

The documentation and process conversion measures necessary to comply with this revision shall be completed by 15 September 1997

INCH POUND

MIL-PRF-19500/539B
 15 June 1997
 SUPERSEDING
 MIL-S-19500/539A
 20 October 1993

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, NPN, SILICON, POWER
 TYPES 2N6300, 2N6301 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. Two levels of product assurance are provided for each device type as specified in MIL-PRF-19500. For JAN quality assurance level (see 6.3).

1.2 Physical dimensions. See figure 1.

1.3 Maximum ratings.

	P _T 1/		V _{CB0}	V _{CEO}	V _{EBO}	I _C	I _B	T _{OP} and T _{STG}
	T _C = 0°C	T _C = 100°C						
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>mA dc</u>	<u>°C</u>
2N6300	75	32	60	60	5	8	120	-55 TO +200
2N6301	75	32	80	80	5	8	120	-55 TO +200

1/ Derate linearly at 0.428 W/°C above T_C > 0°C.

1.4 Primary electrical characteristics.

	h _{FE2} 1/ V _{CE} = 3 V dc I _C = 4 A dc	h _{FE3} 1/ V _{CE} = 3 V dc I _C = 8 A dc	h _{fe} V _{CE} = 3 V dc I _C = 3 A dc f = 1 MHz	C _{obo} 100 kHz ≤ f ≤ 1 MHz/ V _{CB} = 10 V dc I _E = 0	Pulse response	
					t _{on}	t _{off}
Min	750	100	25	<u>pF</u>	<u>μs</u>	<u>μs</u>
Max	18000		350	200	2.0	8.0

See footnote at end of table.

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-VAT, 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.

1.4 Primary electrical characteristics. Continued.

	$V_{BE(sat)}$ $I_C = 8 \text{ A dc}$ $I_B = 80 \text{ mA dc}$ 1/	$V_{CE(sat)}$ $I_C = 8 \text{ A dc}$ $I_B = 80 \text{ mA dc}$ 1/	h_{fe} $V_{CE} = 3 \text{ V dc}$ $I_C = 3 \text{ A dc}$ $f = 1 \text{ kHz}$	$R_{\theta JC}$
Min	<u>V dc</u>	<u>V dc</u>	300	<u>°C/W</u>
Max	4.0	3.0		2.33

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 Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, 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 6.4).

3.2 Associated performance specification. The individual item performance 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 Design, construction, and physical dimensions. The design, construction, and physical dimensions for the purpose of interchangeability shall be as specified on figure 1 herein.

