

The documentation and process conversion measures necessary to comply with this revision shall be completed by 21 May 2008.

INCH POUND

MIL-PRF-19500/552E
21 February 2008
SUPERSEDING
MIL-PRF-19500/552D
4 December 2006

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, TRANSIENT VOLTAGE SUPPRESSOR,
TYPES 1N6469 THROUGH 1N6476, 1N6469US THROUGH 1N6476US,
JAN, JANTX, AND JANTXV

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 1,500-watt silicon, transient voltage suppressor diodes. Three levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

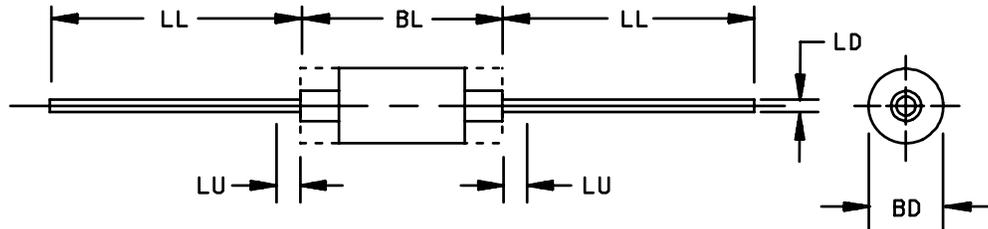
1.2 Physical dimensions. See figures 1 (axial lead) and 2 (surface mount).

1.3 Maximum ratings. Maximum ratings are as shown in maximum test ratings (see 3.6) and as follows:

- a. $P_R = 3 \text{ W}$ (derate $20 \text{ mW}/^\circ\text{C}$ above $T_A = +25^\circ\text{C}$) (see figure 3).
- b. (Derate at $100 \text{ mW}/^\circ\text{C}$ above $T_{EC} = +145^\circ\text{C}$ for surface mount devices) (see figure 4).
- c. $P_{pp} = 1,500 \text{ W}$ (see figure 5) at $T_P = 1 \text{ ms}$.
- d. $I_{FSM} = 130 \text{ A(pk)}$. $T_P = 8.33 \text{ ms}$ ($T_A = +25^\circ\text{C}$).
- e. $-55^\circ\text{C} \leq T_J \leq +175^\circ\text{C}$; $-55^\circ\text{C} \leq T_{STG} \leq +175^\circ\text{C}$ (ambient).

1.4 Primary electrical characteristics. Primary electrical characteristics are as shown in maximum test ratings herein (see 3.6).

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>.

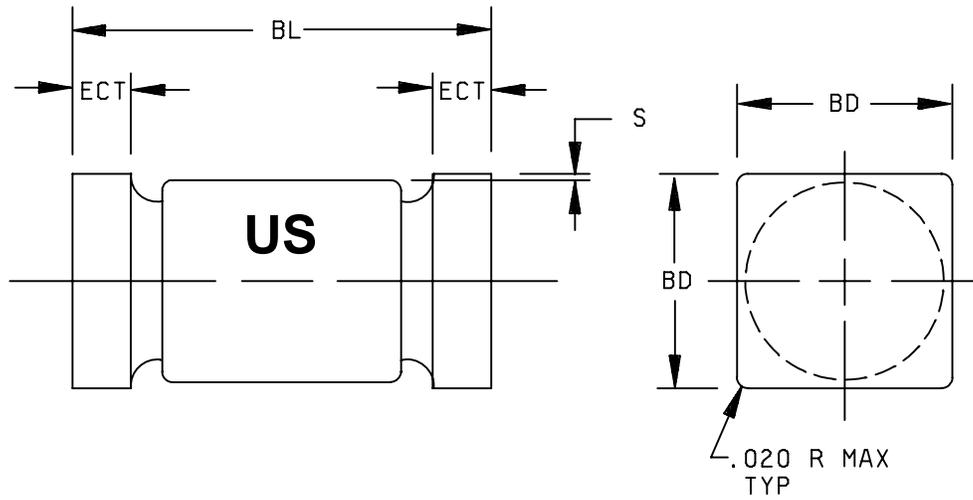


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BD	.150	.185	3.81	4.70	3
BL	.150	.375	3.81	9.53	3
LD	.037	.042	0.94	1.07	
LL	.900	1.300	22.86	33.02	
LU		.050		1.27	4

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Package contour optional within BD and length BL. Heat slugs, if any, shall be included within this cylinder but shall not be subject to minimum limit of BD.
4. Within this zone, lead diameter may vary to allow for lead finishes and irregularities other than heat slugs.
5. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.

