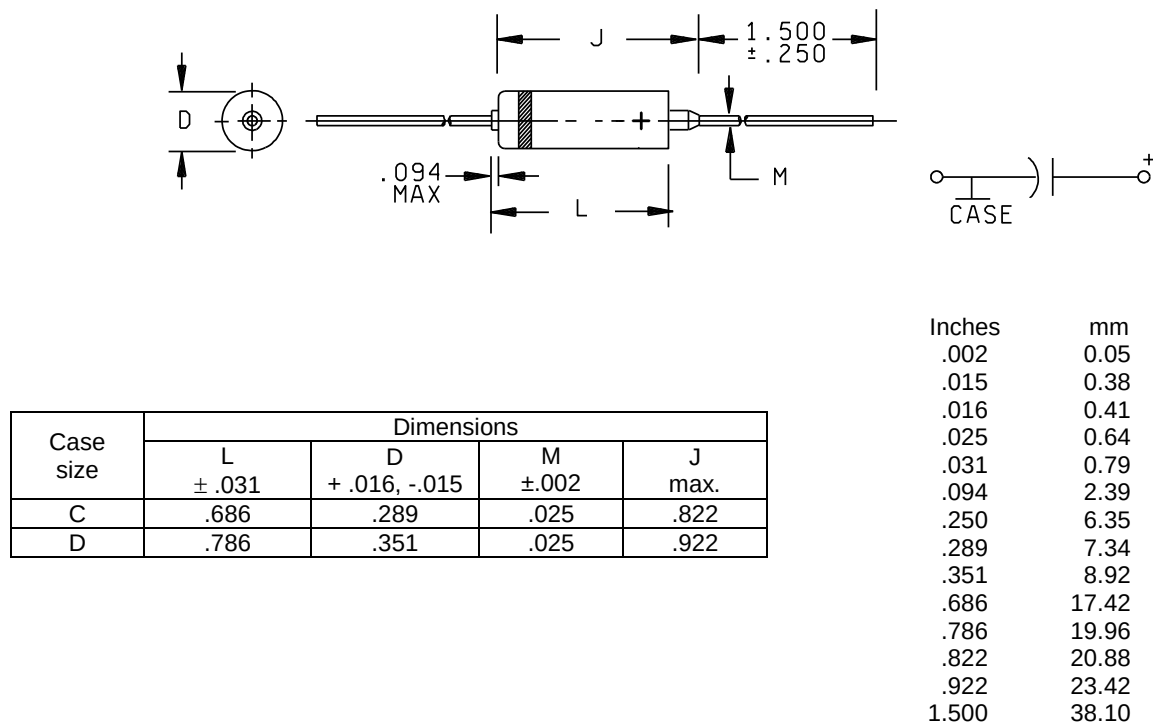


PERFORMANCE SPECIFICATION SHEET

CAPACITOR, FIXED, ELECTROLYTIC (SOLID ELECTROLYTE), TANTALUM
 (POLARIZED, SINTERED SLUG), HIGH FREQUENCY, ESTABLISHED RELIABILITY,
 STYLE CSS21 (HIGH RELIABILITY APPLICATIONS)

This specification sheet is approved for use by all Departments
 and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist
 of this specification sheet and [MIL-PRF-39003](#).



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The case insulation shall extend .015 inch (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.
4. Lead length may be a minimum of 1-inch long for use in tape and reel automatic insertion equipment, when specified.
5. Black band to indicate negative end of case.

FIGURE 1. Dimensions and configuration.



REQUIREMENTS:

Dimensions and configuration: See [figure 1](#).

Case type:

Tubular, insulated or uninsulated.

Material: Metal (alloy unspecified).

Type of seal: Hermetic.

Leads: Solderable.

DC rated voltage: See [table I](#). Above +85°C voltage derating is required (see [MIL-PRF-39003](#)).

DC leakage (DCL): See [table I](#).

Capacitance (Cap.) (nom): See [table I](#).

Cap. tolerance: See [table I](#).

Dissipation factor (DF): See [table I](#).

Equivalent series resistance (ESR) at 100 kHz: See [table I](#).

Operating temperature: -55°C to +125°C.

Failure rate level (FRL): See [table I](#).

Stability at low and high temperatures: In accordance with [MIL-PRF-39003](#).

Step 1 (+25°C):

DCL: See [table I](#).