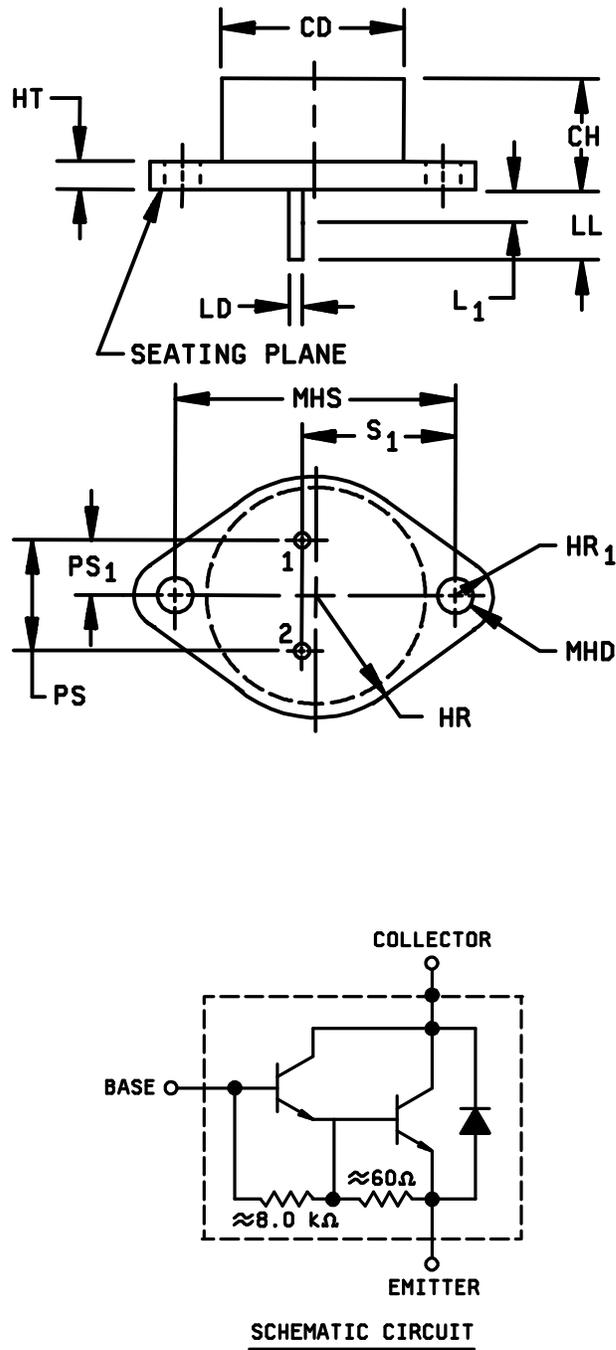


FIGURE 1. Physical dimensions.

Ltr	Dimensions					Notes	Ltr	Dimensions					Notes
	Inches		Millimeters		Notes			Inches		Millimeters		Notes	
	Min	Max	Min	Max				Min	Max	Min	Max		
CH	.250	.340	6.35	8.64			L ₁		.050		1.27	5, 9	
LD	.028	.034	0.71	.86	4, 9		MHD	.142	.152	3.61	3.86	7	
CD		.620		15.75	3		MHS	.958	.962	24.33	24.43		
PS	.190	.210	4.83	5.33	4		HR		.350		8.89		
PS ₁	.0095	.0105	2.41	2.66	3		HR ₁	.115	.145	2.92	3.68	6	
HT	.050	.075	1.27	1.91	3		S ₁	.570	.590	14.48	14.99	4	
LL	.360	.500	9.14	12.70	5								

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. Measured at points .050 (1.27 mm) - .055 (1.4 mm) below the seating plane. When gauge is not used, measurement will be made at the seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. The collector shall be electrically connected to the case.
9. LD applies between L₁ and LL. Diameter is uncontrolled within L₁.

FIGURE 1. Physical dimensions - Continued.

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

3.4 Marking. Devices shall be marked as specified in MIL-PRF-19500.

4. QUALITY ASSURANCE PROVISIONS

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.

4.3 Screening. Screening shall be in accordance with appendix E, 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 appendix E, table IV of MIL-PRF-19500)	Measurements
	JANTX AND JANTXV levels
11	I_{CEX1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein; $\Delta h_{FE2} = \pm 40$ percent $I_{CEX1} = 100$ percent of initial value or 100 nA dc whichever is greater.

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

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

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 appendix E, table V of MIL-PRF-19500 and table I herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VIb (JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

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

Subgroup	Method	Conditions
B3	1037	$V_{CE} \geq 10 \text{ V dc}$, 2,000 cycles.
B5	3151	$R_{\theta JC} = 2.33^\circ\text{C/W}$.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VII of MIL-PRF-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table II herein.

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

Subgroup	Method	Conditions
C2	2036	Test condition A, weight = 10 lbs, t = 15 s.
C6	1037	$V_{CE} \geq 10$ V dc, 6,000 cycles.

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.

