This is an advance copy of the dated document. The final document after review by the Defense Automated Printing Service may be slightly different in format. Actual technical content will be the same.

The documentation and process conversion measures necessary to comply with this revision shall be completed by 29 September 1999

INCH-POUND

MIL-PRF-19500/374D
29 June 1999
SUPERSEDING
MIL-S-19500/374C
01 May 1995

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER, TYPES 2N3996 THROUGH 2N3999, JAN, JANTX, JANTXV, JANS, JANHC AND JANKC

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN silicon, power transistors for use in high-speed power switching applications. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for the unencapsulated die.

1.2 Physical dimensions. See 3.3 and figure 1 (types 2N3996 and 2N3997, 4 lead stud package), figure 2 (types 2N3998 and 2N3999, 3 lead stud package), figure 3, and figure 4 (JANHC and JANKC).

1.3 Maximum ratings.

P_T 1/ $T_A = +25°C$	P_T 2/ $T_C = +100°C$	V_{EBO}	V_{CBO}	V_{CEO}	I_B	I_C	I_C 3/	T_{STG} and T_J	$R_{\Theta JC}$
W	W	V dc	V dc	V dc	A dc	A dc	A dc	°C	°C/W
2	30	8	100	80	0.5	5.0	10	-65 to +200	3.33

1/ Derate linearly, 11.4 mW/°C for $T_A \geq +25°C$.
2/ Derate linearly, 300 mW/°C for $T_C \geq +100°C$.
3/ This value applies for $t_p \leq 1$ ms, duty cycle ≤ 50%.

1.4 Primary electrical characteristics at $T_C = +25°C$.

Limit	h_{FE2} 1/ $V_{CE} = 2$ V dc; $I_C = 1$ A dc		$\|h_{fe}\|$ $V_{CE} = 5$ V dc; $I_C = 1$ A dc; f = 10 MHz	$V_{BE(sat)2}$ 1/ $I_C = 5$ A dc; $I_B = 500$ mA dc	$V_{CE(sat)2}$ 1/ $I_C = 5$ A dc; $I_B = 500$ mA dc	C_{obo} $V_{CB} = 10$ V dc $I_E = 0$ 100 kHz ≤ f ≤ 1 MHz
	2N3996 2N3998	2N3997 2N3999		V dc	V dc	pF
Minimum	40	80	3	---	---	---
Maximum	120	240	12	1.6	2.0	150

1/ Pulsed (see 4.5.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad St., Columbus, OH 43216-5000, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5961

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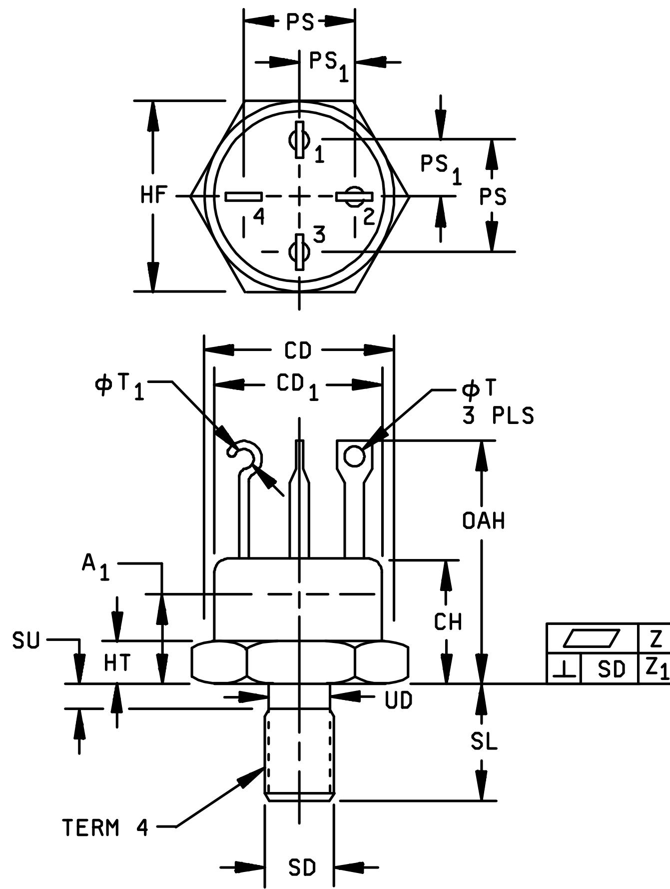


FIGURE 1. Physical dimensions for transistor types 2N3996 and 2N3997.

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.345	.400	8.76	10.16	
A_1		.250		6.35	3
CD	.318	.380	8.08	9.65	
CD_1	.370	.437	9.40	11.10	3
HF	.424	.437	10.77	11.10	
PS	.180	.215	4.57	5.46	5
PS_1	.080	.110	2.03	2.79	5
HT	.090	.140	2.29	3.56	2,6
OAH	.575	.675	14.61	17.15	1
UD	.155	.189	3.94	4.80	
SL	.400	.455	10.16	11.56	
SU		.078		1.98	7
ϕT	.040	.065	1.02	1.65	
ϕT_1	.040	.065	1.02	1.65	4
SD	.190-32 UNF-2A				8
Z		.002		0.05	
Z_1		.006		0.15	