FIGURE 1. Physical dimensions (1N6469 through 1N6476).



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BD	.183	.202	4.65	5.13
BL	.205	.245	5.21	6.22
ECT	.019	.028	0.48	0.71
S	.003		0.08	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Referencing to dimension S, minimum clearance of glass body to mounting surface on all orientations.
4. Dimensions are pre-solder dip.
5. In accordance with ASME Y14.5M, diameters are equivalent to Φ x symbology.

FIGURE 2. Physical dimensions 1N6469US through 1N6476US.

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.

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.

P_{PP} Peak pulse power dissipation.

P_R Reverse power dissipation.

V_{CF} Forward clamping voltage.

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

3.4.1 Metallurgically bonded construction. Metallurgically bonded construction is required. The bonding flow shall have flow points above 260°C.

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

3.6 Electrical performance characteristics. Unless otherwise specified, the electrical performance characteristics are as specified in 1.3, 1.4, and tables I and II.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I subgroup 2.

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 inspection. 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 and tables I, II, and III).

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

4.2.1 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 require the performance of table IV tests, the tests specified in table IV 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 (JANTX and JANTXV levels only). Screening shall be in accordance with table E-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 E-IV of MIL-PRF-19500)	Measurement
	JANTX and JANTXV levels
9	Not applicable
11	I_D and V_{BR}
12	See 4.3.1
13	$\Delta I_D \leq 50$ percent of initial reading or 20 percent of column 5 of table II herein, whichever is greater; $\Delta V_{(BR)} \leq \pm 2$ percent of initial reading.

* 4.3.1 Power burn-in and steady-state operation life test conditions. This test shall be conducted with the devices subjected to test conditions in the following order of events and conditions:

- * a. Read and record I_D and V_{BR} at $T_A = +25^\circ\text{C}$.
- b. Pulse in accordance with 4.5.2.a, 20 times (screening and group B operation life test) and 100 times (group C) at $T_A = +25^\circ\text{C}$.
- c. Read I_D and V_{BR} at $T_A = +25^\circ\text{C}$, remove defective devices, and record the number of failures.
- d. Apply the working peak reverse voltage (V_{RWM}) (column 4 of table II herein) at an ambient temperature of $T_A = +125^\circ\text{C}$, as follows. End-point measurements shall be performed within 24 hours.
 - (1) 96 hours minimum (JANTX and JANTXV) for the screening test.
 - (2) 340 hours (JAN, JANTX, and JANTXV) for group B steady-state operation life test.
 - (3) 1,000 hours for group C steady-state operation life test.
- e. Read and record I_D and V_{BR} at $T_A = +25^\circ\text{C}$. Devices with $\Delta I_D > 50$ percent (100 percent for steady-state operation life) of initial value or 20 percent of column 5, table II herein, whichever is greater, or $\Delta V_{BR} > 2$ percent (± 5 percent for steady-state operation life) of initial value shall be considered defective. For steady-state operation life, I_D limit (maximum) shall be two times the table I, subgroup 2 limit. Remove defective devices and record the number of failures.

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. End-point electrical measurements shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIb of MIL-PRF-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

