

The documentation and process conversion measures necessary to comply with this revision shall be completed by 6 March 2013.

INCH-POUND

MIL-PRF-19500/262G
 6 December 2013
 SUPERSEDING
 MIL-S-19500/262F
 19 February 1969

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, HIGH-POWER
 TYPES 2N1722 AND 2N1724, JAN AND JANTX

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. Two levels of product assurance are provided for each device type as specified in [MIL-PRF-19500](#).

1.2 Physical dimensions. See [figure 1](#) (TO-53) and [figure 2](#) (TO-61).

1.3 Maximum ratings unless otherwise specified $T_A = +25^\circ\text{C}$.

P_T (1) $T_A = +25^\circ\text{C}$	P_T (2) $T_C = +100^\circ\text{C}$	$R_{\theta JC}$	V_{CBO}	V_{CEO}	V_{EBO}	I_c	T_{stg} and T_J
<u>W</u>	<u>W</u>	<u>$^\circ\text{C}/\text{W}$</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>$^\circ\text{C}$</u>
3	50	1.5	175	80	10	5	-65 to +200

(1) Derate linearly at 20 mW/ $^\circ\text{C}$ for $T_A \geq +25^\circ\text{C} \leq +175^\circ\text{C}$.

(2) Derate linearly at 666 mW/ $^\circ\text{C}$ for $T_C > +100^\circ\text{C} \leq +175^\circ\text{C}$.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@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.dla.mil/>.

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

Limits	h _{FE1} (1) V _{CE} = 15 V I _C = 2 A	h _{fe} V _{CE} = 15 V I _C = 500 mA dc f = 10 MHz	V _{BE(sat)1} (1) I _C = 2 A dc I _B = 200 mA dc	V _{CE(sat)1} (1) I _C = 2 A dc I _B = 200 mA dc	C _{obo} V _{CB} = 15 V dc I _E = 0 f = 100 kHz ≤ f ≤ 1 MHz
			<u>V dc</u>	<u>V dc</u>	<u>pF</u>
Min	30	1	1.2	0.6	550
Max	120	5			

(1) Pulsed (see 4.5.1).

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.

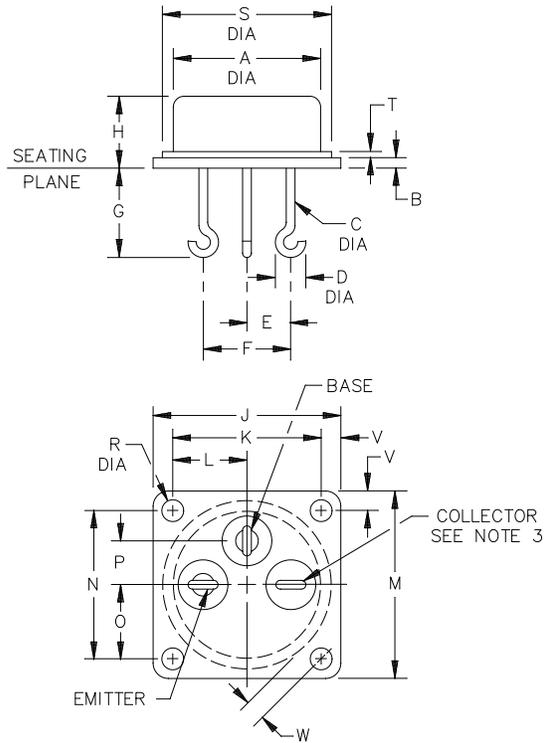
DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) - Test Methods for Semiconductor Devices.

