0.5	C2	TC.15-50C2 (1)M
4.7	6	3.0	C5	TC4.7-50C5 (1)M
6.8	6	9.0	C6	TC6.8-50C6 (1)M

Note:
(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
4.7	10	0.5	N1	TC4.7-2N1 (1)M
15	10	1.0	N2	TC15-2N2 (1)M
47	15	2.0	N3	TC47-2N3 (1)M
68	15	3.0	N4	TC68-2N4 (1)M
3 WVDC AT + 85 °C				
3.3	10	0.5	N1	TC3.3-3N1 (1)M
10	10	1.0	N2	TC10-3N2 (1)M
33	10	2.0	N3	TC33-3N3 (1)M
47	10	3.0	N4	TC47-3N4 (1)M
4 WVDC AT + 85 °C				
2.2	8	0.5	N1	TC2.2-4N1 (1)M
6.8	8	1.0	N2	TC6.8-4N2 (1)M
22	8	2.0	N3	TC22-4N3 (1)M
33	8	3.0	N4	TC33-4N4 (1)M
6 WVDC AT + 85 °C				
1.5	6	0.5	N1	TC1.5-6N1 (1)M
4.7	6	1.0	N2	TC4.7-6N2 (1)M
15	6	2.0	N3	TC15-6N3 (1)M
22	6	3.0	N4	TC22-6N4 (1)M
10 WVDC AT + 85 °C				
1.0	6	0.5	N1	TC1.0-10N1 (1)M
3.3	6	1.0	N2	TC3.3-10N2 (1)M
10	6	2.0	N3	TC10-10N3 (1)M
15	6	3.0	N4	TC15-10N4 (1)M
15 WVDC AT + 85 °C				
0.68	6	0.5	N1	TC.68-15N1 (1)M
6.8	6	2.0	N3	TC6.8-15N3 (1)M
10	6	3.0	N4	TC10-15N4 (1)M
20 WVDC AT + 85 °C				
0.47	6	0.5	N1	TC.47-20N1 (1)M
1.5	6	1.0	N2	TC1.5-20N2 (1)M
2.2	6	1.0	N2	TC2.2-20N2 (1)M
4.7	6	2.0	N3	TC4.7-20N3 (1)M
6.8	6	3.0	N4	TC6.8-20N4 (1)M
25 WVDC AT + 85 °C				
0.33	6	0.5	N1	TC.33-25N1 (1)M
1.0	6	1.0	N2	TC1.0-25N2 (1)M
3.3	6	2.0	N3	TC3.3-25N3 (1)M
4.7	6	3.0	N4	TC4.7-25N4 (1)M
35 WVDC AT + 85 °C				
0.10	6	0.5	N1	TC.10-35N1 (1)M
0.15	6	0.5	N1	TC.15-35N1 (1)M
0.22	6	0.5	N1	TC.22-35N1 (1)M
0.33	6	1.0	N2	TC.33-35N2 (1)M
0.47	6	1.0	N2	TC.47-35N2 (1)M
0.68	6	1.0	N2	TC.68-35N2 (1)M
1.0	6	2.0	N3	TC1.0-35N3 (1)M
50 WVDC AT + 85 °C				
2.2	6	3.0	N4	TC2.2-50N4 (1)M

Note:
(1) Add A for axial, R for radial

MARKING

TC Capacitors case sizes C3 - C6 and N2 - N4 are print marked:
- Capacitance is in picofarads
- 1st and 2nd digits are significant figures
- 3rd digit indicates the number of zeros.

Capacitance Tolerance	Color	Tolerance
Is indicated by a dot on the side of the case. Black dot is omitted.	Gold	± 5 %
	Silver	± 10 %
	None	± 20 %
	None	+ 40 %/- 20 %

The positive lead is indicated by a color dot of red epoxy on the unit.

All other case sizes have color dot marking:

Capacitance	Color	Digit
In picofarads, indicated by 3 dots. 1st and 2nd dot give the significant digits. 3rd dot indicates the number of zeros. Color dot location is shown on the dimensional sketches. Black dot is omitted on black sleeve.	Black	0
	Brown	1
	Red	2
	Orange	3
	Yellow	4
	Green	5
	Blue	6
	Violet	7
	Grey	8
	White	9

e.g. Yellow-Violet-Green = 4 700 000 pF

= 4.7 µF

PERFORMANCE AND RELIABILITY

The capacitors are tested in accordance with MIL-PRF-49137, with specific requirements as follows:

Temperature Stability: When tested per MIL-PRF-49137/6, capacitance shall be within ± 15 % at - 55 °C and 85 °C, and ± 10 % at 25 °C after exposure to temperature extremes. DF shall be within 200 % of initial limit at - 55 °C, 150 % of initial limit at 85 °C, and meet the initial at 25 °C. DCL shall be within 10 x initial limit at 85 °C, and meet the initial limit at 25 °C.

Moisture Resistance: (per Method 106 of MIL-STD-202) After 10 cycles of 24 h at 25 °C to 65 °C and 80 - 98 % RH; capacitance shall be within ± 15 % of initial value, DF within 1.5 x initial limit and leakage within 3 x initial limit.

Life: (per Method 108 of MIL-STD-202) after 1000 h at 85 °C and rated voltage; capacitance shall be within ± 10 % of initial limit, DF within initial limits, and leakage within 200 % of initial limit.

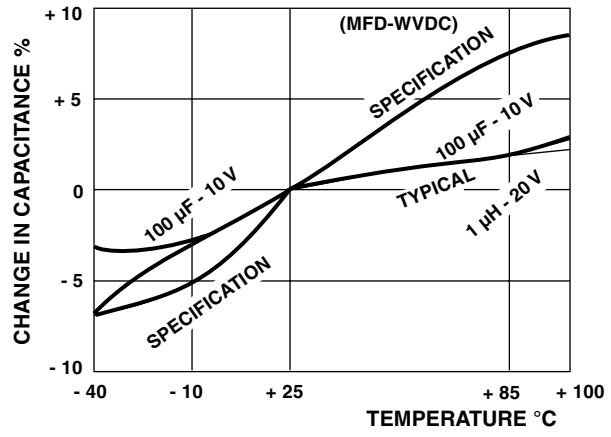
Surge Voltage: (per MIL-PRF-49317) After 1000 cycles at 85 °C and 1.3 x WVDC; capacitance shall be within ± 10 % of initial limit, DF and leakage within initial limits.

Resistance to Soldering Heat: (per Method 210 of MIL-STD-202, Condition B) After immersion in 260 °C molten solder to within a 1/4" of the body of the unit, there shall be no evidence of mechanical or electrical degradation.

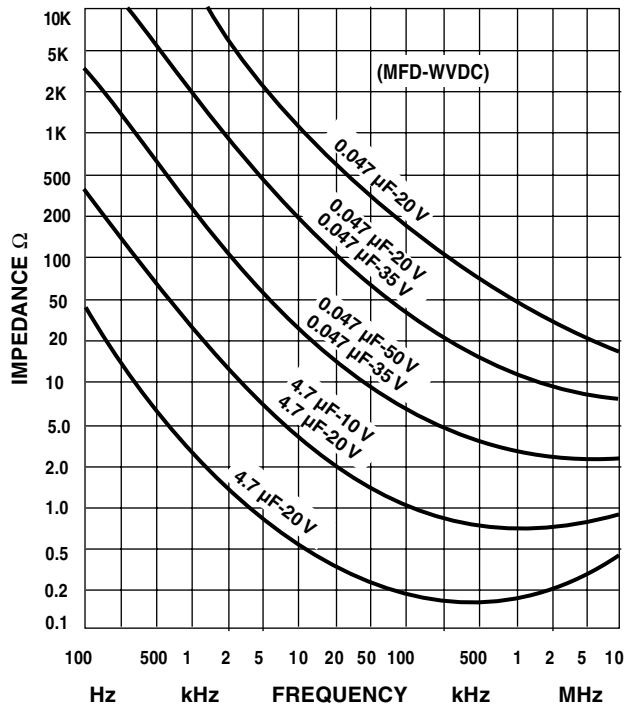
Solderability: (per Method 208 of MIL-STD-202) After dipping leads in 235 °C molten solder to within 0.125" of the body of the unit, the solder shall cover 95 % of the lead surface.

Terminal Strength: (per Method 211 of MIL-STD-202) After the following test there shall be no loosening of the terminals or permanent damage to the terminals. Test Condition A: (Pull Test) 0.010" leads withstand 1 pound, 0.016" leads 2 pounds and 0.007" leads 1/2 pound. Test Condition C: (Bend Test) All leads shall withstand 3 - 90° bends with a 1/2 pound applied force.

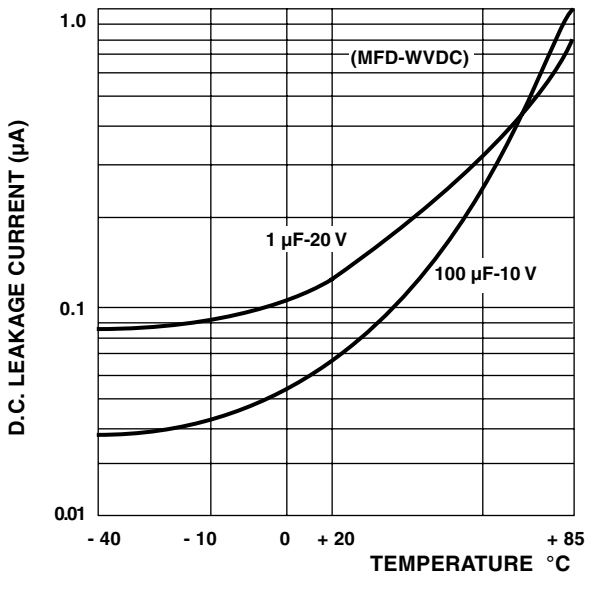
CAPACITANCE VS. TEMPERATURE



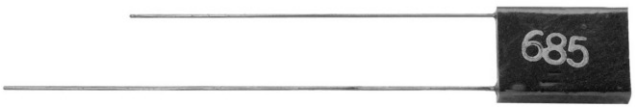
IMPEDANCE VS. FREQUENCY



LEAKAGE CURRENT - TEMPERATURE



Subminiature, Leaded Solid Tantalum Capacitors Polar or Non-Polar



FEATURES

- Subminiature package size and light weight
- Rectangular case with axial or radial leads
- 2 to 35 V_{DC}
- 0.1 µF to 470 µF
- Operating temperature range: - 55 °C to + 125 °C
- High stability and reliability
- Tested in accordance with MIL-PRF-49137
- Unique and comprehensive custom design capability

ELECTRICAL CHARACTERISTICS

Operating temperature range: - 55 °C to + 125 °C

Capacitance: Measured at 120 Hz and 25 °C with a maximum of 2.2 V_{DC} bias and 1.0 V_{rms} signal.

Capacitance Tolerance: Standard tolerance is ± 20 % for ratings 0.1 µF and above, and + 40, - 20 % for ratings below 0.1 µF. Special tolerances are also available.

Dissipation Factor: When measured simultaneously with capacitance, DF shall not exceed the value shown in the ratings tables.

DC Leakage Current (DCL Max.):

When measured with DC voltage applied through a 1000 Ω resistor for 5 min, DC leakage (µA) shall not exceed:

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 and 66 % of Rated Voltage: Leakage current shall not exceed 15 times the values listed in the Standard Ratings Tables

Operating Voltage: Full working voltage up to 85 °C. From 85 °C to 125 °C working voltage derates linearly to 66 % of the 85 °C working voltage

APPLICATIONS

- Hearing aids
- Portable communications
- Space/avionics
- Laptop computers

MECHANICAL SPECIFICATIONS

Solder coated nickel leads (type N32 per MIL-STD-1276) are standard on all case sizes

Leads are weldable and/or solderable

Special leads are available on request (e.g. bare nickel, gold plated nickel or ribbon leads)

Lead length is 1 1/2" [38.1 mm] minimum on nonpolar parts

On polar parts the negative lead is 1 1/4" [31.8 mm] minimum and the positive lead is 1 1/2" [38.1 mm] minimum

ORDERING INFORMATION

STC	1.0	35	C2	A (1)	M
MODEL	CAPACITANCE IN µF	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD CONFIGURATION	CAPACITANCE TOLERANCE
			C = Polar N = Non-polar	A = Axial R = Radial	E = + 40, - 20 % M = ± 20 % K = ± 10 % J = ± 5 %

Example of Part Number Code: STC1.0-35C2AM

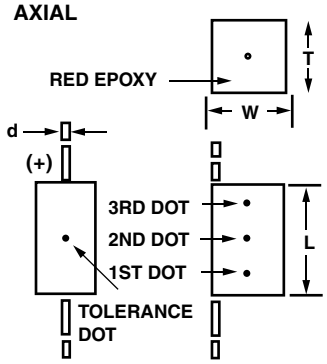
Note:

(1) To complete part number in rating tables, add A or R.
Change suffix if special capacitance tolerance is required.

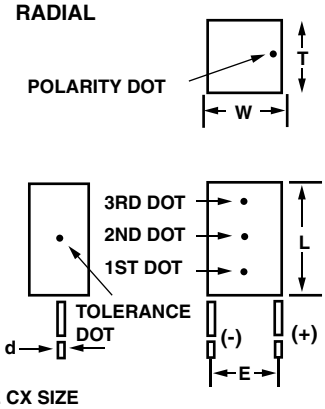
DIMENSIONS in inches [millimeters]

POLAR STYLE

AXIAL



RADIAL

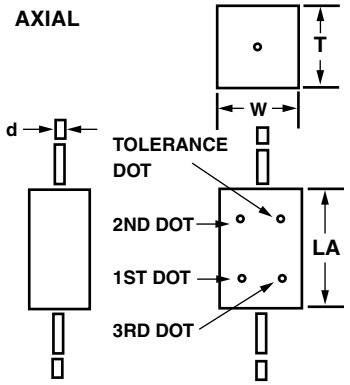


THE 3RD DOT IS ON THE END OF THE CX SIZE

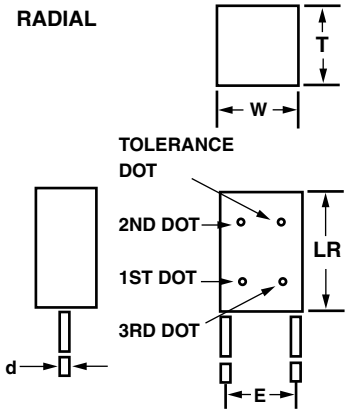
CASE CODE	L MAX.	W MAX.	T MAX.	E	E TOL. ±	d
CX	0.075 [1.91]	0.050 [1.27]	0.040 [1.02]	0.030 [0.76]	0.015 [0.38]	0.007 [0.18]
C0	0.100 [2.54]	0.050 [1.27]	0.040 [1.02]	0.030 [0.76]	0.015 [0.38]	0.007 [0.18]
C1	0.125 [3.18]	0.070 [1.78]	0.040 [1.02]	0.050 [1.27]	0.015 [0.38]	0.010 [0.25]
C2	0.165 [4.19]	0.120 [3.05]	0.070 [1.78]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
C3	0.225 [5.72]	0.185 [4.70]	0.075 [1.91]	0.150 [3.81]	0.020 [0.51]	0.010 [0.25]
C4	0.290 [7.37]	0.220 [5.59]	0.110 [2.79]	0.180 [4.57]	0.025 [0.64]	0.016 [0.41]
C5	0.310 [7.87]	0.230 [5.84]	0.130 [3.30]	0.200 [[5.08]	0.025 [0.64]	0.016 [0.41]
C6	0.475 [12.07]	0.375 [9.53]	0.150 [3.81]	0.300 [7.62]	0.025 [0.64]	0.016 [0.41]

NON POLAR STYLE

AXIAL



RADIAL



CASE CODE	LA MAX.	LR MAX.	W MAX.	T MAX.	E MAX.	E TOL. ±	d
N1	0.220 [5.59]	0.180 [4.57]	0.125 [3.18]	0.125 [3.18]	0.100 [2.54]	0.020 [0.51]	0.010 [0.25]
N2	0.280 [7.11]	0.240 [6.10]	0.140 [3.56]	0.180 [4.57]	0.100 [2.54]	0.025 [0.64]	0.010 [0.25]
N3	0.370 [9.40]	0.315 [8.00]	0.180 [4.57]	0.220 [5.59]	0.150 [3.81]	0.025 [0.64]	0.016 [0.41]
N4	0.390 [9.91]	0.335 [8.51]	0.230 [5.84]	0.230 [5.84]	0.180 [4.57]	0.025 [0.64]	0.016 [0.41]

STANDARD RATINGS - POLAR CAPACITORS				
CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
2 WVDC AT + 85 °C				
0.0022	10	0.5	CX	STC.0022-2CX (1)E
0.0033	10	0.5	CX	STC.0033-2CX (1)E
0.0047	10	0.5	CX	STC.0047-2CX (1)E
0.0068	10	0.5	CX	STC.0068-2CX (1)E
0.10	10	0.5	CX	STC.10-2CX (1)M
0.15	10	0.5	CX	STC.15-2CX (1)M
0.22	10	0.5	CX	STC.22-2CX (1)M
0.33	10	0.5	CX	STC.33-2CX (1)M
0.47	10	0.5	CX	STC.47-2CX (1)M
0.68	10	0.5	CX	STC.68-2CX (1)M
1.0	10	0.5	CX	STC1.0-2CX (1)M
1.5	10	0.5	CX	STC1.5-2CX (1)M
2.2	10	0.5	CX	STC2.2-2CX (1)M
2.2	10	0.5	C0	STC2.2-2C0 (1)M
6.8	10	0.5	C1	STC6.8-2C1 (1)M
100	10	2.0	C3	STC100-2C3 (1)M
3 WVDC AT + 85 °C				
1.5	10	0.5	C0	STC1.5-3C0 (1)M
22	10	1.0	C2	STC22-3C2 (1)M
68	10	2.0	C3	STC68-3C3 (1)M
100	10	3.0	C4	STC100-3C4 (1)M
4 WVDC AT + 85 °C				
1.0	10	0.5	C0	STC1.0-4C0 (1)M
4.7	10	0.5	C1	STC4.7-4C1 (1)M
10	8	1.0	C2	STC10-4C2 (1)M
15	8	1.0	C2	STC15-4C2 (1)M
47	8	2.0	C3	STC47-4C3 (1)M
68	8	3.0	C4	STC68-4C4 (1)M
220	15	9.0	C5	STC220-4C5 (1)M
470	15	10.0	C6	STC470-4C6 (1)M
6 WVDC AT + 85 °C				
0.68	10	0.5	C0	STC.68-6C0 (1)M
3.3	8	0.5	C1	STC3.3-6C1 (1)M
33	6	2.0	C3	STC33-6C3 (1)M
47	6	3.0	C4	STC47-6C4 (1)M
150	10	9.0	C5	STC150-6C5 (1)M
330	15	10.0	C6	STC330-6C6 (1)M
10 WVDC AT + 85 °C				
0.47	10	0.5	C0	STC.47-10C0 (1)M
1.5	6	0.5	C1	STC1.5-10C1 (1)M
2.2	6	0.5	C1	STC2.2-10C1 (1)M
6.8	6	1.0	C2	STC6.8-10C2 (1)M
22	6	2.0	C3	STC22-10C3 (1)M
33	6	3.0	C4	STC33-10C4 (1)M
100	8	9.0	C5	STC100-10C5 (1)M
220	6	0.5	C6	STC220-10C6 (1)M
15 WVDC AT + 85 °C				
1.0	6	0.5	C1	STC1.0-15C1 (1)M
4.7	6	1.0	C2	STC4.7-15C2 (1)M
15	6	2.0	C3	STC15-15C3 (1)M
22	6	3.0	C4	STC22-15C4 (1)M
68	6	6.0	C5	STC68-15C5 (1)M
150	10	10.0	C6	STC150-15C6 (1)M

Note:

(1) Add A for axial, R for radial

STANDARD RATINGS - POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT+ 25 °C (µA)	CASE CODE	PART NUMBER
		20 WVDC AT + 85 °C		
0.68	6	0.5	C1	STC.68-20C1 (1)M
3.3	6	1.0	C2	STC3.3-20C2 (1)M
6.8	6	2.0	C3	STC6.8-20C3 (1)M
10	6	2.0	C3	STC10-20C3 (1)M
15	6	3.0	C4	STC15-20C4 (1)M
47	6	6.0	C5	STC47-20C5 (1)M
100	10	10.0	C6	STC100-20C6 (1)M
		25 WVDC AT + 85 °C		
0.47	6	0.5	C1	STC.47-25C1 (1)M
2.2	6	1.0	C2	STC2.2-25C2 (1)M
3.3	6	2.0	C3	STC3.3-25C3 (1)M
4.7	6	2.0	C3	STC4.7-25C3 (1)M
10	6	3.0	C4	STC10-25C4 (1)M
15	6	6.0	C5	STC15-25C5 (1)M
22	6	6.0	C5	STC22-25C6 (1)M
33	6	6.0	C5	STC33-25C5 (1)M
68	6	10.0	C6	STC68-25C6 (1)M
		35 WVDC AT + 85 °C		
0.33	6	0.5	C1	STC.33-35C1 (1)M
0.68	6	1.0	C2	STC.68-35C2 (1)M
1.0	6	1.0	C2	STC1.0-35C2 (1)M
1.5	6	1.0	C2	STC1.5-35C2 (1)M

Note:
(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
		2 WVDC AT + 85 °C		
10	10	1.0	N1	STC10-2N1*M
		3 WVDC AT + 85 °C		
33	10	2.0	N2	STC33-3N2*M
47	8	3.0	N3	STC47-3N3*M
100	10	6.0	N4	STC100-3N4*M
		4 WVDC AT + 85 °C		
6.8	8	1.0	N1	STC6.8-4N1*M
22	8	2.0	N2	STC22-4N2*M
33	8	3.0	N3	STC33-4N3*M
68	8	6.0	N4	STC68-4N4*M
		6 WVDC AT + 85 °C		
4.7	6	1.0	N1	STC4.7-6N1*M
15	6	2.0	N2	STC15-6N2*M
22	6	3.0	N3	STC22-6N3*M
47	6	6.0	N4	STC47-6N4*M
		10 WVDC AT + 85 °C		
3.3	6	1.0	N1	STC3.3-10N1*M
10	6	2.0	N2	STC10-10N2*M
15	6	3.0	N3	STC15-10N3*M
33	6	6.0	N4	STC33-10N4*M

Note:
(1) Add A for axial, R for radial

STANDARD RATINGS - NON-POLAR CAPACITORS

CAPACITANCE (µF)	MAX. DF (%)	MAX. DCL AT + 25 °C (µA)	CASE CODE	PART NUMBER
15 WVDC AT + 85 °C				
2.2	6	1.0	N1	STC2.2-15N1*M
6.8	6	2.0	N2	STC6.8-15N2*M
10	6	3.0	N3	STC10-15N3*M
22	6	6.0	N4	STC22-15N4*M
20 WVDC AT + 85 °C				
1.5	6	1.0	N1	STC1.5-20N1*M
4.7	6	2.0	N2	STC4.7-20N2*M
6.8	6	3.0	N3	STC6.8-20N3*M
15	6	6.0	N4	STC15-20N4*M
25 WVDC AT + 85 °C				
1.0	6	1.0	N1	STC1.0-25N1*M
2.2	6	2.0	N2	STC2.2-25N2*M
3.3	6	2.0	N2	STC3.3-25N2*M
4.7	6	3.0	N3	STC4.7-25N3*M
10	6	6.0	N4	STC10-25N4*M
35 WVDC AT + 85 °C				
0.68	6	1.0	N1	STC.68-35N1*M

Note:
(1) Add A for axial, R for radial

MARKING

STC Capacitors case sizes C3 - C6 and N2 - N4 are print marked:
- Capacitance is in picofarads
- 1st and 2nd digits are significant figures
- 3rd digit indicates the number of zeros.

