

The documentation and process conversion measures necessary to comply with this revision shall be completed by 19 December 2016.

INCH-POUND

MIL-PRF-19500/411T
 19 September 2016
 SUPERSEDING
 MIL-PRF-19500/411R
 5 May 2014

PERFORMANCE SPECIFICATION SHEET

* SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST RECOVERY, ENCAPSULATED (THROUGH-HOLE AND SURFACE MOUNT PACKAGES), 1N5415 THROUGH 1N5420, JAN, JANTX, JANTXV, AND JANS

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 (JAN, JANTX, JANTXV and JANS) are provided for each encapsulated device. Provision for radiation hardness assurance (RHA) to four radiation ("M", "D", "R", and "H") test levels is provided for JANTXV and JANS product assurance levels.

* 1.2 Package outlines. The device package outline is as follows: axial lead in accordance with [figure 1](#) and surface mount in accordance with [figure 2](#) for all encapsulated device types.

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	Col. 11
Types	V_{BR}	V_{RWM}	I_O (1) $T_A = 55^\circ\text{C}$ (2) (3)	I_O $T_A = 100^\circ\text{C}$ (2) (3)	I_{FSM} $I_O = 2 \text{ A dc}$ $T_A = 55^\circ\text{C}$ $t_p = 8.3 \text{ ms}$	t_{rr}	T_{STG} and T_J	$R_{\theta JL}$ at $L = .375 \text{ in.}$ (9.53 mm) (4)	$R_{\theta JEC}$ at $L = 0$ for US versions (5)	$R_{\theta JX}$ (3)
	V dc	V (pk)	A dc	A dc	A (pk)	ns	$^\circ\text{C}$	$^\circ\text{C/W}$	$^\circ\text{C/W}$	$^\circ\text{C/W}$
1N5415, US	50	50	3	2	80	150	-65	22	6.5	43
1N5416, US	100	100	3	2	80	150	to	22	6.5	43
1N5417, US	200	200	3	2	80	150	+175	22	6.5	43
1N5418, US	400	400	3	2	80	150		22	6.5	43
1N5419, US	500	500	3	2	80	250		22	6.5	43
1N5420, US	600	600	3	2	80	400		22	6.5	43

See notes on next page.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.



1.3 Maximum ratings – Continued.

- (1) Derate linearly at 22 mA/°C for $55^{\circ}\text{C} \leq T_A \leq 100^{\circ}\text{C}$.
- (2) Derate linearly at 26.7 mA/°C for $100^{\circ}\text{C} \leq T_A \leq 175^{\circ}\text{C}$.
- (3) For the 3A rating at 55°C ambient and the 2A rating at 100°C ambient, these I_o ratings are for a thermally mounting methods (PC boards or other) where the lead or end-cap temperatures cannot be maintained and where thermal resistance from mounting point to ambient is still sufficiently controlled where $T_{J(\text{MAX})}$ in 1.3 is not exceeded. This equates to $R_{\theta JX} \leq 43^{\circ}\text{C/W}$ in col. 11 of 1.3. Also see application notes in 6.4.
- (4) See [figure 3](#).
- (5) See [figure 4](#).

* 1.4 Part or Identifying Number (PIN). The PIN is in accordance with [MIL-PRF-19500](#), and as specified herein. See [6.4](#) for PIN construction example and [6.5](#) for a list of available PINs.

* 1.4.1 JAN certification mark and quality level for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JAN, JANTX, JANTXV" and "JANS".

* 1.4.2 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest are as follows: "M", "D", "R", and "H".

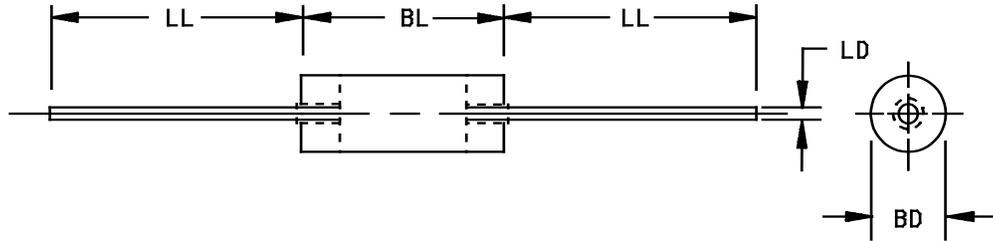
* 1.4.3 Device type. The designation system for the device types of diodes covered by this specification sheet are as follows.

* 1.4.3.1 First number and first letter symbols. The diodes of this specification sheet use the first number and letter symbols "1N".

* 1.4.3.2 Second number symbols. The second number symbols for the diodes covered by this specification sheet are as follows: "5415", "5416", "5417", "5418", "5419" and "5420".

* 1.4.3.3 Suffix letters. No suffix letters are used on devices that are packaged in the axial leaded package of [figure 1](#). The suffix letters "US" are used on devices that are packaged in the surface mount package of [figure 2](#).

