

The documentation and process conversion measures necessary to comply with this revision shall be completed by 7 July 2004.

INCH-POUND

MIL-PRF-19500/411L  
7 April 2004  
SUPERSEDING  
MIL-PRF-19500/411K  
30 December 2002

PERFORMANCE SPECIFICATION SHEET

\* SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST RECOVERY  
1N5415 THROUGH 1N5420, 1N5415US THROUGH 1N5420US,  
JAN, JANTX, JANTXV, JANS, JANTXVM, JANTXVD, JANTXVR,  
JANTXVH, JANSM, JANSD, JANSR, AND JANSH

This specification 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-19500.

1. SCOPE

\* 1.1 Scope. This specification covers the performance requirements for silicon rectifier diodes. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500. Provision for radiation hardness assurance (RHA) to four radiation test levels is provided for JANTXV and JANS product assurance levels. RHA level designators "M", "D", "R", and "H" are appended to the device prefix to identify devices which have passed RHA requirements.

1.2 Physical dimensions. See figure 1 (similar to DO-41) and figure 2 (surface mount).

1.3 Maximum ratings. Unless otherwise specified  $T_A = 25^\circ\text{C}$ .

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	* Col. 8	Col. 9	Col. 10
Types	$V_R$	$V_{RWM}$	$I_o$ (1) $T_A = 55^\circ\text{C}$ (2)	$I_o$ (1) $T_A = 100^\circ\text{C}$ (3)	$I_{FSM}$ $I_o = 2 \text{ A dc}$ $T_A = 100^\circ\text{C}$ $t_p = 8.3 \text{ ms}$	$t_{rr}$	$T_{STG}$ and $T_J$	$R_{\theta JL}$ at $L = .375$ in. (9.53 mm)	$R_{\theta JEC}$ at $L = 0$ for US versions
	V dc	V (pk)	A dc	A dc	A (pk)	ns	$^\circ\text{C}$	$^\circ\text{C/W}$	$^\circ\text{C/W}$
1N5415, 1N5415US	50	50	3	2	80	150	-65 to +175	20	10
1N5416, 1N5416US	100	100	3	2	80	150	-65 to +175	20	10
1N5417, 1N5417US	200	200	3	2	80	150	-65 to +175	20	10
1N5418, 1N5418US	400	400	3	2	80	150	-65 to +175	20	10
1N5419, 1N5419US	500	500	3	2	80	250	-65 to +175	20	10
1N5420, 1N5420US	600	600	3	2	80	400	-65 to +175	20	10

(1) This rating is typical for PC boards where thermal resistance from mounting point to ambient is sufficiently controlled where  $T_{J(max)}$  in paragraph 1.3. are not exceeded.

(2) Derate linearly at 22 mA/ $^\circ\text{C}$  for  $55^\circ\text{C} \leq T_A \leq 100^\circ\text{C}$ .

\*(3) Derate linearly at 25 mA/ $^\circ\text{C}$  for  $100^\circ\text{C} \leq T_A \leq 175^\circ\text{C}$ .

\* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, or emailed to [Semiconductor@dsc.dla.mil](mailto:Semiconductor@dsc.dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://www.dodssp.daps.mil>.

## 2. APPLICABLE DOCUMENTS

\* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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 of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

### 2.2 Government documents.

\* 2.2.1 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 cited in the solicitation or contract.

#### \* DEPARTMENT OF DEFENSE SPECIFICATIONS

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

#### \* DEPARTMENT OF DEFENSE STANDARDS

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

\* (Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or [www.dodssp.dap.mil](http://www.dodssp.dap.mil) or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 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 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

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

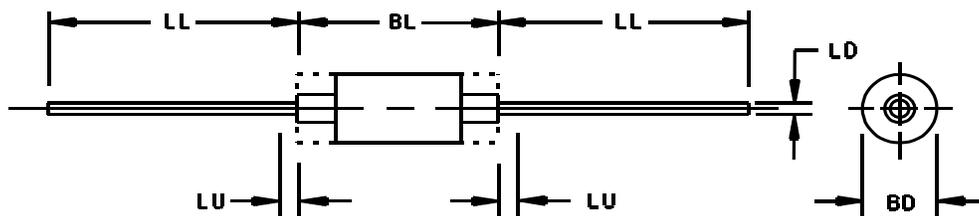
3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows:

EC .....End cap.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 (DO-41) and figure 2 (surface mount) herein.

