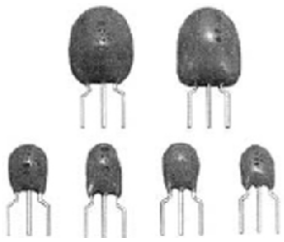
Solid-Electrolyte TANTALEX® Capacitors, Tripole Triple-Lead, Resin-Coated



FEATURES

- Radial through hole terminations: tin / lead (SnPb), 100 % tin (Sn)
- Triple-lead design allows reverse installations
- 6 miniature case codes available
- EIA standard case sizes
- Easy installation, economical, high performance
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free Available

RoHS* Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

PERFORMANCE CHARACTERISTICS

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

Capacitance Range: 0.10 µF to 680 µF

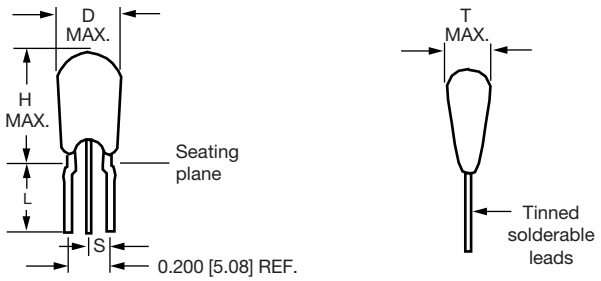
Capacitance Tolerance: ± 20 %, ± 10 % standard ± 5 % available as special

Voltage Rating: 3 V_{DC} to 50 V_{DC}

ORDERING INFORMATION

299D	227	X0	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 CODE	D (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]

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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 V_{DC} AT + 85 °C, SURGE = 3.6 V; 2 V_{DC} AT + 125 °C, SURGE = 2.4 V				
4.7	A	299D475X_003AB_	0.5	6
6.8	A	299D685X_003AB_	0.5	6
10	A	299D106X_003AB_	0.5	8
15	A	299D156X_003AB_	0.5	8
22	B	299D226X_003BB_	0.6	8
33	B	299D336X_003BB_	1.0	8
47	C	299D476X_003CB_	1.4	8
68	D	299D686X_003DB_	2.0	8
100	D	299D107X_003DB_	3.0	10
150	D	299D157X_003DB_	4.0	10
220	E	299D227X_003EB_	5.0	10
330	E	299D337X_003EB_	6.0	10
470	F	299D477X_003FB_	8.0	10
680	F	299D687X_003FB_	10.0	10
6.3 V_{DC} AT + 85 °C, SURGE = 8 V; 4 V_{DC} 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	B	299D106X_6R3BB_	0.6	8
15	B	299D156X_6R3BB_	0.9	8
22	C	299D226X_6R3CB_	1.3	8
33	C	299D336X_6R3CB_	2.0	8
47	D	299D476X_6R3DB_	2.9	8
68	D	299D686X_6R3DB_	4.0	8
100	D	299D107X_6R3DB_	5.0	10
150	E	299D157X_6R3EB_	6.0	10
220	F	299D227X_6R3FB_	7.0	10
330	F	299D337X_6R3FB_	8.0	10
10 V_{DC} AT + 85 °C, SURGE = 13 V; 7 V_{DC} 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	B	299D106X_010BB_	1.0	8
15	C	299D156X_010CB_	1.5	8
22	C	299D226X_010CB_	2.0	8
33	D	299D336X_010DB_	3.0	8
47	D	299D476X_010DB_	4.0	8
68	D	299D686X_010DB_	5.0	8
100	E	299D107X_010EB_	6.0	10
150	F	299D157X_010FB_	7.0	10
220	F	299D227X_010FB_	8.0	10

Note

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

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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 (%)
16 V_{DC} AT + 85 °C, SURGE = 20 V; 10 V_{DC} 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	C	299D106X_016CB_	1.5	8
15	C	299D156X_016CB_	2.4	8
22	D	299D226X_016DB_	3.5	8
33	D	299D336X_016DB_	4.0	8
47	E	299D476X_016EB_	5.0	8
68	E	299D686X_016EB_	6.0	8
100	F	299D107X_016FB_	7.0	10
150	F	299D157X_016FB_	8.0	10
20 V_{DC} AT + 85 °C, SURGE = 26 V; 13 V_{DC} 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	C	299D106X_020CB_	2.0	8
15	D	299D156X_020DB_	2.5	8
22	D	299D226X_020DB_	3.0	8
33	E	299D336X_020EB_	4.0	8
47	E	299D476X_020EB_	5.0	8
68	F	299D686X_020FB_	6.0	8
100	F	299D107X_020FB_	7.0	10
25 V_{DC} AT + 85 °C, SURGE = 33 V; 17 V_{DC} 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	C	299D106X_025CB_	2.5	8
15	D	299D156X_025DB_	3.0	8
22	D	299D226X_025DB_	4.0	8
33	E	299D336X_025EB_	5.0	8
47	F	299D476X_025FB_	6.0	8
68	F	299D686X_025FB_	7.0	8