4.4.2.1 Group B inspection, appendix E, table E-VIb of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B2	1051	-55°C to $+175^\circ\text{C}$, 25 cycles $n = 22$, $c = 0$.
B3	1026	See 4.3.1.
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 appendix E, table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	2036	Test condition A; weight = 5 pounds; t = 15 seconds \pm 3 seconds.
C6	1026	$T_A = +125^\circ\text{C}$ (see 4.3.1).
C5	4081	$R_{\Theta\text{JL}} \leq 50^\circ\text{C/W}$ at L = .375 inch (9.53 mm), non-surface mount devices. $R_{\Theta\text{JEC}} \leq 20^\circ\text{C/W}$ at L = 0 inches, surface mount devices. $T_A = +125^\circ\text{C}$.
C7	1018	Not required.
C8		Maximum peak pulse current; conditions, see 4.5.2.b (20 μs pulse only) 10 pulses; 22 devices, c = 0.
C9	4071	∞V_{BR} in accordance with method 4071 of MIL-STD-750, I_{BR} = column 3 of table II herein, $T_1 = +25^\circ\text{C} \pm 3^\circ\text{C}$; $T_2 = +125^\circ\text{C}$; maximum limits = column 8 of table II herein; units = $\%/^\circ\text{C}$; 22 devices, c = 0.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-IX of MIL-PRF-19500 and as specified herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. See table III herein 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 Group C steady-state operation life test (alternate procedure). When the group B, 340 hour life test is continued on test to 1,000 hours to satisfy the group C life test requirements, the test shall be performed as given in 4.3.1 with the following exceptions: 4.3.1.d shall be repeated at the end of the 1,000 hours.

* 4.5.2 Maximum peak pulse current (see figure 5) (I_{PP}). The peak currents specified in column 7 of table II herein shall be applied in the reverse direction while simultaneously maintaining a reverse bias voltage of not less than the applicable voltage specified in column 4 of table II herein. The peak current shall be applied with a current versus time waveform as follows (1 pulse per minute maximum):

- Pulse current shall reach 100 percent of I_{PP} at $t \leq 10 \mu\text{s}$ and decay to 50 percent at $t \geq 1 \text{ ms}$ for $t_{\text{p}} \geq 1 \text{ ms}$ (see figure 6).
- Pulse current shall reach 100 percent of I_{PP} at $t \leq 8 \mu\text{s}$ and decay to 50 percent at $t \geq 20 \mu\text{s}$ for $t_{\text{p}} \geq 20 \mu\text{s}$ (see figure 7).

4.5.3 Clamping voltage (V_{C}). The peak pulse clamping voltage shall be measured across the diode in a 1 ms time interval. The response detector shall demonstrate equipment accuracy of ± 3 percent. The peak clamping voltage, as specified in column 6 of table II herein, shall be applicable to the 1 ms pulse of 4.5.2.a only.

MIL-PRF-19500/552E

* TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit <u>2/</u>		Unit
	Method	Conditions <u>2/</u>		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage	4021	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; I_{BR} = column 3 of table II	V_{BR1}	Column 2 of table II		V dc
Reverse current	4016	DC method, $V_R = V_{RWM}$ (column 4 of table II)	I_D		Column 5 of table II	μ A dc
<u>Subgroup 3</u>						
Minimum breakdown voltage	4021	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; I_{BR} = column 3 of table II; $T_A = -55^\circ\text{C}$	V_{BR2}	Column 9 of table II		V dc
High temperature operation:		$T_A = 125^\circ\text{C}$				
Reverse current leakage	4016	DC method, $V_R = V_{RWM}$, column 4 of table II	I_{D2}		Column 11 of table II	μ A dc
<u>Subgroup 4</u>						
Clamping voltage maximum (see 4.5.3)		$t_p = 1.0$ ms (see 4.5.2.a) I_{PP} = column 7 of table II	V_C		Column 6 of table II	V(pk)
Forward voltage	4011	$I_F = 4$ A dc	V_F		1.5	V(pk)
Forward voltage	4011	$I_{FM} = 100$ A (pk), $t_p = 300$ μ s, duty cycle = 4 pulses per minute maximum	V_{FM}		4.8	V(pk)
<u>Subgroup 5</u>						
Not applicable						
<u>Subgroup 6</u>						
Surge current	4066	One pulse, half sine wave 8.3 ms; $I_F = 0$, $I_{FSM} = 130$ A (pk), $V_{RWM} = 0$, $T_A = +25^\circ\text{C}$	I_{FSM}			
Electrical measurements		Table III, steps 1 and 2				

See notes at end of table.