3.4.1 Lead finish. Unless otherwise specified, lead or end cap finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. When solder alloy is used for finish the maximum lead temperature is limited to 175°C maximum. Where a choice of finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4.2 Encapsulant material. In addition to those categories of hermetically sealed package requirements specified in MIL-PRF-19500, fused-metal-oxide to metal shall also be acceptable.

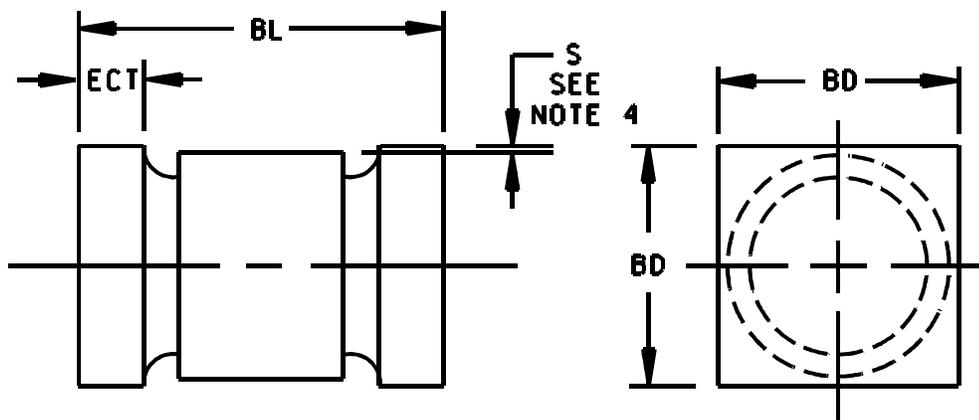


Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BD	.110	.180	2.79	4.57	3
LD	.037	.042	0.94	1.07	4
BL	.130	.260	3.30	6.60	4
LL	.90	1.30	22.9	33.0	
LU		.050		1.27	5

NOTES:

1. Dimensions are in inches.
2. Millimeter equivalents are given for general information only.
3. Dimension BD shall be measured at the largest diameter.
4. The BL dimension shall include all uncontrolled areas of the device leads.
5. Dimension LU shall include the sections of the lead over which the diameter is uncontrolled. This uncontrolled area is defined as the zone between the edge of the diode body and extending .050 inch (1.27 mm) onto the leads.
6. Dimensioning and tolerancing shall be in accordance with ASME Y14.5M.

\* FIGURE 1. Physical dimensions (similar to DO-41).



Symbol	Dimension			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.200	.225	5.080	5.72
ECT	.019	.028	0.48	0.71
S	.003		0.08	
BD	.137	.148	3.48	3.76

NOTES:

1. Dimensions are in inches.
2. Millimeter equivalents are given for general information only.
3. Dimensions are pre-solder dip.
4. Minimum clearance of glass body to mounting surface on all orientations.

FIGURE 2. Physical dimensions of surface mount family.

3.4.3 Diode construction. These devices shall be constructed utilizing non-cavity double plug construction with high temperature metallurgical bonding between both sides of the silicon die and terminal pins. Metallurgical bond shall be in accordance with the requirements of category I in MIL-PRF-19500.

3.5 Marking. Devices shall be marked in accordance with MIL-PRF-19500.

3.5.1 Marking of US version. For US version only, all marking may be omitted from the device except for the cathode marking. All marking which is omitted from the body of the device shall appear on the label of the initial container.

3.5.2 Polarity. The polarity shall be indicated with a contrasting color band to denote the cathode end. Alternately for surface mount (US) devices, a minimum of three evenly spaced contrasting color dots around the periphery of the cathode end may be used. No color coding will be permitted.

3.5.3 Radiation hardness assurance (RHA). Radiation hardness assurance requirements, part number designators, and test levels shall be as defined in MIL-PRF-19500.

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

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

3.7.1 Post irradiation performance characteristics. The electrical performance characteristics of the RHA devices are as specified in 4.4.4 herein.