Note

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

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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 (%)
35 V_{DC} AT + 85 °C, SURGE = 46 V; 23 V_{DC} 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	D	299D106X_035DB_	3.5	8
15	E	299D156X_035EB_	4.0	8
22	E	299D226X_035EB_	5.0	8
33	F	299D336X_035FB_	6.0	8
47	F	299D476X_035FB_	7.0	8
50 V_{DC} AT + 85 °C, SURGE = 65 V; 33 V_{DC} 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	F	299D106X_050FB_	4.0	8
15	F	299D156X_050FB_	5.0	8
22	F	299D226X_050FB_	6.0	8

Note

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

PRODUCT INFORMATION	
Mounting of Through Hole Components	www.vishay.com/doc?40108
Solid Tantalum Capacitors (With MnO_2 Electrolyte) Voltage Derating	www.vishay.com/doc?40246
SELECTOR GUIDES	
Quick Reference Guide	www.vishay.com/doc?40037
Selector Guide	www.vishay.com/doc?49054
Parameter Comparison Guide	www.vishay.com/doc?40033
FAQ	
Frequently Asked Questions	www.vishay.com/doc?40110

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PERFORMANCE CHARACTERISTICS

1. **Operating Temperature:** capacitors are designed to operate over the temperature range of -55 °C to +85 °C with no derating.

1.1 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)
3.0	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 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 ± 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 V_{RMS} at 120 Hz at +25 °C. If the AC voltage applied is less than 0.5 V_{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 %

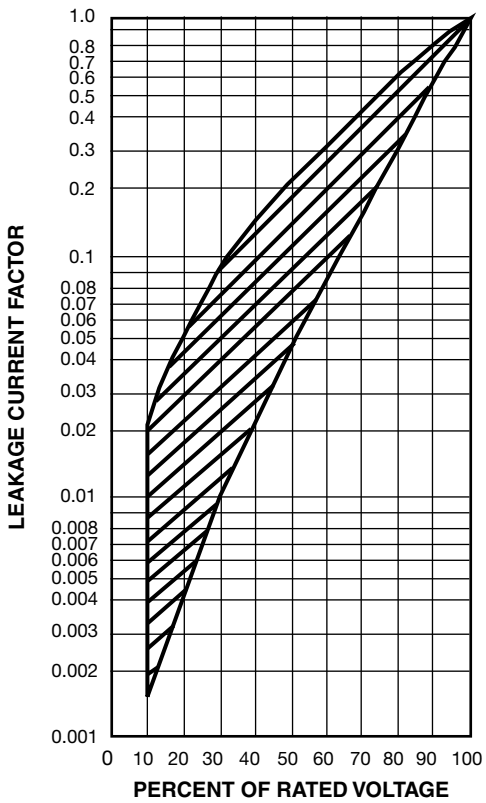
6. **Dissipation Factor:** the dissipation factor, determined from the expression $2\pi fC_R$, shall not exceed values listed in the Standard Ratings table.

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 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.

LEAKAGE AS A FUNCTION OF VOLTAGE AND TEMPERATURE



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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 h, 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 (9 N) 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 UL 94 V-0 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 Ta_2O_5 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 h 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. **AC Ripple Current:** the maximum allowable ripple current shall be determined from the formula:

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

where,

P = power dissipation in W at +25 °C as given in the table in paragraph number 7 (Power Dissipation)

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

2. **AC Ripple Voltage:** the maximum allowable ripple voltage shall be determined from the formula:

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

or, from the formula:

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

where,

P = power dissipation in W at +25 °C as given in the table in paragraph number 7 (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.

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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

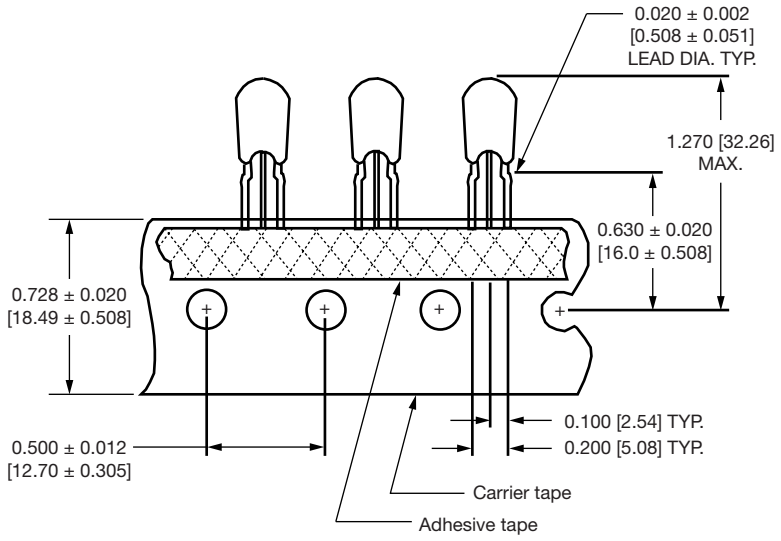
5. **Solvent Resistance:** type 299D capacitors are conformally coated with thermosetting resin. Markings are either laser imprinted or are a heat cured black epoxy ink conforming to EIA Standard RS-327A. Marked units are compatible with Class 1 (Alcohols), Class 2 (Aromatic Hydrocarbons), Class 3 (Mineral 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 mm] from the capacitor body, for up to 10 s. 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 I_{RMS} 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

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