

The documentation and process conversion measures necessary to comply with this revision shall be completed by 4 November 1999

INCH-POUND

MIL-PRF-19500/504C
4 August 1999
SUPERSEDING
MIL-S-19500/504B
10 August 1993

PERFORMANCE SPECIFICATION SHEET
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, NPN, SILICON, POWER
TYPES 2N6283 AND 2N6284 JAN, JANTX AND JANTXV

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, Darlington, silicon, power transistors. Three levels of product assurance is provided for each encapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO – 204AA similar to TO – 3) herein.

1.3 Maximum ratings.

	P _T 1/		V _{CB0}	V _{CEO}	V _{EBO}	I _C	I _B	T _J and T _{STG}	R _{θJC}
	T _C = 25°C	T _C = 100°C							
2N6283	$\frac{W}{175}$	$\frac{W}{87.5}$	$\frac{V\ dc}{80}$	$\frac{V\ dc}{80}$	$\frac{V\ dc}{7}$	$\frac{A\ dc}{20}$	$\frac{A\ dc}{0.5}$	°C -65 to +200	°C/W 0.857 max
2N6284	$\frac{W}{175}$	$\frac{W}{87.5}$	$\frac{V\ dc}{100}$	$\frac{V\ dc}{100}$	$\frac{V\ dc}{7}$	$\frac{A\ dc}{20}$	$\frac{A\ dc}{0.5}$	°C -65 to +200	°C/W 0.857 max

1/ Derate linearly at 1.17 W/°C above T_C > 25°C.

1.4 Primary electrical characteristics.

	h _{FE1} 1/	h _{FE2} 1/	V _{CE(sat)1}	V _{CE(sat)2}	V _{BE(sat)1}	Switching	
	V _{CE} = 3 V dc I _C = 1 A dc	V _{CE} = 3 V dc I _C = 10 A dc	I _C = 20 A dc I _B = 200 mA dc	I _C = 10 A dc I _B = 40 mA dc	I _C = 20 A dc I _B = 200 mA dc	t _{on}	t _{off}
Min	1,500	1,250	$\frac{V\ dc}{3.0}$	$\frac{V\ dc}{2.0}$	$\frac{V\ dc}{4.0}$	μs	μs
Max		18,000				2	10

	C _{obo} V _{CB} = 10 V dc I _E = 0 100 kHz ≤ f ≤ 1 MHz	h _{fe} V _{CE} = 3 V dc I _C = 10 A dc f = 1 MHz
	Min	$\frac{PF}{300}$
Max		80

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 Street, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1/ Pulsed see 4.5.1

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.

2.2.1 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 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, Building 4D (DPM-DODSSP), 700 Robbins Avenue, 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 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500 and as specified herein.

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 (TO – 204AA similar to TO – 3) herein.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500, and herein.

3.5 Marking. Devices shall be marked in accordance with MIL-PRF-19500.

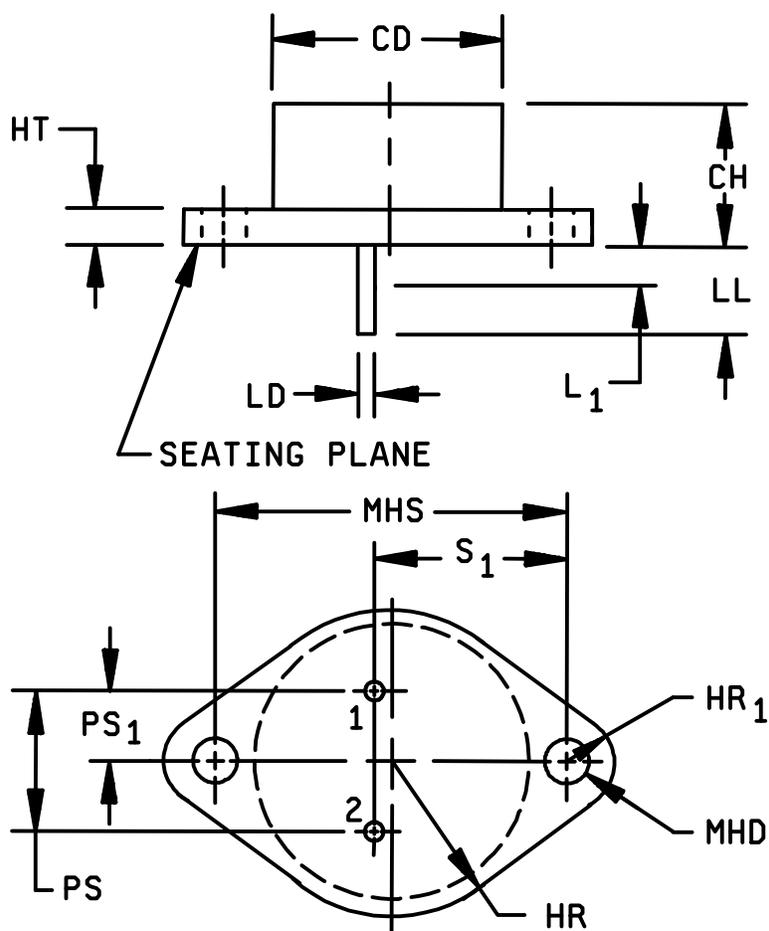
3.6 Electrical performance characteristics. Unless otherwise specified, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

