

The documentation and process conversion measures necessary to comply with this document shall be completed by 14 December 2011.

INCH-POUND

MIL-PRF-19500/315G
 14 September 2011
 SUPERSEDING
 MIL-PRF-19500/315F
 30 June 1999

* PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
 TYPES 2N2880, 2N3749, JAN, JANTX, JANTXV, AND JANS

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. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

* 1.2 Physical dimensions. Type 2N2880, see figure 1 (TO-59), for type 2N3749, see figure 2 (TO-111).

* 1.3 Maximum ratings.

P_T (1) $T_A = 25^\circ\text{C}$	P_T (2) $T_C = 100^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{STG} and T_{OP}
<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>°C</u>
2	30	110	80	8	5	0.5	-65 to +200

(1) Derate linearly 11.4 mW/°C for $T_A > 25^\circ\text{C}$.

* (2) Derate linearly 300 mW/°C for $T_C > 100^\circ\text{C}$, see figure 3.

1.4 Primary electrical characteristics at $T_C = 25^\circ\text{C}$.

Limits	h_{FE3} (1) $V_{CE} = 5 \text{ V dc}$ $I_C = 5 \text{ A dc}$	h_{FE2} (1) $V_{CE} = 2 \text{ V dc}$ $I_C = 1 \text{ A dc}$	$ h_{fe} $ $V_{CE} = 10 \text{ V dc}$ $I_C = 1 \text{ A dc}$ $f = 10 \text{ MHz}$	$V_{BE(sat)}$ (1) $I_C = 1 \text{ A dc}$ $I_B = 100 \text{ mA dc}$	$V_{CE(sat)}$ (1) $I_C = 1 \text{ A dc}$ $I_B = 100 \text{ mA dc}$	C_{obo} $V_{CB} = 10 \text{ V dc}$ $I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	$R_{\theta JC}$
				<u>V dc</u>	<u>V dc</u>	<u>pF</u>	<u>°C/W</u>
Min	15	40	3	1.2	0.25	150	3.33
Max	---	120	12				

(1) Pulsed (see 4.5.1).

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

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.

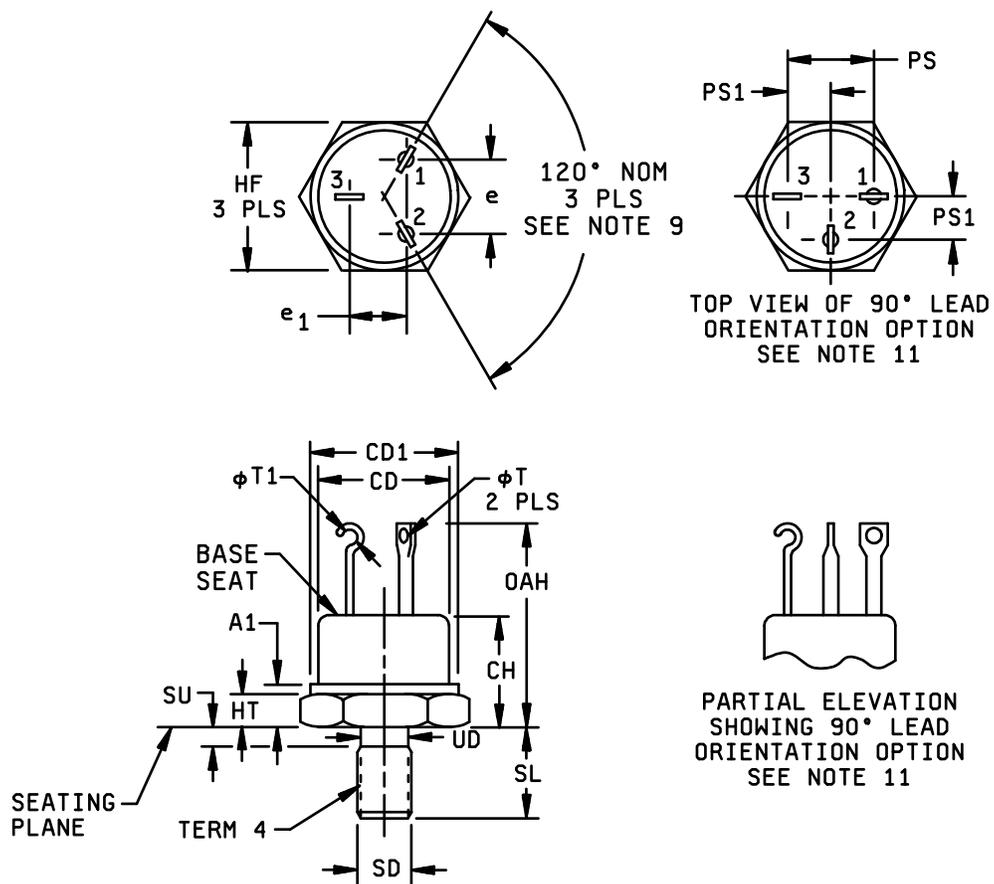


FIGURE 1. Physical dimensions of transistor type 2N2880 (TO-59).

