

The documentation and process conversion measures necessary to comply with this document shall be completed by 26 April 2025.

INCH-POUND

MIL-PRF-19500/374G
w/AMENDMENT 1
26 February 2025
SUPERSEDING
MIL-PRF-19500/374G
22 June 2020

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, POWER,
DEVICE TYPES 2N3996 THROUGH 2N3999,
ENCAPSULATED (CASE MOUNT STUD) AND UN-ENCAPSULATED,
QUALITY LEVELS JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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, power transistors for use in high-speed power switching applications. Four levels of product assurance (JAN, JANTX, JANTXV, and JANS) are provided for each encapsulated device. Two levels of product assurance (JANHC and JANKC) are provided for the un-encapsulated die.

1.2 Physical dimensions.

1.2.1 Package outlines. The device package outlines for the encapsulated device types are as follows: 4 terminal stud (TO-111) package in accordance with [figure 1](#) for types 2N3996 and 2N3997 and 3 terminal stud (TO-111) package in accordance with [figure 2](#) for types 2N3998 and 2N3999.

1.2.2 Un-encapsulated die. The dimensions and topography for JANHC and JANKC un-encapsulated die JANHC and JANKC, A-version in accordance with [figure 3](#), B-version in accordance with [figure 4](#), and C-version in accordance with [figure 5](#).

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

P_T (1) $T_A = +25\text{ }^{\circ}\text{C}$	P_T (2) $T_C = +100\text{ }^{\circ}\text{C}$	V_{EBO}	V_{CBO}	V_{CEO}	I_B	I_C	I_C (3)	T_{STG} and T_J	$R_{\theta JC}$
<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>$^{\circ}\text{C}$</u>	<u>$^{\circ}\text{C/W}$</u>
2	30	8	100	80	0.5	5.0	10	-65 to +200	3.33

- (1) Derate linearly, 11.4 mW/ $^{\circ}\text{C}$ for $T_A \geq +25\text{ }^{\circ}\text{C}$.
- (2) Derate linearly, 300 mW/ $^{\circ}\text{C}$ for $T_C \geq +100\text{ }^{\circ}\text{C}$.
- (3) This value applies for $t_p \leq 1\text{ ms}$, duty cycle ≤ 50 percent.

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1.4 Primary electrical characteristics. Unless otherwise specified, at $T_C = +25\text{ }^{\circ}\text{C}$.

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

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.5 for a list of available PINs.

1.5.1 JAN certification mark and quality level.

1.5.1.1 Quality level designators for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JAN", "JANTX", "JANTXV" and "JANS".

1.5.1.2 Quality level designators for un-encapsulated devices (die). The quality level designators for un-encapsulated devices (die) that are applicable for this specification sheet from the lowest to the highest level are as follows: "JANHC" and "JANKC".

1.5.2 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.2.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

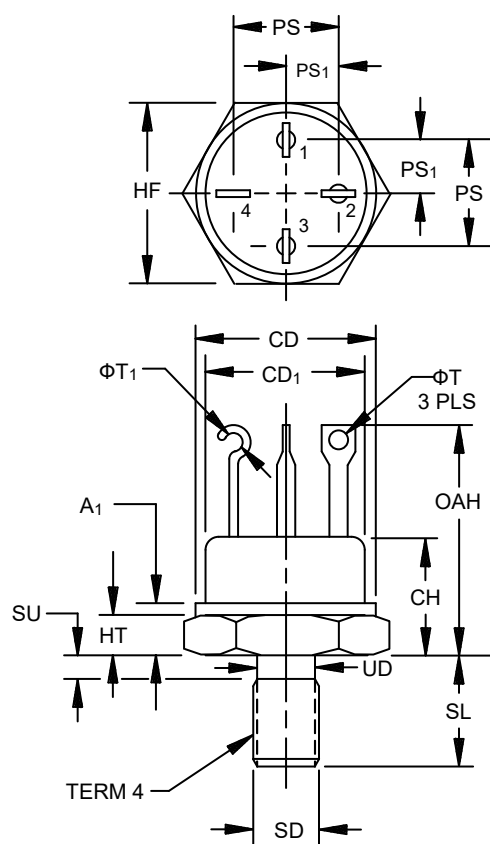
1.5.2.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "3996", "3997", "3998" and "3999".

1.5.3 Suffix symbols. Suffix symbols are not applicable for this specification sheet.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QML-19500.

1.5.5 Die identifiers for un-encapsulated devices (manufacturers and critical interface identifiers). The manufacturer die identifiers that are applicable for this specification sheet are "A", "B", and "C" (see figures 3, 4, and 5).