Capacitance Tolerance	Color	Tolerance
Is indicated by a dot on the side of the case. Black dot is omitted.	Gold	± 5 %
	Silver	± 10 %
	None	± 20 %
	None	+ 40 %/- 20 %

The positive lead is indicated by a color dot of red epoxy on the unit.

All other case sizes are have color dot marking:

Capacitance	Color	Digit
In picofarads, indicated by 3 dots. 1st and 2nd dot give the significant digits. 3rd dot indicates the number of zeros. Color dot location is shown on the dimensional sketches. Black dot is omitted on black sleeve.	Black	0
	Brown	1
	Red	2
	Orange	3
	Yellow	4
	Green	5
	Blue	6
	Violet	7
	Grey	8
	White	9

e.g. Yellow-Violet-Green = 4 700 000 pf

= 4.7 µF

PERFORMANCE AND RELIABILITY

The capacitors are tested in accordance with MIL-PRF-49137, with specific requirements as follows:

Temperature Stability: When tested per MIL-PRF-49137/6, capacitance shall be within ± 15 % at - 55 °C and 85 °C, and ± 10 % at 25 °C after exposure to temperature extremes. DF shall be within 200 % of initial limit at - 55 °C, 150 % of initial limit at 85 °C, and meet the initial at 25 °C. DCL shall be within 10 x initial limit at 85 °C, and meet the initial limit at 25 °C.

Moisture Resistance: (per Method 106 of MIL-STD-202) After 10 cycles of 24 h at 25 °C to 65 °C and 80 - 98 % RH; capacitance shall be within ± 15 % of initial value, DF within 1.5 x initial limit and leakage within 3 x initial limit.

Life: (per Method 108 of MIL-STD-202) after 1000 h at 85 °C and rated voltage; capacitance shall be within ± 10 % of initial limit, DF within initial limits, and leakage within 200 % of initial limit.

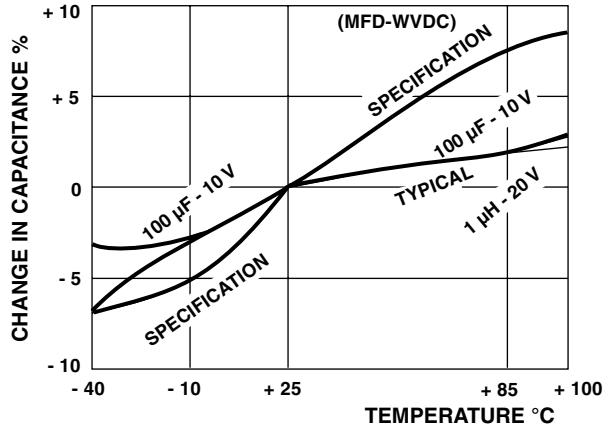
Surge Voltage: (per MIL-PRF-49317) After 1000 cycles at 85 °C and 1.3 x WVDC; capacitance shall be within ± 10 % of initial limit, DF and leakage within initial limits.

Resistance to Soldering Heat: (per Method 210 of MIL-STD-202, Condition B) After immersion in 260 °C molten solder to within a 1/4" of the body of the unit, there shall be no evidence of mechanical or electrical degradation.

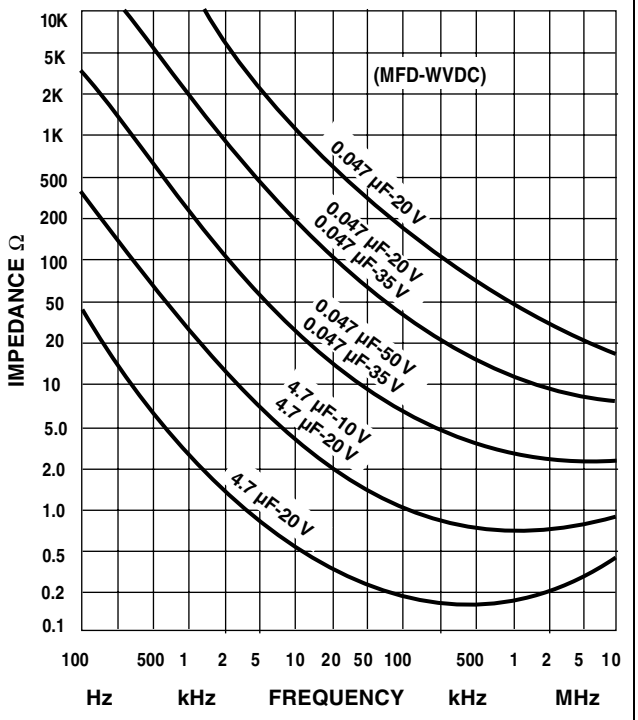
Solderability: (per Method 208 of MIL-STD-202) After dipping leads in 235 °C molten solder to within 0.125" of the body of the unit, the solder shall cover 95 % of the lead surface.

Terminal Strength: (per Method 211 of MIL-STD-202) After the following test there shall be no loosening of the terminals or permanent damage to the terminals. Test Condition A: (Pull Test) 0.010" leads withstand 1 pound, 0.016" leads 2 pounds and 0.007" leads 1/2 pound. Test Condition C: (Bend Test) All leads shall withstand 3 - 90° bends with a 1/2 pound applied force.

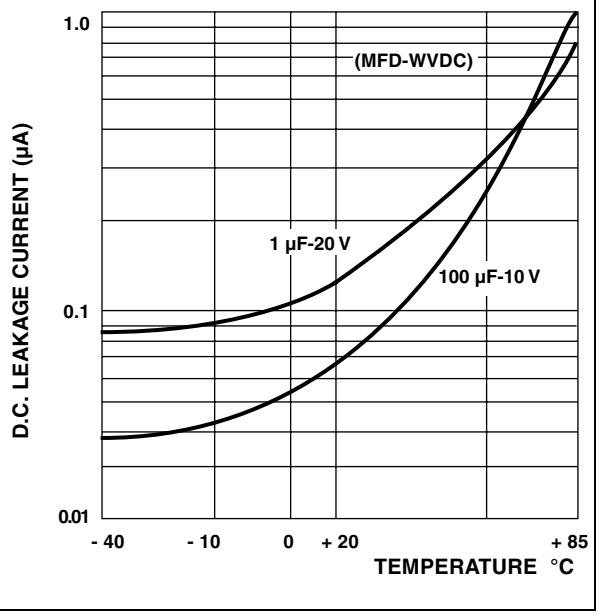
CAPACITANCE VS. TEMPERATURE



IMPEDANCE VS. FREQUENCY



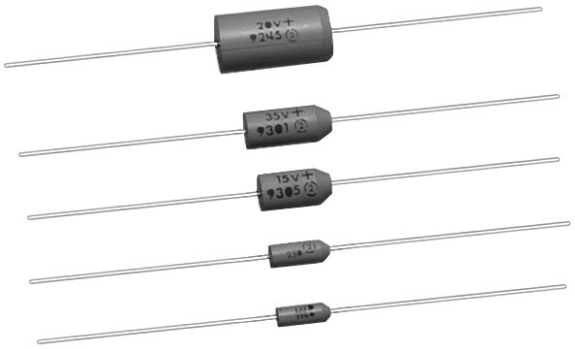
LEAKAGE CURRENT - TEMPERATURE



Resin Coated

Contents

Solid-Electrolyte TANTALEX® Capacitors, Axial-Leaded, Molded-Case



FEATURES

- Terminations: Tin/lead (SnPb), 100 % Tin (RoHS compliant)
- Miniature axial-lead capacitors available in 5 sizes
- Precision molded in gold colored, flame retardant, thermosetting epoxy resin
- Laser marked for improved legibility and tapered end of case provides easy identification of positive terminal
- Standard orders are lead taped and reeled; orders under 500 are taped only

Pb-free Available

RoHS*
COMPLIANT

APPLICATIONS

- Designed for high performance automotive, industrial and commercial electronic equipment

PERFORMANCE CHARACTERISTICS

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

Capacitance Tolerance: At 120 Hz, + 25 °C. ± 20 %, ± 10 % standard ± 5 % available as special

Dissipation Factor: At 120 Hz, + 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 shall not exceed 15 times the values listed in the Standard Ratings Tables

Life Test: Capacitors shall withstand rated DC voltage applied at + 85 °C for 2000 h and for 1000 h applied at + 25 °C derated voltage

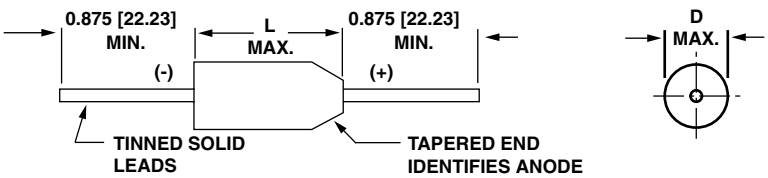
Following the life test:

1. DCL shall not exceed 125 % of the initial requirements
2. Dissipation Factor shall meet the initial requirement
3. Change in capacitance shall not exceed ± 10 %

ORDERING INFORMATION

173D	335	X9	006	U	W	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	PACKAGING	ROHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 % X9 = ± 10 % *X5 = ± 5 % *special order	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating.	See Ratings and Case Codes Table	W = Tape and Reel Blank =Ammo Pack	E3 = 100 % tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in inches [millimeters]



CASE CODE	D (MAX.)	L (MAX.)	LEAD DIAMETER
U	0.095 [2.41]	0.260 [6.60]	0.020 [0.51]
V	0.110 [2.79]	0.290 [7.37]	0.020 [0.51]
W	0.180 [4.57]	0.345 [8.76]	0.020 [0.51]
X	0.180 [4.57]	0.420 [10.67]	0.020 [0.51]
Y	0.280 [7.11]	0.550 [13.97]	0.025 [0.64]

* Pb containing terminations are not RoHS compliant, exemptions may apply

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	MAX. DCL AT + 25 °C (µA)	MAX. DF AT + 25 °C 120 Hz (%)
2 WVDC AT + 85 °C, SURGE = 2.5 V . . . 1.5 WVDC AT + 125 °C, SURGE = 1.8 V					
6.8	U	173D685X0002U	173D685X9002U	0.5	10
8.2	U	-	173D825X9002U	0.5	10
10.0	U	173D106X0002U	173D106X9002U	0.5	10
12.0	V	-	173D126X9002V	0.5	10
15.0	V	173D156X0002V	173D156X9002V	0.5	10
18.0	V	-	173D186X9002V	0.5	10
22.0	V	173D226X0002V	173D226X9002V	0.5	10
27.0	V	-	173D276X9002V	0.5	10
33.0	V	173D336X0002V	173D336X9002V	0.5	10
39.0	W	-	173D396X9002W	0.6	10
47.0	W	173D476X0002W	173D476X9002W	0.8	10
56.0	W	-	173D566X9002W	0.9	10
68.0	W	173D686X0002W	173D686X9002W	1.1	10
4 WVDC AT + 85 °C, SURGE = 5 V . . . 2.5 WVDC AT + 125 °C, SURGE = 3 V					
4.7	U	173D475X0004U	173D475X9004U	0.5	8
5.6	U	-	173D565X9004U	0.5	8
6.8	U	173D685X0004U	173D685X9004U	0.5	8
8.2	V	-	173D825X9004V	0.5	8
10.0	V	173D106X0004V	173D106X9004V	0.5	8
12.0	V	-	173D126X9004V	0.5	8
15.0	V	173D156X0004V	173D156X9004V	0.5	8
18.0	V	-	173D186X9004V	0.6	8
22.0	V	173D226X0004V	173D226X9004V	0.7	8
27.0	W	-	173D276X9004W	0.9	8
33.0	W	173D336X0004W	173D336X9004W	1.1	8
39.0	W	-	173D396X9004W	1.2	8
47.0	W	173D476X0004W	173D476X9004W	1.5	8
56.0	X	-	173D566X9004X	1.5	8
68.0	X	173D686X0004X	173D686X9004X	2.2	8
6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V					
3.3	U	173D335X0006U	173D335X9006U	0.5	4
3.9	U	-	173D395X9006U	0.5	4
4.7	U	173D475X0006U	173D475X9006U	0.5	4
5.6	V	-	173D565X9006V	0.5	4
6.8	V	173D685X0006V	173D685X9006V	0.5	6
8.2	V	-	173D825X9006V	0.5	6
10.0	V	173D106X0006V	173D106X9006V	0.5	6
12.0	V	-	173D126X9006V	0.6	6
15.0	V	173D156X0006V	173D156X9006V	0.7	6
18.0	W	-	173D186X9006W	0.9	6
22.0	W	173D226X0006W	173D226X9006W	1.1	6
27.0	W	-	173D276X9006W	1.3	6
33.0	W	173D336X0006W	173D336X9006W	1.5	6
39.0	X	-	173D396X9006X	1.9	6
47.0	X	173D476X9006X	173D476X9006X	2.3	6
56.0	X	-	173D566X9006X	2.7	6
68.0	X	173D686X0006X	173D686X9006X	3.3	6
82.0	Y	-	173D826X9006Y	3.9	8
100.0	Y	173D107X0006Y	173D107X9006Y	4.8	8
120.0	Y	-	173D127X9006Y	5.0	8
150.0	Y	173D157X0006Y	173D157X9006Y	5.0	8
180.0	Y	-	173D187X9006Y	8.6	8
220.0	Y	173D227X0006Y	173D227X9006Y	10.0	8
270.0	Y	-	173D277X9006Y	10.0	8
330.0	Y	173D337X0006Y	173D337X9006Y	10.0	8

Note:
(1) Part number should include “X5”; for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	MAX. DCL AT + 25 °C (µA)	MAX. DF AT+ 25 °C 120 Hz (%)
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V					
2.2	U	173D225X0010U	173D225X9010U	0.5	4
2.7	U	-	173D275X9010U	0.5	4
3.3	U	173D335X0010U	173D335X9010U	0.5	4
3.9	V	-	173D395X9010V	0.5	4
4.7	V	173D475X0010V	173D475X9010V	0.5	4
5.6	V	-	173D565X9010V	0.5	4
6.8	V	173D685X0010V	173D685X9010V	0.5	6
8.2	V	-	173D825X9010V	0.7	6
10.0	V	173D106X0010V	173D106X9010V	0.8	6
12.0	W	-	173D126X9010W	1.0	6
15.0	W	173D156X0010W	173D156X9010W	1.2	6
18.0	W	-	173D186X9010W	1.4	6
22.0	W	173D226X0010W	173D226X9010W	1.5	6
27.0	X	-	173D276X9010X	2.2	6
33.0	X	173D336X0010X	173D336X9010X	2.6	6
39.0	X	-	173D396X9010X	3.1	6
47.0	X	173D476X0010X	173D476X9010X	3.8	6
56.0	Y	-	173D566X9010Y	4.4	6
68.0	Y	173D686X0010Y	173D686X9010Y	5.0	6
82.0	Y	-	173D826X9010Y	5.0	8
100.0	Y	173D107X0010Y	173D107X9010Y	8.0	8
120.0	Y	-	173D127X9010Y	9.6	8
150.0	Y	173D157X0010Y	173D157X9010Y	10.0	8
180.0	Y	-	173D187X9010Y	10.0	8
220.0	Y	173D227X0010Y	173D227X9010Y	10.0	8
15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V					
1.5	U	173D155X0015U	173D155X9015U	0.5	4
1.8	U	-	173D185X9015U	0.5	4
2.2	U	173D225X0015U	173D225X9015U	0.5	4
2.7	V	-	173D275X9015V	0.5	4
3.3	V	173D335X0015V	173D335X9015V	0.5	4
3.9	V	-	173D395X9015V	0.5	4
4.7	V	173D475X0015V	173D475X9015V	0.6	4
5.6	V	-	173D565X9015V	0.7	4
6.8	V	173D685X0015V	173D685X9015V	0.8	6
8.2	W	-	173D825X9015W	1.0	6
10.0	W	173D106X0015W	173D106X9015W	1.2	6
12.0	W	-	173D126X9015W	1.4	6
15.0	W	173D156X0015W	173D156X9015W	1.5	6
18.0	X	-	173D186X9015X	2.2	6
22.0	X	173D226X9015X	173D226X9015X	2.6	6
27.0	X	-	173D276X9015X	3.2	6
33.0	X	173D336X0015X	173D336X9015X	4.0	6
39.0	Y	-	173D396X9015Y	4.7	6
47.0	Y	173D476X0015Y	173D476X9015Y	5.0	6
56.0	Y	-	173D566X9015Y	6.7	6
68.0	Y	173D686X0015Y	173D686X9015Y	8.2	6
82.0	Y	-	173D826X9015Y	9.8	8
100.0	Y	173D107X0015Y	173D107X9015Y	10.0	8
120.0	Y	-	173D127X9015Y	10.0	8
150.0	Y	173D157X0015Y	173D157X9015Y	10.0	8

Note:
(1) Part number should include “X5”; for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	MAX. DCL AT+ 25 °C (µA)	MAX. DF AT + 25 °C 120 Hz (%)
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V					
1.0	U	173D105X0020U	173D105X9020U	0.5	4
1.2	U	-	173D125X9020U	0.5	4
1.5	U	173D155X0020U	173D155X9020U	0.5	4
1.8	V	-	173D185X9020V	0.5	4
2.2	V	173D225X0020V	173D225X9020V	0.5	4
2.7	V	-	173D275X9020V	0.5	4
3.3	V	173D335X0020V	173D335X9020V	0.5	4
3.9	V	-	173D395X9020V	0.6	4
4.7	V	173D475X0020V	173D475X9020V	0.8	4
5.6	W	-	173D565X9020W	0.9	4
6.8	W	173D685X0020W	173D685X9020W	1.1	6
8.2	W	-	173D825X9020W	1.3	6
10.0	W	173D106X0020W	173D106X9020W	1.6	6
12.0	X	-	173D126X9020X	1.9	6
15.0	X	173D156X0020X	173D156X9020X	2.4	6
18.0	X	-	173D186X9020X	2.9	6
22.0	X	173D226X0020X	173D226X9020X	3.5	6
27.0	Y	-	173D276X9020Y	4.3	6
33.0	Y	173D336X0020Y	173D336X9020Y	5.0	6
39.0	Y	-	173D396X9020Y	6.2	6
47.0	Y	173D476X0020Y	173D476X9020Y	7.5	6
56.0	Y	-	173D566X9020Y	8.9	6
68.0	Y	173D686X0020Y	173D686X9020Y	10.0	6
82.0	Y	-	173D826X9020Y	10.0	6
100.0	Y	173D107X0020Y	173D107X9020Y	10.0	6
25 WVDC AT + 85 °C, SURGE = 32 V . . . 17 WVDC AT + 125 °C, SURGE = 21 V					
0.47	U	173D474X0025U	173D474X9025U	0.5	3
0.56	U	-	173D564X9025U	0.5	3
0.68	U	173D684X0025U	173D684X9025U	0.5	3
0.82	U	-	173D824X9025U	0.5	3
1.0	U	173D105X0025U	173D105X9025U	0.5	3
1.2	V	-	173D125X9025V	0.5	3
1.5	V	173D155X0025V	173D155X9025V	0.5	3
1.8	V	-	173D185X9025V	0.5	3
2.2	V	173D225X0025V	173D225X9025V	0.5	3
2.7	V	-	173D275X9025V	0.5	3
3.3	V	173D335X0025V	173D335X9025V	0.7	3
3.9	W	-	173D395X9025W	0.8	3
4.7	W	173D475X0025W	173D475X9025W	0.9	4
5.6	W	-	173D565X9025W	1.1	4
6.8	W	173D685X0025W	173D685X9025W	1.4	4
8.2	W	-	173D825X9025W	1.5	4
10.0	W	173D106X0025W	173D106X9025W	1.5	4
12.0	X	-	173D126X9025X	2.4	4
15.0	X	173D156X0025X	173D156X9025X	3.0	4
18.0	Y	-	173D186X9025Y	3.6	6
22.0	Y	173D226X9025Y	173D226X9025Y	4.4	6
27.0	Y	-	173D276X9025Y	5.4	6
33.0	Y	173D336X0025Y	173D336X9025Y	6.6	6
39.0	Y	-	173D396X9025Y	7.8	6
47.0	Y	173D476X0025Y	173D476X9025Y	9.4	6