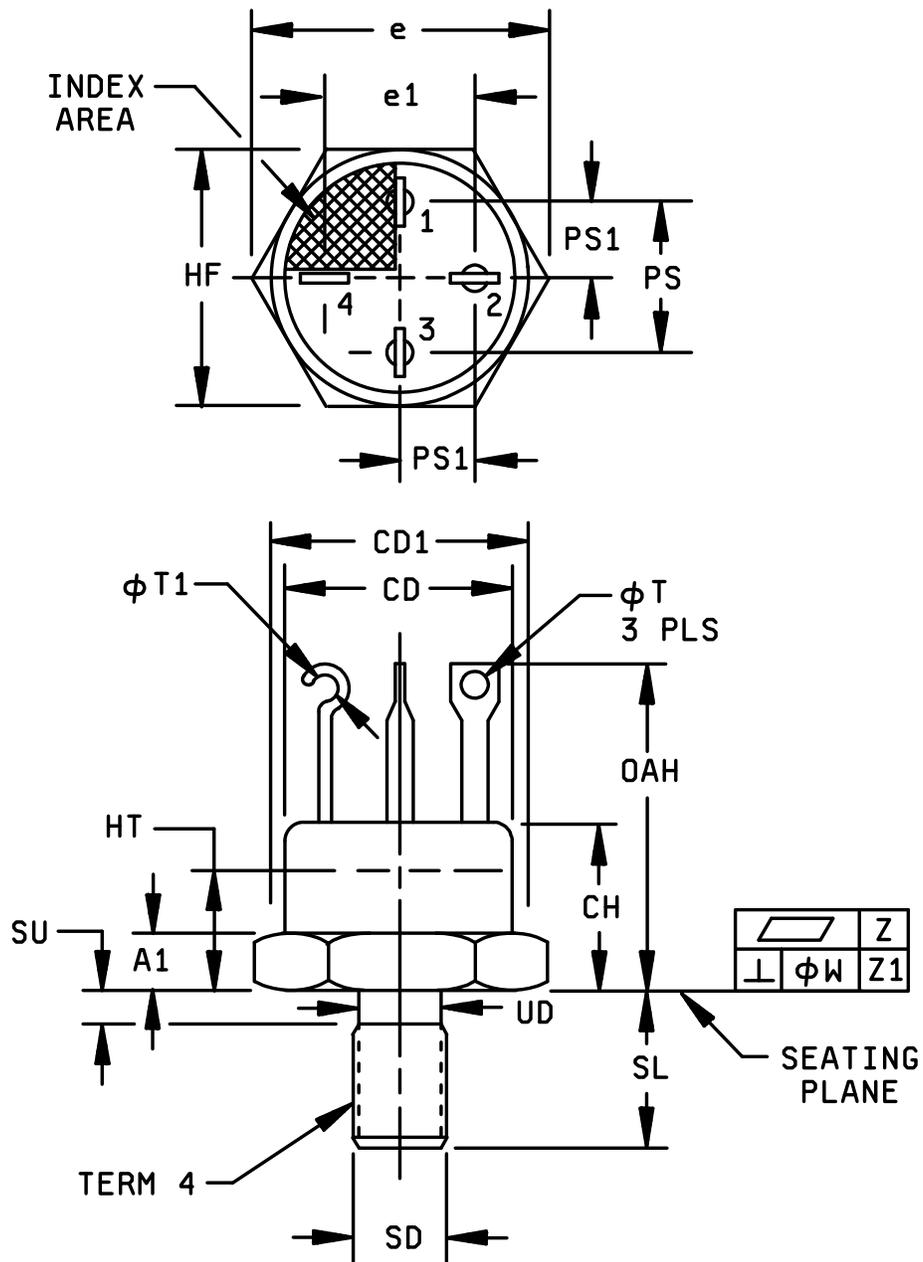
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Symbol	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.320	.468	8.13	11.89	
HT		250		6.35	
CD	.318	.380	8.08	9.65	
CD ₁	.380	.437	9.65	11.10	
HF	.423	.438	10.74	11.13	
E	.125	.165	3.18	4.19	5, 8, 9
e ₁	.110	.145	2.79	3.68	5, 8
A ₁	.090	.150	2.29	3.81	
OAH	.570	.763	14.48	19.38	4
UD	.155	.189	3.94	4.80	
SL	.400	.455	10.16	11.56	
SU		.078	---	1.98	10
φT	.040	.065	1.02	1.65	
φT ₁	.040	.070	1.02	1.78	
SD	0.190-32UNF-2A				4
PS ₁	.090	.110	2.29	2.79	5, 8, 9
PS	.185	.215	4.70	5.46	5, 8, 9

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Collector shall be electrically connected to the case. This terminal may be flattened and pierced only when the 90 degree option is used.
4. SD is the outer diameter of coated threads. (Reference: Screw thread standards for Federal Standard H28/1, (FED-STD-H28/1).
5. The orientation of the terminals in relation to the hex flats is not controlled.
6. All three terminals.
7. The case temperature may be measured anywhere on the seating plane within .125 (3.18 mm) of the stud.
8. Terminal spacing measured at the base seat only.
9. Dimensions e, e₁, PS₁, and PS are measured from the center line of terminals.
10. Maximum unthreaded dimension.
11. This dimension applies to the location of the center line of the terminals.
12. A 90 degree angle lead orientation as shown may be used at the option of the manufacturer. All dimensions of the basic outline except e, e₁, and the 120 degree lead angle apply to this option.
13. Terminal -1, emitter; terminal -2, base; terminal -3, collector.
14. A slight chamfer or undercut on one, or both, ends of the hexagonal is optional.

FIGURE 1. Physical dimensions of transistor type 2N2880 (TO-59) - Continued.



* FIGURE 2. Physical dimensions of transistor type 2N3749 (TO-111).