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

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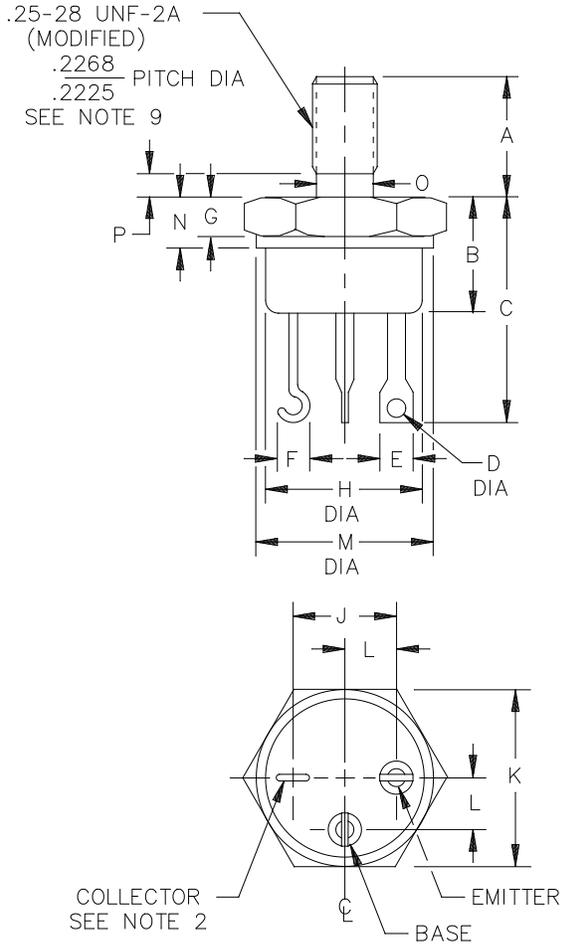


Ltr	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.670	.680	17.02	17.27	
B	.040	.055	1.02	1.40	
C	.035	.045	0.89	1.14	4
D	.130	.150	3.30	3.81	4
E	.190	.210	4.83	5.33	
F	.385	.415	9.78	10.54	
G	.370	.420	9.40	10.67	4
H	.305	.355	7.75	9.02	
J	.850	.870	21.59	22.1	
K	.670	.690	17.02	17.53	
L	.330	.350	8.38	8.89	
M	.850	.870	21.59	22.1	
N	.670	.690	17.02	17.53	
O	.330	.350	8.38	8.89	
P	.190	.210	4.83	5.33	
R	.096	.106	2.44	2.69	7
S	.765	.785	19.43	16.94	
T	.030	.065	0.76	1.65	
V	.075	.105	1.91	2.67	6
W	.075	-	1.91	-	5

NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Lead spacing measured at seating plane.
3. The collector shall be electrically connected to the case.
4. All three leads.
5. All four locations.
6. All eight locations.
7. All four holes.
8. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions of transistor types 2N1722 (TO-53).



Ltr	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.422	.455	10.72	11.56	
B	.325	.460	8.26	11.68	
C	.640	.875	16.26	22.22	6
D	.047	.072	1.19	1.83	7
E	.095	.115	2.41	2.92	7
F		.150		3.81	
G	.090	.150	2.29	3.81	
H	.570	.610	14.48	15.49	
J	.340	.415	8.64	10.54	
K	.667	.687	16.94	17.45	8
L	.170	.213	4.32	5.41	
M	.610	.687	15.49	17.45	
N		.270		6.86	
O	.220	.249	5.59	6.32	
P		.090		2.29	

NOTES:

1. Dimensions are in inches, millimeters are given for general information only.
2. The collector shall be electrically connected to the case.
3. Lead spacing measured at seat only.
4. Position of leads in relation to hex is not controlled.
5. Maximum recommended mounting torque: 20 in-lb.
6. All three leads.
7. Two leads.
8. All three locations.
9. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
10. Threads in accordance with Handbook H28.

FIGURE 2. Physical dimensions (TO-61) for 2N1724.

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 and as follows.

$R_{\theta JA}$	Thermal resistance junction to ambient.
$R_{\theta JC}$	Thermal resistance junction to case.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and on [figure 1](#) (TO-53) and [figure 2](#) (TO-61) 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 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 as specified in [table I](#) herein.

3.7 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

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](#) and [tables I and II](#)).

