

METRIC

MIL-S-19500/594  
29 October 1993

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER,  
FAST RECOVERY, LOW LEAKAGE, TYPES 1N6664 THRU 1N6666, AND 1N6664R THRU 1N6666R  
JAN, JANTX, JANTXV, AND JANS

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 detail requirements for a silicon, fast recovery power rectifier diodes. Three levels of product assurance are provided for each device type as specified in MIL-S-19500. See 6.3.1 for JAN level.

1.2 Physical dimensions. See figure 1 (T0-257AA).

1.3 Maximum ratings (per leg).

Types	$V_R$ and $V_{RVM}$	$T_C = I_O \frac{1}{100^\circ C}$	$T_C = \frac{I_{FSM}}{100^\circ C}$ $t_p = 8.3 \text{ ms}$	$t_{rr}$
	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>ns</u>
1N6664, 1N6664R	100	10	100	35
1N6665, 1N6665R	150	10	100	35
1N6666, 1N6666R	200	10	100	35

- 1/ Derate linearly, 100 mA/°C from +100°C to +200°C.  
Storage temperature:  $T_{STG} = -65^\circ C$  to  $+200^\circ C$ .  
Operating temperature:  $T_J = -65^\circ C$  to  $+200^\circ C$ .  
Barometric pressure reduced (altitude operation): 8 mmHg.  
 $R_{\theta JC} = 2.5^\circ C/W$  maximum.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

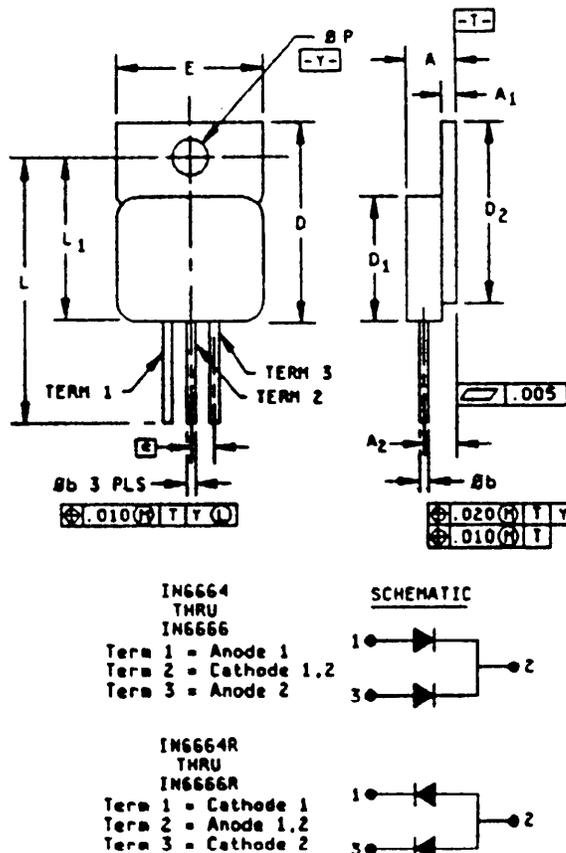
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-EC, 1507 Wilmington Pike, Dayton, OH 45444-5270, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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FSC 5961

Ltr	Dimensions			
	Millimeters		Inches	
	Min	Max	Min	Max
A	4.83	5.08	.190	.200
A <sub>1</sub>	0.89	1.14	.035	.045
A <sub>2</sub>	3.05 BSC		.120 BSC	
D	16.38	16.89	.645	.665
D <sub>1</sub>	10.41	10.92	.410	.430
D <sub>2</sub>	15.06	15.42	.593	.607
e	2.54 BSC		.100 BSC	
E	10.41	10.67	.410	.420
L	26.21	28.75	1.032	1.132
L <sub>1</sub>	13.39	13.64	.527	.537
φP	3.56	3.81	.140	.150
φb	0.64	0.89	.025	.035
Term 1	See Schematic			
Term 2	See Schematic			
Term 3	See Schematic			



NOTES:

1. Dimensions are in millimeters.
2. Inch equivalents are given for general information only.
3. Glass meniscus included in dimension D and D<sub>1</sub>.

FIGURE 1. Dimensions and configuration (TO-257AA).

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

MILITARY

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

STANDARDS

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, Building 40, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

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

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and on figure 1 herein. Plastic packages are prohibited. The US governments preferred system of measurement is the metric SI system. However, since this item was originally designed using inch-pound units of measurement, in the event of conflict between the metric and inch-pound units, the inch-pound units shall take precedence.

3.3.1 Lead material and finish. Lead material shall be copper clad steel with a minimum of 70 percent copper by weight. Lead finish shall be in accordance with MIL-S-19500 and MIL-STD-750. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

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

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

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

4.2.1 Construction verification. Cross sectional photos from three devices shall be submitted in the qualification report.

