MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, SWITCHING

TYPE 1N4500 and TX1N4500

1. SCOPE

1.1 Scope. This specification covers the detail requirements for silicon, switching diodes for use in circuits with high forward conductance, and shall be in accordance with MIL-S-19500 except as otherwise specified herein. The prefix "TX" is used on devices submitted to and passing the special process-conditioning, testing, and screening as specified in 4.5 through 4.5.12.

1.2 Physical dimensions. See figure 1.

1.3 Ratings.

BV	V_{RM}(wkg)	I_o	i_f(surge) (1 sec)	i_f(surge) (1 μsec)	T_{op}	T_{stg}
Vdc	v(pk)	mAdc	a	a	°C	°C
80	75	300 1/	0.5	4.0	-65 to +175	-65 to +200

1/ Derate 2.0 mAdc/°C for T_A above 25°C.

1.4 Characteristics.

Limits	V_{F_1} I_F=250μAdc	V_{F_2} I_F=1.0mAdc	V_{F_3} I_F=10mAdc	V_{F_4} I_F=20mAdc	V_{F_5} 1/ I_F=300mAdc
	mVdc	mVdc	mVdc	mVdc	Vdc
Minimum	470	520	640	670	---
Maximum	560	600	720	770	1.10

Limits	C V_R = 0 100 kHz ≤ f ≤ 1 MHz v_{sig} = 50 mv(p-p)	t_{rr} I_F = I_R = 10 mAdc: R_L = 100 ohms
	pF	nsec
Minimum	---	---
Maximum	4.0	6.0

1/ Pulsed (See 4.4.4).

FSC 5961

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATION

MILITARY

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

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-750 - Test Methods for Semiconductor Devices.
MIL-STD-1276 - Leads, Weldable, for Electronic Component Parts.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The diodes shall be of the design, construction, and physical dimensions as shown in figure 1.

3.3.1 Lead material and finish. Lead finish shall be tin (or tinned). Lead finish and material may be type D in accordance with MIL-STD-1276 when specified in the contract or order, providing the devices conform to subgroups 2, 4, and 5 of group B inspection (see 6.2).

3.4 Performance characteristics. Performance characteristics shall be as specified in tables I and II, and as follows:

3.4.1 Process-conditioning, testing, and screening for "TX" types. Process-conditioning, testing, and screening for the "TX" types shall be as specified in 4.5.

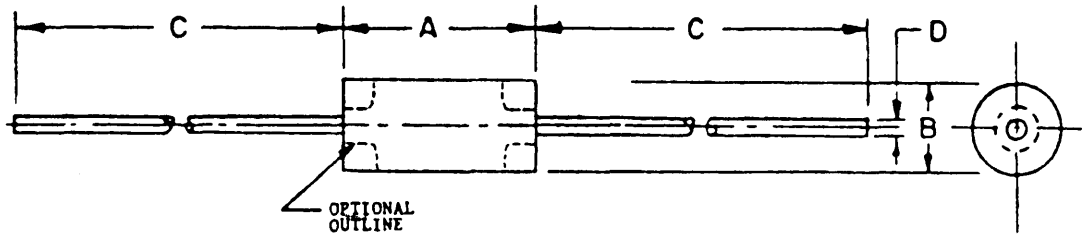
3.5 Marking. The following marking specified in MIL-S-19500 may be omitted at the option of the manufacturer:

(a) Manufacturer's identification
(b) Country of origin
(c) First letter "C" of the manufacturer's designating code.
(d) Acceptance date and inspection lot identification.

3.5.1 Polarity. The polarity shall be indicated with a contrasting color band to denote the cathode end.

3.5.2 "TX" marking. Devices in accordance with the "TX" requirements (see 4.5) shall be marked with a "TX" preceding the type designation.

3.6 Hermetic seal. All diodes shall be subjected to the seal leak tests, as specified in 4.5.5 and 4.5.6. If the devices are being processed for the "TX" type, the sequence specified in 4.5 must be followed. If the non-TX type devices are being processed, submission to the seal leak tests specified in 4.5.5 and 4.5.6 may occur at any point in the manufacturing process after assembly and prior to group A testing.



Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.140	.300	3.56	7.62	
B	.060	.107	1.52	2.72	3, 4
C	1.000	1.500	25.40	38.10	2
D	.018	.022	.46	.56	5, 2

NOTES:
1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Both leads shall be within the specified limits (see 3.3.1).
3. The maximum diameter of dimension B shall apply for dimension A.
4. The minimum diameter of dimension B shall apply over at least .075 (1.91 mm) of dimension A.
5. The specified lead diameter applies in the zone between .050 (1.27 mm) and 1.00 (25.4 mm) from the diode body to the end of the lead. Outside of this zone the lead diameter shall not exceed diameter B.

