The documentation and process conversion measures necessary to comply with this revision shall be completed by 6 January 1994

INCH-POUND

MIL-S-19500/505A(USAF)
6 October 1993
SUPERSEDING
MIL-S-19500/505(USAF)
16 October 1975

MILITARY SPECIFICATION
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER
TYPE 2N6286, 2N6287, JANTX, AND JANTXV

This specification is approved for use by the Department of the Air Force and is available to all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP, Darlington, silicon, power transistors. Two levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See 3.3 (similar to TO-3).

1.3 Maximum ratings.

Type	P_T 1/		V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	Top and T_{STG}
	T_C = +25°C	T_C = +100°C						
	W	W	V dc	V dc	V dc	A dc	A dc	°C
2N6286	175	87.5	-80	-80	-7	-20	-0.5	-65 to +175
2N6287	175	87.5	-100	-100	-7	-20	-0.5	-65 to +175

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

1.4 Primary electrical characteristics.

	h_{FE2} 1/	h_{FE3} 1/	$V_{CE(sat)1}$	$V_{CE(sat)2}$	$V_{BE(sat)}$	Switching	
	V_{CE} = -3 V dc I_C = -10 A dc	V_{CE} = -3 V dc I_C = -20 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}
			V dc	V dc	V dc	µs	µs
Min	1,250	300					
Max	18,000		-3.0	-2.0	-4.0	2	10

	C_{obo} V_{CB} = -10 V dc I_E = 0 100 kHz ≤ f ≤ 1 MHz	$R_{\theta JC}$	h_{fe} V_{CE} = -3 V dc I_C = -10 A dc f = 1 MHz	$\lvert h_{fe} \rvert$ V_{CE} = -3 V dc I_C = -10 A dc f = 1 MHz
	pF	°C/W		
Min			700	8
Max	300	.857		80

1/ 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 Electronics Supply Center, ATTN: DESC-ES, 1507 Wilmington Pike, Dayton, OH 45444-5270 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 Government documents.

2.1.1 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

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. 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.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

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

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 appendix F, figure 11, T-4A (similar to TO-3).

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500.

3.4 Marking. Marking shall be in accordance with MIL-S-19500. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

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

4.3 Screening (JANTX and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500)	Measurements
	JANTX and JANTXV levels
11	I_{CEX1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein; I_{CEX1} = 100 percent of initial value or -100 µA dc, whichever is greater. Δh_{FE1} = ±40 percent of initial value.

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

T_J = +162.5°C ±12.5°C, V_{CE} ≥ -10 V dc.

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

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-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 table IVb (JANTX and JANTXV) of MIL-S-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

Subgroup	Method	Condition
B3	1037	V_{CB} ≥ -10 V dc; ΔT_J between cycles ≥ +100°C. T_{on} = T_{off} = 3 minutes minimum 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 table V of MIL-S-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

Subgroup	Method	Condition
C2	2036	Tension: test condition A; weight = 10 lbs; time = 15 s.
C6	1037	V_{CB} ≥ -10 V dc; ΔT_J between cycles ≥ +100°C. T_{on} = T_{off} = 3 minutes minimum 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	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, collector - emitter	3011	Bias condition D; I_C = -100 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6286				-80		V dc
2N6287				-100		V dc
Collector - emitter cutoff current	3041	Bias condition A; V_{BE} = +1.5 V dc	I_{CEX1}		-0.5	mA dc
2N6286		V_{CE} = -80 V dc				
2N6287		V_{CE} = -100 V dc				
Collector - emitter cutoff current	3041	Bias condition D	I_{CEO}		-1.0	mA dc
2N6286		V_{CE} = -40 V dc				
2N6287		V_{CE} = -50 V dc				
Emitter - base cutoff current	3061	Bias condition D; V_{EB} = -7 V dc	I_{EBO}		-2.5	mA dc
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	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued.						
Forward-current transfer ratio	3076	V_{CE} = -3 V dc; I_C = -20 A dc; pulsed (see 4.5.1)	h_{FE3}	300		
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector - emitter cutoff current 2N6286 2N6287	3041	Bias condition A; V_{BE} = +1.5 V dc; V_{CE} = -80 V dc V_{CE} = -100 V dc	I_{CEX2}		-5.0	mA dc
Collector - emitter saturated voltage	3071	I_C = -10 A dc; I_B = -40 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)3}$		-2.0	V dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = -3 V dc; I_C = -10 A dc; pulsed (see 4.5.1)	h_{FE4}	150		
Subgroup 4						
Pulse response						
Turn-on time		V_{CC} = -30 V dc; I_C = -10 A dc; I_B = -40 mA dc; (see figure 1)	t_{on}		2.0	µs
Turn-off time		V_{CC} = -30 V dc; I_C = -10 A dc; I_{B1} = I_{B2} = -40 mA dc; (see figure 1)	t_{off}		10	µs
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = -3 V dc; I_C = -10 A dc; f = 1.0 MHz	$\|h_{fe}\|$	8	80	
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = -3 V dc; I_C = -10 A dc	h_{fe}	300		
Open circuit output capacitance	3236	V_{CB} = -10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		300	pF