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Symbol	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.320	.458	8.13	11.63	
HT		.250		6.35	5
E		.505		12.83	
CD	.318	.380	8.08	9.65	
CD ₁	.380	.437	9.65	11.10	5
HF	.423	.438	10.74	11.13	
e ₁	.180	.215	4.57	5.46	7
E	.080	.110	2.03	2.79	7
A ₁	.090	.150	2.29	3.81	4, 8
OAH	.570	.763	14.48	19.38	
SL	.400	.455	10.16	11.56	
SU		.078		1.98	9
φT	.040	.065	1.02	1.65	
φT ₁	.040	.070	1.02	1.78	6
SD	0.190-32UNF-2A				10
Z		.002		0.05	
Z ₁		.006		0.15	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Terminal 1 - emitter; terminal 2 - base; terminal 3 - collector; terminal 4 - case.
4. Chamfer or undercut on one, or both, ends of hexagonal portion is optional.
5. The outline contour, with the exception of the hexagon, is optional within cylinder defined by CD₁ and HT.
6. Terminal 4 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.
7. Angular orientation of terminals with respect to hexagon is optional.
8. A₁ dimension does not include sealing flanges.
9. SU is the length of incomplete or undercut threads.
10. SD is the outer diameter of coated threads. (Reference: Screw thread standards for Federal Standard H28/1, (FED-STD-H28/1).

* FIGURE 2. Physical dimensions of transistor type 2N3749 (TO-111) - Continued.

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 manufacturers list 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. Interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1, 2N2880 (TO-59), and figure 2, 2N3749 (TO-111).
 - * 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 1.3, 1.4, and table I herein.
 - 3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.
 - * 3.8 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

- 4.1 Classification of 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.
 - * 4.2.1 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 II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

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* 4.3 Screening (JANS, JANTX, and JANTXV). Screening shall be in accordance with table E-IVb of MIL-PRF-19500 (JANS, JANTX, and JANTXV), 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
(1) 3c	Thermal impedance, method 3131 of MIL-STD-750 (see 4.3.1)	Thermal impedance, method 3131 of MIL-STD-750 (see 4.3.1)
9	I_{CBO1} and h_{FE2}	I_{CBO1}
11	I_{CBO1} and h_{FE2} ; ΔI_{CBO1} = 100 percent of initial reading or 50 nA dc, whichever is greater; Δh_{FE2} = +15 percent, -10 percent	I_{CBO1} and h_{FE2} ΔI_{CBO1} = 100 percent of initial reading or 100 nA dc, whichever is greater.
12	See 4.3.2	See 4.3.2
13(a)	Subgroups 2 and 3 of table I herein; ΔI_{CBO1} = 100 percent of initial value or 50 nA dc, whichever is greater; Δh_{FE2} = +15 percent, -10 percent	Subgroup 2 of table I herein ΔI_{CBO1} = 100 percent of initial value or 100 nA dc, whichever is greater; Δh_{FE2} = +20 percent, -10 percent
13(b) (2N3749 only)	Method 1016 of MIL-STD-750, insulation resistance test condition B (short connector, emitter, and base terminals together) $R_{ISO} = 10^9$ ohms (min)	Method 1016 of MIL-STD-750 insulation resistance test condition B (short connector, emitter, and base terminals together) $R_{ISO} = 10^9$ ohms (min)

* (1) Shall be performed anytime after temperature cycling, screen 3a; TX and TXV 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 3161 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s max. See table II, group E, subgroup 4 herein.

4.3.2 Power burn-in conditions. Power burn-in conditions (all levels) are as follows:

- a. $T_J = 187.5 \pm 12.5^\circ\text{C}$.
- b. $T_A \leq 100^\circ\text{C}$.
- c. $V_{CE} = 25 \pm 5$ V dc.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. (End-point electrical measurements shall be in accordance with table I, subgroup 2 herein.)

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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 table E-VIa (JANS) and E-VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table III herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B4	1037	$V_{CE} \geq 5 \text{ V dc}$; $T_A = 25 \pm 3^\circ\text{C}$, 2,000 cycles.
B5	1027	$V_{CE} \geq 5 \text{ V dc}$; 96 hours. $P_T = 2 \text{ W}$ at $T_A = 100^\circ\text{C}$ or adjusted as required by the chosen T_A to give an average lot $T_J = 275^\circ\text{C}$. Marking legibility requirements shall not apply.
B6	3131	See 4.5.2.
* B7	3053	Load condition C; 22 devices; $c = 0$ (unclamped inductive load) (see figure 4). $T_A = 25^\circ\text{C}$; duty cycle ≤ 10 percent; $R_S = 0.1 \Omega$; $T_P = 640 \mu\text{s}$. Test 1, $R_{BB1} = 39 \Omega$; $V_{BB1} = 20 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $V_{CC} = 15 \text{ V dc}$; $I_C = 5 \text{ A dc}$; $L = 1 \text{ mH}$; (0.5 Ω , 5 A dc) (Tower #7870 or equivalent). Test 2, $T_P = 2.88 \text{ ms}$; $R_{BB1} = 120 \Omega$; $V_{BB1} = 20 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB} = 0$; $V_{CC} = 15 \text{ V dc}$; $I_C = 1.6 \text{ A dc}$; $L = 10 \text{ mH}$; (0.11 Ω , 12.5 A dc) (Stancor C-2688 or equivalent).
* B7	3053	See figures 5 and 6 (clamped inductive load). $T_A = 25^\circ\text{C}$; $I_B = 0.5 \text{ A dc}$; $I_C = 5 \text{ A dc}$; $V_{CC} = 55 \text{ V dc}$.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$T_J = 187.5 \pm 12.5^\circ\text{C}$; $T_A \leq 35^\circ\text{C}$; $V_{CE} = 25 \pm 5 \text{ V dc}$.
B5	3131	See 4.5.2.
* B7	3053	Load condition C; 22 devices; $c = 0$ (unclamped inductive load) (see figure 3). $T_A = 25^\circ\text{C}$; duty cycle ≤ 10 percent; $R_S = 0.1 \Omega$. Test 1, $T_P = 640 \mu\text{s}$, $R_{BB1} = 39 \Omega$; $V_{BB1} = 20 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $V_{CC} = 15 \text{ V dc}$; $I_C = 5 \text{ A dc}$; $L = 1 \text{ mH}$; (0.5 Ω , 5 A dc) (Tower #7870 or equivalent). Test 2, $T_P = 2.88 \text{ ms}$; $R_{BB1} = 120 \Omega$; $V_{BB1} = 20 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB} = 0$; $V_{CC} = 15 \text{ V dc}$; $I_C = 1.6 \text{ A dc}$; $L = 10 \text{ mH}$; (0.11 Ω , 12.5 A dc) (Stancor C-2688 or equivalent).
* B7	3053	See 4 and 5, (clamped inductive load). $T_A = 25^\circ\text{C}$; $I_B = 0.5 \text{ A dc}$; $I_C = 5 \text{ A dc}$; $V_{CC} = 55 \text{ V dc}$.