NOTES:
1. Terminal 1, emitter; terminal 2, base; terminal 3, collector; terminal 4, case.
2. Chamfer or undercut on one or both ends of hexagonal portion is optional.
3. The outline contour with the exception of the hexagon is optional within cylinder defined by CD_1 and A_1.
4. Terminal r can be flattened and pierced or hook type. A visual index is required when the flattened and pierced tab terminal contour (identical to the adjacent terminals) option is used. The case terminal (hook) is mechanically connected to the case. The other three terminals shall be electrically isolated from the case.
5. Angular orientation of terminals with respect to hexagon is optional.
6. HT dimension does not include sealing flanges.
7. SU is the length of incomplete or undercut threads.
8. SD is the pitch diameter of coated threads. Reference: Screw threads standards for Federal Service Handbook H28, part I.
9. Dimensions are in inches.
10. Metric equivalents are giving for general information only and are based upon 1.00 inch = 25.4 mm.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions for transistor types 2N3996 and 2N3997 - Continued.

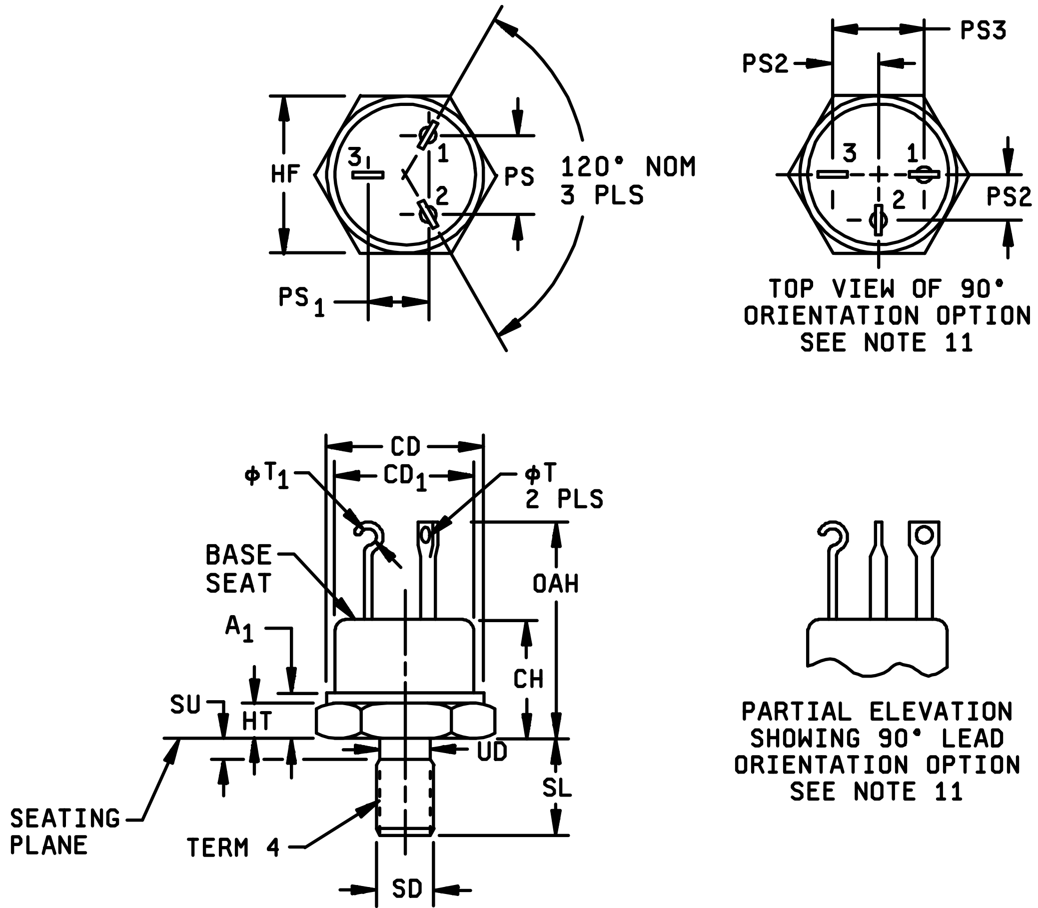


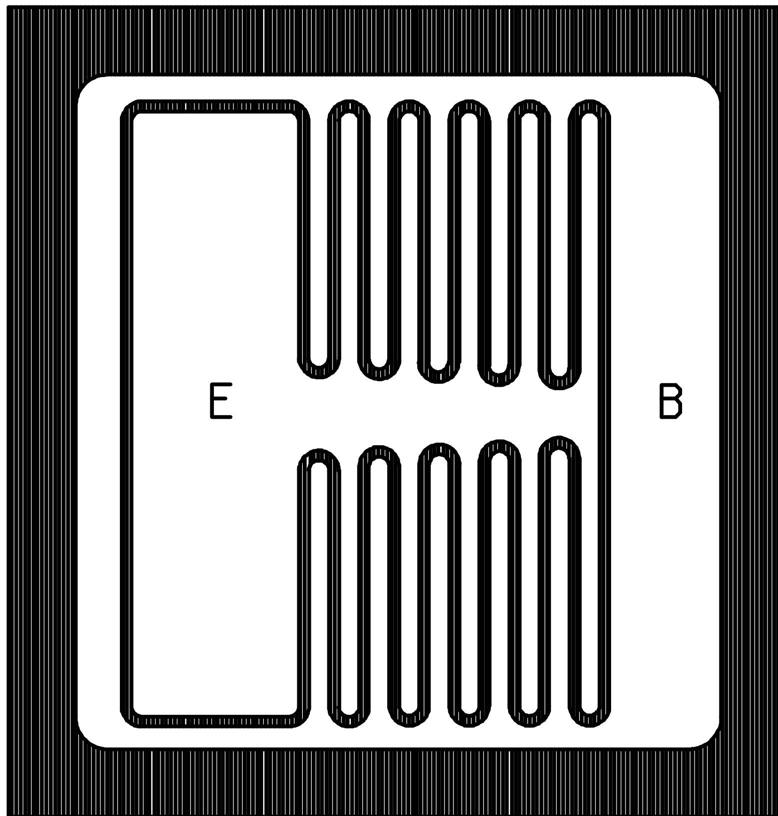
FIGURE 2. Physical dimensions for transistor types 2N3998 and 2N3999.

