

The documentation and process conversion measures necessary to comply with this revision shall be completed by 11 October 2005.

INCH-POUND

MIL-PRF-19500/554C
 11 July 2005
 SUPERSEDING
 MIL-PRF-19500/554B
 10 June 2004

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON,
 SCHOTTKY BARRIER, FAST RECOVERY,
 TYPE 1N6392, JAN, JANTX, JANTXV, AND JANHC

This specification is approved for use by the 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 a silicon, fast recovery, Schottky barrier semiconductor diode. Three levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. One level of product assurance is provided for each unencapsulated device type.

1.2 Physical dimensions. See figure 1 (DO-5) and figure 2 (JANHC die).

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

Type	V_{RRM} and V_{RWM} (1)	V_{RSM}	V_R (1)	I_{FM} (2)	I_O (3)	I_{FSM}	T_J T_{STG}	Max $R_{\theta JC}$
				$T_C = +115^\circ\text{C}$	$T_C = +115^\circ\text{C}$			
	<u>V(pk)</u>	<u>V(pk)</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A (pk)</u>	<u>°C</u>	<u>°C/W</u>
1N6392	45	54	45	60	54	1,000	-55 to +175	1.0

- (1) Full rated V_{RRM} and V_{RWM} is applicable over the range of $T_C = -55^\circ\text{C}$ to $+173^\circ\text{C}$ for $I_{FM} = 0$. Full rated V_R is applicable over the temperature range of $T_C = -55^\circ\text{C}$ to $+166^\circ\text{C}$. When $V_R = 45$ V dc and $T_C = +166^\circ\text{C}$, then $T_J = +175^\circ\text{C}$.
- (2) Average current with a 50 percent duty cycle square wave including reverse amplitude equal to the magnitude of full rated V_{RWM} . Derate linearly at 1.09 A dc/°C for $T_C > +115^\circ\text{C}$.
- (3) Average current with an applied sine wave peak value equal to the magnitude of full rated V_{RWM} . See 3.7.1 device derating.

* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to 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://assist.daps.dla.mil>.

1.4 Unless otherwise noted, primary electrical characteristics at $T = +25^{\circ}\text{C}$.

Type	Max V_{FM1} $I_{FM} = 120 \text{ A (pk)}$	Max V_{FM3} $I_{FM} = 10 \text{ A (pk)}$	Max I_{RM} $V_{RM} = 45 \text{ V (pk)}$		Max C_T $V_R = 5 \text{ V dc}$
			$T_J = +175^{\circ}\text{C}$	$T_J = +25^{\circ}\text{C}$	
	<u>V (pk)</u>	<u>V (pk)</u>	<u>mA (pk)</u>	<u>mA (pk)</u>	<u>pF</u>
1N6392	0.82	0.51	200	2.0	3,000

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

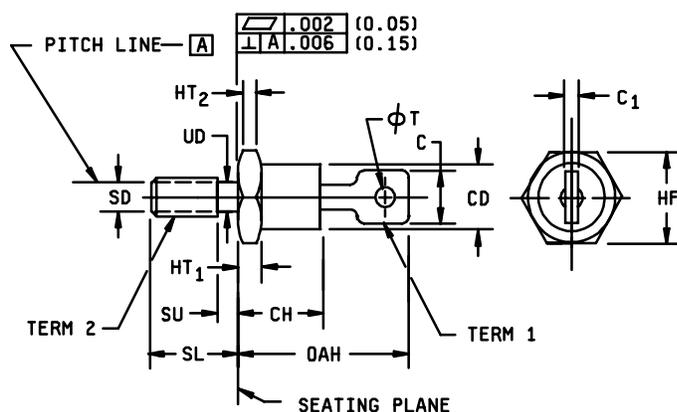
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

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 <http://assist.daps.dla.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.