Capacitance: Within tolerance of [table I](#) value.

DF: See [table I](#).

Step 2 (-55°C):

Capacitance: Shall not change more than ± 10 percent of step 1 measured value.

DF: 2 times step 1 measured value or [table I](#), whichever is greater.

Step 3 (+25°C):

DCL: See [table I](#).

Capacitance: Shall not change more than ± 2 percent of step 1 measured value.

DF: See [table I](#).

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Step 4 (+85°C):

DCL: See [table I](#).

Capacitance: Shall not change more than ± 8 percent of step 1 measured value.

DF: 1.5 times step 1 measured value or [table I](#), whichever is greater.

Step 5 (+125°C):

DCL: See [table I](#).

Capacitance: Shall not change more than ± 12 percent of step 1 measured value.

DF: 1.5 times step 1 measured value or [table I](#), whichever is greater.

Step 6 (+25°C):

DCL: See [table I](#).

Δ Cap.: Shall not change more than ± 2 percent of step 1 measured value.

DF: See [table I](#).

Surge current: Capacitors shall be tested in accordance with the following:

Temperature and number of cycles: 10 cycles minimum at -55°C (-5°C/+0°C) and 10 cycles minimum at +85°C (+5°C/-0°C).

Applied voltage: Rated dc voltage ± 2 percent. Maximum voltage (including transients) shall not exceed 130% of +85°C rated voltage.

Charge cycle: 4 seconds ± 1 second.

Discharge cycle: 4 seconds ± 1 second to a voltage below 1 percent of rated voltage.

Test current: 10 amperes, minimum. The peak current to any group of capacitors under test shall be achieved in less than 100 microseconds.

Test circuit (see [figure 2](#)):

Series resistance: The total dc resistance (excluding the capacitor) including the wiring, fuse, fixturing and output impedance of the regulated power supply to each test position during the charging cycle shall be 1.0 ohm, maximum.

Energy storage bank: The energy storage bank shall consist of a single or multiple electrolytic capacitor(s), of the ultra-low impedance type. The capacitor(s) shall have a minimum capacitance value of 20,000 μ F and have a working voltage equal to or higher than the rated dc voltage of the capacitors under test.

Power supply: The power supply shall be capable of supplying the specified rated dc voltage for the capacitors under test at a minimum current level of 15 amps.

Each capacitor under test shall have a 1 to 5 ampere fuse connected in series.

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Procedure: Capacitors shall be placed in the chamber at the specified temperature, in such a position with respect to the air stream that there is substantially no obstruction to the flow of air across and around the capacitors. The capacitors shall be soaked for a minimum of 1/2 hour or until all capacitors have stabilized to the chamber temperature. The first temperature to be tested shall be -55°C. The test sequence shall consist of 10 cycles at -55°C and 10 cycles at +85°C. A cycle shall consist of closing the switch (see [figure 2](#)) and allowing the capacitors under test to charge and discharge through 1.0 ohm, maximum.

Failure criteria: Any blown fuse or out of spec (DCL at +25°C) conditions or visible indications of damage shall reject the capacitor.

Measurements after test:

DCL: See [table I](#).

Cap.: Shall be within the tolerance specified (see [table I](#)).

DF: See [table I](#).

System check: System shall be checked at the beginning of each 8 hour shift. The necessary minimum level of resistance (R) and inductance (L) are achieved when the peak surge current level of a single CSS style capacitor (330 μ F at 6 WV dc) is at least 18 amperes when tested at 6 WV dc. A dc resistance measurement shall be used for calibration purposes.

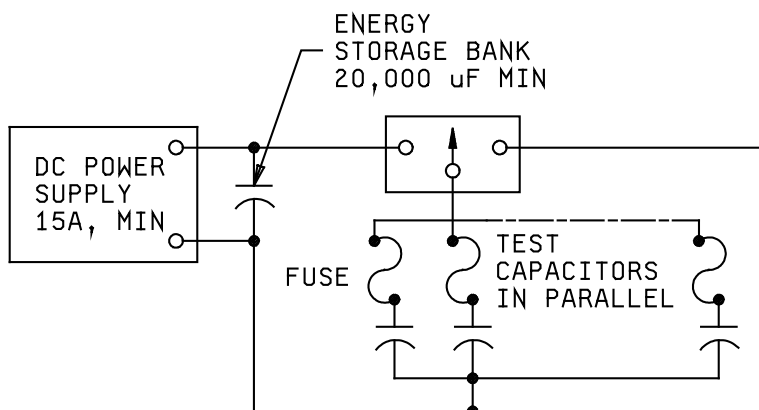


FIGURE 2. Typical surge current test circuit.

