

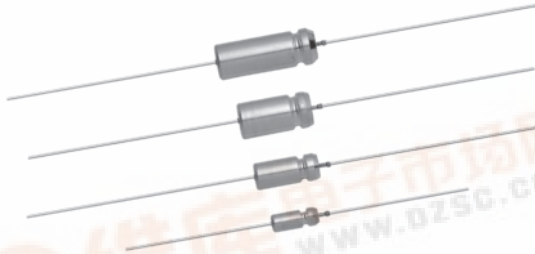


138D

Vishay

Wet Tantalum Capacitors

Sintered Anode TANTALEX[®] Capacitors Hermetically-Sealed with True Glass-to-Tantalum Seal



PERFORMANCE CHARACTERISTICS

Operating Temperature: - 55°C to + 85°C and with voltage derating to two-thirds the + 85°C rating at + 125°C. Use of Type 138D capacitors for high temperature applications is recommended.

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

DC Leakage Current (DCL Max.):

At + 25°C, + 85°C and + 125°C: Leakage current shall not exceed the values listed in the Standard Ratings Tables.

Life Test: Capacitors are capable of withstanding a 2000 hour life test at a temperature of + 85°C or + 125°C at the applicable rated DC working voltage.

FEATURES

Improved reliability through the use of a glass-to-tantalum true hermetic anode seal is the prime feature of the Type 138D sintered anode TANTALEX[®] capacitor. This construction offers outstanding resistance to thermal shock.

Model 138D is the commercial equivalents of Tansitor Styles WT, UWT, Mallory-NACC Styles TLX, TXX and Military Styles CL66, CL67, CLR65, and CLR69, designed to meet the performance requirements of Military Specification MIL-PRF-39006/09/21. Capacitors in accordance with military specifications should be ordered by their military part numbers.

Following the life test:

1. DCL shall not exceed 125% of the original requirement.
2. The ESR shall not exceed 200% of the initial requirement.
3. Change in capacitance value shall not exceed the percentages below.
 - a) 6WVDC Units: + 10% to - 25% of initial measurement.
 - b) 8WVDC and 10WVDC Units: + 10% to - 20% of initial measurement.
 - c) 15WVDC Units: + 10% to - 15% of initial measurement.
 - d) 20WVDC and above: $\pm 10\%$ of initial measurement.

ORDERING INFORMATION

138D MODEL	306 CAPACITANCE	X0 CAPACITANCE TOLERANCE	006 DC VOLTAGE RATING AT + 85°C	C CASE CODE	2 STYLE NUMBER
	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = $\pm 20\%$ X9 = $\pm 10\%$ X5 = $\pm 5\%$ Special Order.	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating. A decimal point is indicated by an "R" (6R3 = 6.3 volts).	See Ratings and Case Codes Table.	0 = No outer tube. 2 = Outer plastic-film insulation.

Packaging: The use of formed plastic trays for packaging these axial lead components is standard. Tape and reel is not recommended due to the unit weight.

DIMENSIONS in inches [millimeters]

CASE CODE	BARE TUBE		WITH OUTER PLASTIC - FILM INSULATION		LEAD LENGTH	Max. WEIGHT (Ounces/Grams)
	D	L	D (Max.)	L (Max.)		
C	0.188 $\pm$ 0.016 [4.78 $\pm$ 0.41]	0.453 + 0.031 - 0.016 [11.51 + 0.79 - 0.41]	0.219 [5.56]	0.608 [15.45]	1.500 $\pm$ 0.250 [38.10 $\pm$ 6.35]	0.07 [2.0]
F	0.281 $\pm$ 0.016 [7.14 $\pm$ 0.41]	0.641 + 0.031 - 0.016 [16.28 + 0.79 - 0.41]	0.312 [7.92]	0.796 [20.22]	2.250 $\pm$ 0.250 [57.15 $\pm$ 6.35]	0.18 [5.1]
T	0.375 $\pm$ 0.016 [9.53 $\pm$ 0.41]	0.766 + 0.031 - 0.016 [19.46 + 0.79 - 0.41]	0.406 [10.31]	0.921 [23.40]	2.250 $\pm$ 0.250 [57.15 $\pm$ 6.35]	0.36 [10.2]
K	0.375 $\pm$ 0.016 [9.53 $\pm$ 0.41]	1.062 + 0.031 - 0.023 [26.97 + 0.79 - 0.58]	0.406 [10.31]	1.127 [30.91]	2.250 $\pm$ 0.250 [57.15 $\pm$ 6.35]	0.49 [13.9]