MIL-PRF-19500/552E

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit <u>2/</u>		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 7</u> Forward clamping voltage (see 4.5.3)		$t_p = 1.0$ ms (see 4.5.2.a) at I_{pp} except use forward direction current without prior bias voltage	VCF		Column 10 of table II	V(pk)

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

2/ Column references are to table II herein.

TABLE II. Electrical characteristics.

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Type	V _{BR1} at I _{BR} min	Test current I _{BR}	Working peak reverse voltage V _{RWM}	Maximum standby current I _D	Maximum clamping voltage V _C at I _{PP}	Maximum peak pulse current I _{PP} (figure 6)	Maximum temperature coefficient of V _{BR} α _{VBR}	V _{BR2} minimum at I _{BR} T _A = -55°C	V _{CF} at I _{PP}	Maximum I _D current at	Maximum peak pulse current I _{PP}
						tp = 1 mS tr = 10 μS (10/1,000 μs)			Inverse polarity (max)	I _D T _A = + 125°C	tp=20 μS tr=8 μS (8 x 20)
	V dc	mA dc	V pk	μA dc	V pk	A pk	%/°C	V dc	V pk	μA dc	μA dc
1N6469	5.6	50	5	1,500	9.0	167	-.03, +.045	5.4	-3.5	12,000	
1N6470	6.5	50	6	1,000	11.0	137	+.060	6.2	-3.2	8,000	
1N6471	13.6	10	12	20	22.6	66	+.085	12.7	-3.8	100	
1N6472	16.4	10	15	10	26.5	57	+.085	15.3	-3.8	100	
1N6473	27.0	5	24	5	41.4	36.5	+.096	24.9	-3.6	100	
1N6474	33.0	1	30.5	5	47.5	32	+.098	30.2	-3.6	100	
1N6475	43.7	1	40.3	5	63.5	24	+.101	40.0	-3.5	100	
1N6476	54.0	1	51.6	5	78.5	19	+.103	48.5	-3.4	100	

* TABLE III. Group A, B, and C electrical end-point and delta measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Reverse current	4016	DC method, $V_R = V_{RWM}$ (column 4 of table II)	I_D		Column 5 of table II	μA dc
2.	Breakdown voltage	4021	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; $I_{BR} =$ column 3 of table II	V_{BR1}	Column 2 of table II		V dc
3.	Reverse current	4016	DC method; $V_R = V_{RWM}$ column 4 of table II	ΔI_D		100 percent of initial reading or 20 percent of column 5 of table II, whichever is greater.	
4.	Breakdown voltage	4021	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; $I_{BR} =$ column 3 of table II	ΔV_{BR1}		± 5 percent of initial value.	
5.	Clamping voltage		$t_p = 1.0$ ms (see 4.5.2.a); $I_{PP} =$ column 7 of table II	V_C	Column 2 of table II		V (pk)

1/ The electrical measurements for table E-VIb (JANTX and JANTXV) of MIL-PRF-19500 are as follows:

- a. Subgroup 2, see table III herein, steps 1 and 2.
- b. Subgroup 3, see table III herein, steps 1, 2, 3, and 4 (see 4.3.1.d).
- c. Subgroup 6, see table III herein, steps 1, 2, 3, and 4.