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.345	.400	8.76	10.16	
A_1		.250		6.35	
CD_1	.318	.380	8.08	9.65	
CD	.370	.437	9.40	11.10	
HF	.424	.437	10.77	11.10	
PS	.125	.165	3.18	4.19	4,7,8
PS_1	.110	.145	2.79	3.68	4,7
PS_2	.090	.140	2.29	3.56	4,7,8
PS_3	.185	.215	4.70	5.46	4,7,8
HT	.090	.140	2.29	3.56	
OAH	.575	.675	14.61	17.15	5
UD	.155	.189	3.94	4.80	
SL	.400	.455	10.16	11.56	
SU		.078		1.98	9
ϕT	.040	.065	1.02	1.65	
ϕT_1	.040	.065	1.02	1.65	
SD	.190-32 UNF-2A				3

NOTES:

1. Metric equivalents are given for general information only and are based upon 1.00 inch = 25.4 mm.
2. Collector shall be electrically connected to the case. This terminal may be flattened and pierced only when the 90° option is used.
3. SD is the pitch diameter of coated threads. Reference: Screw thread standards for Federal Service Handbook H28, part I.
4. The orientation of the terminals in relation to the hex flats is not controlled.
5. All three terminals.
6. The case temperature may be measured anywhere on the seating plane within .125 (3.18 mm) of the stud.
7. Terminal spacing measured at the base seat only.
8. Dimensions PS, PS_1, PS_2, and PS_3 are measured from the centerline of terminals.
9. Maximum unthreaded dimension.
10. This dimension applies to the location of the center line of the terminals.
11. A 90° angle lead orientation as shown may be used at the option of the manufacturer. All dimensions of the basic outline except PS, PS_1, and the 120°lead angle apply to this option.
12. Terminal 1, emitter; terminal 2, base; terminal 3, collector.
13. A slight chamfer or undercut on one or both ends of the hexagonal is optional.
14. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

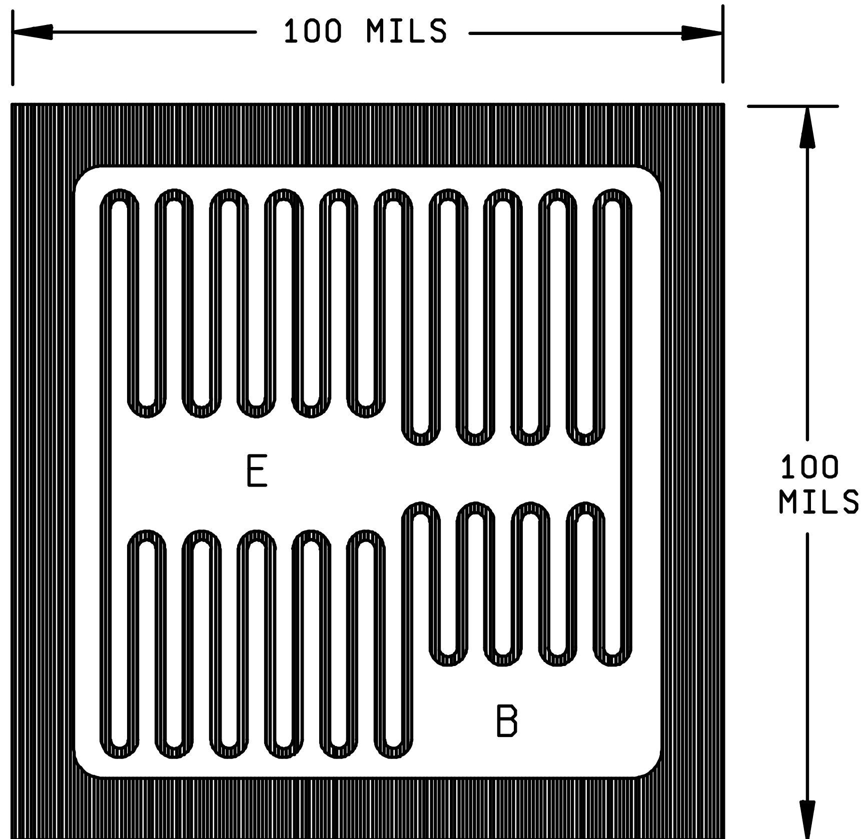
FIGURE 2. Physical dimensions for transistor types 2N3998 and 2N3999 - Continued.