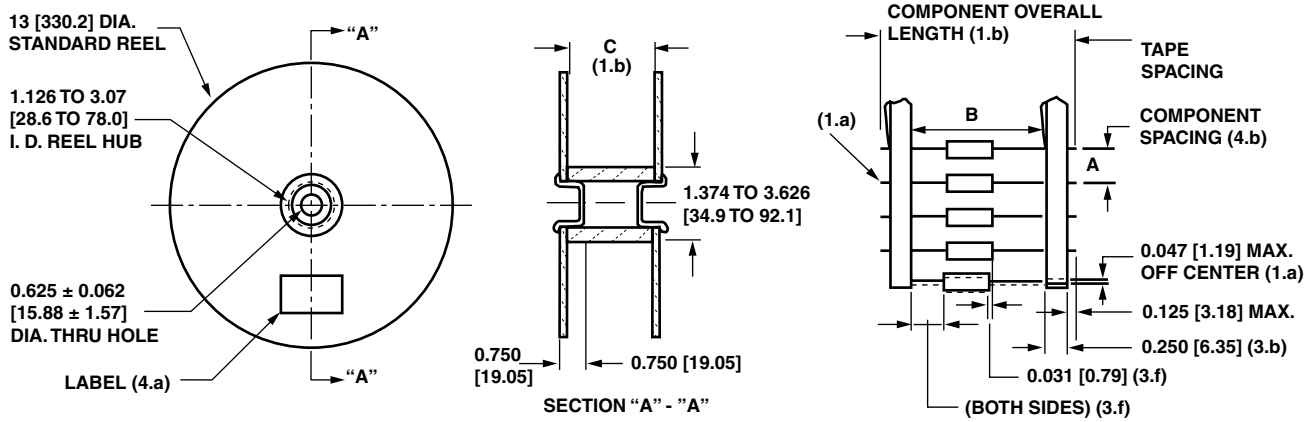
Note:
(1) Part number should include “X5”; for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %	PART NUMBER (1) CAP. TOL. ± 10 %	MAX. DCL AT+ 25 °C (µA)	MAX. DF AT + 25 °C 120 Hz (%)
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V					
0.10	U	173D104X0035U	173D104X9035U	0.5	3
0.12	U	-	173D124X9035U	0.5	3
0.15	U	173D154X0035U	173D154X9035U	0.5	3
0.18	U	-	173D184X9035U	0.5	3
0.22	U	173D224X0035U	173D224X9035U	0.5	3
0.27	U	-	173D274X9035U	0.5	3
0.33	U	173D334X0035U	173D334X9035U	0.5	3
0.39	U	-	173D394X9035U	0.5	3
0.47	U	173D474X0035U	173D474X9035U	0.5	3
0.56	V	-	173D564X9035V	0.5	3
0.68	V	173D684X0035V	173D684X9035V	0.5	3
0.82	V	-	173D824X9035V	0.5	3
1.0	V	173D105X0035V	173D105X9035V	0.5	3
1.2	V	-	173D125X9035V	0.5	3
1.5	V	173D155X0035V	173D155X9035V	0.5	3
1.8	W	-	173D185X9035W	0.5	3
2.2	W	173D225X0035W	173D225X9035W	0.6	3
2.7	W	-	173D275X9035W	0.8	3
3.3	W	173D335X0035W	173D335X9035W	0.9	4
3.9	W	-	173D395X9035W	1.1	4
4.7	W	173D475X0035W	173D475X9035W	1.3	4
5.6	X	-	173D565X9035X	1.6	4
6.8	X	173D685X0035X	173D685X9035X	1.9	4
8.2	X	-	173D825X9035X	2.3	4
10.0	X	173D106X0035X	173D106X9035X	2.8	4
12.0	Y	-	173D126X9035Y	3.3	4
15.0	Y	173D156X0035Y	173D156X9035Y	4.2	6
18.0	Y	-	173D186X9035Y	5.0	6
22.0	Y	173D226X0035Y	173D226X9035Y	6.2	6
27.0	Y	-	173D276X9035Y	7.5	6
33.0	Y	173D336X0035Y	173D336X9035Y	9.2	6
39.0	Y	-	173D396X9035Y	10.0	6
47.0	Y	173D476X0035Y	173D476X9035Y	10.0	6
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V					
0.10	U	173D104X0050U	173D104X9050U	0.5	3
0.12	U	-	173D124X9050U	0.5	3
0.15	U	173D154X0050U	173D154X9050U	0.5	3
0.18	U	-	173D184X9050U	0.5	3
0.22	U	173D224X0050U	173D224X9050U	0.5	3
0.27	U	-	173D274X9050U	0.5	3
0.33	V	173D334X0050V	173D334X9050V	0.5	3
0.39	V	-	173D394X9050V	0.5	3
0.47	V	173D474X0050V	173D474X9050V	0.5	3
0.56	V	-	173D564X9050V	0.5	3
0.68	V	173D684X0050V	173D684X9050V	0.5	3
0.82	V	-	173D824X9050V	0.5	3
1.0	V	173D105X0050V	173D105X9050V	0.5	3
1.2	W	-	173D125X9050W	0.5	3
1.5	W	173D155X0050W	173D155X9050W	0.6	4
1.8	W	-	173D185X9050W	0.7	4
2.2	W	173D225X0050W	173D225X9050W	0.9	4
2.7	X	-	173D275X9050X	1.1	4
3.3	X	173D335X0050X	173D335X9050X	1.3	4
3.9	X	-	173D395X9050X	1.6	4
4.7	X	173D475X0050X	173D475X9050X	1.9	4
5.6	Y	-	173D565X9050Y	2.2	4
6.8	Y	173D685X0050Y	173D685X9050Y	2.7	4
8.2	Y	-	173D825X9050Y	3.2	4
10.0	Y	173D106X0050Y	173D106X9050Y	4.0	6
12.0	Y	-	173D126X9050Y	5.0	6
15.0	Y	173D156X0050Y	173D156X9050Y	6.0	6
18.0	Y	-	173D186X9050Y	6.0	6

Note:
(1) Part number should include “X5”; for ± 5 % units (special order)

TAPE AND REEL PACKAGING in inches [millimeters]



CASE CODE	UNITS PER REEL	COMPONENT SPACING	TAPE SPACING	UNITS PER AMMOPACK
		A	B	
U	4500	0.200 ± 0.015 [5.08 ± 3.81]	2.062 ± 0.062 [2.37 ± 1.57]	1000
V	4000			
W, X	2500			500
Y	500	0.400 ± 0.015		

STANDARD REEL PACKAGING INFORMATION

1. Component Leads:

a. Component leads shall not be bent beyond 0.047" [1.19 mm] maximum from their nominal position when measured from the leading edge of the component lead at the inside tape edge and at the lead egress from the component.

b. The "C" dimension shall be governed by the overall length of the reel packaged component. The distance between flanges shall be 0.125" to 0.250" [3.18 mm to 6.35 mm] greater than the overall component length.

2. Orientation:

a. All polarized components must be oriented to one direction. The cathode lead tape shall be a color and the anode lead tape shall be white.

3. Reeling:

a. Components on any reel shall not represent more than two date codes when date code identification is required.

b. Component leads shall be positioned between pairs of 0.250" [6.35 mm] tape.

c. The disposable reels have hubs with corrugated fibreboard flanges and core.

d. A minimum of 12" [304.8 mm] leader of tape shall be provided before the first and after the last component on the reel.

e. 50 to 60 lb. Kraft paper must be wound between layers of components as far as necessary for component protection. Width of paper to be 0.062" to 0.250" [1.57 mm to 6.35 mm] less than the "C" dimension of the reel.

f. Row components must be centered between tapes ± 0.047" [1.19 mm]. In addition, individual components may deviate from center of component row ± 0.031" [0.79].

g. Staples shall not be used for splicing. Not more than 4 layers of tape shall be used in any splice area and no tape shall be offset from another by more than 0.031" [0.79 mm] non-cumulative. Tape splices shall overlap at least 6" [152.4 mm] for butt joints and at least 3" [76.2 mm] for lap joints and shall not be weaker than unspliced tape. Universal splicing clips may also be used.

h. Quantity per reel shall be controlled so that tape components and cover shall not extend beyond the smallest dimension of the flange (either across flats or diameter). Once the quantity per reel for each part number has been established, future orders for that part number shall be packaged in that quantity. When order release quantity is less than the established quantity, a standard commercial pack is to be used.

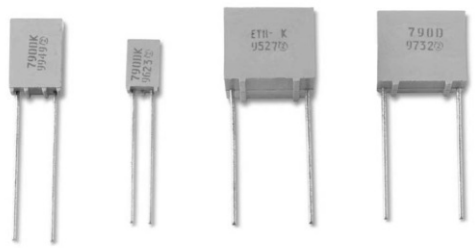
i. A maximum of 0.25 % of the components per reel quantity may be missing without consecutive missing components.

j. Adequate protection must be provided to prevent physical damage to both reel and components during shipment and storage.

4. Marking:

a. Minimum reel and carton marking shall consist of the following: Customer Part Number, Purchase Order No., Quantity, Package Date, Manufacturer's name, Electrical Value, Date Code, Vishay Sprague Part Number and Country of Origin.

Resin-Molded, Radial-Lead Solid Tantalum Capacitors



FEATURES

- Terminations: Tin/lead (SnPb), 100 % Tin (Sn)
- Four case sizes precisely molded with a flame retardant epoxy resin
- Stand off on all case sizes
- Available on tape for automatic insertion equipment (only A- and B-case, C- and D-case on request)
- Low leakage current
- Low impedance
- Extended value ranges available

Pb-free Available

RoHS*

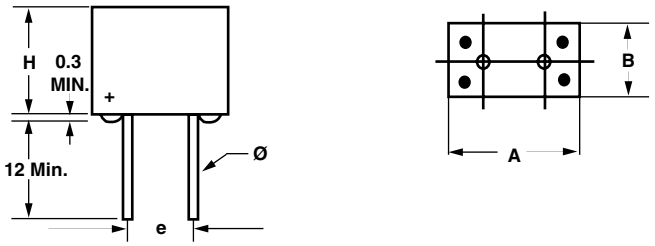
PERFORMANCE CHARACTERISTICS

Operating Temperature: - 55 °C to + 125 °C

ORDERING INFORMATION

790D	157	X0	006	R	2	P	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT +85 °C	CASE CODE	STYLE NUMBER	PACKAGING	ROHS COMPLIANT
790D = Standard and Extended Range	Expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros following.	X0 = ± 20 % X9 = ± 10 %	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 V)	See Ratings and Case Codes Table	Insulated Case (Standard)	See Taping Specification B : Bulk G : Ammopack H = 16.5 mm H : Ammopack H = 18.5 mm I : Ammopack Shouldered Leads (A case) X : Reel Pack H = 16.5 mm Y : Reel Pack H = 18.5 mm Z : Reel Pack Shouldered Leads (A case)	E3 = 100 % tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in millimeters



CASE CODE	H MAX. (mm)	A MAX. (mm)	B MAX. (mm)	E ± 0.15 (mm)	Ø 0.05 (+ 10 %) (mm)
A	7.3	4.7	4.2	2.54	0.5
B	10.5	7.3	4.8	5.08	0.5
C	10.5	12.3	7.3	10.16	0.6
D	10.5	12.3	12.3	10.16	0.6

PACKAGING QUANTITIES

CASE CODE	REEL X/Y	AMMO G/H	BULK B
A	1000	1000	500
B	1000	1000	250
C	300*	300*	100
D	200*	200*	50

* Pb containing terminations are not RoHS compliant, exemptions may apply

RATINGS AND CASE CODES

CR µF	RATED VOLATAGE U_R AT + 85 °C															
	6.3 V		10 V		16 V		20 V		25 V		35 V		40 V		50 V	
	CATEGORY VOLTAGE U_C AT + 125 °C															
	4.0 V		6.3 V		10 V		13 V		16 V		23 V		25 V		32 V	
	Std.	Ext.	Std.	Ext.	Std.	Ext.	Std.	Ext.	Std.	Ext.	Std.	Ext.	Std.	Ext.	Std.	Ext.
0.10													A		A	
0.15															A	
0.22															A	
0.33													A			
0.47													A			
0.68																
1.0													A			
1.5									A				B		A	
2.2					A		A						B		B	
3.3					A							A	B		B	
4.7			A							A			B		B	
6.8	A							A					B		B	
10						A			B			B	C		C	
15				A	B		B			B			C		C	
22		A			B			B		B			C		C	
33			B			B			C			C				
47	B			B	C		C									
68		B		B	C			C								
100			C		D	C	D									
150	C			C												
220		C	D													
330	D															

STANDARD/EXTENDED RATINGS

CAPACITANCE C_R (µF)	CASE CODE	PART NUMBER	MAX. DCL AT + 25 °C (µA)	MAX. DF 120 Hz, AT + 25 °C (%)	MAX. IMPEDANCE 100 kHz, AT + 25 °C (Ω)
U_R = 6.3 V AT + 85 °C, SURGE = 8 V . . . U_C = 4 V AT + 125 °C, SURGE = 5 V					
6.8	A	790D685X(*)6R3A2(#)	1.0	6	4.0
22.0	**A**	**790D226X(*)6R3A2(#)**	**1.3**	**6**	**2.1**
47.0	B	790D476X(*)6R3B2(#)	2.9	6	1.3
68.0	**B**	**790D686X(*)6R3B2(#)**	**4.2**	**6**	**1.3**
150.0	C	790D157X(*)6R3C2(#)	9.4	6	0.6
220.0	**C**	**790D227X(*)6R3C2(#)**	**13.8**	**6**	**0.6**
330.0	D	790D337X(*)6R3D2(#)	20.7	8	0.4
U_R = 10 V AT + 85 °C, SURGE = 13 V . . . U_C = 6.3 V AT + 125 °C, SURGE = 8 V					
4.7	A	790D475X(*)010A2(#)	1.0	6	4.0
15.0	**A**	**790D156X(*)010A2(#)**	**1.5**	**6**	**2.5**
33.0	B	790D336X(*)010B2(#)	3.3	6	1.3
47.0	**B**	**790D476X(*)010B2(#)**	**4.7**	**6**	**1.4**
68.0	**B**	**790D686X(*)010B2(#)**	**6.8**	**6**	**1.3**
100.0	C	790D107X(*)010C2(#)	10.0	6	0.6
150.0	**C**	**790D157X(*)010C2(#)**	**15.0**	**6**	**0.6**
220.0	D	790D227X(*)010D2(#)	22.0	8	0.4
U_R = 16 V AT + 85 °C, SURGE = 20 V . . . U_C = 10 V AT + 125 °C, SURGE = 13 V					
2.2	A	790D225X(*)016A2(#)	1.0	6	5.5
3.3	A	790D335X(*)016A2(#)	1.0	6	4.4
10.0	**A**	**790D106X(*)016A2(#)**	**1.6**	**6**	**2.7**
15.0	B	790D156X(*)016B2(#)	2.4	6	1.6
22.0	B	790D226X(*)016B2(#)	3.5	6	1.3
33.0	**B**	**790D336X(*)016B2(#)**	**5.2**	**6**	**1.6**
47.0	C	790D476X(*)016C2(#)	7.5	6	0.8
68.0	C	790D686X(*)016C2(#)	10.8	6	0.6
100.0	**C**	**790D107X(*)016C2(#)**	**16.0**	**6**	**0.7**
100.0	D	790D107X(*)016D2(#)	16.0	6	0.5
U_R = 20 V AT + 85 °C, SURGE = 26 V . . . U_C = 13 V AT + 125 °C, SURGE = 16 V					
2.2	A	790D225X(*)020A2(#)	1.0	6	5.5
6.8	**A**	**790D685X(*)020A2(#)**	**1.3**	**6**	**3.5**
15.0	B	790D156X(*)020B2(#)	3.0	6	1.5
22.0	**B**	**790D226X(*)020B2(#)**	**4.4**	**6**	**2.1**
47.0	C	790D476X(*)020C2(#)	9.4	6	0.7
68.0	**C**	**790D686X(*)020C2(#)**	**13.6**	**6**	**0.8**
100.0	D	790D107X(*)020C2(#)	20.0	6	0.7

Note:
Extended Ratings in bold print
(*) Insert 0 for ± 20 % tolerance or 9 for ± 10 %
(#) See order information, packaging code

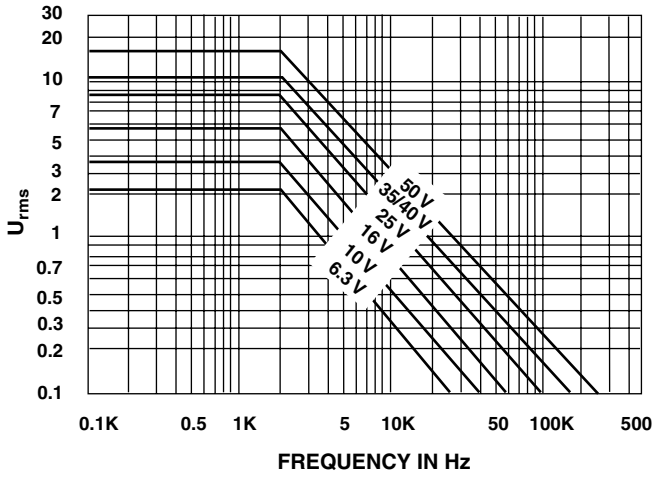
STANDARD/EXTENDED RATINGS

CAPACITANCE C_R (µF)	CASE CODE	PART NUMBER	MAX. DCL AT + 25 °C (µA)	MAX. DF 120 Hz, AT + 25 °C (%)	MAX. IMPEDANCE 100 kHz, AT + 25 °C (Ω)
U_R = 25 V AT + 85 °C, SURGE = 32 V . . . U_C = 16 V AT + 125 °C, SURGE = 20 V					
1.5	A	790D155X(*)025A2(#)	1.0	6	6.0
4.7	**A**	**790D475X(*)025A2(#)**	**1.1**	**6**	**4.5**
10.0	B	790D106X(*)025B2(#)	2.5	6	1.6
15.0	**B**	**790D156X(*)025B2(#)**	**3.7**	**6**	**2.4**
22.0	**B**	**790D226X(*)025B2(#)**	**5.5**	**6**	**2.1**
33.0	C	790D336X(*)025C2(#)	8.2	6	0.8
U_R = 35 V AT + 85 °C, SURGE = 45 V . . . U_C= 23 V AT + 125×C, SURGE = 29 V					
3.3	**A**	**790D335X(*)035A2(#)**	**1.2**	**6**	**6.0**
10.0	**B**	**790D106X(*)035B2(#)**	**3.5**	**6**	**2.6**
33.0	**C**	**790D336X(*)035C2(#)**	**11.6**	**6**	**1.3**
U_R = 40 V AT + 85 °C, SURGE = 52 V . . . U_C = 25 V AT + 125 °C, SURGE = 32 V					
0.10	A	790D104X(*)040A2(#)	1.0	6	30
0.33	A	790D334X(*)040A2(#)	1.0	6	14
0.47	A	790D474X(*)040A2(#)	1.0	6	11
1.0	A	790D105X(*)040A2(#)	1.0	6	6.5
1.5	B	790D155X(*)040B2(#)	1.0	6	5.2
2.2	B	790D225X(*)040B2(#)	1.0	6	4.0
3.3	B	790D335X(*)040B2(#)	1.3	6	2.8
4.7	B	790D475X(*)040B2(#)	1.8	6	2.0
6.8	B	790D685X(*)040B2(#)	2.7	6	1.6
10.0	C	790D106X(*)040C2(#)	4.0	6	1.3
15.0	C	790D156X(*)040C2(#)	6.0	6	1.0
22.0	C	790D226X(*)040C2(#)	8.8	6	0.8
U_R = 50 V AT + 85 °C, SURGE = 65 V . . . U_C = 32 V AT + 125 °C, SURGE = 41 V					
0.10	A	790D104X(*)050A2(#)	1.0	6	30
0.15	A	790D154X(*)050A2(#)	1.0	6	24
0.22	A	790D224X(*)050A2(#)	1.0	6	18
1.0	A	790D105X(*)050A2(#)	1.0	6	6.5
1.5	B	790D155X(*)050B2(#)	1.0	6	5.2
2.2	B	790D225X(*)050B2(#)	1.1	6	4.0
3.3	B	790D335X(*)050B2(#)	1.6	6	2.8
4.7	B	790D475X(*)050B2(#)	2.3	6	2.0
6.8	C	790D685X(*)050C2(#)	3.4	6	1.6
10.0	C	790D106X(*)050C2(#)	5.0	6	1.3
15.0	C	790D156X(*)050C2(#)	7.5	6	1.0

Note:
Extended Ratings in bold print
(*) Insert 0 for ± 20 % tolerance or 9 for ± 10 %
(#) See order information, packaging code

MAXIMUM PERMISSIBLE RIPPLE VOLTAGE AT + 25 °C

CASE SIZE "A"



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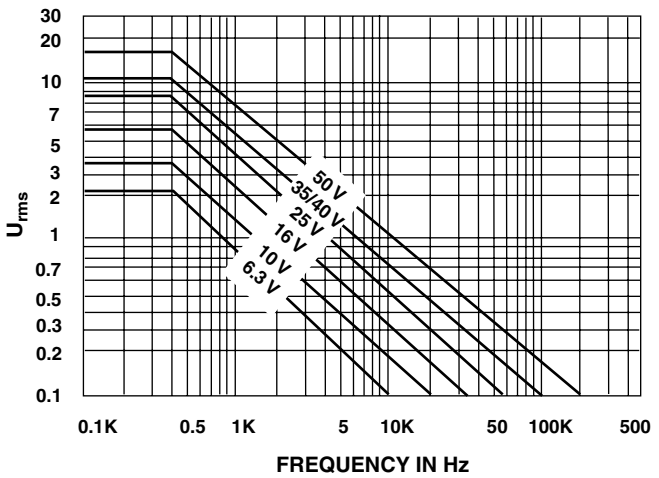
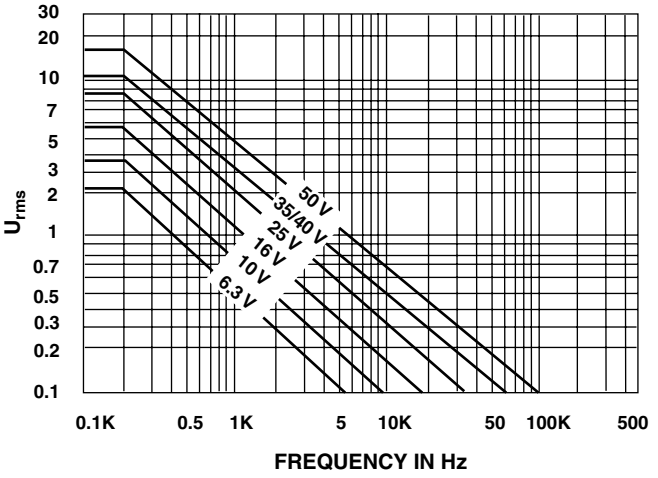
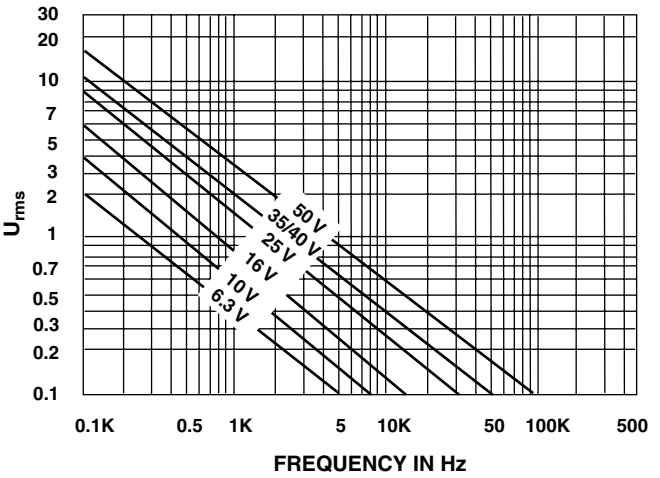


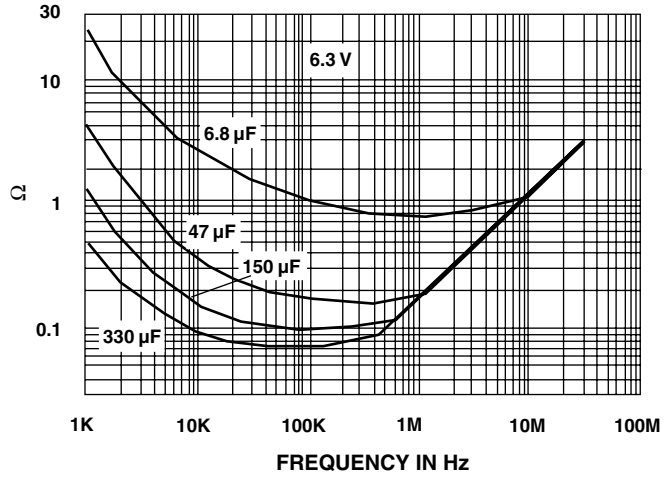
CASE SIZE "C"

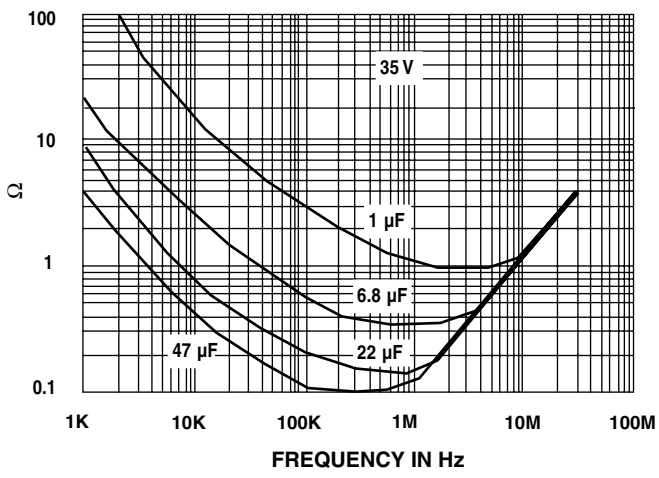


CASE SIZE "D"



TYPICAL CURVES OF IMPEDANCE VS FREQUENCY





PERFORMANCE CHARACTERISTICS

1. **Operating Temperature:** - 55 °C to + 85 °C with rated voltage U_R applied. + 85 °C to 125 °C with linear voltage derating to category voltage U_C (see general information) applied.
2. **Capacitance and Tolerance:**
   Capacitance measured at 100 Hz and + 25 °C shall be within the specified tolerance limits of the nominal rating
3. **Reverse Voltage:** 15 % of rated voltage at + 25 °C
   5 % of rated voltage at + 85 °C
4. **Surge Voltage:** 130 % of U_R at + 85 °C
   130 % of U_C at + 125 °C
5. **Impedance at 100 kHz:** Measured at + 20 °C ± 5 °C, impedance shall not exceed the values listed in data sheet.
6. **Stability at low and high temperatures**
   Capacitance change with temperature, dissipation factor and DC leakage current shall not exceed the limits of the following table.