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

4.3 Screening. Screening shall be in accordance with table E-IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement
	JANTX level
2	Required, $T_A = +200^\circ\text{C}$
(1) 3c	Thermal impedance, method 3131 of MIL-STD-750 (see 4.3.1)
9	I_{EBO} , I_{CES} , and h_{FE1}
11	I_{EBO} , I_{CES} , and h_{FE1} $\Delta I_{EBO} = 100$ percent of initial value or $100 \mu\text{A}$ dc, whichever is greater. $\Delta I_{CES} = 100$ percent of initial value or $100 \mu\text{A}$ dc, whichever is greater. $\Delta h_{FE1} = \pm 15$ percent of initial value.
12	See 4.3.1; 168 hours minimum
13	Subgroup 2 of table I herein; I_{EBO} , I_{CES} , and h_{FE1} $\Delta I_{EBO} = 100$ percent of initial value or $100 \mu\text{A}$ dc, whichever is greater. $\Delta I_{CES} = 100$ percent of initial value or $100 \mu\text{A}$ dc, whichever is greater. $\Delta h_{FE1} = \pm 15$ percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: $V_{CE} = 10\text{-}30$ V dc; power shall be applied to achieve $T_J = +175^\circ\text{C}$ minimum using a minimum power dissipation = 75 percent of maximum rated PT (see 1.3). NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.3.2 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} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. See table II, subgroup 4 herein.

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

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIB (JAN and JANTX) of MIL-PRF-19500 and herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with the applicable steps of 4.5.3 herein.

4.4.2.1 Group B inspection, table E-VIB (JAN and JANTX) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1037	$V_{CB} \geq 10$ V dc, 2,000 cycles.

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 herein. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition A; weight = 10 pounds; time = 15 s.
C2	2036	Test condition D1; torque = 6 inch-ounce; time = 15 s (2N1724 only).
C2	2036	Stud torque (2N1724 only), test condition D2; torque = 15 inch-pound; time = 15 s.
C5	3131	See 4.3.2 , $R_{\theta JC} = 1.5^{\circ}C/W$.
C6	1037	$V_{CB} \geq 100$ V dc, 6,000 cycles.

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 II](#) herein. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein; delta measurements shall be in accordance with the applicable steps of [4.5.3](#).

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

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

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

4.5.3 Delta requirements. Delta requirements shall be as specified below: (1) (2) (3) (4)

Steps	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 60$ V dc	ΔI_{CES1}	100 percent of initial value or 50 μA , whichever is greater.		
2.	Forward - current transfer ratio	3076	$I_C = 2$ A dc $V_{CE} = 5$ V dc, pulsed (see 4.5.1)	Δh_{FE2}	± 20 percent change from initial reading		

- (1) The delta measurements for table E-VIB (JAN and JANTXV) of MIL-PRF-19500 are as follows:
 - a. Subgroup 3, see [4.5.3](#) herein, steps 1 and 2.
 - b. Subgroup 4, see [4.5.3](#) herein, steps 1 and 2.
- (2) The delta measurements for table E-VII of MIL-PRF-19500 are as follows: Subgroup 6, see [4.5.3](#) herein, steps 1 and 2.
- (3) Devices which exceed the [table I](#) limits for this test shall not be accepted.
- (4) Group E, [table II](#) herein, subgroups 1 and 2, see [4.5.3](#) herein, steps 1 and 2.