* 1.4.4 Lead finish. The lead finishes applicable to this specification sheet are listed on [QPDSIS-19500](#).

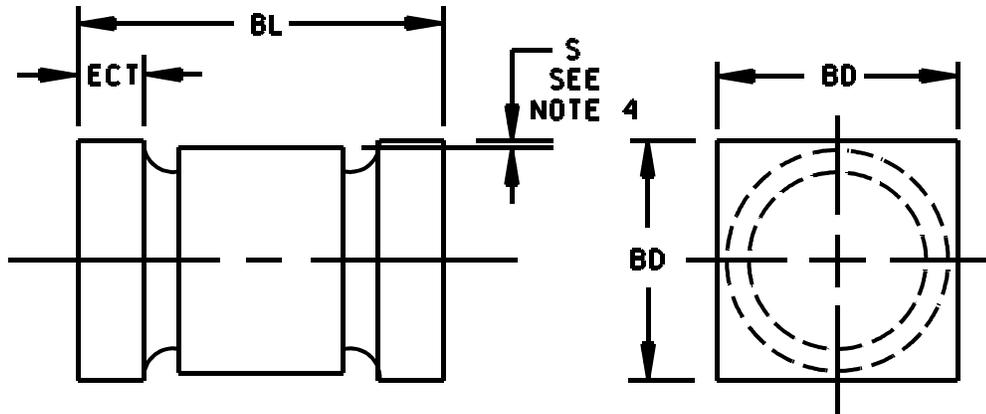


Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BD	.110	.180	2.79	4.57	3
LD	.036	.042	0.91	1.07	4
BL	.130	.260	3.30	6.60	4
LL	.90	1.30	22.9	33.0	

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 the entire body including slugs and 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.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Physical dimensions (axial lead).



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.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 2. Physical dimensions of surface mount family.

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 of documents cited in sections 3 and 4 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://quicksearch.dla.mil/>).

2.3 Order of precedence. Unless otherwise noted herein or in the contract, 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](#) (axial lead) 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 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. Marking shall be 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, Diode, Silicon, Power Rectifier, Fast Recovery, 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 inspection shall be performed for qualification or re-qualification 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 that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening (JANS, JANTXV and JANTX levels only). Screening shall be in accordance with table E-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 E-IV of MIL-PRF-19500)	JANS level	JANTXV and JANTX level
2	Optional	Not required
(1) 3c	Thermal impedance (see 4.3.1)	Thermal impedance (see 4.3.1)
9	IR1 and VF1	Not required
10	Method 1038 of MIL-STD-750, condition A	Method 1038 of MIL-STD-750, condition A
(2) 11	IR1 and VF1; $\Delta IR1 \leq 100$ percent of initial reading or 250 nA dc, whichever is greater; $\Delta VF1 \leq \pm 0.1$ V dc	IR1 and VF1
12	Required, see 4.3.2	Required, see 4.3.2
(2) (3) 13	Subgroups 2 and 3 of table I herein; $\Delta IR1 \leq 100$ percent of initial value or 250 nA dc, whichever is greater; $\Delta VF1 \leq \pm 0.1$ V dc, scope display evaluation (see 4.5.2)	Subgroup 2 of table I herein; $\Delta IR1 \leq 100$ percent of initial value or 250 nA dc, whichever is greater; $\Delta VF1 \leq \pm 0.1$ V dc, scope display evaluation (see 4.5.2)
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) For JANTX and JANTXV devices, $\Delta VF1$ may be omitted if thermal impedance is performed, unless irradiation is used to reduce the carrier lifetime.
- (3) $Z_{\theta JX}$ is not required in screen 13, if already previously performed.

4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3101 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H shall be 10 ms, t_{MD} shall be 70 μ s maximum. The thermal impedance limit shall comply with the thermal impedance graphs herein (less than or equal to the curve value at the same t_H time) and shall be less than the process determined statistical maximum limit as outlined in method 3101. See table III, subgroup 4 herein.

4.3.2 Power burn-in conditions. Power burn-in conditions are as follows: $I_O = 3A$ minimum; $T_A = 55^\circ C$ maximum. Test conditions in accordance with method 1038 of MIL-STD-750, condition B. Use method 3100 of MIL-STD-750 to measure T_J . Adjust I_O or T_A to achieve the required T_J . $T_J = 135^\circ C$ minimum. With approval of the qualifying activity, alternate burn-in criteria (hours, bias conditions, T_J , mounting conditions) may be used for JANTX and JANTXV quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing sites burn-in data and performance history will be essential criteria for burn-in modification approval.

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 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 table E-VIA (JANS) and table E-VIB (JAN, JANTX, and JANTXV) of [MIL-PRF-19500](#). Delta measurements shall be as specified in [table IV](#) herein.

