The documentation and process conversion measures necessary to comply with this revision shall be completed by 28 August 2014.

INCH-POUND

MIL-PRF-19500/552G
28 May 2014
SUPERSEDING
MIL-PRF-19500/552F
14 May 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, TRANSIENT VOLTAGE SUPPRESSOR, TYPES 1N6469 THROUGH 1N6476, 1N6469US THROUGH 1N6476US, 1N6469URS THROUGH 1N6476URS, 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), 2 (surface mount), and 3 (surface mount).

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

a. P_R = 3 W (derate 20 mW/°C above T_A = +25°C) (see figure 4).

b. Derate at 100 mW/°C above T_{EC} = +145°C for surface mount devices. (see figure 5).

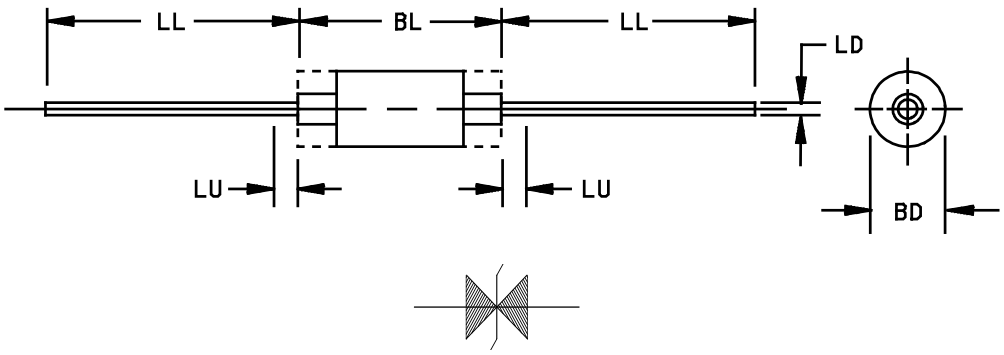
c. P_{PP} = 1,500 W at T_P = 1 ms.

d. I_{FSM} = 130 A(pk). T_P = 8.33 ms (T_A = +25°C).

e. -55°C ≤ T_J ≤ +175°C; -55°C ≤ T_{STG} ≤ +175°C (ambient).

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

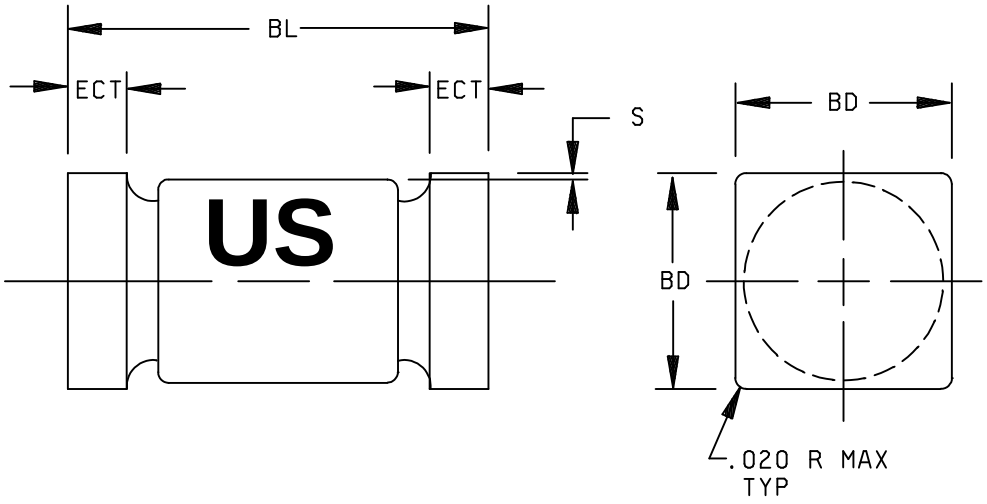
Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to semiconductor@dla.mil . Since contact information can change, you may want to verify the currency of this address information using the ASSIST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



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.