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STANDARD RATINGS									
CAPACITANCE (μF)	CASE CODE	PART NUMBER*	Max. ESR at + 25°C (Ohms)	Max. IMP. at - 55°C (Ohms)	Max. DCL (μA) at		Max. CAPACITANCE CHANGE (%) at		
					+ 25°C	+ 85°C + 125°C	- 55°C	+ 85°C	+ 125°C
6WVDC at + 85°C . . . 4WVDC at + 125°C									
30	C	138D306X0006C2	4	100	1	2	- 40	+ 10.5	+ 12
68	C	138D686X0006C2	4	60	1	2	- 40	+ 14	+ 16
140	F	138D147X0006F2	2	40	1	3	- 40	+ 14	+ 16
270	F	138D277X0006F2	4	25	1	6.5	- 44	+ 17.5	+ 20
330	T	138D337X0006T2	2	20	2	7.9	- 44	+ 14	+ 16
560	T	138D567X0006T2	3	25	2	13	- 64	+ 17.5	+ 20
1200	K	138D128X0006K2	1.6	20	3	14	- 80	+ 25	+ 25
8WVDC at + 85°C . . . 5WVDC at + 125°C									
25	C	138D256X0008C2	4	100	1	2	- 40	+ 10.5	+ 12
56	C	138D566X0008C2	4	59	1	2	- 40	+ 14	+ 16
220	F	138D227X0008F2	4	30	1	7	- 44	+ 17.5	+ 20
430	T	138D437X0008T2	3	25	2	14	- 64	+ 17.5	+ 20
850	K	138D857X0008K2	1	22	4	16	- 80	+ 25	+ 25
10WVDC at + 85°C . . . 7WVDC at + 125°C									
20	C	138D206X0010C2	4	175	1	2	- 32	+ 10.5	+ 12
47	C	138D476X0010C2	5	100	1	2	- 36	+ 14	+ 16
100	F	138D107X0010F2	2	60	1	4	- 36	+ 14	+ 16
180	F	138D187X0010F2	4	40	1	7	- 36	+ 14	+ 16
250	T	138D257X0010T2	2	30	2	10	- 40	+ 14	+ 16
390	T	138D397X0010T2	3	25	2	16	- 64	+ 17.5	+ 20
750	K	138D757X0010K2	1	23	4	16	- 80	+ 25	+ 25
15WVDC at + 85°C . . . 10WVDC at + 125°C									
15	C	138D156X0015C2	5	155	1	2	- 24	+ 10.5	+ 12
33	C	138D336X0015C2	5	90	1	2	- 28	+ 14	+ 16
70	F	138D706X0015F2	4	75	1	4	- 28	+ 14	+ 16
120	F	138D127X0015F2	4	50	1	7	- 28	+ 17.5	+ 20
170	T	138D177X0015T2	2	35	2	10	- 32	+ 14	+ 16
270	T	138D277X0015T2	3	30	2	16	- 56	+ 17.5	+ 20
540	K	138D547X0015K2	1.0	23	6	24	- 80	+ 25	+ 25
20WVDC at + 85°C . . . 13WVDC at + 125°C									
27	C	138D276X0020C2	5	100	1	2	- 20	+ 11	+ 14
220	T	138D227X0020T2	4	30	2	16	- 48	+ 13	+ 15
25WVDC at + 85°C . . . 15WVDC at + 125°C									
10	C	138D106X0025C2	6	220	1	2	- 16	+ 8	+ 9
22	C	138D226X0025C2	5	140	1	2	- 20	+ 10.5	+ 12
50	F	138D506X0025F2	4	70	1	5	- 28	+ 13	+ 15
100	F	138D107X0025F2	4	50	1	10	- 28	+ 13	+ 15
180	T	138D187X0025T2	4	32	2	18	- 48	+ 13	+ 15
350	K	138D357X0025K2	1.3	24	7	28	- 70	+ 25	+ 25
30WVDC at + 85°C . . . 20WVDC at + 125°C									
8.0	C	138D805X0030C2	7.5	275	1	2	- 16	+ 8	+ 12
15	C	138D156X0030C2	8	175	1	2	- 20	+ 10.5	+ 12
40	F	138D406X0030F2	4	65	1	5	- 24	+ 10.5	+ 12
100	T	138D107X0030T2	6	40	2	12	- 28	+ 10.5	+ 12
150	T	138D157X0030T2	2.5	35	2	16	- 48	+ 13	+ 15
300	K	138D307X0030K2	1.6	25	8	32	- 60	+ 25	+ 25