* 4.4.2.1 Quality level JANS, table E-VIA 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	4066	Condition A, IFSM = rated IFSM (see col. 6 of 1.3); ten surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 2$ A dc, $V_{RWM} =$ rated V_{RWM} (see col. 3 of 1.3).
B4	1037	Adjust I_O to achieve the required T_J , apply (see col. 5 of 1.3), $V_R =$ rated V_{RWM} (see col. 3 of 1.3 and 4.5.3); 2,000 cycles.
B5	1027	$I_O = 3$ A minimum (see col. 4 of 1.3); apply $V_R =$ rated V_{RWM} (see col. 3 of 1.3 and 4.5.3) adjust I_O or T_A to achieve $T_J = 175^\circ\text{C}$ minimum; $f = 50 - 60$ Hz; $n = 45$ $c = 0$. $t = 1,000$ hours; $T_A = 55^\circ\text{C}$ max. For irradiated devices, include t_{rr} as an end-point measurement.
B8	4065	Peak reverse power. $P_{RM} \geq 636$ W for square wave in accordance with test method 4065 of MIL-STD-750 ($P_{RM} \geq 1,000$ 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, table E-VIB of [MIL-PRF-19500](#).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$I_O = 3$ A minimum (see col. 4 of 1.3) minimum; adjust I_O or T_A 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). $T_A = 55^\circ\text{C}$ (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 table E-VII of MIL-PRF-19500. Delta measurements shall be as specified in table IV herein.

	<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
*	C2	2036	Tension: Test condition A; weight = 20 pounds (9.1 kg), t = 15 seconds. Lead Fatigue: Test condition E; weight = 2 lbs. (non US devices)
*		2038	Tab Pull: Test condition B; weight = 20 pounds (9.1 kg), t = 15 seconds. (US devices)
	C5	4081	See 4.3.1 $R_{\theta JL}$ (maximum) $\leq 22^{\circ}\text{C/W}$ (see 4.3.1); $L = .375$ inch (9.53 mm). For surface mount devices (US version), $R_{\theta JEC} = 6.5^{\circ}\text{C/W}$ maximum.
	C6	1026	$I_O = 3$ A minimum; and adjust I_O or T_A 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), $T_A = 55^{\circ}\text{C}$ (max). For irradiated devices, include t_{rr} as an end-point measurement.

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 table E-IX of MIL-PRF-19500 and as specified herein. 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 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 Free air burn-in and life tests. The use of a current limiting or ballast resistor is permitted provided that each DUT still sees the required T_J and 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. $T_A = 55^{\circ}\text{C}$ maximum.

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 . Measurement delay time $t_{MD} = 70 \mu\text{s}$ max. See MIL-PRF-19500, table E-IX, subgroup 4. Forced moving air or draft shall not be permitted across the devices during test.

MIL-PRF-19500/411T

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TABLE I. Group A inspection.

Inspection <u>1/</u>	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 <u>2/</u>	3101	See 4.3.1	$Z_{\theta JX}$			°C/W
* Forward voltage	4011	Condition A, $I_F = 1.5$ A dc (pulsed see 4.5.1)	V_{F1}	0.5	1.2	V
* Forward voltage	4011	Condition A, $I_F = 9$ A dc (pulsed see 4.5.1); $t_p = 300$ μ S; 2 percent maximum duty cycle	V_{F2}	0.6	1.5	V
Reverse current	4016	DC method, $V_R =$ rated (see col. 2 of 1.3).	I_{R1}		1.0	μ A
Breakdown voltage	4021	$I_R = 50$ μ A dc	$V_{(BR)1}$			
1N5415, 1N5415US				55		V
1N5416, 1N5416US				110		V
1N5417, 1N5417US				220		V
1N5418, 1N5418US				440		V
1N5419, 1N5419US				550		V
1N5420, 1N5420US				660		V
<u>Subgroup 3</u>						
High temperature operation:		$T_A = +100^\circ\text{C}$				
Reverse current	4016	DC method, $V_R =$ rated (see col. 2 of 1.3).	I_{R2}		20	μ A
Low temperature operation:		$T_A = -55^\circ\text{C}$				
* Forward voltage	4011	Condition A, $I_F = 0.5$ A (pulsed see 4.5.1)	V_{F3}	0.5	1.4	V
Breakdown voltage	4021	$I_R = 50$ μ A	$V_{(BR)2}$			
1N5415, 1N5415US				50		V
1N5416, 1N5416US				100		V
1N5417, 1N5417US				200		V
1N5418, 1N5418US				400		V
1N5419, 1N5419US				500		V
1N5420, 1N5420US				600		V

See footnote at end of table.

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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	trr			
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	Condition A, IFSM = rated (see col. 6 of 1.3); ten surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 2 \text{ A dc}$, $V_{RWM} = \text{rated } V_{RWM}$ (see col. 3 of 1.3).				
Electrical measurement		See table IV, step 1.				
<u>Subgroup 7</u>						
Not applicable						

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

2/ This test required for the following end-point measurements only:
 Group B, subgroups 3, 4, and 5 (JANS).
 Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).
 Group C, subgroup 2 and 6.
 Group E, subgroup 1.