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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. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table III herein.

	<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
*	C2	2036	Test condition A; weight= 10 pounds; time = 15 s.
	C2	2036	Thermal strength (terminal torque). Test condition D1; torque = 6 inch-ounces; t = 15 s; (tubulated leads only).
	C2	2036	Terminal strength (stud torque). Test condition D2; torque = 15 inch-pound; application time = 15 s.
	C2	2036	Terminal strength (tension). Test condition A; weight = 7 pounds ±5 ounces; application time = 15 s (tubulated leads only).
*	C6	1026	$T_J = 187.5 \pm 12.5^\circ\text{C}$; $T_A \leq 35^\circ\text{C}$; $V_{CE} = 25 \pm 5 \text{ V dc}$.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-IX of MIL-PRF-19500 and as specified in table II herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 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 measurements shall be as specified in MIL-STD-750.

4.5.2 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 applications shall be selected with $0.8 \text{ A dc} \leq I_C \leq 1.2 \text{ A dc}$ and recorded before test is started.
- 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 selected with $25^\circ\text{C} \leq T_R \leq 75^\circ\text{C}$ 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 .

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

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* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2 2/</u>						
* Thermal impedance	3131	See 4.3.1	$Z_{\theta JX}$			°C/W
Breakdown voltage, collector to base	3001	Bias condition D; $I_C = 10 \mu\text{A dc}$	$V_{(BR)CBO}$	110		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 100 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Breakdown to voltage, emitter to base	3026	Bias condition D; $I_E = 10 \mu\text{A dc}$	$V_{(BR)EBO}$	8		V dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 80 \text{ V dc}$	I_{CBO1}		0.2	$\mu\text{A dc}$
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 110 \text{ V dc}$; $V_{BE} = -0.5 \text{ V dc}$	I_{CEX1}		1.0	$\mu\text{A dc}$
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 60 \text{ V dc}$	I_{CEO}		20	$\mu\text{A dc}$
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 6 \text{ V dc}$	I_{EBO}		0.2	$\mu\text{A dc}$
Forward current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 50 \text{ mA dc}$	h_{FE1}	40	120	
Forward current transfer ratio	3076	$V_{CE} = 2 \text{ V dc}$; $I_C = 1 \text{ A dc}$ pulsed (see 4.5.1)	h_{FE2}	40	120	
Forward current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 5 \text{ A dc}$ pulsed (see 4.5.1)	h_{FE3}	15		
Collector to emitter voltage (saturated)	3071	$I_C = 1.0 \text{ A dc}$; $I_B = 0.1 \text{ A dc}$; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.25	V dc
Collector to emitter voltage (saturated)	3071	Test condition A; $I_C = 5.0 \text{ A dc}$; $I_B = 0.5 \text{ A dc}$; pulsed (see 4.5.1)	$V_{CE(sat)2}$		1.5	V dc

See footnotes at end of table.

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* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued 2/						
Base to emitter voltage (non-saturated)	3066	Test condition B; $V_{CE} = 2$ V dc; $I_C = 1$ A dc; pulsed (see 4.5.1)	V_{BE}		1.2	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 1$ A dc; $I_B = 0.1$ A dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		1.2	V dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = 150^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 80$ V dc; $V_{BE} = 0.5$ V dc	I_{CEX2}		50	μA dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 60$ V dc	I_{CBO2}		10	μA dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current cutoff current	3076	$V_{CE} = 5$ V dc; $I_C = 1$ A dc	h_{FE4}	15		
<u>Subgroup 4</u>						
Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 5$ V dc; $I_C = 50$ mA dc; $f = 1$ kHz	h_{fe}	40	140	
Multitude of small-signal short-circuit forward current transfer ratio	3306	$V_{CE} = 10$ V dc; $I_C = 1$ A dc; $f = 10$ MHz	$ h_{fe} $	3	12	
Open circuit output capacitance	3236	$V_{CB} = 10$ V dc; $I_E = 0$; $100 \leq f \leq 1$ MHz	C_{obo}		150	pF
Switching parameters:						
Pulse delay time		See figure 7	t_d		60	ns
Pulse rise time		See figure 7	t_r		300	ns
Pulse storage time		See figure 7	t_s		1.7	μs
Pulse fall time		See figure 7	t_f		300	ns

See footnotes at end of table.

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* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (dc)	3051	$T_C = +100^\circ\text{C}$; powers application time = 10 s (see figure 8)				
Test 1		$V_{CE} = 80\text{ V dc}$, $I_C = 80\text{ mA dc}$				
Test 2		$V_{CE} = 20\text{ V dc}$, $I_C = 1.5\text{ A dc}$				
Safe operating area (clamped switching)		See figures 4 and 5 (clamped inductive load) $T_A = +25^\circ\text{C}$; $I_B = 0.5\text{ A dc}$; $I_C = 5\text{ A dc}$; $V_{CC} = 15\text{ V dc}$				
Endpoint electrical measurements		See table I, subgroup 2 herein.				
<u>Subgroups 6 and 7</u>						
Not applicable						

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

2/ For JANS level, all devices required by the specified sampling plan shall be subjected to subgroups 2, 3, and 4 combined.