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)	$V_{(BR)CEO}$	60 80		V dc V dc
2N6300 2N6301						
Collector - emitter cutoff current	3041	Bias condition A, $V_{BE} = -1.5$ V dc;	I_{CEX1}			
2N6300 2N6301		$V_{CE} = 60$ V dc $V_{CE} = 80$ V dc			0.5 0.5	mA dc mA dc
Collector - emitter cutoff current	3041	Bias condition D,	I_{CEO}			
2N6300 2N6301		$V_{CE} = 30$ V dc $V_{CE} = 40$ V dc			0.5 0.5	mA dc mA dc
Emitter - base cutoff current	3061	Bias condition D, $V_{EB} = 5$ V dc	I_{EBO}		2.0	mA dc
Forward - current transfer ratio	3076	$V_{CE} = 3$ V dc, $I_C = 1$ A dc pulsed (see 4.5.1)	h_{FE1}	500		
Forward - current transfer ratio	3076	$V_{CE} = 3$ V dc, $I_C = 4$ A dc pulsed (see 4.5.1)	h_{FE2}	750	18000	
Forward - current transfer ratio	3076	$V_{CE} = 3$ V dc; $I_C = 8$ A dc pulsed (see 4.5.1)	h_{FE3}	100		
Base - emitter voltage (nonsaturated)	3066	Test condition B; $V_{CE} = 3$ V dc; $I_C = 4$ A dc; pulsed (see 4.5.1)	$V_{BE(on)}$		2.8	V dc
Base - emitter voltage (saturated)	3066	Test condition A; $I_C = 8$ A dc; $I_B = 80$ mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector - emitter voltage (saturated)	3071	$I_C = 4$ A dc; $I_B = 16$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		2.0	V dc
Collector - emitter voltage (saturated)	3071	$I_C = 8$ A dc; $I_B = 80$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		3.0	V dc

See footnote at end of table.

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = -1.5\text{ V dc}$,	I_{CEX2}			
2N6300		$V_{CE} = 60\text{ V dc}$			5.0	mA dc
2N6301		$V_{CE} = 80\text{ V dc}$			5.0	mA dc
Low temperature operation		$T_A = -55^\circ\text{C}$				
Forward - current transfer ratio	3076	$V_{CE} = 3\text{ V dc}$; $I_C = 4\text{ A dc}$; pulsed (see 4.5.1)	h_{FE4}	200		
<u>Subgroup 4</u>						
Small signal short circuit forward current transfer ratio	3206	$V_{CE} = 3\text{ V dc}$; $I_C = 3\text{ A dc}$; $f = 1\text{ kHz}$	h_{fe}	300		
Magnitude of small signal short - circuit forward - current transfer ratio	3306	$V_{CE} = 3\text{ V dc}$; $I_C = 3\text{ A dc}$; $f = 1.0\text{ MHz}$	$ h_{fe} $	25	350	
Pulse response						
Turn-on time		(See figure 2); $V_{CC} = 30\text{ V dc}$; $I_C = 4\text{ A dc}$; $I_{B1} = 16\text{ mA dc}$	t_{on}		2.0	μs
Turn-off time		(See figure 3) $V_{CC} = 30\text{ V dc}$; $I_C = 4\text{ A dc}$; $I_{B1} = I_{B2} = 16\text{ mA dc}$	t_{off}		8.0	μs
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}		200	pF

See footnote at end of table.