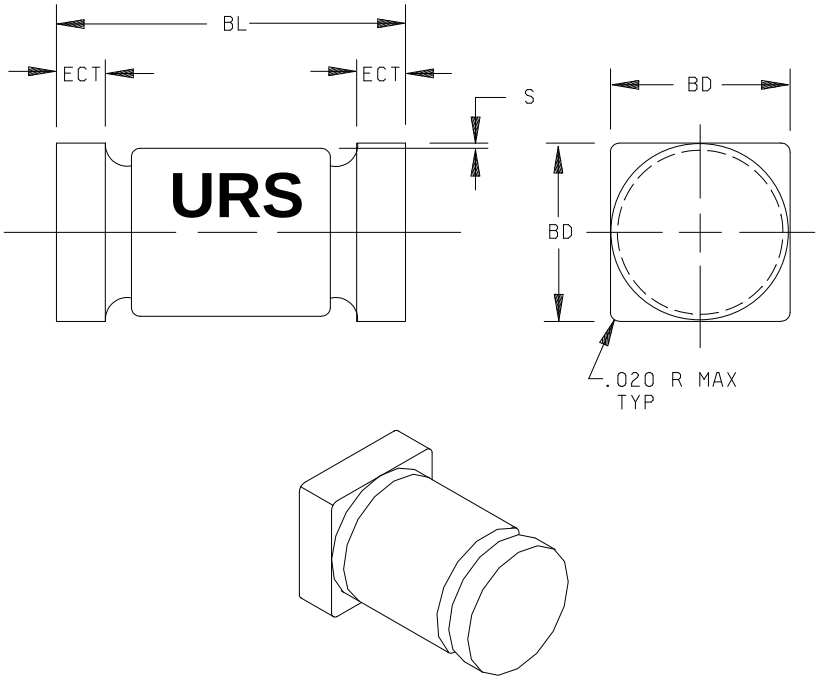
FIGURE 1. Physical dimensions (1N6469 through 1N6476).



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 Φx symbology.

FIGURE 2. Physical dimensions 1N6469US through 1N6476US.



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. Dimensions are pre-solder dip.
4. One endcap shall be square and the other endcap shall be round.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 3. Physical dimensions 1N6469URS through 1N6476URS.

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3 or 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 or 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.

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, figure 2, and figure 3 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.

3.5.1 Marking of US and URS versions. For US and URS versions only, all marking may be omitted from the device except for the cathode marking. US and URS devices shall be marked with a cathode band as a minimum; or a minimum of three evenly spaced contrasting color dots around the periphery of the cathode end may be used. At the option of the manufacturer, URS devices may include laser marking on an end-cap, to include part number and lot date code for all levels. The prefixes JAN, JANTX, or JANTXV may be abbreviated as J, JX, or JV, respectively. (For example: The part number may be reduced to JV6469). All device marking, except for polarity and serial numbers, shall also appear on the unit package used as the initial protection for delivery. No color coding will be permitted.

3.5.2 URS polarity. For URS surface mount parts only, cathode shall be connected to the round end-cap.

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. 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°C.

b. Read I_D and V_{BR} at T_A = +25°C, remove defective devices, and record the number of failures.

c. Apply the working peak reverse voltage (V_{WM}) (column 4 of table II herein) at an ambient temperature of T_A = +125°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.

d. Read and record I_D and V_{BR} at T_A = +25°C. Devices with ΔI_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 ΔV_{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.

Subgroup	Method	Conditions
B2	1051	-55°C to +175°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.

	Subgroup	Method	Conditions
*	C2	2036	Test condition A, 20 pounds, t = 15 seconds, ±3 seconds. Suitable fixtures may be used to pull the end-caps in a manner which does not aid construction. Reference to axial lead may be interpreted as end-cap with fixtures used for mounting (see figure 6 herein). (Lead fatigue is not applicable to US or URS devices.)
*	C2	2038	US devices: Test condition B, weight = 20 pounds; t = 15 seconds.
	C5	4081	$R_{\Theta JL} \leq 50°C/W$ at L = .375 inch (9.53 mm), non-surface mount devices. $R_{\Theta JEC} \leq 20°C/W$ at L = 0 inches, surface mount devices. $T_A = +25°C$.
	C6	1026	$T_A = +125°C$ (see 4.3.1).
	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	$\propto V_{(BR)}$ in accordance with method 4071 of MIL-STD-750, I_{BR} = column 3 of table II herein, $T_1 = +25°C \pm 3°C$; $T_2 = +125°C$; maximum limits = column 8 of table II herein; units = %/°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 (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 clamping voltage (Vc) shall be as specified in 4.5.3. The peak current shall be applied with a current versus time waveform as follows (1 pulse per minute maximum): (See figure 7, 8, and 9 herein.)

a. Pulse current shall reach 100 percent of I_{PP} at $t \leq 10$ μs and decay to 50 percent at $t \geq 1$ ms for $t_p \geq 1$ ms.

b. Pulse current shall reach 100 percent of I_{PP} at $t \leq 8$ μs and decay to 50 percent at $t \geq 20$ μs for $t_p \geq 20$ μs.