NOTES:

1. Chip size .... 82 X 82 mils
2. Chip thickness .... 6 to 12 mils
3. Top metal .... Aluminum 25,000 Å minimum, 30,000 Å nominal
4. Back metal .... Gold 2,500 Å minimum, 3,000 Å nominal
5. Backside .... Collector
6. Bonding pad .... B = 8 x 60 mils, E = 8 x 50 mils

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



NOTES:

1. Chip size .... 100 X 100 mils
2. Chip thickness .... 6 to 12 mils
3. Top metal .... Aluminum 25,000 Å minimum, 33,000 Å nominal
4. Back metal .... Gold 1,500 Å minimum, 2,500 Å nominal
5. Backside .... Collector
6. Bonding pad .... 12 x 30 mils

FIGURE 4. JANHC and JANKC (B-versions) die dimensions.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 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 documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, 700 Robbins Avenue, Building 4D (DPM-DODSSP), 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 (except for related associated specifications or specification sheets), 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 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

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

3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, and figures 1, 2, 3, 4, herein.

3.3.1 Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein.

3.4 Marking. Devices shall be marked in accordance with MIL-PRF-19500. At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the transistor.

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

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2 and 6.2).

4. VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3)

c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.2 JANHC and JANKC devices. Qualification for JANHC and JANKC devices shall be in accordance with appendix G of MIL-PRF-19500. This testing may be performed utilizing a TO-5 package in lieu of the TO-59 or the TO-11.

4.3 Screening (JANS, JANTXV, JANTX levels only). Screening shall be in accordance with MIL-PRF-19500 (table IV) and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
3c 1/	Thermal impedance (see 4.5.5)	Thermal impedance (see 4.5.5)
9	I_{CES1} and h_{FE2}	I_{CES1}
11	I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater; Δh_{FE2} = +15 percent, -10 percent	I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 100 nA dc; whichever is greater.
12	See 4.3.1	See 4.3.1
13a	Subgroups 2 and 3 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater; Δh_{FE2} = +15 percent, -10 percent	Subgroup 2 of table I herein, ΔI_{CES1} = 100 percent of initial value or 200 nA dc, whichever is greater; Δh_{FE2} = +20 percent, -10 percent
13b	Insulation resistance (terminal to case) Method 1016 of MIL-STD-750 (types 2N3996 and 2N3997 only); test condition B (short collector, emitter, and base terminals together); $R_{iso} = 10^9\ \Omega$ minimum	Insulation resistance (terminal to case) Method 1016 of MIL-STD-750 (types 2N3996 and 2N3997 only); test condition B (short collector, emitter, and base terminals together); $R_{iso} = 10^9\ \Omega$ minimum.

1/ May be performed anytime before screen 9.

4.3.1 Power burn-in conditions. Power burn-in conditions for all levels are as follows:

V_{CE} = 25 V dc, ±5 V dc; T_J = 187.5°C, ± 12.5°C; T_A = 35°C. max

4.3.2 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with appendix G of MIL-PRF-19500. Test limits and conditions shall be chosen by the supplier to demonstrate compliance with electrical characteristics specified in table I herein.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF19500 and as specified herein. Group A inspection shall be performed on each sublot.

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 the applicable inspections of table I, group A, 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 tables VIa (JANS) and VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and paragraphs 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

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

Subgroup	Method	Condition
B4	1037	V_{CE} ≥ 10 V dc, 2,000 cycles.
B5	1027	V_{CE} = 20 V dc ±1.0 V dc; 96 hours. Adjusted as required by the chosen T_A to give an average lot T_J = 275°C.
B7	3053	Load condition C (unclamped inductive) (see figure 6), T_A = 25°C ±3°C, duty cycle ≤ 10 percent; R_S = 0.1Ω. TEST 1 - t_p = 640 µs; R_{BB1} = 39Ω; V_{BB1} = 20 V dc; R_{BB2} = ∞; V_{BB2} = 0; V_{CC} = 10 V dc; I_C = 4.3 A dc; L = 1 mH (0.5Ω, 5A) (Tower #7870 or equivalent). TEST 2 - t_p = 2.88 mS; R_{BB1} = 120Ω; V_{BB1} = 20 V dc; R_{BB2} = ∞; V_{BB2} = 0; V_{CC} = 10 V dc; I_C = 1.4 A dc; L = 10 mH (0.11 Ω, 12.5A) (Stancor C-2688 or equivalent)
B7	3053	Safe operating area (switching) (destructive); Load condition B (clamped inductive) T_A = 25°C; I_B = 0.5 A dc, I_C = 5 A dc; V_{CC} = 55 V dc, L = 1.0 mH, V_{BB2} = 3.0 V, R_{BB2} = 20 Ω.

