

## Solid-Electrolyte TANTALEX<sup>®</sup> 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<sup>®</sup> 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 (CSRxxxxxxx) 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.

| <b>MILITARY SPECIFICATION MIL-PRF-39003 PART NUMBERING SYSTEM INFORMATION</b> |  |   |   |
|---|--|---|---|
| <b>M39003</b>   | <b>/01</b>   | <b>-2254</b>                                | <b>A (1)</b>  |
| 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)<br>A = + 25 °C, after Weibull<br>B = - 55 °C and + 85 °C, after Weibull<br>C = - 55 °C and + 85 °C, before Weibull<br>D = + 25 °C, after Weibull, High Temperature solder<br>E = - 55 °C and + 85 °C, after Weibull, High Temperature solder<br>F = - 55 °C and + 85 °C, before Weibull, High Temperature solder<br>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<br>± 0.031 [0.79] | D<br>+ 0.016 [0.41]<br>- 0.015 [0.38] | M<br>± 0.002 [0.05] | J<br>(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<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |          |           |            |          |           |            | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|---|--------------|-----------------------|--|----------|-----------|------------|----------|-----------|------------|------------------|---------|----------|--------------------|---------------------|
|   |              |                       | M<br>1.0   | P<br>0.1 | R<br>0.01 | S<br>0.001 | B<br>0.1 | C<br>0.01 | D<br>0.001 | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
| <b>6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V</b> |              |                       |  |          |           |            |          |           |            |                  |         |          |                    |                     |
| 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                   |



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

Vishay Sprague

| <b>STANDARD RATINGS: CSR13, M39003/01-XXXX</b>                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |         |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |         |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |         |
| <b>10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V</b>   |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |         |
| 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       |
| <b>15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |         |
| 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       |
| <b>20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |         |
| 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       |



| <b>STANDARD RATINGS: CSR13, M39003/01-XXXX</b>                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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 | 5638  | 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                   |
| <b>35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |



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

Vishay Sprague

| STANDARD RATINGS: CSR13, M39003/01-XXXX                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                |         |
|--|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|----------------|---------|
| CAPACITANCE<br>(µF)  | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT |         |
|  |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C        | + 85 °C |
|  |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 | + 25 °C          | + 85 °C | + 125 °C | + 25 °C        | + 85 °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 | 2819 | 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       |



| <b>STANDARD RATINGS: CSR13, M39003/01-XXXX</b>                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |
| <b>75 WVDC AT + 85 °C, SURGE = 98 V . . . 50 WVDC AT + 125 °C, SURGE = 64 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |



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

Vishay Sprague

| STANDARD RATINGS: CSR13, M39003/01-XXXX                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                |          |
|--|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|----------------|----------|
| CAPACITANCE<br>(µF)  | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT |          |
|  |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C        | + 85 °C  |
|  |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 | + 25 °C          | + 85 °C | + 125 °C | + 25 °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 | 5516 | 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 | 8298  | 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        |



| <b>STANDARD RATINGS: CSR13, M39003/01-XXXX</b>                                    |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |





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

Vishay Sprague

| STANDARD RATINGS: CSR13, M39003/01-XXXX   |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(μF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/01-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (μA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>100 WVDC AT + 85 °C, SURGE = 130 V . . . 67 WVDC AT + 125 °C, SURGE = 86 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/09-<br>FAILURE RATE LEVEL (%/1000 h) |          |           |            |          |           |            | MAX. DCL<br>(µA) AT |       |        | MAX.<br>DF AT<br>+25°C<br>1 kHz<br>(%) | MAX.<br>ESR AT<br>+25°C<br>100 kHz<br>(Ω) | DERATED<br>MAX.<br>RIPPLE<br>CURRENT<br>AT +25°C<br>(A) |          |  |
|---|--------------|-----------------------|--|----------|-----------|------------|----------|-----------|------------|---------------------|-------|--------|--|---|---|----------|--|
|   |              |                       | M<br>1.0   | P<br>0.1 | R<br>0.01 | S<br>0.001 | B<br>0.1 | C<br>0.01 | D<br>0.001 | +25°C               | +85°C | +125°C |  |   | 40<br>kHz   | 1<br>kHz |  |
| <b>6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V</b>     |              |                       |  |          |           |            |          |           |            |                     |       |        |  |   |   |          |  |
| 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      |  |
| <b>10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V</b>   |              |                       |  |          |           |            |          |           |            |                     |       |        |  |   |   |          |  |
| 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      |  |
| <b>15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V</b> |              |                       |  |          |           |            |          |           |            |                     |       |        |  |   |   |          |  |
| 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      |  |
| <b>20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V</b> |              |                       |  |          |           |            |          |           |            |                     |       |        |  |   |   |          |  |
| 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      |  |