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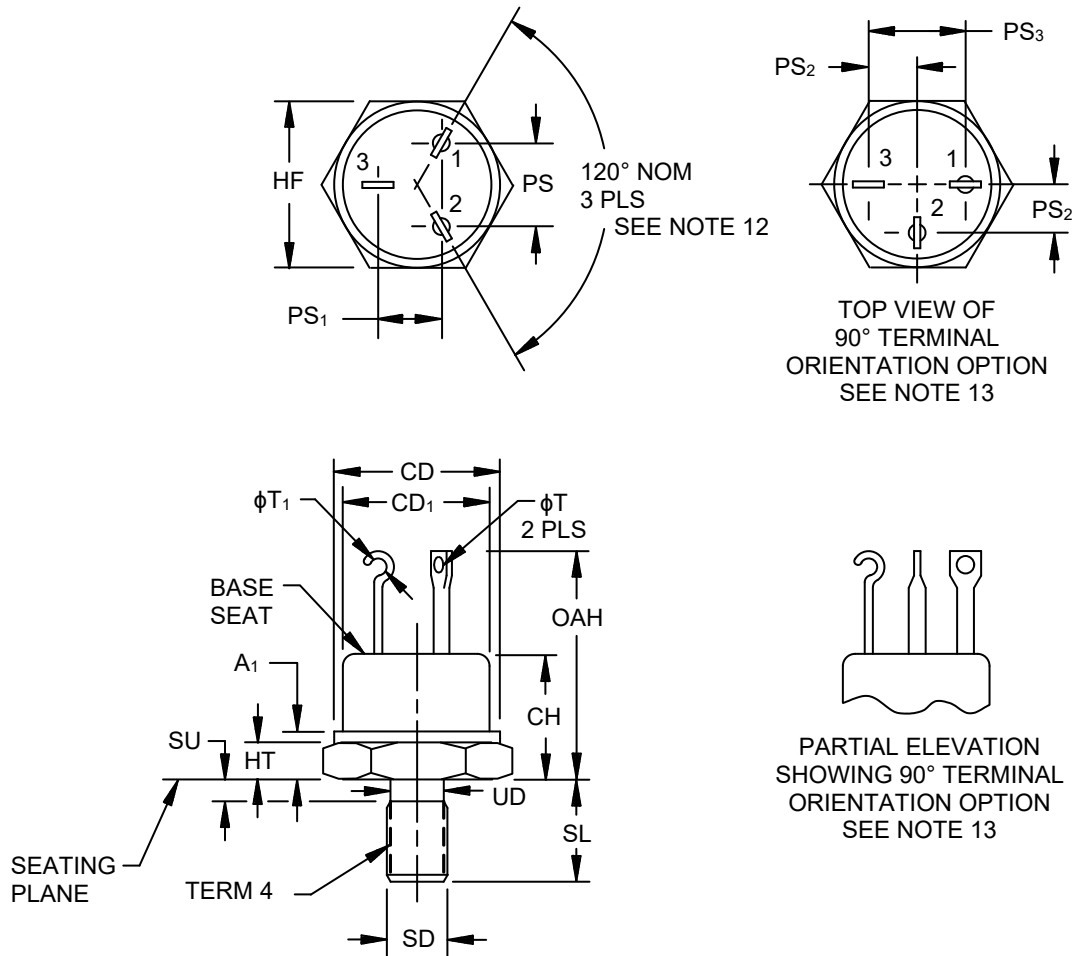
	Dimensions				
Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max	
A ₁		.250		6.35	4
CD	.370	.437	9.40	11.10	4
CD ₁	.318	.380	8.08	9.65	
CH	.345	.400	8.76	10.16	
HF	.424	.437	10.77	11.10	
HT	.090	.140	2.29	3.56	5, 6
OAH	.575	.675	14.61	17.15	7
PS	.180	.215	4.57	5.46	3
PS1	.080	.110	2.03	2.79	3
SD	.190-32 UNF-2A				8
SL	.400	.455	10.16	11.56	
SU		.078		1.98	9
UD	.155	.189	3.94	4.80	
Z		.002		0.05	
Z ₁		.006		0.15	
ϕT	.040	.065	1.02	1.65	
ϕT ₁	.040	.065	1.02	1.65	10

NOTES:

1. Dimensions are in inches. Millimeters are giving for general information only.
2. Terminal 1, emitter; terminal 2, base; terminal 3, collector; terminal 4, case. The case terminal (hook) is electrically connected to the case. The other three terminals shall be electrically isolated from the case.
3. The angular orientation of terminals in relation to the hex flats is not controlled.
4. The outline contour with the exception of the hexagon is optional within cylinder defined by dimensions A₁ and CD.
5. A slight chamfer or undercut on one or both ends of hexagon is optional.
6. Dimension HT does not include sealing flanges.
7. Applies to all four terminals.
8. Dimension SD is the pitch diameter of coated threads. The ASME thread reference is 10-32 UNF-2A.
9. Dimension SU is the length of incomplete or undercut threads (maximum unthreaded dimension).
10. This terminal 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.

* FIGURE 1. Physical dimensions for four terminal TO-111 (modified), transistor types 2N3996 and 2N3997.

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Symbol	Inches		Millimeters		Notes	Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max			Min	Max	Min	Max	
A ₁		.250		6.35	4	PS ₁	.110	.145	2.79	3.68	3, 8, 9
CD	.370	.437	9.40	11.10	4	PS ₂	.090	.140	2.29	3.56	3, 7, 8, 9
CD ₁	.318	.380	8.08	9.65		PS ₃	.185	.215	4.70	5.46	3, 7, 8, 9
CH	.345	.400	8.76	10.16		SD	.190-32 UNF-2A				10
HF	.424	.437	10.77	11.10		SL	.400	.455	10.16	11.56	
HT	.090	.140	2.29	3.56	5, 6	SU		.078		1.98	11
OAH	.575	.675	14.61	17.15	7	UD	.155	.189	3.94	4.80	
PS	.125	.165	3.18	4.19	3	φT	.040	.065	1.02	1.65	
						φT ₁	.040	.065	1.02	1.65	

* FIGURE 2. Physical dimensions for three terminal TO-111 (modified), transistor types 2N3998 and 2N3999.

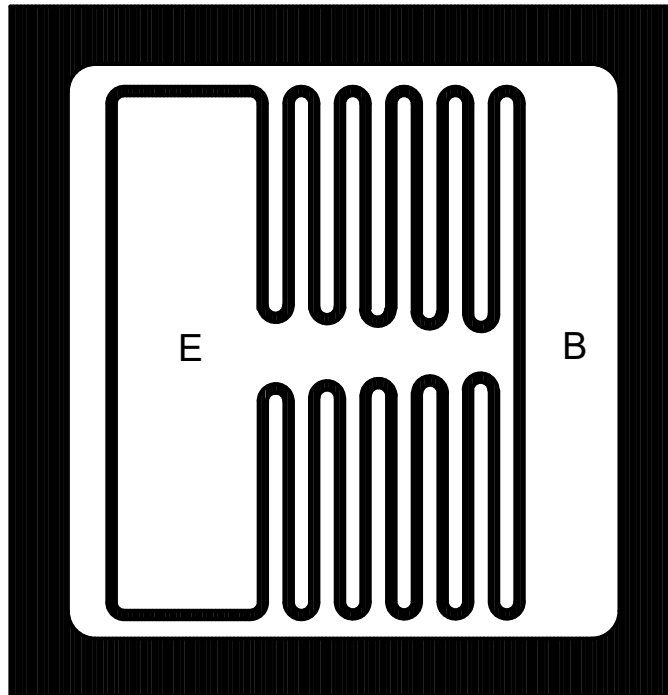
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NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Terminal 1, emitter; terminal 2, base; terminal 3, collector. Collector shall be electrically connected to the case.
3. The angular orientation of the terminals in relation to the hex flats is not controlled.
4. The outline contour with the exception of the hexagon is optional within cylinder defined by dimensions A1 and CD.
5. A slight chamfer or undercut on one or both ends of the hexagonal is optional.
6. Dimension HT does not include sealing flanges.
7. Applies to all three terminals.
8. Terminal spacing measured at the base seat only.
9. Dimensions PS, PS1, PS2, and PS3 are measured from the centerline of terminals.
10. Dimension SD is the pitch diameter of coated threads.
11. Dimension SU is the length of incomplete or undercut threads (maximum unthreaded dimension).
12. This angle dimension applies to the location of the center line of the terminals.
13. A 90 degree angle terminal orientation as shown may be used at the option of the manufacturer. All dimensions of the basic outline except PS, PS1, PS2, and PS3, and the 120° terminal angle apply to this option.
14. The case temperature may be measured anywhere on the seating plane within .125 (3.18 mm) of the stud.

