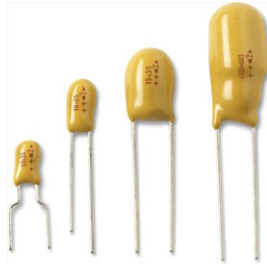


# Resin-Coated, Radial-Lead Solid Tantalum Capacitors



## 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 ammpack
- Low impedance and ESR at high frequencies
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



## 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.

## ELECTRICAL CHARACTERISTICS

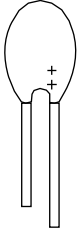
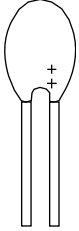
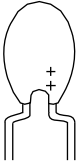
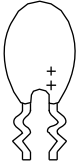
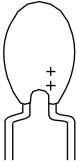
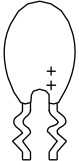
**Operating Temperature:** -55 °C to +85 °C: type 489D  
 -55 °C to +125 °C (above 85 °C, voltage derating is required): type 499D

## 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
<b>489D</b> Standard +85 °C <b>499D</b> 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 Ratings and Case Codes table	1, 2, 3, 4, 6, 9 See description on next page	A = ammpack 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												
<b>Bulk: Code V</b> 						<b>Reel / Ammo: Code A, B, C</b> 						
LEAD CASE	D	STYLES 1-2-3-4			STYLE 6		STYLE 9		STYLES 2-4		STYLE 6	
		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	-	-	-	-	

LEAD STYLE	
<p><b>LEAD STYLE 1:</b></p> <p>Straight leads, 2.5 mm lead space, uneven length</p> 	<p><b>LEAD STYLE 2:</b></p> <p>Straight leads, 2.5 mm lead space, even length</p> 
<p><b>LEAD STYLE 3:</b></p> <p>Straight leads, 5 mm lead space, uneven length</p> 	<p><b>LEAD STYLE 4:</b></p> <p>Straight leads, 5 mm lead space, even length</p> 
<p><b>LEAD STYLE 6:</b></p> <p>Shouldered leads, 5 mm lead space</p> 	<p><b>LEAD STYLE 9:</b></p> <p>Snap-In leads, 5 mm lead space</p> 

RATINGS, CASE CODES AND LEAD STYLE										
C <sub>R</sub> μF	RATED VOLTAGE U <sub>R</sub> 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								



<b>STANDARD RATINGS</b>						
CAPACITANCE $C_R$ ( $\mu$ F)	CASE CODE	PART NUMBER	MAX. DCL	MAX. DCL	MAX. DF, 100 Hz	
			AT +25 °C ( $\mu$ A) 489D	AT +25 °C ( $\mu$ A) 499D	AT +25 °C (%) 489D, 499D	
<b><math>U_R = 3 V_{DC}</math> AT +85 °C, SURGE = 4 V; <math>U_C = 2 V_{DC}</math> AT +125 °C, SURGE = 2.6 V (ONLY 499D)</b>						
6.8	A	489D685X(*)003A__	1.0	0.5	6	
10	B	489D106X(*)003B__	1.0	0.5	8	
15	B	489D156X(*)003B__	1.0	0.5	8	
22	C	489D226X(*)003C__	1.0	0.5	8	
33	C	489D336X(*)003C__	1.4	0.7	8	
47	D	489D476X(*)003D__	2.1	1.1	8	
68	D	489D686X(*)003D__	3.0	1.6	8	
100	E	489D107X(*)003E__	4.5	2.4	10	
150	H	489D157X(*)003H__	6.7	3.6	10	
220	M	489D227X(*)003M__	9.9	5.2	10	
330	N	489D337X(*)003N__	14.8	7.9	10	
470	N	489D477X(*)003N__	21.1	11.2	12	
680	R	489D687X(*)003R__	30.6	16.3	12	
<b><math>U_R = 6.3 V_{DC}</math> AT +85 °C, SURGE = 8 V; <math>U_C = 4 V_{DC}</math> AT +125 °C, SURGE = 5.2 V (ONLY 499D)</b>						
4.7	A	489D475X(*)6R3A__	1.0	0.5	6	
6.8	A	489D685X(*)6R3A__	1.0	0.5	6	
10	B	489D106X(*)6R3B__	1.0	0.5	8	
15	B	489D156X(*)6R3B__	1.4	0.7	8	
22	C	489D226X(*)6R3C__	2.0	1.1	8	
33	C	489D336X(*)6R3C__	3.1	1.6	8	
47	D	489D476X(*)6R3D__	4.4	2.3	8	
68	D	489D686X(*)6R3D__	6.4	3.4	8	
100	E	489D107X(*)6R3E__	9.4	5.0	10	
150	M	489D157X(*)6R3M__	14.1	7.5	10	
220	M	489D227X(*)6R3M__	20.7	11.0	10	
330	N	489D337X(*)6R3N__	31.1	16.6	10	
470	R	489D477X(*)6R3R__	44.4	23.6	12	
680	R	489D687X(*)6R3R__	64.2	34.2	12	
<b><math>U_R = 10 V_{DC}</math> AT +85 °C, SURGE = 13 V; <math>U_C = 7 V_{DC}</math> AT +125 °C, SURGE = 8.6 V (ONLY 499D)</b>						
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	B	489D106X(*)010B__	1.5	0.8	8	
15	C	489D156X(*)010C__	2.2	1.2	8	
22	C	489D226X(*)010C__	3.3	1.7	8	
33	D	489D336X(*)010D__	4.9	2.6	8	
47	D	489D476X(*)010D__	7.0	3.7	8	
68	E	489D686X(*)010E__	10.2	5.4	8	
100	M	489D107X(*)010M__	15.0	8.0	10	
150	M	489D157X(*)010M__	22.5	12.0	10	
220	N	489D227X(*)010N__	33.0	17.6	10	
330	R	489D337X(*)010R__	49.5	26.4	10	