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

Inspection 1/ <u>Subgroup 1</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
Neutron irradiation	1017					
Electrical measurements		IF = 9 A dc, (pulsed see 4.5.1)				
* Forward voltage M, D, R, H 1N5415, 1N5415US 1N5416, 1N5416US 1N5417, 1N5417US 1N5418, 1N5418US 1N5419, 1N5419US 1N5420, 1N5420US	4011	Condition A, tp = 300 μs; 2 percent maximum duty cycle	VF	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 V V V V V
Reverse current, M, D, R, H 1N5415, 1N5415US 1N5416, 1N5416US 1N5417, 1N5417US 1N5418, 1N5418US 1N5419, 1N5419US 1N5420, 1N5420US	4016	DC method VR = 50 V VR = 100 V VR = 200 V VR = 400 V VR = 500 V VR = 600 V	IR		1.0 1.0 1.0 1.0 1.0 1.0	μA μA μA μA μA μA
<u>Subgroup 2</u> Total dose irradiation	1019					
Electrical measurements		IF = 9 A dc (pulsed see 4.5.1)	VF			

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	Condition A, $t_p = 300 \mu s$; 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 V V V V V
Reverse current M, D, R, H 1N5415, 1N5415US 1N5416, 1N5416US 1N5417, 1N5417US 1N5418, 1N5418US 1N5419, 1N5419US 1N5420, 1N5420US	4016	DC method $V_R = 50 \text{ V dc}$ $V_R = 100 \text{ V dc}$ $V_R = 200 \text{ V dc}$ $V_R = 400 \text{ V dc}$ $V_R = 500 \text{ V dc}$ $V_R = 600 \text{ V dc}$	IR		1.0 1.0 1.0 1.0 1.0 1.0	μA μA μA μA μA μA

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

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

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1A</u>			45 devices c = 0
Temperature cycling (air to air)	<u>1/</u> 1051	20 cycles, low temperature shall be -195°C and high temperature shall be +150°C.	
Hermetic seal <u>2/</u>	1071		
Electrical measurements		See table I , subgroup 2, and table IV , herein.	
<u>Subgroup 1B</u>			
Temperature cycling (air to air)	1051	500 cycles, condition C, -65°C to +175°C.	
Hermetic seal <u>2/</u>	1071		
Electrical measurements		See table IV , herein.	
<u>Subgroup 2</u>			
Steady-state dc blocking life	1048	1,000 hours, $V_R = V_{RWM}$ (see col. 3 of 1.3).	
Electrical measurements		See table I , subgroup 2, and table IV , steps 1, 2, 3, and 4. For irradiated devices, include t_{ir} as an end-point measurement.	
<u>Subgroup 4</u>			
Thermal impedance curves		See MIL-PRF-19500 .	22 devices c = 0
<u>Subgroup 5</u>			
Barometric pressure, reduced (altitude operation)	1001	Pressure 8.0 mm.	

See footnotes at end of table.

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

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 8</u> ^{3/} Peak reverse power Electrical measurements	4065	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. 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.	45 devices
<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 Electrical measurements	4066	Condition A, $I_{FSM} = 80$ A(pk); ten surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 2$ A dc; $V_{RWM} = \text{rated } V_{RWM}$ (see col. 3 of 1.3). $T_A = +55^\circ\text{C}$. See table I, subgroup 2, and table IV, herein.	22 devices c = 0

^{1/} Test method 1056 condition D, using liquid nitrogen may be used in lieu of TM 1051.

^{2/} Opaque glass double plug non cavity axial lead diodes may use TM 2068 in lieu of TM 1071.

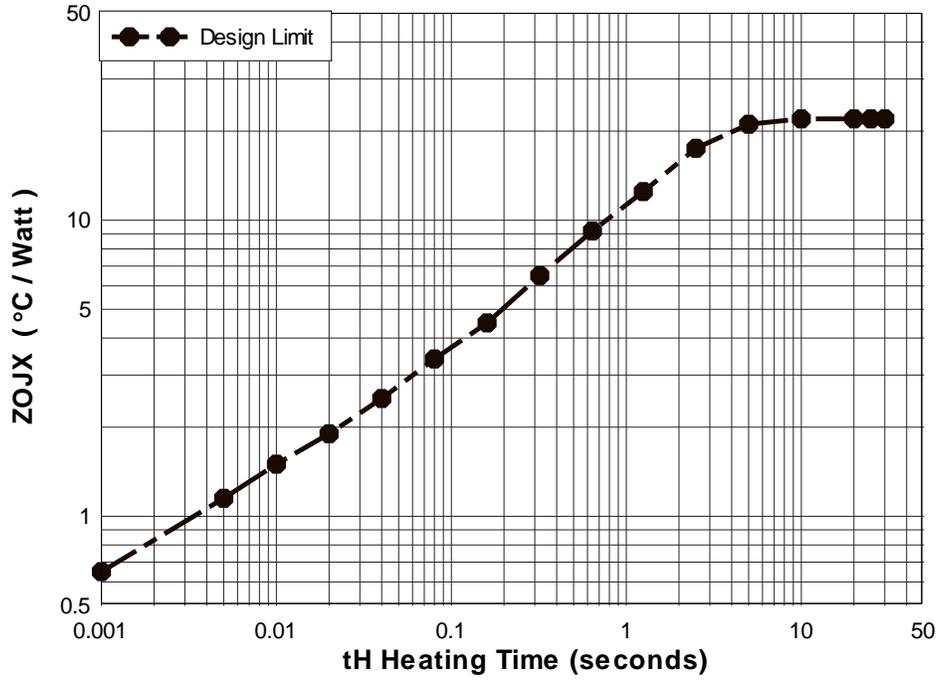
^{3/} The sample size for this step stress requirement shall be determined by the supplier. A statistically significant sample size is required.