* FIGURE 2. Physical dimensions for three terminal TO-111 (modified), transistor types 2N3998 and 2N3999 - continued.

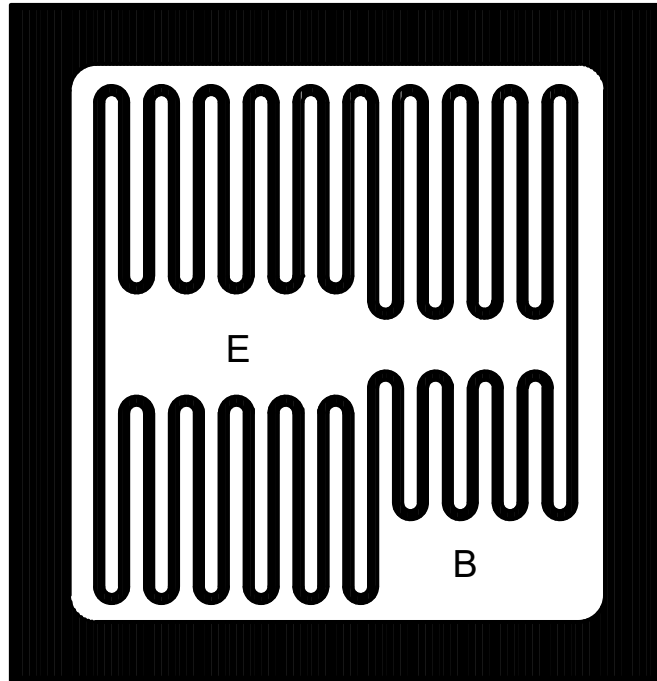
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NOTES:

- | | |
|------------------|--|
| 1. Die size | .082 x .082 inch (2.08 x 2.08 mm) |
| 2. Die thickness | .006 to .012 inch (0.15 to 0.30 mm) |
| 3. Back metal | Gold 2,500 Å minimum, 3,000 Å nominal |
| 4. Backside | Collector |
| 5. Top metal | Aluminum 25,000 Å minimum, 30,000 Å nominal |
| 6. Bonding pads | B = .008 x .060 inch (0.20 x 1.62 mm)
E = .008 x .050 inch (0.20 x 1.27 mm) |

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

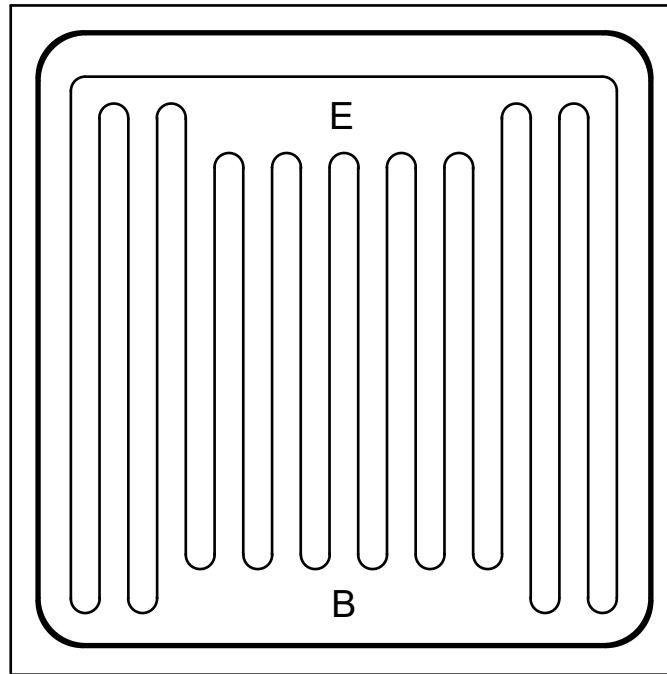


NOTES:

- | | |
|------------------|---|
| 1. Die size | .100 x .100 inch (2.54 mm x 2.54 mm) |
| 2. Die thickness | .006 to .012 inch (.15 to .30 mm) |
| 3. Back metal | Gold 1,500 Å minimum, 2,500 Å nominal |
| 4. Backside | Collector |
| 5. Top metal | Aluminum 25,000 Å minimum, 33,000 Å nominal |
| 6. Bonding pads | .012 to .030 inch (.30 to .76 mm) |

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

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NOTES:

- | | |
|------------------|--|
| 1. Die size | .120 x .120 inch $\pm$.002 inch (3.05 x 3.05 mm $\pm$ 0.05 mm). |
| 2. Die thickness | .014 inch $\pm$.0015 inch nominal (0.35 mm $\pm$ 0.04 mm). |
| 3. Back metal | Gold 6,000Å minimum, 8,000Å nominal. |
| 4. Backside | Collector |
| 5. Top metal | Aluminum, 54,000Å minimum, 60,000Å nominal. |
| 6. Bonding pads | B = .060 x .012 inch (1.5 mm x 0.30 mm). |
| | E = .050 x .012 inch (1.27 mm x 0.30 mm). |

FIGURE 5. JANHC and JANKC (C-versions) die dimensions.