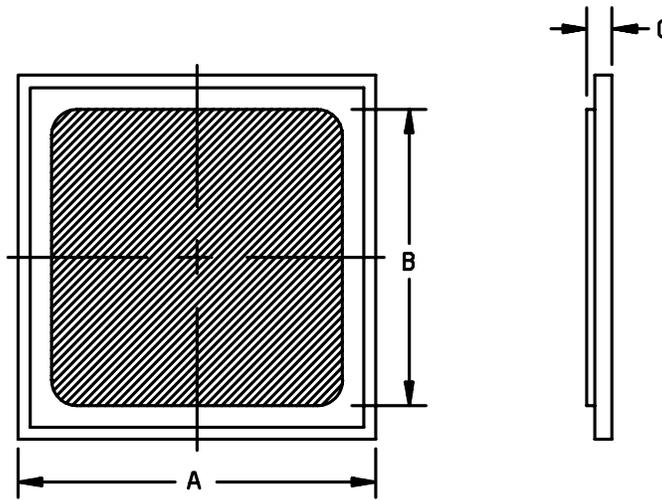


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
C		.375		9.52	7
C1	.025	.080	0.64	2.03	
CD		.667		16.94	
CH		.450		11.43	
HF	.669	.688	17.00	17.47	
HT1	.115	.200	2.93	5.08	
HT2	.060		1.53		6
OAH	.750	1.00	19.05	25.40	
SD					5
SL	.422	.453	10.72	11.50	
SU		.090		2.28	
UD	.220	.249	5.59	6.32	4
ϕT	.140	.175	3.56	4.44	

NOTES:

- Dimensions are in inches.
- Millimeters are given for general information only.
- Units must not be damaged by torque of 30 inch-pound applied to .25-28 UNF-2B nut assembled on thread.
- Length of incomplete or undercut threads of UD.
- Maximum pitch diameter of plated threads shall be basic pitch diameter .2268 inch (5.76 mm) reference (FED-STD-H28, "Screw-Thread Standards for Federal Services").
- A chamfer or undercut on one or both ends of the hex portion is optional; minimum base diameter at seating plane .600 inch (15.24 mm).
- The angular orientation and peripheral configuration of terminal 1 is undefined, however, the major surfaces over dimensions C and C₁ shall be flat and the minimum cross-sectional area from the hole to any point on the periphery shall be .0025 in² (1.59 mm²).
- In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions (similar to DO-5).



A, B, and C versions

Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.212	.215	5.38	5.46
B	.198	.200	5.03	5.08
C	.012	.013	.30	.33

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The metallization characteristics of the die are:
 JANHC version: Anode (front) Cathode (back)
 A Ag Ag
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 2. JANHCA die dimensions (A version).

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

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figures 1 and 2 herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Diode construction. These devices shall be constructed in a manner and using material which enable the diodes to meet the applicable requirements of MIL-PRF-19500 and this document.

3.5.1 Polarity. Devices shall have the cathode electrically connected to the stud.

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

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

3.7.1 Device derating. Device derating curve see figure 4 herein.

* 3.8 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I.

3.9 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 Group E qualification. Group E inspection shall be performed 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 II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.2 JANHC devices. JANHC devices shall be qualified in accordance with MIL-PRF-19500.

MIL-PRF-19500/554C

* 4.3 Screening (JANTX and JANTXV levels only). 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) (1)	Measurement
	JANTX and JANTXV levels
3a	Condition C
3b	Surge, see 4.3.2
3c	Thermal impedance, see 4.3.3
4	Not applicable
7	Optional
9	Not applicable
10	Not applicable
(1) (2) 11	Reverse energy test (see 4.5.2), followed by V_{FM1} and I_{RM1} of table I, subgroup 2.
12	Burn-in, method 1038 of MIL-STD-750, test condition A; see 4.3.4.
(2) (3) 13	V_{FM1} and I_{RM1} of table 1, subgroup 2; $\Delta V_{FM1} = 0.05 \text{ V (pk)}$, $\Delta I_{RM1} = \pm 100 \text{ percent or } 5 \text{ mA dc}$, whichever is greater. Scope display evaluation (see 4.5.3).
14	Required

(1) I_{RM1} shall not be indicative of an open condition.

(2) All JAN level devices shall be subjected to the scope display evaluation test, and reverse energy test.

(3) Surge current shall precede thermal response. These tests shall be performed anytime after screen 3 and before screen 10.

4.3.1 Screening (JANH C). Screening of JANHC die shall be in accordance with MIL-PRF-19500.

4.3.2 Surge current. Surge current shall be performed in accordance with method 4066 of MIL-STD-750, with the following conditions: $I_{FSM} = 1,000 \text{ A}$, 6 surges, $t_p = 8.3 \text{ ms}$, 1/2 sine wave, or rectangular pulse of equivalent I_{RMS} , $I_O = 0 \text{ A}$, $V_{RWM} = 0$, duty factor one percent minimum, $T_A = 25^\circ\text{C}$.

4.3.3 Thermal impedance. Thermal impedance $Z_{\theta JC}$ measurements shall be performed in accordance with method 3101 of MIL-STD-750. Read and record data ($Z_{\theta JC}$) shall be supplied to the qualifying activity on one lot (random sample of 500 devices minimum) prior to shipment. Twenty-two samples shall be serialized and provided to the qualifying activity for test correlation. The following conditions shall apply: $I_H \geq$ rated I_O , $t_H = 150$ to 400 ms, $I_M = 50$ mA to 250 mA, $t_{MD} = 50$ to 300 μ s. The maximum limit for $Z_{\theta JC}$ under these test conditions is $Z_{\theta JC}(\max) = 1.0^\circ$ C/W.