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TABLE IV. Delta measurements. 1/ 2/ 3/ 4/ 5/

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Reverse current	4016	DC method V _R = rated (see col. 2 of 1.3)	ΔI _R	100 percent of initial value or 250 nA dc, whichever is greater.		

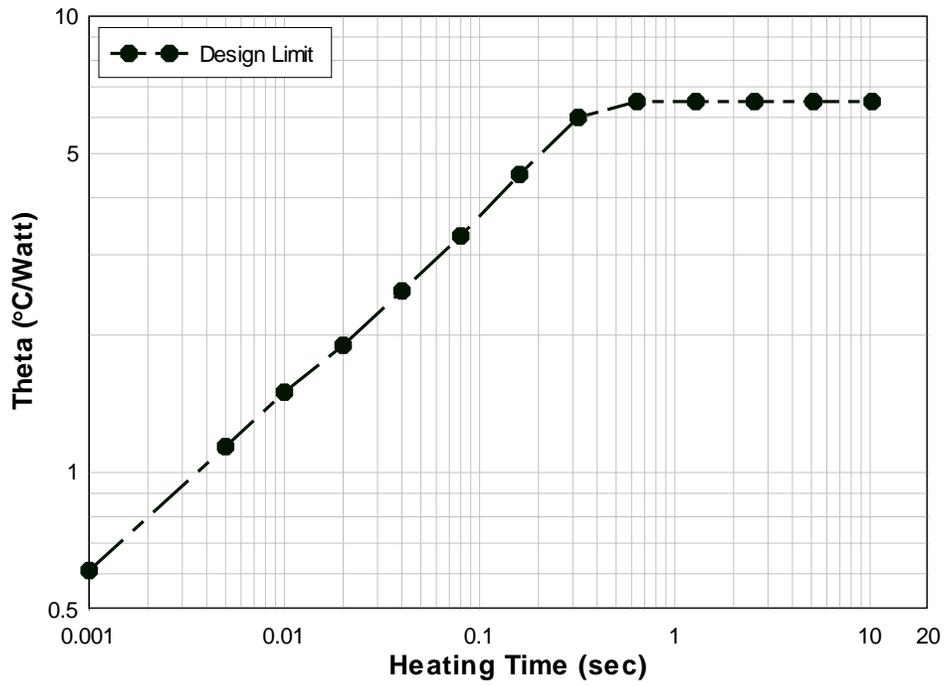
- 1/ Devices which exceed the group A limits for this test shall not be accepted.
- 2/ The delta measurements for group B inspection in table E-VIA (JANS) of MIL-PRF-19500 are as follows:
 - a. Subgroup 4, see table IV herein, step 1.
 - b. Subgroup 5, see table IV herein, step 1.
- 3/ The delta measurements for group B inspection in table E-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 delta measurements for group C inspection in table E-VII (all quality levels) of MIL-PRF-19500 are as follows:
 - a. Subgroup 2, see table IV herein, step 1.
 - b. Subgroup 6, see table IV herein, step 1.
- 5/ The delta measurements for group E inspection in table E-IX of MIL-PRF-19500 are as follows:
 - a. Subgroup 1, see table IV herein, step 1.
 - b. Subgroup 2, see table IV herein, step 1.
 - c. Subgroup 10, see table IV herein, step 1.



$Z_{\theta JX} = 1.5^{\circ}\text{C/W}$ at 10 ms

$R_{\theta JL} = 22^{\circ}\text{C/W}$

FIGURE 3. Axial leaded thermal-impedance curve, maximum.



