

The documentation and process conversion measures necessary to comply with this revision shall be completed by 12 September 2011.

INCH-POUND

MIL-PRF-19500/399F
 29 July 2011
 SUPERSEDING
 MIL-PRF-19500/399E
 25 March 2005

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING
 TYPE 2N3960 AND 2N3960UB

JAN, JANTX, JANTXV, JANTXVM, JANTXVD, JANTXVP, JANTXVL, JANTXVR, JANTXVF, JANTXVG, JANTXVH,
 JANS, JANSM, JANSJ, JANSK, JANSR, JANSF, JANSJ, JANSK, JANSR, JANSF, JANSJ, JANSK, JANSR, JANSF,
 JANHCL, JANHCR, JANHCF, JANHCG, JANHCH, JANKC, JANKCM, JANKCD, JANKCP, JANKCL, JANKCR,
 JANKCF, JANKCG, AND JANKCH

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 NPN silicon, switching transistors. Four levels of product assurance are provided for each device type and two levels for unencapsulated die as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type. RHA level designators "M", "D", "P", "L", "R", "F", "G", and "H" are appended to the device prefix to identify devices which have passed RHA requirements.

1.2 Physical dimensions. See figure 1 (TO-18), figure 2 (UB), and figure 3 (JANHC, JANKC).

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

$P_T(1)$ $T_A = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	T_J and T_{STG}
<u>mW</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>°C</u>
400	20	12	4.5	-65 to +200

(1) Derate linearly 2.3 mW/°C above $T_A = +25^\circ\text{C}$.

* 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@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 <https://assist.daps.dla.mil>.

1.4 Primary electrical characteristics.

Limits	h_{FE1}	h_{FE2}	$V_{CE(sat)1}$	$V_{CE(sat)2}$	C_{obo}	$ h_{fe} $	V_{BE1}	V_{BE2}
	$V_{CE} = 1.0$ V dc $I_C = 1.0$ mA dc	$V_{CE} = 1.0$ V dc $I_C = 10$ mA dc	$I_C = 1.0$ mA dc $I_B = 0.1$ mA dc	$I_C = 30$ mA dc $I_B = 3.0$ mA dc	$V_{CB} = 4$ V dc $I_E = 0$ $100 \text{ kHz} \leq f \leq 1$ MHz	$V_{CE} = 4$ V dc $I_C = 5.0$ mA dc $f = 100$ MHz	$I_C = 1.0$ mA dc $V_{CE} = 1.0$ V dc	$I_C = 30$ mA dc $V_{CE} = 1.0$ V dc
Min	40	60	<u>V dc</u>	<u>V dc</u>	<u>pF</u>	13	<u>V dc</u>	<u>V dc</u>
Max		300	0.2	0.3	2.5		0.8	1.0

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.

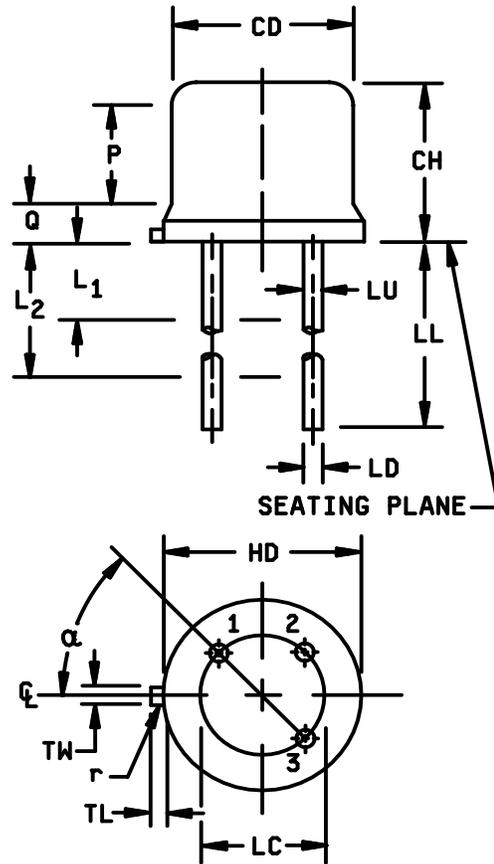
DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <https://assist.daps.dla.mil/quicksearch> or <https://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. 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.