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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 of documents cited in sections 3 and 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 <https://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-19500) 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 requirements and physical dimensions shall be as specified in MIL-PRF-19500, and figures 1, 2, 3, 4, and 5 herein.

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 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

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

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3.8 Electrostatic discharge sensitive (ESDS). The devices covered by this specification sheet have been classified as ESDS. The devices shall be handled in accordance with the ESD program established to comply with the requirements of [MIL-PRF-19500](#) to avoid damage due to the accumulation of static charge. The following handling practices shall be followed:

- a. Devices shall be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber, or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source, $R \leq 100 \text{ k}\Omega$, whenever bias voltage is to be applied drain to source.

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 [table I](#) and [II](#)).
- d. Element evaluation (see [4.6](#)).

4.2 Qualification inspection. Qualification inspection shall be in accordance with [MIL-PRF-19500](#) and as specified herein.

4.2.1 Group E inspection. 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 III](#) tests, the tests specified in [table III](#) 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 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-111 package.

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4.3 Screening (quality levels JANS, JANTX, and JANTXV only). Screening of encapsulated devices 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	Measurements for JANS level	Measurements for JANTX and JANTXV levels
(1) 3c	Thermal impedance (see 4.3.1)	Thermal impedance (see 4.3.1)
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 4.3.2	See 4.3.2
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 (see 4.3.3)	Insulation resistance (see 4.3.3)

- (1) Shall be performed anytime after temperature cycling, screen 3a. Quality levels JANTX and JANTXV levels do not need to be repeated in screening requirements.

4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3131 of [MIL-STD-750](#) using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} , t_{MD} (and V_H where appropriate). See [table III](#), group E, subgroup 4 herein.

4.3.2 Power burn-in conditions. The power burn-in conditions for all quality levels shall be as follows:
 V_{CE} = 25 V dc, ± 5 V dc; T_J = 187.5 °C, ± 12.5 °C; T_A = 35 °C maximum.

4.3.3 Insulation resistance (types 2N3996 and 2N3997 only). The test for insulation resistance voltage shall be performed in accordance with method 1016 of [MIL-STD-750](#). The following details shall apply. The test voltage shall be 500 volts ± 10 percent, (short collector, emitter, and base terminals together); R_{iso} = $10^9 \Omega$ minimum.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#) and as specified herein. Group A inspection shall be performed on each subplot.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with [MIL-PRF-19500](#), and [table I](#) herein. Delta measurements shall be in accordance with [table II](#) herein.

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4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in 4.4.2.1 for quality level JANS and 4.4.2.2 for quality levels JAN, JANTX, and JANTXV of [MIL-PRF-19500](#). Delta measurements shall be in accordance with [table II](#) herein.

4.4.2.1 Quality level JANS (table E-VIA of [MIL-PRF-19500](#)).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B4	1037	$V_{CE} \geq 10$ V dc.
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; $R_S = 0.1$ Ω . Test 1: $t_p = 640$ μ s; $R_{BB1} = 39$ Ω ; $V_{BB1} = 20$ 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; $R_{BB1} = 120$ Ω ; $V_{BB1} = 20$ 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, $R_{BB2} = 20$ Ω .

4.4.2.2 Quality levels JAN, JANTX and JANTXV (table E-VIB of [MIL-PRF-19500](#)).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1037	For solder die attach; $V_{CE} \geq 10$ V dc.
B3	1027	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 ≤ 10 percent; $R_S = 0.1$ Ω . Test 1: $t_p = 640$ μ s; $R_{BB1} = 39$ Ω ; $V_{BB1} = 20$ 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; $R_{BB1} = 120$ Ω ; $V_{BB1} = 20$ 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, $R_{BB2} = 20$ Ω .

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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. Delta measurements shall be in accordance with [table II](#) herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Tubulated leads only: Test condition A; weight = 7 pounds $\pm$ 5 ounce (3.18 kg $\pm$ 141 g), application time = 15 s, Test condition D1; torque = 8 inch-ounce (5.64 N-cm); application time = 15 s.
C2	2036	Stud only: Test condition D2; torque = 15 inch-pound (1.69 N-m); application time = 15 s.
* C5	3131	See 4.5.4, $R_{\theta JC} = 3.33$ °C/W.
C6	1037	For solder die attach; $V_{CE} \geq 10$ V dc, 6,000 cycles
C6	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

4.4.4 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 III](#) herein. Delta measurements shall be in accordance with [table II](#) herein.

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 at a T_C of +25 °C.

4.5.4 Thermal resistance. Thermal resistance measurement shall be performed in accordance with method 3131 of [MIL-STD-750](#) using the guidelines in that method for determining I_M , I_H , and t_H . Forced moving air or draft shall not be permitted across the devices during test.

4.5.5 Coil selection for safe operating area (SOA) tests. In selecting coils for use in the clamped and unclamped inductive SOA tests, prime consideration should be given to the recommended commercially available coil. However, due to the extreme critical nature of the coil in these circuits and the wide tolerance of some commercially available coils (+100%, -50%), it shall be the semiconductor manufacturer's responsibility, to prove upon request, compliance or equivalency of any coil used (commercial or in-plant designed) to be within ($\pm 20\%$) of the specified inductance at the rated current and dc resistance.

4.6 Element evaluation of un-encapsulated die. The element evaluation of un-encapsulated die shall be in accordance with appendix G of [MIL-PRF-19500](#).