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (DC)	3051	$T_C = 25^\circ\text{C} + 10^\circ\text{C}$; $t = 1\text{ s}$; 1 cycle; (see figure 4)				
Test 1		$V_{CE} = 8\text{ V dc}$; $I_C = 8\text{ A dc}$				
Test 2		$V_{CE} = 20\text{ V dc}$; $I_C = 2.0\text{ A dc}$;				
Test 3		$I_C = 100\text{ mA dc}$;				
2N6300 2N6301		$V_{CE} = 60\text{ V dc}$ $V_{CE} = 80\text{ V dc}$				
Safe operating area (switching)	3053	Load condition B; (clamped inductive load); $T_A = 25^\circ\text{C}$; $t_r + t_f \leq 1.0\ \mu\text{s}$ duty cycle $\leq 10\%$; $t_p = 1\text{ ms}$; (vary to obtain I_C); $R_s = 0.1\text{ ohms}$; $R_{BB1} = 80\text{ ohms}$; $V_{BB1} = 16\text{ V dc}$; $R_{BB2} = 100\text{ ohms}$; $V_{BB2} = 1.5\text{ V dc}$; $V_{CC} = 50\text{ V dc}$; $I_C = 8\text{ A dc}$; $R_L \leq 2\text{ ohms}$; $L = 1\text{ mH}$; clamp voltage =				
2N6300 2N6301			60 V dc 80 V dc			
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load) (see figure 5) $T_A = 25^\circ\text{C}$; duty cycle $\leq 10\%$; $R_S \leq 0.1\text{ ohm}$				
Test 1		$t_p = 1\text{ ms}$ (vary to obtain I_C); $R_{BB1} = 80\text{ ohms}$; $V_{BB1} \geq 12\text{ V dc}$; $R_{BB2} = \infty$; $V_{CC} \geq 30\text{ V dc}$; $I_C = 8\text{ A dc}$; $R_L \leq 0.5\text{ ohms}$; $L = 1\text{ mH}$ at 8 A dc				
Test 2		$t_p = 1\text{ ms}$ (vary to obtain I_C); $R_{BB1} = 80\text{ ohms}$; $V_{BB1} \geq 12\text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0\text{ V dc}$; $V_{CC} \geq 30\text{ V dc}$; $I_C = 0.2\text{ A dc}$; $R_L \leq 0.5\text{ ohms}$; $L = 100\text{ mH}$ at 0.2 A dc				
End point electrical measurements		See table II steps 1 and 3				
<u>Subgroups 6 & 7</u>						
Not applicable						

1/ For sampling plan see MIL-PRF-19500

TABLE II. Groups B and C electrical measurements.

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5 \text{ V dc};$	I_{CEX1}		0.5	mA dc
	2N6300 2N6301		$V_{CE} = 60 \text{ V dc}$ $V_{CE} = 80 \text{ V dc}$				
2.	Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5 \text{ V dc};$	I_{CEX2}		1.0	mA dc
	2N6300 2N6301		$V_{CE} = 60 \text{ V dc}$ $V_{CE} = 80 \text{ V dc}$				
3.	Forward - current transfer ratio	3076	$V_{CE} = 3 \text{ V dc};$ $I_C = 4 \text{ A dc}$ pulsed (see 4.5.1)	h_{FE2}	750	18000	
4.	Forward - current transfer ratio	3076	$V_{CE} = 3 \text{ V dc};$ $I_C = 4 \text{ A dc}$ pulsed (see 4.5.1)	Δh_{FE2}	$\pm 40\%$		

1/ The electrical measurements for appendix E, table VIb (JANTX and JANTXV) of MIL-PRF-19500 are as follows:

- a. Subgroup 2, see table II herein, steps 1 and 3.
- b. Subgroup 3, see table II herein, steps 2 and 4.
- c. Subgroup 6, see table II herein, steps 2 and 4.

2/ The electrical measurements for appendix E, table VII of MIL-PRF-19500 are as follows:

- a. Subgroup 3, see table II herein, steps 1 and 3.
- b. Subgroup 6, see table II herein, steps 2 and 4.

