The documentation and process conversion measures necessary to comply with this revision shall be completed by 15 June 1993.

INCH-POUND

MIL-S-19500/515B
15 March 1993
SUPERSEDING
MIL-S-19500/515A
1 April 1992

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON POWER
TYPE 2N6378, 2N6379, JANTX, JANTXV, AND JANC

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 detail requirements for PNP silicon, power transistors. Three levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See 3.3 and figure 1 (JANC).

1.3 Maximum ratings. T_C = +25°C, unless otherwise specified.

	P_T 1/ T_C = +25°C	P_T 1/ T_C = +100°C	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_{OP} and T_{STG}	$R_{\theta JC}$
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N6378	250	143	120	100	6	20	50	-65 to +200	0.7
2N6379	250	143	140	120	6	20	50	-65 to +200	0.7

1/ Between T_C = +25°C and T_C = +200°C, linear derating factor (average) = 1.43 W/°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Research Laboratory, ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5601, 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

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1.4 Primary electrical characteristics. T_C = +25°C, unless otherwise specified.

	h_{FE3} 1/		h_{FE2} 1/		$V_{BE(SAT)}$ 1/		$V_{CE(SAT)}$ 1/		C_{obo}		$\|h_{fe}\|$		Pulse response	
	V_{CE} = 4 V dc, I_C = 50 A dc		V_{CE} = 4 V dc, I_C = 20 A dc		I_C = 20 A dc, I_B = 2 A dc		I_C = 20 A dc, I_B = 2 A dc		.1 MHz ≤ f ≤ 1 MHz, V_{CB} = 10 V dc, I_E = 0		f = 10 MHz, I_C = 1 A dc, V_{CE} = 10 V dc		t_{on}	t_{off}
					V dc		V dc		pF				µs	µs
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Max	Max
2N6378	10		30	120		1.8		1.0		1500	3	12	0.5	1.05
2N6379	10		30	120		1.8		1.0		1500	3	12	0.5	1.05

1/ Pulsed (see 4.5.1).

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.

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 shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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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 and figure 1 herein.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-S-19500, and herein. Where a choice of lead finish is desired, it shall be specified in the contract or purchase order (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-S-19500, except at the option of the manufacturer, the marking of the country of origin may be omitted from the body of the device.

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.

4.2.1 JANC devices. JANC devices are qualified in accordance with appendix H of MIL-S-19500.

4.3 Screening (JANTX and JANTXV levels only). Screening shall be in accordance with MIL-S-19500 (table II), 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)	Measurement JANTX and JANTXV levels
1/	Thermal response (see 4.3.3) or SOA manufacturers option.
11	h_{FE2} and I_{CEX}
12	Burn-in (see 4.3.2), MIL-STD-750, method 1039, test condition B
13	Subgroup 2 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 2 μA dc; whichever is greater. Δh_{FE2} = ±25 percent

1/ This test shall be performed anytime between screens 3 and 9.

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4.3.1 Screening (JANC). Screening of JANC die shall be in accordance with MIL-S-19500, appendix H. As a minimum, die shall be 100 percent probed to insure the assembled chips will meet the requirements of Group A, subgroup 2.

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

T_J = 187.5°C ±12.5°C, $V_{CB} \geq 20$ V dc.

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

4.3.3 Thermal response (ΔV_{BE} measurements). The ΔV_{BE} measurements shall be performed in accordance with MIL-STD-750, method 3131. The ΔV_{BE} conditions (I_H and V_H) and maximum limit shall be derived by each vendor. The chosen V_{BE} measurement and conditions for each device in the qualification lot shall be submitted in the qualification report and a thermal response curve shall be plotted. The chosen ΔV_{BE} shall be considered final after the manufacturer has had the opportunity to test five consecutive lots. One hundred percent Safe Operating Area (SOA) testing may be performed in lieu of thermal response testing herein provided that the procedures, circuit and the appropriate conditions of temperature, time, current, and voltage to achieve die attach integrity are submitted to the qualifying activity. The following parameter measurements shall apply:

a. I_M measurement - - - - - - - - - - - - - - - - 20 mA.