$Z_{\theta JX} = 1.5^{\circ}\text{C/W}$ at 10 ms

$R_{\theta JEC} = 6.5^{\circ}\text{C/W}$

FIGURE 4. Surface mount thermal-impedance curve, maximum.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When 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. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

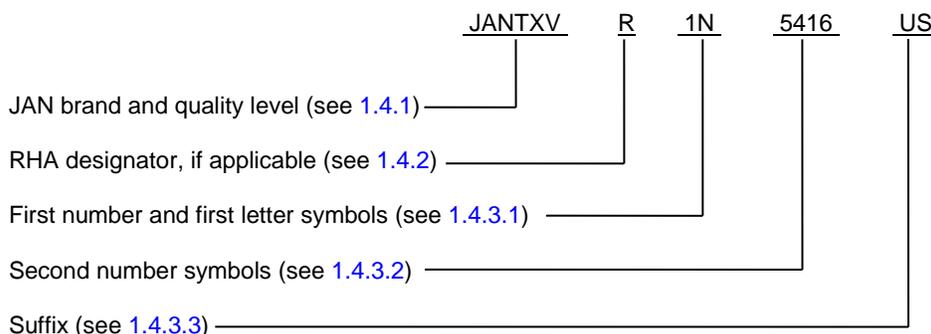
* 6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).

* d. The complete PIN, see 1.4 and 6.5.

* 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 DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

* 6.4 PIN construction example. The PINs for encapsulated devices are construction using the following form.



* 6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

Axial lead package of figure 1					
PINs for devices of the "JAN" quality level	PINs for devices of the "JANTX" quality level	PINs for devices of the "JANTXV" quality level	PINs for devices of the "JANTXV" quality level with RHA (1)	PINs for devices of the "JANS" quality level	PINs for devices of the "JANS" quality level with RHA (1)
JAN1N5415	JANTX1N5415	JANTXV1N5415	JANTXV#1N5415	JANS1N5415	JANS#1N5415
JAN1N5416	JANTX1N5416	JANTXV1N5416	JANTXV#1N5416	JANS1N5416	JANS#1N5416
JAN1N5417	JANTX1N5417	JANTXV1N5417	JANTXV#1N5417	JANS1N5417	JANS#1N5417
JAN1N5418	JANTX1N5418	JANTXV1N5418	JANTXV#1N5418	JANS1N5418	JANS#1N5418
JAN1N5419	JANTX1N5419	JANTXV1N5419	JANTXV#1N5419	JANS1N5419	JANS#1N5419
JAN1N5420	JANTX1N5420	JANTXV1N5420	JANTXV#1N5420	JANS1N5420	JANS#1N5420

(1) The number sign (#) represents one of four RHA designators available on this specification sheet ("M", "D", "R", or "H").

Surface mount package of figure 2					
PINs for devices of the "JAN" quality level	PINs for devices of the "JANTX" quality level	PINs for devices of the "JANTXV" quality level	PINs for devices of the "JANTXV" quality level with RHA (1)	PINs for devices of the "JANS" quality level	PINs for devices of the "JANS" quality level with RHA (1)
JAN1N5415US	JANTX1N5415US	JANTXV1N5415US	JANTXV#1N5415US	JANS1N5415US	JANS#1N5415US
JAN1N5416US	JANTX1N5416US	JANTXV1N5416US	JANTXV#1N5416US	JANS1N5416US	JANS#1N5416US
JAN1N5417US	JANTX1N5417US	JANTXV1N5417US	JANTXV#1N5417US	JANS1N5417US	JANS#1N5417US
JAN1N5418US	JANTX1N5418US	JANTXV1N5418US	JANTXV#1N5418US	JANS1N5418US	JANS#1N5418US
JAN1N5419US	JANTX1N5419US	JANTXV1N5419US	JANTXV#1N5419US	JANS1N5419US	JANS#1N5419US
JAN1N5420US	JANTX1N5420US	JANTXV1N5420US	JANTXV#1N5420US	JANS1N5420US	JANS#1N5420US

(1) The number sign (#) represents one of four RHA designators available on this specification sheet ("M", "D", "R", or "H").

6.6 Application data.

6.6.1 PCB mounting with FR4 material for full 3 amp I_o. For a PCB mounting example with FR4 material where the full 3 amp I_o rating (half-sine-wave) is used at a T_J of 175°C and ambient temperature of 55°C, the following steps guide the user in what the PCB pad size will need to be with 1 oz, 2 oz, and 3 oz copper. For axial-leaded, the lead length for mounting will be .187 inch (4.76 mm) or less from body to entry point on PCB surface.

- a. Use the I_o versus P_o curve on [figure 5](#) to look up 3 amps (X-axis) and follow up to the T_J = +175°C curve (lower) for 2.81 watts.
- b. Calculate maximum thermal resistance needed $(+175^{\circ}\text{C} - 55^{\circ}\text{C}) / 2.81 \text{ W} = 43^{\circ}\text{C/W}$.
- c. Look up thermal resistance of 43°C/W on Y-axis using a thermal resistance versus pad area plot on one of the three curves on [figure 6](#) for different weights of copper cladding and then intersect curve horizontally to get answer. These curves assume still air, horizontal position.
- d. In this example, the answer is: 1 oz PCB = 1.00 in x 1.00 in (25.4 mm x 25.4 mm), 2 oz PCB = .50 in x .50 in (12.7 x 12.7 mm), 3 oz PCB = .32 in x .32 in (8.128 x 8.128 mm) for each pad.
- e. Add a conservative guard-band to the pad size (larger) to keep T_J below +175°C.