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.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical Examination	2071					
Subgroup 2						
Breakdown voltage	4022	$t_p \leq 300$ 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	µA dc
Subgroup 3						
Minimum breakdown Voltage	4022	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; I_{BR} = column 3 of table II; T_A = -55°C	V_{BR2}	Column 9 of table II		V dc
High temperature operation:		T_A = 125°C				
Reverse current leakage	4016	DC method, $V_R = V_{RWM}$, column 4 of table II	I_{D2}		Column 11 of table II	µA dc
Subgroup 4						
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 µs, duty cycle = 4 pulses per minute maximum	V_{FM}		4.8	V(pk)
Subgroup 5						
Not applicable						
Subgroup 6						
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°C	I_{FSM}			
Electrical measurements		Table III, steps 1 and 2				
Subgroup 7						
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	V_{CF}		Column 10 of table II	V(pk)

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

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_{WM})	Maximum standby current I_D	Maximum clamping voltage V_C at I_{PP}	Maximum peak pulse current I_{PP}	Maximum temperature coefficient of V_{BR} α_{VBR}	V_{BR2} minimum at I_{BR} T_A = -55ºC	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 TA = + 125ºC	tp=20 µS tr=8 µS (8 x 20)
	V dc	mA dc	V pk	µA dc	V pk	A pk	%/ºC	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	Set P_{PP} to 8.5 KW minimum
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/

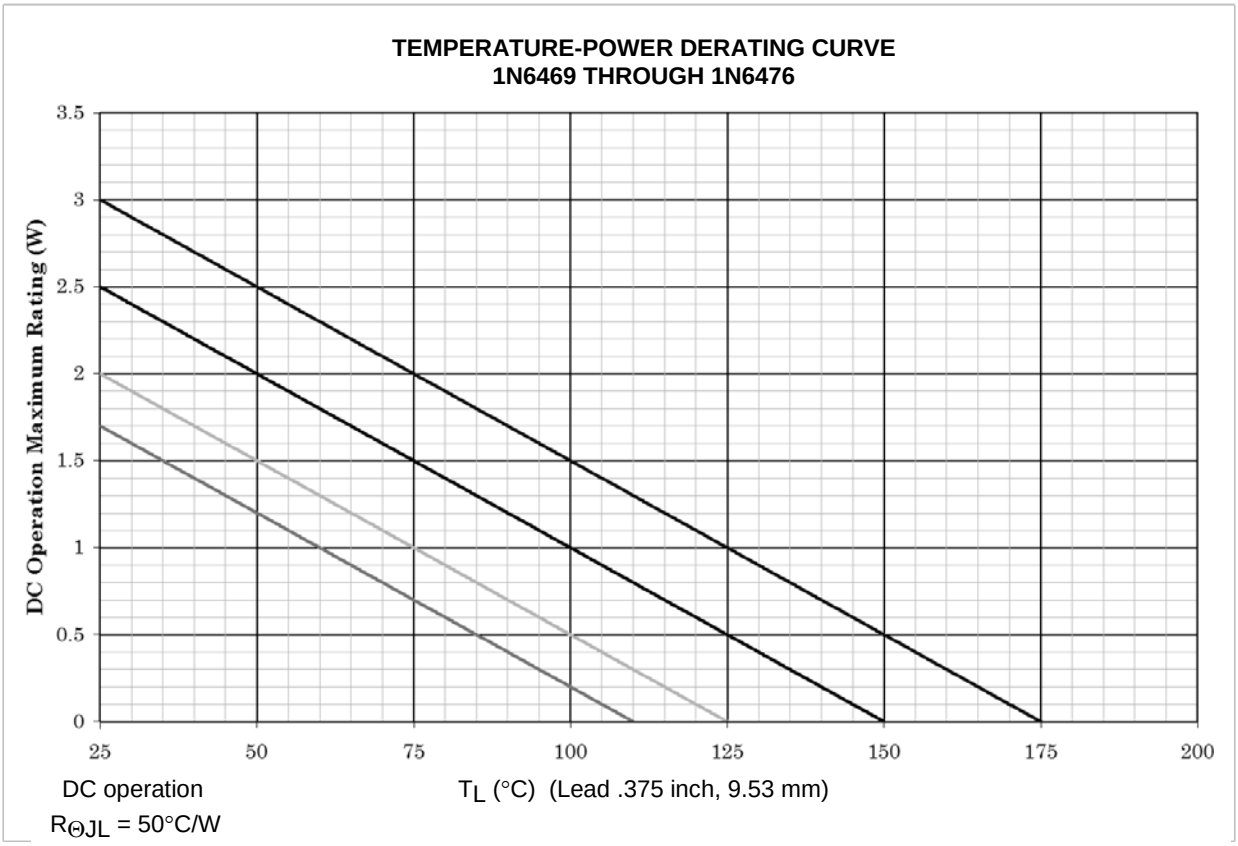
Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Reverse current	4016	DC method, $V_R = V_{RWM}$ (column 4 of table II)	I_D		Column 5 of table II	µA dc
2.	Breakdown voltage	4022	$t_p \leq 300$ ms, duty cycle ≤ 2 percent; I_{BR} = column 3 of table II	V_{BR1}	Column 2 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	4022	$t_p \leq 300$ 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.c).
- 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.c).
- c. Subgroup 8, see table III herein, steps 1 and 2.