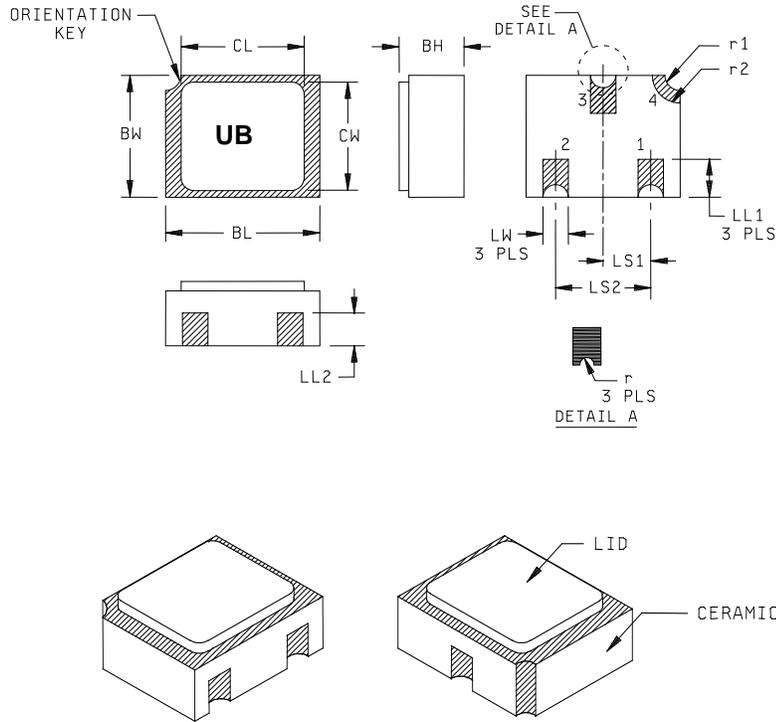
Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,11
LL	.500	.750	12.70	19.05	7
LU	.016	.019	0.41	0.48	12
L1		.050		1.27	7
L2	.250		6.35		7
P	.100		2.54		5
Q		.040		1.02	4
TL	.028	.048	0.71	1.22	3
TW	.036	.046	0.91	1.17	9
r		.010		0.25	10
α	45° TP		45° TP		6



NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LD applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum.
8. Lead number three is electrically connected to case.
9. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
10. Symbol r applied to both inside corners of tab.
11. Measured in a zone beyond .250 (6.35 mm) from the seating plane.
12. Measured in the zone between .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
13. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.
14. Lead 1 is emitter, lead 2 is base, and case is collector.

FIGURE 1. Physical dimensions (similar to TO-18).



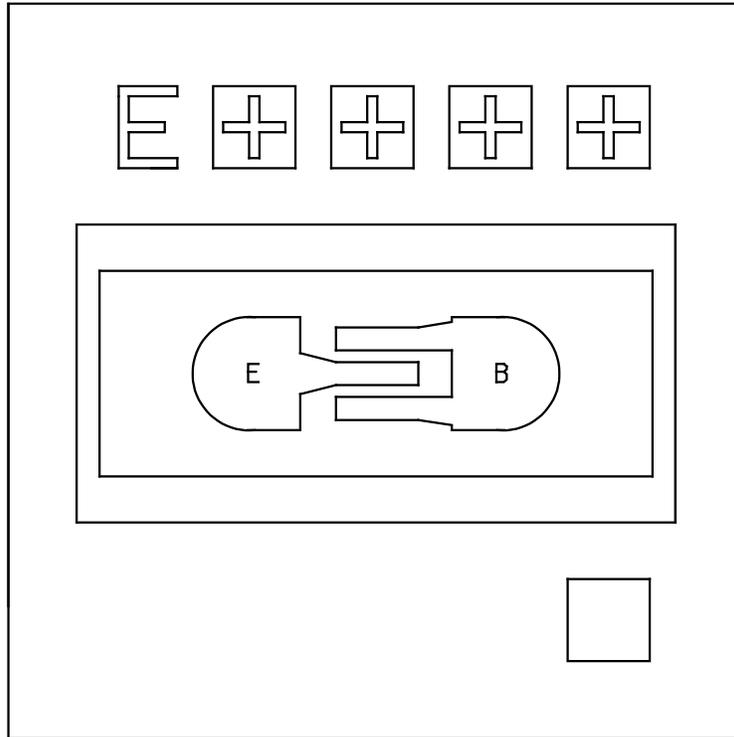
Ltr.	Dimensions				Note	Ltr.	Dimensions				Note
	Inches		Millimeters				Inches		Millimeters		
	Min	Max	Min	Max			Min	Max	Min	Max	
BH	.046	.056	1.17	1.42		LS1	.035	.040	0.89	1.02	
BL	.115	.128	2.92	3.25		LS2	.071	.079	1.80	2.01	
BW	.085	.108	2.16	2.74		LW	.016	.024	0.41	0.61	
CL		.128		3.25		r		.008		0.20	
CW		.108		2.74		r1		.012		0.31	
LL1	.022	.038	0.56	0.96		r2		.022		0.56	
LL2	.017	.035	0.43	0.89							

NOTES:

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metallized areas.
4. Lid material: Kovar.
5. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Shielding connected to the lid.
6. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 2. Physical dimensions for 2N3960UB, surface mount.