6.6.2 PCB mounting with FR4 material for 1 amp I_o. For a PCB mounting example with FR4 material to support a 1 amp I_o square wave switching at a 0.50 duty factor (50 percent duty cycle) at T_J = +125°C and ambient temperature of +55°C, the following steps guide the user in what the PCB pad size will need to be with 1 oz, 2 oz, and 3 oz copper.

- a. Find size of copper pads on standard FR4 PCB to support operation at 1 amp I_o square wave switching at a 0.50 duty factor (50 percent duty cycle) at T_J = +100°C with T_A = +55°C.
- b. Calculate peak I_F = 1A / 0.50 duty factor = 2 amps.
- c. Use the V_F versus I_F curve on [figure 7](#) to look up I_F = 2 A (Y-axis) and follow across to the T_J = +125°C curve (middle) for V_F = 0.775 V.
- d. Calculate power = I_F x V_F x duty factor = 2 x 0.775 x 0.50 = 0.775 W.
- e. Calculate maximum thermal resistance needed $(+100^{\circ}\text{C} - 55^{\circ}\text{C}) / 0.775 \text{ W} = 58^{\circ}\text{C/W}$.
- f. Look up thermal resistance of 90°C/W on the Y-axis using a thermal resistance versus pad area plot on one of the three curves on [figure 7](#) for different weights of copper cladding and then intersect curve horizontally to get answer. Curves assume still air, horizontal position.
- g. In this example, the answer is: 1oz PCB = .092 in X .092 in (2.34 mm x 2.34 mm), 2oz PCB = .055 in x .055 in (1.4 mm x 1.4 mm), 3oz PCB = .036 in x .036 in (0.91 mm x 0.91 mm) for each pad.
- h. A conservative pad guard-band is optional since T_J is only +100°C. NOTE: Multilayer PCBs, forced air cooling will improve performance. Closed confinement of the PCB will do the opposite. Use sound thermal management.

Average Sine Current (I_o) vs Total Power (P_o)
 1N5420 ss411

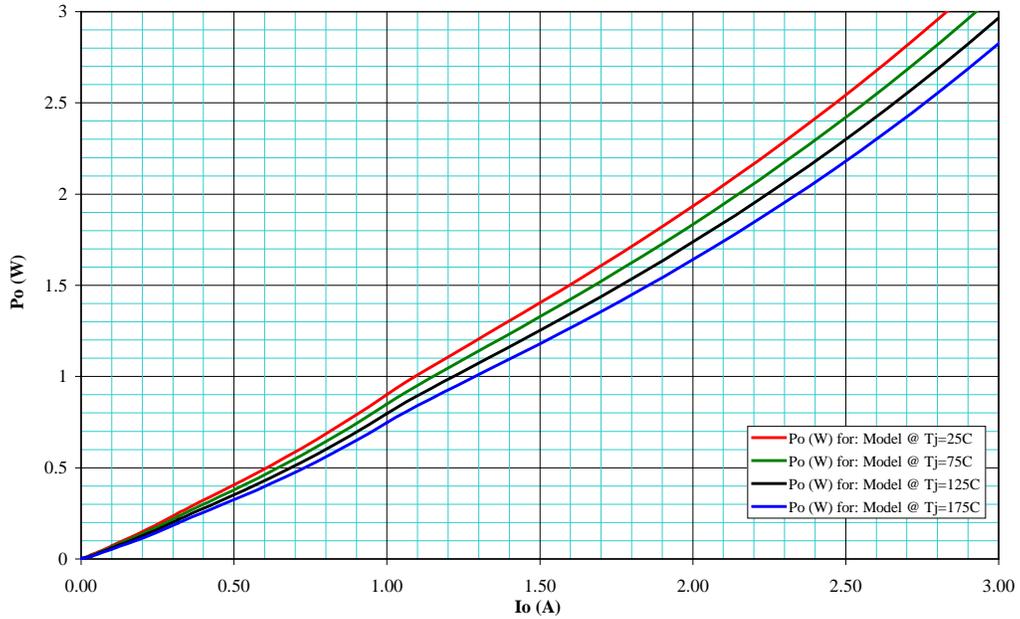


FIGURE 5. Rectifier power versus I_o (average forward current).