Weibull FR level grading: Capacitors shall be subjected to an accelerated voltage test in accordance with [MIL-PRF-39003](#), except the time shall be 168 hours minimum. After testing there shall be no visible damage and the part shall meet the following:

DCL: See [table I](#).

Cap.: Shall be within the tolerance specified (see [table I](#)).

DF: See [table I](#).

ESR: See [table I](#).

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Life: In accordance with [MIL-PRF-39003](#).

At 240, 1,000, and 2,000 hours:

At +25°C (as applicable):

DCL: Shall not exceed 200 percent of the initial limit (see [table I](#)).

Capacitance: Shall not change more than ± 5 percent of initial measured value.

DF: See [table I](#).

ESR (after 240 and 2,000 hours): See [table I](#).

At +85°C:

DCL: See [table I](#).

At +125°C:

DCL: See [table I](#).

Marking: In accordance with [MIL-PRF-39003](#).

TABLE I. Electrical characteristics and PINs.

Cap.	Cap. tolerance	DC leakage			DF 1 kHz +25°C	ESR 100 kHz +25°C	Ripple current 40 kHz +25°C	Derated ripple current 1 kHz +25°C	Case size	PIN M39003/11- 1/ FRL for (%/1,000 hours)	
		+25°C	+85°C	+125°C						B (0.1)	C (0.01)
μF	$\pm\%$	μA	μA	μA	%	Ω (max)	A (max)	A (max)			
6 V _{dc}											
150	5	4.5	90	113	10	0.065	3.3	2	C	2001-	3001-
150	10	4.5	90	113	10	0.065	3.3	2	C	2002-	3002-
150	20	4.5	90	113	10	0.065	3.3	2	C	2003-	3003-
180	5	5.5	110	138	10	0.06	3.4	2.4	C	2004-	3004-
180	10	5.5	110	138	10	0.06	3.4	2.4	C	2005-	3005-
270	5	6.5	130	163	10	0.05	4.1	3.4	D	2006-	3006-
270	10	6.5	130	163	10	0.05	4.1	3.4	D	2007-	3007-
330	5	7.5	150	188	12	0.045	4.3	3.8	D	2008-	3008-
330	10	7.5	150	188	12	0.045	4.3	3.8	D	2009-	3009-
330	20	7.5	150	188	12	0.045	4.3	3.8	D	2010-	3010-
10 V _{dc}											
82	5	4	80	100	8	0.085	2.9	1.8	C	2011-	3011-
82	10	4	80	100	8	0.085	2.9	1.8	C	2012-	3012-
100	5	5	100	125	8	0.075	3	2.2	C	2013-	3013-
100	10	5	100	125	8	0.075	3	2.2	C	2014-	3014-
100	20	5	100	125	8	0.075	3	2.2	C	2015-	3015-
120	5	6	120	150	8	0.07	3.2	2.5	C	2016-	3016-
120	10	6	120	150	8	0.07	3.2	2.5	C	2017-	3017-
180	5	9	180	226	8	0.06	3.7	3.4	D	2018-	3018-
180	10	9	180	226	8	0.06	3.7	3.4	D	2019-	3019-
220	5	10	200	250	10	0.055	3.9	3.4	D	2020-	3020-
220	10	10	200	250	10	0.055	3.9	3.4	D	2021-	3021-
220	20	10	200	250	10	0.055	3.9	3.4	D	2022-	3022-

See footnote at end of table.

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TABLE I. Electrical characteristics and PINs - Continued.