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STANDARD RATINGS									
CAPACITANCE (μF)	CASE CODE	PART NUMBER*	Max. ESR at + 25°C (Ohms)	Max. IMP. at - 55°C (Ohms)	Max. DCL (μA) at		Max. CAPACITANCE CHANGE (%) at		
					+ 25°C	+ 85°C + 125°C	- 55°C	+ 85°C	+ 125°C
35WVDC at + 85°C . . . 22WVDC at + 125°C									
68	F	138D686X0035F2	6	60	1	8	- 24	+ 12	+ 15
120	T	138D127X0035T2	4	38	2	16	- 30	+ 13	+ 15
270	K	138D277X0035K2	2.2	23	8	32	- 45	+ 20	+ 25
50WVDC at + 85°C . . . 30WVDC at + 125°C									
5.0	C	138D505X0050C2	9	400	1	2	- 16	+ 5	+ 6
10	C	138D106X0050C2	8	250	1	2	- 24	+ 8	+ 9
25	F	138D256X0050F2	6	95	1	5	- 20	+ 10.5	+ 12
47	F	138D476X0050F2	6	70	1	9	- 28	+ 10.5	+ 15
60	T	138D606X0050T2	3	45	2	12	- 16	+ 10.5	+ 12
82	T	138D826X0050T2	4	45	2	16	- 32	+ 13	+ 15
160	K	138D167X0050K2	2.2	27	8	32	- 50	+ 25	+ 25
60WVDC at + 85°C . . . 40WVDC at + 125°C									
4.0	C	138D405X0060C2	10	550	1	2	- 16	+ 5	+ 6
8.2	C	138D825X0060C2	8	275	1	2	- 24	+ 8	+ 9
20	F	138D206X0060F2	5	105	1	5	- 16	+ 10.5	+ 12
39	F	138D396X0060F2	7	90	1	9	- 28	+ 10.5	+ 12
50	T	138D506X0060T2	4	50	2	12	- 16	+ 10.5	+ 12
68	T	138D686X0060T2	6	50	2	16	- 32	+ 10.5	+ 12
140	K	138D147X0060K2	2.4	28	8	32	- 40	+ 20	+ 20
75WVDC at + 85°C . . . 50WVDC at + 125°C									
3.5	C	138D355X0075C2	10	650	1	2	- 16	+ 5	+ 6
6.8	C	138D685X0075C2	8	300	1	2	- 20	+ 8	+ 9
15	F	138D156X0075F2	6.5	150	1.0	5	- 16	+ 8	+ 9
33	F	138D336X0075F2	7	90	1.0	10	- 24	+ 10.5	+ 15
40	T	138D406X0075T2	5	60	2.0	12	- 16	+ 10.5	+ 12
56	T	138D566X0075T2	6	60	2.0	17	- 28	+ 10.5	+ 15
110	K	138D117X0075K2	3.1	29	9	36	- 35	+ 20	+ 20
100WVDC at + 85°C . . . 65WVDC at + 125°C									
2.5	C	138D255X0100C2	26.5	950	1.0	2	- 16	+ 7	+ 8
4.7	C	138D475X0100C2	10	500	1.0	2	- 16	+ 7	+ 8
11	F	138D116X0100F2	6	200	1.0	4	- 16	+ 7	+ 8
22	F	138D226X0100F2	7	100	1.0	9	- 16	+ 7	+ 8
30	T	138D306X0100T2	4	80	2.0	12	- 16	+ 7	+ 8
43	T	138D436X0100T2	6	70	2.0	17	- 20	+ 7	+ 8
86	K	138D866X0100K2	3.1	30	9	36	- 25	+ 15	+ 15
125WVDC at + 85°C . . . 85WVDC at + 125°C									
1.7	C	138D175X0125C2	54.6	1250	1.0	2	- 16	+ 7	+ 8
3.6	C	138D365X0125C2	15	600	1.0	2	- 16	+ 7	+ 8
9.0	F	138D905X0125F2	15	240	1.0	5	- 16	+ 7	+ 8
14	F	138D146X0125F2	12	167	1.0	7	- 16	+ 7	+ 8
18	T	138D186X0125T2	11	129	2.0	9	- 16	+ 7	+ 8
25	T	138D256X0125T2	10	93	2.0	13	- 16	+ 7	+ 8
56	K	138D566X0125K2	4.1	32	10	40	- 25	+ 15	+ 15