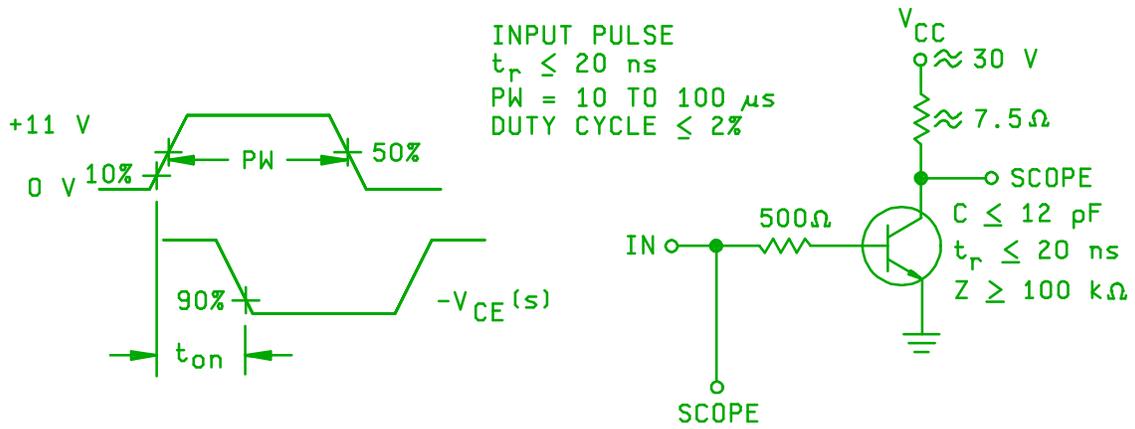
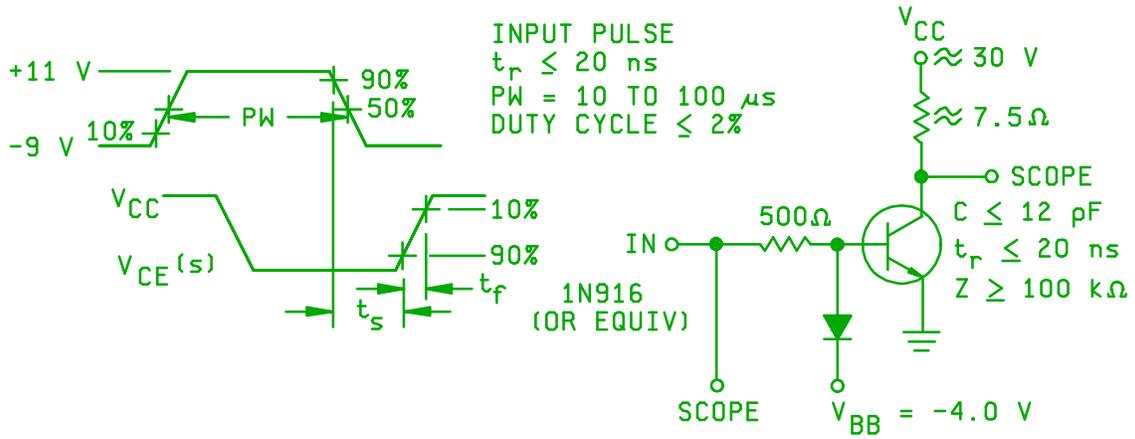


FIGURE 2. Turn on (t_{on}) time test circuit.



NOTE: $t_s + t_f = t_{off}$

FIGURE 3. Switching time test circuit.