3.8 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

#### 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).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Qualification for radiation hardness assurance. Qualification inspection for radiation hardness assured JANS and JANTXV devices shall consist of group D examinations and tests specified in table II herein.

4.2.2 Group E qualification. Group E qualification shall be performed herein for qualification or requalification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein shall be performed on the first inspection lot to this revision to maintain qualification.

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\* 4.3 Screening (JANS, JANTXV and JANTX levels only). Screening shall be in accordance with table IV of MIL-PRF-19500 and as specified herein. Specified electrical measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screening (see table IV of MIL-PRF-19500)	JANS level	JANTXV and JANTX level
1a	Required	Not required
1b	Required	Required (JANTXV only)
2	Optional	Not required
3a (1) 3c	Required Thermal impedance (see 4.3.1 and 4.4.1)	Required Thermal impedance (see 4.3.1 and 4.4.1)
4	Not applicable	Not applicable
5	Not applicable	Not applicable
6	Not applicable	Not applicable
7a	Not applicable	Not applicable
7b	Optional	Optional
8	Required	Not required
9	$I_{R1}$ and $V_{F1}$	Not required
10	Method 1038 of MIL-STD-750, condition A	Method 1038 of MIL-STD-750, condition A
11	$I_{R1}$ and $V_{F1}$ ; $\Delta I_{R1} \leq 100$ percent of initial reading or 250 nA dc, whichever is greater; $\Delta V_{F1} \leq \pm 0.1$ V dc.	$I_{R1}$ and $V_{F1}$
12	Required, see 4.3.2	Required, see 4.3.2
(2) 13	Subgroups 2 and 3 of table I herein; $\Delta I_{R1} \leq 100$ percent of initial value or 250 nA dc, whichever is greater; $\Delta V_{F1} \leq \pm 0.1$ V dc. Scope display evaluation (see 4.5.2)	Subgroup 2 of table I herein; $\Delta I_{R1} \leq 100$ percent of initial value or 250 nA dc, whichever is greater; $\Delta V_{F2} \leq \pm 0.1$ V dc. Scope display evaluation (see 4.5.2)
14a	Not applicable	Not applicable
(3) 14b	Required	Required
15	Required	Not required
16	Required	Not required

- (1) Thermal impedance shall be performed any time after sealing provided temperature cycling is performed in accordance with MIL-PRF-19500, screen 3 prior to this thermal test.
- (2)  $Z_{\theta JX}$  is not required in screen 13, if already previously performed.
- (3) For clear glass diodes, the hermetic seal (gross leak) may be performed at any time after temperature cycling.

\* 4.3.1 Thermal impedance  $Z_{\theta JX}$  measurements for screening. The  $Z_{\theta JX}$  measurements shall be performed in accordance with method 3101 of MIL-STD-750. The maximum screen limit shall be developed by the supplier using statistical methods and it shall not exceed the group A, subgroup 2 herein. See 4.4.1 for test conditions.

4.3.1.1 Thermal impedance ( $Z_{\theta JX}$  measurements) for initial qualification or requalification. The  $Z_{\theta JX}$  measurements shall be performed in accordance with method 3101 of MIL-STD-750 (read and record data  $Z_{\theta JX}$ ).  $Z_{\theta JX}$  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.

\* 4.3.2 Power burn-in conditions. Power burn-in conditions, method 1038 of MIL-STD-750 and as follows (see 4.5.3 and 4.5.3.1) adjust  $I_O$  to achieve the required  $T_J$ .

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 following test conditions shall be used for  $Z_{\theta JX}$ :  $Z_{\theta JX} = 1.5^\circ\text{C/W}$  max.

- a.  $I_H$ ..... 5 A minimum.
- b.  $t_H$ ..... 10 ms.
- c.  $I_M$ ..... 1 mA to 10 mA.
- d.  $t_{MD}$ ..... 100  $\mu\text{s}$  maximum.

\* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table VIa (JANS) and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein; except,  $Z_{\theta JX}$  need not be performed. See table IV for delta limits when applicable.