Die size:	.016 x .016 inch (0.41 x 0.41 mm).
Die thickness:	.008 ±.0016 inch (0.20 ±0.041 mm).
Base pad:	.0027 x .0027 inch 0.069 x 0.069 mm).
Emitter pad:	.0027 x .0027 inch.
Back metal:	Gold, 6500 ±1950 Ang.
Top metal:	Aluminum, 17500 ±2500 Ang.
	Back side: Collector.
Glassivation:	SiO ₂ , 7500 ±1500 Ang.

FIGURE 3. JANHC and JANKC (A-version) die dimensions.

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.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figures 1 (TO-18), figure 2 (UB), and figure 3 (JANHC, JANKC).

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 Radiation hardness assurance (RHA). Radiation hardness assurance requirements, PIN designators, and test levels shall be as defined in MIL-PRF-19500.

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

3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.8 Marking. Devices shall be marked in accordance with MIL-PRF-19500, except for the UB suffix package. Marking on the UB package shall consist of an abbreviated part number, the date code, and the manufacturer's symbol or logo. The prefixes JAN, JANTX, JANTXV, and JANS can be abbreviated as J, JX, JV, and JS respectively. The "2N" prefix and the "UB" suffix can also be omitted. The radiation hardened designator M, D, P, L, R, F, G, or H shall immediately precede (or replace) the device "2N" identifier (depending upon degree of abbreviation required).

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 and Tables I, II, III).

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 re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request 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.

4.2.2 JANHC and JANKC qualification. JANHC and JANKC qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANS, 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	
	JANS level	JANTX and JANTXV levels
3c	Thermal impedance Method 3131 of MIL-STD-750 (see 4.3.3).	Thermal impedance Method 3131 of MIL-STD-750 (see 4.3.3). (1)
9	I_{CEX2} and h_{FE2}	Not applicable
10	$V_{CB} = 12$ V, 48 hours minimum.	$V_{CB} = 12$ V, 48 hours minimum.
11	I_{CEX2} and h_{FE2} $\Delta I_{CEX2} = 100$ percent of initial value or 2 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 20$ percent.	I_{CEX2} and h_{FE2}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; $\Delta I_{CEX2} = 100$ percent of initial value or 2 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 20$ percent.	Subgroup 2 of table I herein; $\Delta I_{CEX2} = 100$ percent of initial value or 2 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 20$ percent.
14	Required.	Required.

(1) Shall be performed anytime after temperature cycling, screen 3a; and does not need to be repeated in screening requirements for JANTX and JANTXV level devices.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: $V_{CB} = 10$ V dc. Power shall be applied to achieve $T_J = +135^\circ\text{C}$ minimum using a minimum $P_D = 75$ percent of P_T maximum. $T_A =$ room ambient as defined in 1.3. With approval of the qualifying activity and preparing activity, alternate burn-in data criteria (hours, bias conditions, T_J , and mounting conditions) may be used for JANTX and JANTXV quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing site's burn-in data and performance history will be essential criteria for burn-in modification approval. Method 3100 of MIL-STD-750 to measure T_J shall be used.

4.3.2 Screening (JANHNC and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500, "Discrete Semiconductor Die/Chip Lot Acceptance". Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

4.3.3 Thermal response (ΔV_{BE} measurements). The ΔV_{BE} measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining V_H , V_{CE} , I_M , I_H , t_H , and t_{MD} . The ΔV_{BE} limit used in screen 3c and table I, subgroup 2 shall be set statistically by the supplier over several die lots and submitted to the qualifying activity for approval.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. If alternate screening is being performed in accordance with MIL-PRF-19500, a sample of screened devices shall be submitted to, and pass, the requirements of group A1 and A2 inspection only (table E-VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) 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 tests and conditions specified for subgroup testing in table E-VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. (See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing). Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 and delta requirements shall be in accordance with table III herein as specified in the footnotes for table III.

