

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

INCH-POUND

MIL-PRF-19500/540B  
 15 June 1997  
 SUPERSEDING  
 MIL-S-19500/540A  
 19 August 1994

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP SILICON, POWER  
 TYPE 2N6298, 2N6299 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 PNP, Darlington, silicon, power transistors. Three levels of product assurance is provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See 3.3 (similar to T0-66).

1.3 Maximum ratings.

Type	P <sub>T</sub> <sup>1/</sup>		V <sub>CB0</sub>	V <sub>CEO</sub>	V <sub>EBO</sub>	I <sub>C</sub>	I <sub>B</sub>	T <sub>OP</sub> and T <sub>STG</sub>
	T <sub>C</sub> = 0°C	T <sub>C</sub> = 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>
2N6298	75	32	60	60	5	8	120	-65 to +175
2N6299	75	32	80	80	5	8	120	-65 to +175

<sup>1/</sup> Derate linearly at 0.428 W/°C above T<sub>C</sub> > 0°C.

1.4 Primary electrical characteristics.

	h <sub>FE2</sub> <sup>1/</sup>	h <sub>FE3</sub> <sup>1/</sup>	h <sub>fe</sub>   V <sub>CE</sub> = 3 V dc	C <sub>obo</sub> 100 kHz ≤ f ≤ 1 MHz	Pulse response		V <sub>BE(sat)</sub>	V <sub>CE(sat)</sub> <sup>2</sup>	h <sub>fe</sub> V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 3 A dc f = 1 kHz	R <sub>θJC</sub>
	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 4 A dc	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 8 A dc	I <sub>C</sub> = 3 A dc f = 1 MHz	V <sub>CB</sub> = 10 V dc I <sub>E</sub> = 0	t <sub>on</sub>	t <sub>off</sub>	I <sub>C</sub> = 8 A dc I <sub>B</sub> = 80 mA dc <sup>1/</sup>	I <sub>C</sub> = 8 A dc I <sub>B</sub> = 80 mA dc <sup>1/</sup>		°C/W
Min	750	100	25	pF	μs	μs	<u>V dc</u>	<u>V dc</u>	300	
Max	18,000		350	200	2.0	8.0				2.33

<sup>1/</sup> Pulsed (see 4.5.1).

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.

AMSC N/A

FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

## 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 6.3).

3.2 Associated 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 shall be as specified in figure 1, (similar to TO-66).

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

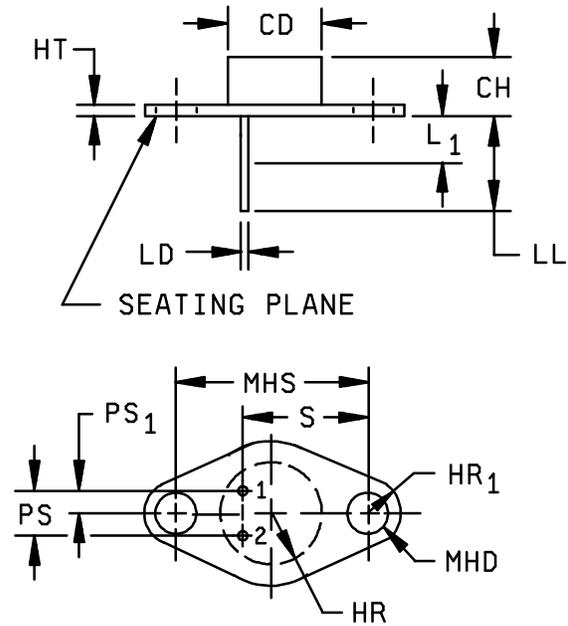
3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.6 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (similar to TO-65).

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

3.8 Electrical test requirements. The electrical test requirements shall be the subgroup specified in 4.4.2 and 4.4.3.

Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max	
CD		.620		15.76	
CH	.250	.340	6.35	8.64	
HR		.350		8.89	
HT	.050	.075	1.27	1.91	
HR <sub>1</sub>	.115	.145	2.92	3.68	4
LD	.028	.034	.71	.86	4, 6
LL	.360	.500	9.14	12.70	
L <sub>1</sub>		.050		1.27	6
MHD	.142	.152	3.61	3.86	4
MHS	.958	.962	24.33	24.43	
PS	.190	.210	4.83	5.33	3
PS <sub>1</sub>	.093	.107	2.36	2.73	3
S	.570	.590	14.48	14.99	
Notes	1, 2, 5, 7				



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. These dimensions should be measured at points .050 inch (1.27 mm) +.005 inch (0.13 mm) -.000 inch (0.00 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
4. Two places.
5. The seating plane of the header shall be flat within .001 inch (0.03 mm) concave to .004 inch (0.10 mm) convex inside a .930 inch (23.62 mm) diameter circle on the center of the header and flat within .001 inch (0.03 mm) concave to .006 inch (0.15 mm) convex overall.
6. Lead diameter shall not exceed twice LD within L<sub>1</sub>.
7. Lead number 1 is the emitter, lead 2 is the base, case is the collector
8. In accordance with ANSI Y14.5M, diameters are equivalent to Nx symbology.