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

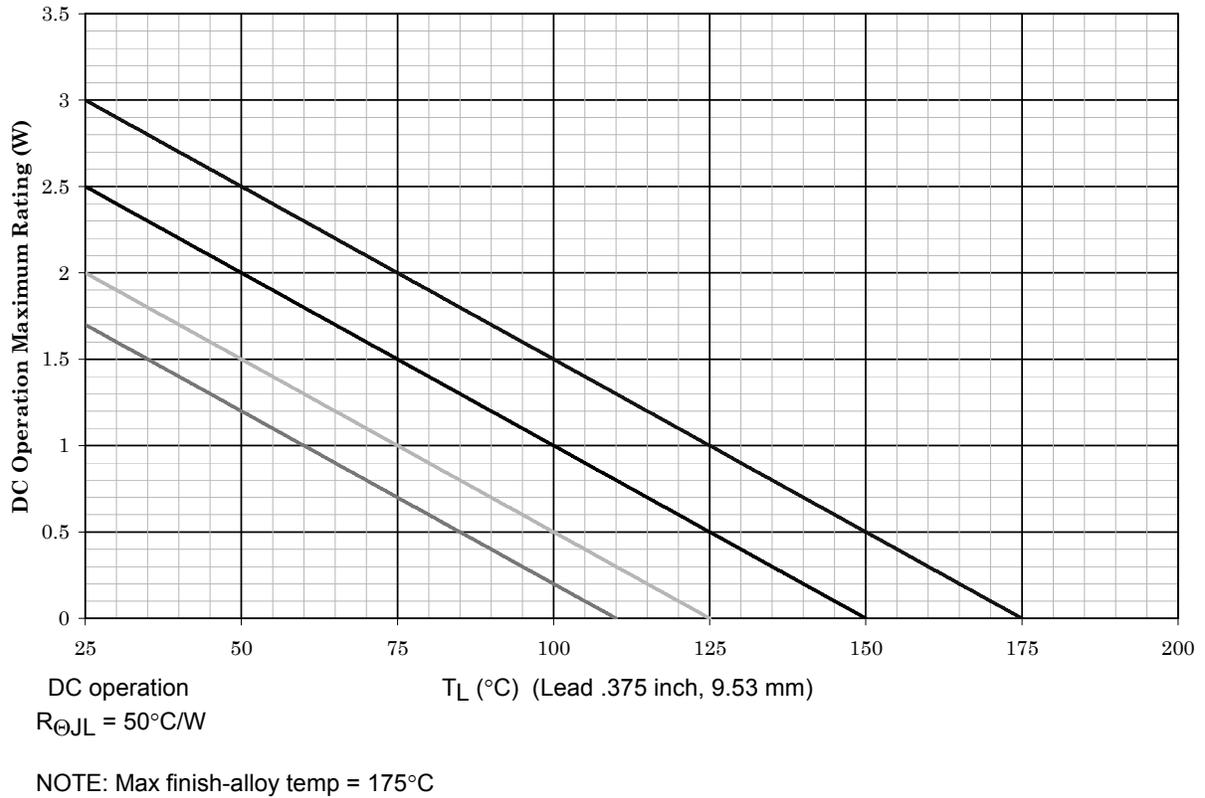
- a. Subgroup 2, see table III herein, steps 1 and 2.
- b. Subgroup 6, see table III herein, steps 1, 2, 3, and 4 (see 4.3.1.d).
- c. Subgroup 8, see table III herein, steps 1 and 2.

3/ Column references are to table II herein.

* TABLE IV. Group E inspection (all quality levels) for qualification only.