*Part Numbers listed are for units with outer plastic-film insulation and a capacitance tolerance of $\pm 20\%$. For bare case units, substitute "0" for "2" at the end of the Part Number. For capacitors with $\pm 10\%$ tolerance, change the digit following the letter "X" to "9".

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**EXTENDED RATINGS**

CAPACITANCE (μF)	CASE CODE	PART NUMBER*	Max. ESR at + 25°C (Ohms)	Max. IMP. at - 55°C (Ohms)	Max. DCL (μA) at		Max. CAPACITANCE CHANGE (%) at		
					+ 25°C	+ 85°C + 125°C	- 55°C	+ 85°C	+ 125°C
6WVDC at + 85°C . . . 4WVDC at + 125°C									
560	F	138D567X0006F2	2.5	20	3	14	- 80	+ 16	+ 20
820	F	138D827X0006F2	2.5	18	3	14	- 88	+ 16	+ 20
1500	T	138D158X0006T2	1.5	18	5	20	- 90	+ 20	+ 25
2200	K	138D228X0006K2	1	13	6	24	- 90	+ 25	+ 30
8WVDC at + 85°C . . . 5WVDC at + 125°C									
180	C	138D187X0008C2	3	45	2	9	- 60	+ 13	+ 16
470	F	138D477X0008F2	2.5	25	3	14	- 75	+ 16	+ 20
680	F	138D687X0008F2	2.5	22	3	14	- 83	+ 16	+ 20
1800	K	138D188X0008K2	1	14	7	25	- 90	+ 20	+ 30
10WVDC at + 85°C . . . 7WVDC at + 125°C									
100	C	138D107X0010C2	3.0	60	2	9	- 50	+ 13	+ 16
150	C	138D157X0010C2	3	54	2	9	- 55	+ 13	+ 16
390	F	138D397X0010F2	2.5	30	3	16	- 70	+ 16	+ 20
560	F	138D567X0010F2	2.5	27	3	16	- 77	+ 16	+ 20
1200	T	138D128X0010T2	1.5	18	5	20	- 88	+ 20	+ 25
1500	K	138D158X0010K2	1	15	7	25	- 88	+ 25	+ 30
15WVDC at + 85°C . . . 10WVDC at + 125°C									
68	C	138D686X0015C2	4	80	2	9	- 40	+ 13	+ 16
100	C	138D107X0015C2	4	72	2	9	- 44	+ 13	+ 16
270	F	138D277X0015F2	2.5	35	3	16	- 60	+ 16	+ 20
390	F	138D397X0015F2	2.5	31	3	16	- 16	+ 16	+ 20
540	T	138D547X0015T2	1.8	25	6	24	- 70	+ 20	+ 25
820	T	138D827X0015T2	1.8	22	6	24	- 77	+ 20	+ 25
1000	K	138D108X0015K2	1.2	17	8	32	- 77	+ 25	+ 30
20WVDC at + 85°C . . . 13WVDC at + 125°C									
56	C	138D566X0020C2	4.3	90	2	9	- 38	+ 13	+ 16
82	C	138D826X0020C2	4.3	81	2	9	- 43	+ 13	+ 16
220	F	138D227X0020F2	2.7	35	3	16	- 60	+ 16	+ 20
330	F	138D337X0020F2	2.7	31	3	16	- 66	+ 16	+ 20
25 WVDC at + 85°C . . . 15 WVDC at + 125°C									
47	C	138D476X0025C2	4.3	100	2	9	- 35	+ 12	+ 15
68	C	138D686X0025C2	4.3	90	2	9	- 40	+ 12	+ 15
180	F	138D187X0025F2	2.7	37	3	16	- 55	+ 13	+ 16
270	F	138D277X0025F2	2.7	33	3	16	- 62	+ 13	+ 16
350	T	138D357X0025T2	1.8	27	7	28	- 60	+ 20	+ 25
30WVDC at + 85°C . . . 20WVDC at + 125°C									
39	C	138D396X0030C2	5.2	110	2	9	- 32	+ 12	+ 15
56	C	138D566X0030C2	5.2	100	2	9	- 38	+ 12	+ 15
150	F	138D157X0030F2	2.5	40	3	16	- 50	+ 13	+ 16
220	F	138D227X0030F2	2.5	36	3	16	- 60	+ 13	+ 16
330	T	138D337X0030T2	1.8	28	8	32	- 50	+ 20	+ 25
470	T	138D477X0030T2	1.8	25	8	32	- 65	+ 20	+ 25
560	K	138D567X0030K2	1.3	20	9	36	- 65	+ 25	+ 30