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TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance <u>2/</u>	3131	See 4.3.1	$Z_{\theta JX}$			$^{\circ}\text{C}/\text{W}$
Breakdown voltage, collector to base	3001	Bias condition D, $I_C = 10\ \mu\text{A}$ dc, $I_B = 0$	$V_{(BR)CBO}$	100		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 50\ \text{mA}$ dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 80\ \text{V}$ dc, $V_{BE} = 0$	I_{CES1}		200	nA dc
Collector to emitter cutoff current	3041	Bias condition D, $V_{CE} = 60\ \text{V}$ dc, $I_B = 0$	I_{CEO}		10	μA dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 5\ \text{V}$ dc, $I_C = 0$	I_{EBO1}		200	nA dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 8\ \text{V}$ dc, $I_C = 0$	I_{EBO2}		10	μA dc
Base-emitter voltage (saturated)	3066	Test condition A, $I_C = 1\ \text{A}$ dc, $I_B = 0.1\ \text{A}$ dc, pulsed (see 4.5.1)	$V_{BE(sat)1}$	0.6	1.2	V dc
Base-emitter voltage (saturated)	3066	Test condition A, $I_C = 5\ \text{A}$ dc, $I_B = 0.5\ \text{A}$ dc, pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.6	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 1\ \text{A}$ dc; $I_B = 0.1\ \text{A}$ dc, pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.25	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 5\ \text{A}$ dc; $I_B = 0.5\ \text{A}$ dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		2	V dc
Forward-current transfer ratio 2N3996, 2N3998 2N3997, 2N3999	3076	$V_{CE} = 2\ \text{V}$ dc; $I_C = 50\ \text{mA}$ dc, pulsed (see 4.5.1)	h_{FE1}	30 60		
Forward-current transfer ratio 2N3996, 2N3998 2N3997, 2N3999	3076	$V_{CE} = 2\ \text{V}$ dc; $I_C = 1\ \text{A}$ dc, pulsed (see 4.5.1)	h_{FE2}	40 80	120 240	

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> – Continued						
Forward-current transfer ratio 2N3996, 2N3998 2N3997, 2N3999	3076	V _{CE} = 5 V dc; I _C = 5 A dc, pulsed (see 4.5.1)	h _{FE3}	15 20		
<u>Subgroup 3</u>						
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 2N3996, 2N3998 2N3997, 2N3999	3076	V _{CE} = 2 V dc; I _C = 1 A dc, pulsed (see 4.5.1)	h _{FE4}	10 20		
<u>Subgroup 4</u>						
Open circuit output capacitance	3236	V _{CB} = 10 V dc; I _E = 0; 100 kHz ≤ f ≤ 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 7	t _d		100	ns
Pulse rise time		See figure 7	t _r		240	ns
Pulse storage time		See figure 7	t _s		1.4	μs
Pulse fall time		See figure 7	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

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> – continued						
2N3997 and 2N3999 Pulse delay time		See figure 7	t_d		100	ns
Pulse rise time		See figure 7	t_r		240	ns
Pulse storage time		See figure 7	t_s		1.75	μs
Pulse fall time		See figure 7	t_f		0.3	μs
t_{on}		$t_d + t_r$	t_{on}		0.3	μs
t_{off}		$t_s + t_f$	t_{off}		2.0	μs
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3051	$T_C = 100\text{ }^{\circ}\text{C}$; power application time = 1.0 sec. (see figure 8)				
Test 1		$V_{CE} = 80\text{ V dc}$; $I_C = .080\text{ A dc}$				
Test 2		$V_{CE} = 20\text{ V dc}$; $I_C = 1.5\text{ A dc}$				
Safe operating area (switching)	3053	Load condition C, (see figures 9 and 10); $T_A = 25\text{ }^{\circ}\text{C}$; $I_B = 0.5\text{ A dc}$; $I_C = 5\text{ A dc}$; $V_{CC} = 15\text{ V dc}$; clamp voltage = 100 V +0, -5 V				
Electrical measurements		See table I , subgroup 2 herein.				
<u>Subgroup 6 and 7</u>						
Not applicable						

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ This test required for the following end-point measurements only:
Group B, subgroups 3, 4, and 5 (JANS).
Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).
Group C, subgroup 2 and 6.
Group E, subgroup 1.

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TABLE II. Delta measurements for groups A, B, C, and E. 1/ 2/ 3/ 4/ 5/

Step	Inspection	MIL-STD-750		Symbol	Limits	Limits	Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	$V_{CE} = 2 \text{ V dc}$, $I_C = 1 \text{ A dc}$ pulsed (see 4.5.1)	Δh_{FE2}	± 20 percent change from initial reading.		
2.	Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 60 \text{ V dc}$, $I_B = 0$	ΔI_{CEO}	100 percent of initial value or 100 nA dc, whichever is greater.		
3.	Collector to emitter voltage (saturated)	3071	$I_C = 1 \text{ A dc}$, $I_B = 0.1 \text{ A dc}$, pulsed (see 4.5.1)	$\Delta V_{CE(SAT)1}$	$\pm 50 \text{ mV dc}$ change from previously measured value.		
4.	Thermal impedance	3131	See 4.3.1	$\Delta Z_{\theta JX}$		3.3	$^{\circ}\text{C/W}$

- 1/ The devices which exceed the group A limits for this test shall not be acceptable.
- 2/ The delta measurements taken during group B inspection for quality level JANS (table E-VIA of MIL-PRF-19500) shall be as follows:
 - a. In addition to the measurements specified for subgroups 4 and 5, the measurements of steps 1 and 4 shall also be taken.
 - b. In addition to the measurements specified for subgroup 7, the measurements of step 1 shall also be taken.
- 3/ The delta measurements taken during group B inspection for quality level JAN, JANTX and JANTXV (table E-VIB of MIL-PRF-19500) shall be as follows:
 - a. In addition to the measurements specified for subgroup 3, the measurements of steps 1 and 4 shall also be taken.
 - b. In addition to the measurements specified for subgroup 6, the measurements of step 2 shall also be taken.
 - c. In addition to the measurements specified for subgroup 7, the measurements of step 1 shall also be taken.
- 4/ The delta measurements taken during group C inspection (table E-VII of MIL-PRF-19500) shall be as follows:
 - a. In addition to the measurements specified for Subgroup 2, the measurements of step 3 for quality level JANS shall also be taken.
 - b. In addition to the measurements specified for Subgroup 6, the measurements of steps 1, 2, and 4 for quality level JANS shall also be taken.
 - c. In addition to the measurements specified for Subgroup 6 the measurements of steps 1 and 4 for quality level JAN, JANTX, and JANTXV shall also be taken.
- 5/ The delta measurements taken for subgroup 1 of group E inspection for all quality levels (table E-IX of MIL-PRF-19500) shall include all steps.