4.4.2.2 Group B inspection, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1037	For solder die attach; $V_{CE} \geq 10$ V dc, 2000 cycles
B3	1026	For eutectic die attach $T_A = 35°C$ max, P_T adjusted to achieve $T_J = 175°C$ min, $V_{CE} \geq 10$ V dc
B5	---	Not applicable.
B7	3053	Load condition C (unclamped inductive) (see figure 6), $T_A = 25°C$, duty cycle $\leq$ 10 percent; $R_S = 0.1\ \Omega$. TEST 1 - $t_p = 640\ \mu s$; $R_{BB1} = 39\Omega$; $V_{BB1} = 20$ V dc; $R_{BB2} = \infty$; $V_{BB2} = 0$; $V_{CC} = 10$ V dc; $I_C = 4.3$ A dc; L = 1 mH (0.5 Ω, 5A) (Tower #7870 or equivalent). TEST 2 - $t_p = 2.88$ mS; $R_{BB1} = 120\Omega$; $V_{BB1} = 20$ V dc; $R_{BB2} = \infty$; $V_{BB2} = 0$; $V_{CC} = 10$ V dc; $I_C = 1.4$ A dc; L = 10 mH (0.11 Ω, 12.5A) (Stancor C-2688 or equivalent)
B7	3053	Safe operating area (switching) (destructive); Load condition B (clamped inductive) $T_A = 25°C$; $I_B = 0.5$ A dc, $I_C = 5$ A dc; $V_{CC} = 55$ V dc, L = 1.0 mH, $V_{BB2} = 3.0$ V, $R_{BB2} = 20\ \Omega$.

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

Subgroup	Method	Condition
C2	2036	Test condition A; weight = 7 pounds ±5 ounce, application time = 15 s, tubulated leads only. Test condition D2; Torque = 15 inch-pound; application time = 15 s. Test condition D1; torque = 8 in-oz; application time = 15 s; tubulated leads only.
C3	1037	For solder die attach; $V_{CE} \geq 10$ V dc, 6000 cycles
C3	1026	For eutectic die attach $T_A = 35°C$ max, P_T adjusted to achieve $T_J = 175°C$ min, $V_{CE} \geq 10$ V dc

4.5 Methods 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.

4.5.2 Case-temperature control for h_{fe} test. To maintain the case temperature at less than +40°C for this test, the specified dc collector current should be applied for not longer than 10 seconds without employing a heat sink.

4.5.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted as a case temperature (T_C) of +25°C.

4.5.4 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

a. Collector current magnitude during power application shall be 0.833 A dc.

b. Collector to emitter voltage magnitude shall be 20 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be 25°C $\leq T_R \leq$ 75°C and recorded before the test is started.

e. Mounting arrangement shall be with heat sink to case.

f. Maximum limit of $R_{\theta JC}$ shall be 3.33°C /W.

4.5.5 Thermal impedance $Z_{\theta JX}$ measurements for screening. The ΔV_{BE} measurements shall be performed in accordance with MIL-STD-750, method 3131. The maximum limit and conditions for ΔV_{BE} in screening (see table II of MIL-PRF-19500) shall be derived by each vendor by means of process control of actual measurements which characterizes the die attach process. When three lot date codes have exhibited control, the data from these three lots will be used to establish a fixed screening limit (not to exceed the group A limit). Once a fixed limit has been established, monitor all future sealing lots using a sample from each lot to be plotted on the applicable X and R chart.

a. I_M measure current .... 10 mA.

b. I_H forward heating current .... 1.0 A to 3.0 A.

c. t_H heating time.. 100 ms max

d. t_{MS} measurement delay time.................................... 70 µs max

e. V_H forward heating voltage...................................... 10 V minimum.

The maximum limit for $Z_{\theta JX}$ under these test conditions are $Z_{\theta JX}$ (max) = 3.3°C/W.

4.5.5.1 Thermal impedance ($Z_{\theta JX}$ measurements) for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750. Method 3131 (read and record data $Z_{\theta JX}$) derived conditions limits and thermal response curve shall be supplied to the qualifying activity on the qualification lot prior to qualification approval.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. 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.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Thermal impedance	3131	See 4.5.5	$Z_{\theta JX}$		3.3	°C /W
Breakdown voltage, collector to base	3001	Bias condition D, I_C = 10 µA dc I_B = 0	$V_{(BR)CBO}$	100		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 50 mA dc pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 80 V dc, V_{BE} = 0	I_{CES1}		200	nA dc
Collector to emitter cutoff current	3041	Bias condition D, V_{CE} = 60 V dc, I_B = 0	I_{CEO}		10	µA dc
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 5 V dc, I_C = 0	I_{EBO1}		200	nA dc
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 8 V dc, I_C = 0	I_{EBO2}		10	µA dc
Base-emitter voltage (saturated)	3066	Test condition A, I_C = 1 A dc; I_B = 0.1 A dc, pulsed (see 4.5.1)	$V_{BE(sat)1}$	0.6	1.2	V dc
Base-emitter voltage (saturated)	3066	Test condition A, I_C = 5 A dc; I_B = 0.5 A dc, pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.6	V dc
Collector to emitter voltage (saturated)	3071	I_C = 1 A dc; I_B = 0.1 A dc, pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.25	V dc
Collector to emitter voltage (saturated)	3071	I_C = 5 A dc; I_B = 0.5 A dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		2	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Forward-current transfer ratio	3076	V_{CE} = 2 V dc; I_C = 50 mA dc, pulsed (see 4.5.1)	h_{FE1}			
2N3996, 2N3998				30		
2N3997, 2N3999				60		
Forward-current transfer ratio	3076	V_{CE} = 2 V dc; I_C = 1 A dc, pulsed (see 4.5.1)	h_{FE2}			
2N3996, 2N3998				40	120	
2N3997, 2N3999				80	240	
Forward-current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 5 A dc, pulsed (see 4.5.1)	h_{FE3}			
2N3996, 2N3998				15		
2N3997, 2N3999				20		
Subgroup 3						
High temperature operation		T_C = +150°C				
Collector to emitter cutoff current	3041	Bias Condition C, V_{CE} = 80 V dc, V_{BE} = 0	I_{CES2}		50	μA dc
Low-temperature operation		T_C = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 2 V dc; I_C = 1 A dc, pulsed (see 4.5.1)	h_{FE4}			
2N3996, 2N3998				10		
2N3997, 2N3999				20		

