

ENGINEERING PRACTICES STUDY 1155

TITLE: STUDY TO REVIEW PROPOSALS FOR RECTIFIER T_A LIFE TEST
CONDITIONS.

31 May 2017

STUDY PROJECT

5961-2016-111

FINAL REPORT

Study Conducted by DLA LAND AND MARITIME

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ATTACH 1

I. **OBJECTIVES:** DLA Land and Maritime-VAC conducted an EP study to review the ambient life test limits for MIL-PRF-19500 rectifier specification sheets. The purpose of this EP study was to obtain input from the military services, manufacturers, and user communities to review a proposal to remove the ambient maximum temperature limit in rectifier life tests.

II. **BACKGROUND:** The existing testing flow for MIL-PRF-19500 rectifier life tests require a minimum current and voltage be applied to reach a specified T_J . In most cases the applicable specification sheet maximum current and voltage are specified as a minimum. The test also specifies a maximum T_A that the device cannot exceed. This maximum T_A was specified in the past, when no minimum current was specified, so that manufacturers were forced to use a reasonable amount of current to meet the T_J instead of just using an oven to meet the T_J .

Proposal: We received a proposal from a manufacturer to remove the maximum T_A limit that is currently in the rectifier life test conditions. This proposal is based upon a recent similar approved change to MIL-PRF-19500/533 to match the other Zener diodes. Although the MIL-PRF-19500/533 is a Zener diode, the justification is that the T_A max limit is equally irrelevant on the rectifier specification sheets that now specify the rated current.

The goal of the test method TM1027 of MIL-STD-750 is to test the devices at steady state operation while meeting a specified temperature, in this case the maximum rated T_J . If the max ratings are used and the T_J minimum is met, it was suggested that the T_A max requirement is only limiting the board design, with no benefit to the test itself.

During testing, the specified I_o is achieved and exceeded, the T_J is achieved, and the manufacturer is performing the test at 1000 hours and 340 hours respectively for conformance inspection testing. Currently with the maximum T_A in place, the manufacturer is having to exceed the specified I_o to meet the minimum T_J because they are limited to a maximum T_A of 55°C. The only other option would be for the manufacturer to redesign their testing boards.

Attachment 1 is a marked up copy of the affected portion of MIL-PRF-19500/477 showing the requested changes. This will be considered applicable to all rectifiers using a similar life test format.

III. **RESULTS:** The comments submitted to DLA Land and Maritime have been reviewed and indicate that the proposed recommendations should be used as the basis for the proposed changes in the applicable specification sheets.

IV. **CONCLUSIONS:** Based on the proposal and the comments received, the T_A maximum limit is not needed for the life test conditions when the specification maximum current and maximum voltage are specified as a minimum requirement for the life test.

V. **RECOMMENDATIONS:** DLA Land and Maritime recommends that the proposed changes outlined in **Attachment 1** in this study be used as a basis for updating applicable rectifier specification sheets.

ATTACHMENT 1:

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and [table I](#) herein. The $Z_{\theta JX}$ end-point shall be derived by the supplier and approved by the qualifying activity. This $Z_{\theta JX}$ end-point shall also be documented in the qualification report.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in appendix E, table E-VIA (JANS) and table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and herein. See [table III](#) herein for delta measurements when applicable.

4.4.2.1 Quality level JANS (see table E-VIA of MIL-PRF-19500).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	4066	Condition A, IFSM = rated IFSM (see col. 5 of 1.3.2); ten surges of 8.3 ms each at 1 minute intervals, superimposed on IO1 (See col. 4 of 1.3.2), V_{RWM} = rated, see col. 2 of 1.3.2 . $T_A=25^{\circ}\text{C}$.
B4	1037	$I_O = I_{O1}$ rated minimum (see 1.3.2); V_R = rated V_{RWM} (see 1.3.2 and 4.5.3 and 4.5.3.1); 2,000 cycles.
B5	1027	$I_O = I_{O1}$ rated minimum (see col. 4 of 1.3.2); apply V_R = rated V_{RWM} (see col. 2 of 1.3.2 , and 4.5.3 and 4.5.3.1) adjust I_O or T_A to achieve $T_J = 175^{\circ}\text{C}$ minimum; $n = 45$, $c = 0$; $t = 1,000$ hours; $f = 50 - 60$ Hz. $T_A=55^{\circ}\text{C max.}$ For irradiated devices, include t_{rr} as an end-point measurement.
B8	4065	Peak reverse power: For 1N5802 - 1N5806, $P_{RM} \geq 318$ W for square wave in accordance with TM 4065 ($P_{RM} \geq 500$ W for half sine-wave). For 1N5807 - 1N5811, $P_{RM} \geq 636$ W for square wave in accordance with TM 4065 ($P_{RM} \geq 1,000$ W for half sine-wave). Test shall be performed on each subplot; sampling plan: $n = 10$, $c = 0$, electrical end-points, see table I , subgroup 2 herein.