FIGURE 1. Physical dimensions (similar to TO-66).

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.

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

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:  $V_{CE} \geq 10$  V dc;  $T_J = 162.5^\circ C \pm 12.5^\circ C$ .

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.

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

Subgroup	Method	Condition
B3	1037	$V_{CE} \geq 10$ V dc; $\Delta T_J$ between cycles $\geq 100^\circ C$ ; $t_{ON} = t_{OFF} = 3$ minutes for 2,000 cycles. No heat sink or forced-air cooling on the devices shall be permitted.

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) shall be in accordance with the table I, group A, subgroup 2 herein.

Subgroup	Method	Condition
C2	2036	Test condition A; weight = 10 pounds., time = 15 seconds.
C6	1037	$V_{CE} \geq 10$ V dc; $\Delta T_J$ between cycles $\geq 100^\circ\text{C}$ ; $t_{on} = t_{off} = 3$ minutes for 6,000 cycles. No heat sink or forced-air cooling on device shall be permitted.

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 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical evaluation	2071					
<u>Subgroup 2</u>						
Breakdown voltage, collector to emitter 2N6298 2N6299	3011	Bias condition D, $I_C = 100$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	60 80		V dc V dc
Collector to emitter cutoff current 2N6298 2N6299	3041	Bias condition A, $V_{BE} = 1.5$ V dc  $V_{CE} = 60$ V dc $V_{CE} = 80$ V dc	$I_{CEX1}$		0.5 0.5	mA dc mA dc
Collector to emitter cutoff current 2N6298 2N6299	3041	Bias condition D  $V_{CE} = 30$ V dc $V_{CE} = 40$ V dc	$I_{CEO}$		0.5 0.5	mA dc mA dc
Emitter to 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	18,000	
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; pulses (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 to emitter voltage (saturated)	3071	$I_C = 4$ A dc; $I_B = 16$ mA dc; pulsed, (see 4.5.1)	$V_{BE(sat)1}$		2.0	V dc