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

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices, c = 0
Temperature cycling	1051	500 cycles minimum.	
Hermetic seal	1071	Fine and gross leak.	
Electrical measurements		See table I , subgroup 2 and table II herein.	
<u>Subgroup 2</u>			45 devices, c = 0
Blocking life	1048	Test temperature = +125 °C, T = 1,000 hours, V _{CB} = 80 percent of rated.	
Electrical measurements		See table I , subgroup 2.	
<u>Subgroup 4</u>			Sample size, N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 8</u>			22 devices, c = 0
Reverse stability	1033	Condition B	

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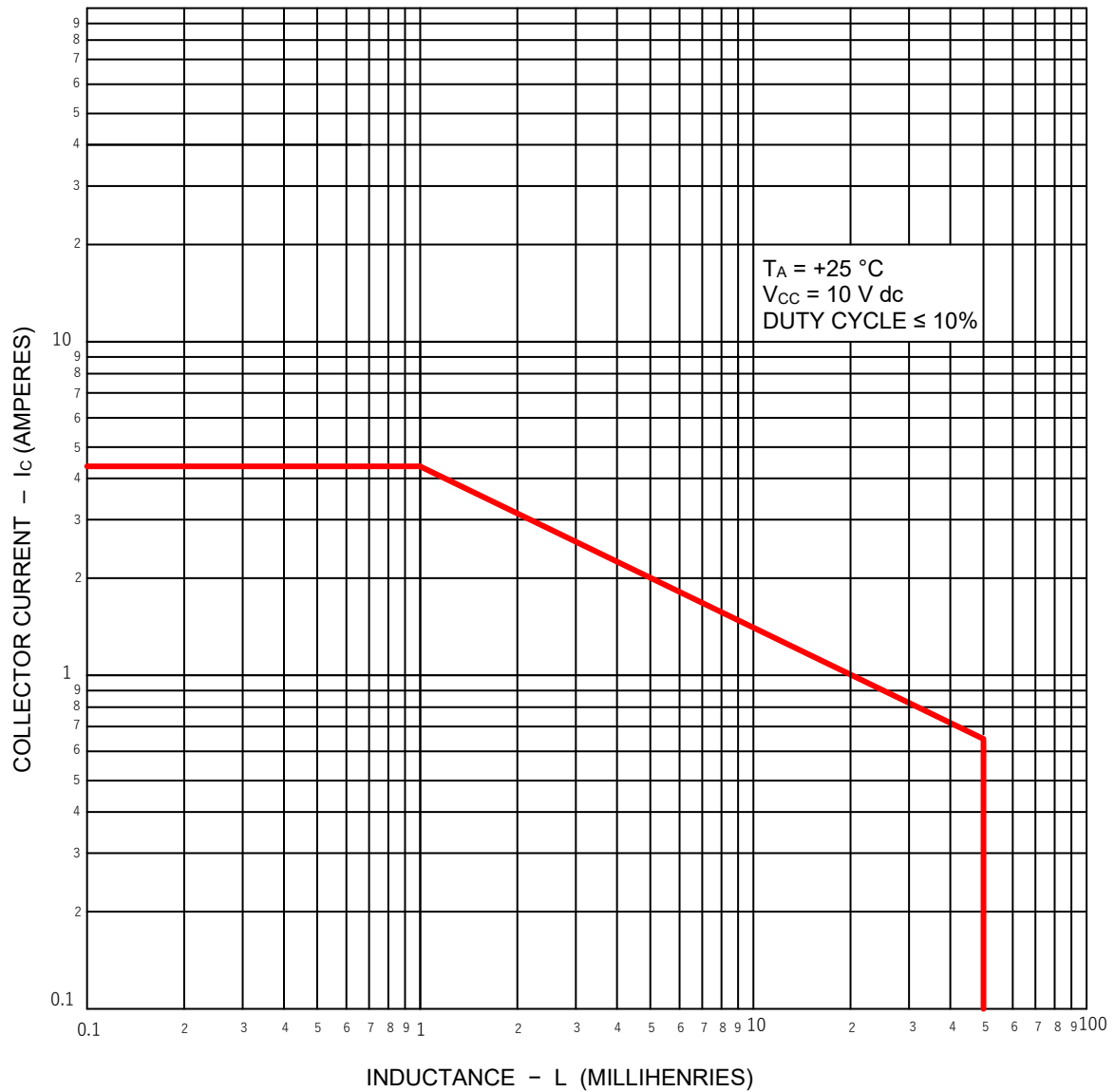
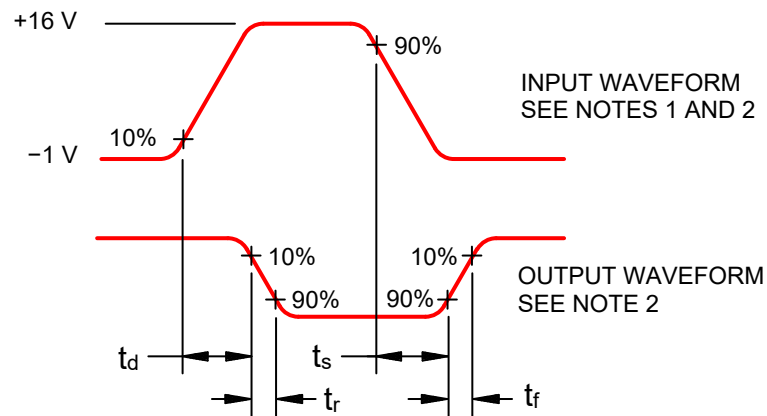
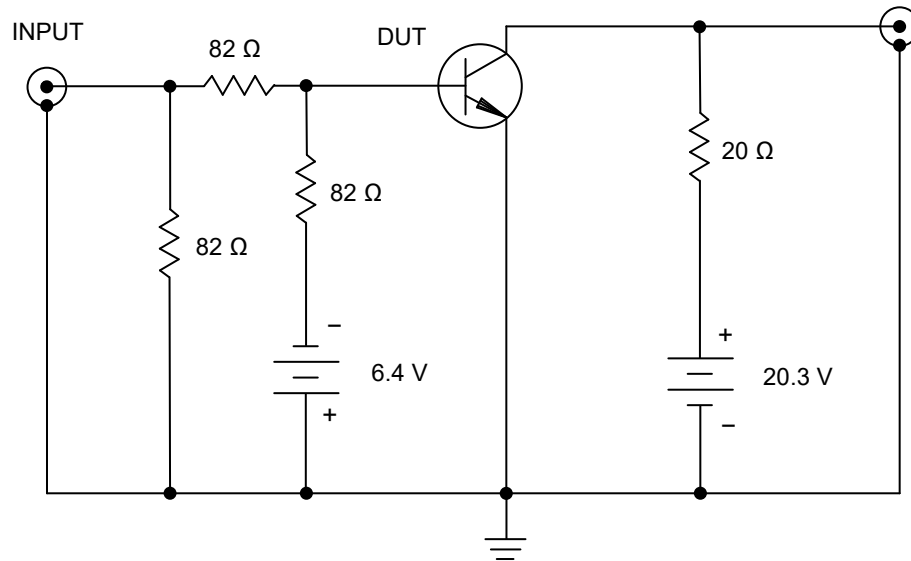