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz $\leq$ f $\leq$ 1 MHz	C_{obo}		150	pF
Magnitude of common emitter small-signal short-circuit forward current transfer ratio	3306	V_{CE} = 5 V dc; I_C = 1 A dc; f = 10 MHz, (see 4.5.2)	h_{fe}	3	12	
Switching parameters:						
2N3996 and 2N3998						
pulse delay time		See figure 5	t_d		100	ns
pulse rise time		See figure 5	t_r		240	ns
pulse storage time		See figure 5	t_s		1.4	µs
pulse fall time		See figure 5	t_f		.3	µs
t_{on}		$t_d + t_r$	t_{on}		.3	µs
t_{off}		$t_s + t_f$	t_{off}		1.5	µs
2N3997 and 2N3999						
pulse delay time		See figure 5	t_d		100	ns
pulse rise time		See figure 5	t_r		240	ns
pulse storage time		See figure 5	t_s		1.75	µs
pulse fall time		See figure 5	t_f		.3	µs
t_{on}		$t_d + t_r$	t_{on}		.3	µs
t_{off}		$t_s + t_f$	t_{off}		2.0	µs
Subgroup 5						
Safe operating area (DC)	3051	T_C = 100°C; power application time = 1.0 sec. (see figure 6)				
Test 1		V_{CE} = 80 V dc; I_C = .080 A dc				
Test 2		V_{CE} = 20 V dc; I_C = 1.5 A dc				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - continued						
Safe operating area (clamped inductive)		(See figures 8 and 9); (clamped inductive load) T_A = 25°C; I_B = 0.5 A dc; I_C = 5 A dc; V_{CC} = 15 V dc; Load condition C				
Electrical measurements		See subgroups 2 herein.				
Subgroup 6 and 7						
Not applicable						

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

TABLE II. Groups A, B, and C delta measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	V_{CE} = 2 V dc I_C = 1 A dc pulsed (see 4.5.1)	Δh_{FE2} 1/		±20 percent change from initial reading.	
2.	Collector to emitter cutoff current	3041	Bias condition D; V_{CE} = 60 V dc I_B = 0	ΔI_{CEO} 1/		100 percent of initial value or 100 nA dc, whichever is greater.	
3.	Collector to emitter voltage (saturated)	3071	I_C = 1 A dc I_B = 0.1 A dc pulsed (see 4.5.1)	$\Delta V_{CE(SAT)1}$ 1/		±50 percent mV dc change from previously measured value.	
4.	Thermal impedance	3131	See 4.4.1 and 4.5.5	$\Delta Z_{\theta JX}$		3.3	°C/W

1/ The devices which exceed the group A limits for this test shall not be acceptable.

2/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:

a. Subgroups 4 and 5, see table II herein, step 1 and 4.

b. Subgroup 7, see table II herein, step 1.

3/ The delta measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows:

a. Subgroup 3, see table II herein, step 1 and 4.

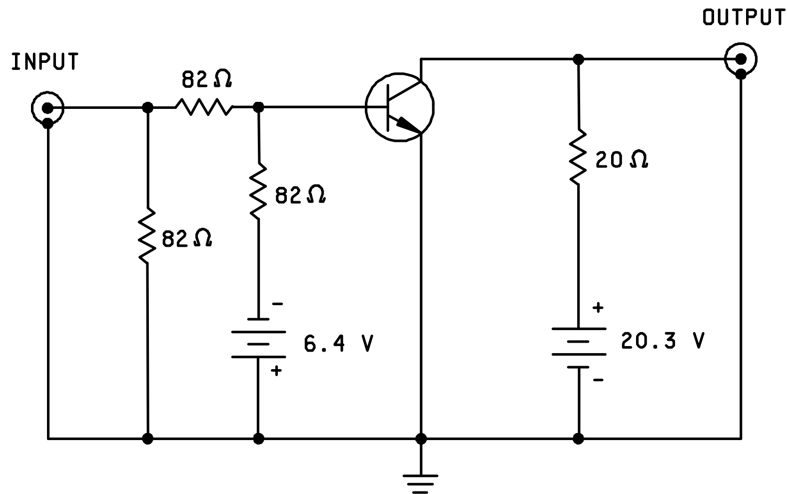
b. Subgroup 6, see table II herein, step 2.

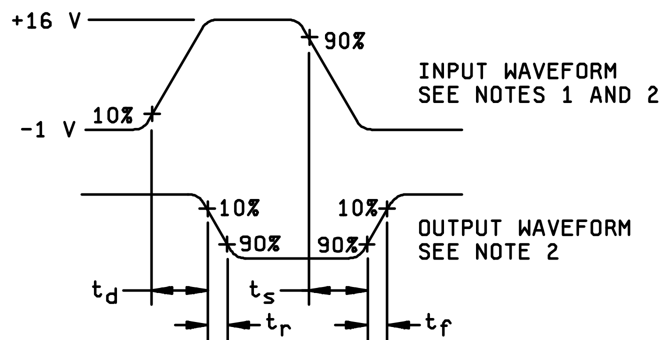
c. Subgroup 7, see table II herein, step 1

4/ The electrical measurements for table V of MIL-PRF-19500 are as follows:

a. Subgroup 2, see table II herein, step 3 for JANS.

b. Subgroup 6, see table II herein, step 1; 2 and 4 for JANS and steps 1 and 4 for JAN, JANTX and JANTXV.