4.4.2.1 Group B inspection, table E-VIa (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B4	1037	$V_{CB} = 10$ V dc, 2,000 cycles, $t_{ON} = t_{OFF} = 3$ minutes, $P_{D(ON)} = P_D$ max rated per 1.3; $P_{D(OFF)} = 0$.
B5	1027	$V_{CB} = 10$ V dc, 1,000 hours at 75 percent of maximum rated power shall be applied and ambient temperature adjusted to achieve $T_J = +150^\circ\text{C}$ minimum. $n = 45$, $c = 0$.

4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new "assembly lot" option is exercised, the failed assembly lot shall be scrapped.

<u>Step</u>	<u>Method</u>	<u>Condition</u>
1	1026	Steady-state life: Test condition B, 1000 hours minimum, $V_{CB} = 10$ V dc, power shall be applied to the device and T_A adjusted to achieve $T_J = +150^\circ\text{C}$ minimum, and minimum $P_D = 75$ percent of max rated P_T (see 1.3 herein); $n = 45$, $c = 0$.
2	1048	HTRB: Test condition A, 48 hours minimum. $n = 45$, $c = 0$.
3	1032	High- temperature life (non-operating), $T_A = +200^\circ\text{C}$, $t = 340$ hours, $n = 22$, $c = 0$.

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- a. For JAN, JANTX, and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. For JANS samples shall be selected from each inspection lot. See MIL-PRF-19500.
- b. Shall be chosen from an inspection lot that has been submitted to and passed group A, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (subgroups B4 and B5 for JANS, and group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 and the delta requirements in accordance with the notes of table III herein.

4.4.3.1 Group C inspection, table E-VII (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	2036	Test condition E, not applicable to UB.
C6	1026	$V_{CB} = 10$ V dc, 1,000 hours; maximum rated power shall be applied and T_A adjusted to achieve $T_J = +150^\circ\text{C}$ minimum and a minimum of $P_D = 75$ percent of maximum rated PT as defined in 1.3.

4.4.3.2 Group C inspection, table VII (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E, (method 2036 not applicable for UB devices).
C6	1026	Not applicable.

4.4.3.3 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for C6 life test may be pulled prior to the application of final lead finish. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

4.4.4 Group D inspection. Conformance inspection for hardness assured JANS and JANTXV types shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and method 1019 of MIL-STD-750 for total ionizing dose, or method 1017 of MIL-STD-750 for neutron fluence, as applicable (see 6.2 herein), except group D, subgroup 2 may be performed separate from other subgroups. Group D inspection may also be performed ahead of the screening lot using die selected in accordance with MIL-PRF-19500 and related documents. Alternate package options may also be substituted for the testing provided there is no adverse effect to the fluence profile.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table IV herein. Electrical measurements (end-points) and the delta requirements shall be in accordance with table I, subgroup 2 and the delta requirements in accordance with the notes of table III herein.

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

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

MIL-PRF-19500/399F

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 2/</u>						
Visual and mechanical inspection <u>3/</u>	2071	n = 45 devices, c = 0				
Solderability <u>3/ 4/</u>	2026	n = 15 leads, c = 0				
Resistance to solvents <u>3/ 4/ 5/</u>	1022	n = 15 devices, c = 0				
Temp cycling <u>3/ 4/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal <u>4/</u> Fine leak Gross leak	1071	n = 22 devices, c = 0 Test conditions G or H Test conditions C or D				
Electrical measurements <u>4/</u>		Table I, subgroup 2				
Bond strength <u>3/ 4/</u>	2037	Precondition $T_A = +250^\circ\text{C}$ at t = 24 hrs or $T_A = +300^\circ\text{C}$ at t = 2 hrs n = 11 wires, c = 0				
De-cap internal visual	2075	n = 4, c = 0				
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.3	ΔV_{BE}			mV
Collector to base cutoff current	3036	Bias condition D, $V_{CB} = 20\text{ V dc}$	I_{CBO}		10	$\mu\text{A dc}$
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 4.5\text{ V dc}$	I_{EBO}		10	$\mu\text{A dc}$
Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 10\ \mu\text{A dc}$, pulsed (see 4.5.1)	$V_{(BR)CEO}$	12		V dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10\text{ V dc}$, $V_{BE} = 0.4\text{ V dc}$	I_{CEX1}		1.0	$\mu\text{A dc}$
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10\text{ V dc}$, $V_{BE} = 2.0\text{ V dc}$	I_{CEX2}		5.0	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 1\text{ V dc}$; $I_C = 1.0\text{ mA dc}$	h_{FE1}	40		