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TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.2	Z _{θJX}			°C/W
Collector to base breakdown voltage	3011	Bias condition D, I _C = 200 mA dc; pulsed (see 4.5.1)	V _{(BR)CEO}	80		V dc
Emitter to base breakdown voltage	3011	Bias condition D, I _E = 10 mA dc; pulsed (see 4.5.1)	V _{(BR)EBO}	10		V dc
Collector to emitter cutoff current	3041	Bias condition C, V _{CE} = 60 V dc	I _{CES1}		300	μA dc
Collector to base cutoff current	3036	Bias condition D; V _{CB} = 175 V dc	I _{CBO}		5	mA dc
Emitter to base cutoff current	3041	Bias condition A, V _{EB} = 7 V dc	I _{EBO}		400	μA dc
Base emitter voltage	3066	Test condition A; I _C = 2 A dc; I _B = 200 mA dc; pulsed (see 4.5.1)	V _{BE(sat)1}		1.2	V dc
Collector to emitter saturated voltage	3071	I _C = 2 A dc; I _B = 200 mA dc; pulsed (see 4.5.1)	V _{CE(sat)1}		0.6	V dc
Forward-current transfer ratio	3076	V _{CE} = 15 V dc; I _C = 2 A dc; pulsed (see 4.5.1)	h _{FE1}	30	120	
Forward-current transfer ratio	3076	V _{CE} = 15 V dc; I _C = 5 A dc; pulsed (see 4.5.1)	h _{FE2}	15		
Forward-current transfer ratio	3076	V _{CE} = 15 V dc; I _C = 100 mA dc; pulsed (see 4.5.1)	h _{FE3}	30		
<u>Subgroup 3</u>						
High-temperature operation:		T _A = +150°C				
Collector to emitter cutoff current	3041	Bias condition C; V _{CE} = 60 V dc	I _{CES2}		1.5	mA dc
Collector to emitter cutoff current	3041	Bias condition C; V _{CE} = 120 V dc	I _{CES3}		10	mA dc
Low-temperature operation :		T _A = -55°C				
Forward-current transfer ratio	3076	V _{CE} = 15 V dc I _C = 2 A dc; pulsed (see 4.5.1)	h _{FE4}	15		

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal short-circuit forward- current transfer ratio	3306	$V_{CE} = 15 \text{ V dc}; I_C = 500 \text{ mA dc}; f = 10 \text{ MHz}$	$ h_{fe} $	1.0	5	
Open capacitance (open circuit)	3236	$V_{CB} = 15 \text{ V dc}; I_E = 0;$ $100 \text{ kHz} \leq f \leq 1.0 \text{ MHz}$	C_{obo}		550	pF
<u>Subgroup 5</u>						
Safe operating area (dc operation)	3051	$t = 60 \text{ s}; 1 \text{ cycle};$ (see figure 3), $t_r \leq 6 \text{ sec}; t_f \leq 6 \text{ sec}, 1 \text{ cycle}$				
Test 1		$T_C = +100^\circ\text{C}, V_{CE} = 10 \text{ V dc}; I_C = 5 \text{ A dc}$				
Test 2		$T_C = +145^\circ\text{C}, V_{CE} = 80 \text{ V dc}; I_C = 250 \text{ mA dc}$				
Safe operating area (unclamped switching)	3053	$T_A = +25^\circ\text{C}, R_{BB1} = 5 \Omega; R_{BB2} = 10 \Omega;$ (see figure 4); Load condition C, $V_{BB2} = 5 \text{ V dc}$				
Test 1		$I_C = 5 \text{ A dc}; V_{BB1} = 15 \text{ V dc},$ $V_{CC} = 18 \text{ V dc}, L = 2 \text{ mH}, .56 \Omega$ (2 are used, or equivalent)				
Test 1		$I_C = 1 \text{ A dc}; V_{BB1} = 8 \text{ V dc},$ $V_{CC} = 13.5 \text{ V dc}, L = 20 \text{ mH}, .22 \Omega$ (2 are used, or equivalent)				
Safe operating area (clamped switching)	3053	$T_A = +25^\circ\text{C}, I_C = 5 \text{ A dc}, V_{CC} = 175 \text{ V dc}$ (see figure 5); Load condition B, $V_{BB1} = 15 \text{ V dc},$ $V_{BB2} = 5.0 \text{ V dc}, R_{BB1} = 5 \Omega; R_{BB2} = 10 \Omega; R_L = 35 \Omega; L = 20 \text{ mH};$				

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

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

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I , subgroup 2 and 4.5.3 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	$V_{CB} \geq 10$ V dc , 6,000 cycles.	
Electrical measurements		See table I , subgroup 2 and 4.5.3 herein.	
<u>Subgroup 4</u>			
Thermal impedance curves		See table E-IX of MIL-PRF-19500 , group E, subgroup 4.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

