

The documentation and process conversion measures necessary to comply with this revision shall be completed by 1 November 1999

INCH-POUND

MIL-PRF-19500/308C
1 August 1999
SUPERSEDING
MIL-S-19500/308B
7 April 1989

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST-RECOVERY
TYPES 1N3909, 1N3910, 1N3911, 1N3912, 1N3913, R AND A VERSIONS
JAN, JANTX, AND JANTXV

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

1. SCOPE

1.1 Scope. This specification covers the performance requirements for silicon, semiconductor fast recovery, power rectifier diodes. Three levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (DO-5).

1.3 Maximum ratings.

Types	V_R	V_{RWM}	I_O ^{1/} $T_C = 100^\circ C$	I_f (surge) at 1/120 s $T_C = 100^\circ C$	t_{rr}
	<u>V dc</u>	<u>V (pk)</u>	<u>A dc</u>	<u>A dc</u>	<u>ns</u>
1N3909, R	50	50	30	300	200
1N3909A, AR	50	50	50	400	150
1N3910, R	100	100	30	300	200
1N3910A, AR	100	100	50	400	150
1N3911, R	200	200	30	300	200
1N3911A, AR	200	200	50	400	150
1N3912, R	300	300	30	300	200
1N3912A, AR	300	300	50	400	150
1N3913, R	400	400	30	300	200
1N3913A, AR	400	400	50	400	150

^{1/} Derate linearly, 2 percent of I_O per $^\circ C$ for $T_C > 100^\circ C$.

Storage temperature: $T_C = -65^\circ C$ to $+175^\circ C$,

Operating temperature: $T_C = -65^\circ C$ to $+150^\circ C$,

Barometric pressure reduced (altitude operation): 8 mmHg.

1.4 Primary electrical characteristics. $R_{\theta JC} = 0.8^\circ C/W$ maximum.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad St., Columbus, OH 43216-5000, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 and 4 of this specification, whether or not they are listed.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

FEDERAL

FED-STD-H28 - Screw Thread Standards for Federal Services.

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (DO-5) herein.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500. Where a choice of lead finish is desired, it shall be specified in the contract or purchase order (see 6.2).

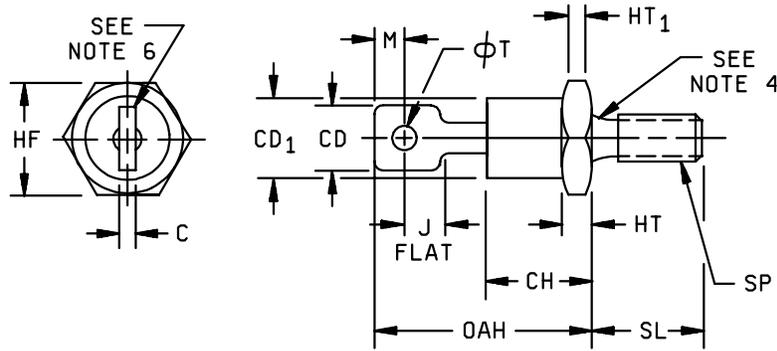
3.4 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.4.1 Polarity. The polarity shall be indicated by a graphic symbol with the arrow pointing toward the negative end for forward bias. The reversed units shall also be marked with an R following the last digit in the type number.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturer's list before contract award (see 4.2 and 6.3).



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
C	0.030	0.080	0.76	2.03
CD	0.250	0.375	6.35	9.52
CD ₁		0.667		16.94
CH		0.450		11.43
HF	0.669	0.688	16.99	17.48
HT	0.115	0.200	2.93	5.08
HT ₁	0.060		1.53	
J	0.156		3.97	
M	0.030		0.77	
OAH	0.750	1.000	19.05	25.40
ØT	0.140	0.175	3.56	04.44
SL	0.422	0.453	10.72	11.50
SP	.250-28 UNF-2A THD NF optional		6.35-28 UNF-2A THD NF optional	

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Units must not be damaged by torque of 30 inch-pounds applied to 0.250-28 UF-2B nut assembled on thread.
4. Diameter of unthreaded portion 0.249 inch (6.32 mm) max and 0.220 inch (5.59 mm) minimum.
5. Complete threads to extend to within 2.5 threads of seating plane.
6. Angular orientation for this terminal is underlined, however the major surfaces over dimension CD shall be flat and the minimum distance from the hole to any point on the periphery shall be 0.030 inch (0.76 mm) outside dimension J.
7. Max pitch diameter of plated threads shall be basic pitch diameter 0.2268 inch (5.76 mm) reference FED-STD-H28.
8. (Screw Thread Standards for Federal Services.)
9. A chamfer or undercut on one or both ends of the hex portion is optional: Minimum bas diameter at seating plane. 0.600 inch (15.24 mm).
10. Reversed (anode to stud) units shall be marked with an R following the last digit in the type number.