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\* 4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500. For B5, if a failure occurs, resubmission shall be at the test conditions of the original sample.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1056	0°C to +100°C, 25 cycles.
B3	1051	-55°C to +175°C, 100 cycles.
B3	4066	I <sub>FSM</sub> = rated I <sub>FSM</sub> (see col. 6 of 1.3); 10 surges of 8.3 ms each at 1 minute intervals, superimposed on I <sub>O</sub> = 0, V <sub>RWM</sub> = 0.
B4	1037	I <sub>O</sub> = I <sub>O</sub> rated minimum (see col. 5 of 1.3) V <sub>R</sub> = rated V <sub>RWM</sub> (see col. 3 of 1.3 and 4.5.3); 2,000 cycles.
B5	1027	I <sub>O</sub> = I <sub>O</sub> rated minimum (see col. 5 of 1.3); apply V <sub>R</sub> = rated V <sub>RWM</sub> (see col. 3 of 1.3 and 4.5.3) adjust I <sub>O</sub> to achieve T <sub>J</sub> minimum; f = 50-60 Hz; n = 45 c = 0.  Option 1: T <sub>A</sub> = + 30°C max. ; T <sub>J</sub> = 225°C minimum; t = 216 hours.  or Option 2: T <sub>A</sub> = + 30°C max. ; T <sub>J</sub> = 200°C minimum; t = 1,000 hours, (see 4.5.3.1).
* B6	3101 or 4081	R <sub>θJL</sub> (maximum) ≤ 20°C/W; L = .375 inch (9.53 mm). For surface mount devices(US version), R <sub>θJEC</sub> = 10°C/W maximum.
B7		Peak reverse power, see 4.5.4 and figure 3. P <sub>RM</sub> ≥ 1,000 W. 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 Group B inspection, table VIb (JAN, JANTX and JANTXV of MIL-PRF-19500).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1056	0°C to +100°C, 10 cycles.
B2	1051	-55°C to +175°C, 25 cycles.
B3	1027	Adjust I <sub>O</sub> to achieve the required T <sub>J</sub> ; f = 50-60 Hz; apply V <sub>R</sub> = rated V <sub>RWM</sub> (see column 3 of 1.3 and 4.5.3.1).
B5		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 VII of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein; except,  $Z_{\theta JX}$  need not be performed. See table IV for delta limits when applicable.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	1056	0°C to +100°C, 10 cycles.
C2	1051	-55°C to +175°C, 25 cycles.
C2	2036	Tension: Test condition A; weight = 20 pounds; t = 30 seconds. Lead fatigue: Test condition E; weight 2 pounds. NOTE: Both tension and lead fatigue are not applicable for US devices.
* C5	3101 or 4081	See 4.5.5.
C6	1026	$I_O = 3$ A minimum; and adjust $I_O$ to achieve the required $T_J$ ; apply $V_R =$ rated $V_{RWM}$ (see col. 3 of 1.3), $f = 50$ -60 Hz (see 4.5.3.1).

4.4.4 Group D inspection. Radiation hardness assured JANS and JANTXV devices shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and method 1019 of MIL-STD-750 for total ionizing dose or method 1017 for neutron fluence as applicable.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table IX of MIL-PRF-19500 and as specified herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein; except,  $Z_{\theta JX}$  need not be performed. See table IV for delta limits when applicable.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and 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. Scope display may be performed on ATE (automatic test equipment) for screening only, with the approval of the qualifying activity. Scope display in group A shall be performed on a scope. The reverse current ( $I_{BR}$ ) over the knee shall be 500  $\mu$ A 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 Free air burn-in. Deliberate heat sinking, baffles to create an oven, forced air-cooling or heating is prohibited unless otherwise approved by the qualifying activity. The use of a current limiting or ballast resistor is permitted provided that each DUT still sees the full  $P_t$  (minimum) and that the minimum applied voltage, where applicable, is maintained through out the burn-in period.  $T_J = 135^\circ\text{C}$  minimum for 96 hours. Use method 3100 of MIL-STD-750 to measure  $T_J$ .

4.5.4 Peak reverse power test. This test shall be measured in the circuit of figure 3, or equivalent. A 20 microsecond half-sine waveform of current shall be used and peak reverse power shall be determined by the product of peak reverse voltage and peak reverse current.