* Part Numbers listed are for units with outer plastic-film insulation and a capacitance tolerance of $\pm 20\%$. For bare case units, substitute "0" for "2" at the end of the Part Number. For capacitors with $\pm 10\%$ tolerance, change the digit following the letter "X" to "9".

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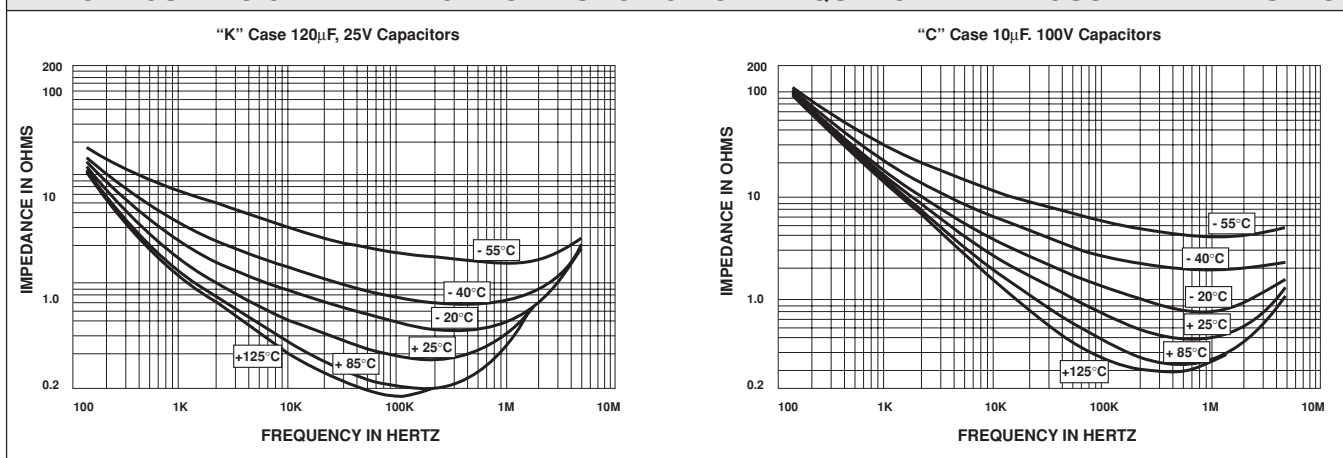
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CAPACITANCE (μF)	CASE CODE	PART NUMBER*	Max. ESR at + 25°C (Ohms)	Max. IMP. at - 55°C (Ohms)	Max. DCL (μA) at		Max. CAPACITANCE CHANGE (%) at		
					+ 25°C	+ 85°C + 125°C	- 55°C	+ 85°C	+ 125°C
35WVDC at + 85°C . . . 22WVDC at + 125°C									
33	C	138D336X0035C2	5.2	130	2	9	- 30	+ 10	+ 12
47	C	138D476X0035C2	5.2	115	2	9	- 35	+ 10	+ 12
120	F	138D127X0035F2	2.5	45	3	16	- 45	+ 13	+ 16
220	T	138D227X0035T2	1.8	30	8	32	- 45	+ 20	+ 25
390	T	138D397X0035T2	1.8	27	8	32	- 58	+ 20	+ 25
470	K	138D477X0035K2	1.3	21	9	36	- 58	+ 25	+ 30
50WVDC at + 85°C . . . 30WVDC at + 125°C									
22	C	138D226X0050C2	5	150	2	9	- 24	+ 10	+ 12
33	C	138D336X0050C2	5	135	2	9	- 29	+ 10	+ 12
82	F	138D826X0050F2	2.5	55	4	24	- 35	+ 10	+ 15
120	F	138D127X0050F2	2.5	49	4	24	- 42	+ 12	+ 15
160	T	138D167X0050T2	1.8	32	6	32	- 35	+ 20	+ 25
270	T	138D277X0050T2	1.8	29	8	32	- 46	+ 20	+ 25
330	K	138D337X0050K2	1.5	22	9	36	- 46	+ 25	+ 30
60WVDC at + 85°C . . . 40WVDC at + 125°C									
18	C	138D186X0060C2	5	160	3	12	- 20	+ 10	+ 12
27	C	138D276X0060C2	5	144	3	12	- 24	+ 10	+ 12