FIGURE 1. Semiconductor device, diode, types 1N4500 and TX 1N4500.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall consist of the examination and tests specified in tables I and II.

4.2.1 Qualification testing. The non-TX types shall be used for qualification testing. At the manufacturer's request to the qualifying activity, qualification will be extended to include the "TX" type of the device.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of the examinations and tests specified for groups A and B. When specified in the contract or order, one copy of the quality conformance inspection data, pertinent to the device inspection lot, shall be supplied with each shipment.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table II.

4.4 Methods of examination and test. Methods of examination and test shall be as specified in tables I and II, and as follows:

4.4.1 Time limits for end points. End-point tests for qualification and quality conformance inspection shall be completed within 96 hours after completion of the last test in the subgroup.

4.4.2 Stored charge test. Stored charge shall be measured using a B-Line Electronics Corporation Model QS-3 Stored Charge Meter or equivalent. Conditions shall be as specified in Table I.

4.4.3 Steady-state operation life. This test shall be conducted with a half-sine wave of the peak voltage specified herein impressed across the diode in the reverse direction, followed by a half-sine waveform of the average rectified current specified herein. The forward conduction angle of the rectified current shall be not greater than 180 degrees nor less than 150 degrees.

4.4.4 Pulse measurements. Pulse measurements shall be in accordance with section 4 of MIL-STD-750.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		LTPD		Symbol	Limits		
	Method	Details	Non TX	TX		Min	Max	Unit
Subgroup 1			5	5				
Visual and mechanical examination	2071				---	---	---	---
Subgroup 2			5	2				
Forward voltage	4011	I_F = 250 µAdc			V_{F_1}	470	560	mVdc
Forward voltage	4011	I_F = 1.0 mAdc			V_{F_2}	520	600	mVdc
Forward voltage	4011	I_F = 10 mAdc			V_{F_3}	640	720	mVdc
Forward voltage	4011	I_F = 20 mAdc			V_{F_4}	670	770	mVdc
Forward voltage	4011	I_F = 300 mAdc Pulsed, (See 4.4.4)			V_{F_5}	---	1.10	Vdc
Reverse current	4016	DC method; V_R = 75 Vdc			I_R	---	100	nAdc
Subgroup 3			5	3				
Breakdown voltage	4021	I_R = 5.0 µAdc			BV	80	---	Vdc
Reverse current	4016	DC method; T_A = 150° C; V_R = 75 Vdc			I_R	---	100	µAdc
Capacitance	4001	V_R = 0 Vdc; v_{sig} = 50 mv (p-p), max; 100 kHz ≤ f ≤ 1 MHz			C	---	4.0	pF
Reverse recovery time	4031	Test condition B. $I_F = I_R$ = 10 mAdc R_L = 100 ohms ; C ≤ 3 pF			t_{rr}	---	6	nsec
Stored charge	---	See 4.4.2			Q_s			
Test 1		I_F = 0.1 mAdc				---	4.5	pcb
Test 2		I_F = 1.0 mAdc				---	20	pcb
Test 3		I_F = 10 mAdc				---	70	pcb

TABLE II. Group B inspection

Examination or test	MIL-STD-750		LTPD		Symbol	Limits		
	Method	Details	Non TX	TX		Min	Max	Unit
Subgroup 1			15	15				
Physical dimensions	2066	See figure 1			---	---	---	---
Subgroup 2			10	10				
Solderability	2026				---	---	---	---