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

Vishay Sprague

| STANDARD RATINGS: CSR21, M39003/09-XXXX   |           |                   |  |      |      |       |      |      |       |        |                     |         |              |                |             |  |  |
|---|-----------|-------------------|--|------|------|-------|------|------|-------|--------|---------------------|---------|--------------|----------------|-------------|--|--|
| CAPACITANCE<br>(µF)   | CASE CODE | CAP. TOL.<br>(±%) | PART NO. M39003/09-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       |        | MAX. DCL<br>(µA) AT |         |              | MAX. DF AT     | MAX. ESR AT | DERATED<br>MAX. RIPPLE<br>CURRENT<br>AT +25 °C |  |
|   |           |                   | M  | P    | R    | S     | B    | C    | D     | +25 °C | +85 °C              | +125 °C | +25 °C       | +25 °C         | AT +25 °C   |  |  |
|   |           |                   | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |        |                     |         | 1 kHz<br>(%) | 100 kHz<br>(Ω) | 40 kHz      | 1 kHz  |  |
| <b>20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V</b> |           |                   |  |      |      |       |      |      |       |        |                     |         |              |                |             |  |  |
| 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  |  |
| <b>35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V</b> |           |                   |  |      |      |       |      |      |       |        |                     |         |              |                |             |  |  |
| 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  |  |
| <b>50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V</b> |           |                   |  |      |      |       |      |      |       |        |                     |         |              |                |             |  |  |
| 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  |  |



| <b>STANDARD RATINGS: CSR23, M39003/03-XXXX</b>                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/03-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>6 WVDC AT + 85 °C, SURGE = 8 V . . . 4 WVDC AT + 125 °C, SURGE = 5 V</b>     |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                  |
| <b>10 WVDC AT + 85 °C, SURGE = 13 V . . . 7 WVDC AT + 125 °C, SURGE = 9 V</b>   |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                  |
| <b>15 WVDC AT + 85 °C, SURGE = 20 V . . . 10 WVDC AT + 125 °C, SURGE = 12 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |



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

Vishay Sprague

| <b>STANDARD RATINGS: CSR23, M39003/03-XXXX</b>                                  |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
|---|--------------|-----------------------|--|------|------|-------|------|------|-------|------------------|---------|----------|--------------------|---------------------|
| CAPACITANCE<br>(µF)   | CASE<br>CODE | CAP.<br>TOL.<br>(± %) | PART NO. M39003/03-<br>FAILURE RATE LEVEL (%/1000 h) |      |      |       |      |      |       | MAX. DCL (µA) AT |         |          | MAX. DF (%) AT     |                     |
|   |              |                       | M  | P    | R    | S     | B    | C    | D     | + 25 °C          | + 85 °C | + 125 °C | - 55 °C<br>+ 25 °C | + 85 °C<br>+ 125 °C |
|   |              |                       | 1.0  | 0.1  | 0.01 | 0.001 | 0.1  | 0.01 | 0.001 |                  |         |          |                    |                     |
| <b>20 WVDC AT + 85 °C, SURGE = 26 V . . . 13 WVDC AT + 125 °C, SURGE = 16 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |
| <b>35 WVDC AT + 85 °C, SURGE = 46 V . . . 23 WVDC AT + 125 °C, SURGE = 28 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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                   |
| <b>50 WVDC AT + 85 °C, SURGE = 65 V . . . 33 WVDC AT + 125 °C, SURGE = 40 V</b> |              |                       |  |      |      |       |      |      |       |                  |         |          |                    |                     |
| 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 ( $\beta$ ) is shown as less than one ( $\beta < 1$ ) during infant mortality, one ( $\beta = 1$ ) during the useful life and greater than one ( $\beta > 1$ ) during the wearout period. Since Weibull distribution works well on units with a beta less than 1, solid tantalum capacitors can use this method for determining failure rates. Solid tantalum capacitors fail early in life (normally during the aging or burn-in 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:

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

$V_s$  = 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  $\mu$ F, 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:

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

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

t = Actual test time

$\beta$  = Weibull shape parameter (beta)

$\alpha$  = 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.





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