Cap.	Cap. tolerance	DC leakage			DF 1 kHz +25°C	ESR 100 kHz +25°C	Ripple current 40 kHz +25°C	Derated ripple current 1 kHz +25°C	Case size	PIN M39003/11- 1/ FRL for (%/1,000 hours)	
		+25°C	+85°C	+125°C						B (0.1)	C (0.01)
μF	±%	μA	μA	μA	%	Ω (max)	A (max)	A (max)			
15 V _{dc}											
56	5	4	80	100	6	0.1	2.6	1.8	C	2023-	3023-
56	10	4	80	100	6	0.1	2.6	1.8	C	2024-	3024-
68	5	5	100	125	6	0.095	2.7	2.2	C	2025-	3025-
68	10	5	100	125	6	0.095	2.7	2.2	C	2026-	3026-
68	20	5	100	125	6	0.095	2.7	2.2	C	2027-	3027-
120	5	9	180	226	8	0.07	3.5	2.8	D	2028-	3028-
120	10	9	180	226	8	0.07	3.5	2.8	D	2029-	3029-
150	5	10	200	250	8	0.065	3.6	3.1	D	2030-	3030-
150	10	10	200	250	8	0.065	3.6	3.1	D	2031-	3031-
150	20	10	200	250	8	0.065	3.6	3.1	D	2032-	3032-
20 V _{dc}											
27	5	2.5	50	63	5	0.145	2.2	1.2	C	2033-	3033-
27	10	2.5	50	63	5	0.145	2.2	1.2	C	2034-	3034-
33	5	3.5	70	88	5	0.13	2.3	1.4	C	2035-	3035-
33	10	3.5	70	88	5	0.13	2.3	1.4	C	2036-	3036-
33	20	3.5	70	88	5	0.13	2.3	1.4	C	2037-	3037-
39	5	4	80	100	5	0.12	2.4	1.7	C	2038-	3038-
39	10	4	80	100	5	0.12	2.4	1.7	C	2039-	3039-
47	5	4.5	90	113	6	0.11	2.5	1.8	C	2040-	3040-
47	10	4.5	90	113	6	0.11	2.5	1.8	C	2041-	3041-
47	20	4.5	90	113	6	0.11	2.5	1.8	C	2042-	3042-
56	5	5.5	110	138	6	0.1	2.9	2.2	D	2043-	3043-
56	10	5.5	110	138	6	0.1	2.9	2.2	D	2044-	3044-
68	5	7	140	175	6	0.095	3	2.4	D	2045-	3045-
68	10	7	140	175	6	0.095	3	2.4	D	2046-	3046-
68	20	7	140	175	6	0.095	3	2.4	D	2047-	3047-
82	5	8	160	200	6	0.085	3.1	2.5	D	2048-	3048-
82	10	8	160	200	6	0.085	3.1	2.5	D	2049-	3049-
100	5	10	200	250	8	0.075	3.3	2.5	D	2050-	3050-
100	10	10	200	250	8	0.075	3.3	2.5	D	2051-	3051-
100	20	10	200	250	8	0.075	3.3	2.5	D	2052-	3052-
35 V _{dc}											
22	5	4	80	100	4	0.16	2.1	1.5	C	2053-	3053-
22	10	4	80	100	4	0.16	2.1	1.5	C	2054-	3054-
22	20	4	80	100	4	0.16	2.1	1.5	C	2055-	3055-
27	5	4.5	90	113	4	0.145	2.4	1.9	D	2056-	3056-
27	10	4.5	90	113	4	0.145	2.4	1.9	D	2057-	3057-
33	5	5.5	110	138	5	0.13	2.5	1.9	D	2058-	3058-
33	10	5.5	110	138	5	0.13	2.5	1.9	D	2059-	3059-
33	20	5.5	110	138	5	0.13	2.5	1.9	D	2060-	3060-
39	5	7	140	175	5	0.12	2.6	2	D	2061-	3061-
39	10	7	140	175	5	0.12	2.6	2	D	2062-	3062-
47	5	8	160	200	5	0.11	2.7	2.2	D	2063-	3063-
47	10	8	160	200	5	0.11	2.7	2.2	D	2064-	3064-
47	20	8	160	200	5	0.11	2.7	2.2	D	2065-	3065-
50 V _{dc}											
5.6	5	2.2	45	56	3	0.3	1.5	0.6	C	2066-	3066-
5.6	10	2.2	45	56	3	0.3	1.5	0.6	C	2067-	3067-
6.8	5	2.2	45	56	3	0.275	1.6	0.7	C	2068-	3068-
6.8	10	2.2	45	56	3	0.275	1.6	0.7	C	2069-	3069-
6.8	20	2.2	45	56	3	0.275	1.6	0.7	C	2070-	3070-

See footnote at end of table.