4.3.4 Burn-in. Method 1038 of MIL-STD-750, test condition A, $T_C = 165^\circ$ C, $V_{RM} = 36$ V (pk), $I_O = 0$, $f = 60$ Hz, $t = 48$ hrs; Alternate test: $V_R = 36$ V dc and $T_C = 165^\circ$ C, $t = 48$ hrs.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

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 as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$T_C = 165^\circ$ C, $V_{RM} = 36$ V (pk) or $V_R = 36$ V dc.
B5	4081	See 4.5.4.
B7	4066	$I_{FSM} = 1,000$ A (pk); $V_{RM} = 45$ V (pk), $I_O = 45$ A dc; 10 surges of 8.3 ms each at 1 minute intervals; 100° C $< T_C < 125^\circ$ C; 22 devices, $c = 0$.

* 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 as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition A, 15 lbs, $t = 15$ s. Test condition F (method B), 15 pounds, $t = 15$ s. Test condition D1, 3 inch-pound, $t = 15$ s. Test condition D2, 30 inch-pound, $t = 15$ s.
C5	4081 or 3101	$R_{\theta JC} = 1.0^\circ$ C/W maximum in accordance with 4.3.3 except $t_H = 25$ s (minimum). $n = 22$, $c = 0$.
C6	1027	$T_C = 165^\circ$ C, $V_{RM} = 36$ V (pk) or $V_R = 36$ V dc.
C7	1037	Operational power cycling, $I_O = 50$ A dc, T_C (low) = $+40^\circ$ C $+0^\circ$ C, -15° C; T_C (high) = 115° C $+5^\circ$ C, -0° C; 5,000 cycles; 22 devices, $c = 0$, (see 4.5.6).

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

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

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

4.5.2 Peak reverse energy test. The peak reverse energy test is to be performed as on figure 3. The Schottky rectifier under test must be capable of absorbing the reverse energy, as defined, and meet the electrical requirements of table I, subgroup 4 herein.

4.5.3 Scope display evaluation. A curve trace visual display of the reverse characteristics (voltage versus current) shall be made using a calibration of 10 mA per division vertical sensitivity, and 10 V dc per division horizontal sensitivity. Increase the reverse voltage until the reverse current reaches 50 mA minimum to 70 mA maximum. Observe the curve characteristics. Any device with an erratic pattern, such as double trace, other than capacitance effects, intermittence, discontinuities other than zener noise at the knee of the curve, or shorts shall be removed from the lot. Time limit for this test shall be 5 seconds minimum.

This test shall be the last test performed on the device in the 100 percent screening tests. The percent defective result for evaluation against the percent defective allowed (PDA) shall be determined prior to the results of this test.

4.5.4 Thermal resistance. Thermal resistance measurements shall be performed in accordance with method 4081 of MIL-STD-750. The case reference temperature shall be held to equilibrium within the range of +20°C to +70°C during the power application, and shall be measured at the hex flat. The maximum limit of $R_{\theta JC}$ shall be 1.0°C/W. The following parameter measurements shall be used:

- a. I_{F1} = 20 A dc minimum to 50 A dc maximum.
- b. I_{F2} = 100 mA dc.

4.5.5 Reverse current at peak reverse voltage, alternate test. The reverse current at peak reverse voltage test requirement may be satisfied by performing the reverse energy test of 4.5.2 and measuring breakdown voltage to ensure $V_{BR} \geq 54$ V (pk) with $I_{RM} = 2.0$ A (pk).

4.5.6 Operating power cycling. Method 1037 of MIL-PRF-19500. One complete cycle for this test shall consist of the following two steps: Step 1, heat the case to the T_C (high) specified by passing the specified forward current through the diode under test. The reverse voltage shall be only enough to permit the reverse current to flow, and in any event should be a maximum of 5 V dc. Step 2, remove the applied current and allow the case temperature to cool to the T_C (low) specified. No time limit is applicable to the steps, but the cycling must be continuous until the required number of cycles has been completed. It is permissible to force cool the device during step 2.

This test shall be considered a qualification test only, and needs to be performed during the initial qualification and as applicable to verify the adequacy of a design change.

4.5.7 Inspection conditions. Unless otherwise specified in MIL-PRF-19500 or herein, all inspections shall be conducted at a case temperature (T_C) of +25°C ± 3°C.