NOTES:

1. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\ \Omega$, pW = 2 µs, duty cycle ≤ 2 percent.
2. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
3. Resistors must be non-inductive types.
4. The d-c power supplies may require additional by-passing in order to minimize ringing.

FIGURE 5. Pulse response test circuit.

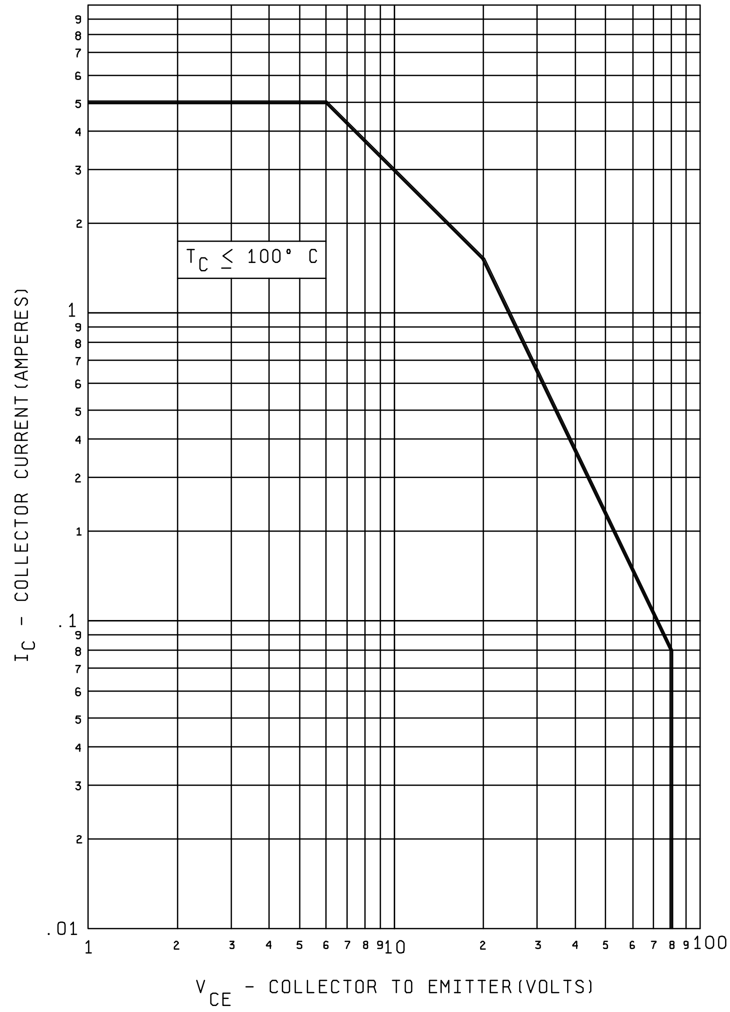


FIGURE 6. Maximum safe operating area graph (dc).