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area continuous (dc)	3051	T_C = +25°C; t = 1 s; 1 cycle; (see figure 2)				
Test 1		V_{CE} = -8.75 V dc; I_C = -20 A dc				
Test 2		V_{CE} = -30 V dc; I_C = -5.8 A dc				
Test 3						
2N6286		V_{CE} = -80 V dc; I_C = -100 mA dc				
2N6287		V_{CE} = -100 V dc; I_C = -100 mA dc				
Electrical measurements		See table II, steps 1 and 2				
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load); (see figure 3); T_A = +25°C; $R_s \leq 0.1\ \Omega$; $t_r + t_f \leq 15$ ns; duty cycle ≤2 percent				
Test 1		t_p = 80 µs; (vary to obtain I_C); $R_{B81} \geq 50\ \Omega$; $V_{B81} \geq -10$ V dc; $R_{B82} = \infty$; $V_{B82} = 0$; I_C = -20 A dc; $V_{CC} \geq -50$ 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)).				
Test 2		t_p = 1 ms; (vary to obtain I_C); $R_{B81} \geq 50\ \Omega$; $V_{B81} \geq -10$ V dc; $R_{B82} = \infty$; $V_{B82} = 0$; I_C = -500 mA dc; $V_{CC} \geq -50$ 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 (Triad C-48u or equivalent)).				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued.						
Electrical measurements		See table II, steps 1 and 2				
Safe operating area (switching)	3053	Load condition B; (clamped inductive load); T_A = +25°C; R_s = 0.1 Ω; $t_r + t_f \leq 1.0$ µs; duty cycle ≤ 2 percent; t_p = 1 ms (vary to obtain I_C); R_{BB1} = 50 Ω; V_{BB1} = -10 V dc; R_{BB2} = 100 Ω; V_{BB2} = +1.5 V dc; V_{CC} = -25 V dc; I_C = -20 A dc; $R_L \leq 2$ Ω; L = 5 mH; (Four coils in parallel, 20 mH windings (Triad C-48u or equivalent)).				
2N6286		Clamp voltage = 80 +0, -5 V dc				
2N6287		Clamp voltage = 100 +0, -5 V dc Device fails if clamp voltage not reached				
Electrical measurements		See table II, steps 1 and 2				
Subgroups 6 and 7						
Not applicable						