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* TABLE II. Group E inspection (all quality levels) - for qualification and re-qualification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			
Temperature cycling	1051	500 cycles, condition D.	45 devices c = 0
Hermetic seal	1071		
Fine leak			
Gross leak			
Electrical measurements		See table I, subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Blocking life	1048	1,000 hours minimum, $T_A = 150^\circ\text{C}$, $V_{CB} = 80$ percent of rated.	
Electrical measurements		See table I, subgroup 2 herein.	
<u>Subgroup 4</u>			
Thermal impedance curves		See table E-IX of MIL-PRF-19500, group E, subgroup 4.	
<u>Subgroup 6</u>			11 devices
ESD	1020		
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

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* TABLE III. Groups B, C, and E delta measurements. 1/ 2/ 3/

Step	Inspection <u>4/</u>	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 80$ V dc	ΔI_{CBO1} <u>5/</u>		100 percent of initial value or 100 nA dc, whichever is greater.	
2.	Forward current transfer ratio	3076	$V_{CE} = 2$ V dc; $I_C = 1$ A dc; pulsed (see 4.5.1)	Δh_{FE2} <u>5/</u>		+20 percent, -10 percent change from initial reading.	
3.	Collector to emitter voltage (saturated)	3071	$I_C = 1.0$ A dc; $I_B = 0.1$ A dc; pulsed (see 4.5.1)	$\Delta V_{CE(sat)1}$ <u>5/</u>		50 mV dc change from previously measured value.	

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

a. Subgroup 4, see table III herein, steps 1, 2, and 3.

b. Subgroup 5, see table III herein, steps 1, 2, and 3.

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

a. Subgroup 3, see table III herein, step 2.

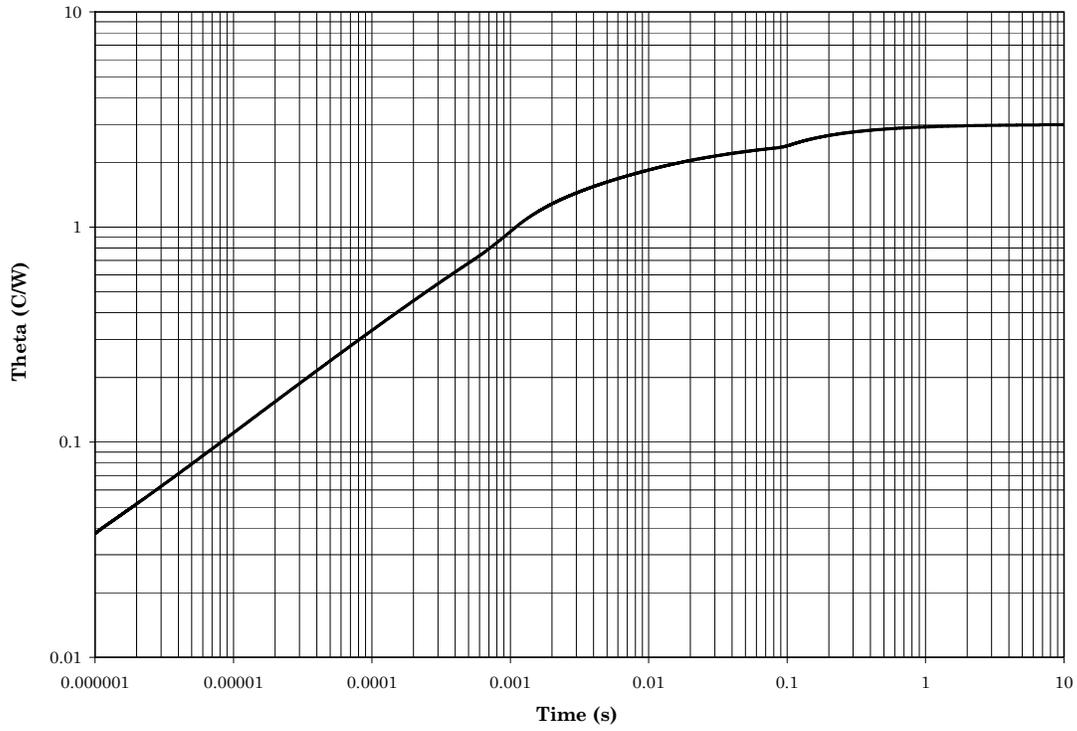
b. Subgroup 6, see table III herein, steps 1 and 2.

3/ The delta measurements for table E-VII of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, steps 1 and 2 (JANS) and step 2 (JAN, JANTX, and JANTXV).