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

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).



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Body contour is optional within zone defined by CD.
4. These dimensions shall be measured at points 0.050 (1.27 mm) to 0.055 (1.40 mm) below seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. Terminal 1 is the emitter, terminal 2 is base. The collector shall be electrically connected to the case.
9. LD applies between L₁ and LL. Diameter is uncontrolled in L₁.
10. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Physical dimensions (TO - 204AA similar to TO - 3).

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max			
CD		0.875		22.23	3
CH	0.250	0.360	6.35	9.14	
HR	0.495	0.525	12.57	13.34	
HR ₁	0.131	0.188	3.33	4.78	
HT	0.060	0.135	1.52	3.43	
LD	0.038	0.043	0.97	1.09	5, 9
LL	0.312	0.500	7.92	12.7	5
L ₁		0.050		1.27	5, 9
MHD	0.151	0.165	3.84	4.19	7
MHS	1.177	1.197	29.90	30.40	
PS	0.420	0.440	10.67	11.18	4
PS ₁	0.205	0.225	5.21	5.72	
S ₁	0.655	0.675	16.64	17.15	

FIGURE 1. Physical dimensions (TO – 204AA similar to TO – 3) - Continued.

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

4.3 Screening. Screening shall be in accordance with table 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 and JANTXV levels
11	I_{CEX1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein; $\Delta I_{CEX1} = 100$ percent of initial value or $100 \mu A$ dc, whichever is greater. $\Delta h_{FE1} = \pm 40$ percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

$$T_J = 162.5^\circ C \pm 12.5^\circ C, V_{CE} \geq 10 \text{ V dc.}$$

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

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

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

Subgroup	Method	Condition
B3	1037	For solder die attach: $V_{CE} \geq 10 \text{ V dc}$; $T_A \leq 35^\circ C$, 2,000 cycles.
B3	1026	For eutectic die attach: $T_A \leq 35^\circ C$ adjust P_T to achieve $T_J = 150^\circ C$ minimum, $V_{CE} \geq 10 \text{ V dc}$.
B5	3131	$R_{\theta JC} = 0.857^\circ C/W$ maximum.

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

4.4.3.1. Group C inspection, table VII of MIL-PRF-19500.

Subgroup	Method	Condition
C6	1037	For solder die attach: $V_{CE} \geq 10 \text{ V dc}$; $T_A \leq 35^\circ C$, 6,000 cycles.
C6	1026	For eutectic die attach: $T_A \leq 35^\circ C$ adjust P_T to achieve $T_J = 150^\circ C$ minimum, $V_{CE} \geq 10 \text{ V dc}$.

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage, collector - emitter	3011	Bias condition D; $I_C = 100$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	80 100		V dc V dc
2N6283 2N6284						
Collector - emitter cutoff current	3041	Bias condition D; $V_{CE} = 40$ V dc $V_{CE} = 50$ V dc	I_{CEO}		1.0	mA dc
2N6283 2N6284						
Emitter - base cutoff current	3061	Bias condition D; $V_{EB} = 7$ V dc	I_{EBO}		2.5	mA dc
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5$ V dc; $V_{CE} = 80$ V dc $V_{CE} = 100$ V dc	I_{CEX1}		0.5	mA dc
2N6283 2N6284						
Base - emitter (nonsaturated)	3066	Test condition B; $V_{CE} = 3$ V dc; $I_C = 10$ A dc	V_{BE}		2.8	V dc
Base - emitter voltage (saturated)	3066	Test condition A; $I_C = 20$ A dc; $I_B = 200$ mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector - emitter saturated voltage	3071	$I_C = 20$ A dc; $I_B = 200$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		3.0	V dc
Collector - emitter saturated voltage	3071	$I_C = 10$ A dc; $I_B = 40$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		2.0	V dc
Forward-current transfer ratio	3076	$V_{CE} = 3$ V dc; $I_C = 1$ A dc; pulsed (see 4.5.1)	h_{FE1}	1,500		
Forward-current transfer ratio	3076	$V_{CE} = 3$ V dc; $I_C = 10$ A dc; pulsed (see 4.5.1)	h_{FE2}	1,250	18,000	