FIGURE 1. Physical dimensions (DO – 5).

4. VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3)
- c. Conformance inspection (see 4.4).

4.1.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-PRF-19500 and herein, except lot accumulation period shall be 3 months in lieu of 6 weeks.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening. Screening shall be in accordance with table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurements
	JANTX and JANTXV levels
1/	Surge, see 4.3.1 Thermal response, see 4.3.2
4	Not applicable
9	V_{F2} and I_{R1} 2/
10	MIL-STD-750, method 1038 test condition A, t = 48 hours
11 3/	Subgroup 2 of table I herein V_{F2} and I_{R1} ; $\Delta V_{F2} = \pm 0.1$ v(pk); $\Delta I_{R1} = \pm 5$ μ A dc or 100 percent from the initial value, whichever is greater.
12	Not applicable
13	Not applicable

1/ Surge shall precede thermal response. These tests shall be performed anytime after screen 3 and before screen 9.

2/ I_{R1} measurement shall not be indicative of an open condition.

3/ PDA of screen 13 shall apply to screen 11.

4.3.1 Surge current. Surge current, see MIL-STD-750, method 4066. $I_O = 0$; $V_{RM(w)} = 0$; Non-A version, $I_{F(surge)} = 400$ A; A version, $I_{F(surge)} = 500$ A; six surges; $T_A = 25^\circ\text{C}$; $t_p = 8.3$ ms

4.3.2 Thermal response. The thermal response measurements shall be performed in accordance with method 3101 of MIL-STD-750. The thermal response conditions and maximum thermal response limit shall be derived by each vendor. The chosen thermal response measurement and conditions for each device in the qualification lot shall be submitted in the qualification report and a thermal response curve shall be plotted. The chosen thermal response values shall be considered final after the manufacturer has had the opportunity to test five consecutive lots. Heating current (I_H) \geq rated I_O ; $t_H = 150$ to 400 ms; $t_{MD} = 50$ to 300 μ s; 50 mA $\leq I_M \leq 250$ mA.

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

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4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.1 herein. . Electrical measurements (end-points) shall be in accordance with subgroup 2 of table I herein. Delta measurements shall be in accordance with table II herein.

4.4.2.1 Group B inspection, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	4066	Non-A version devices: $T_C = 100^\circ\text{C}$; $V_R = \text{Rated } V_{RM}$ (see 1.3), six surges. 1 surge per minute maximum. $t_p = 8.3 \text{ ms}$. $i_f(\text{surge}) = 300 \text{ A}$; $I_O = 30 \text{ A dc}$
B2	4066	A version devices: $T_C = 100^\circ\text{C}$; $V_R = \text{Rated } V_{RM}$ (see 1.3), six surges. 1 surge per minute maximum. $t_p = 8.3 \text{ ms}$. $i_f(\text{surge}) = 400 \text{ A}$; $I_O = 50 \text{ A dc}$
B3	1037	0.25 Rated $I_O \leq I_O$ applied \leq Rated I_O (see 4.5.1) 2,000 cycles, $T_A \leq 35^\circ\text{C}$.
B3	1038 or 1049	Condition A; 340 hrs.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500 and 4.4.3.1 herein. Electrical measurements (end-points) shall be in accordance with subgroup 2 of table I herein. Delta measurements shall be in accordance with table II herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition F, method B, Weight = 15 pounds, $t = 15\text{s}$.
C2	2036	Test condition D1, seal torque = 3 pound-inches, $t = 15\text{s}$.
C2	2036	Test condition D2, stud torque = 30 pound-inches, $t = 15\text{s}$.
C6	1037	0.25 Rated $I_O \leq I_O$ applied \leq Rated I_O (see 4.5.1) 6,000 cycles. $T_A \leq 35^\circ\text{C}$.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with subgroup 2 of table I herein. Delta measurements shall be in accordance with table II herein.

4.4.4.1 Group E inspection, table IX of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>	<u>Sampling plan</u>
E1	1056	0°C to 100°C, 100 cycles.	22 devices, c = 0
E2	1038	Condition A; 1,000 hrs.	22 devices, c = 0
E3	2101	Photos of cross sections shall be submitted In the qualification report. Vendors shall Retain duplicate photos.	3 devices, c = 0
E4	3101	$R_{\theta JC} = 0.8^{\circ}\text{C}/\text{W}$ maximum; $I_M = 50$ mA to 250 mA; $I_H \geq$ rated I_O ; $t_H = 150$ to 400 ms; $t_{MD} = 50$ to 300 μs	22 devices, c = 0
E5	1001	$t = 60$ s, While the test is being performed, I_R shall be monitored and shall not exceed group A limits. $T_C = 25^{\circ}\text{C}$. 1N3912, 8 mmHg; $V = 300$ Vdc. 1N3913, 8 mmHg; $V = 400$ Vdc.	22 devices, c = 0