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

TABLE II. Groups B and C electrical measurements. 1/ 2/

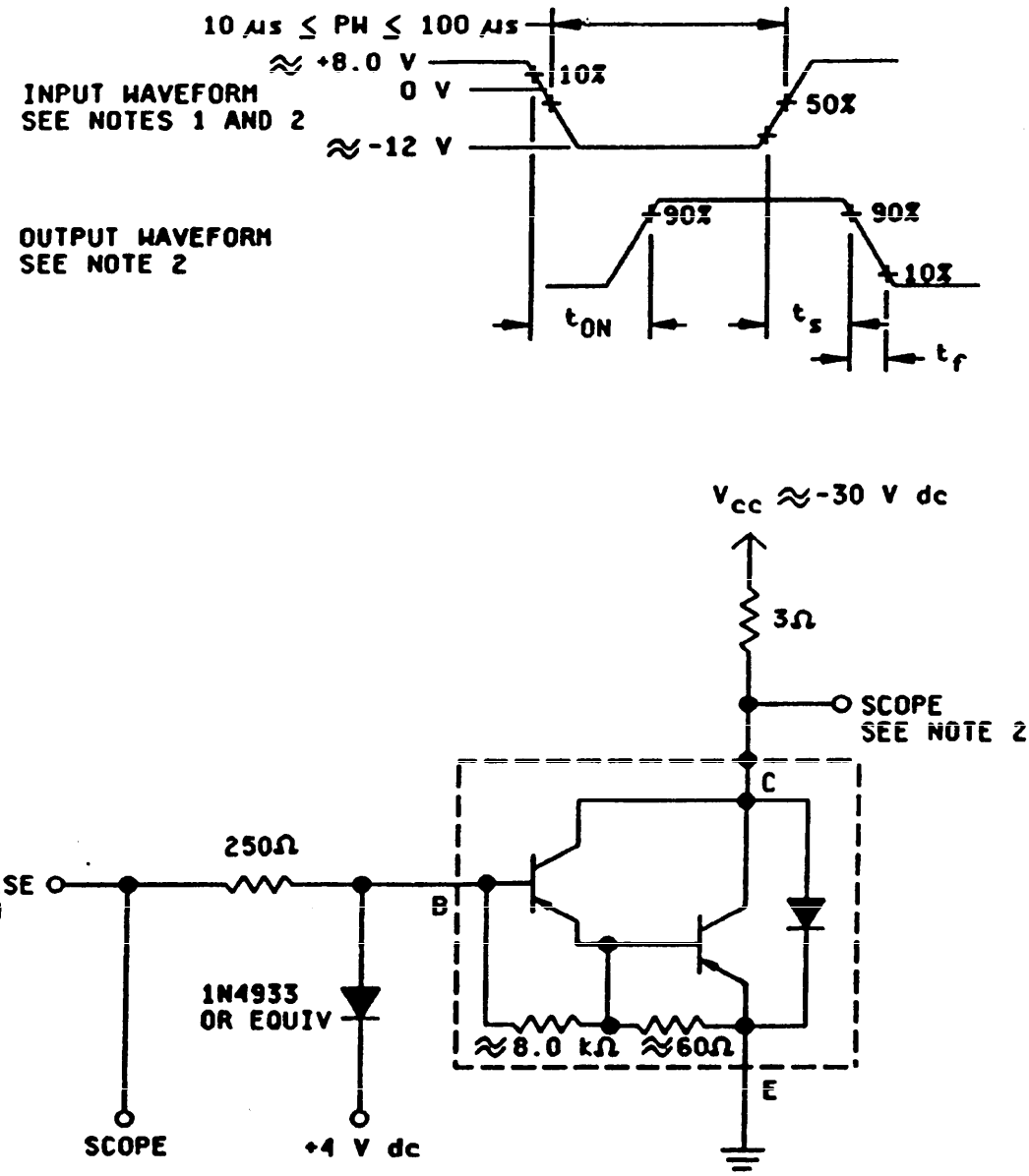
Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current 2N6286 2N6287	3041	Bias condition A; V_{BE} = +1.5 V dc; V_{CE} = -80 V dc V_{CE} = -100 V dc	I_{CEX1}		-0.5	mA dc
2.	Forward-current transfer ratio	3076	V_{CE} = -3 V dc; I_C = -10 A dc; pulsed (see 4.5.1)	h_{FE2}	1,250	18,000	

1/ The electrical measurements for table IVb (JANTX and JANTXV) of MIL-S-19500 are as follows:

Subgroups 2, 3, and 6, see table II herein, steps 1 and 2.

2/ The electrical measurements for table V of MIL-S-19500 are as follows:

Subgroups 3 and 6, see table II herein, steps 1 and 2.



NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $Z_{out} = 50\ \Omega$, PW = 23 µs, duty cycle ≤ 2 percent.
2. The output waveform is monitored on a sampling oscilloscope with $Z_{in} \geq 20$ MΩ, $C_{in} \leq 11.5$ pF, $t_r \leq 2$ ns.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 1. Pulse response test circuit.

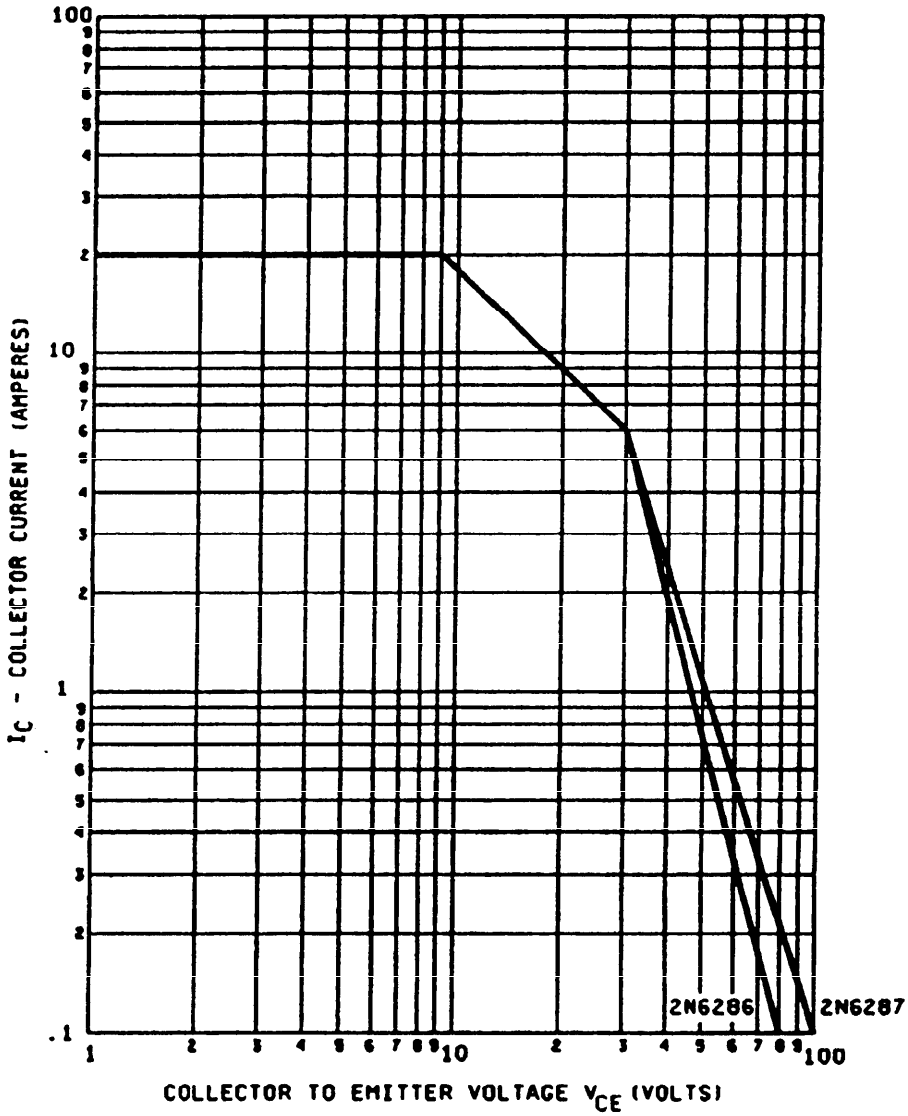


FIGURE 2. Maximum safe operating area (continuous dc).