TEMP.	CAPACITANCE CHANGE $C_RU_R \leq 1900$ $C_RU_R > 1900$	DISSIPATION FACTOR I_L	LEAKAGE CURRENT
- 55 °C	- 10 %	9 %	-
		11 %	
+ 25 °C	-	6 %	0.01 C_R x U_R or 1 µA whichever is greater
		8 %	
+ 85 °C	+ 12 %	9 %	0.1 C_R x U_R or 10 µA whichever is greater
		11 %	
+ 125 °C	+ 15 %	12 %	0.125 C_R x U_R or 12.5 µA whichever is greater
		14 %	

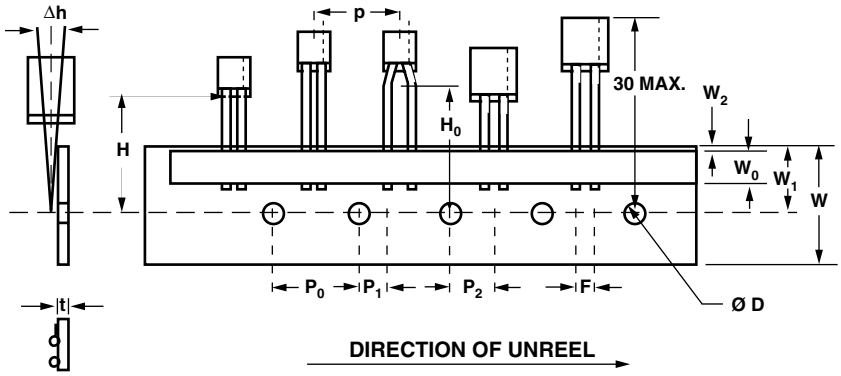
7. **Life Test:** 2000 h at + 85 °C with rated voltage applied
   2000 h at + 125 °C. with category voltage applied
   $\Delta C/C \leq 10$ % of initial value
   IL ≤ 1.25 initial limit
   DF ≤ initial limit
8. **Humidity Test:** 56 days at + 40 °C, 90 % relative humidity
   $\Delta C/C \leq 8$ % of initial value
   IL ≤ initial limit
   DF ≤ initial limit

- **Charge and Discharge Test:**
  1 million cycles at + 85 °C,
  0.5 s charge at UR
  0.5 s discharge
  Series resistance < 0.5 Ω
  $\Delta C/C \leq 5$ % of initial value
  IL ≤ initial limit
  DF ≤ initial limit

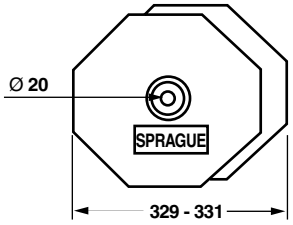
10. **Marking:**
    Top: Rating and polarity
    Front: Type, date code, Sprague trademark

TAPE AND REEL PACKING

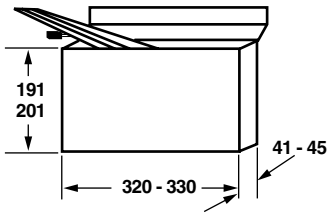
"A" AND "B" CASES ONLY (MEETS IEC 286-2)



REEL PACKING



AMMOPACKING



CASE CODE	TAPE WIDTH	DIMENSIONS (mm)/UNITS PER REEL		
Pitch of component	P [mm]	12.7 ± 1.0		
Feed hole pitch	P_0 [mm]	12.7 ± 0.3		
Tape width	W [mm]	18 (+ 1/- 0.5)		
Hold down tape width	W_0 [mm]	5.0		
Hole position	W_1 [mm]	9 (+ 0.75/-0.5)		
Hold down tape position	W_2 [mm]	0 (+ 3/-0)		
Feed hole diameter	D_0 [mm]	4.0 ± 0.3		
Tape thickness	T [mm]	0.5 ± 0.2		
Component alignment	Δh [mm]	0 ± 2		
Lead clinch height	H_0 [mm]	16.0 ± 0.5		
Hole center to component center	P_2 [mm]	6.35 ± 1.3		
Lead wire spacing Feed hole center to wire center	F [mm] P_1 [mm]	**Case A** 2.5 + 0.6, - 0.1 5.1 ± 0.7	**Case B** 5 + 0.6, - 0.1 3.85 ± 0.7	**Case B** 5 + 0.6, - 0.1 3.85 ± 0.7
Reel pack options	H = 16.5 mm H = 18.5 mm	X Y	Z	X Y
Ammopack options	H = 16.5 mm H = 18.5 mm	G H	I	G H
Quantity per reel/box		1000	1000	1000

Solid-Electrolyte TANTALEX® Capacitors, Resin-Coated, Radial-Lead

FEATURES

- Terminations: Tin/lead (SnPb), 100 % tin (Sn)
- Economy and high performance are combined in these radial-lead, solid-electrolyte TANTALEX® capacitor
- Rugged, reliable capacitors featuring low leakage current and low dissipation factor
- Six miniature case sizes and five lead styles. All case sizes are available in standard tape and reel packaging per EIA-RS-468
- Standard ratings include replacements for Type 196D capacitors
- Lead (Pb)-free capacitors have "L" in body marking

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- Suitable for a broad range of consumer, commercial and industrial equipment

PERFORMANCE CHARACTERISTICS

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

Capacitance Tolerance: At 120 Hz, + 25 °C, ± 20 %, ± 10 % standard. ± 5 % available as special

Dissipation Factor: At 120 Hz, + 25 °C. Dissipation factor, 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 shall not exceed 15 times the values listed in the Standard Ratings Tables.

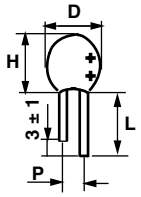
Life Test: Capacitors shall withstand rated DC voltage applied at + 85 °C for 1000 h with a circuit resistance not greater than 3 Ω.

Following the life test:

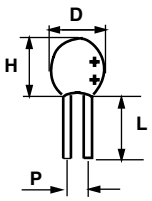
1. DCL shall not exceed 125 % of the initial requirements
2. Dissipation Factor shall meet the initial requirement
3. Change in capacitance shall not exceed ± 10 %

LEAD STYLE CONFIGURATIONS AND DIMENSIONS** (LL = Lead Length)

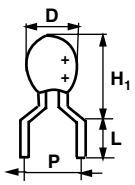
"LONG/SHORT" LL 1, 3 and Y



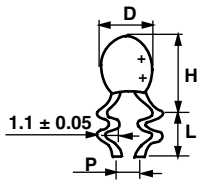
EVEN LL 2, 4 and 5



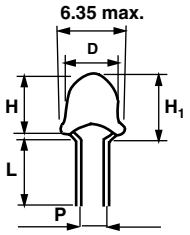
"OUTSIDE HOCKEYSTICK" 6 and 7



"SNAP-IN" 9



"HAIRPIN" X, Z



(1) - WIRE DIAMETER (NOMINAL) 0.020" [0.51 mm]

AVAILABLE LEAD STYLES AND PACKAGING TYPES PER CASE SIZE

LEAD STYLE/CASE	1	2	3	4	5	6	7	9	X	Y	Z
A	Bulk V1	Bulk V1 Reel B1 Ammo A1			Bulk V1 Reel B1 Ammo A1	Bulk V1 Reel B1 Ammo A1	Bulk V1 Reel B1 Ammo A1	Bulk V1 Reel B1 Ammo A1	Bulk V1 Reel B1 Ammo A1	Bulk V1	Bulk V1 Reel B1 Ammo A1
B											
C											
D											
E			Bulk V1	Bulk/Reel Ammo							
F											

* Pb containing terminations are not RoHS compliant, exemptions may apply

DIMENSIONS in inches [millimeters]

LEAD STYLE		1, 2, 3, 4		1, 2, 3	2, 4	5, Y		6		
CASE	D max.	P ± 0.024 [0.60]	H max.	L min.	L ± 0.118 [3.0]	P ± 0.03 [0.76]	L ± 0.118 [3.0]	P ± 0.024 [0.60]	H1 max.	L
A	0.173 [4.40]	0.100 [2.54]	0.280 [7.11]	0.591 [15.0]	0.748 [19.0]	0.125 [3.18]	0.748 [19.0]	0.200 [5.08]	0.378 [9.61]	0.240 ± 0.030 [6.1 ± 0.76]
B	0.197 [5.00]		0.300 [7.62]						0.398 [10.12]	
C	0.217 [5.50]		0.360 [9.14]						0.458 [11.64]	
D	0.236 [6.00]		0.400 [10.16]						0.498 [12.66]	
E	0.339 [8.60]	0.200 [5.08]	0.492 [12.50]			-	-		0.591 [15.00]	1 ± 0.122 [25.4 ± 3.1]
F	0.378 [9.60]		0.650 [16.50]			-	-		0.748 [19.00]	

DIMENSIONS in inches [millimeters]

LEAD STYLE	7, 9	7			9			X, Z				X	Z
CASE	D max.	P ± 0.024 [0.60]	H1 max.	L ± 0.03 [0.76]	P ± 0.024 [0.60]	H1 max.	L ± 0.03 [0.76]	D max.	H max.	H1 max.	L ± 0.125	P ± 0.024	P ± 0.024
A	0.173 [4.40]	0.25 [6.35]	0.378 [9.61]	0.240 [6.10]	0.200 [5.08]	0.398 [10.11]	0.240 [6.10]	0.173 [4.40]	0.280 [7.11]	0.340 [8.64]	0.750 [19.05]	0.100 [2.54]	0.125 [3.175]
B	0.197 [5.00]		0.398 [10.12]			0.418 [10.62]		0.197 [5.00]	0.300 [7.62]	0.360 [9.14]			
C	0.217 [5.50]		0.458 [11.64]			0.478 [12.14]		0.217 [5.50]	0.360 [9.14]	0.420 [10.67]			
D	0.236 [6.00]		0.498 [12.66]			0.518 [13.16]		0.236 [6.00]	0.400 [10.16]	0.460 [11.68]			

Note:
• Lead space measured within 0.05 [1.27] of the body of the capacitor or from the bottom of the crimp

ORDERING INFORMATION

199D	475	X9	003	A	1 (1)	V1	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD STYLE	PACKAGING	RoHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 % X9 = ± 10 % ** X5 = ± 5 % ** Special Order	This is expressed in V. To complete the three-digit block, zeros precede the voltage rating. A decimal point is indicated by an "R" (6R3 = 6.3 V).	See Ratings and Case Codes table.		V1 = Bulk B1 = Tape and reel A1 = Ammo	E3 = 100 % tin termination (RoHS compliant) Blank = Tin/lead termination

Note:
(1) see lead styles table

199D OBSOLETE VS. CURRENT ORDERING CROSS REFERENCE		
OBSOLETE	**NEW**	**DESCRIPTION**
A1	1V1	0.100 SP, UNEVEN STRAIGHT LL, BULK CASES A - D
A1	3V1	0.200 SP, UNEVEN STRAIGHT LL, BULK, CASES E, F
A1	2V1	0.100 SP, EVEN STRAIGHT LL, BULK, CASES A - D
A6	2B1	0.100 SP, EVEN STRAIGHT LL, REEL POSITIVE LEADER, CASES A - D
A6	2A1	0.100 SP, EVEN STRAIGHT LL, AMMO, CASES A - D
A1	4V1	0.200 SP, EVEN STRAIGHT LL, BULK, CASES E, F
A6	4B1	0.200 SP, EVEN STRAIGHT LL, REEL POSITIVE LEADER, CASES E, F
A6	4A1	0.200 SP, EVEN STRAIGHT LL, AMMO, CASES E, F
A2	5V1	0.125 SP, EVEN STRAIGHT LL, BULK, CASES A - D
A7	5B1	0.125 SP, EVEN STRAIGHT LL, REEL POSITIVE LEADER, CASES A - D
A7	5A1	0.125 SP, EVEN STRAIGHT LL, AMMO, CASES A - D
A2	YV1	0.125 SP, UNEVEN STRAIGHT LL, BULK, CASES A - D
B1	XV1	0.100 SP, HAIRPIN LL, BULK CASES A - D
B6	XB1	0.100 SP, HAIRPIN LL, REEL POSITIVE LEADER, CASES A - D
B6	XA1	0.100 SP, HAIRPIN LL, AMMO, CASES A - D
B2	ZV1	0.125 SP, HAIRPIN LL, BULK, CASES A - D
B7	ZB1	0.125 SP, HAIRPIN LL, REEL POSITIVE LEADER, CASES A - D
B7	ZA1	0.125 SP, HAIRPIN LL, AMMO, CASES A - D
E2	6V1	0.200 SP, HOCKEY STICK LL, BULK, CASES A - F
E7	6B1	0.200 SP, HOCKEY STICK LL, REEL POSITIVE LEADER, CASES A - F
E7	6A1	0.200 SP, HOCKEY STICK LL, AMMO, CASES A - F
E3	7V1	0.250 SP, HOCKEY STICK LL, BULK, CASES A - D
E8	7B1	0.250 SP, HOCKEY STICK LL, REEL POSITIVE LEADER, CASES A - D
E8	7A1	0.250 SP, HOCKEY STICK LL, AMMO, CASES A - D
E4		OBSOLETE
G2	9V1	0.200 SP, SNAP-IN LL, BULK, CASES A - D
G7	9B1	0.200 SP, SNAP-IN LL, REEL POSITIVE LEADER, CASES A - D
G7	9A1	0.200 SP, SNAP-IN LL, AMMO, CASES A - D

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER*	MAX. DCL at + 25 °C (µA)	MAX. DF at + 25 °C 120 Hz (%)
3 WVDC AT + 85 °C, SURGE = 3.6 V . . . 2 WVDC AT + 125 °C, SURGE = 2.4 V				
4.7	A	199D475(1)003A(2)(3)	0.5	6
6.8	A	199D685(1)003A(2)(3)	0.5	6
10.0	A	199D106(1)003A(2)(3)	0.5	8
15.0	A	199D156(1)003A(2)(3)	0.5	8
22.0	B	199D226(1)003B(2)(3)	0.6	8
33.0	B	199D336(1)003B(2)(3)	1.0	8
47.0	C	199D476(1)003C(2)(3)	1.4	8
68.0	C	199D686(1)003C(2)(3)	2.0	8
100.0	D	199D107(1)003D(2)(3)	3.0	10
150.0	D	199D157(1)003D(2)(3)	4.0	10
220.0	E	199D227(1)003E(2)(3)	5.0	10
330.0	E	199D337(1)003E(2)(3)	6.0	10
470.0	F	199D477(1)003F(2)(3)	8.0	10
680.0	F	199D687(1)003F(2)(3)	10.0	10
6.3 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V				
4.7	A	199D475(1)6R3A(2)(3)	0.5	6
6.8	A	199D685(1)6R3A(2)(3)	0.5	6
10.0	B	199D106(1)6R3B(2)(3)	0.6	8
15.0	B	199D156(1)6R3B(2)(3)	0.9	8
22.0	C	199D226(1)6R3C(2)(3)	1.3	8
33.0	C	199D336(1)6R3C(2)(3)	2.0	8
47.0	D	199D476(1)6R3D(2)(3)	2.9	8
68.0	D	199D686(1)6R3D(2)(3)	4.0	8
100.0	D	199D107(1)6R3D(2)(3)	5.0	10
150.0	E	199D157(1)6R3E(2)(3)	6.0	10
220.0	E	199D227(1)6R3E(2)(3)	7.0	10
330.0	F	199D337(1)6R3F(2)(3)	8.0	10
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V				
3.3	A	199D335(1)010A(2)(3)	0.5	6
4.7	A	199D475(1)010A(2)(3)	0.5	6
6.8	B	199D685(1)010B(2)(3)	0.6	6
10.0	B	199D106(1)010B(2)(3)	1.0	8
15.0	C	199D156(1)010C(2)(3)	1.5	8
22.0	C	199D226(1)010C(2)(3)	2.0	8
33.0	D	199D336(1)010D(2)(3)	3.0	8
39.0	D	199D339(1)010D(2)(3)	3.9	8
47.0	D	199D476(1)010D(2)(3)	4.0	8
68.0	D	199D686(1)010D(2)(3)	5.0	8
100.0	E	199D107(1)010E(2)(3)	6.0	10
150.0	E	199D157(1)010E(2)(3)	7.0	10
220.0	F	199D227(1)010F(2)(3)	8.0	10
16 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V				
2.2	A	199D225(1)016A(2)(3)	0.5	6
3.3	A	199D335(1)016A(2)(3)	0.5	6
4.7	B	199D475(1)016B(2)(3)	0.7	6
6.8	B	199D685(1)016B(2)(3)	1.0	6
10.0	C	199D106(1)016C(2)(3)	1.5	8
15.0	C	199D156(1)016C(2)(3)	2.4	8
22.0	D	199D226(1)016D(2)(3)	3.5	8
33.0	D	199D336(1)016D(2)(3)	4.0	8
47.0	E	199D476(1)016E(2)(3)	5.0	8
68.0	E	199D686(1)016E(2)(3)	6.0	8
100.0	F	199D107(1)016F(2)(3)	7.0	10
150.0	F	199D157(1)016F(2)(3)	8.0	10

Notes:

* (1) For capacitance tolerance: (X0 = ± 20 %), (X9 = ± 10 %) or (X5 = 5 %)

(2) To specify Lead Style/Spacing/Packaging insert the last three characters in the Part Number. Use the appropriate code shown in the Current Ordering Cross Reference table and explained in the Ordering Information and Lead Styles table.

(3) E3 = RoHS compliant 100 % tin leads. Blank or no suffix = standard tin/lead termination.

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER*	MAX. DCL at + 25 °C (µA)	MAX. DF at + 25 °C 120 Hz (%)
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V				
3.3	B	199D335(1)020B(2)(3)	0.8	6
4.7	B	199D475(1)020B(2)(3)	1.0	6
6.8	C	199D685(1)020C(2)(3)	1.5	6
10.0	C	199D106(1)020C(2)(3)	2.0	8
15.0	D	199D156(1)020D(2)(3)	2.5	8
22.0	D	199D226(1)020D(2)(3)	3.0	8
33.0	E	199D336(1)020E(2)(3)	4.0	8
47.0	E	199D476(1)020E(2)(3)	5.0	8
68.0	F	199D686(1)020F(2)(3)	6.0	8
100.0	F	199D107(1)020F(2)(3)	7.0	10
25 WVDC AT + 85 °C, SURGE = 33 V . . . 17 WVDC AT + 125 °C, SURGE = 21 V				
1.0	A	199D105(1)025A(2)(3)	0.5	4
1.5	A	199D155(1)025A(2)(3)	0.5	6
2.2	A	199D225(1)025A(2)(3)	0.5	6
3.3	B	199D335(1)025B(2)(3)	0.8	6
4.7	B	199D475(1)025B(2)(3)	1.0	6
6.8	C	199D685(1)025C(2)(3)	1.5	6
10.0	C	199D106(1)025C(2)(3)	2.5	8
15.0	D	199D156(1)025D(2)(3)	3.0	8
22.0	D	199D226(1)025D(2)(3)	4.0	8
33.0	E	199D336(1)025E(2)(3)	5.0	8
47.0	E	199D476(1)025E(2)(3)	6.0	8
68.0	F	199D686(1)025F(2)(3)	7.0	8
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V				
0.1	A	199D104(1)035A(2)(3)	0.5	4
0.15	A	199D154(1)035A(2)(3)	0.5	4
0.22	A	199D224(1)035A(2)(3)	0.5	4
0.33	A	199D334(1)035A(2)(3)	0.5	4
0.47	A	199D474(1)035A(2)(3)	0.5	4
0.68	A	199D684(1)035A(2)(3)	0.5	4
1.0	A	199D105(1)035A(2)(3)	0.5	4
1.5	A	199D155(1)035A(2)(3)	0.5	6
1.8	B	199D185(1)035B(2)(3)	0.7	6
2.2	B	199D225(1)035B(2)(3)	0.7	6
3.3	B	199D335(1)035B(2)(3)	1.0	6
4.7	C	199D475(1)035C(2)(3)	1.5	6
6.8	D	199D685(1)035D(2)(3)	2.3	6
10.0	D	199D106(1)035D(2)(3)	3.5	8
15.0	E	199D156(1)035E(2)(3)	4.0	8
22.0	E	199D226(1)035E(2)(3)	5.0	8
33.0	F	199D336(1)035F(2)(3)	6.0	8
47.0	F	199D476(1)035F(2)(3)	7.0	8
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V				
0.1	A	199D104(1)050A(2)(3)	0.5	4
0.15	A	199D154(1)050A(2)(3)	0.5	4
0.22	A	199D224(1)050A(2)(3)	0.5	4
0.33	A	199D334(1)050A(2)(3)	0.5	4
0.47	A	199D474(1)050A(2)(3)	0.5	4
0.68	A	199D684(1)050A(2)(3)	0.5	4
1.0	B	199D105(1)050B(2)(3)	0.5	4
1.5	C	199D155(1)050C(2)(3)	0.7	6
2.2	C	199D225(1)050C(2)(3)	1.1	6
3.3	D	199D335(1)050D(2)(3)	1.5	6
4.7	D	199D475(1)050D(2)(3)	2.0	6
6.8	F	199D685(1)050F(2)(3)	3.0	6
10.0	F	199D106(1)050F(2)(3)	4.0	8
15.0	F	199D156(1)050F(2)(3)	5.0	8
22.0	F	199D226(1)050F(2)(3)	6.0	8

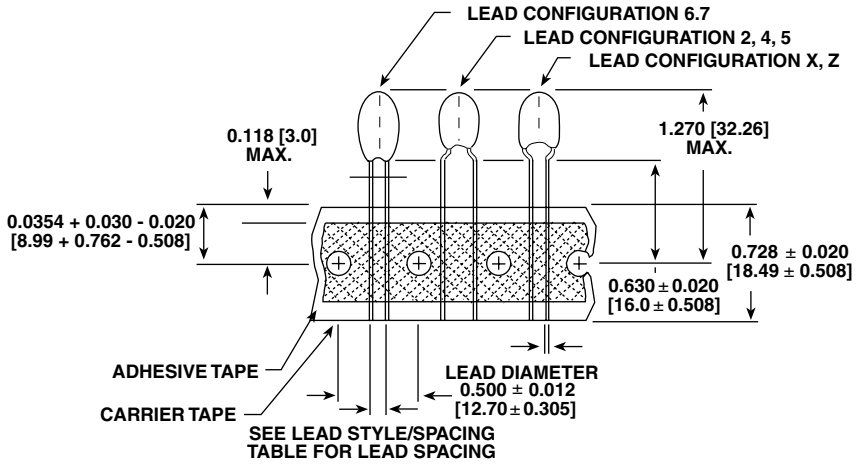
Notes:

* (1) For capacitance tolerance: (X0 = ± 20 %), (X9 = ± 10 %) or (X5 = 5 %)

(2) To specify Lead Style/Spacing/Packaging insert the last three characters in the Part Number. Use the appropriate code shown in the Current Ordering Cross Reference table and explained in the Ordering Information and Lead Styles table.