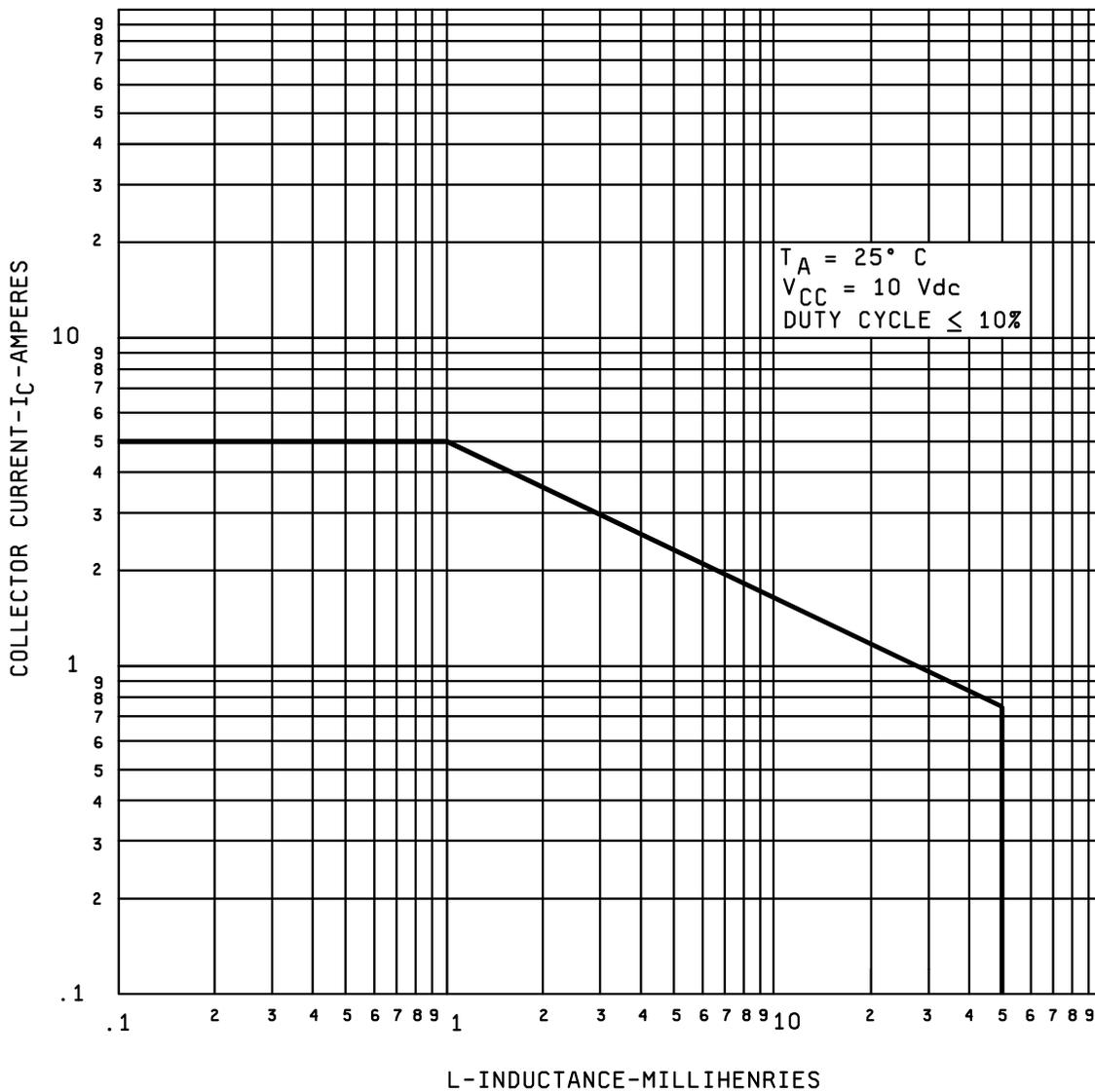
4/ See MIL-PRF-19500 for sampling plan.

5/ Devices which exceed the group A limits for this test shall not be accepted.

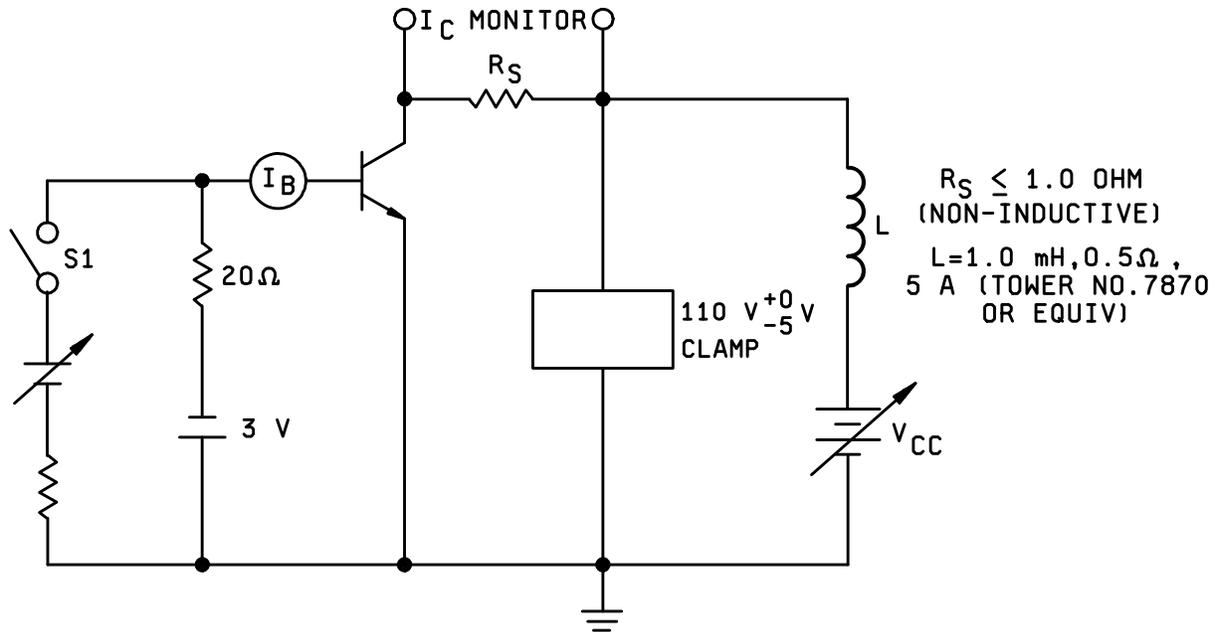
Maximum Thermal Impedance



* FIGURE 3. Thermal impedance graph ($R_{\theta JC}$) for 2N2880 and 2N3749 (similar to TO-59 and TO-111).