b. V_{CE} measurement voltage - - - - - - - - - - - - 10 (same as V_H).

c. I_H collector heating current - - - - - - - - - 5 A (min).

d. V_H collector-emitter heating voltage - - - - 10 V (min).

e. t_H heating time - - - - - - - - - - - - - - - - 100 ms.

f. t_{MD} measurement delay time - - - - - - - - - - 50 to 80 µs (max).

g. t_{SW} sample window time - - - - - - - - - - - - 10 µs (max).

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. (End-point electrical measurements shall be in accordance with the applicable steps of table V 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) of MIL-S-19500. Electrical measurements (endpoints) and delta requirements shall be in accordance with the applicable steps of table II herein.

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

a. Subgroup 3, condition for Steady-state operation life are as follows:

T_J = +187.5°C ±12.5°C, $V_{CE} \geq 20$ V dc.

b. Subgroup 3, condition for Bond strength are as follows:

Test condition A, all internal leads for each device shall be pulled separately; LTPD = 20.

c. Subgroup 5, condition for Thermal resistance, see 4.5.2 herein.

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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 (endpoints) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

a. Subgroup 2, condition for Terminal strength are as follows:

Lead fatigue - Test condition A; weight = 10 pounds, t = 15 s.

b. Subgroup 6, condition for Steady-state operation life are as follows:

T_J = +187.5°C ±12.5°C, $V_{CE} \geq$ 20 V dc.

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

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

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

a. Collector current magnitude during power applications shall be 5 A dc.

b. Collector to emitter voltage magnitude shall be $\geq$ 10 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be 25°C $\leq T_R \leq$ 75°C and recorded before the test is started.

e. Mounting arrangement shall be with heat sink to header.

f. Maximum limit shall be $R_{\theta JC}$ = 0.7°C/W.

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 must specify the following:

a. Title, number, and date of the specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Lead finish (see 3.3.1).

d. For die acquisition, the JANC letter version shall be specified (see figure 1).

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TABLE I Group A inspection.

Inspection 1/	Method	MIL-STD-750 Conditions	Symbol	Limits Min	Limits Max	Unit
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Collector to emitter breakdown voltage	3011	Bias condition D; I_C = 50 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6378				100		V dc
2N6379				120		V dc
Collector to emitter cutoff current	3041	Bias condition D	I_{CEO}		50	µA dc
2N6378		V_{CE} = 50 V dc				
2N6379		V_{CE} = 70 V dc				
Collector to emitter cutoff current	3041	Bias condition A	I_{CEX1}		10	µA dc
2N6378		V_{BE} = 1.5 V dc; V_{CE} = 120 V dc				
2N6379		V_{CE} = 140 V dc				
Emitter to base voltage cutoff current	3061	Bias condition D; V_{EB} = 6 V dc	I_{EBO}		100	µA dc
Collector to base cutoff current	3036	Bias condition D	I_{CBO}		10	µA dc
2N6378		V_{CB} = 120 V dc				
2N6379		V_{CB} = 140 V dc				
Forward-current transfer ratio	3076	V_{CE} = 4 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	h_{FE1}	50		
Forward-current transfer ratio	3076	V_{CE} = 4 V dc; I_C = 20 A dc; pulsed (see 4.5.1)	h_{FE2}	30	120	
Forward-current transfer ratio	3076	V_{CE} = 4 V dc; I_C = 50 A dc; pulsed (see 4.5.1)	h_{FE3}	10		
Collector-emitter saturated voltage	3071	I_C = 20 A dc; I_B = 2.0 A dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		1.0	V dc
Collector-emitter saturated voltage	3071	I_C = 50 A dc; I_B = 10 A dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		3.0	V dc
Base-emitter saturated voltage	3066	Test condition A; I_C = 20 A dc; I_B = 2.0 A dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		1.8	V dc

See footnote at end of table.