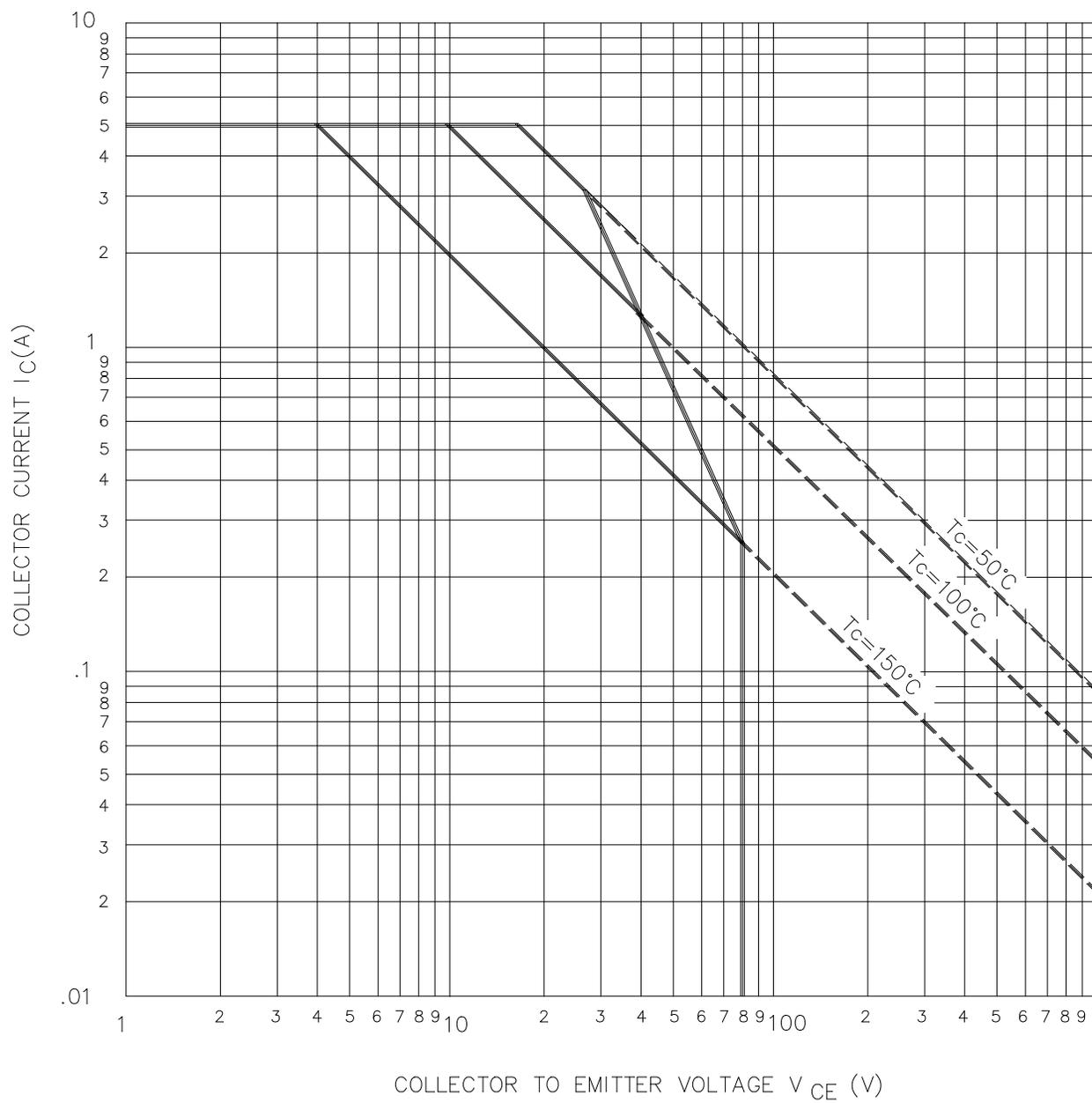


FIGURE 3. Safe operating area test graph (DC operation).