68	F	138D686X0060F2	3	60	4	20	- 30	+ 12	+ 15
100	F	138D107X0060F2	2.5	54	4	20	- 36	+ 12	+ 15
140	T	138D147X0060T2	2	32	8	32	- 30	+ 16	+ 20
220	T	138D227X0060T2	1.8	29	8	32	- 40	+ 16	+ 20
270	K	138D277X0060K2	1.5	23	9	36	- 45	+ 20	+ 25
75WVDC at + 85°C . . . 50WVDC at + 125°C									
15	C	138D156X0075C2	5	175	3	12	- 16	+ 10	+ 12
22	C	138D226X0075C2	5	157	3	12	- 19	+ 10	+ 12
56	F	138D566X0075F2	3	70	4	24	- 25	+ 12	+ 15
82	F	138D826X0075F2	2.5	63	4	24	- 30	+ 12	+ 15
110	T	138D117X0075T2	2	33	9	36	- 25	+ 16	+ 20
180	T	138D187X0075T2	1.8	30	9	36	- 35	+ 16	+ 20
220	K	138D227X0075K2	2.2	24	10	40	- 40	+ 20	+ 25
100WVDC at + 85°C . . . 65WVDC at + 125°C									
8.2	C	138D825X0100C2	6	250	3	12	- 12	+ 10	+ 12
10	C	138D106X0100C2	6	200	3	12	- 17	+ 10	+ 12
33	F	138D336X0100F2	3.5	85	5	24	- 18	+ 12	+ 15
39	F	138D396X0100F2	3.5	80	5	24	- 20	+ 12	+ 15
68	T	138D686X0100T2	2.2	40	10	40	- 30	+ 14	+ 16
120	K	138D127X0100K2	2.8	30	12	48	- 35	+ 15	+ 17
125WVDC at + 85°C . . . 85WVDC at + 125°C									
6.8	C	138D685X0125C2	11.7	300	3	12	- 14	+ 10	+ 12
27	F	138D276X0125F2	3.5	90	5	24	- 18	+ 12	+ 15
39	T	138D396X0125T2	2.2	60	10	40	- 16	+ 14	+ 16
47	T	138D476X0125T2	2.2	50	10	40	- 26	+ 14	+ 16
82	K	138D826X0125K2	2.8	32	12	48	- 30	+ 15	+ 17

*Part Numbers listed are for units with outer plastic-film insulation and a capacitance tolerance of $\pm 20\%$. For bare case units, substitute "0" for "2" at the end of the Part Number. For capacitors with $\pm 10\%$ tolerance, change the digit following the letter "X" to "9".