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward-current transfer ratio	3076	$V_{CE} = 3 \text{ V dc}; I_C = 20 \text{ A dc};$ pulsed (see 4.5.1)	h_{FE3}	500		
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector - emitter cutoff current 2N6283 2N6284	3041	Bias condition A; $V_{BE} = 1.5 \text{ V dc};$ $V_{CE} = 80 \text{ V dc}$ $V_{CE} = 100 \text{ V dc}$	I_{CEX2}		5.0	mA dc
Collector - emitter saturated voltage	3071	$I_C = 10 \text{ A dc}; I_B = 40 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(sat)3}$		2.0	V dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 3 \text{ V dc}; I_C = 10 \text{ A dc};$ pulsed (see 4.5.1)	h_{FE4}	200		
<u>Subgroup 4</u>						
Pulse response						
Turn-on time		(See figure 2); $V_{CC} = 30 \text{ V dc};$ $I_C = 10 \text{ A dc}; I_B = 40 \text{ mA dc}$	t_{on}		2.0	μs
Turn-off time		(See figure 2); $V_{CC} = 30 \text{ V dc};$ $I_C = 10 \text{ A dc}; I_{B1} = I_{B2} = 40 \text{ mA dc}$	t_{off}		10	μs
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 3 \text{ V dc}; I_C = 10 \text{ A dc};$ $f = 1.0 \text{ MHz}$	$ h_{fe} $	8	80	
Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 3 \text{ V dc}; I_C = 10 \text{ A dc};$ $f = 1 \text{ kHz}$	h_{fe}	700		
Open circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}; I_E = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		300	pF

See footnote at end of table.

TABLE I. Group A inspection - Continued.