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 Collector to emitter voltage (saturated)	3071	$I_C = 8A$ dc; $I_B = 80$ mA dc; pulsed, (see 4.5.1)	$V_{CE(sat)2}$		3.0	V dc
<u>Subgroup 3</u> High temperature operation: Collector to emitter cutoff current 2N6298 2N6299 Low temperature operation: Forward-current transfer ratio	304    3076	$T_A = +150^\circ C$ Bias condition A, $V_{BE} = 1.5$ V dc $V_{CE} = 60$ V dc $V_{CE} = 80$ V dc $T_A = -55^\circ C$ $V_{CE} = 3$ V dc; $I_C = 4$ A dc; pulsed (see 4.5.1)	$I_{CEX2}$    $h_{FE4}$		5.0 5.0	mA dc mA dc
<u>Subgroup 4</u> Small-signal short-circuit forward current transfer ratio Magnitude of small-signal short-circuit forward-current transfer ratio Pulse response Turn-on time Turn-off time Open circuit output capacitance	3206  3306    3236	$V_{CE} = 3$ V dc; $I_C = 3$ A dc; $f = 1$ kHz $V_{CE} = 3$ V dc; $I_C = 3$ A dc; $f = 1.0$ MHz See figure 1; $V_{CC} = 30$ V dc; $I_C = 4$ A dc; $I_{B1} = 16$ mA dc See figure 1; $V_{CC} = 30$ V dc; $I_C = 4$ A dc; $I_{B1} = 16$ mA dc $V_{CB} = 10$ V dc; $I_E = 0$ ; $100$ kHz $\leq f \leq 1$ MHz	$h_{fe}$  $ h_{fe} $  $t_{on}$  $t_{off}$  $C_{obo}$	300  25	350  2.0 8.0 200	    $\mu s$  $\mu s$  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 (dc)	3051	$T_C = 25^\circ\text{C} + 10^\circ\text{C}$ , $t = 1$ s; 1 cycle; see figure 3				
Test 1		$V_{CE} = 8$ V dc; $I_C = 8$ A dc				
Test 2		$V_{CE} = 20$ V dc; $I_C = 2.0$ A dc				
Test 3		$I_C = 100$ mA dc				
2N6298 2N6299		$V_{CE} = 60$ V dc $V_{CE} = 80$ 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 $\leq 10$ percent, $t_p = 1$ ms; (vary to obtain $I_C$ ); $R_S = 0.1$ ohms; $R_{BB1} = 80$ ohms; $V_{BB1} = 16$ V dc; $R_{BB2} = 100$ ohms; $V_{BB2} = 1.5$ V dc; $V_{CC} = 50$ V dc; $I_C = 8$ A dc; $R_L \leq 2$ ohms; $L = 1$ mH; clamp voltage				
2N6298 2N6299		60 V dc 80 V dc				
Safe operation area (switching)	3053	Load condition C; (unclamped inductive load) See figure 4, $T_A = 25^\circ\text{C}$ ; duty cycle $\leq 10$ percent $R_S = 0.1$ ohms				
Test 1		$t_p = 1$ ms; (vary to obtain $I_C$ ); $R_{BB1} = 80$ ohms; $V_{BB1} \geq 12$ V dc; $R_{BB2} = \infty$ ; $V_{CC} \geq 30$ V dc; $I_C = 8$ A dc; $R_L \leq 0.5$ ohms; $L = 1$ mH at 8 A dc				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <sup>1/</sup>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> - Continued						
Test 2		$t_p = 1 \text{ ms}$ ; (vary to obtain $I_C$ ); $R_{BB1} = 80 \text{ ohms}$ ; $V_{BB1} \geq 12 \text{ V dc}$ ; $R_{BB2} = \infty$ ; $V_{BB2} = 0 \text{ V dc}$ ; $V_{CC} = 30 \text{ V dc}$ ; $I_C = 0.2 \text{ A dc}$ ; $R_L \leq 0.5 \text{ ohms}$ ; $L = 100 \text{ mH}$ ; at $0.2 \text{ A dc}$				
End point electrical measurements						
Collector to emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5 \text{ V dc}$	$I_{CEX1}$			
2N6298		$V_{CE} = 60 \text{ V dc}$			0.5	mA dc
2N6299		$V_{CE} = 60 \text{ V dc}$			0.5	mA dc
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	18,000	

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

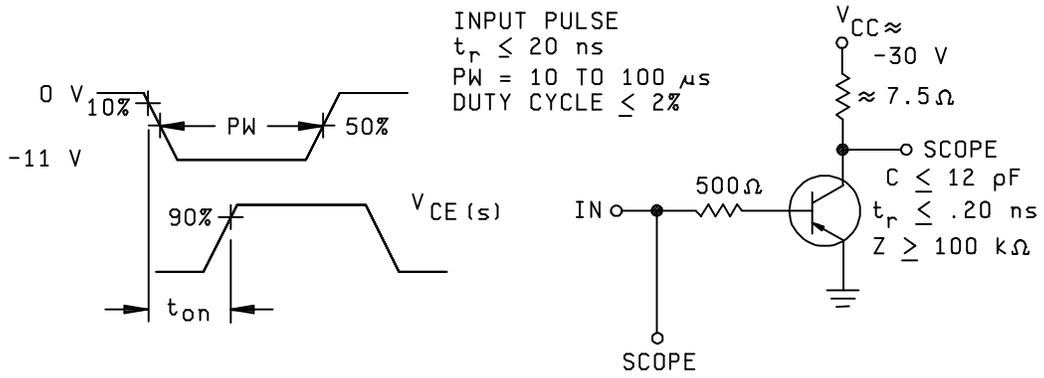


FIGURE 2. Turn-on time test circuit.

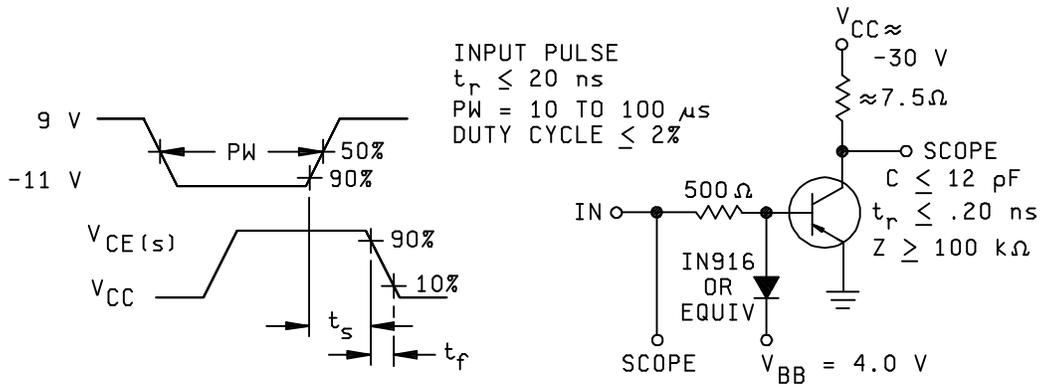


FIGURE 3. Turn-off time test circuit.