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TABLE I. Electrical characteristics and PINs - Continued.

Cap.	Cap. tolerance	DC leakage			DF 1 kHz +25°C	ESR 100 kHz +25°C	Ripple current 40 kHz +25°C	Derated ripple current 1 kHz +25°C	Case size	PIN M39003/11- 1/ FRL for (%/1,000 hours)	
		+25°C	+85°C	+125°C						B (0.1)	C (0.01)
μF	±%	μA	μA	μA	%	Ω (max)	A (max)	A (max)			
50 V _{dc} - continued.											
8.2	5	2.5	50	63	3	0.25	1.6	0.9	C	2071-	3071-
8.2	10	2.5	50	63	3	0.25	1.6	0.9	C	2072-	3072-
10	5	2.5	50	63	3	0.23	1.7	1.1	C	2073-	3073-
10	10	2.5	50	63	3	0.23	1.7	1.1	C	2074-	3074-
10	20	2.5	50	63	3	0.23	1.7	1.1	C	2075-	3075-
12	5	3	60	75	3	0.21	1.8	1.3	C	2076-	3076-
12	10	3	60	75	3	0.21	1.8	1.3	C	2077-	3077-
15	5	4	80	100	3	0.19	1.9	1.4	C	2078-	3078-
15	10	4	80	100	3	0.19	1.9	1.4	C	2079-	3079-
15	20	4	80	100	3	0.19	1.9	1.4	C	2080-	3080-
18	5	4.5	90	113	4	0.175	2	1.4	C	2081-	3081-
18	10	4.5	90	113	4	0.175	2	1.4	C	2082-	3082-
22	5	5.5	110	138	4	0.16	2.3	1.7	D	2083-	3083-
22	10	5.5	110	138	4	0.16	2.3	1.7	D	2084-	3084-
22	20	5.5	110	138	4	0.16	2.3	1.7	D	2085-	3085-

1/ Complete dash number shall include an additional letter that indicates the sleeving option (S for sleeved, U for unsleeved).

Qualification: A manufacturer shall be considered qualified for CSS style capacitors if they qualify to the B or C, as applicable, or better failure level of [MIL-PRF-39003](#) for the equivalent CSR style capacitors.

Inspection lot: An inspection lot shall consist of all the capacitors of a single nominal capacitance/voltage rating of one design. It shall be processed as a single lot through manufacturing steps on the same equipment, to the same revisions of the manufacturer's documentation, and identified with the same date and lot code designation. In addition, the lot shall conform to the following:

Tantalum powder and tantalum wire shall be traceable to the same raw material lot and be from the same supplier.

Production lot numbers shall provide traceability to the anode pressing lot.

The anode pressing lot shall be pressed within a 24 hour period on the same pressing machine. Further, it shall be sintered as a complete lot.

The entire inspection/production lot shall be voltage formed (same time and tank), impregnated, and otherwise processed through final sealing as a complete lot, with all parts receiving the same processing.

Traceability to the operator and the date each operation was performed shall be maintained.

Lot identity shall be maintained from the time the lot is assembled.

Lot date code shall be assigned at or before formation of dielectric (Ta₂O₅).

Traceability and documentation shall be maintained for a minimum of ten years.

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w/AMENDMENT 1

Rework: Rework shall not be allowed on any operation except for marking, sleeving, and lead rework.

Inspection of product for delivery: Inspection of product for delivery shall consist of the group A inspection herein.

Group A inspection: Group A inspection shall consist of the inspections specified in [table II](#), in the order listed, except X-ray may be performed at any point in the sequence. Failure to meet the applicable percent defective allowable (PDA) per [table II](#) shall be cause for lot rejection. Summary of group A data shall be forwarded to acquiring activity with the parts.

TABLE II. Group A inspection. [4/](#)

Examination or test	Notes	Sample size	PDA (Max) 6/
<u>Subgroup 1</u>			
X-Ray (2 views 90° apart)	1/ , 7/	100%	N/A
Thermal shock (10 cycles)	1/ , 5/	100%	N/A
Surge current	5/	100%	N/A
10 cycles at -55°C			
10 cycles at +85°C			
DC leakage at +25°C	1/	100%	N/A
Capacitance	1/	100%	5%
D.F.	1/	100%	N/A
Seal	1/	100%	N/A
Weibull FR level grading	5/	100%	N/A
DC leakage at +25°C	1/	100%	N/A
Capacitance	1/	100%	5%
ESR (100 kHz)	1/ , 2/	100%	2/
<u>Subgroup 2</u>			
Visual and mechanical inspection	3/	13 pcs	N/A
<u>Subgroup 3</u>			
Stability at low and high temperature	3/	20 pcs	N/A

[1/](#) Unless otherwise specified, requirements and/or methods in accordance with [MIL-PRF-39003](#).