4.5.5 Thermal resistance. Thermal resistance measurement shall be performed in accordance with method 3101 or 4081 of MIL-STD-750. Read and record data in accordance with group E herein and shall be included in the qualification report. Forced moving air or draft shall not be permitted across the devices during test. The maximum limit under this test condition shall be  $R_{\theta JL(max)} = 20^{\circ}C/W$  for  $L = .375$  (9.53 mm);  $R_{\theta JEC(max)} = 10^{\circ}C/W$  for  $L = 0$  (US version).  $LS =$  Lead spacing = .375 inch (9.52 mm) as defined on figure 4. Lead temperature as defined in figure 5. The following conditions shall apply:

- a.  $I_H$  ..... 3 A minimum.
- b.  $t_H$  ..... Thermal equilibrium.
- c.  $I_M$  ..... 1.0 mA to 10 mA.
- d.  $t_{MD}$  ..... 70  $\mu s$  maximum.

\* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Thermal impedance	3101	See 4.3.1	Z <sub>θJX</sub>		1.5	°C/W
Forward voltage	4011	I <sub>F</sub> = 1.5 A dc	V <sub>F1</sub>	0.5	1.2	V dc
Forward voltage	4011	I <sub>F</sub> = 9 A dc (pulsed see 4.5.1); t <sub>p</sub> = 300 μs; 2 percent maximum duty cycle	V <sub>F2</sub>	0.6	1.5	V (pk)
Reverse current	4016	DC method V <sub>R</sub> = rated (see col. 2 of 1.3).	I <sub>R1</sub>		1.0	μA dc
Breakdown voltage	4021	I <sub>R</sub> = 50 μA dc	V <sub>(BR)1</sub>			
1N5415, 1N5415US				55		V dc
1N5416, 1N5416US				110		V dc
1N5417, 1N5417US				220		V dc
1N5418, 1N5418US				440		V dc
1N5419, 1N5419US				550		V dc
1N5420, 1N5420US				660		V dc
<u>Subgroup 3</u>						
High temperature operation:		T <sub>A</sub> = +100°C				
Reverse current	4016	DC method; V <sub>R</sub> = rated (see col. 2 of 1.3).	I <sub>R2</sub>		20	μA dc
Low temperature operation:		T <sub>A</sub> = -55°C				
Forward voltage	4011	I <sub>F</sub> = 0.5 A dc	V <sub>F3</sub>	0.5	1.4	V dc
Breakdown voltage	4021	I <sub>R</sub> = 50 μA dc	V <sub>(BR)2</sub>			
1N5415, 1N5415US				50		V dc
1N5416, 1N5416US				100		V dc
1N5417, 1N5417US				200		V dc
1N5418, 1N5418US				400		V dc
1N5419, 1N5419US				500		V dc
1N5420, 1N5420US				600		V dc

See footnote at end of table.

\* TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 4</u>						
Reverse recovery time	4031	Condition B1	$t_{rr}$			
1N5415, 1N5415US					150	ns
1N5416, 1N5416US					150	ns
1N5417, 1N5417US					150	ns
1N5418, 1N5418US					150	ns
1N5419, 1N5419US					250	ns
1N5420, 1N5420US					400	ns
Capacitance	4001	$V_R = 4 \text{ V dc};$ $100 \text{ Khz} \leq f \leq 1 \text{ Mhz}$	C			
1N5415, 1N5415US					550	pF
1N5416, 1N5416US					430	pF
1N5417, 1N5417US					250	pF
1N5418, 1N5418US					165	pF
1N5419, 1N5419US					140	pF
1N5420, 1N5420US					120	pF
Scope display evaluation	4023	See 4.5.2 $n = 116, c = 0$				
<u>Subgroup 5</u>						
Not applicable						
<u>Subgroup 6</u>						
Forward surge	4066	$I_{FSM} = \text{rated (see col. 6 of 1.3);}$ 10 surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 0, V_{RSM} = 0$				
Electrical measurement		See table I, subgroup 2.				
<u>Subgroup 7</u>						
Not applicable						