See footnotes 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 2</u> - Continued						
Forward-current transfer ratio	3076	$V_{CE} = 1 \text{ V dc}; I_C = 10 \text{ mA dc}$, pulsed (see 4.5.1)	h_{FE2}	60	300	
Forward-current transfer ratio	3076	$V_{CE} = 1 \text{ V dc}; I_C = 30 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE3}	30		
Collector to emitter saturated voltage	3071	$I_C = 1.0 \text{ mA dc}; I_B = 0.1 \text{ mA dc}$	$V_{CE(sat)1}$		0.2	V dc
Collector to emitter saturated voltage	3071	$I_C = 30 \text{ mA dc}; I_B = 3.0 \text{ mA dc}$, pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.3	V dc
Base emitter voltage (non- saturated)	3066	Test condition B, $V_{CE} = 1.0 \text{ V dc}$, $I_C = 1.0 \text{ mA dc}$	V_{BE1}		0.8	V dc
Base emitter voltage (non- saturated)	3066	Test condition B, $V_{CE} = 1.0 \text{ V dc}$, $I_C = 30 \text{ mA dc}$	V_{BE2}		1.0	V dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10 \text{ V dc}$, $V_{EB} = 2 \text{ V dc}$	I_{CEX3}		5.0	μA dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 1.0 \text{ V dc}; I_C = 10 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE4}	30		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal short- circuit forward- current transfer ratio	3306	$V_{CE} = 4 \text{ V dc}; I_C = 5.0 \text{ mA dc}$; $f = 100 \text{ MHz}$	$ h_{fe1} $	13		

See footnotes 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 4</u> - continued.						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 4 \text{ V dc}; I_C = 10 \text{ mA dc}; f = 100 \text{ MHz}$	$ h_{fe2} $	14		
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 4 \text{ V dc}; I_C = 30 \text{ mA dc}; f = 100 \text{ MHz}$	$ h_{fe3} $	12		
Open circuit output capacitance	3236	$V_{CB} = 4 \text{ V dc}; I_E = 0; 100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		2.5	pF
Input capacitance (output open-circuited)	3240	$V_{EB} = 0.5 \text{ V}, I_C = 0, 100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ibo}		2.5	pF
<u>Subgroups 5, 6, and 7</u>						
Not applicable						

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

2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.

3/ Separate samples may be used.

4/ Not required for JANS devices

5/ Not required for laser marked devices.

* TABLE II. Group D inspection and end-point limits.

Inspection <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 4/</u>						
Neutron Irradiation	1017	Neutron exposure $V_{CES} = 0$ V				
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 10$ uA dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$	12		V dc
Collector to base cutoff current	3036	Bias condition D, $V_{CB} = 20$ V	I_{CBO}		20	uA dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 4.5$ V dc	I_{EBO}		20	uA dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10$ V dc, $V_{BE} = 0.4$ V dc	I_{CEX1}		2.0	uA dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10$ V dc, $V_{BE} = 2.0$ V dc	I_{CEX2}		10	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 1.0$ mA dc	$[h_{FE1}]$	[20] <u>5/</u>		
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 10$ mA dc, pulsed (see 4.5.1)	$[h_{FE2}]$	[30] <u>5/</u>	300	
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 30$ mA dc, pulsed (see 4.5.1)	$[h_{FE3}]$	[15] <u>5/</u>		
Collector to emitter saturated voltage	3071	$I_C = 1.0$ mA dc; $I_B = 0.1$ mA dc	$V_{CE(sat)1}$		0.23	V dc
Collector to emitter saturated voltage	3071	$I_C = 30$ mA dc; $I_B = 3$ mA dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.35	V dc
Base emitter voltage (non saturated)	3066	Test condition B, $V_{CE} = 1.0$ V dc, $I_C = 1.0$ mA dc	V_{BE1}		0.92	V dc
Base emitter voltage (non saturated)	3066	Test condition B, $V_{CE} = 1.0$ V dc, $I_C = 30$ mA dc	V_{BE2}		1.15	V dc

See footnotes at end of table.

* TABLE II. Group D inspection and end-point limits – Continued.