TABLE I. Group A inspection.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Thermal impedance	3101	See 4.3.3			1.0	°C/W
Forward voltage	4011	I _{FM} = 120 A (pk) pulsed (see 4.5.1)	V _{FM1}		0.82	V (pk)
		I _{FM} = 60 A (pk) pulsed (see 4.5.1)	V _{FM2}		0.68	V (pk)
		I _{FM} = 10 A (pk) pulsed (see 4.5.1)	V _{FM3}		0.51	V (pk)
Reverse current	4016	Pulsed method, (see 4.5.1) V _{RM} = 45 V (pk)	I _{RM1}		2.0	mA (pk)
<u>Subgroup 3</u>						
High temperature operation						
Reverse current leakage	4016	Pulse method, (see 4.5.1) V _{RM} = 45 V (pk)				
		T _J = +175°C	I _{RM2}		200	mA (pk)
		T _J = +125°C	I _{RM3}		60	mA (pk)
Low temperature operation		T _C = -55°C				
Reverse current leakage	4016	Pulse method, (see 4.5.1) V _{RM} = 45 V (pk)	I _{RM4}		400	mA (pk)
Forward voltage	4011	Pulsed (see 4.5.1) I _F = 10 A (pk)	V _{FM4}		0.69	V (pk)
<u>Subgroup 4</u>						
Reverse current leakage at peak reverse voltage	4016	Peak reverse energy test (see 4.5.2) V _{RSM} = 54 V (pk) (alternate test, see 4.5.5)	I _{RM5}		2.0	A (pk)
Capacitance	4001	V _R = 5 V dc; f = 100 KHz ≤ f ≤ 1 Mhz	C _T		3,000	pF

See footnote at end of table.

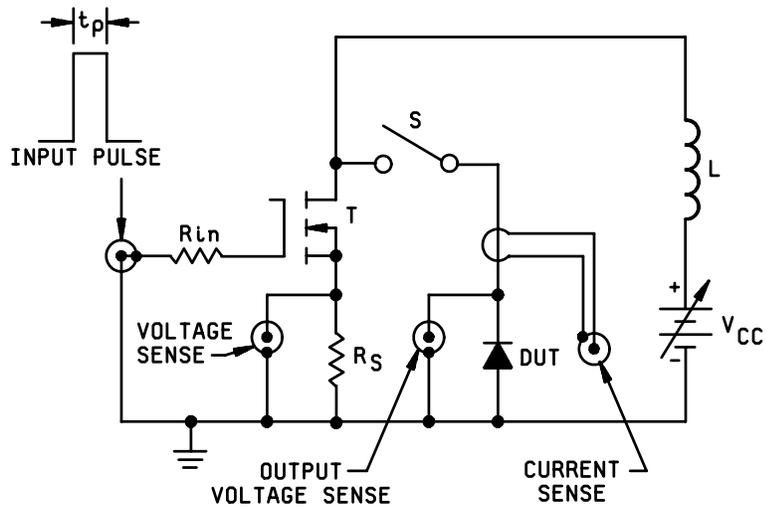
TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> Not applicable						
<u>Subgroup 6</u> Forward surge	4066	$I_{FSM} = 1,000 \text{ A (pk)}$; 10 surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 22.5 \text{ A dc}$; $V_{RWM} = \text{rated } V_{RWM}$ (see 1.3); $T_A = +100^\circ\text{C}$.				
Electrical end-points		See table I, subgroup 2				
<u>Subgroup 7</u> Not applicable						

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

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

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			22 devices c = 0
Thermal shock	1056	100 cycles, 0° to 100°C.	
Hermetic seal	1071	Test condition C and H1	
Electrical measurement		See table I, subgroup 2.	
<u>Subgroup 2</u>			22 devices c = 0
Steady-state reverse bias	1038	Test condition A, 1,000 hours.	
Electrical measurement		See table I, subgroup 2	
<u>Subgroup 4</u>			Sample size = N/A
Thermal impedance curves		Each supplier shall submit their qual-lot average and design thermal impedance curves to the qualifying activity. In addition, the optimal test conditions and thermal impedance limit shall be provided to the qualifying activity in the qualification report.	
<u>Subgroup 5</u>			
Not applicable			