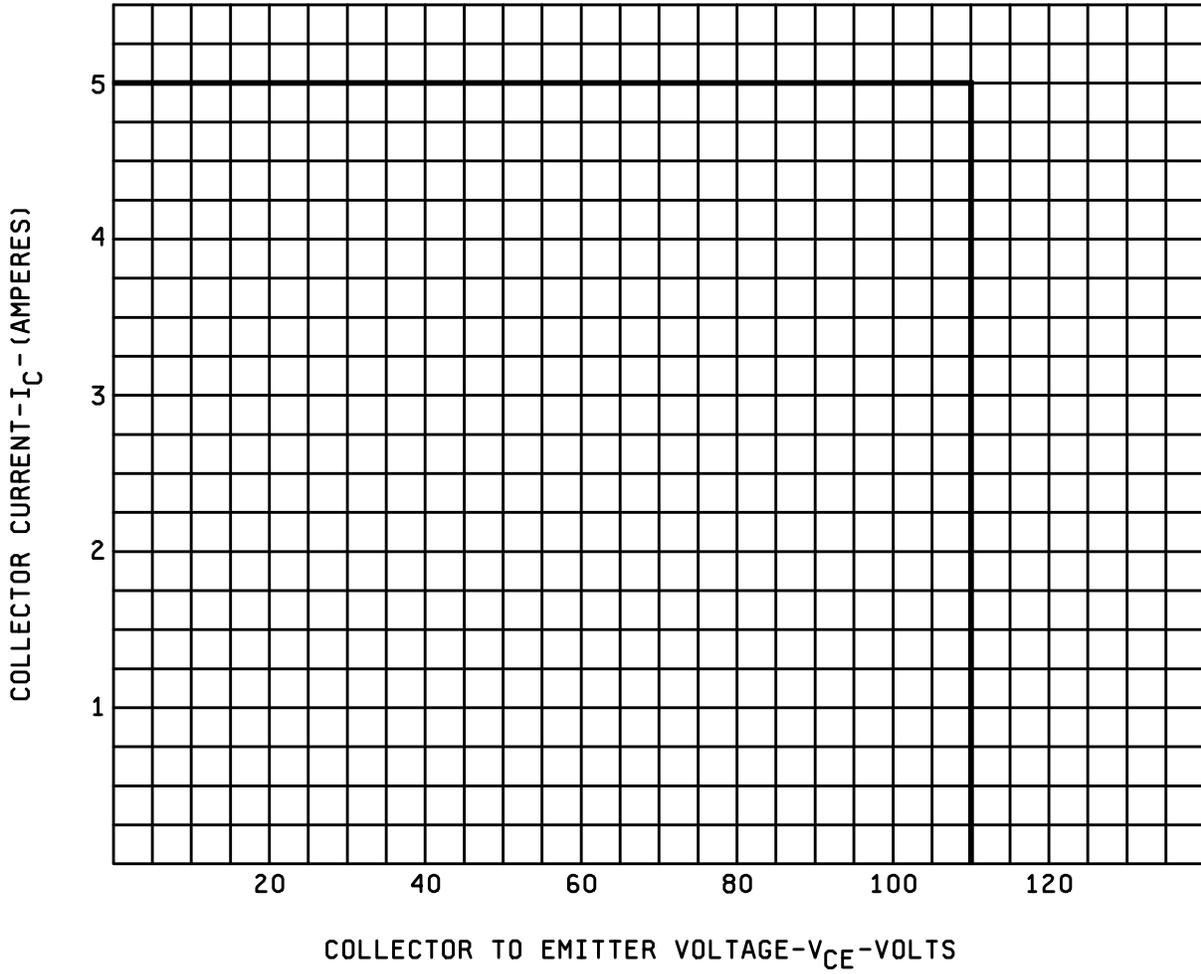
* FIGURE 4. Safe operating area for switching between saturation and cutoff - unclamped inductive load.



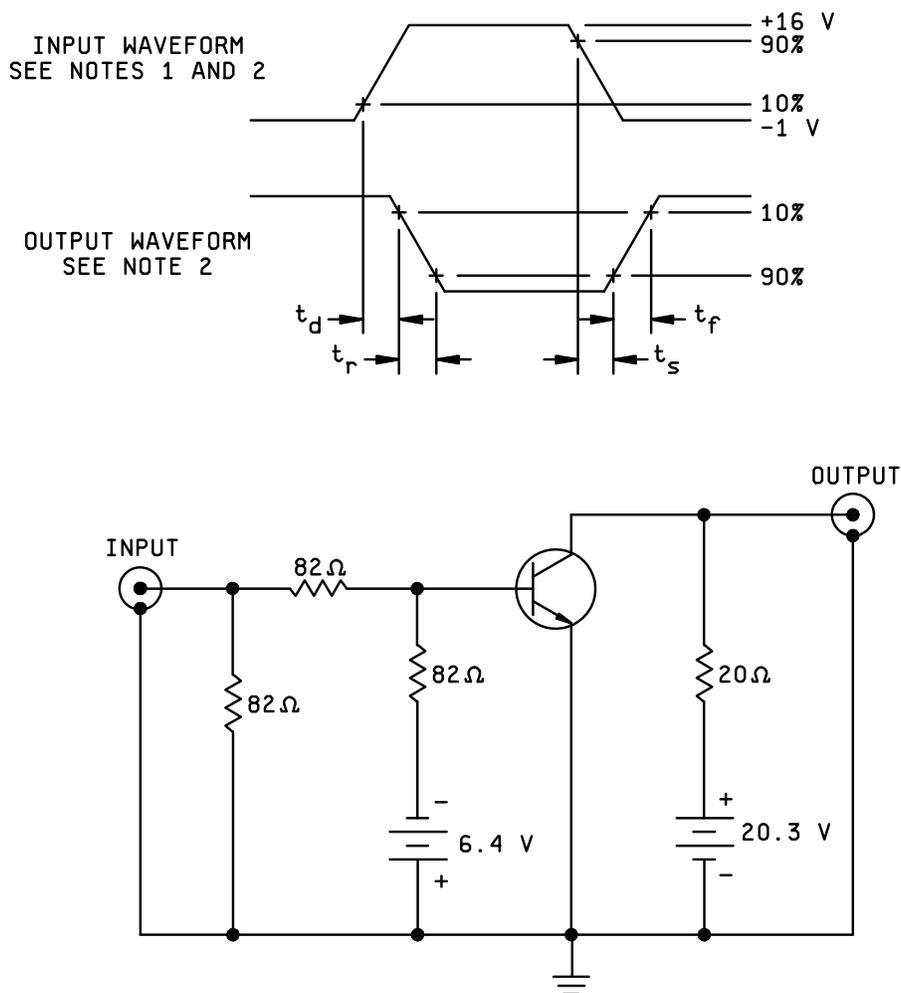
Procedure:

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

* FIGURE 5. Clamped inductive sweep test circuit.



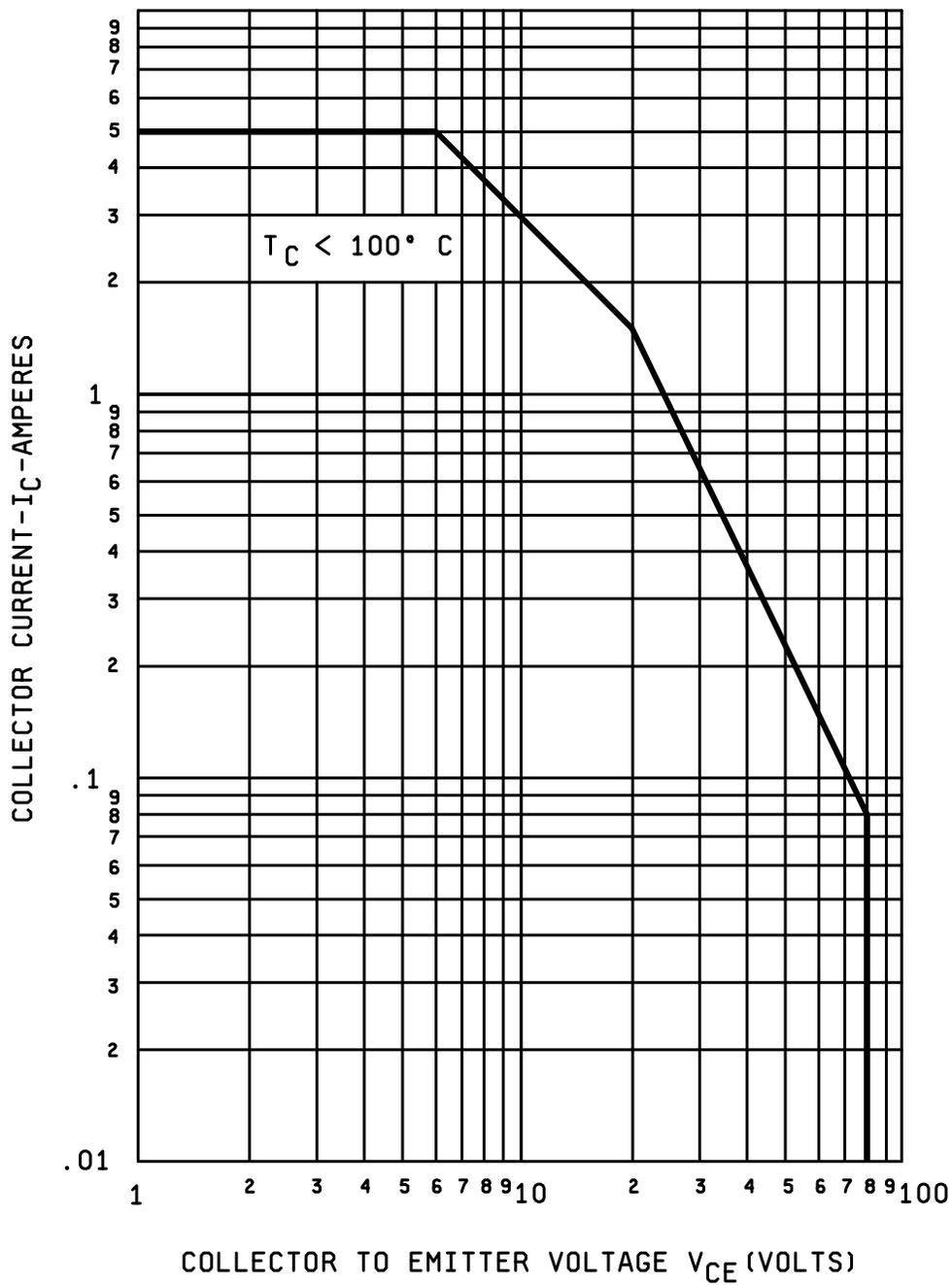
* FIGURE 6. Safe operating areas for switching between saturation and cutoff - clamped inductive load.



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:
 $t_r \leq 15 \text{ ns}$, $t_f \leq 15 \text{ ns}$, $Z_{OUT} = 50 \Omega$, $PW = 2 \mu\text{s}$, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics:
 $t_r \leq 15 \text{ ns}$, $R_{in} \geq 10 \text{ m}\Omega$, $C_{in} \leq 11.5 \text{ pF}$.
3. Resistors shall be non-inductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

* FIGURE 7. Pulse response test circuit.



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

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.

* 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 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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

Preparing activity:
DLA - CC

(Project 5961-2011-003)

Review activities:
Army - AR, MI, SM
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Navy - AS, MC, OS, SH

* 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>.