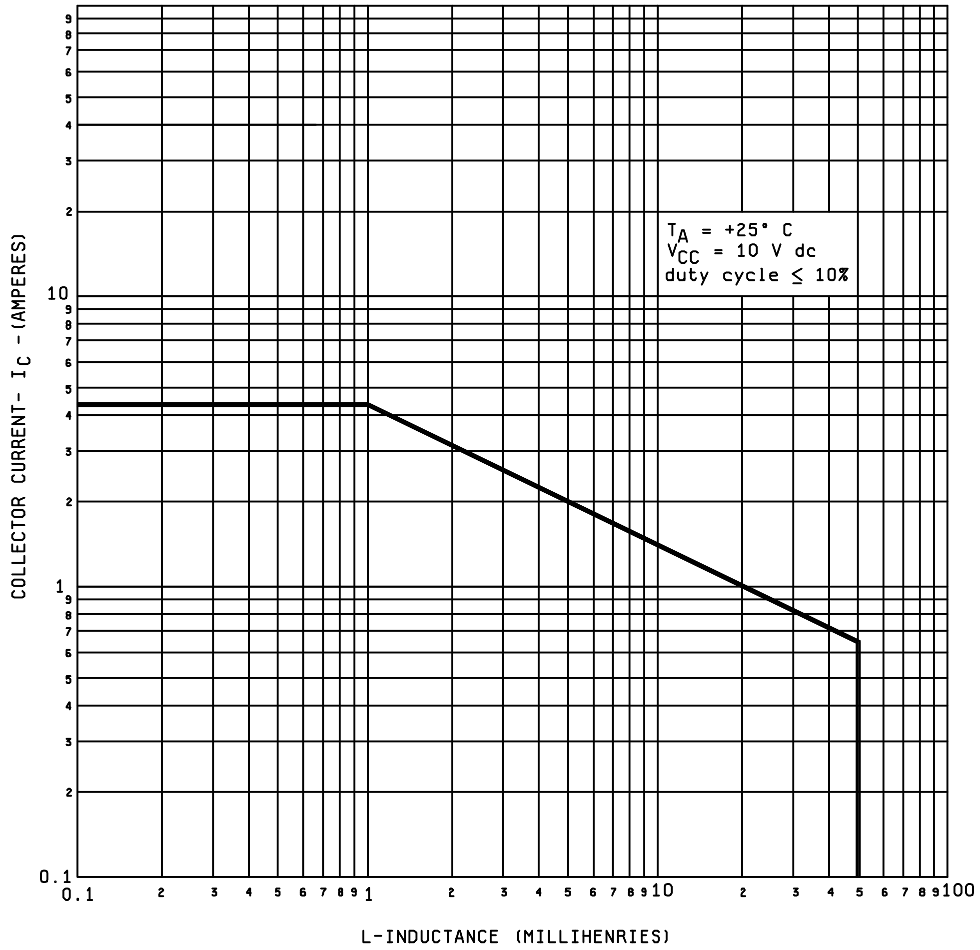
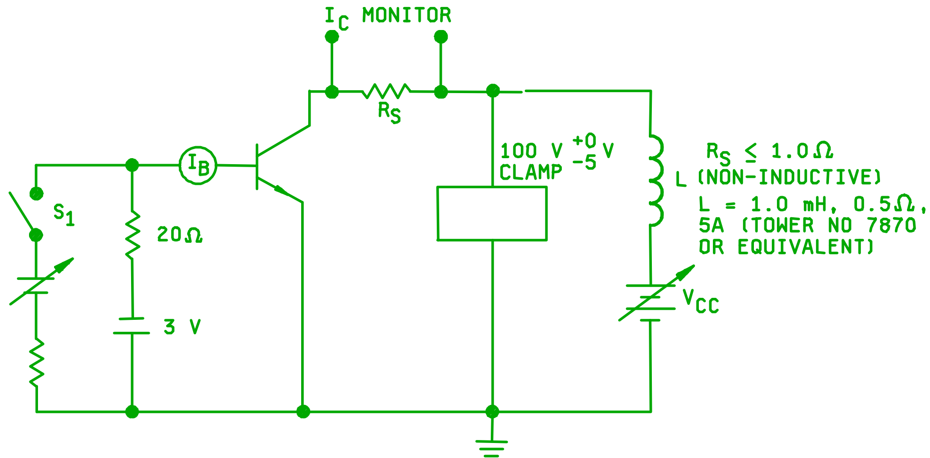


FIGURE 7. Safe operating area for switching between saturation and cutoff - unclamped inductive load.



Procedure:

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1. Device fails if clamp voltage not reached.
3. Perform specified end point test.

FIGURE 8. Clamped inductive sweep test circuit.

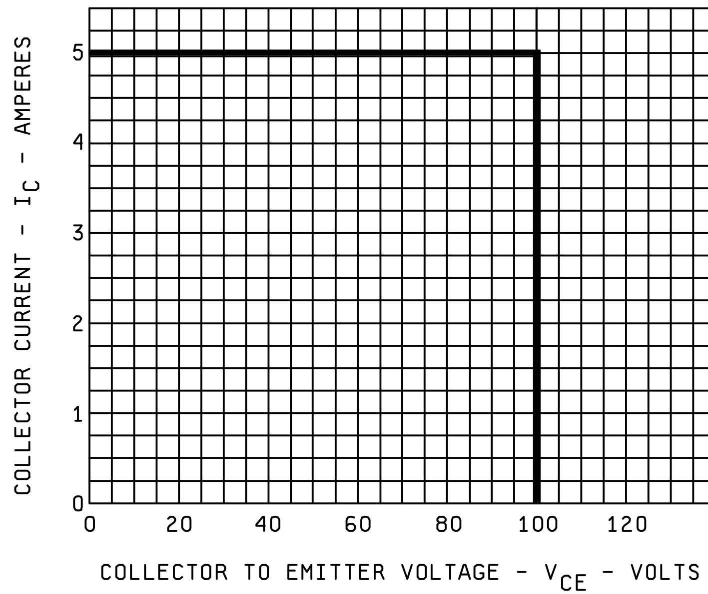


FIGURE 9. Safe operating area for switching between saturation and cutoff - clamped inductive load.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1).

b. Lead finish (see 3.3.1).

c. Type designation and product assurance level.

d. Packaging requirements (see 5.1).

6.3 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N3996) will be identified on the QPL.

JANHC and JANKC ordering information		
Pin	Manufacturer 1/	
	33178	34156
2N3996	JANHCA2N3996	JANHCB2N3996
2N3997	JANHCA2N3997	JANHCB2N3997
2N3998	JANHCA2N3998	JANHCB2N3998
2N3999	JANHCA2N3999	JANHCB2N3999

1/ For JANKC level, replace the JANHC prefix with JANKC.

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

6.5 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, Columbus, OH 43216.

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

Preparing activity:
DLA - CC

Review activities:
Army - AV
Air Force – 99

(Project 5961-2166)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/374D	2. DOCUMENT DATE *(YYYYMMDD)*

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER, TYPES 2N3996 THROUGH 2N3999, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(If applicable)*	7. DATE SUBMITTED *(YYYYMMDD)*

8. PREPARING ACTIVITY

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c. ADDRESS *(Include Zip Code)* DSCC-VAC 3900 East Broad Street Columbus, Ohio 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703)767-6888 DSN 427-6888