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

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TABLE II. Group D inspection and end-point limits for radiation hardness assured JANS and JANTXV devices only.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 1</u>						
Neutron irradiation	1017					
Electrical measurements		$I_F = 9 \text{ A dc}$ , (pulsed see 4.5.1)				
Forward voltage	4011	$t_p = 300 \mu\text{s}$ ; 2 percent maximum duty cycle	$V_F$			
M, D, R, H						
1N5415, 1N5415US				0.6	1.6	V (pk)
1N5416, 1N5416US				0.6	1.6	V (pk)
1N5417, 1N5417US				0.6	1.7	V (pk)
1N5418, 1N5418US				0.6	1.7	V (pk)
1N5419, 1N5419US				0.6	1.8	V (pk)
1N5420, 1N5420US				0.6	1.8	V (pk)
Reverse current, M, D, R, H	4016	DC method:	$I_R$			
1N5415, 1N5415US		$V_R = 50 \text{ V dc}$			1.0	$\mu\text{A dc}$
1N5416, 1N5416US		$V_R = 100 \text{ V dc}$			1.0	$\mu\text{A dc}$
1N5417, 1N5417US		$V_R = 200 \text{ V dc}$			1.0	$\mu\text{A dc}$
1N5418, 1N5418US		$V_R = 400 \text{ V dc}$			1.0	$\mu\text{A dc}$
1N5419, 1N5419US		$V_R = 500 \text{ V dc}$			1.0	$\mu\text{A dc}$
1N5420, 1N5420US		$V_R = 600 \text{ V dc}$			1.0	$\mu\text{A dc}$
<u>Subgroup 2</u>						
Total dose irradiation	1019					
Electrical measurements		$I_F = 9 \text{ A dc}$ (pulsed see 4.5.1)	$V_F$			

See footnote at end of table.

TABLE II. Group D inspection and end-point limits for radiation hardness assured JANS and JANTXV devices only. - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward voltage M, D, R, H  1N5415, 1N5415US 1N5416, 1N5416US 1N5417, 1N5417US 1N5418, 1N5418US 1N5419, 1N5419US 1N5420, 1N5420US	4011	$t_p = 300 \mu s$ ; 2 percent maximum duty cycle		0.6 0.6 0.6 0.6 0.6 0.6	1.6 1.6 1.7 1.7 1.8 1.8	V (pk) V (pk) V (pk) V (pk) V (pk) V (pk)
Reverse current M, D, R, H  1N5415, 1N5415US 1N5416, 1N5416US 1N5417, 1N5417US 1N5418, 1N5418US 1N5419, 1N5419US 1N5420, 1N5420US	4016	DC method:  $V_R = 50 \text{ V dc}$ $V_R = 100 \text{ V dc}$ $V_R = 200 \text{ V dc}$ $V_R = 400 \text{ V dc}$ $V_R = 500 \text{ V dc}$ $V_R = 600 \text{ V dc}$	$I_R$		1.0 1.0 1.0 1.0 1.0 1.0	$\mu A \text{ dc}$ $\mu A \text{ dc}$

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

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\* TABLE III. Group E inspection (all quality levels) for qualification and requalification only.

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Thermal shock	1056	20 cycles, condition D except low temperature shall be achieved using liquid nitrogen (-195°C) Perform a visual for cracked glass.	
Temperature cycling	1051	500 cycles, condition C, -65°C to +175°C.	
Hermetic seal	1071		
Electrical measurements		See table I, subgroup 2 herein.	
<u>Subgroup 2</u>			22 devices c = 0
Steady state dc blocking life	1048	1,000 hours, condition A $V_R = V_{RWM}$ (see col. 3 of 1.3).	
Electrical measurements		See table I, subgroup 2 herein except for thermal impedance.	
<u>Subgroup 3</u>			3 devices, c = 0
DPA (decap analysis)	2101	Cross section and scribe and break. Separate samples shall be used for each test.	
<u>Subgroup 4</u>			Not applicable
Thermal impedance curves		Each supplier shall submit their (typical) maximum design thermal impedance curves. In addition, optional test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report.	
<u>Subgroup 5</u>			22 devices c = 0
Barometric pressure, reduced (altitude operation)	1001	Pressure 8.0 mm	
<u>Subgroup 8 1/</u>			
Peak reverse power		See 4.5.4 and figure 3 herein. Peak reverse power ( $P_{RM}$ ) shall be characterized by the supplier and this data shall be available to the government. Test shall be performed on each subplot.	
Electrical measurements		During the $P_{RM}$ test, the voltage ( $V_{BR}$ ) shall be monitored to verify it has not collapsed. Any collapse in $V_{BR}$ during or after the $P_{RM}$ test or rise in leakage current ( $I_R$ ) after the test that exceeds $I_{R1}$ in Group A shall be considered a failure to that level of applied $P_{RM}$ . Progressively higher levels of $P_{RM}$ shall be applied until failure occurs on all devices within the chosen sample size to characterize each subplot.	