4.4.2.2 Quality levels JAN, JANTX and JANTXV (see table E-VIB of MIL-PRF-19500).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$I_O = I_{O1}$ rated minimum (see col. 4 of 1.3.2); adjust I_O or T_A to achieve $T_J = 150^{\circ}\text{C}$ minimum, apply V_R = rated V_{RWM} (see col. 2 of 1.3.2), $f = 50 - 60$ Hz (see 4.5.3 and 4.5.3.1). $T_A=55^{\circ}\text{C (max.)}$. For irradiated devices, include t_{rr} as an end-point measurement.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-VII of MIL-PRF-19500. See [table III](#) herein for delta measurements when applicable.

4.4.3.1 Group C inspection, appendix E, table E-VII of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Axial devices – Tension: Condition A, 12 pounds (5.44 Kg), t = 15s for 1N5802, 1N5804, 1N5806. Condition A, 20 pounds (9.07 Kg), t = 15s for - 1N5807, 1N5809, 1N5811. Fatigue: Condition E for all types, 2 pounds (0.91 Kg). (Lead fatigue is not applicable to US diodes).
C2	2038	US, URS devices – Tension: Condition B, 12 pounds (5.44 Kg), t = 15s for 1N5802US, 1N5804US, 1N5806US. Condition B, 20 pounds (9.07 Kg), t = 15s for 1N5807US, 1N5809US, 1N5811US.
C5	4081	$R_{\theta JL}$ (maximum) see col. 8 of 1.3.2 and 4.3.1 herein. L = .375 inch (9.53 mm). For surface mount devices (US version), $R_{\theta JC}$, see col. 9 of 1.3.2 and 4.3.1 herein.
C6	1027	$I_O = I_{O1}$ rated minimum (see col. 4 of 1.3.2); adjust I_O or T_A to achieve $T_J = 150^\circ\text{C}$ minimum, apply VR = rated VRWM (see col. 2 of 1.3.2), f = 50 - 60 Hz (see 4.5.3 and 4.5.3.1). $T_A = 55^\circ\text{C (max)}$. For irradiated devices, include t_{rr} as an end-point measurement.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-IX of MIL-PRF-19500 and as specified herein. See [table III](#) herein for delta measurements when applicable.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Scope display evaluation. Scope display evaluation shall be stable in accordance with method 4023 of MIL-STD-750, condition A. Scope display may be performed on ATE (automatic test equipment) for screening only with the approval of the qualifying activity. Scope display in [table I](#), subgroup 4 shall be performed on a curve tracer. The reverse current (I_{BR}) over the knee shall be 500 μA peak.

4.5.3 Burn-in and life tests. These tests shall be conducted with a half-sine waveform of the specified peak voltage impressed across the diode in the reverse direction followed by a half-sine waveform of the specified average rectified current. The forward conduction angle of the rectified current shall be neither greater than 180 degrees, nor less than 150 degrees.

4.5.3.1 Burn-in. The use of a current limiting or ballast resistor is permitted provided that each DUT still sees the I_O and that the minimum required voltage, where applicable, is maintained through-out the burn-in period. Use method 3100 of MIL-STD-750 to measure T_J . $T_J = 135^\circ\text{C}$ minimum for screening and 150°C minimum for life tests. $T_A = 55^\circ\text{C max}$

4.5.4 Thermal resistance. Thermal resistance measurement shall be performed in accordance with method 4081 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , and t_H . See table E-IX of MIL-PRF-19500, subgroup 4, and figures 6, 7, 8, and 9 herein. Forced moving air or draft shall not be permitted across the devices during test.