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

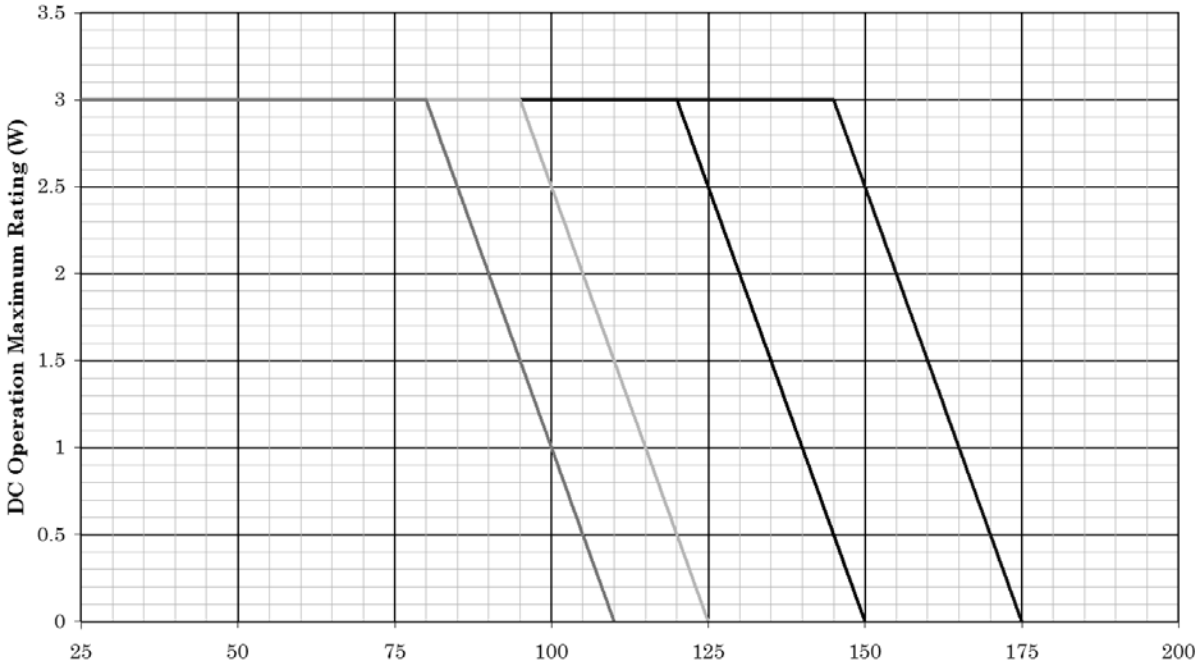
Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
Subgroup 1			n = 45, c = 0
Temperature cycling	1051	500 cycles, condition C, -55°C to +175°C.	
Electrical measurements		See table I, subgroup 2.	
Subgroup 2			n = 22, c = 0
Life test		1,000 hours. See 4.3.1.	
Electrical measurements		See table I, subgroup 2.	
Subgroups 3, 4, 5, and 6			
Not applicable			
Subgroup 8			
Peak pulse current		See 4.5.2. I_{PP} 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.	



NOTE: Max finish-alloy temp = 175°C

* FIGURE 4 Temperature-power derating for 1N6469 through 1N6476.