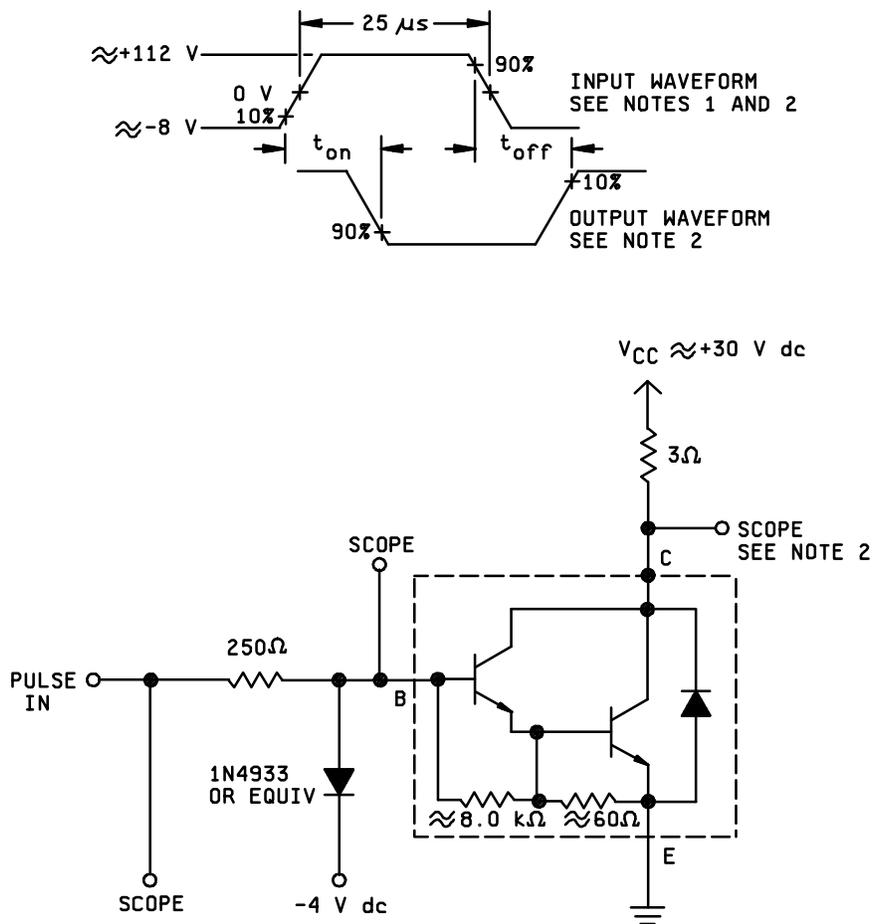
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area continuous (dc)	3051	$T_C = +25^\circ\text{C}$; $t = 1\text{ s}$; 1 cycle; (see figure 3)				
<u>Test 1</u> (Both device types)		$V_{CE} = 8.75\text{ V dc}$; $I_C = 20\text{ A dc}$				
<u>Test 2</u> (Both device types)		$V_{CE} = 30\text{ V dc}$; $I_C = 5.8\text{ A dc}$				
<u>Test 3</u> 2N6283		$V_{CE} = 80\text{ V dc}$; $I_C = 100\text{ mA dc}$				
2N6284		$V_{CE} = 100\text{ V dc}$; $I_C = 100\text{ mA dc}$				
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load); (see figure 4) $T_A = 25^\circ\text{C}$; $R_S \leq 0.1\ \Omega$; $t_r + t_f \leq 15\text{ ns}$; duty cycle $\leq 2\text{ percent}$				
<u>Test 1</u>		$t_p = 80\ \mu\text{s}$; (vary to obtain I_C); $R_{BB1} \geq 50\ \Omega$; $V_{BB1} \geq 10\text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $I_C = 20\text{ A dc}$; $V_{CC} \geq 50\text{ V dc}$; The coil used shall provide a minimum inductance of 1 mH at 20 A. (For reference only; two coils in parallel (Super Electric Corporation type S16884 or equivalent).)				
<u>Test 2</u>		$t_p = 1\text{ ms}$; (vary to obtain I_C); $R_{BB1} \geq 50\ \Omega$; $V_{BB1} \geq 10\text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $I_C = 500\text{ mA dc}$; $V_{CC} \geq 50\text{ V dc}$; The coil used shall provide a minimum inductance of 100 mH at 500 mA. (For reference only; two coils in series, 80 mH and 20 mH windings (Super Electric Corporation type S16884 or equivalent).)				

See footnote at end of table.

TABLE I. Group A inspection. - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> - Continued Safe operating area (switching) 2N6283 2N6284 End point electrical measurements <u>Subgroups 6 and 7</u> Not applicable	3053	Load condition B; (clamped inductive load); $T_A = 25^\circ\text{C}$; $R_S \leq 0.1 \Omega$; $t_r + t_f \leq 1.0 \mu\text{s}$; duty cycle ≤ 2 percent; $t_p = 1 \text{ ms}$ (vary to obtain I_C); $R_{BB1} = 50 \Omega$; $V_{BB1} = 10 \text{ V dc}$; $R_{BB2} = 100 \Omega$; $V_{BB2} = 1.5 \text{ V dc}$; $V_{CC} = 25 \text{ V dc}$; $I_C = 20 \text{ A dc}$; $R_L \leq 2 \Omega$; $L = 5 \text{ mH}$; (Four coils in parallel, 20 mH windings) (Triad c-48u or equivalent). Clamp voltage = 80 +0, -5 V dc Clamp voltage = 100 +0, -5 V dc Device fails if clamp voltage is not reached. See subgroup 2 herein.				

1/ For sampling plan see MIL-PRF-19500



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:

$$t_r \leq 20 \text{ ns}, t_f \leq 20 \text{ ns}, Z_{out} = 50 \Omega, PW = 25 \mu\text{s}, \text{duty cycle} \leq 2 \text{ percent.}$$

2. Output waveforms are monitored on an oscilloscope with the following characteristics:

$$t_r \leq 20 \text{ ns}, Z_{in} \geq 20\text{k} \Omega, C_{in} \leq 11.5 \text{ pF.}$$

3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 2. Pulse response test circuit.