FIGURE 6. Safe operating area for switching between saturation and cutoff - unclamped inductive load.

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NOTES:

1. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50$ Ω, $pW = 2$ 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 7. Pulse response test circuit.

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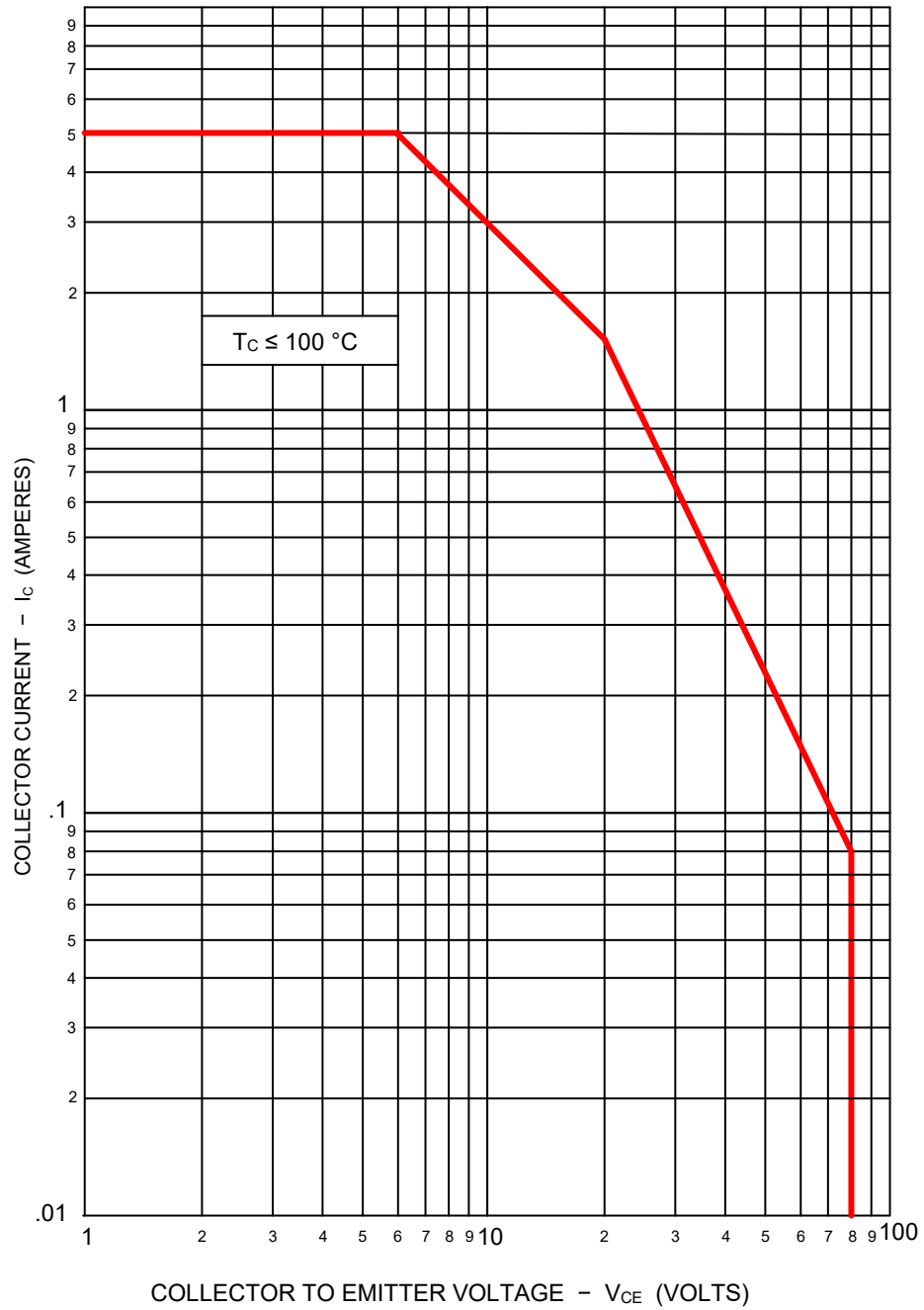
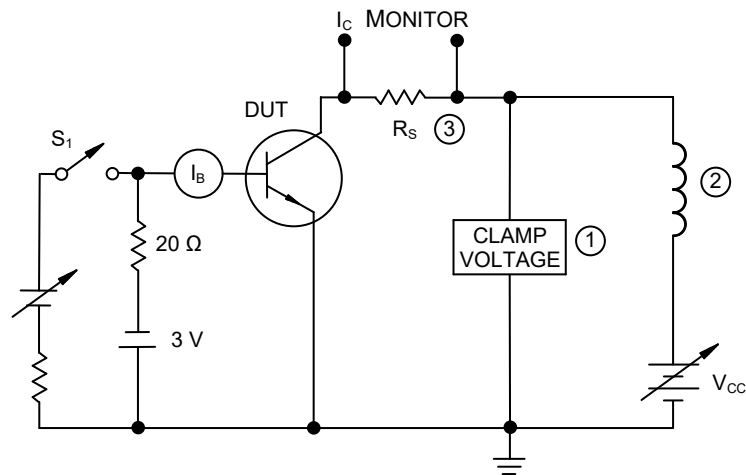


FIGURE 8. Maximum safe operating area graph (dc).