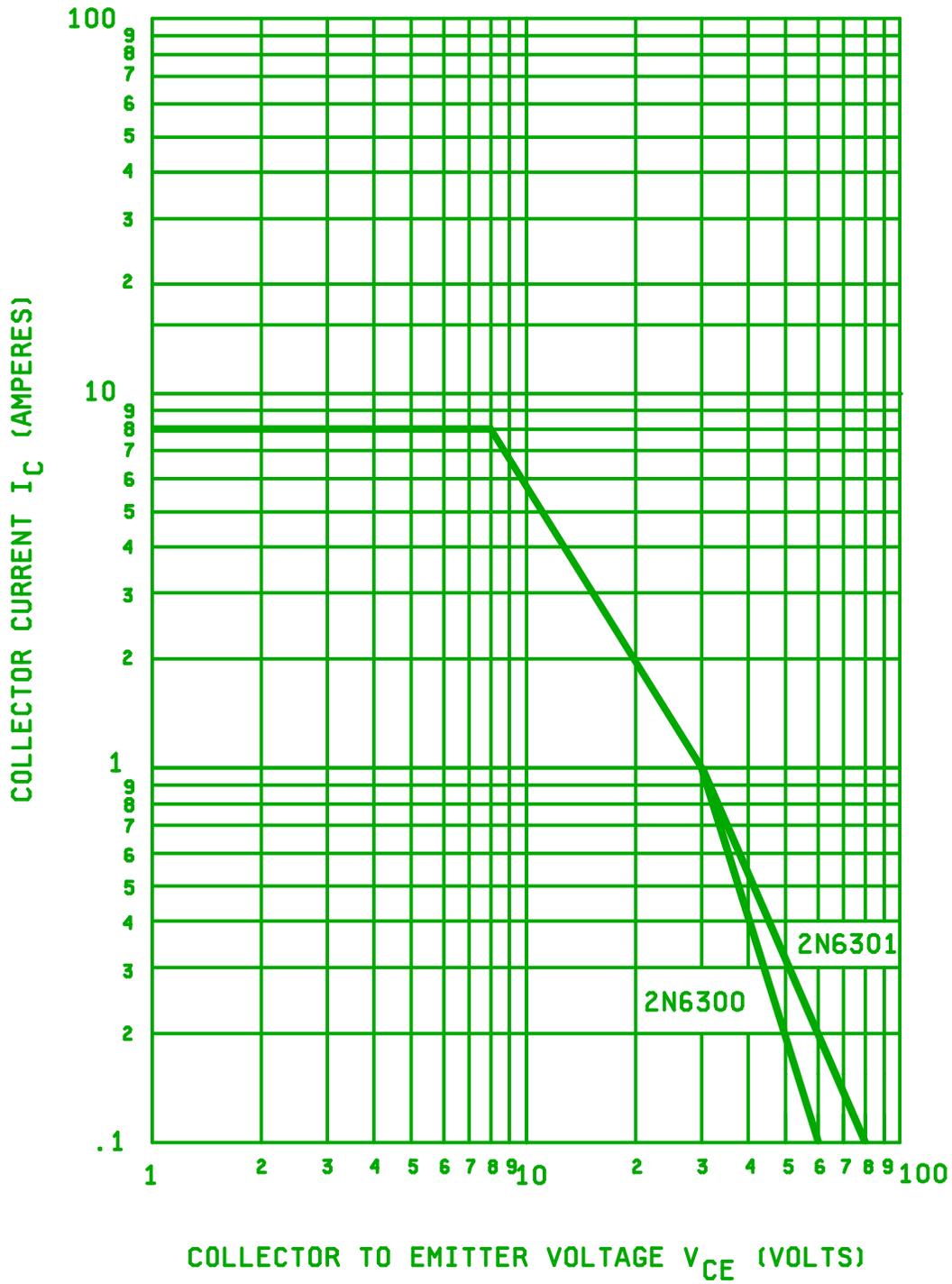


FIGURE 4. Maximum safe operating graph (dc).