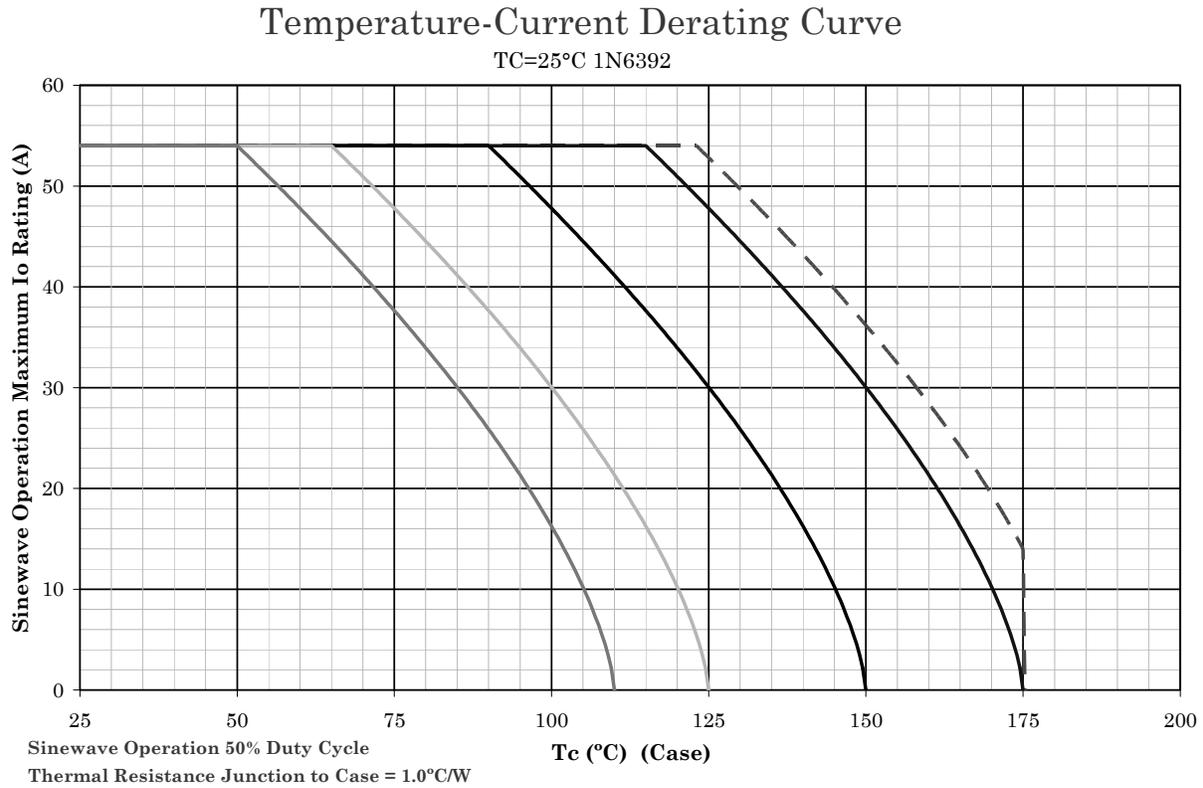


Input pulse	$R_{in} = 50 \text{ ohms}, 1 \text{ W}$
$V_G = 10 \text{ V dc}$	$R_S = 0.1 \text{ ohms}, 1 \text{ W}$
$R_G = 50 \text{ ohms}$	$V_{CC} \approx 10 \text{ V dc}$
P.W. $\approx 30 \mu\text{s}$	$L = 260 \mu\text{H}$
Duty cycle $\leq 1 \text{ percent}$	$T = \text{IRF130/2N6756 or equivalent}$

PROCEDURES:

1. With S open, adjust pulse width to test current of 2 A across R_S .
2. Close S, verify test current with current sense.
3. Read peak output voltage (see 4.5.5).

FIGURE 3. Peak reverse energy test circuit.



NOTES:

1. Top curve is thermal runaway loci and cannot be used as a derate design curve since it exceeds the maximum ratings for this part. Operating under this curve using these mounting conditions assures the device will not have a thermal runaway. This is the true inverse of the worst case thermal resistance value extrapolated out to the thermal runaway point.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq 200^\circ\text{C}$) and current rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq 150^\circ\text{C}$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq 125^\circ\text{C}$, and 110°C to show current rating where most users want to limit T_J in their application.

FIGURE 4. Temperature current derating curve.

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.)

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 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 Suppliers of JANHC die. The qualified JANHC suppliers with the applicable letter version (example, JANHCA1N6392) will be identified on the QPL.

JANHC ordering information	
	Manufacturer
PIN	59377
1N6392	JANHCA1N6392

6.5 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:
Air Force - 11
DLA – CC

Preparing activity:
DLA - CC

Review activities:
Air Force - 19, 99

(Project 5961-2973)

* 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://assist.daps.dla.mil>.