(3) E3 = RoHS compliant 100 % tin leads. Blank or no suffix = standard tin/lead termination.

STANDARD REEL PACKAGING SPECIFICATIONS PER EIA RS-468 in inches [millimeters]



CASE CODE	OBSOLETE	LEAD STYLE	LEAD SPACING	LL MIN. (BULK)
A, B, C, D	A1, A6	1V1 (Bulk), 2B1 (T and R)	0.100 + 0.024 - 0.016 [2.54 + 0.60 - 0.40]	0.187 [4.7]
A, B, C, D	B1, B6	XV1 (Bulk), XB1 (T and R)	0.100 + 0.024 - 0.016 [2.54 + 0.60 - 0.40]	0.187 [4.7]
A, B, C, D, E, F	E2, E7	6V1 (Bulk), 6B1 (T and R)	0.200 + 0.024 - 0.016 [5.08 + 0.06 - 0.40]	0.187 [4.7]

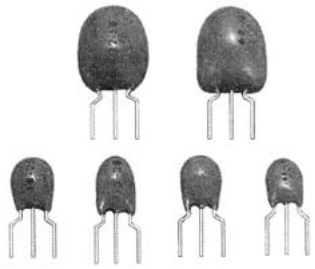
Note:

- Lead space measured within 0.05 [1.27] of the body of the capacitor, or from the bottom of the crimp. Lead Style 'A' may be supplied with 0.59 [15] anode lead and 0.47 [12] cathode lead.

Tape and Reel Packaging: Type 199D radial-leaded tantalum capacitors, all lead styles exept 1, 3 and Y are available taped and reeled per EIA-468.

CASE CODE	A	B	C	D	E	F
Quantity per box bulk	1000		500		100	
Quantity per box ammopack	2500	2000	1500	1000	500	
Quantity per reel	1000				500	

Solid-Electrolyte TANTALEX® Capacitors, Tripole Triple-Lead, Resin-Coated



FEATURES

Terminations: Tin/lead (SnPb), 100 % Tin (Sn)

- Easy Installation, economical, high performance
- Triple-Lead design allows reverse installations
- 6 Miniature Case Codes available
- EIA Standard Case Sizes

Pb-free Available

RoHS* COMPLIANT

PERFORMANCE CHARACTERISTICS

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

Capacitance Range: 0.10 µF to 680 µF

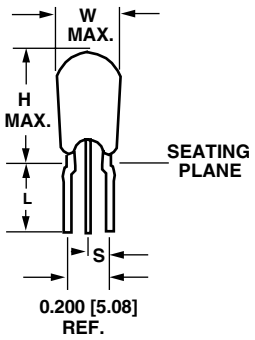
Capacitance Tolerance: ± 20 %, ± 10 % standard ± 5 % available as special

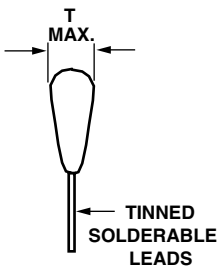
Voltage Rating: 3 WVDC to 50 WVDC

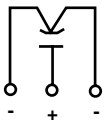
ORDERING INFORMATION

299D	227	X	003	A	B	1	E3
MODEL	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD STYLE	PACKAGING	ROHS COMPLIANT
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 % X9 = ± 10 % *X5 = ± 5 % *special order	Expressed in volts. To complete the 3-digit block, zeros precede the voltage rating. A decimal point is indicated by an "R" (6R3 = 6.3 V).	See Ratings and Case Codes Table	B = Hockey Stick	1 = Bulk 6 = Tape and Reel 13" [330 mm] Reel	E3 = 100 % tin termination (RoHS compliant) Blank = SnPb termination

DIMENSIONS in inches [millimeters]







CASE	W (MAX.)	T (MAX.)	H (MAX.)	L	S	LEAD SIZE	
						AWG NO.	NOM. DIA.
A	0.280 [7.1]	0 .190 [4.82]	0.360 [9.14]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]
B	0.280 [7.1]	0.200 [5.08]	0.360 [9.14]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]
C	0.280 [7.1]	0 .230 [5.84]	0.380 [9.65]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]
D	0.280 [7.1]	0 .270 [6.85]	0.440 [11.17]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]
E	0.340 [8.63]	0 .340 [8.63]	0.560 [14.22]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]
F	0.360 [9.14]	0 .360 [9.14]	0.620 [15.74]	0.187 ± 0.032 [4.75 ± 0.82]	0.100 ± 0.015 [2.54 ± 0.38]	24	0.020 [0.51]

* Pb containing terminations are not RoHS compliant, exemptions may apply

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER [1] CAP. TOL. ± 20 %, ± 10 %	Max. DCL at + 25 °C (µA)	Max. DF at + 25 °C 120 Hz (%)
3 WVDC AT + 85 °C, SURGE = 3.6 V . . . 2 WVDC AT + 125 °C, SURGE = 2.4 V				
4.7	A	299D475X_003AB_	0.5	6
6.8	A	299D685X_003AB_	0.5	6
10.0	A	299D106X_003AB_	0.5	8
15.0	A	299D156X_003AB_	0.5	8
22.0	B	299D226X_003BB_	0.6	8
33.0	B	299D336X_003BB_	1.0	8
47.0	C	299D476X_003CB_	1.4	8
68.0	D	299D686X_003DB_	2.0	8
100.0	D	299D107X_003DB_	3.0	10
150.0	D	299D157X_003DB_	4.0	10
220.0	E	299D227X_003EB_	5.0	10
330.0	E	299D337X_003EB_	6.0	10
470.0	F	299D477X_003FB_	8.0	10
680.0	F	299D687X_003FB_	10.0	10
6.3 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5.0 V				
3.3	A	299D335X_6R3AB_	0.5	6
4.7	A	299D475X_6R3AB_	0.5	6
6.8	A	299D685X_6R3AB_	0.5	6
10.0	B	299D106X_6R3BB_	0.6	8
15.0	B	299D156X_6R3BB_	0.9	8
22.0	C	299D226X_6R3CB_	1.3	8
33.0	C	299D336X_6R3CB_	2.0	8
47.0	D	299D476X_6R3DB_	2.9	8
68.0	D	299D686X_6R3DB_	4.0	8
100.0	D	299D107X_6R3DB_	5.0	10
150.0	E	299D157X_6R3EB_	6.0	10
220.0	F	299D227X_6R3FB_	7.0	10
330.0	F	299D337X_6R3FB_	8.0	10
10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9.0 V				
2.2	A	299D225X_010AB_	0.5	6
3.3	A	299D335X_010AB_	0.5	6
4.7	A	299D475X_010AB_	0.5	6
6.8	B	299D685X_010BB_	0.6	6
10.0	B	299D106X_010BB_	1.0	8
15.0	C	299D156X_010CB_	1.5	8
22.0	C	299D226X_010CB_	2.0	8
33.0	D	299D336X_010DB_	3.0	8
47.0	D	299D476X_010DB_	4.0	8
68.0	D	299D686X_010DB_	5.0	8
100.0	E	299D107X_010EB_	6.0	10
150.0	F	299D157X_010FB_	7.0	10
220.0	F	299D227X_010FB_	8.0	10
16 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V				
1.5	A	299D155X_016AB_	0.5	6
2.2	A	299D225X_016AB_	0.5	6
3.3	A	299D335X_016AB_	0.5	6
4.7	B	299D475X_016BB_	0.7	6
6.8	B	299D685X_016BB_	1.0	6
10.0	C	299D106X_016CB_	1.5	8
15.0	C	299D156X_016CB_	2.4	8
22.0	D	299D226X_016DB_	3.5	8
33.0	D	299D336X_016DB_	4.0	8
47.0	E	299D476X_016EB_	5.0	8
68.0	E	299D686X_016EB_	6.0	8
100.0	F	299D107X_016FB_	7.0	10
150.0	F	299D157X_016FB_	8.0	10

Note:

[1] Insert capacitance tolerance code “X5”; for ± 5 % units (special order)

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1) CAP. TOL. ± 20 %, ± 10 %	Max. DCL at + 25 °C (µA)	Max. DF at + 25 °C 120 Hz (%)
20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V				
1.0	A	299D105X_020AB_	0.5	4
1.5	A	299D155X_020AB_	0.5	6
2.2	A	299D225X_020AB_	0.5	6
3.3	B	299D335X_020BB_	0.8	6
4.7	B	299D475X_020BB_	1.0	6
6.8	C	299D685X_020CB_	1.5	6
10.0	C	299D106X_020CB_	2.0	8
15.0	D	299D156X_020DB_	2.5	8
22.0	D	299D226X_020DB_	3.0	8
33.0	E	299D336X_020EB_	4.0	8
47.0	E	299D476X_020EB_	5.0	8
68.0	F	299D686X_020FB_	6.0	8
100.0	F	299D107X_020FB_	7.0	10
25 WVDC AT + 85 °C, SURGE = 33 V . . . 17 WVDC AT + 125 °C, SURGE = 21 V				
1.0	A	299D105X_025AB_	0.5	4
1.5	A	299D155X_025AB_	0.5	6
2.2	A	299D225X_025AB_	0.5	6
3.3	B	299D335X_025BB_	0.8	6
4.7	B	299D475X_025BB_	1.0	6
6.8	C	299D685X_025CB_	1.5	6
10.0	C	299D106X_025CB_	2.5	8
15.0	D	299D156X_025DB_	3.0	8
22.0	D	299D226X_025DB_	4.0	8
33.0	E	299D336X_025EB_	5.0	8
47.0	F	299D476X_025FB_	6.0	8
68.0	F	299D686X_025FB_	7.0	8
35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V				
0.10	A	299D104X_035AB_	0.5	4
0.15	A	299D154X_035AB_	0.5	4
0.22	A	299D224X_035AB_	0.5	4
0.33	A	299D334X_035AB_	0.5	4
0.47	A	299D474X_035AB_	0.5	4
0.68	A	299D684X_035AB_	0.5	4
1.0	A	299D105X_035AB_	0.5	4
1.5	A	299D155X_035AB_	0.5	6
2.2	B	299D225X_035BB_	0.7	6
3.3	B	299D335X_035BB_	1.0	6
4.7	C	299D475X_035CB_	1.5	6
6.8	D	299D685X_035DB_	2.2	6
10.0	D	299D106X_035DB_	3.5	8
15.0	E	299D156X_035EB_	4.0	8
22.0	E	299D226X_035EB_	5.0	8
33.0	F	299D336X_035FB_	6.0	8
47.0	F	299D476X_035FB_	7.0	8
50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V				
0.10	A	299D104X_050AB_	0.5	4
0.15	A	299D154X_050AB_	0.5	4
0.22	A	299D224X_050AB_	0.5	4
0.33	A	299D334X_050AB_	0.5	4
0.47	A	299D474X_050AB_	0.5	4
0.68	A	299D684X_050AB_	0.5	4
1.0	B	299D105X_050BB_	0.5	4
1.5	C	299D155X_050CB_	0.7	6
2.2	C	299D225X_050CB_	1.1	6
3.3	D	299D335X_050DB_	1.5	6
4.7	D	299D475X_050DB_	2.0	6
6.8	F	299D685X_050FB_	3.0	6
10.0	F	299D106X_050FB_	4.0	8
15.0	F	299D156X_050FB_	5.0	8
22.0	F	299D226X_050EB_	6.0	8

Note:

(1) Insert capacitance tolerance code "X5"; for ± 5 % units (special order)

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)
3	3.6	2.0	2.4
6.3	8.0	4.0	5.0
10	13	7.0	9.0
16	20	10	12
20	26	13	16
25	33	17	21
35	46	23	28
50	65	33	40

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 Ω ± 5 % resistor at the rate of o1.5 min on, 1.5 minute off, at + 85 °C, for 1000 successive test cycles.

3.2 Following the surge voltage test, the dissipation factor and the leakage current shall meet the initial requirements; the capacitance shall not have changed more than ± 5 %.

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 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 measurement shall be 2 Vrms at 120 Hz at + 25 °C. If the AC voltage applied is less than one-half volt rms, no DC bias is required. Measurement 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 % at:

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

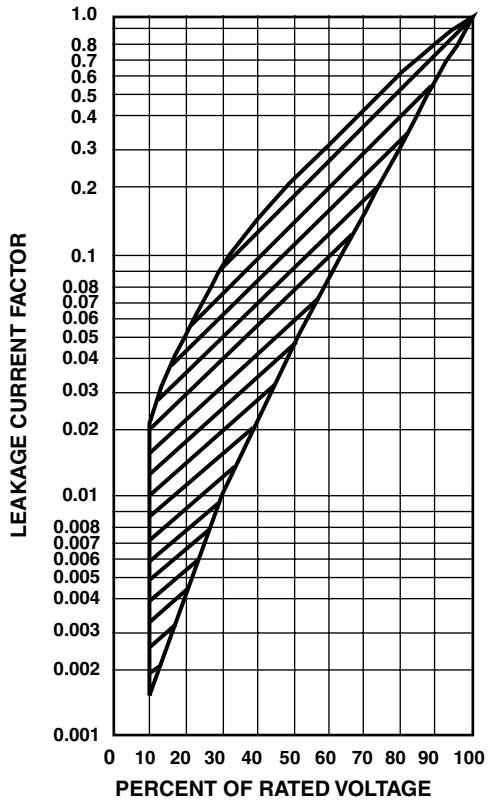
6. **Dissipation Factor:** The dissipation factor, determined from the expression $2\pi fRC$, shall not exceed values listed in the Standard Ratings Table.

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

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

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

LEAKAGE AS A FUNCTION OF VOLTAGE AND TEMPERATURE



PERFORMANCE CHARACTERISTICS

(Continued)

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 15 times the value listed in the Standard Ratings Table.

8. **Life Test:** Capacitors shall withstand rated DC voltage applied at + 85 °C for 1000 hours, with a circuit resistance no greater than 3 Ω.

8.1 Following the life test, the dissipation factor shall meet the initial requirement; the capacitance change shall not exceed - 10 % to + 10 %; the leakage current shall not exceed 125 % of the initial requirement.

9. Lead Strength:

9.1 Capacitors shall withstand a force of 2 pounds (9N) applied axially to the leads for 10 seconds, without failure.

9.2 Capacitor leads shall withstand 2 bends through 90° at the point of egress from the case, without failure.

9.3 No stress shall be applied to the capacitor case during the preceding tests.

10. **Flammability:** Encapsulant materials meet UL94 VO with an oxygen index of 32 %.

11. **Capacitor Failure Mode:** The predominant failure mode for solid tantalum capacitors is increased leakage current resulting in a shorted circuit. Capacitor failure may result from excess forward or reverse DC voltage, surge current, ripple current, thermal shock or excessive temperature. The increase in leakage is caused by a breakdown of the Ta2O5 dielectric. For additional information on leakage failure of solid tantalum chip capacitors, refer to Vishay Sprague Technical Paper, "Leakage Failure Mode in Solid Tantalum Chip Capacitors."

12. **Humidity Test:** Capacitors shall withstand 1000 hours at + 55 °C, 90 % to 95 % relative humidity, with no voltage applied.

12.1 Following the humidity test, capacitance change shall not exceed - 10 % to + 10 % of the initial value, dissipation factor shall not exceed 150 % of the initial requirement; leakage current shall not exceed 200 % of the initial requirement.

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 at + 25 °C as given in the table in Paragraph Number 6 (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 at + 25 °C as given in the table in Paragraph Number 6 (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.

2.3 **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	0.8
+ 85 °C	0.6
+ 125 °C	0.4

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, 5 % of the DC rating at + 85 °C and 1 % of the DC rating at + 105 °C

4. **Recommended rated working voltage guidelines:**

APPLICATION VOLTAGE (V)	RECOMMENDED CAPACITOR VOLTAGE RATING (V)
2.5	4.0
4.0	6.3
6.0	10.0

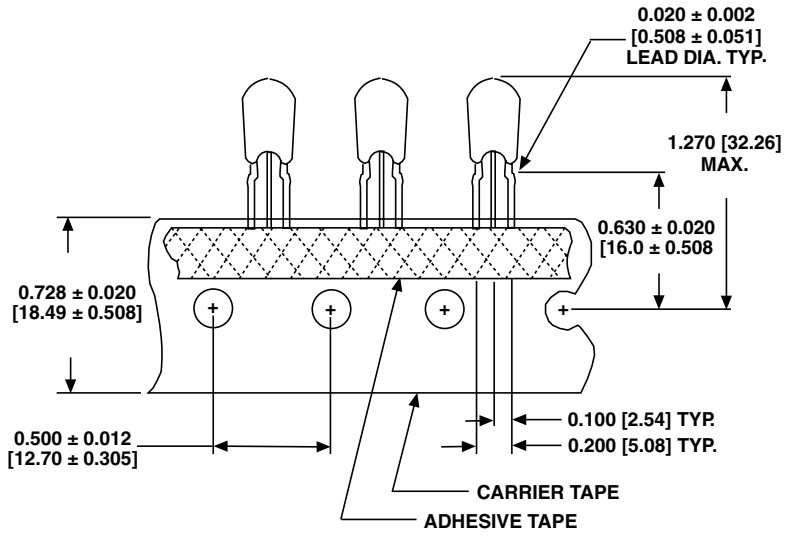
5. **Solvent Resistance:** Type 299D capacitors are conformally coated with thermosetting resin. Markings are either laser imprinted or are a heat cured black epoxy ink conforming to EIA Standard RS-327A. Marked units are compatible with Class 1 (Alcohols), Class 2 (Aromatic Hydrocarbons), Class 3 (Mineral Spirits), Class 4 (Chlorinated Hydrocarbons) and Class 5 (Fluorocarbon Methylene Chloride Azeotropes) solvents.

6. **Wave Soldering Compatibility:** Capacitor leads may be subjected to immersion in molten solder at + 260 °C, to a distance of not less than 0.1" [2.54] from the capacitor body, for up to 10 seconds. The physical integrity of the capacitor shall not be impaired and the leakage current, dissipation factor and capacitance shall remain within the initial requirements after such exposure.

7. **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 AT + 25 °C (W) IN FREE AIR
A	0.140
B	0.160
C	0.180
D	0.210
E	0.240
F	0.270

TAPE AND REEL PACKAGING in inches [millimeters]



Tape and Reel Specifications: Type 299D radial-leaded tantalum capacitors are available taped and reeled per EIA-468.

Requirements for non-standard configurations may be submitted to a Vishay Sales Office or representative for evaluation.

Quantity of components per reel as follows:

CASE CODE	UNITS PER REEL
	13" [330] REEL (MAX.)
A, B, C, D	1000
E, F	500

Resin-Coated, Radial-Lead Solid Tantalum Capacitors

FEATURES

- Terminations: standard SnPb, 100 % Tin available
- Large capacitance range
- Encapsulated in a hard orange epoxy resin
- Large variety of lead styles available
- Supplied on tape and reel or ammopack
- Low impedance and ESR at high frequencies

Pb-free Available

RoHS* COMPLIANT

ELECTRICAL CHARACTERISTICS

Operating Temperature: - 55 °C to + 85 °C: **Type 489D**

- 55 °C to + 125 °C: **Type 499D**

APPLICATIONS

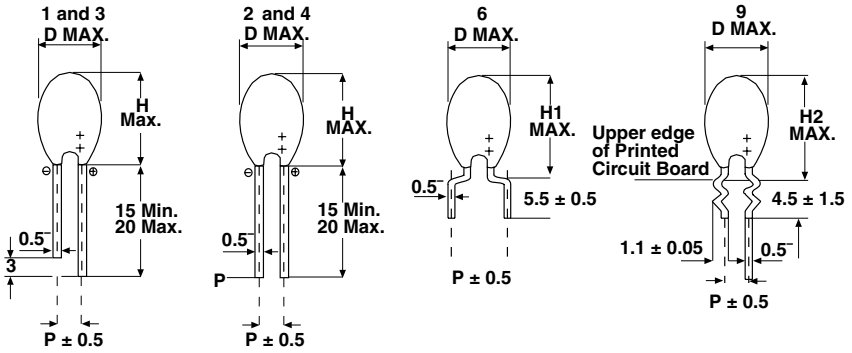
- Offer a very cost effective solution in the consumer, industrial and professional electronics markets. The capacitors are intended for high volume applications.