**Note**

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



<b>STANDARD RATINGS</b>						
<b>CAPACITANCE C<sub>R</sub> (μF)</b>	<b>CASE CODE</b>	<b>PART NUMBER</b>	<b>MAX. DCL AT +25 °C (μA) 489D</b>	<b>MAX. DCL AT +25 °C (μA) 499D</b>	<b>MAX. DF, 100 Hz AT +25 °C (%) 489D, 499D</b>	
<b>U<sub>R</sub> = 16 V<sub>DC</sub> AT +85 °C, SURGE = 20 V; U<sub>C</sub> = 10 V<sub>DC</sub> AT +125 °C, SURGE = 13 V (ONLY 499D)</b>						
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	C	489D106X(*)016C__	2.4	1.2	8	
15	D	489D156X(*)016D__	3.6	1.9	8	
22	D	489D226X(*)016D__	5.2	2.8	8	
33	E	489D336X(*)016E__	7.9	4.2	8	
47	F	489D476X(*)016F__	11.2	6.0	8	
68	M	489D686X(*)016M__	16.3	8.7	8	
100	N	489D107X(*)016N__	24.0	12.8	10	
150	N	489D157X(*)016N__	36.0	19.2	10	
220	R	489D227X(*)016R__	52.8	28.1	10	
<b>U<sub>R</sub> = 20 V<sub>DC</sub> AT +85 °C, SURGE = 26 V; U<sub>C</sub> = 13 V<sub>DC</sub> AT +125 °C, SURGE = 16 V (ONLY 499D)</b>						
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	D	489D106X(*)020D__	3.0	1.6	8	
15	E	489D156X(*)020E__	4.5	2.4	8	
22	F	489D226X(*)020F__	6.6	3.5	8	
33	H	489D336X(*)020H__	9.9	5.2	8	
47	M	489D476X(*)020M__	14.1	7.5	8	
68	N	489D686X(*)020N__	20.4	10.8	8	
100	N	489D107X(*)020N__	30.0	16.0	10	
<b>U<sub>R</sub> = 25 V<sub>DC</sub> AT +85 °C, SURGE = 32 V; U<sub>C</sub> = 17 V<sub>DC</sub> AT +125 °C, SURGE = 21 V (ONLY 499D)</b>						
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	D	489D106X(*)025D__	3.7	2.0	8	
15	E	489D156X(*)025E__	5.6	3.0	8	
22	H	489D226X(*)025H__	8.2	4.4	8	
33	M	489D336X(*)025M__	12.3	6.6	8	
47	M	489D476X(*)025M__	17.6	9.4	8	
68	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						
CAPACITANCE C <sub>R</sub> (μF)	CASE CODE	PART NUMBER	MAX. DCL AT +25 °C (μA) 489D	MAX. DCL AT +25 °C (μA) 499D	MAX. DF, 100 Hz AT +25 °C (%) 489D, 499D	
<b>U<sub>R</sub> = 35 V<sub>DC</sub> AT +85 °C, SURGE = 46 V; U<sub>C</sub> = 23 V<sub>DC</sub> AT +125 °C, SURGE = 28 V (ONLY 499D)</b>						
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	F	489D106X(*)035F__	5.2	2.8	8	
15	M	489D156X(*)035M__	7.8	4.2	8	
22	M	489D226X(*)035M__	11.5	6.1	8	
33	N	489D336X(*)035N__	17.3	9.2	8	
47	N	489D476X(*)035N__	24.6	13.1	8	
<b>U<sub>R</sub> = 50 V<sub>DC</sub> AT +85 °C, SURGE = 65 V; U<sub>C</sub> = 33 V<sub>DC</sub> AT +125 °C, SURGE = 40 V (ONLY 499D)</b>						
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	N	489D106X(*)050N__	7.5	4.0	8	
15	N	489D156X(*)050N__	11.2	6.0	8	
22	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

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			



PERFORMANCE CHARACTERISTICS

- 1. **Operating Temperature:** -55 °C to +85 °C with rated DC voltage  $U_R$  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  $V_{RMS}$  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 +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) <sup>(1)</sup>	2	4	7	10	13	17	23	33
DC surge voltage at +125 °C (V) <sup>(1)</sup>	2.6	5.2	8.6	13	16	21	28	40

Note

<sup>(1)</sup> For 499D

Capacitors shall withstand the surge voltage applied in series with a 1000 Ω (± 5 %) resistor, at the rate of 1.5 min on, 5.5 min off for 1000 successive test cycles at +85 °C.