B-Pkg/E-Pkg MELF/Axial Thermal Resistance vs FR4 Pad Area
 Still Air, PCB Horizontal

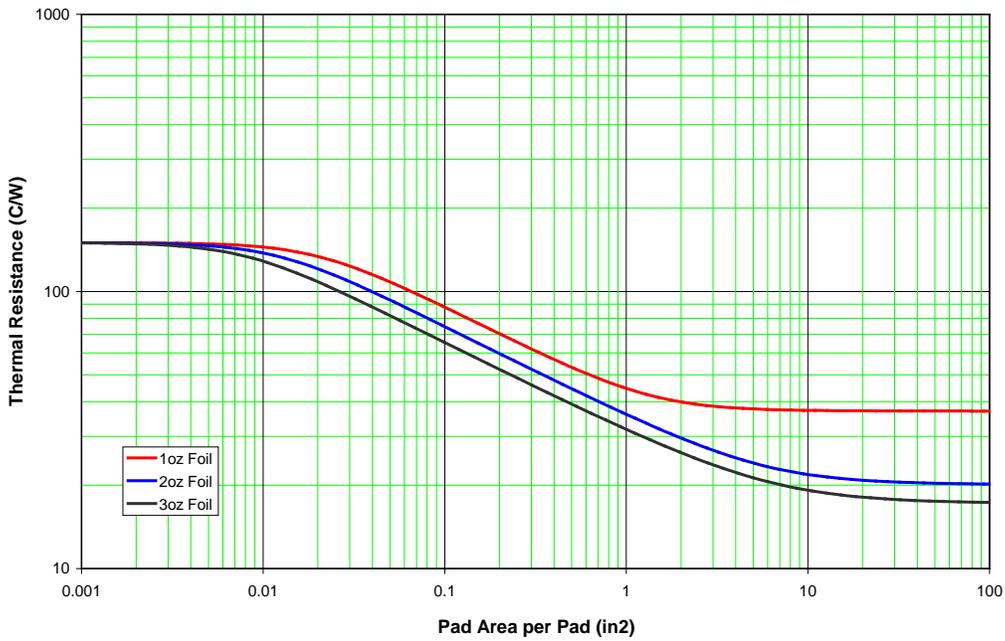


FIGURE 6. Thermal resistance versus pad area (for each pad) with 1 oz, 2 oz, and 3 oz copper.

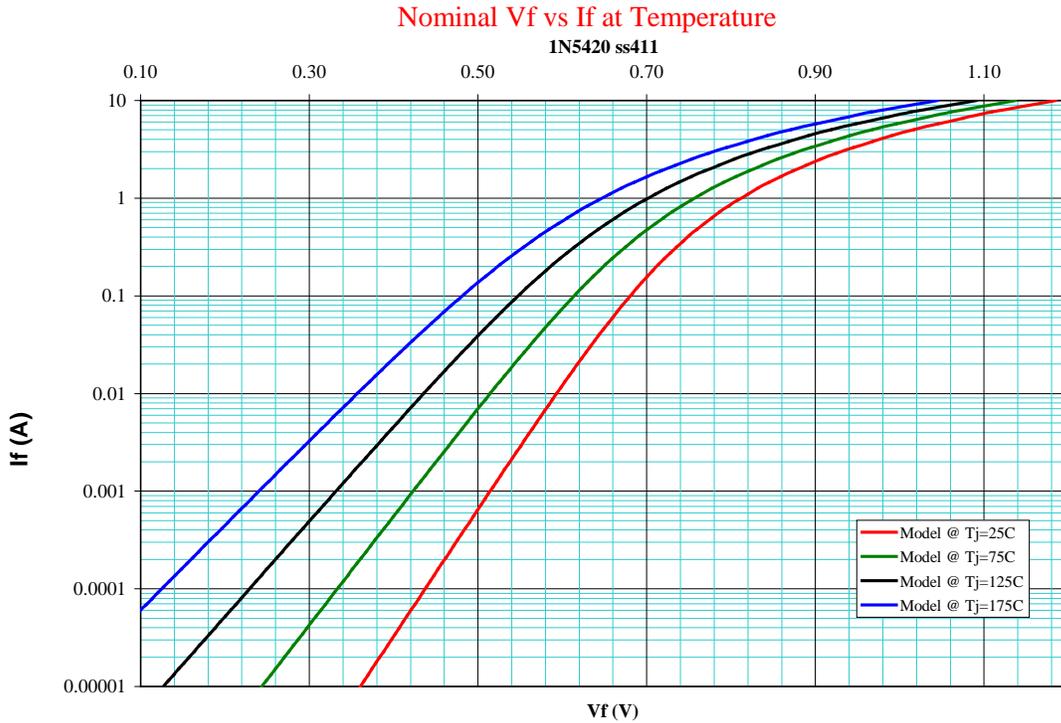


FIGURE 7. Forward voltage versus forward current for 1N5420.

* 6.7 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 693-1642 or DSN 850-6939.

6.8 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 previous issue.

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 Navy - EC
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Preparing activity:
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 (Project 5961-2016-090)

Review activities:
 Army - AR, AV, MI, SM
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