4.3 Screening (JANTX, JANTXV, and JANS levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
3c 1/	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
4	$Y_1$ at 10,000 G	Not applicable
9	Not applicable	Not applicable
11	Subgroup 2 of table I herein; $V_{F2}$ and $I_{R1}$	Subgroup 2 of table I herein; $V_{F2}$ and $I_{R1}$
12	See 4.3.1, MIL-STD-750, method 1038, test condition A, $t = 96$ hours	See 4.3.1, MIL-STD-750, method 1038, test condition A, $t = 48$ hours
13	Subgroups 2 and 3 of table I herein; $\Delta V_{F2} = \pm 0.05$ V (pk); $\Delta I_{R1} = 150$ nA dc or 100% of the initial value, whichever is greater.	Subgroup 2 of table I herein; $\Delta V_{F2} = \pm 0.05$ V (pk); $\Delta I_{R1} = 150$ nA dc or 100% of the initial value, whichever is greater.

1/ Thermal impedance shall be performed any time after sealing provided. Temperature cycling is performed in accordance with MIL-S-19500, screen 3 prior to this thermal impedance.

4.3.1 Burn-in conditions. Burn-in conditions are as follows:  $T_A = +150^\circ\text{C}$ ;  $V_R = 0.8$  to  $0.85$  rated  $V_R$  dc (see 1.3).

4.3.2 Thermal impedance  $Z_{\theta JX}$  measurements for screening. The  $Z_{\theta JX}$  measurements shall be performed in accordance with MIL-STD-750, method 3101. The maximum limit (not to exceed the group A, subgroup 2 limit) for  $Z_{\theta JX}$  in screening (table II of MIL-S-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable  $\bar{X}$ , R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for Engineering evaluation and disposition.

4.3.2.1 Thermal impedance ( $Z_{\theta JX}$  measurements) for initial qualification or requalification. The  $Z_{\theta JX}$  measurements shall be performed in accordance with MIL-STD-750, method 3101 (read and record date  $Z_{\theta JX}$ ).  $Z_{\theta JX}$  shall be supplied on one lot (500 pieces minimum and a thermal response curve shall be submitted). Twenty two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurements conditions shall be in accordance with 4.4.1.

4.3.3 Surge current. Surge current, see MIL-STD-750, method 4066.  $I_{FSM} = 100$  A; 6 surges;  $t_p = 8.3$  ms or rectangular pulse of equivalent  $I_{RMS}$ ; 3 surges.  $I_0 = 0$  A;  $V_{RMS} = 0$  V; duty factor 1 percent minimum  $T_A = +25^\circ\text{C}$ .

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. The following test conditions shall be used for  $Z_{\theta JX}$ , group A inspection:  
 $Z_{\theta JX} \leq 2.5^\circ\text{C/W}$

$I_H$	=	-----	5 A minimum
$t_H$	=	-----	100 ms
$I_M$	=	-----	10 mA
$t_{HD}$	=	-----	200 $\mu\text{s}$ maximum

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions of tables IVa (JANS) and IVb (JANTX and JANTXV) of MIL-S-19500. Electrical measurements (endpoints) and delta requirements shall be in accordance with the applicable steps of table I, group A, subgroup 2 herein except  $Z_{\theta JX}$  shall be performed after Intermittent Life only.

4.4.2.1 Group B inspection, table IVa (JANS of MIL-S-19500).

Subgroup	Method	Condition
3	4066	$T_C = +100^\circ\text{C}$ ; $t_s \leq 8.3$ ms; $V_R = \text{rated } V_R$ (see 1.3); six 1/120 s surges; 1 surge/minute maximum. $I_F(\text{surge}) = 100$ A dc; $I_0 = 10$ A dc.
3	2037	Test condition A, all internal wires for each device shall be pulled separately.
4	1037	2,000 cycles, 25 percent rated $I_0 \leq I_0$ applied $\leq$ rated $I_0$ (see 4.5.2)
5	1027	$I_F = 0.5$ A dc at $T_A = +25^\circ\text{C}$ , for 96 hours, or adjusted as required by the chosen $T_A$ to give an average lot at $T_J = +275^\circ\text{C}$ .
6	3101	See 4.4.1 except $t_H \approx 500$ ms.

4.4.2.2 Group B inspection, table IVb (JANTX and JANTXV of MIL-S-19500).

Subgroup	Method	Condition
2	4066	$T_C = +100^\circ\text{C}$ ; $t_s \leq 8.3$ ms; $V_R = \text{rated } V_R$ (see 1.3); six 1/120 s surges; 1 surge/minute maximum. $I_F(\text{surge}) = 100$ A dc; $I_0 = 10$ A dc.
3	1037	$I_F \geq 0.5$ A dc, $I_0$ (see 4.5.2); 2,000 cycles.
4		Not applicable
5		Not applicable

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (endpoints) and delta requirements shall be in accordance with the applicable steps of table I, group A, subgroup 2 herein except  $Z_{\theta JX}$  shall be performed after Intermittent Life only.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Condition
2	2036	Test condition A, weight = 10 pounds, $t = 15$ seconds.
2	1021	Omit initial conditioning.
6	1037	$I_F \geq 0.5$ A dc, $I_0$ (see 4.5.2); 6,000 cycles.

4.4.4 Group E inspection. Group e inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-S-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps and footnotes of table I, group A, subgroup 2 herein, except  $Z_{eJX}$  is not required.