See footnote at end of table.

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\* TABLE III. Group E inspection (all quality levels) for qualification and requalification only - Continued.

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 9</u> Resistance to glass cracking	1057	Step stress to destruction by increasing cycles or up to a maximum of 25 cycles.	45 devices
<u>Subgroup 10</u> Forward surge	4066	Condition A, $I_{FSM} = 80 \text{ A(pk)}$ ; 10 surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 2 \text{ A dc}$ ; $V_{RWM} =$ rated $V_{RWM}$ (see col. 3 of 1.3). $T_A = +100^\circ\text{C}$ .	22 devices $c = 0$
Electrical measurement		See table I, subgroup 2 herein.	

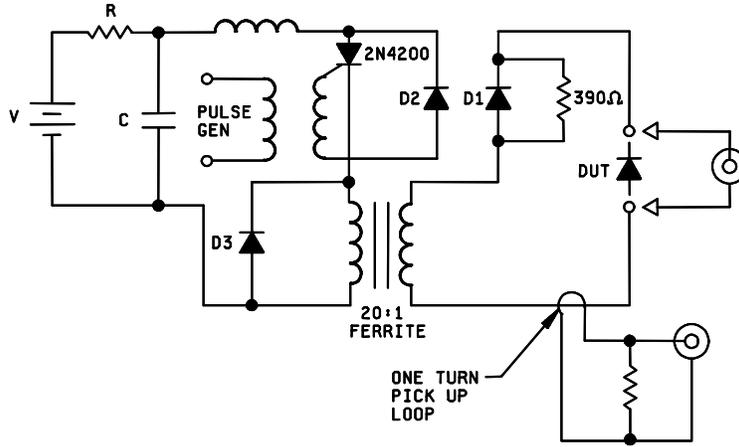
1/ The sample size for this step stress requirement shall be determined by the supplier. A statistically significant sample size is required.

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TABLE IV. Delta requirements. 1/ 2/ 3/ 4/

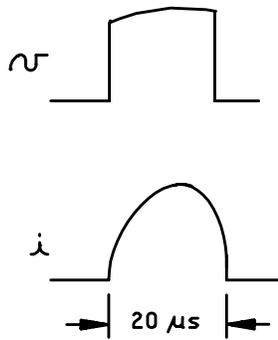
Step	Inspection	MIL-STD-750		Symbol	Limit
		Method	Conditions		
1	Reverse current	4016	DC method $V_R = \text{rated}$ (see col. 2 of 1.3)	$\Delta I_R$ <u>1/</u>	100 percent of initial value or 250 nA dc, whichever is greater.

- 1/ Devices which exceed the group A limits for this test shall not be accepted.
- 2/ The electrical measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:
  - a. Subgroup 4, see table IV herein, step 1.
  - b. Subgroup 5, see table IV herein, step 1.
- 3/ The electrical measurements for table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows:
  - a. Subgroup 3, see table IV herein, step 1.
  - b. Subgroup 6, see table IV herein, step 1.
- 4/ The electrical measurements for table VII (all quality levels) of MIL-PRF-19500 are as follows: Subgroup 6, see table IV herein, step 1.



NOTES:

- L = 13T H22 on 1 inch (25.4 mm) diameter form (air core).
- C ~ 1 to 10  $\mu$ fd to give 20  $\mu$ s pulse width.
- V - Adjustable to 200 volts for power desired in DUT.
- D1 - 3 kV; 600 Ma (1N3647 or equivalent).
- D2, D3 - 600 V; 3A (1N5552 or equivalent).
- \* Values not stated are determined at the time of test.



TYPICAL WAVEFORMS

FIGURE 3. Peak reverse power measurement circuit and waveform.