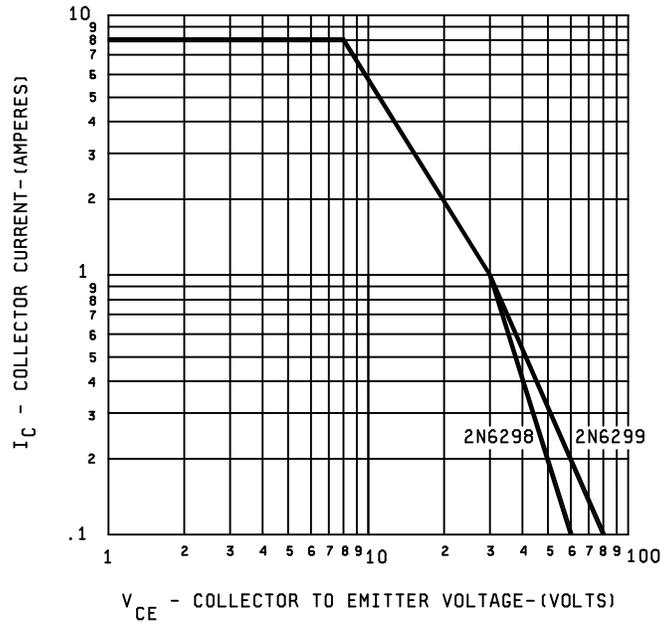


FIGURE 4. Maximum safe operating graph (dc).

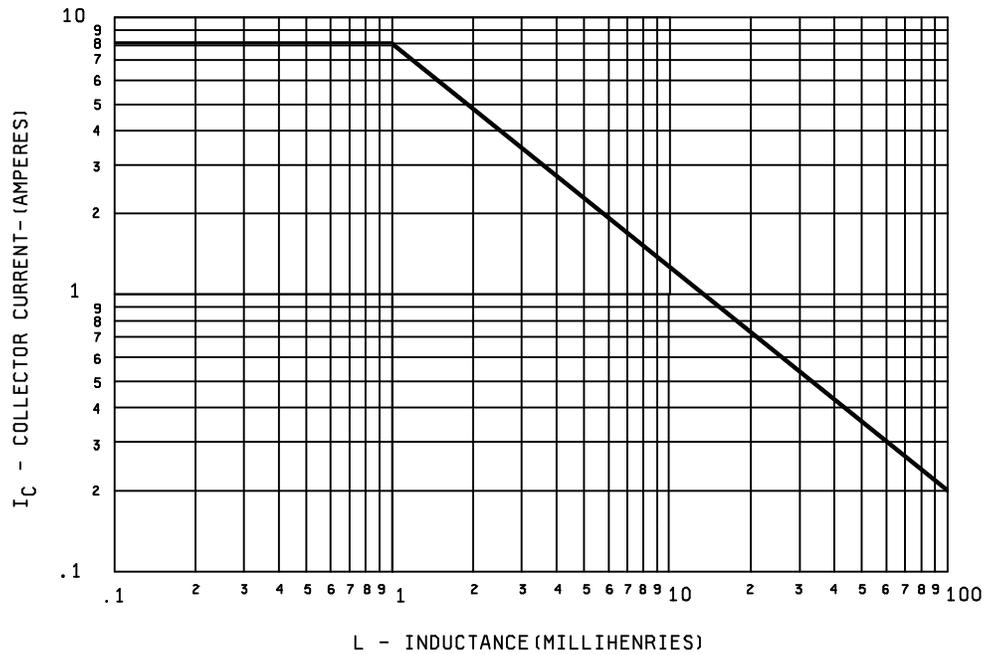


FIGURE 5. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or purchase 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.

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 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.

6.4 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.

Custodian:  
Air Force - 17

Preparing activity:  
DLA - CC

Review activities:  
Air Force - 19, 85, 99

(Project 5961-1871)

**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-19500/540B

**2. DOCUMENT DATE (YYMMDD)**  
970615

**3. DOCUMENT TITLE**

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP SILICON, POWER TYPES 2N6298 AND 2N6299, 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)

**7. DATE SUBMITTED**  
(YYMMDD)

- (1) Commercial
- (2) AUTOVON  
(If applicable)

**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)  
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