TEMPERATURE-POWER DERATING CURVE
1N6469US THROUGH 1N6476US
1N6469URS THROUGH 1N6476URS

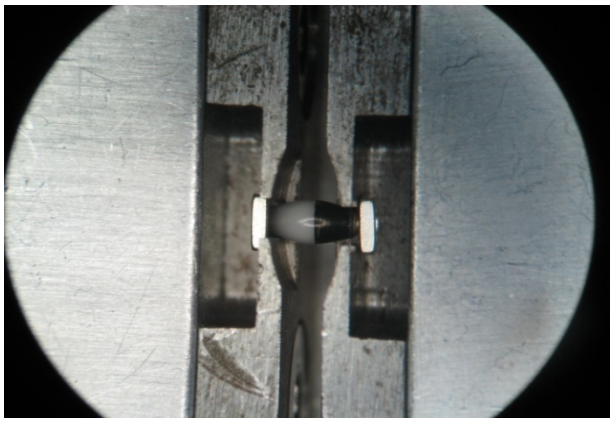


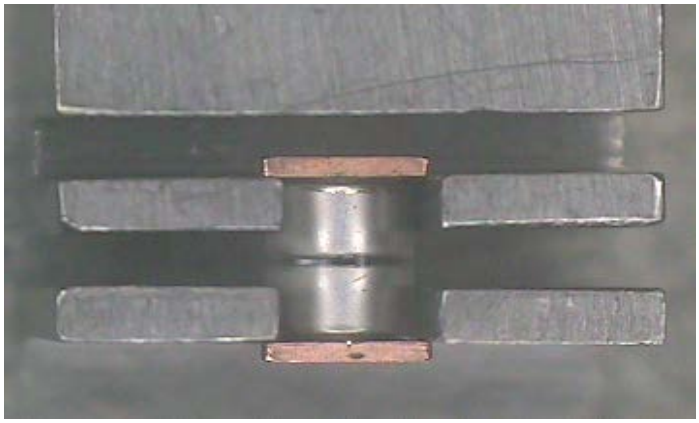
DC operation

$R_{\Theta JEC}$ = 10°C/W

NOTE: Max finish-alloy temp = 175°C

* FIGURE 5 Temperature-power derating for 1N6469US through 1N6476US and 1N6469URS through 1N6476URS.





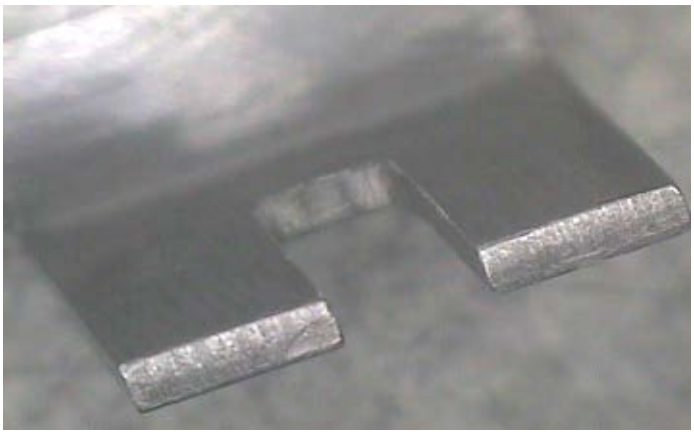
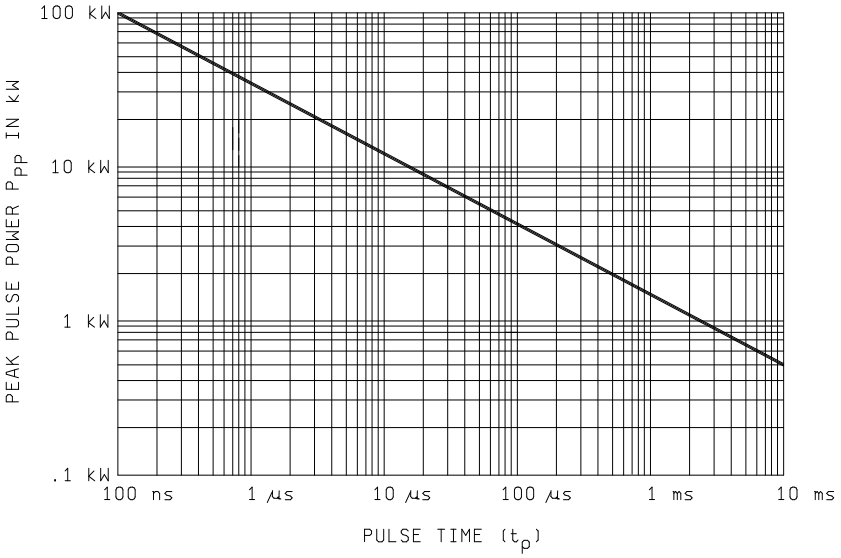


FIGURE 6. US terminal strength mounting.