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

4.5.1 DC intermittent operation life. A cycle shall consist of an "on" period, when power is applied suddenly, not gradually, to the device for the time necessary to achieve a delta case temperature of $85^{\circ}\text{C} +15^{\circ}\text{C}$, -5°C followed by an "off" period, when the power is suddenly removed, for cooling. Auxiliary (forced) cooling is permitted during the "off" period only. The heating time is such that $30 \text{ s} \leq t_{\text{heating}} \leq 60 \text{ s}$. $P = V_F \times I_F$ or $P = V_{F(pk)} \times I_{av}$ if using sine wave current. DC full wave current (or equivalent half sine wave current) shall be used for the power required during the "on" period and equivalent half sine wave is permissible.

Within the time interval of 50 cycles before to 500 cycles after the termination of the test, the sample units shall be removed from the specified test conditions and allowed to reach room ambient conditions. Specified end-point measurements for qualification and quality conformance inspections shall be completed within 96 hours after removal of sample units from the specified test conditions. Additional readings may be taken at the discretion of the manufacturer.

4.5.2 Reverse recovery time. The reverse recovery time shall be measured in the circuit of figure 2 or equivalent. Care should be exercised to minimize stray inductances in the test circuit and to ensure the total resistance of the reverse current loop can be adjusted sufficiently low so that more than 2 amperes will flow if not blocked by the diode being tested. Switch SW shall be activated and the regulated voltage source adjusted to achieve the following characteristics of the waveform.

- The di/dt shall be the specified value between the forward 0.5 ampere point and the reverse 0.2 ampere point.
- The $i_r(\text{rec})$ shall be the maximum value obtainable, except when it exceeds 2 amperes.

The reverse-recovery time shall then be determined from the current waveform as shown on figure 3.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Forward voltage	4011	$t_p \leq 8.3$ ms, duty cycle ≤ 2 percent pulse; $i_f = 50$ A(pk)	V_{F2}		1.40	V (pk)
Reverse current	4016	DC method, $V_R =$ rated V_R (see 1.3)	I_{R1}	---	15	μ A dc
<u>Subgroup 3</u>						
High temperature operation:		$T_C = 150^\circ\text{C}$				
Reverse current	4016	DC method, $V_R =$ rated V_R (see 1.3)	I_{R2}	---	6.0	mA dc
<u>Subgroup 4</u>						
Reverse recovery time	4031	$I_F = 1$ A dc; $V_R = 30$ V dc; $di/dt = -25$ A/ μ s $i_r(\text{rec}) \leq 2$ A(pk) See 4.5.2 See figures 2 and 3				
Non A-versions			t_{rr}	---	200	ns
A-versions			t_{rr}	---	150	ns
<u>Subgroup 5</u>						
Forward voltage	4011	$I_F = I_{F(\text{surge})}$, $t_p = 800$ μ s	V_{F1}		2.75	V dc
Forward voltage	4011	$I_F = I_{F(\text{surge})}$, $t_p = 8.3$ ms	V_{F1}		2.55	V dc

1/ For sampling plan, see MIL-PRF-19500.

2/ V_{F1} shall be performed with either $t_p = 800$ μ s or $t_p = 8.3$ ms.

TABLE II. Groups A, B, C and E delta electrical end-point measurements. 2/ 3/ 4/

Step	Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Thermal response	3101	See 4.3.2	ΔV_F			mV dc

1/ Devices which exceed the group A limits for this test shall be rejected.

2/ The delta electrical measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows:

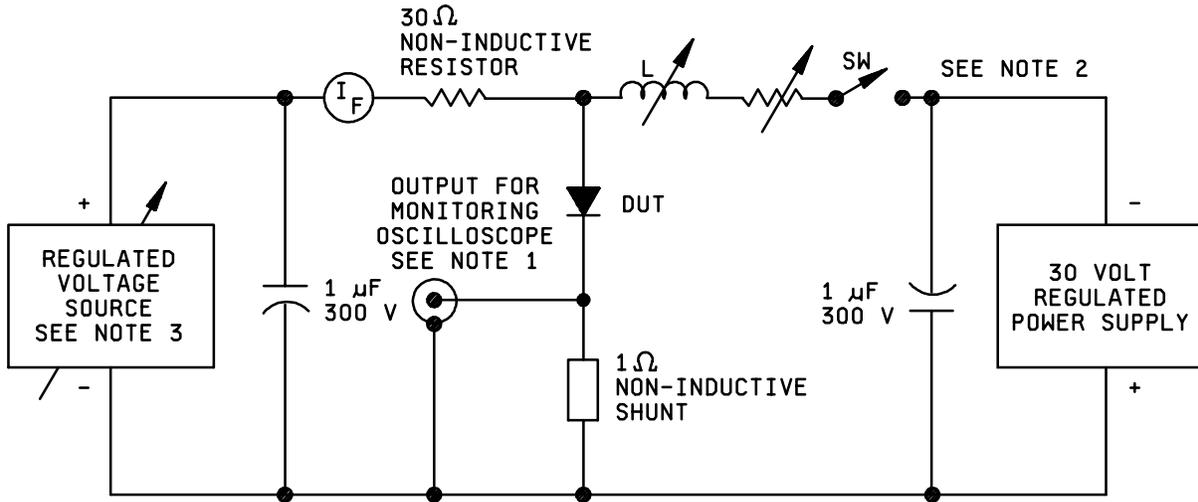
a. Subgroup 3, see table II herein, step 1.

