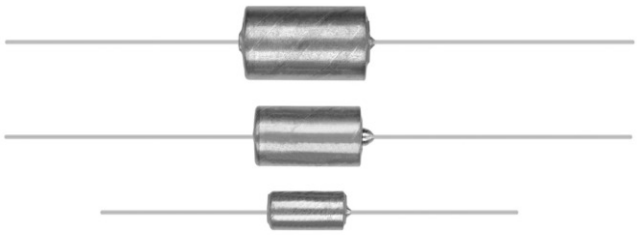
Solid-Electrolyte TANTALEX® Capacitors, Military MIL-PRF-39003 Qualified, Styles CSR13, 21, 23



FEATURES

- Hermetically sealed
- Metal cased
- Axial lead
- Tubular

STYLE, DOCUMENT/DETAIL SPECIFICATION

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.

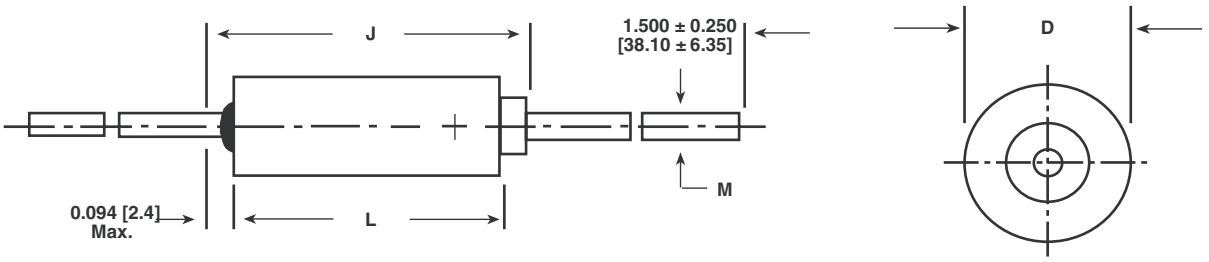
MILITARY SPECIFICATION MIL-PRF-39003 PART NUMBERING SYSTEM INFORMATION

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, after 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, before 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]



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) 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														
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)							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
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.

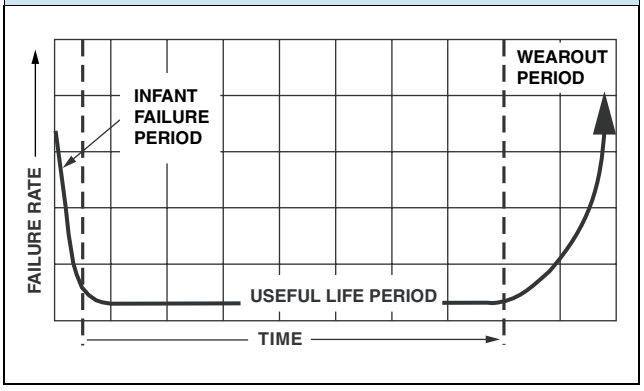
Increasingly, more stringent quality measurement systems are being used in the electronics industry. AQL sample plans are being replaced by programs measuring component quality in PPM (Parts Per Million). Product quality specifications seemingly approach perfection. Procedures used to calculate PPM quality 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 (β < 1) during infant mortality, one (β = 1) during the useful life and greater than one (β > 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 (Continued)

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 mcl/c Q.A.R./ENG. [signature]

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