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

FIGURE 7. Peak pulse power versus pulse time.

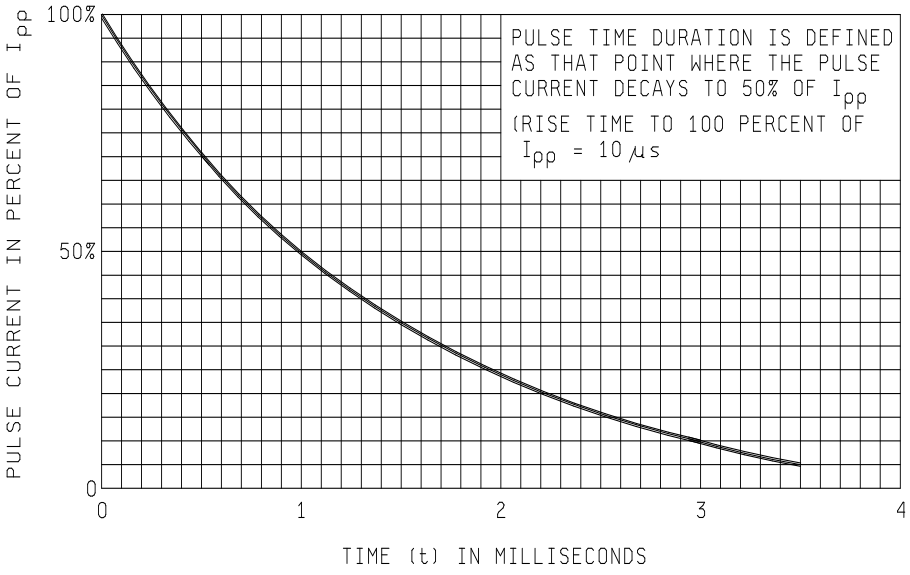


FIGURE 8. Current impulse waveform.

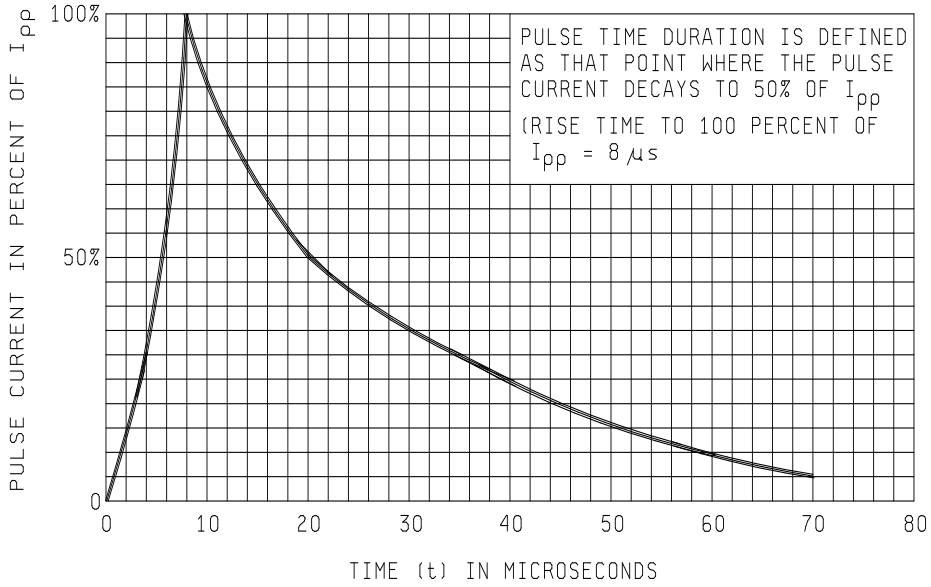


FIGURE 9. Current impulse waveform.

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. 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 Part or Identifying Number (PIN), see title and section 1.

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 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 - 85
DLA - CC

Review activities:
Air Force - 19, 99

Preparing activity:
DLA - CC

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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 https://assist.dla.mil .