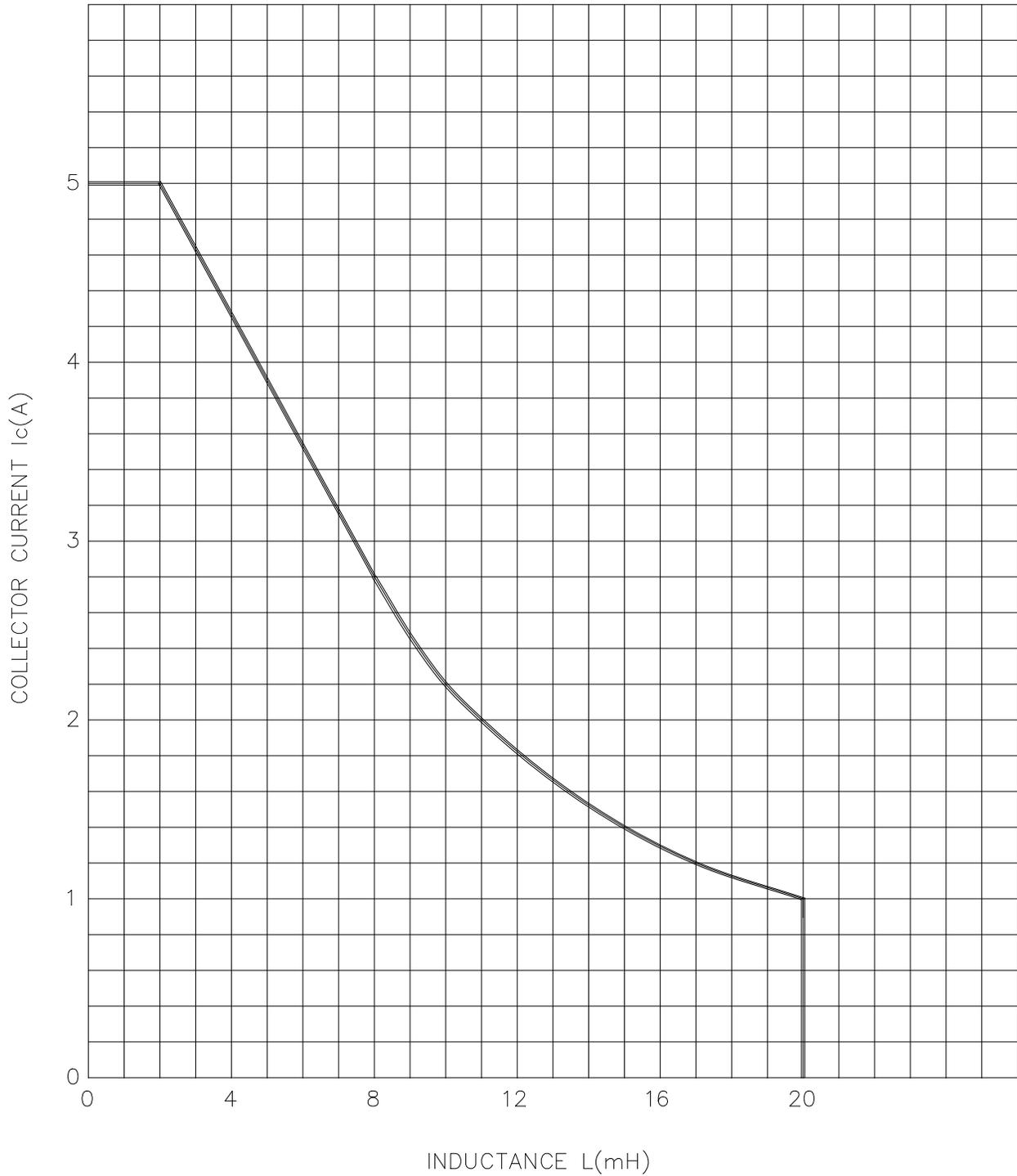


FIGURE 4. Safe operating area for switching between saturation and cutoff - unclamped inductive load.