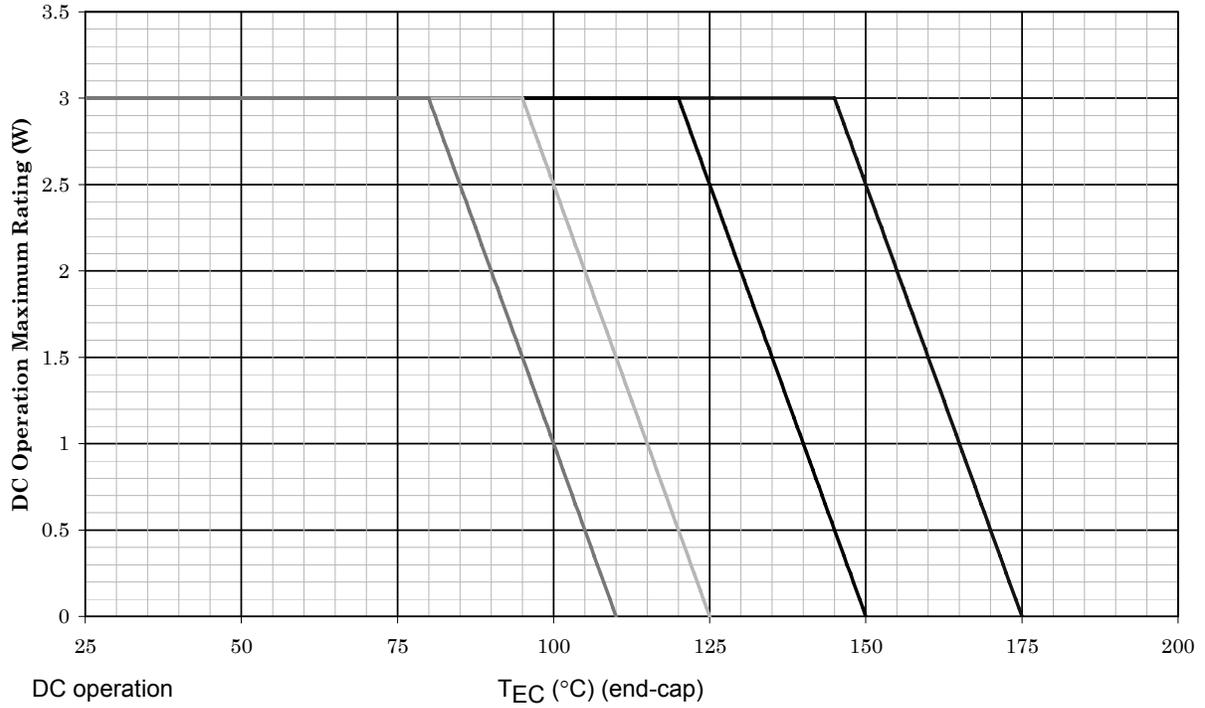
Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			n = 45, c = 0
Temperature cycling	1051	500 cycles, condition C, -55°C to +175°C.	
Electrical measurements		See table I, subgroup 2.	
<u>Subgroup 2</u>			n = 22, c = 0
Life test		1,000 hours. See 4.3.1.	
Electrical measurements		See table I, subgroup 2.	
<u>Subgroups 3, 4, 5 and 6</u>			
Not applicable			
<u>Subgroup 7</u>			n = 45, c = 0
Soldering heat	2031	1 cycle. For procedures or fixturing and dipping surface mounted devices, see test method 2026 of MIL-STD-750.	
Electrical measurements		See table I, subgroup 2.	
<u>Subgroup 8</u>			
Peak pulse current		See 4.5.2. Ipp shall be characterized by the supplier and this data shall be available to the Government. Test shall be performed on each low and high voltage device for each structurally identical grouping. Test to failure.	
Electrical measurements		See table I, subgroup 2.	

**TEMPERATURE-POWER DERATING CURVE
1N6469 THROUGH 1N6476**



* FIGURE 3. Derating curve.

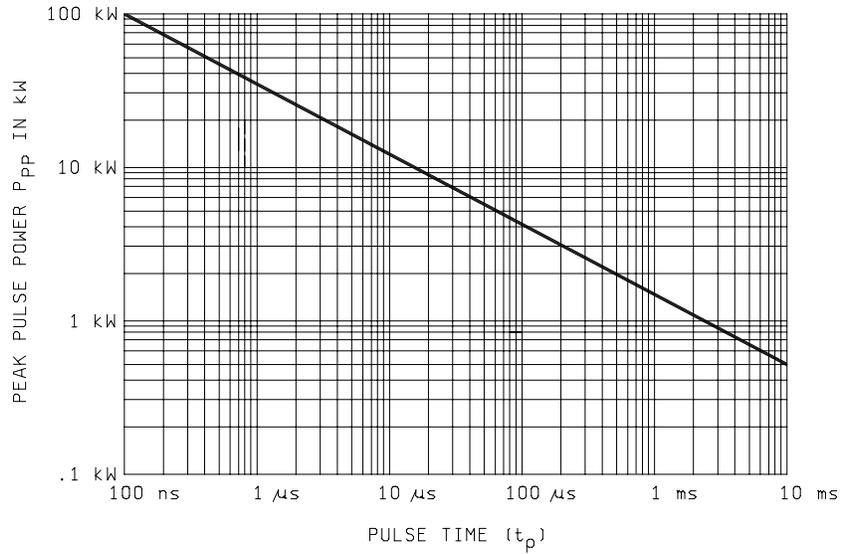
**TEMPERATURE-POWER DERATING CURVE
1N6469US THROUGH 1N6476US**



DC operation
 $R_{\theta JEC} = 10^{\circ}\text{C/W}$

NOTE: Max finish-alloy temp = 175°C

* FIGURE 4. Derating curve.