[2/](#) Parts with ESR greater than specification limits shall be rejected. Parts with ESR greater than 150 percent of specified limits shall be used for computation of percent defectives.

[3/](#) Any failure shall require 100 percent examination of the lot.

[4/](#) All capacitors delivered to this specification shall meet nominal values specified in [table I](#).

[5/](#) As specified herein.

[6/](#) Overall PDA shall not exceed 10%.

[7/](#) [MIL-PRF-39003](#) X-ray pictorials shall be used with the following details and exceptions:

- Anodes may be cocked within the case, provided the pellet is not greater than 15 degrees from being parallel with the wall of the case.
- Bent tantalum riser wire is rejectable.

APPLICATION NOTES

- Rated ripple current is the rms value of the maximum allowable alternating current of a specified frequency, at which the capacitor may be operated continuously at a specified temperature. Derate ripple current for ambient temperature in accordance with the curve shown on [figure 3](#).
- For derating the frequency, use the derated ripple currents at 1 kHz given in [table I](#). Below 1 kHz these same currents are applicable provided the peak ac voltage does not result in voltage reversal or exceeds the rated dc voltage. Between 1 kHz and 40 kHz the ripple current may be interpolated linearly with frequency. The ripple current is applicable at frequencies above 40 kHz.

3. Although style CSS21 capacitors are rated to operate with the specified levels of rms ripple current, they are basically polar devices. Care must be exercised to assure that sufficient dc bias is applied to prevent ac voltage reversal in excess of specified reverse voltage ratings (see [MIL-HDBK-198](#)).
4. When two or more style CSS21 capacitors are used in parallel, ripple current may not divide equally as a result of unequal ESRs of the capacitors. It is imperative that each capacitor be operated within the specified limit of rms ripple current.

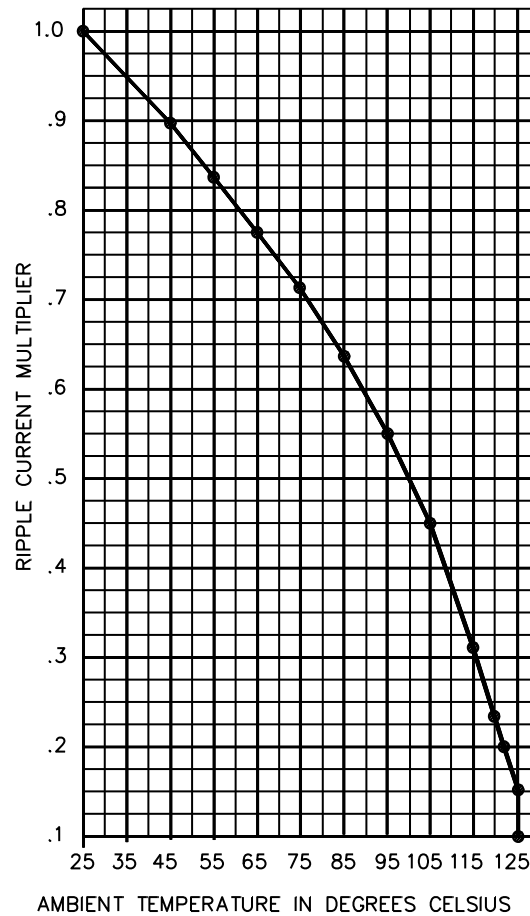


FIGURE 3. Ripple current derating with respect to temperature.

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w/AMENDMENT 1

Reference documents. In addition to [MIL-PRF-39003](#), this specification sheet references the following documents:

[MIL-HDBK-198](#)

Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

Custodians:

Army – CR
Navy – EC
Air Force – 85
DLA - CC

Preparing activity:
DLA – CC

(Project 5910-2016-029)

Review activities:

Navy – AS, MC, OS, SH
Air Force – 19, 99
Other - MDA

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil/>.