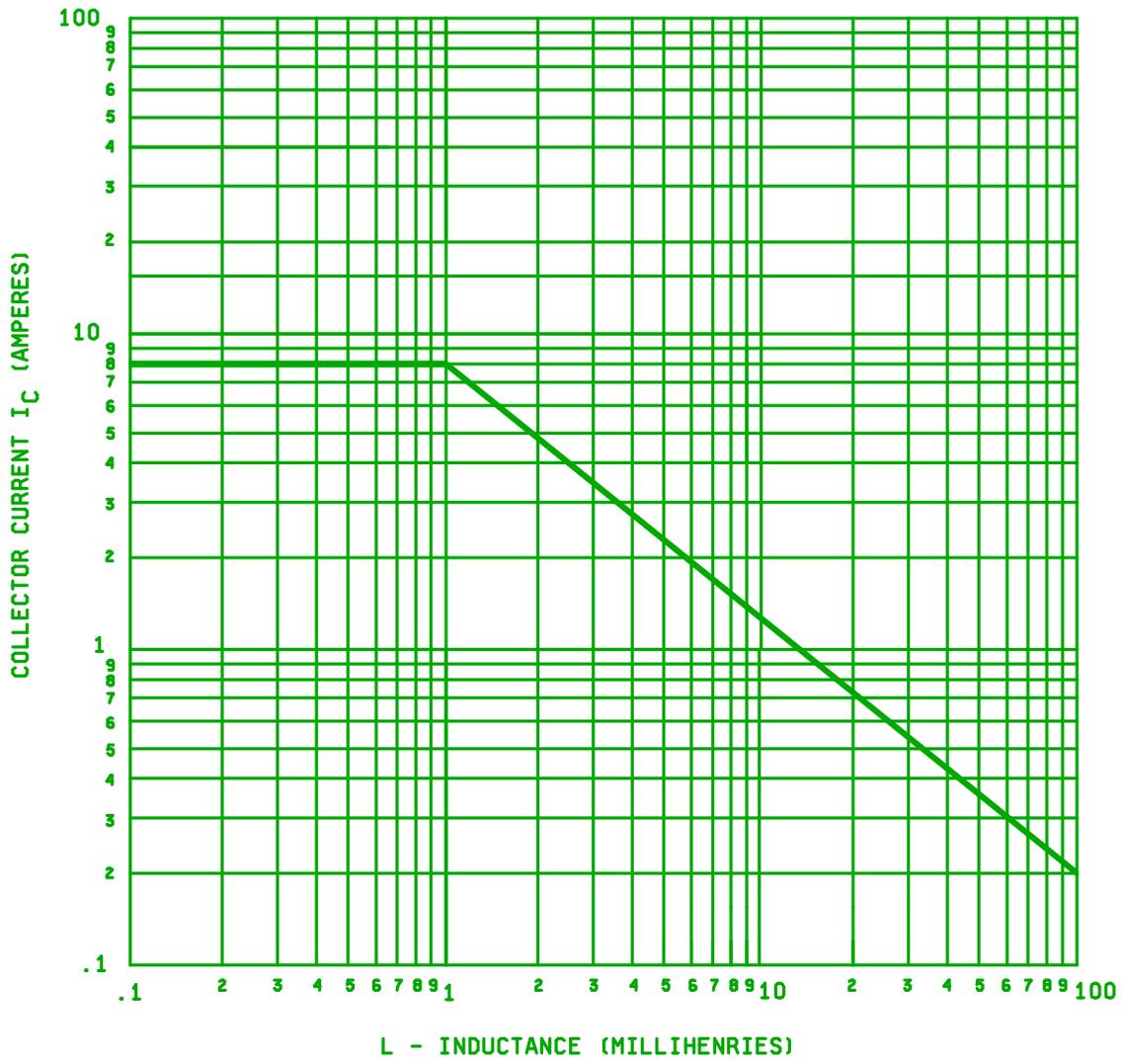


FIGURE 5. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. 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.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-STD-129.

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. See MIL- PRF-19500.

6.3 Substitution of JAN devices. JANTX quality level devices are a oneway direct substitute for JAN quality level devices (example JANTX2N6300 for JAN2N6300). Manufacturers can no longer manufacture device types from this specification with a JAN assurance level.

6.4 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 Products List QPL No.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 : Commander, Defense Supply Center Columbus, ATTN: DSCC-VQE, 3990 East Broad Street, Columbus, OH 43216-5000.

6.5 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.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - EC
Air Force - 17
NASA -NA

Preparing activity:
DLA CC

(Project 5961-1883)

Review activities:
Air Force - 19, 80, 85,99

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.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-PRF-19500/539B	2. DOCUMENT DATE (YYMMDD) 970615
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, NPN, SILICON, POWER TYPES 2N6300, 2N6301 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) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME Alan Barone		b. TELEPHONE (Include Area Code) (1) Commercial (614) 692-0510 (2) AUTOVON 850-0510	
c. ADDRESS (Include Zip Code) : Commander, Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	