ORDERING INFORMATION

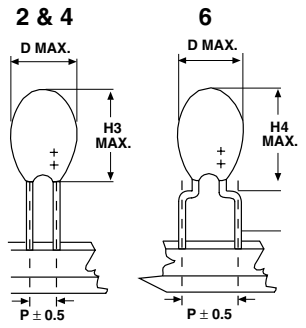
489D	686	X0	6R3	D	2	A	E3
TYPE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	CASE CODE	LEAD STYLE	PACKAGING	RoHS COMPLIANT
489D Standard + 85 °C **499D** Standard + 125 °C Low IL	Expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros following.	X0 = ± 20 % X9 = ± 10 %	Expressed by zeros if needed to complete the 3 digit block. A decimal point is indicated by an "R" (6R3 = 6.3 V).	See Table Ratings and Case Codes	1, 2, 3, 4, 6, 9 See description on next page	A = Ammopack B = Reel pack, positive leader C = Reel pack, negative leader V = Bulk Pack	E3 = 100 % tin termination (RoHS compliant design) Blank = SnPb termination (standard design)

LEAD STYLE CONFIGURATIONS AND DIMENSIONS (MAX) in millimeters

BULK : CODE V



REEL/AMMO : CODE A, B, C



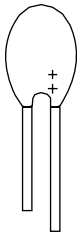
LEAD		STYLES 1-2-3-4		STYLE 6		STYLE 9		STYLES 2-4		STYLE 6	
CASE	D	P	H	P	H1	P	H2	P	H3	P	H4
A	3.7	2.5	7.0	5	11.0	5	10.0	2.5	7.0	5	11.0
B	4.0	2.5	7.5	5	11.5	5	10.5	2.5	7.5	5	11.5
C	4.5	2.5	8.0	5	12.0	5	11.0	2.5	8.0	5	12.0
D	5.0	2.5	9.0	5	13.0	5	12.0	2.5	9.0	5	13.0
E	5.5	2.5	10.0	5	14.0	5	13.0	2.5	10.0	5	14.0
F	6.0	2.5	11.0	5	15.0	5	14.0	2.5	11.0	5	15.0
H	6.5	2.5	12.0	5	16.0	5	15.0	2.5	12.0	5	16.0
M	10.0	5.0	14.5	-	-	5	18.0	5.0	14.5	-	-
N	11.0	5.0	16.0	-	-	5	19.0	-	-	-	-
R	12.0	5.0	19.0	-	-	5	22.0	-	-	-	-

* Pb containing terminations are not RoHS compliant, exemptions may apply

LEAD STYLE

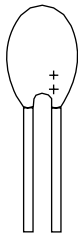
LEAD STYLE 1:

Straight leads,
2.5 mm Lead Space,
Uneven Length



LEAD STYLE 2:

Straight leads,
2.5 mm Lead Space,
Even Length



LEAD STYLE 3:

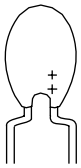
Straight leads,
5 mm Lead Space,
Uneven Length

LEAD STYLE 4:

Straight leads,
5 mm Lead Space,
Even Length

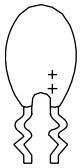
LEAD STYLE 6:

Shouldered leads,
5 mm Lead Space



LEAD STYLE 9:

Snap-In leads,
5 mm Lead Space



STANDARD RATINGS, CASE CODES AND LEAD STYLE

C_R µF	RATED VOLTAGE U_R AT + 85 °C								LEAD STYLE	
	3.0 V	6.3 V	10 V	16 V	20 V	25 V	35 V	50 V	BULK	AMMO/REEL
0.10							A	A		
0.15							A	A		
0.22							A	A		
0.33							A	B		
0.47							A	B	1 - 2	
0.68							B	C	6 - 9	2 - 6
1.0						A	B	D		
1.5					A	B	C	E		
2.2				A	B	B	C	F		
3.3			A	B	C	C	D	F		
4.7		A	A	B	C	C	D	H		
6.8	A	A	B	C	D	D	E	N		
10	B	B	B	C	D	D	F	N	3 - 4 - 9	4
15	B	B	C	D	E	E	M	N		
22	C	C	C	D	F	H	M	N		
33	C	C	D	E	H	M	N			
47	D	D	D	F	M	M	N			
68	D	D	E	M	N	N				
100	E	E	M	N	N					
150	H	M	M	N						
220	M	M	N	R						
330	N	N	R							
470	N	R								
680	R	R								

STANDARD RATINGS

C_R (µF)	CASE CODE	TYPE PART NUMBER	489D MAX. DCL AT + 25 °C (µA)	499D MAX. DCL AT + 25 °C (µA)	489D, 499D MAX. DF, 100 Hz AT + 25 °C (%)
U_R = 3 V AT + 85 °C, SURGE = 4 V . . . U_C = 2 V AT + 125 °C, SURGE = 2.6 V (ONLY 499D)					
6.8	A	489D685X(*)003A_ _	1.0	0.5	6
10.0	B	489D106X(*)003B_ _	1.0	0.5	8
15.0	B	489D156X(*)003B_ _	1.0	0.5	8
22.0	C	489D226X(*)003C_ _	1.0	0.5	8
33.0	C	489D336X(*)003C_ _	1.4	0.7	8
47.0	D	489D476X(*)003D_ _	2.1	1.1	8
68.0	D	489D686X(*)003D_ _	3.0	1.6	8
100.0	E	489D107X(*)003E_ _	4.5	2.4	10
150.0	H	489D157X(*)003H_ _	6.7	3.6	10
220.0	M	489D227X(*)003M_ _	9.9	5.2	10
330.0	N	489D337X(*)003N_ _	14.8	7.9	10
470.0	N	489D477X(*)003N_ _	21.1	11.2	12
680.0	R	489D687X(*)003R_ _	30.6	16.3	12
U_R = 6.3 V AT + 85 °C, SURGE = 8 V . . . U_C = 4 V AT + 125 °C, SURGE = 5.2 V (ONLY 499D)					
4.7	A	489D475X(*)6R3A_ _	1.0	0.5	6
6.8	A	489D685X(*)6R3A_ _	1.0	0.5	6
10.0	B	489D106X(*)6R3B_ _	1.0	0.5	8
15.0	B	489D156X(*)6R3B_ _	1.4	0.7	8
22.0	C	489D226X(*)6R3C_ _	2.0	1.1	8
33.0	C	489D336X(*)6R3C_ _	3.1	1.6	8
47.0	D	489D476X(*)6R3D_ _	4.4	2.3	8
68.0	D	489D686X(*)6R3D_ _	6.4	3.4	8
100.0	E	489D107X(*)6R3E_ _	9.4	5.0	10
150.0	M	489D157X(*)6R3M_ _	14.1	7.5	10
220.0	M	489D227X(*)6R3M_ _	20.7	11.0	10
330.0	N	489D337X(*)6R3N_ _	31.1	16.6	10
470.0	R	489D477X(*)6R3R_ _	44.4	23.6	12
680.0	R	489D687X(*)6R3R_ _	64.2	34.2	12
U_R = 10 V AT + 85 °C, SURGE = 13 V . . . U_C = 7 V AT + 125 °C, SURGE = 8.6 V (ONLY 499D)					
3.3	A	489D335X(*)010A_ _	1.0	0.5	6
4.7	A	489D475X(*)010A_ _	1.0	0.5	6
6.8	B	489D685X(*)010B_ _	1.0	0.5	6
10.0	B	489D106X(*)010B_ _	1.5	0.8	8
15.0	C	489D156X(*)010C_ _	2.2	1.2	8
22.0	C	489D226X(*)010C_ _	3.3	1.7	8
33.0	D	489D336X(*)010D_ _	4.9	2.6	8
47.0	D	489D476X(*)010D_ _	7.0	3.7	8
68.0	E	489D686X(*)010E_ _	10.2	5.4	8
100.0	M	489D107X(*)010M_ _	15.0	8.0	10
150.0	M	489D157X(*)010M_ _	22.5	12.0	10
220.0	N	489D227X(*)010N_ _	33.0	17.6	10
330.0	R	489D337X(*)010R_ _	49.5	26.4	10

Note:
489D Type part number 489D, 499D
(*) Insert 0 for ± 20 % tolerance or 9 for ± 10 %
_ _ Case code/lead style see case code table

PACKAGING QUANTITIES

CASE CODE	A	B	C	D	E	F	H	M	N	R
BULK	500							100		
AMMOPACK	2500		2000		1500			500		
REEL PACK	2500		2000		1500			500		

STANDARD RATINGS

C_R (µF)	CASE CODE	TYPE PART NUMBER	489D MAX. DCL AT + 25 °C (µA)	499D MAX. DCL AT + 25 °C (µA)	489D, 499D MAX. DF, 100 Hz AT + 25 °C (%)
U_R = 16 V AT + 85 °C, SURGE = 20 V . . . U_C = 10 V AT + 125 °C, SURGE = 13 V (ONLY 499D)					
2.2	A	489D225X(*)016A_ _	1.0	0.5	6
3.3	B	489D335X(*)016B_ _	1.0	0.5	6
4.7	B	489D475X(*)016B_ _	1.1	0.6	6
6.8	C	489D685X(*)016C_ _	1.6	0.8	6
10.0	C	489D106X(*)016C_ _	2.4	1.2	8
15.0	D	489D156X(*)016D_ _	3.6	1.9	8
22.0	D	489D226X(*)016D_ _	5.2	2.8	8
33.0	E	489D336X(*)016E_ _	7.9	4.2	8
47.0	F	489D476X(*)016F_ _	11.2	6.0	8
68.0	M	489D686X(*)016M_ _	16.3	8.7	8
100.0	N	489D107X(*)016N_ _	24.0	12.8	10
150.0	N	489D157X(*)016N_ _	36.0	19.2	10
220.0	R	489D227X(*)016R_ _	52.8	28.1	10
U_R = 20 V AT + 85 °C, SURGE = 26 V . . . U_C = 13 V AT + 125 °C, SURGE = 16 V (ONLY 499D)					
1.5	A	489D155X(*)020A_ _	1.0	0.5	4
2.2	B	489D225X(*)020B_ _	1.0	0.5	6
3.3	C	489D335X(*)020C_ _	1.0	0.5	6
4.7	C	489D475X(*)020C_ _	1.4	0.7	6
6.8	D	489D685X(*)020D_ _	2.0	1.0	6
10.0	D	489D106X(*)020D_ _	3.0	1.6	8
15.0	E	489D156X(*)020E_ _	4.5	2.4	8
22.0	F	489D226X(*)020F_ _	6.6	3.5	8
33.0	H	489D336X(*)020H_ _	9.9	5.2	8
47.0	M	489D476X(*)020M_ _	14.1	7.5	8
68.0	N	489D686X(*)020N_ _	20.4	10.8	8
100.0	N	489D107X(*)020N_ _	30.0	16.0	10
U_R = 25 V AT + 85 °C, SURGE = 32 V . . . U_C = 17 V AT + 125 °C, SURGE = 21 V (ONLY 499D)					
1.0	A	489D105X(*)025A_ _	1.0	0.5	4
1.5	B	489D155X(*)025B_ _	1.0	0.5	4
2.2	B	489D225X(*)025B_ _	1.0	0.5	6
3.3	C	489D335X(*)025C_ _	1.2	0.6	6
4.7	C	489D475X(*)025C_ _	1.7	0.9	6
6.8	D	489D685X(*)025D_ _	2.5	1.3	6
10.0	D	489D106X(*)025D_ _	3.7	2.0	8
15.0	E	489D156X(*)025E_ _	5.6	3.0	8
22.0	H	489D226X(*)025H_ _	8.2	4.4	8
33.0	M	489D336X(*)025M_ _	12.3	6.6	8
47.0	M	489D476X(*)025M_ _	17.6	9.4	8
68.0	N	489D686X(*)025N_ _	25.5	13.6	8

Note:
489D Type part number 489D, 499D
(*) Insert 0 for ± 20 % tolerance or 9 for ± 10 %
_ _ Case code/lead style see case code table

STANDARD RATINGS

C_R (µF)	CASE CODE	TYPE PART NUMBER	489D MAX. DCL AT + 25 °C (µA)	499D MAX. DCL AT + 25 °C (µA)	489D, 499D MAX. DF, 100 Hz AT + 25 °C (%)
U_R = 35 V AT + 85 °C, SURGE = 46 V . . . U_C= 23 V AT + 125 °C, SURGE = 28 V (ONLY 499D)					
0.10	A	489D104X(*)035A_ _	1.0	0.5	4
0.15	A	489D154X(*)035A_ _	1.0	0.5	4
0.22	A	489D224X(*)035A_ _	1.0	0.5	4
0.33	A	489D334X(*)035A_ _	1.0	0.5	4
0.47	A	489D474X(*)035A_ _	1.0	0.5	4
0.68	B	489D684X(*)035B_ _	1.0	0.5	4
1.0	B	489D105X(*)035B_ _	1.0	0.5	4
1.5	C	489D155X(*)035C_ _	1.0	0.5	4
2.2	C	489D225X(*)035C_ _	1.1	0.6	6
3.3	D	489D335X(*)035D_ _	1.7	0.9	6
4.7	D	489D475X(*)035D_ _	2.4	1.3	6
6.8	E	489D685X(*)035E_ _	3.5	1.9	6
10.0	F	489D106X(*)035F_ _	5.2	2.8	8
15.0	M	489D156X(*)035M_ _	7.8	4.2	8
22.0	M	489D226X(*)035M_ _	11.5	6.1	8
33.0	N	489D336X(*)035N_ _	17.3	9.2	8
47.0	N	489D476X(*)035N_ _	24.6	13.1	8
U_R = 50 V AT + 85 °C, SURGE = 65 V . . . U_C = 33 V AT + 125 °C, SURGE = 40 V (ONLY 499D)					
0.10	A	489D104X(*)050A_ _	1.0	0.5	4
0.15	A	489D154X(*)050A_ _	1.0	0.5	4
0.22	A	489D224X(*)050A_ _	1.0	0.5	4
0.33	B	489D334X(*)050B_ _	1.0	0.5	4
0.47	B	489D474X(*)050B_ _	1.0	0.5	4
0.68	C	489D684X(*)050C_ _	1.0	0.5	4
1.0	D	489D105X(*)050D_ _	1.0	0.5	4
1.5	E	489D155X(*)050E_ _	1.1	0.6	4
2.2	F	489D225X(*)050F_ _	1.6	0.8	6
3.3	F	489D335X(*)050F_ _	2.4	1.3	6
4.7	H	489D475X(*)050H_ _	3.5	1.8	6
6.8	N	489D685X(*)050N_ _	5.1	2.7	6
10.0	N	489D106X(*)050N_ _	7.5	4.0	8
15.0	N	489D156X(*)050N_ _	11.2	6.0	8
22.0	N	489D226X(*)050N_ _	16.5	8.8	8

Note:
489D Type part number 489D, 499D
(*) Insert 0 for ± 20 % tolerance or 9 for ± 10 %
_ _ Case code/lead style see case code table

PERFORMANCE CHARACTERISTICS

1. **Operating Temperature:** - 55 °C to + 85 °C with rated DC voltage UR applied. + 85 °C to + 125° C with linear voltage derating to category voltage U_C for 499D only (see general information)

2. **Capacitance and Tolerance:** Capacitance measured at 100 Hz and + 25 °C shall be within the specified tolerance limits of the nominal rating. Capacitance measurement shall be made by means of a polarized capacitance bridge. No polarizing voltage is required. The maximum voltage applied during measurements shall be 0.5 Vrms at 100 Hz and + 25 °C.

3. **Reverse Voltage:** These capacitors are capable of withstanding peak voltage in the reverse direction equal to:
   15 % of the rated DC voltage at + 20 °C
   10 % of the rated DC voltage at + 25 °C
   5 % of the rated DC voltage at + 85 °C

4. **Surge Voltage:**

DC rated voltage at + 85 °C (V)	3	6.3	10	16	20	25	35	50
DC surge voltage at + 85 °C (V)	4	8	13	20	26	32	46	65
DC rated voltage at + 125 °C (V) (1)	2	4	7	10	13	17	23	33
DC surge voltage at + 125 °C (V) (1)	2.6	5.2	8.6	13	16	21	28	40

Note: (1) for 499D

Capacitors shall withstand the surge voltage applied in series with a 1000 Ω (± 5 %) resistor, at the rate of 1.5 minute on, 5.5 minute off for 1000 successive test cycles at + 85 °C. After test, capacitance change shall not exceed 10 % of initial value, dissipation factor and DC leakage current shall meet initial requirements at + 25 °C - Table 2.

5. **Stability at low and high temperatures:**

489D - Table 2A

TEMP.	CAPACITANCE CHANGE	DC LEAKAGE CURRENT (1)	DISSIPATION FACTOR AT 100 Hz	
- 55 °C	- 10 % of initial value	----------	$C_R \leq 1.5$ µF	4 % max
+ 25 °C	----------	0.015 C_R x U_R or 1 µA, whichever is greater	1.5 µF < C_R < 10 µF	6 % max
			10 µF < C_R < 100 µF	8 % max
+ 85 °C	+ 10 % of initial value	0.15 C_R x U_R or 10 µA, whichever is greater	100 µF ≤ C_R ≤ 330 µF	10 % max
			330 µF < C_R	12 % max

TEMP.	CAPACITANCE CHANGE	DC LEAKAGE CURRENT (1)	DISSIPATION FACTOR AT 100 Hz	
- 55 °C	- 10 % of initial value	----------	$C_R \leq 1.5$ µF	4 % max
+ 25 °C	----------	0.008 C_R x U_R or 0.5 µA, whichever is greater	1.5 µF < C_R < 10 µF	6 % max
			10 µF < C_R < 100 µF	8 % max
+ 85 °C	+ 10 % of initial value	0.08 C_R x U_R or 5 µA, whichever is greater	100 µF ≤ C_R ≤ 330 µF	10 % max
+ 125 °C (2)	+ 10 % of initial value	0.1 C_R x U_R or 6.25 µA, whichever is greater	330 µF < C_R	12 % max

Notes:
(1) Rated voltage applied for 5 minutes with a series resistor of 1000 Ω
(2) Only for 499 D

6. **Life Test:** After 2000 hours at + 85 °C with rated DC voltage applied, or after 1000 hours at + 125 °C. With derated DC voltage*, capacitors shall meet the requirements in table below. (*only for 499D)

Capacitance change	Within ± 10 % of initial value
DC leakage current	Within initial requirements at + 25 °C
Dissipation factor	Within initial requirements at + 25 °C

7. **Humidity Test:** After 21 days (504 hours) (1) at + 40 °C, 90 to 95 % of relative humidity (per IEC 68-2-3) with no voltage applied, capacitors shall meet the requirements in table below.

Capacitance change	Within ± 5 % of initial value
DC leakage current	Within initial requirements at + 25 °C - Table 2
Dissipation factor	Within initial requirements at + 25 °C - Table 2

Note: (1) Humidity test is 56 days (1350 hours) for 499D

8. **Marking:** The capacitors shall be marked with the rated capacitance and the rated DC working voltage. A code may be used for both capacitance and voltage. Units rated at 6.3 volts are usually marked as 6 volts. The package shall be marked with full Vishay Sprague part number, date code and quantity.

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 at + 25 °C as given below

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:

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

where,

Z = The capacitor Impedance at the specified frequency.

3. **AC ripple current or voltage derating factor:** 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 in the table below:

TEMPERATURE	DERATING FACTOR
+ 25 °C	1.0
+ 55 °C	0.9
+ 85 °C	0.8
+ 125 °C	0.4

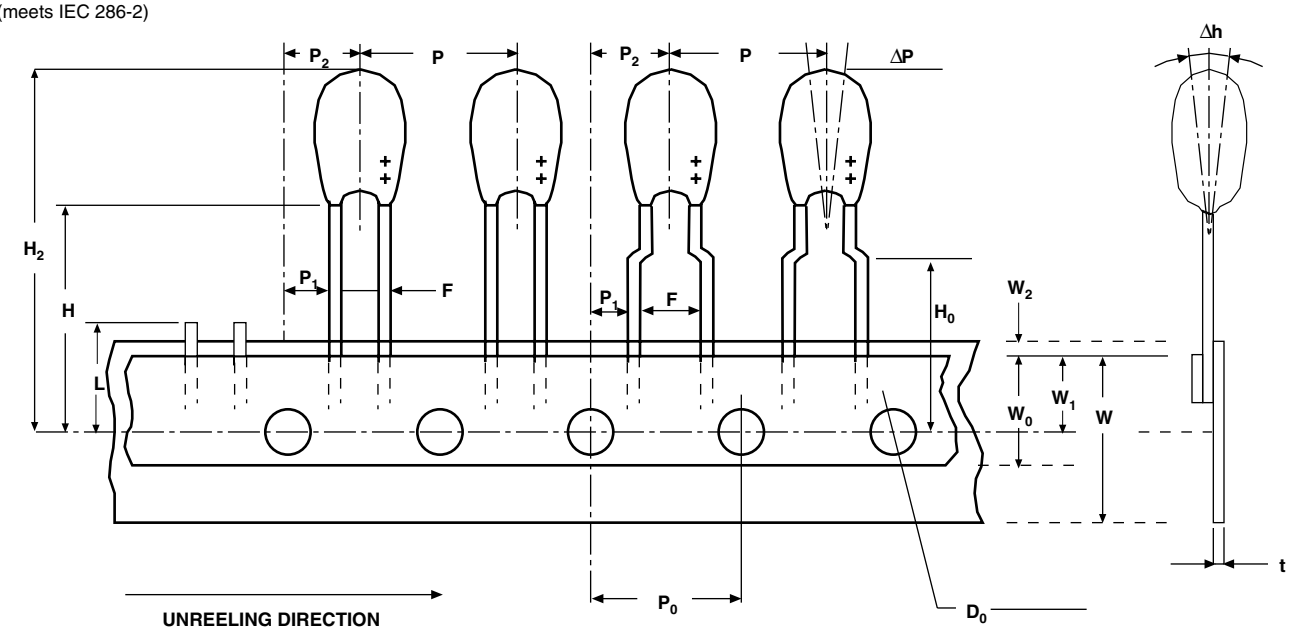
4. **Power dissipation:** Power dissipation will be affected by the heat sinking capability of the mounting surface. Non-sinusoidal ripple current may produce heating effects which differ from those shown in the following table. It is important that the equivalent I_{RMS} value be established when calculating permissible operating levels.

CASE CODE	POWER DISSIPATION AT + 25 °C (W)
A	0.080
B	0.090
C	0.100
D	0.110
E	0.120
F	0.130
H	0.140
M	0.150
N	0.160
R	0.180

5. **Cleaning:** These capacitors are compatible with all commonly used solvents, such as TES, TMS, Prelete and Chloretane. Solvents containing methylene chloride or other epoxy solvents should be avoided since these will attack the epoxy encapsulation material.