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD		Symbol	Limits		
	Method	Details	Non TX	TX		Min	Max	Unit
Subgroup 2 - Continued								
Thermal shock (temperature cycling)	1051	Test condition C;			---	---	---	---
Thermal shock (glass strain)	1056	Test condition A			---	---	---	---
Terminal strength: Tension	2036	Test condition A; 15 sec, 4 lb			---	---	---	---
Moisture resistance	1021				---	---	---	---
End points: (see 4.4.1)								
Forward voltage	4011	I_F = 300 mAdc Pulsed, (See 4.4.4)			V_{F_5}	---	1.10	Vdc
Reverse current	4016	DC method; V_R = 75 Vdc			I_R	---	100	nAdc
Breakdown voltage	4021	I_R = 5.0 µAdc			BV	80	---	Vdc
Subgroup 3			10	10				
Shock	2016	Nonoperating: 1,500 G; t = 0.5 msec; 5 blows in each orientation: X_1, Y_1, and Y_2			---	---	---	---
Vibration, variable frequency	2056	Nonoperating			---	---	---	---
Constant acceleration	2006	Nonoperating; 20,000 G: X_1, Y_1, and Y_2 orientations			---	---	---	---
End points: (see 4.4.1) (same as subgroup 2)								
Subgroup 4			10	10				
Terminal strength: Lead fatigue	2036	Test condition E			---	---	---	---
Subgroup 5			10	10				
Salt atmosphere (corrosion)	1041				---	---	---	---
Subgroup 6			~~5~~	~~3~~				
High-temperature life (nonoperating)	1031	T_A = 200°C			---	---	---	---
End points: (see 4.4.1)								
Forward voltage	4011	I_F = 300 mAdc Pulsed, (See 4.4.4)			V_{F_5}	---	1.15	Vdc
Reverse current	4016	DC method; V_R = 75 Vdc			I_R	---	200	nAdc
Breakdown voltage	4021	I_R = 5 µAdc			BV	80	---	Vdc

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD		Symbol	Limits		
	Method	Details	Non TX	TX		Min	Max	Unit
Subgroup 7			λ=5	λ=3				
Steady-state operation life (see 4.4.3)	1026	I_o = 300 mAdc; v_r = 75 v(pk); f = 60 Hz			---	---	---	---
End points: (see 4.4.1) (Same as subgroup 6)								
Subgroup 8			10	10				
Surge current	4066	I_F = 200 mAdc; i_f (surge) = 500 ma (pk); 10 surges; t_p = 1 sec; 1 surge/minute			---	---	---	---
Surge current	4066	I_F = 200 mAdc; i_f (surge) = 4a (pk); 10 surges; t_p = 1 μsec; 1 surge minute			---	---	---	---
End points: (see 4.4.1) (Same as subgroup 2)								

4.5 Process-conditioning, testing, and screening for "TX" types. The procedure for process-conditioning, testing, and screening the "TX" types shall be in accordance with 4.5.1 through 4.5.12 and figure 2. Process-conditioning shall be conducted on 100 percent of the lot, prior to submission of the lot to the tests specified in tables I and II. (At the option of the manufacturer, the non-TX types may be subjected to process-conditioning and testing.)

4.5.1 Quality assurance (lot verification). Quality assurance shall keep lot records for 3 years, minimum, monitor for compliance to the prescribed procedures, and observe that satisfactory manufacturing conditions and records on lots are maintained for these devices. The records shall be available for review by the customer at all times. The quality assurance monitoring shall include, but not be limited to: process-conditioning, testing, and screening. (The conditioning and screening tests performed as standard-production tests need not be repeated when these are predesignated and acceptable to the Government as being equal to or more severe than specified herein and this relative process-conditioning sequence is maintained.

4.5.2 High-temperature storage. All devices shall be stored for at least 48 hours at a minimum temperature (T_A) of 200° C.

4.5.3 Thermal shock (glass strain). All devices shall be subjected to thermal shock (glass strain) in accordance with MIL-STD-750, method 1056, test condition A, except that 10 cycles shall be continuously performed.

4.5.4 Acceleration. All devices shall be subjected to acceleration test in accordance with MIL-STD-750, method 2006, with the following exceptions: The test shall be performed one time in the Y_1 orientation only, at a peak level of 20,000 G, minimum. The 1 minute hold-time requirement shall not apply.

4.5.5 Hermetic seal (fine-leak) test. All devices shall be fine-leak tested in accordance with MIL-STD-202, method 112, test condition C, procedure IIIa or IIIb (using the applicable conditions of 4.5.5.1 or 4.5.5.2).

4.5.5.1 Conditions for procedure IIIa. The devices shall be placed in a sealed chamber and pressurized to 50 psig, minimum, with helium gas for a minimum of 4 hours. The devices shall then be removed from the chamber and within 30 minutes be subjected to a helium leak-detection test. Devices shall be rejected that exhibit a leak rate of 5×10^{-7} cubic centimeters of helium per second when measured at a differential pressure of one atmosphere. All devices exhibiting this leakage rate or greater shall be removed from the lot.