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TYPICAL CURVES OF IMPEDANCE AS A FUNCTION OF FREQUENCY AT VARIOUS TEMPERATURES



PERFORMANCE CHARACTERISTICS

- Operating Temperature:** Capacitors are designed to operate over the temperature range of - 55°C to +125°C.

UP TO + 85°C WORKING VOLTAGE (V)	AT + 125°C WORKING VOLTAGE (V)	UP TO + 85°C WORKING VOLTAGE (V)	AT + 125°C WORKING VOLTAGE (V)
6	4	35	22
8	5	50	30
10	7	60	40
15	10	75	50
20	13	100	70
25	15	125	85
30	20	150	100

- DC Working Voltage:** The DC working voltage is the maximum operating voltage for continuous duty at the rated temperature.
- Surge Voltage:** The surge DC rating is the maximum voltage to which the capacitors should be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of capacitors rated below 150 volts is 115% of the rated DC working voltage. The surge voltage of capacitors rated at 150 volts DC is 165 volts.
- Surge Voltage Test:** Capacitors shall withstand the surge voltage test applied through a 1000 ohm $\pm 10\%$ resistor in series with the capacitor and voltage source at the rate of one-half minute on, four and one-half minutes off, for 1000 successive test cycles at + 85°C or + 125°C.
- Capacitance Tolerance:** The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

- Capacitance measurements shall be made by the bridge method at or referred to, a frequency of 120Hz at a temperature of + 25°C. A polarizing voltage shall be used of such magnitude that there shall be no reversal of polarity due to the AC component. The maximum AC voltage will be 1 volt rms applied during measurement.

- Capacitance Change With Temperature:** The capacitance change with temperature shall not exceed the limits given in the Standard and Extended Ratings Table for each capacitor.

- Equivalent Series Resistance:** Measurements shall be made by the bridge method at or referred to, a frequency of 120Hz at a temperature of + 25°C. A polarizing voltage shall be used of such magnitude that there shall be no reversal of polarity due to the AC component. The maximum AC voltage will be 1 volt rms applied during measurement.

- The equivalent series resistance shall not exceed the maximum value in ohms listed in the Standard and Extended Ratings Table for each capacitor.

- The dissipation factor may be calculated from the equivalent series resistance and capacitance values as shown:

$$DF = \frac{2\pi fRC}{10^4}$$

where:

DF = Dissipation Factor in %

R = ESR in ohms

C = Capacitance in μF

f = frequency in Hz



Wet Tantalum Capacitors
Sintered Anode TANTALEX[®] Capacitors Hermetically-Sealed
with True Glass-to-Tantalum Seal

PERFORMANCE CHARACTERISTICS (Cont'd)

At 120Hz, the above equation becomes:

$$DF = \frac{R \times C}{13.26}$$

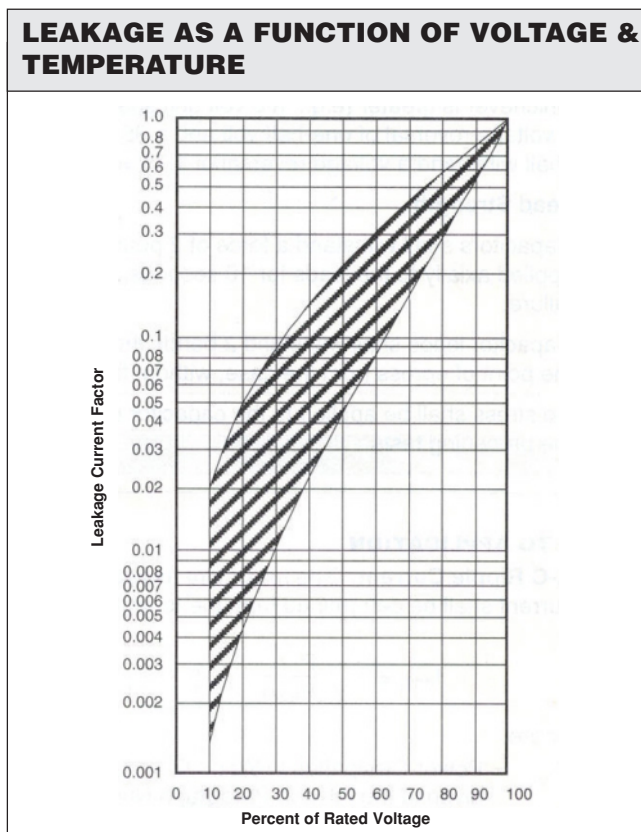
For example, percent dissipation factor of a 30 μ F, 6 volt capacitor, which has a maximum ESR of 3.4 ohms at + 25°C and 120Hz, would be calculated as shown:

$$DF = \frac{2\pi \times 120 \times 3.4 \times 30}{10^4} = \frac{3.4 \times 30}{13.26} = 7.7\%$$

7. **Leakage Current:** Measurements shall be made at the applicable rated working voltage at + 25°C $\pm$ 5°C through application of a steady source of power, such as a regulated power supply. The total resistance in series with each capacitor shall be between 1000 ohms and 10,000 ohms. The voltage shall be applied to the capacitor for 5 minutes before making the leakage current measurement.

- 7.1. The maximum leakage current for any capacitor shall not exceed the value in microamperes listed in the Standard and Extended Ratings Table for each capacitor.

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



8. **Low Temperature Impedance:** The impedance of any capacitor at - 55°C at 120Hz, shall not exceed the values given in the Standard and Extended Ratings Tables.

9. **Life Test:** Capacitors are capable of withstanding a 2000 hour life test at a temperature of + 85°C or + 125°C at the applicable rated DC working voltage.
10. **High Frequency Vibration:** Capacitors shall withstand vibration from 10Hz to 2000Hz at 20g when tested.
11. **Lead Pull Test:** Capacitors shall withstand a lead tensile stress of 3 pounds (13.2N) for 30 seconds, applied axially.
12. **Marking:** Capacitors shall be marked with Sprague[®] and/or the Sprague[®] trademark 2, the Sprague[®] type (138D); rated capacitance and tolerance (the tolerance shall be coded, using the list shown in How to Order); rated DC working voltage at + 85°C; the standard EIA date code of manufacture.

GUIDE TO APPLICATION

1. **Ripple Current:** All capacitors will withstand rms ripple currents as listed for each capacitor.
- 1.1. The rms ripple current rating is independent of temperature or frequency within the following limitations:
- 1.1.1. At frequencies of less than 120Hz, the rated rms ripple current must be multiplied by the factors shown:

FREQUENCY IN HERTZ			
25	50	60	100
0.36	0.59	0.65	0.88

- 1.1.2 The sum of the peak AC voltage plus the DC voltage shall not exceed the DC working voltage of the capacitor.
- 1.1.3 The sum of the negative peak AC voltage, plus the applied DC voltage shall not allow a voltage reversal.
2. Cleaning wiring boards with Type 138D capacitors: Customary cleaning solvents used in the electronics industry at present will not affect Type 138D capacitors. However, the use of ultrasonic cleaning techniques is not recommended under any circumstances.
3. **Apparent Capacitance:** Note that in timing circuit applications, the circuit designer must take into account two important variables which affect any electrolytic capacitor. These are the internal leakage resistance of the capacitor and its dielectric absorption, which will depend on the elapsed time since the capacitor was last energized.

In applications where electrolytic capacitors are subjected to DC energy, or in effect, extremely low frequencies, the value of the apparent capacitance will be somewhat higher than that which is measured at 120Hz.

4. **No Reverse Voltage:** The application of reverse voltage to these capacitors will cause internal damage. The resulting damage will lead to immediate or delayed failure of the unit. This will take the form of a catastrophic short circuit with possible expulsion of the electrolyte.