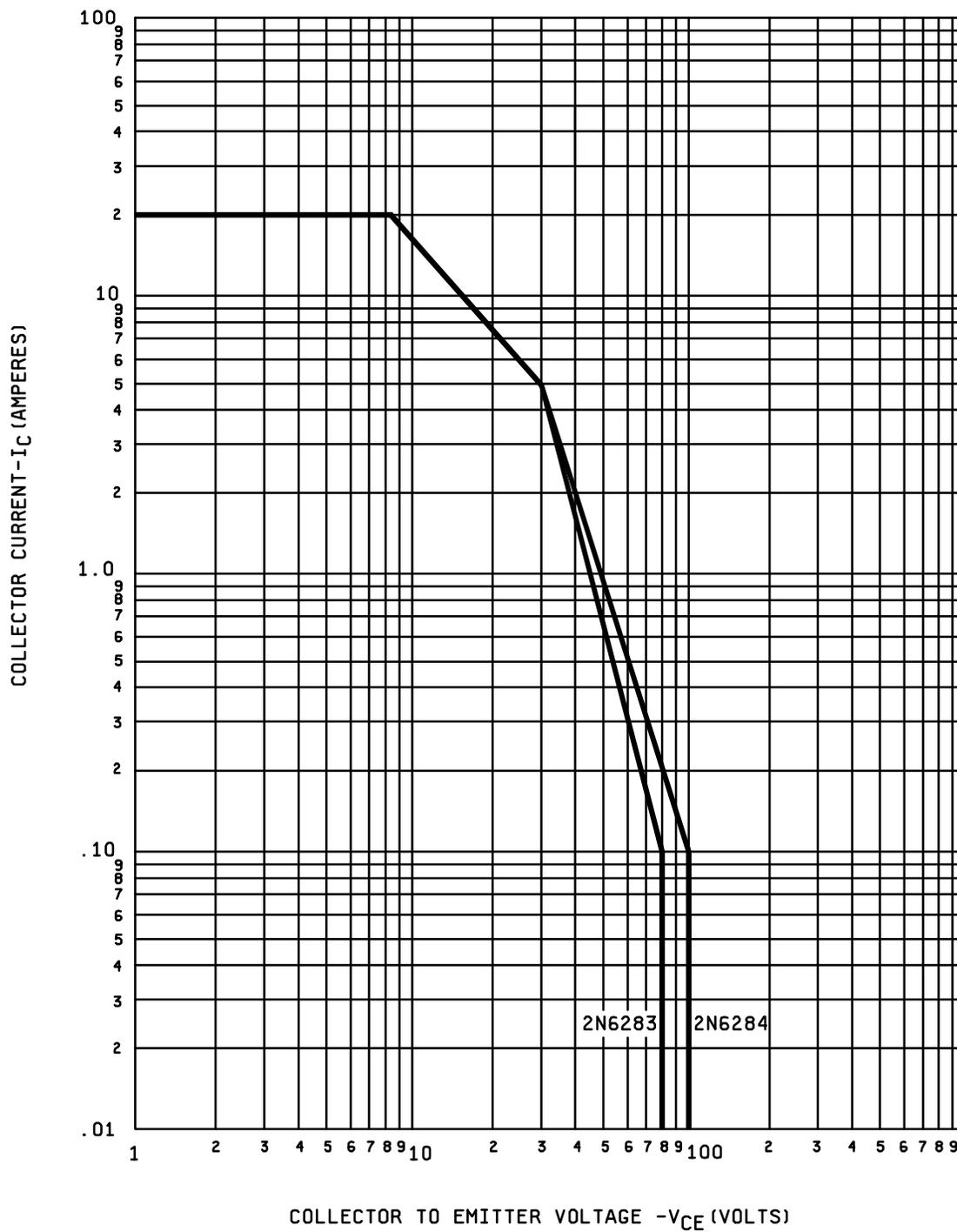


FIGURE 3. Maximum safe operating graph (continuous dc).