4.5.5.2 Conditions for procedure IIIb. The devices shall be placed in an activation tank, pressurized with Krypton 85 tracer gas in a nitrogen solution, for sufficient time to detect a leak rate of 1×10^{-8} atmospheric cubic centimeters per second (atm cc/sec). Within four hours after subjection to this pressurization, the leak rate of the devices shall be determined on an attribute basis using the general equation shown below. Any device exhibiting a leak rate equal to or greater than 1×10^{-8} atm cc/sec shall be removed from the lot. The general equation for use with radioactive-gas leak test equipment is:

$$Q = \frac{R}{SKT(P_e^2 - P_i^2)}$$

where:

Q = leak rate in atm cc/sec.
R = net counting rate of tested part above background in cts/min.
S = specific activity of the test gas mixture in μCi/atm cc.
K = counting efficiency of the system for the given part in cts/min μCi.
P_e = pressure of test gas in activation tank during pressurization in atm abs.
P_i = pressure inside part under test in atm abs.
T = duration of pressurization in test gas mixture in seconds.

4.5.6 Hermetic seal (gross-leak) test. Devices shall be gross-leak tested by employing one of the following methods: 4.5.6.1, 4.5.6.2, or 4.5.6.3.

4.5.6.1 Gross-leak test (fluorescent dye). Devices shall be immersed in water and alcohol solution to which 2 percent by volume of penetrating fluorescent dye (Fluorescein, Na Salt Stain, Curtin No. 34841F or equivalent) has been added. The ambient pressure shall be increased to 150 psig minimum and maintained at this pressure for one hour. After removal from the chamber, the devices shall be immediately rinsed with water to remove the stain. The excess water shall then be blotted from the units with paper towels or equivalent absorbant material. The devices shall then be immediately inspected using an ultraviolet lamp of sufficient power and definition to detect defects (ultraviolet lamp, Curtin No. 12835-75 or equivalent). Any devices giving any evidence of fluorescence indicating leakage, cracked glass, or pinholes shall be classed as defects and removed from the lot.

4.5.6.2 Dye penetrant test (glass-transparent body only). All devices shall be immersed in a dye-penetrant solution (Turco Red Dy-chek No. XC-137R or equivalent) and subjected to a pressure of 100 psig minimum for one hour. After removal from the chamber, the devices shall be immediately rinsed in a suitable solvent to remove the stain, blotted with absorbent material, and inspected for evidence of dye penetration. All devices, exhibiting such penetration shall be classed as defects and removed from the lot.

4.5.6.3 Liquid-immersion test. Devices shall be tested for gross-leaks by immersion in a non-corrosive ethylene glycol at approximately 100 C for a minimum of 15 seconds and observed for bubbles. All devices that bubble shall be removed from the lot.

4.5.7 Pre-reverse-bias tests. The parameter I_R of table III shall be measured and the data recorded for all devices in the lot. All devices shall be handled or identified such that the delta (Δ) end points can be determined after the reverse bias test. All devices which fail to meet the requirement of I_R in table III initially, shall be removed from the inspection lot and the quantity removed recorded on the lot history.

TABLE III. Reverse and forward bias test measurements

Examination or test	MIL-STD-750		Symbol	Limits		Unit
	Method	Details		Min	Max	
Reverse current	4016	DC method V_R = 75 Vdc	I_R	---	100	nAdc
Forward voltage	4011	I_F = 300 mAdc Pulsed (See 4.4.4)	V_F	---	1.10	Vdc

4.5.8 Reverse-bias test. All devices shall be operated for 72 hours minimum under the following conditions:

T_A = 150° C;

V_R = 75 Vdc;

I_F = 0

At the end of the test, T_A shall be decreased to room temperature and the reverse-bias shall remain applied until T_A is less than 35° C.

4.5.9 Post-reverse-bias tests. The parameter I_R of table III shall be retested within 8 hours after the reverse bias test and the data recorded for all devices in the inspection lot. The parameter measured shall not have changed during the reverse-bias test from the initial value by more than the specified amount as follows:

ΔI_R - 100% or 25 nAdc, whichever is greater

All devices that exceed the delta (Δ) limit shall be removed from the lot and the quantity removed shall be noted on the lot history. If this quantity removed after the reverse-bias test should exceed 10 percent of the total inspection lot on the reverse-bias test, the entire lot shall be unacceptable for shipment as TX types.

4.5.10 Pre-forward-bias tests. The parameters I_R and V_F of table III shall be measured and the data recorded for all devices in the lot. All devices shall be handled or identified such that the delta end points can be determined after the forward-bias test. All devices which fail to meet these requirements shall be removed from the lot and the quantity removed shall be noted on the lot history.