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TABLE I. Group A inspection - Continued

Inspection 1/	Method	MIL-STD-750 Conditions	Symbol	Limits Min	Limits Max	Unit
Subgroup 3						
High temperature operation		T_A = +150°C				
Collector to emitter cutoff current 2N6378 2N6379	3041	Bias condition A; V_{BE} = 1.5 V dc V_{CE} = 120 V dc V_{CE} = 140 V dc	I_{CEX2}		1.0	mA dc
Low temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 4.0 V dc; I_C = 20 A dc; pulsed (see 4.5.1)	h_{FE4}	10		
Subgroup 4						
Pulse response:	3251	Test condition A, except test circuit and pulse requirements in accordance with figure 2 herein.				
Turn-on time		V_{CC} approximately 80 V dc; I_C = 20 A dc; I_{B1} = 2.0 A dc	t_{on}		0.5	µs
Turn-off time		V_{CC} approximately 80 V dc; I_C = 20 A dc; I_{B1} = I_{B2} = 2.0 A dc	t_{off}		1.05	µs
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc I_C = 1 A dc f = 10 MHz	$\|h_{fe}\|$	3	12	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 0.1 MHz ≤ f ≤ 1.0 MHz	C_{obo}		1500	pF
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +25°C; t = 1 s; 1 cycle; (see figure 3)				
Test 1 (both device types)		I_C = 50 A dc; V_{CE} = 5 V dc				
Test 2 (both device types)		I_C = 29 A dc; V_{CE} = 8.6 V dc				

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection 1/	Method	MIL-STD-750 Conditions	Symbol	Limits Min	Limits Max	Unit
Subgroup 5 - Continued						
Test 3						
2N6378		I_C = 165 mA dc; V_{CE} = 80 V dc				
2N6379		I_C = 130 mA dc; V_{CE} = 100 V dc				
Safe operating area (switching)	3053	Load condition C (unclamped inductive load) (see figure 4)				
		T_C = +25°C; duty cycle ≤ 10 percent; R_S = 0.1Ω; t_r = t_f ≤ 500 ns				
Test 1		t_p approximately 5 ms (vary to obtain I_C); R_{BB1} = 2Ω; V_{BB1} = 12 V dc; R_{BB2} = ∞; V_{BB2} = 0 V; V_{CC} = 50 V dc; I_C = 40 A dc; L = 100 μH (4 each Miller type 7827 in parallel, 40 A), 0.04 ohm, or equivalent)				
Test 2		t_p approximately 5 ms (vary to obtain I_C); R_{BB1} = 120Ω; V_{BB1} = 12 V dc; R_{BB2} = ∞; V_{BB2} = 0 V; V_{CC} = 50 V dc; I_C = 850 mA dc; L = 100 mH (= 80 + 20 mH 2 each Traid Transformer C-48u, in series), 0.713 ohm, or equivalent.				
Safe operating area (switching)		Clamped inductive load				
2N6378		T_A = +25°C; duty cycle ≤ 5 percent; t_p approximately 1.5 ms (vary to obtain I_C)				
2N6379		V_{CC} = 50 V dc, I_C = 50 A dc; V_{BB1} = 12 V, V_{BB2} = 1.5 V, R_{BB1} = 2Ω, R_{BB2} = 100Ω, R_S ≤ 0.1Ω, L = 370 μH (Miller 7827 or equivalent); clamp voltage = 100 V dc, clamp voltage = 120 V dc				
Electrical measurements		See table II, steps 1 and 5				