PROCEDURE:

1. With switch S₁ closed, set the specified test conditions.
2. Open S₁. Device fails if clamp voltage not reached.
3. Perform specified end point electrical test.

NOTES:

1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 1 mH at 5 A with a maximum dc resistance of 0.5 Ω .
For reference only: Tower number 7870, or equivalent (see 4.5.5).
3. $R_s \leq 1$ ohm, 12 W, 1% tolerance maximum, (noninductive).

FIGURE 9. Clamped inductive sweep test circuit.

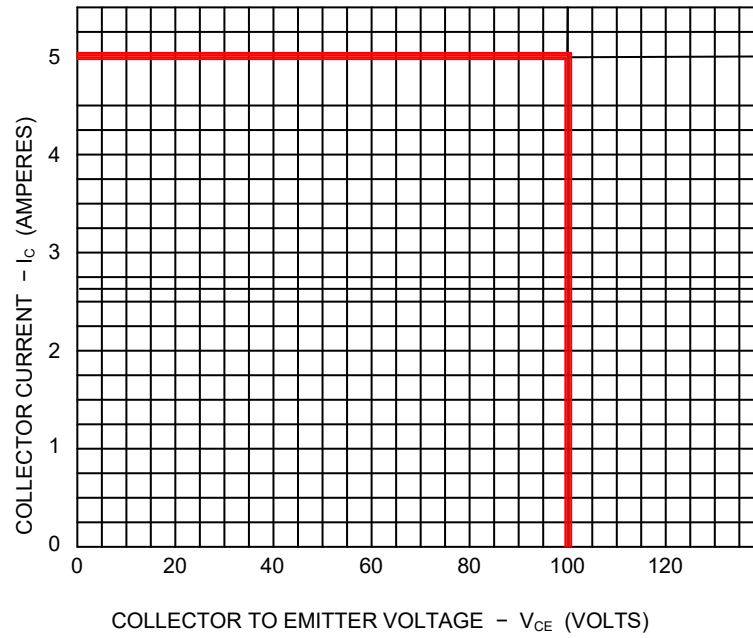


FIGURE 10. Safe operating area for switching between saturation and cutoff - clamped inductive load.

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.

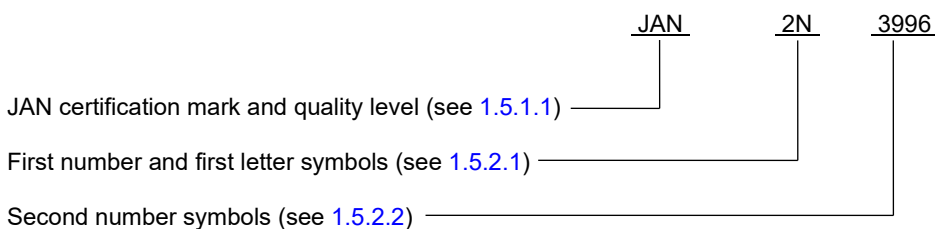
6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. The complete PIN, see 1.5 and 6.4.

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://qpldocs.dla.mil>.

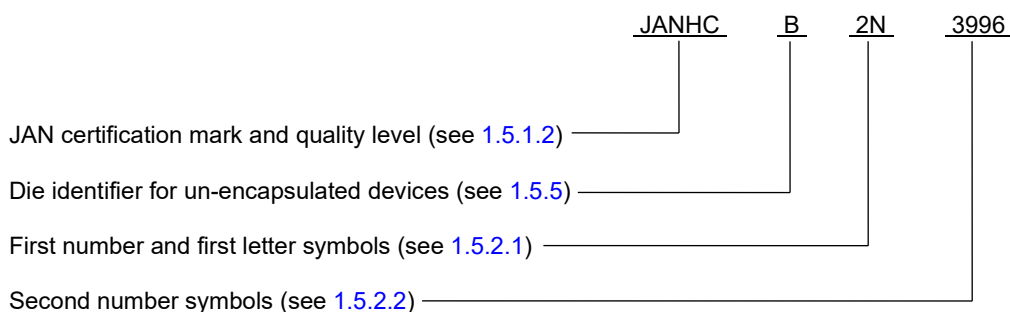
6.4 PIN construction example.

6.4.1 Encapsulated devices The PINs for encapsulated devices are constructed using the following form.



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6.4.2 Un-encapsulated devices. The PINs for un-encapsulated devices are constructed using the following form.



6.5 List of PINs.

6.5.1 List of PINs for encapsulated devices. The following is a list of possible PINs for encapsulated devices available on this specification sheet.

PINs for devices of the base quality level	PINs for devices of the "TX" quality level	PINs for devices of the "TXV" quality level	PINs for devices of the "S" quality level
JAN2N3996	JANTX2N3996	JANTXV2N3996	JANS2N3996
JAN2N3997	JANTX2N3997	JANTXV2N3997	JANS2N3997
JAN2N3998	JANTX2N3998	JANTXV2N3998	JANS2N3998
JAN2N3999	JANTX2N3999	JANTXV2N3999	JANS2N3999

6.5.2 PINs for un-encapsulated die. The following is a list of possible PINs for un-encapsulated die available on this specification sheet. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCB2N3996) will be identified on the QML.

Die ordering information			
Pin	Manufacturer		
	33178 (1)	34156	43611
2N3996	JANHCA2N3996	JANHCB2N3996 JANKCB2N3996	JANHCC2N3996
2N3997	JANHCA2N3997	JANHCB2N3997 JANKCB2N3997	JANHCC2N3997
2N3998	JANHCA2N3998	JANHCB2N3998 JANKCB2N3998	JANHCC2N3998
2N3999	JANHCA2N3999	JANHCB2N3999 JANKCB2N3999	JANHCC2N3999

(1) This die version is no longer manufactured.

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6.6 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 692-6939 or DSN 850-6939.

* 6.7 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. 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 previous issue.

Custodians:
Army – CR
* Navy – SH
Air Force – 85
NASA – NA
DLA – CC

Preparing activity:
DLA – CC

(Project 5961-2025-022)

Review activity:
Army – AV
Air Force – 19

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