4.5.11 Forward-bias test. All devices shall be operated for 72 hours minimum under the following conditions:

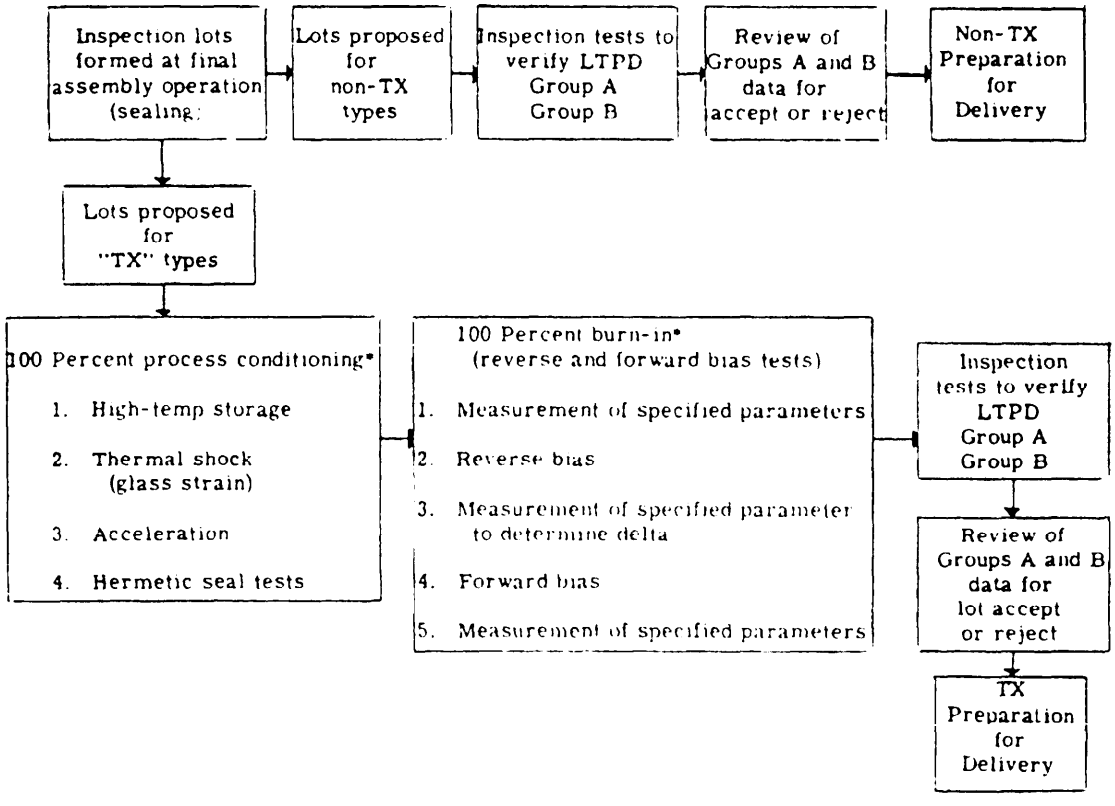
T_A = 150°C; I_F = 50 mAdc

4.5.12 Post-forward-bias tests. The parameters I_R and V_F of table III shall be retested within 24 hours after the forward-bias test and the data recorded for all devices in the lot. The parameters measured shall not have changed during the forward-bias test from those recorded in 4.5.10 by more than the specified amount as follows:

ΔI_R = +25 nAdc

ΔV_F = ±.06 Vdc

All devices that exceed these delta (Δ) limits or the limits of table III shall be removed from the lot and the quantity removed shall be noted on the lot history. If the quantity removed after the forward-bias test should exceed 5 percent of the lot on the forward-bias test, the entire lot shall be unacceptable for shipment as TX types.



* ORDER OF THE TESTS IN THE BLOCKS SHALL BE PERFORMED AS SHOWN

FIGURE 2. Order of procedure diagram for non-TX and "TX" types.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery. Preparation for delivery shall be in accordance with MIL-S-19500.

6. NOTES

6.1 The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Ordering data.

(a) Lead finish if other than tin (or tinned) (see 3.3.1).

(b) Inspection data. (See 4.3).

6.3 The activity responsible for the Qualified Products List is Rome Air Development Center, Attn: EMTSA, Griffiss Air Force Base, New York 13440; however, information pertaining to the qualification of products may be obtained from the Defense Electronics Supply Center, 1507 Wilmington Pike, Dayton, Ohio 45401.

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