NOTE: Power shall be determined from actual clamping voltage at peak pulse current and pulse time duration (see 4.5.2).

FIGURE 5. Peak pulse power versus pulse time.

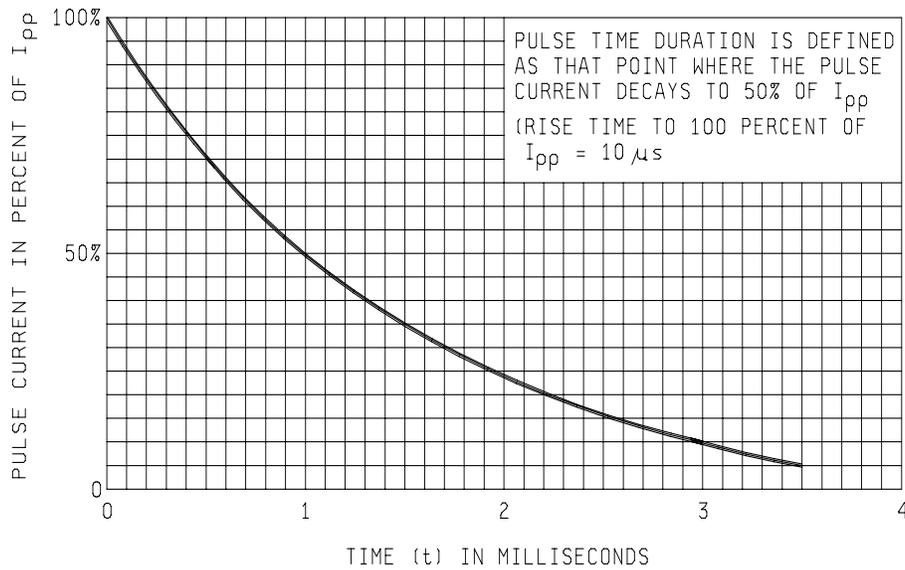
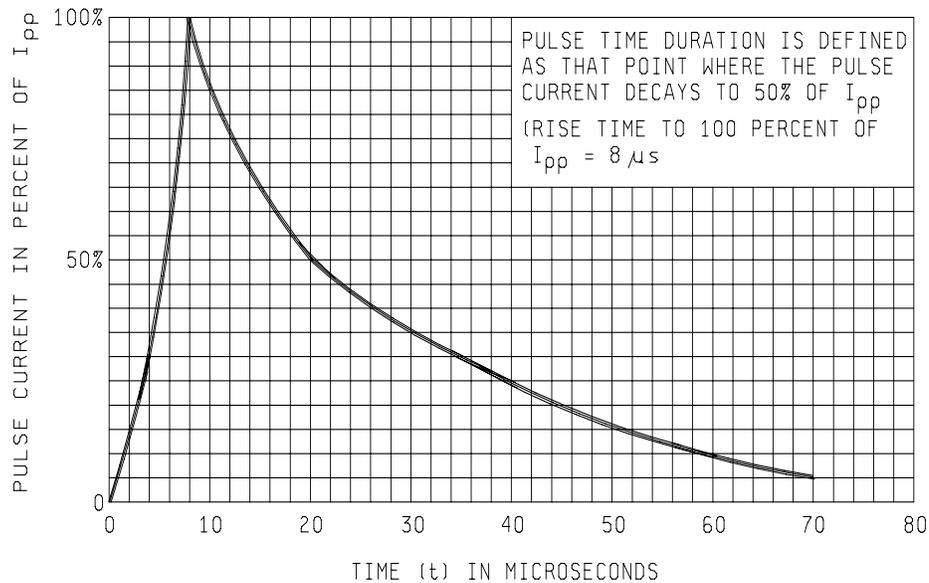


FIGURE 6. Current impulse waveform.

FIGURE 7. Current impulse waveform.

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. 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 3.4.2).
- 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 Steady-state power rating. This rating is not relevant for most applications.

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.

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

Preparing activity:
DLA - CC

(Project 5961-2007-091)

Review activities:
Air Force - 19, 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://assist.daps.dla.mil> .