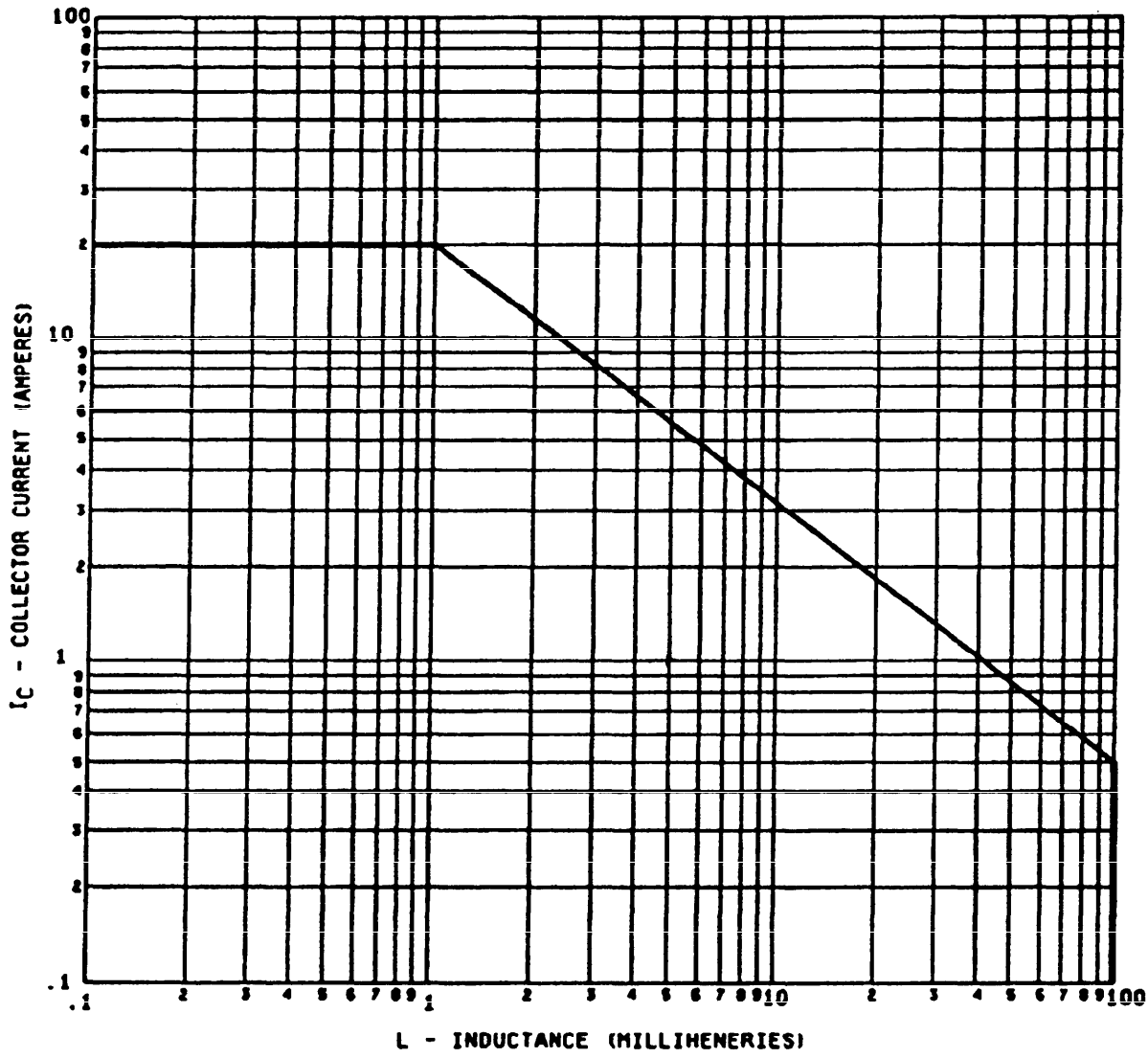


FIGURE 3. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

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-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

b. Type designation and product assurance level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodian:
Air Force - 17

Review activities:
Air Force - 19, 85, 99
DLA - ES

Preparing activity:
Air Force - 17

(Project 5961-F041)

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.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/505A(USAF)	2. DOCUMENT DATE (YYMMDD) 93/10/06

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER
TYPE 2N6286, 2N6287, 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 (Include Zip Code)	6b. 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 513-296-6048	(2) AUTOVON 986-6048
c. ADDRESS (Include Zip Code) DESC-ECT Dayton, OH 45444-5270	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	