Inspection <u>1/</u> <u>2/</u> <u>3/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u>						
Steady-state total dose irradiation	1019	Gamma exposure $V_{CES} = 9.6$ V dc				
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 10$ μ A dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$	12		V dc
Collector to base cutoff current	3036	Bias condition D, $V_{CB} = 20$ V	I_{CBO}		20	μ A dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 4.5$ V dc	I_{EBO}		20	μ A dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10$ V dc, $V_{BE} = 0.4$ V dc	I_{CEX1}		2.0	μ A dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 10$ V dc, $V_{BE} = 2.0$ V dc	I_{CEX2}		10	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 1.0$ mA dc	$[h_{FE1}]$	[20] <u>5/</u>		
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 10$ mA dc, pulsed (see 4.5.1)	$[h_{FE2}]$	[30] <u>5/</u>	300	
Forward-current transfer ratio	3076	$V_{CE} = 1$ V dc, $I_C = 30$ mA dc, pulsed (see 4.5.1)	$[h_{FE3}]$	[15] <u>5/</u>		
Collector to emitter saturated voltage	3071	$I_C = 1.0$ mA dc; $I_B = 0.1$ mA dc	$V_{CE(sat)1}$		0.23	V dc
Collector to emitter saturated voltage	3071	$I_C = 30$ mA dc; $I_B = 3$ mA dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.35	V dc
Base emitter voltage (non-saturated)	3066	Test condition B, $V_{CE} = 1.0$ V dc, $I_C = 1.0$ mA dc	V_{BE1}		0.92	V dc
Base emitter voltage (non-saturated)	3066	Test condition B, $V_{CE} = 1.0$ V dc, $I_C = 30$ mA dc	V_{BE2}		1.15	V dc

1/ Tests to be performed on all devices receiving radiation exposure.

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

3/ Electrical characteristics apply to all device types unless otherwise noted.

4/ See 6.2.e herein.

5/ See method 1019 of MIL-STD-750, for how to determine $[h_{FE}]$ by first calculating the $\Delta(1/h_{FE})$ from the pre- and post-radiation h_{FE} . Note that $[h_{FE}]$ is not the same as h_{FE} and cannot be measured directly. The $[h_{FE}]$ value can never exceed the pre-radiation minimum h_{FE} that it is based upon.

* TABLE III. Groups B, C, and E delta end-point inspection measurements. 1/ 2/ 3/ 4/

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition A, $V_{CE} = 10$ V dc, $V_{BE} = 2.0$ V dc	ΔI_{CEX2} <u>5/</u>	100 percent of initial value or 2 nA dc, whichever is greater;		
2.	Forward current transfer ratio	3076	$V_{CE} = 1.0$ V dc; $I_C = 10$ mA dc; pulsed (see 4.5.1)	Δh_{FE2} <u>5/</u>	±20 percent change from initial value		

- 1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are subgroup 4 and 5, see table III herein, all steps.
- 2/ The delta measurements for group B of 4.4.2.2 herein (JAN, JANTX, and JANTXV) are: Step 1, 2, and 3 of 4.4.2.2, see table III herein, all steps.
- 3/ The delta measurements for table E-VII of MIL-PRF-19500, Subgroup 6, all steps:
- 4/ The delta measurements for table E-IX of MIL-PRF-19500 are: Subgroups 1 and 2, see table III herein, all steps.
- 5/ Devices which exceed the table I limits herein for this test shall not be accepted.

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TABLE IV. Group E inspection (all quality levels) – for qualification or re-qualification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal Fine leak Gross leak	1071	Test conditions G or H Test conditions C or D	
Electrical measurements		See table I, subgroup 2 and table III herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	Intermittent operation life: $V_{CB} = 10$ V dc; 6,000 cycles; $t_{ON} = t_{OFF} = 3$ minutes, $P_{D(ON)} = P_D$ max rated in accordance 1.3; $P_{D(OFF)} = 0$.	
Electrical measurements		See table I, subgroup 2 and table III herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		Each supplier shall submit their qual-lot average and design maximum 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			
<u>Subgroup 6</u>			3 devices
ESD	1020		
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B	

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. Product assurance level and type designator.
- e. For acquisition of RHA designed devices, table II, subgroup 1 testing of group D is optional. If subgroup 1 testing is desired, it should be specified in the contract.

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.daps.dla.mil>.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N3960) will be identified on the QML.

Die ordering information	
PIN	Manufacturer
	34156
2N3960	JANHCA2N3960 JANKCA2N3960

6.5 Changes from previous issue. The margins of this specification are marked with lines 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:

Army - CR
Navy - EC
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:
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Review activities:

Army - AR, MI
Navy - MC
Air Force - 19, 71

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.daps.dla.mil>.