3/ The delta electrical measurements for table VII of MIL-PRF-19500 are as follows:

a. Subgroup 2, see table II herein, step 1.

4/ The delta electrical measurements for table IX of MIL-PRF-19500 are as follows:

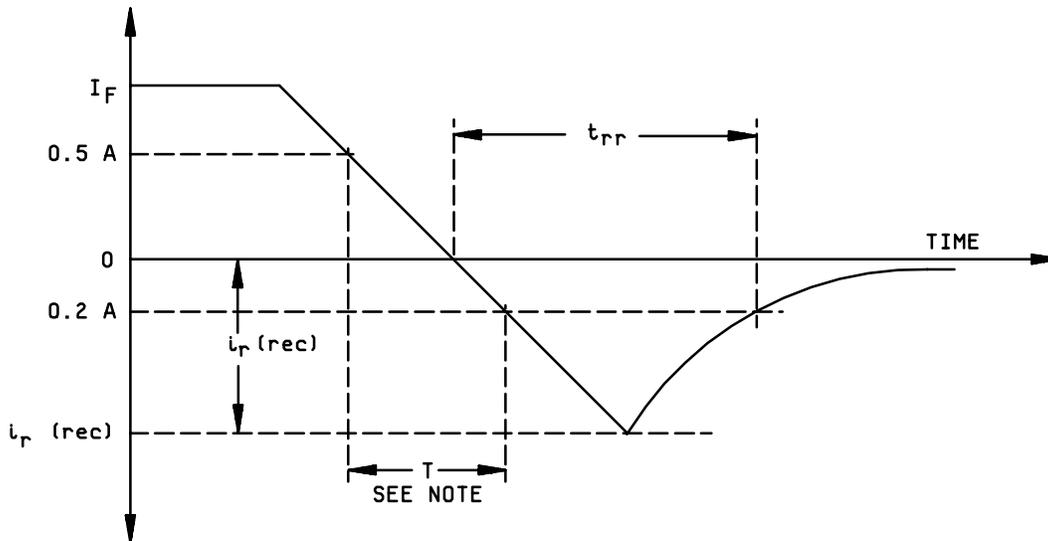
a. Subgroup 1, see table II herein, step 1.



NOTES:

1. Monitoring oscilloscope requirements: $t_r \leq 14 \text{ ns}$, $R_{in} \geq 9 \text{ M}\Omega$, $C_{in} \leq 12 \text{ pF}$, $L_{in} \text{ (series)} \leq 0.5 \text{ }\mu\text{H}$.
2. SW characteristics: Mercury-wetted make-before-break relay switched at a 60 Hz rate. The relay should conduct for approximately 640 μs and be open for approximately 7.7 ms. (C.P. Clare HGP 1004 or equivalent.)
3. Voltage source characteristics: Output impedance $\leq 0.5 \text{ }\Omega$ from 0 to 2 kHz.

FIGURE 2. Reverse recovery test circuit.



NOTE:

Adjust L and R in accordance with 4.5.2 to achieve $T = 0.028 \text{ }\mu\text{s}$ ($L = 1.2 \text{ }\mu\text{H}$). Then $\frac{di}{dt} = \frac{-0.7}{.028} = \frac{-25 \text{ A}}{\mu\text{s}}$.

FIGURE 3. Reverse recovery current waveform through device under test.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements should be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Issue of DODISS to be cited in the solicitation (see 2.1.1).
- b. The lead finish as specified (see 3.3.1).
- c. Type designation and quality assurance level.
- d. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturer's List QML-19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, Columbus, OH 43216.

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC
(Project 5961-2135)

Review activities:
Army - AR, MI, SM
Navy - AS, CG, MC, OS
Air Force - 19, 99

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-19500/308C

2. DOCUMENT DATE
990801

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST-RECOVERY TYPES 1N3909, 1N3910, 1N3911, 1N3912, 1N3913, R AND A VERSIONS JAN, JANTX, AND JANTXV

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
COMMERCIAL
DSN
FAX
EMAIL

7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. Point of Contact
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43216-5000

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