5. Stability at low and high temperatures:

489D - Table 2A

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

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

Notes

<sup>(1)</sup> Rated voltage applied for 5 min with a series resistor of 1000 Ω

<sup>(2)</sup> Only for 499 D

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.

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

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 h) <sup>(1)</sup> 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

<sup>(1)</sup> 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 part number, date code, and quantity.



**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 below

R<sub>ESR</sub> = the capacitor Equivalent Series Resistance at the specified frequency

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

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

where,

Z = the capacitor impedance at the specified frequency

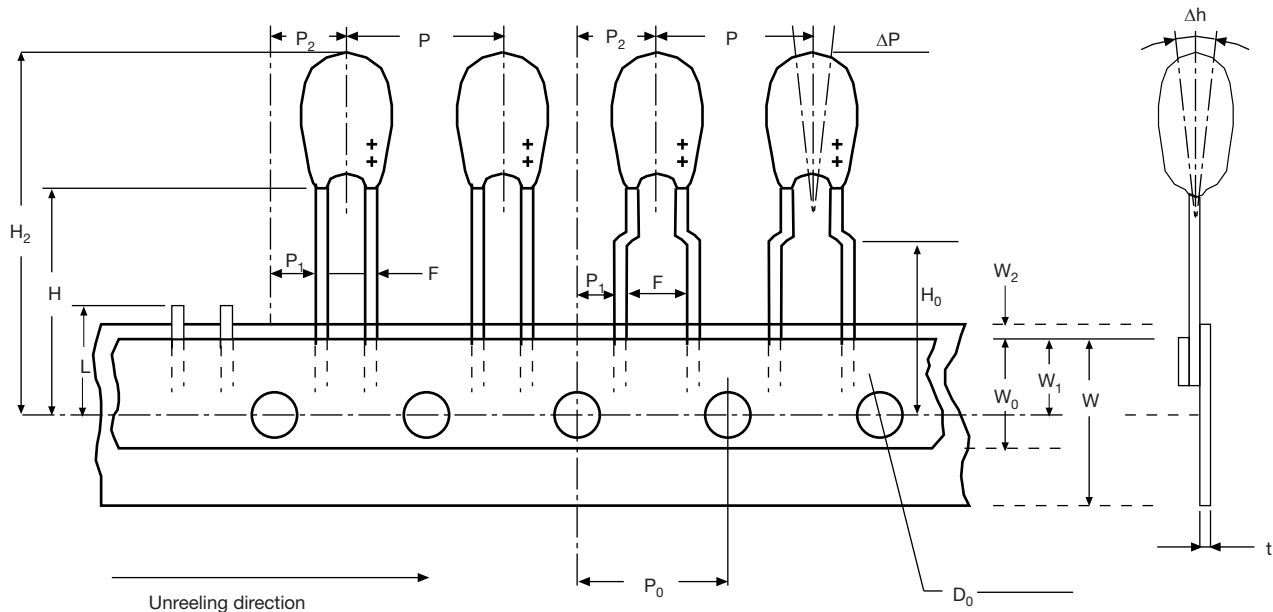
3. **AC Ripple Current or Voltage Derating Factor:** if these capacitors are to be operated at temperatures above +25 °C, the permissible RMS ripple current or voltage shall be calculated using the derating factors in the table below:

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<sub>RMS</sub> 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


Dimensions for components on tape and tolerances:

DESIGNATION	SYMBOL	DIMENSIONS (mm)	
Pitch of component	P	12.7 ± 1.0	
Feed hole pitch	P <sub>0</sub>	12.7 ± 0.3	
Tape width	W	18 (+ 1/- 0.5)	
Hold down tape width	W <sub>0</sub>	5.0	
Hole position	W <sub>1</sub>	9 (+ 0.75/- 0.5)	
Hold down tape position	W <sub>2</sub>	0 (+ 3/- 0)	
Overall component height	H <sub>1</sub>	32 max.	
Component alignment	ΔP	± 1.3 max.	
Feed hole diameter	D <sub>0</sub>	4.0 ± 0.3	
Tape thickness	t	0.5 ± 0.2	
Component alignment	ΔH	0 ± 2	
Length of snapped leads	L	11 max.	
Lead clinch height	H <sub>0</sub>	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 <sub>1</sub>	5.1 ± 0.7	3.65 ± 0.7
Hole center to component center	P <sub>2</sub>	6.35 ± 1.3	6.35 ± 1.3
Component height	H	18 ± 1	





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