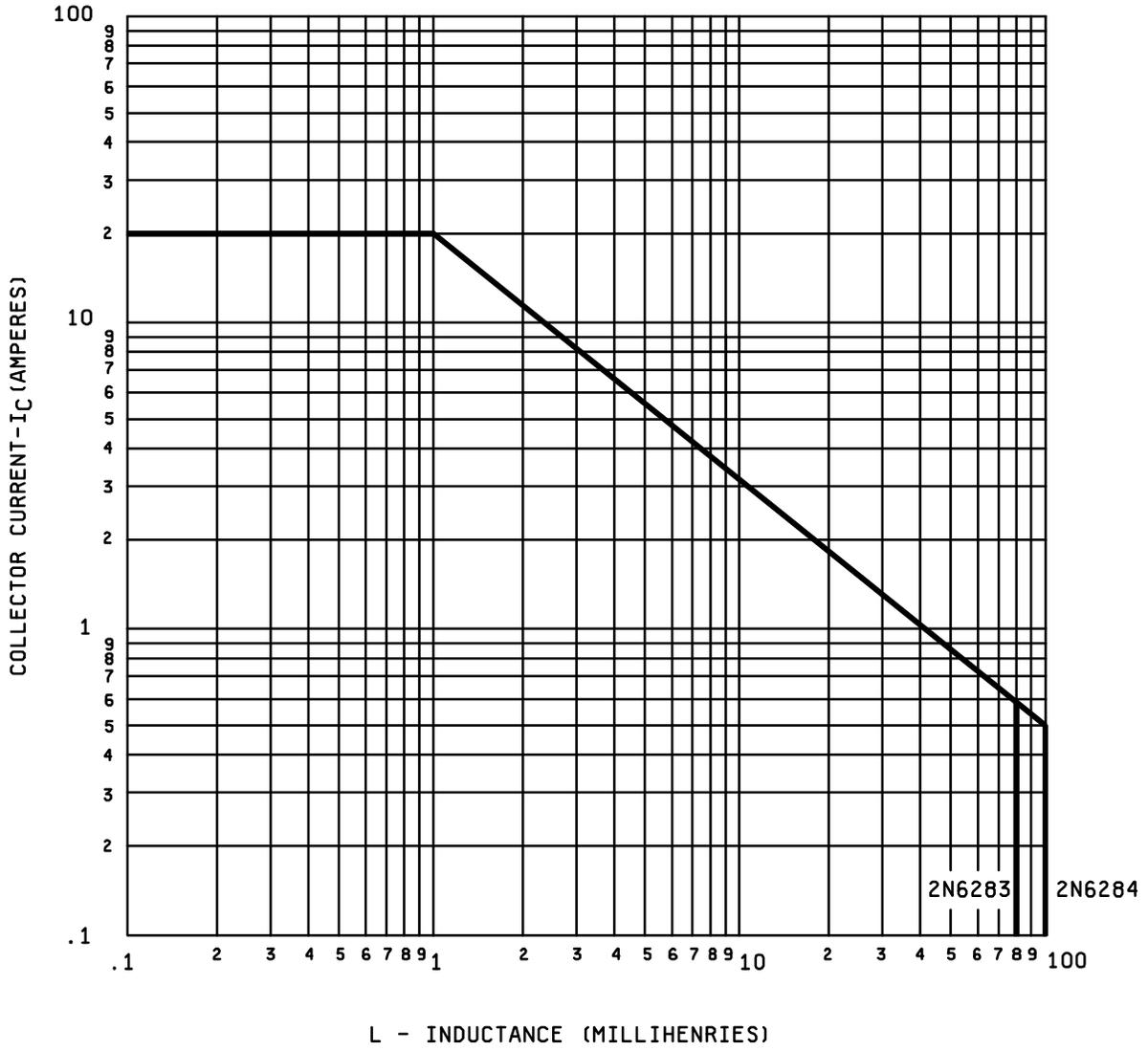


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

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.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements should 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 Departments' 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.)

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

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Issue of DODISS to be cited in the solicitation (see 2.2.1).
- b. The lead finish as specified (see 3.4.1).
- c. Type designation and quality assurance level.
- d. Packaging requirements (see 5.1).

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 Manufacturer's 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.

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:
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

Review activities:
Air Force - 13, 19, 99

(Project 5961-2066)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-19500/504C

2. DOCUMENT DATE (YYMMDD)
990804

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, NPN, SILICON, POWER TYPES 2N6283, 2N6284 JAN, JANTX AND JANTXV

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)
Commercial
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EMAIL

7. DATE SUBMITTED
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8. PREPARING ACTIVITY

a. Point of contact: Alan Barone,

b. TELEPHONE
Commercial DSN FAX EMAIL
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c. ADDRESS : Defense Supply Center
Columbus, ATTN: DSCC-VAC, 3990 East
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