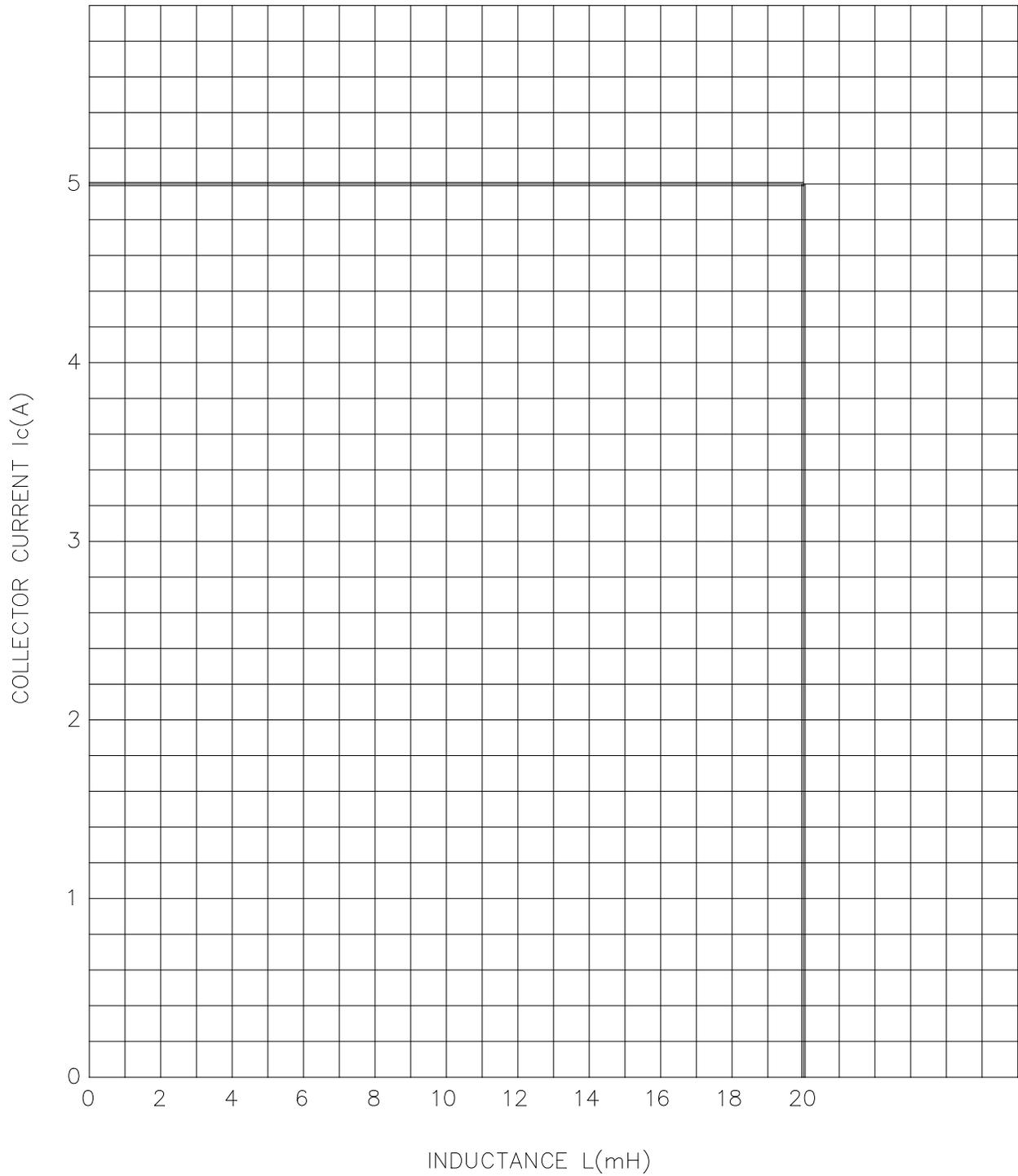


FIGURE 5. Safe operating area for switching between saturation and cutoff - clamped inductive load.

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. 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.dla.mil>.

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.

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

Preparing activity:
 DLA - CC
 (Project 5961-2013-082)

Review activities:
 Army - AR
 Air Force - 19, 99
 Navy - AS, CG, 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.dla.mil>.