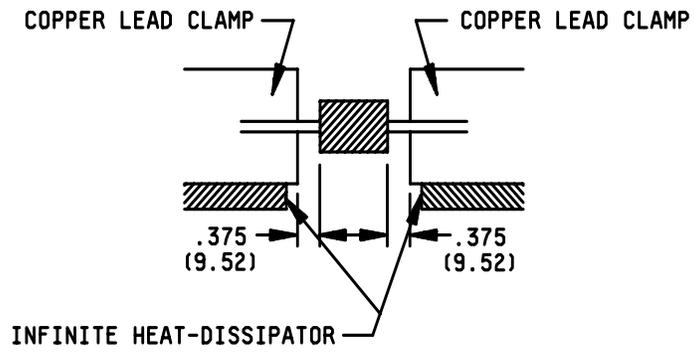
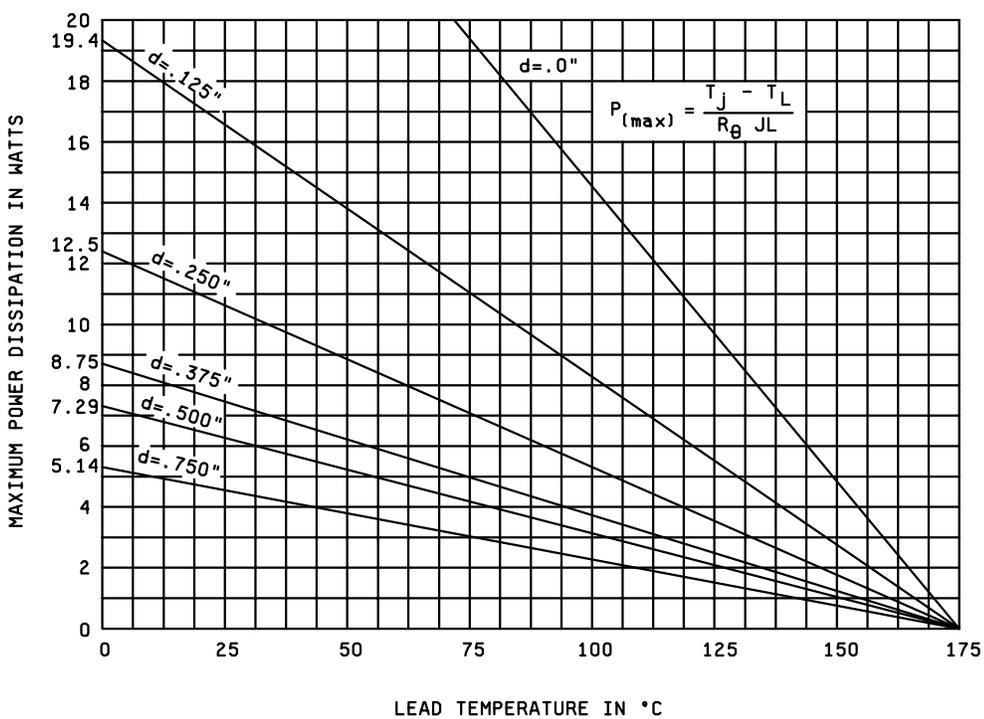


FIGURE 4. Mounting conditions.



Maximum lead temperature in °C (T<sub>L</sub>) at point "L" from body (for maximum operating junction temperature with equal two-lead conditions).

d	R <sub>θJL</sub>
Inches (mm)	°C/W
.000 (0.00)	4
.125 (3.18)	9
.250 (6.35)	14
.375 (9.53)	20
.500 (12.70)	24
.750 (19.05)	34

NOTES:

1. Dimensions are in inches.
2. Millimeter equivalents are given for general information only.

FIGURE 5. Maximum power in watts vs lead temperature.

## 5. PACKAGING

\* 5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's 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 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

\* 6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. Product assurance level and type designator.

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 Manufacturers 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000 or e-mail vqe.chief@dla.mil.

6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. 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 and relationship to the last previous issue.

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

Preparing activity:  
DLA - CC  
  
(Project 5961-2761)

Review activities:  
Army - AR, AV, MI, SM  
Navy - AS, MC  
Air Force - 19, 71, 99

\* 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 <http://www.dodssp.daps.mil>.