TAPE AND REEL PACKAGING in millimeters

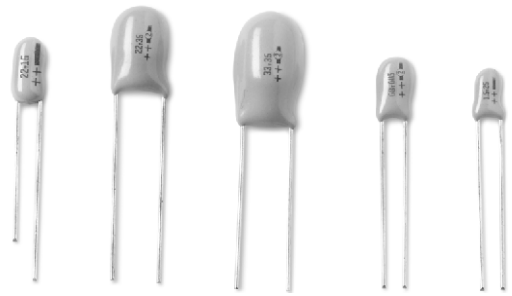
(meets IEC 286-2)



Dimensions for components on tape and tolerances:

DESIGNATION	SYMBOL	DIMENSIONS (mm)	
Pitch of component	P	12.7 ± 1.0	
Feed hole pitch	P_0	12.7 ± 0.3	
Tape width	W	18 (+ 1/- 0.5)	
Hold down tape width	W_0	5.0	
Hole position	W_1	9 (+ 0.75/- 0.5)	
Hold down tape position	W_2	0 (+ 3/- 0)	
Overall component height	H_1	32 max.	
Component alignment	ΔP	± 1.3 max.	
Feed hole diameter	D_0	4.0 ± 0.3	
Tape thickness	t	0.5 ± 0.2	
Component alignment	ΔH	0 ± 2	
Lengh of snipped leads	L	11 max.	
Lead clinch height	H_0	16.0 ± 0.5	
Lead wire spacing	F	2.5 $^{+ 0.6}_{- 0.1}$	5 $^{+ 0.6}_{- 0.1}$
Feed hole center to wire center	P_1	5.1 ± 0.7	3.65 ± 0.7
Hole center to component center	P_2	6.35 ± 1.3	6.35 ± 1.3
Component height	H	18 ± 1	

Resin-Coated, Radial-Leaded Solid Tantalum Capacitors



FEATURES

- RoHS Compliant design available
- Flame retardant encapsulation
- Very high temperature range
- Improved humidity class
- Low leakage current
- Very high CV product
- Low failure rate

Pb-free Available

RoHS* COMPLIANT

MECHANICAL SPECIFICATIONS

Color: Gold

Laser Marked: Capacity and voltage in clear text; Plus pole marked

Leads: Standard (Tin/Lead), RoHS compliant (100 % Tin)

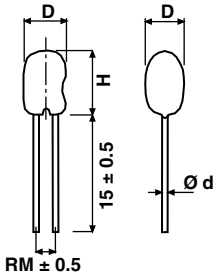
Tantalum capacitors with sintered anode and solid semiconductor electrolyte with flame retardant fluidized bed coating. The type ETPW is characterized by very favorable electrical values even at higher ambient temperatures. The capacitors comply with DIN 45910 part 146 and they are also available as a radially taped version.

ORDERING INFORMATION

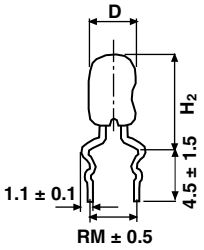
P1A	686	603	M	00	D	E3
TYPE	CAPACITANCE	DC VOLTAGE RATING AT + 85 °C	CAPACITANCE TOLERANCE	LEAD STYLE AND PACKAGING		RoHS COMPLIANT
ETPW 1A .... ETPW 6R	Expressed in picofarads. The first two digits are significant figures. The third is the number of zeros following.	Expressed by zeros if needed to complete the 3 digit block. A decimal point is indicated by an "0" (603 = 6.3 Volts)	M = ± 20 % K = ± 10 %	See Lead styles and packaging table		E3 = 100 % tin termination (RoHS compliant design) Blank = SnPb termination (standard design)

DIMENSIONS in millimeters

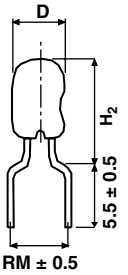
BASIC VERSION



FORM DS



FORM L



MODEL	D MAX.	H MAX.	RM ± 0.5	Ø D ± 0.05	FORM DS		FORM L	
					H_2 MAX.	RM	H_2 MAX.	RM
ETPW - 1 A,B	4.0	7.1	2.5	0.5	10.5	5	10.5	5
ETPW - 2 C,D	4.5	8.0	2.5	0.5	11.0	5	11.0	5
ETPW - 2 E	5.0	9.5	2.5	0.5	12.5	5	12.5	5
ETPW - 3 F	5.0	9.5	2.5	0.5	12.5	5	12.5	5
ETPW - 3 G	5.5	10.0	2.5	0.5	13.0	5	13.0	5
ETPW - 4 H	6.0	10.0	2.5	0.5	13.0	5	13.0	5
ETPW - 5 J,K (1)	8.6	12.5	2.5	0.5	15.5	5	15.5	5
ETPW - 5 J,K,L	8.6	12.5	5.0	0.5	15.5	5	-	-
ETPW - 6 M,N	9.5	15.0	5.0	0.5	18.0	5	-	-
ETPW - 6 P,R	9.5	16.0	5.0	0.5	19.0	5	-	-

Note: (1) J,K with RM 2.5 mm : 100 µF - 6.3 V, 68 µF - 10 V, 47 µF - 16 V, 22 µF - 25 V

* Pb containing terminations are not RoHS compliant, exemptions may apply

STANDARD RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R at + 85 °C						
	3.0 V	6.3 V	10 V	16 V	25 V	35 V	50 V
0.10						1A	1A
0.15						1A	1A
0.22						1A	1A
0.33						1A	1B
0.47						1A	1B
0.68						1A	2C
1.0					1A	1A	2D
1.5					1A	1B	2E
2.2				1A	1B	2C	3F
3.3			1A	1B	2C	2D	3G
4.7		1A	1B	2C	2D	2E	4H
6.8	1A	1B	2C	2D	2E	3F	5J
10	1A	2C	2D	2E	3F	3G	5L
15	1B	2D	2E	3F	4H	5J	6M
22	2C	2E	3F	3G	5J	5L	6P
33	2D	3F	3G	4H	5K	6M	
47	2E	3G	4H	5K	6M	6P	
68	3F	4H	5J	5L	6N		
100	3G	5J	5L	6N			
150	4H	5L	6N	6R			
220	5J	6M	6P				
330	5L	6P					
470							

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (Ω)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 3 V AT + 85 °C, Surge = 3.9 V . . . U_C = 2 V AT + 125 °C										
6.8	1A	P1A685003(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	6.0	0.06
10.0	1A	P1A106003(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	5.0	0.08
15.0	1B	P1B156003(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	4.0	0.08
22.0	2C	P2C226003(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.7	3.2	0.08
33.0	2D	P2D336003(*)_ _D	4.5	8.0	11.0	2.5	0.5	1.0	2.5	0.08
47.0	2E	P2E476003(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.4	2.0	0.08
68.0	3F	P3F686003(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.0	1.6	0.08
100.0	3G	P3G107003(*)_ _D	5.5	10.0	13.0	2.5	0.5	3.0	1.2	0.10
150.0	4H	P4H157003(*)_ _D	6.0	10.0	13.0	2.5	0.5	4.5	1.0	0.10
220.0	5J	P5J227003(*)_ _D	8.6	12.5	15.5	5.0	0.5	6.6	0.8	0.10
330.0	5L	P5L337003(*)_ _D	8.6	12.5	15.5	5.0	0.5	9.9	0.6	0.10

Note: (*) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (Ω)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 6.3 V AT + 85 °C, Surge = 7.8 V . . . U_C = 4 V AT + 125 °C										
4.7	1A	P1A475603(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	6.0	0.06
6.8	1B	P1B685603(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	5.0	0.06
10.0	2C	P2C106603(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.6	4.0	0.08
15.0	2D	P2D156603(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.9	3.2	0.08
22.0	2E	P2E226603(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.4	2.5	0.08
33.0	3F	P3F336603(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.1	2.0	0.08
47.0	3G	P3G476603(*)_ _D	5.5	10.0	13.0	2.5	0.5	3.0	1.6	0.08
68.0	4H	P4H686603(*)_ _D	6.0	10.0	13.0	2.5	0.5	4.3	1.2	0.08
100.0	5J	P5J107603(*)_ _D	8.6	12.5	15.5	2.5	0.5	6.3	1.0	0.10
150.0	5L	P5L157603(*)_ _D	8.6	12.5	15.5	5.0	0.5	9.5	0.8	0.10
220.0	6M	P6M227603(*)_ _D	9.5	15.0	18.0	5.0	0.5	13.9	0.6	0.10
330.0	6P	P6P337603(*)_ _D	9.5	16.0	19.0	5.0	0.5	20.8	0.5	0.10
U_R = 10 V AT + 85 °C, Surge = 13 V . . . U_C = 6.3 V AT + 125 °C										
3.3	1A	P1A335010(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	6.5	0.06
4.7	1B	P1B475010(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	5.0	0.06
6.8	2C	P2C685010(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.7	4.0	0.06
10.0	2D	P2D106010(*)_ _D	4.5	8.0	11.0	2.5	0.5	1.0	3.2	0.08
15.0	2E	P2E156010(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.5	2.5	0.08
22.0	3F	P3F226010(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.2	2.0	0.08
33.0	3G	P3G336010(*)_ _D	5.5	10.0	13.0	2.5	0.5	3.3	1.6	0.08
47.0	4H	P4H476010(*)_ _D	6.0	10.0	13.0	2.5	0.5	4.7	1.2	0.08
68.0	5J	P5J686010(*)_ _D	8.6	12.5	15.5	2.5	0.5	6.8	1.0	0.08
100.0	5L	P5L107010(*)_ _D	8.6	12.5	15.5	5.0	0.5	10.0	0.8	0.10
150.0	6N	P6N157010(*)_ _D	9.5	15.0	18.0	5.0	0.5	15.0	0.6	0.10
220.0	6P	P6P227010(*)_ _D	9.5	16.0	19.0	5.0	0.5	22.0	0.5	0.10
U_R = 16 V AT + 85 °C, Surge = 20.8 V . . . U_C = 10 V AT + 125 °C										
2.2	1A	P1A225016(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	7.0	0.06
3.3	1B	P1B335016(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	6.0	0.06
4.7	2C	P2C475016(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.8	4.5	0.06
6.8	2D	P2D685016(*)_ _D	4.5	8.0	11.0	2.5	0.5	1.1	3.2	0.06
10.0	2E	P2E106016(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.6	2.5	0.08
15.0	3F	P3F156016(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.4	2.0	0.08
22.0	3G	P3G226016(*)_ _D	5.5	10.0	13.0	2.5	0.5	3.5	1.6	0.08
33.0	4H	P4H336016(*)_ _D	6.0	10.0	13.0	2.5	0.5	5.3	1.2	0.08
47.0	5K	P5K476016(*)_ _D	8.6	12.5	15.5	2.5	0.5	7.5	1.0	0.08
68.0	5L	P5L686016(*)_ _D	8.6	12.5	15.5	5.0	0.5	10.9	0.8	0.08
100.0	6N	P6N107016(*)_ _D	9.5	15.0	18.0	5.0	0.5	16.0	0.6	0.10
150.0	6R	P6R157016(*)_ _D	9.5	16.0	19.0	5.0	0.5	24.0	0.5	0.10
U_R = 25 V AT + 85 °C, Surge = 32.5 V . . . U_C = 16 V AT + 125 °C										
1.0	1A	P1A105025(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	8.5	0.04
1.5	1A	P1A155025(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	7.5	0.04
2.2	1B	P1B225025(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.6	6.0	0.06
3.3	2C	P2C335025(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.8	4.5	0.06
4.7	2D	P2D475025(*)_ _D	4.5	8.0	11.0	2.5	0.5	1.2	3.2	0.06
6.8	2E	P2E685025(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.7	2.5	0.06
10.0	3F	P3F106025(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.5	2.0	0.08
15.0	4H	P4H156025(*)_ _D	6.0	10.0	13.0	2.5	0.5	3.8	1.6	0.08
22.0	5J	P5J226025(*)_ _D	8.6	12.5	15.5	2.5	0.5	5.5	1.2	0.08
33.0	5K	P5K336025(*)_ _D	8.6	12.5	15.5	5.0	0.5	8.3	1.0	0.08
47.0	6M	P6M476025(*)_ _D	9.5	15.0	18.0	5.0	0.5	11.8	0.8	0.08
68.0	6N	P6N686025(*)_ _D	9.5	15.0	18.0	5.0	0.5	17.0	0.6	0.08

Note:

(*) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (OHMS)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 35 V AT + 85 °C, Surge = 45.5 V . . . U_C = 23 V AT + 125 °C										
0.1	1A	P1A104035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	38.0	0.04
0.15	1A	P1A154035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	30.0	0.04
0.22	1A	P1A224035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	23.0	0.04
0.33	1A	P1A334035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	18.0	0.04
0.47	1A	P1A474035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	14.0	0.04
0.68	1A	P1A684035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	10.0	0.04
1.0	1A	P1A105035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	8.0	0.04
1.5	1B	P1B155035(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	6.5	0.04
2.2	2C	P2C225035(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.8	5.0	0.06
3.3	2D	P2D335035(*)_ _D	4.5	8.0	11.0	2.5	0.5	1.2	3.5	0.06
4.7	2E	P2E475035(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.6	2.5	0.06
6.8	3F	P3F685035(*)_ _D	5.0	9.5	12.5	2.5	0.5	2.4	2.0	0.06
10.0	3G	P3G106035(*)_ _D	5.5	10.0	13.0	2.5	0.5	3.5	1.6	0.08
15.0	5J	P5J156035(*)_ _D	8.6	12.5	15.5	5.0	0.5	5.3	1.2	0.08
22.0	5L	P5L226035(*)_ _D	8.6	12.5	15.5	5.0	0.5	7.7	1.0	0.08
33.0	6M	P6M336035(*)_ _D	9.5	15.0	18.0	5.0	0.5	11.6	0.8	0.08
47.0	6P	P6P476035(*)_ _D	9.5	16.0	19.0	5.0	0.5	16.5	0.8	0.08
U_R = 50 V AT + 85 °C, Surge = 65 V . . . U_C = 33 V AT + 125 °C										
0.1	1A	P1A104050(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	38.0	0.04
0.15	1A	P1A154050(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	30.0	0.04
0.22	1A	P1A224050(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	23.0	0.04
0.33	1B	P1B334050(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	18.0	0.04
0.47	1B	P1B474050(*)_ _D	4.0	7.1	10.5	2.5	0.5	0.5	14.0	0.04
0.68	2C	P2C684050(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.5	10.0	0.04
1.0	2D	P2D105050(*)_ _D	4.5	8.0	11.0	2.5	0.5	0.5	8.0	0.04
1.5	2E	P2E155050(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.8	6.5	0.04
2.2	3F	P3F225050(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.1	5.0	0.06
3.3	3G	P3G335050(*)_ _D	5.5	10.0	13.0	2.5	0.5	1.7	3.5	0.06
4.7	4H	P4H475050(*)_ _D	6.0	10.0	13.0	2.5	0.5	2.4	2.5	0.06
6.8	5J	P5J685050(*)_ _D	8.6	12.5	15.5	5.0	0.5	3.4	2.0	0.06
10.0	5L	P5L106050(*)_ _D	8.6	12.5	15.5	5.0	0.5	5.0	1.6	0.08
15.0	6M	P6M156050(*)_ _D	9.5	15.0	18.0	5.0	0.5	7.5	1.2	0.08
22.0	6P	P6P226050(*)_ _D	9.5	16.0	19.0	5.0	0.5	11.0	1.0	0.08

Note:

(*) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

PERFORMANCE CHARACTERISTICS

1. **Climatic Category:** 55/125/56 acc. to IEC

2. **Temperature Range:** - 55 °C up to + 125 °C with linear voltage derating to category voltage UC

3. **Rated Voltage, Category Voltage:** 3 V to 50 V; 2 V to 33 V

4. **Surge Voltage:** 1.3 times of rated voltage at + 85 °C

5. **Reverse Voltage (Temporary):**
   15 % of the rated DC voltage at + 20 °C
   10 % of the rated DC voltage at + 55 °C
   5 % of the rated DC voltage at + 85 °C

6. **Rated Capacitance:** 0.1 µF to 330 µF

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

8. **Leakage Current in µA:** Measured at + 20 °C after 5 minutes: ≤ 0.01 x CR x UR or 0.5 µA, whichever is greater

9. **Dissipation Factor:** at 120 Hz and + 20 °C
   See table

10. **Impedance:** Measured at 100 kHz and + 20 °C
    See table

11. **Permissible AC Voltage Stress:** The highest permissible AC voltage for the respective frequency may be taken from the brochure "General information".

    The values apply for + 20 °C For higher temperatures, the values have to be multiplied with the following factors:

TEMPERATURE	FACTOR
+ 50 °C	0.7
+ 85 °C	0.5
+ 125 °C	0.3

    Intermediate values can be obtained by linear interpolation.
    For further notes on AC voltage stress: See general information

12. **Service life:** > 300 000 h (2)

13. **Failure percentage:** ≤ 0.6 % within 100 000 h (2)

14. **Failure rate (λ):** ≤ 0.6 10- 7/h = ≤ 60 fit (2)

15. **Failure criteria:** Catastrophic failure: Short circuit or interruption

    Drift failure: DC/C > + 5 - 15 %
    Z > 3 times initial limit value
    IR > 5 times initial value + 5 µA

Note: (2) related to UR, + 40 °C and a circuit resistance of ≥ 3 W/V

16. **Characteristics at high and low temperatures** (the values shall not exceed the following limits)

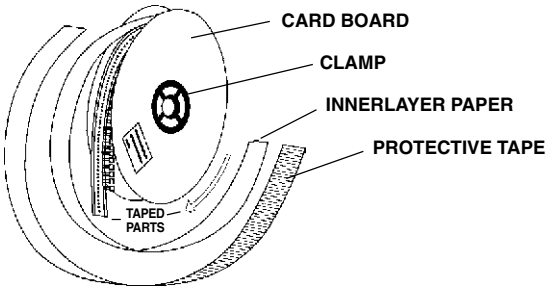
TEST TEMPERATURE	- 55 °C	+ 20 °C	+ 85 °C	+ 125 °C
ΔC/C <	- 10 %	-	+ 12 %	+ 15 %
tanδ				
≤ 1.5 µF	0.04	0.04	0.04	0.06
< 10 µF	0.06	0.06	0.06	0.08
< 100 µF	0.08	0.08	0.08	0.08
≥ 100 µF	0.10	0.10	0.10	0.10
Leakage current IR	-	≤ 0.01 x C_R x U_R or 0.5 µA whichever is greater	≤ 0.1 x C_R x U_R or 10 µA whichever is greater	≤ 0.125 x C_R x U_R or 12.5 µA whichever is greater (1)

Note:

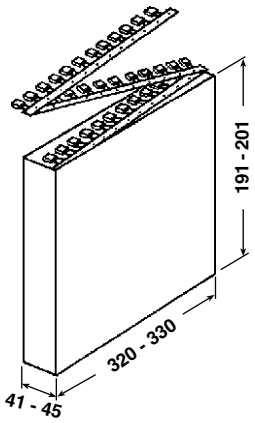
(1) Measured at category voltage

LEAD STYLES AND PACKAGING

REEL PACKING



AMMO PACKAGING (mm)



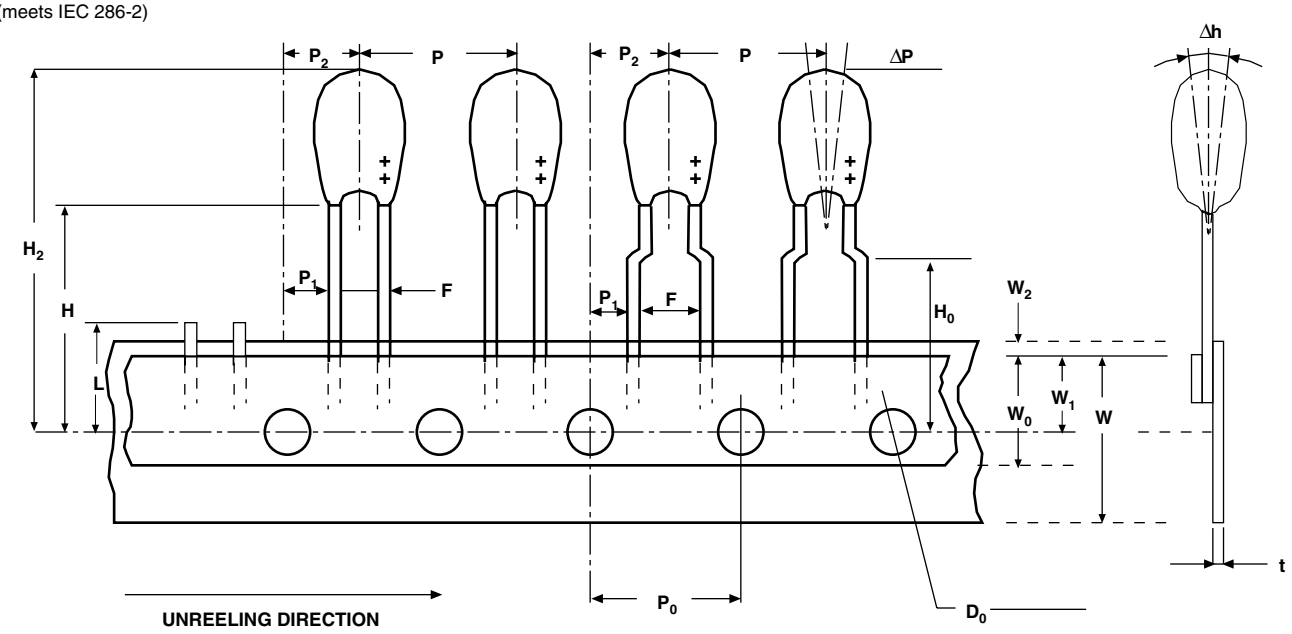
CASE SIZE	CODE	RM in mm ± 0.5	SPECIFICATION	REMARKS
1 - 6	00	2.5 / 5	Bulk	Reel with positive pole in tape run direction in front is standard
1 - 4 (1)	C0	5	Form L, Bulk	
1 - 6	V0	5	Form DS, Bulk	
1 - 4 (1)	W0	2.5	Reel, positive pole in front of unreeling direction	
1 - 4 (1)	T0	2.5	Reel, negative pole in front of unreeling direction	
1 - 4 (1)	H0	2.5	Ammo	
1 - 5	V2	5	Reel, positive pole in front of unreeling direction	
1 - 5	R0	5	Reel, negative pole in front of unreeling direction	
1 - 5	08	5	Ammo	

Note:
(1) 100 µF - 6.3 V, 68 µF - 10 V, 47 µF - 16 V, 22 µF - 25 V

CASE SIZE	BULK 00, V0, C0	REEL W0, T0, V2, R0	AMMO H0, O8
ETPW 1 A,B	500	2500	2500
ETPW 2 C,D,E	500	2000	2000
ETPW 3 F,G	500	1500	1500
ETPW 4 H	500	1500	1500
ETPW 5 J,K,L	100	500	500
ETPW 6 M,N,P, R	100	-	-

TAPING ACCORDING TO IEC 286-2

(meets IEC 286-2)



Dimensions for components on tape and tolerances:

DESIGNATION	SYMBOL	DIMENSIONS (mm)
Holding tape width	W	18.0 (+ 1/- 0.5)
Adhesive tape width	W_0	Min. 5.0
Distance of components	P	12.7 ± 1
Hole center to component center	P_2	6.35 ± 1.3
Hole center to lead	P_1	5.1/3.8 ± 0.7
Distance of body to hole center	H (1)	18.0 (+ 2/- 0)
Distance of lead to hole center	H_0	16.0 ± 0.5
Component upper edge to hole center	H_1	Max. 32.0
Adhesive tape location	W_2	Max. 3.0
Hole location	W_1	9.0 (+ 0.75/- 0.5)
Distance of holes	P_0	12.7 ± 0.3
Hole diameter	D_0	4.0 ± 0.3
Lead diameter	d	0.5 ± 0.05
Component alignment	Δh	Max. ± 2.0
Pitch	F	2.5/5.0 (+ 0.6/- 0.1)
Holding tape thickness	t	0.5 ± 0.2
Component alignment	ΔP	Max. ± 1.3
Length of snipped leads	L	Max. 11.0

Note:
(1) also available: 16 mm and 20 mm taping according to DIN-IEC 286 part 2

Resin-Coated, Radial-Lead Tantalum Capacitors

FEATURES

- RoHS Compliant design available
- Flame retardant encapsulation
- Very high temperature range
- Improved humidity class
- Very low leakage current
- Very high CV product
- Very low leakage current
- Very low failure rate
- Preaged under temperature and voltage

Pb-free Available

RoHS* COMPLIANT

MECHANICAL SPECIFICATIONS

Colour: Gold

Laser Marked: Capacity and voltage in clear text; Plus pole marked, Date code (year/month) according to DIN IEC 62

Leads: Standard (Tin/Lead), RoHS Compliant (100 % Tin)

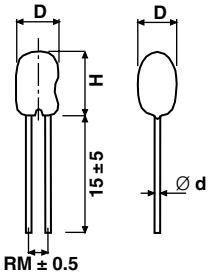
Tantalum capacitors with sintered anode and solid semiconductor electrolyte with flame retardant fluidized bed coating. The type ETQW is characterized by very favorable electrical values even at higher ambient temperatures. The capacitor complies with DIN 45910 part 147. This type is also available as a radially taped version.