4.4.4.1 Group E inspection, table VII of MIL-S-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>	<u>Sampling Plan</u>
1	1056	0°C to +100°C; 100 cycles.	10 devices, c = 0
2	1038	Condition A, t = 1,000 hours	5 devices, c = 0
3		Not applicable	
4	3101	See 4.4.1 except $t_H = 500$ ms	10 devices, c = 0
5	1001	Not 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 4.3.2.1 of MIL-STD-750.

4.5.2 DC intermittent operation life. A cycle shall consist of an "on" period, when forward current is applied suddenly, not gradually, to the device for the time necessary to achieve an increase (delta) case temperature of +85°C +15°C, -5°C followed by an "off" period, when the current is suddenly removed for cooling, the case through a similar delta temperature. Auxiliary (forced) cooling is permitted during the "off" period only. Forward current and/or "on" time, within specific limits, and "off" time may be adjusted to achieve the delta case temperature. Heat sinks shall only be used if and to the degree necessary to maintain test samples with the desired delta temperature tolerance. The heating time shall be such that  $30 \text{ s} \leq t_{\text{heating}} \leq 180 \text{ s}$ . The forward current may be steady-state dc, full-wave rectified dc, or the equivalent half-sine wave dc, of the specified value. The test duration shall be the specified number of cycles. Within the time interval of 50 cycles before and 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.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance	3101	See 4.4.1	$Z_{\theta JX}$		2.5	$^{\circ}\text{C/W}$
Forward voltage	4011	$t_p \leq 400 \mu\text{s}$ , duty cycle $\leq 2$ percent pulse $I_F = 6 \text{ A}$ $I_F = 12 \text{ A}$	$V_{F1}$ $V_{F2}$		1.0 1.5	V dc V
Reverse current leakage	4016	DC method; $V_R = \text{rated } V_R$ (see 1.3)	$I_{R1}$		250	nA dc
Breakdown voltage	4021	$I_R = 1.0 \mu\text{A dc}$	$V_{(BR)1}$			
1N6664, 1N6664R					100	V dc
1N6665, 1N6665R					150	V dc
1N6666, 1N6666R					200	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^{\circ}\text{C}$				
Reverse current leakage	4016	DC method; $V_R = \text{rated } V_R$ (see 1.3)	$I_{R2}$		75	$\mu\text{A dc}$
Forward voltage	4011	$I_{FM} = 6 \text{ A}$ , duty cycle $\leq 2$ percent (pulsed); $t_p \leq 400 \mu\text{s}$	$V_{F3}$		0.95	V
Low temperature operation		$T_A = -55^{\circ}\text{C}$				
Forward voltage	4011	$I_{FM} = 6 \text{ A}$ , duty cycle $\leq 2$ percent (pulsed); $t_p \leq 400 \mu\text{s}$	$V_{F4}$		1.1	V
Breakdown voltage	4021	$I_R = 1.0 \mu\text{A dc}$	$V_{(BR)2}$			
1N6664, 1N6664R					100	V dc
1N6665, 1N6665R					150	V dc
1N6666, 1N6666R					200	V dc
<u>Subgroup 4</u>						
Reverse recovery time	4031	$I_F = 0.5 \text{ A}$ ; $I_R = 1 \text{ A}$ ; $I_{(REC)} = 0.25 \text{ A}$ ; $dI/dt = 85 \text{ A}/\mu\text{s}$ minimum	$t_{rr}$		35	ns
Junction capacitance	4001	$V_R = 10 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $V_{SIG} = 50 \text{ mV (p-p)}$ maximum	$C_J$		100	pF

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Not applicable						
<u>Subgroup 6</u>						
Surge current	4066			100		A

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

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

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-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Issue of DODISS to be cited in the solicitation.
- b. Lead finish as specified (see 3.3.1).
- c. Product assurance level and type designation.

6.3 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying number (PIN). This information in no way implies that manufacturer's PIN's are suitable as a substitute for the military PIN.

6.3.1 JAN substitution. JANTX devices are a direct replacement for JAN devices (example: JANTX1N6664 for JAN1N6664)

6.4 Interchangeability information. MIL-S-19500/594 is a TO-257 package version of MIL-S-19500/477, which is an axial leaded diode version.

CONCLUDING MATERIAL

Custodians:

Army - ER  
Navy - EC  
Air Force - 17  
NASA - NA

Preparing activity:

Navy - EC

Agent:

DLA - ES

Review activities:

Army - AR, MI, SM  
Navy - AS, CG, MC, OS, SH  
Air Force - 19, 85, 99  
DLA - ES

(Project 5961-1511-07)

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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.

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### I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER  
MIL-S-19500/594

2. DOCUMENT DATE (YYMMDD)

### 3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST RECOVERY, LOW LEAKAGE, TYPES 1N6664 THROUGH 1N6666 AND 1N6664R THRU 1N6666R, JAN, JANTX, JANTXV, AND JANS

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)

7. DATE SUBMITTED (YYMMDD)

(1) Commercial  
(2) AUTOVON  
(if applicable)

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