ORDERING INFORMATION

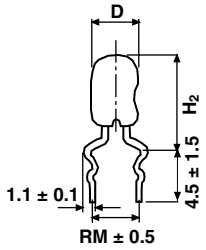
Q1B	685	603	M	00	D	E3
TYPE	CAPACITANCE	DC VOLTAGE RATING AT + 85 °C	CAPACITANCE TOLERANCE	LEAD STYLE AND PACKAGING		RoHS COMPLIANT
ETQW 1A .... ETQW 6R	Expressed in picofarads. The first two digits are significant figures. The third is the number of zeros following.	Expressed by zeros if needed to complete the 3 digit block. A decimal point is indicated by an "0" (603 = 6.3 V)	M = ± 20 % K = ± 10 %	See Lead styles and packaging table		E3 = 100 % tin termination (RoHS compliant design) Blank = SnPb termination (standard design)

DIMENSIONS in millimeters

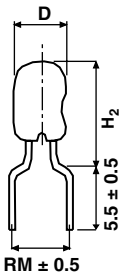
BASIC VERSION



FORM DS



FORM L



MODEL	D MAX.	H MAX.	RM	Ø D ± 0.05	FORM DS		FORM L	
					H_2 MAX.	RM	H_2 MAX.	RM
ETQW - 1	4.5	7.5	2.5	0.5	10.5	5	10.5	5
ETQW - 2	5.0	9.5	2.5	0.5	12.5	5	12.5	5
ETQW - 3	6.0	10.5	2.5	0.5	13.5	5	13.5	5
ETQW - 4	6.5	11.5	2.5	0.5	14.5	5	14.5	5
ETQW - 5	9.0	14.0	5.0	0.5	17.0	5	-	-
ETQW - 6	9.5	17.0	5.0	0.5	20.0	5	-	-

* Pb containing terminations are not RoHS compliant, exemptions may apply

STANDARD RATINGS AND CASE CODES

C_R µF	RATED VOLTAGE U_R at + 85 °C						
	3.0 V	6.3 V	10 V	16 V	25 V	35 V	50 V
0.10						1A	1A
0.15						1A	1A
0.22						1A	1A
0.33						1A	1B
0.47						1A	1B
0.68						1A	2C
1.0					1A	1A	2D
1.5					1A	1B	2E
2.2				1A	1B	2C	3F
3.3			1A	1B	2C	2D	3G
4.7		1A	1B	2C	2D	2E	4H
6.8	1A	1B	2C	2D	2E	3F	5J
10	1A	2C	2D	2E	3F	3G	5L
15	1B	2D	2E	3F	4H	5J	6M
22	2C	2E	3F	3G	5J	5L	6P
33	2D	3F	3G	4H	5K	6M	
47	2E	3G	4H	5K	6M	6P	
68	3F	4H	5J	5L	6N		
100	3G	5J	5L	6N			
150	4H	5L	6N	6R			
220	5J	6M	6P				
330	5L	6P					
470							

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (Ω)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 3 V AT + 85 °C, Surge = 3.9 V . . . U_C = 2 V AT + 125 °C										
6.8	1A	Q1A685003(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.4	0.06
10.0	1A	Q1A106003(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	4.5	0.06
15.0	1B	Q1B156003(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	3.6	0.06
22.0	2C	Q2C226003(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.5	2.9	0.06
33.0	2D	Q2D336003(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.8	2.3	0.06
47.0	2E	Q2E476003(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.1	1.8	0.06
68.0	3F	Q3F686003(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.6	1.4	0.06
100.0	3G	Q3G107003(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.4	1.1	0.08
150.0	4H	Q4H157003(*)_ _D	6.5	11.5	14.5	2.5	0.5	3.6	0.9	0.08
220.0	5J	Q5J227003(*)_ _D	9.0	14.0	17.0	5.0	0.5	5.3	0.7	0.08
330.0	5L	Q5L337003(*)_ _D	9.0	14.0	17.0	5.0	0.5	7.9	0.6	0.08

Note:

(1) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (Ω)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 6.3 V AT + 85 °C, Surge = 7.8 V . . . U_C = 4 V AT + 125 °C										
4.7	1A	Q1A475603(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.4	0.06
6.8	1B	Q1B685603(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	4.5	0.06
10.0	2C	Q2C106603(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.5	3.6	0.06
15.0	2D	Q2D156603(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.8	2.9	0.06
22.0	2E	Q2E226603(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.1	2.3	0.06
33.0	3F	Q3F336603(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.7	1.8	0.06
47.0	3G	Q3G476603(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.4	1.7	0.06
68.0	4H	Q4H686603(*)_ _D	6.5	11.5	14.5	2.5	0.5	3.4	1.1	0.06
100.0	5J	Q5J107603(*)_ _D	9.0	14.0	17.0	5.0	0.5	5.0	0.9	0.08
150.0	5L	Q5L157603(*)_ _D	9.0	14.0	17.0	5.0	0.5	7.6	0.7	0.08
220.0	6M	Q6M227603(*)_ _D	9.5	17.0	20.0	5.0	0.5	11.1	0.6	0.08
330.0	6P	Q6P337603(*)_ _D	9.5	17.0	20.0	5.0	0.5	16.6	0.5	0.08
U_R = 10 V AT + 85 °C, Surge = 13 V . . . U_C = 6.3 V AT + 125 °C										
3.3	1A	Q1A335010(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.9	0.06
4.7	1B	Q1B475010(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	4.5	0.06
6.8	2C	Q2C685010(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.5	3.6	0.06
10.0	2D	Q2D106010(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.8	2.9	0.06
15.0	2E	Q2E156010(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.2	2.3	0.06
22.0	3F	Q3F226010(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.8	1.8	0.06
33.0	3G	Q3G336010(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.6	1.4	0.06
47.0	4H	Q4H476010(*)_ _D	6.5	11.5	14.5	2.5	0.5	3.8	1.1	0.06
68.0	5J	Q5J686010(*)_ _D	9.0	14.0	17.0	5.0	0.5	5.4	0.9	0.06
100.0	5L	Q5L107010(*)_ _D	9.0	14.0	17.0	5.0	0.5	8.0	0.7	0.08
150.0	6N	Q6N157010(*)_ _D	9.5	17.0	20.0	5.0	0.5	12.0	0.6	0.08
220.0	6P	Q6P227010(*)_ _D	9.5	17.0	20.0	5.0	0.5	17.6	0.5	0.08
U_R = 16 V AT + 85 °C, Surge = 20.8 V . . . U_C = 10 V AT + 125 °C										
2.2	1A	Q1A225016(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	6.3	0.06
3.3	1B	Q1B335016(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.4	0.06
4.7	2C	Q2C475016(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.6	4.1	0.06
6.8	2D	Q2D685016(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.9	2.9	0.06
10.0	2E	Q2E106016(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.3	2.3	0.06
15.0	3F	Q3F156016(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.9	1.8	0.06
22.0	3G	Q3G226016(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.8	1.4	0.06
33.0	4H	Q4H336016(*)_ _D	6.5	11.5	14.5	2.5	0.5	4.2	1.1	0.06
47.0	5K	Q5K476016(*)_ _D	9.0	14.0	17.0	5.0	0.5	6.0	0.9	0.06
68.0	5L	Q5L686016(*)_ _D	9.0	14.0	17.0	5.0	0.5	8.7	0.7	0.06
100.0	6N	Q6N107016(*)_ _D	9.5	17.0	20.0	5.0	0.5	12.8	0.6	0.08
150.0	6R	Q6R157016(*)_ _D	9.5	17.0	20.0	5.0	0.5	19.2	0.5	0.08
U_R = 25 V AT + 85 °C, Surge = 32.5 V . . . U_C = 16 V AT + 125 °C										
1.0	1A	Q1A105025(*)_ _D	4.5	7.1	10.5	2.5	0.5	0.5	7.7	0.04
1.5	1A	Q1A155025(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	6.8	0.04
2.2	1B	Q1B225025(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.4	0.06
3.3	2C	Q2C335025(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.7	4.1	0.06
4.7	2D	Q2D475025(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.9	2.9	0.06
6.8	2E	Q2E685025(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.4	2.3	0.06
10.0	3F	Q3F106025(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.0	1.8	0.06
15.0	4H	Q4H156025(*)_ _D	6.5	11.5	14.5	2.5	0.5	3.0	1.4	0.06
22.0	5J	Q5J226025(*)_ _D	9.0	14.0	17.0	5.0	0.5	4.4	1.1	0.06
33.0	5K	Q5K336025(*)_ _D	9.0	14.0	17.0	5.0	0.5	6.6	0.9	0.06
47.0	6M	Q6M476025(*)_ _D	9.5	17.0	20.0	5.0	0.5	9.4	0.7	0.06
68.0	6N	Q6N686025(*)_ _D	9.5	17.0	20.0	5.0	0.5	13.6	0.6	0.06

Note:

(*) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

STANDARD RATINGS

C_R (µF)	CASE CODE	PART NUMBER	DIMENSIONS					MAX. DCL AT + 20 °C, (µA)	MAX. Z AT 100 kHz (Ω)	MAX. DF AT 120 Hz + 20 °C
			D MAX. (mm)	H MAX. (mm)	H_2 MAX. (mm)	RM ± 0.05	d ± 0.05			
U_R = 35 V AT + 85 °C, Surge = 45.5 V . . . U_C = 23 V AT + 125 °C										
0.1	1A	Q1A104035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	34.2	0.04
0.15	1A	Q1A154035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	27.0	0.04
0.22	1A	Q1A224035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	20.7	0.04
0.33	1A	Q1A334035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	16.2	0.04
0.47	1A	Q1A474035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	12.6	0.04
0.68	1A	Q1A684035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	9.0	0.04
1.0	1A	Q1A105035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	7.2	0.04
1.5	1B	Q1A155035(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	5.9	0.04
2.2	2C	Q2C225035(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.6	4.5	0.06
3.3	2D	Q2D335035(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.9	3.2	0.06
4.7	2E	Q2E475035(*)_ _D	5.0	9.5	12.5	2.5	0.5	1.3	2.3	0.06
6.8	3F	Q3F685035(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.9	1.8	0.06
10.0	3G	Q3G106035(*)_ _D	6.0	10.5	13.5	2.5	0.5	2.8	1.4	0.06
15.0	5J	Q5J156035(*)_ _D	9.0	14.0	17.0	5.0	0.5	4.2	1.1	0.06
22.0	5L	Q5L226035(*)_ _D	9.0	14.0	17.0	5.0	0.5	6.2	0.9	0.06
33.0	6M	Q6M336035(*)_ _D	9.5	17.0	20.0	5.0	0.5	9.2	0.7	0.06
47.0	6P	Q6P476035(*)_ _D	9.5	17.0	20.0	5.0	0.5	13.2	0.6	0.06
U_R = 50 V AT + 85 °C, Surge = 65 V . . . U_C = 33 V AT + 125 °C										
0.1	1A	Q1A104050(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	34.2	0.04
0.15	1A	Q1A154050(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	27.0	0.04
0.22	1A	Q1A224050(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	20.7	0.04
0.33	1B	Q1B334050(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	16.2	0.04
0.47	1B	Q1B474050(*)_ _D	4.5	7.5	10.5	2.5	0.5	0.5	12.6	0.04
0.68	2C	Q2C684050(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.5	9.0	0.04
1.0	2D	Q2D105050(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.5	7.2	0.04
1.5	2E	Q2E155050(*)_ _D	5.0	9.5	12.5	2.5	0.5	0.6	5.9	0.04
2.2	3F	Q3F225050(*)_ _D	6.0	10.5	13.5	2.5	0.5	0.9	4.5	0.06
3.3	3G	Q3G335050(*)_ _D	6.0	10.5	13.5	2.5	0.5	1.3	3.2	0.06
4.7	4H	Q4H475050(*)_ _D	6.5	11.5	14.5	2.5	0.5	1.9	2.3	0.06
6.8	5J	Q5J685050(*)_ _D	9.0	14.0	17.0	5.0	0.5	2.7	1.8	0.06
10.0	5L	Q5L106050(*)_ _D	9.0	14.0	17.0	5.0	0.5	4.0	1.4	0.06
15.0	6M	Q6M156050(*)_ _D	9.5	17.0	20.0	5.0	0.5	6.0	1.1	0.06
22.0	6P	Q6P226050(*)_ _D	9.5	17.0	20.0	5.0	0.5	8.8	0.9	0.06

Note:

(*) Insert M for ± 20 % tolerance or K for ± 10 %

_ _ Lead style and packaging code, see lead style and packaging

PERFORMANCE CHARACTERISTICS

1. **Climatic Category:** 55/125/56 acc. to IEC

2. **Temperature Range:** - 55 °C up to + 125 °C with linear voltage derating to category voltage UC

3. **Rated Voltage, Category Voltage:** 3 V to 50 V; 2 V to 33 V

4. **Surge Voltage:** 1.3 times of rated voltage at + 85 °C

5. **Reverse Voltage (Temporary):**
   15 % of the rated DC voltage at + 20 °C
   10 % of the rated DC voltage at + 55 °C
   5 % of the rated DC voltage at + 85 °C

6. **Rated Capacitance:** 0.1 µF to 330 µF

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

8. **Leakage Current in µA:** Measured at + 20 °C after 5 minutes: ≤ 0.008 x CR x UR or 0.5 µA, whichever is greater

9. **Dissipation Factor:** at 120 Hz and + 20 °C
   See table

10. **Impedance:** Measured at 100 kHz and + 20 °C
    See table.

11. **Permissible AC Voltage Stress:** The highest permissible AC voltage for the respective frequency may be taken from the brochure "General information".

    The values apply for + 20 °C. For higher temperatures, the values have to be multiplied with the following factors:

TEMPERATURE	FACTOR
+ 50 °C	0.7
+ 85 °C	0.5
+ 125 °C	0.3

    Intermediate values can be obtained by linear interpolation.
    For further notes on AC voltage stress: See general information

12. **Service life:** > 300.000 h [2]

13. **Failure percentage:** ≤ 0.3 % within 100 000 h [2]

14. **Failure rate (I):** ≤ 0.3 10- 7/h = ≤ 30 fit [2]

15. **Failure criteria:** Catastrophic failure: Short circuit or interruption

    Drift failure: DC/C > + 5 - 15 %
    Z > 3 times initial limit value
    IR > 5 times initial value + 5 µA

Note: [2] related to U_R, + 40 °C and a circuit resistance of ≥ 3 Ω/V

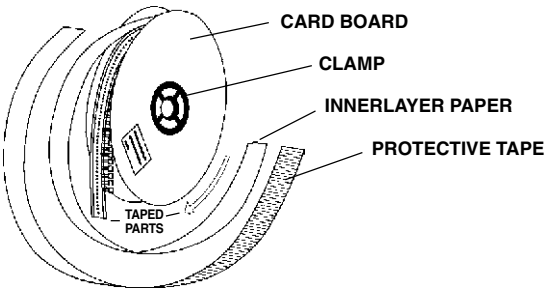
16. **Characteristics at high and low temperatures** (the values shall not exceed the following limits)

TEST TEMPERATURE	- 55 °C	+ 20 °C	+ 85 °C	+ 125 °C
ΔC/C <	- 10 %	-	+ 12 %	+ 15 %
tanδ				
≤ 1.5 µF	0.04	0.04	0.04	0.04
< 10 µF	0.06	0.06	0.06	0.06
< 100 µF	0.08	0.06	0.08	0.08
≥ 100 µF	0.10	0.08	0.10	0.10
Leakage current I_R	-	≤ 0.008 x C_R x U_R or 0.5 µA whichever is greater	≤ 0.08 x C_R x U_R or 5.0 µA whichever is greater	≤ 0.1 x C_R x U_R or 6.25 µA whichever is greater [1]

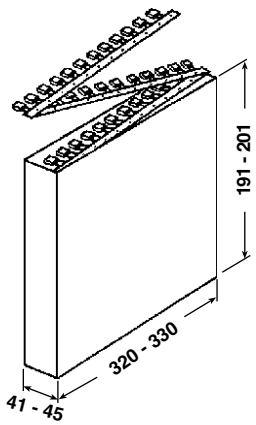
Note:
[1] Measured at category voltage

LEAD STYLES AND PACKAGING

REEL PACKING



AMMO PACKAGING (mm)

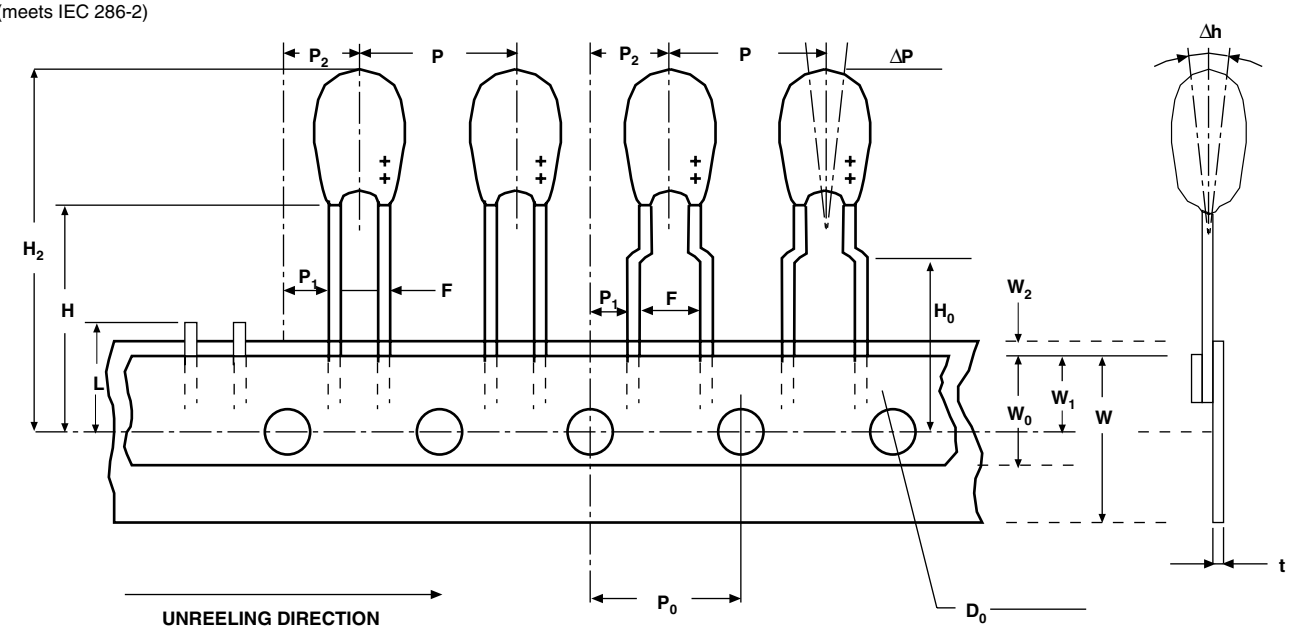


CASE SIZE	CODE	RM in mm ± 0.5	SPECIFICATION	REMARKS
1 - 6	00	2.5 / 5	Bulk	Reel with positive pole in tape run direction in front is standard!
1 - 6	V0	5	Form DS, Bulk	
1 - 4	W0	2.5	Reel, positive pole in front of unreeling direction	
1 - 4	T0	2.5	Reel, negative pole in front of unreeling direction	
1 - 4	H0	2.5	Ammo	
1 - 5	V2	5	Reel, positive pole in front of unreeling direction	
1 - 5	R0	5	Reel, negative pole in front of unreeling direction	
1 - 5	O8	5	Ammo	
1 - 4	C0	5	Style “L“ Bulk	

CASE SIZE	BULK 00, V0, C0	REEL W0, T0, V2, R0	AMMO H0, 08
ETQW 1 A,B	500	2500	2500
ETQW 2 C,D,E	500	2000	2000
ETQW 3 F,G	500	1500	1500
ETQW 4 H	500	1500	1500
ETQW 5 J,K,L	100	500	500
ETQW 6 M,N,P,R	100	-	-

TAPING ACCORDING TO IEC 286-2

(meets IEC 286-2)



Dimensions for components on tape and tolerances:

DESIGNATION	SYMBOL	DIMENSIONS (mm)
Holding tape width	W	18.0 (+ 1/- 0.5)
Adhesive tape width	W_0	Min. 5.0
Distance of components	P	12.7 ± 1
Hole center to component center	P_2	6.35 ± 1.3
Hole center to lead	P_1	5.1/3.8 ± 0.7
Distance of body to hole center	H (1)	18.0 (+ 2/- 0)
Distance of lead to hole center	H_0	16.0 ± 0.5
Component upper edge to hole center	H_1	Max. 32.0
Adhesive tape location	W_2	Max. 3.0
Hole location	W_1	9.0 (+ 0.75/- 0.5)
Distance of holes	P_0	12.7 ± 0.3
Hole diameter	D_0	4.0 ± 0.3
Lead diameter	d	0.5 ± 0.05
Component alignment	Δh	Max. ± 2.0
Pitch	F	2.5/5.0 (+ 0.6/- 0.1)
Holding tape thickness	t	0.5 ± 0.2
Component alignment	ΔP	Max. ± 1.3
Length of snipped leads	L	Max. 11.0

Note:
(1) also available: 16 mm and 20 mm taping according to DIN-IEC 286 part 2

ONLINE INFORMATION

For product information and a current list of sales offices,
representatives and distributors, visit our website:

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