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

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TABLE II. Electrical end-point measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX1}			
	2N6378		V_{CE} = 120 V dc,			10	µA dc
	2N6379		V_{CE} = 140 V dc			10	µA dc
2.	Collector to emitter voltage (saturated)	3071	I_C = 20 A dc, I_B = 2.0 a dc, pulsed (see 4.5.1)	$V_{CE(SAT)1}$		1.0	V dc
3.	Base to emitter voltage (saturated)	3066	Test condition A, I_C = 20 A dc, I_B = 2.0 A dc, pulsed (see 4.5.1)	$V_{BE(SAT)}$		1.8	V dc
4.	Breakdown voltage collector to emitter		Bias condition D, I_C = 50 mA dc, pulsed (see 4.5.1)	$V_{(BR)CE}$			
	2N6378				100		V dc
	2N6379				120		V dc
5.	Forward current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 1 A dc, pulsed (see 4.5.1)	h_{FE1}	50		
6.	Forward current transfer ratio	3076	V_{CE} = 4 V dc, pulsed (see 4.5.1), I_C = 20 A dc	h_{FE2}	30	120	
7.	Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = +1.5 V dc	ΔI_{CEX1}	100 percent of initial value or 2 µA dc whichever is greater.		
	2N6378		V_{CE} = 60 V dc				
	2N6379		V_{CE} = 80 V dc				
8.	Forward current ratio	3076	V_{CE} = 4 V dc, I_C = 20 A dc, pulsed (see 4.5.1)	Δh_{FE2}	25 percent of change in initial recorded value.		
9.	Collector to emitter voltage (saturated)	3071	I_C = 2.0 A dc, I_B = 20 A dc, pulsed (see 4.5.1)	$V_{CE(SAT)1}$	±50 mV change from initial recorded value.		
10	Thermal response 3/	3131	See 4.3.3	ΔV_{BE}			

See footnotes at end of table.

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TABLE II. Electrical end-point meaasurements - Continued.

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

a. Subgroup 2, see table II herein, steps 1 and 3.
b. Subgroup 3, see table II herein, steps 1 and 2.
c. Subgroup 6, see table II herein, steps 1, 3, 6, 7, and 8.

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

a. Subgroups 2 and 3, see table II herein, steps 1 and 6 for all levels.
b. Subgroup 6, see table II herein, steps 1, 2, 3, 6, 7, 8, 9, and 10 for all levels.

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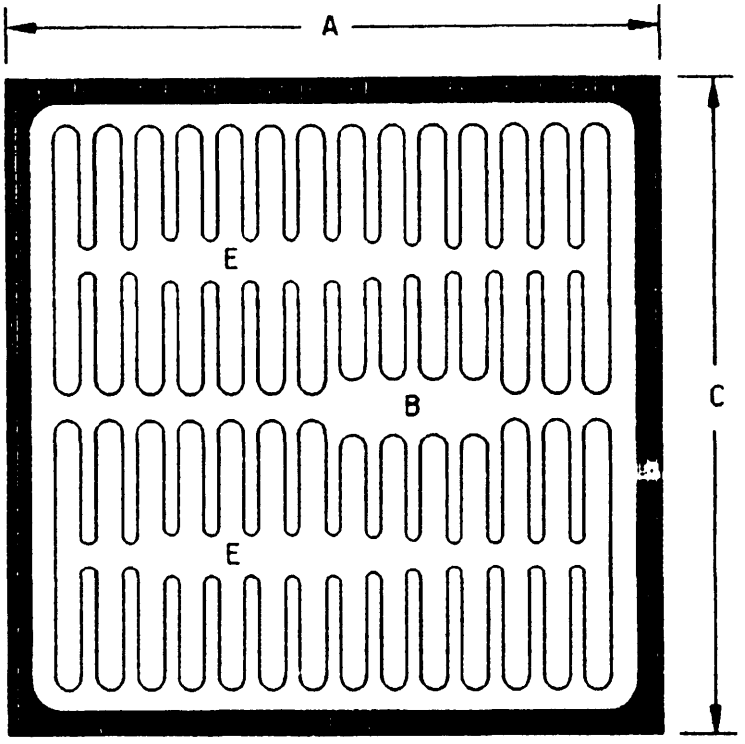

Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.231	.235	5.87	5.97
B	.231	.235	5.87	5.97

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.005 (0.13 mm).
4. The physical characteristics of the die are:
   Thickness: .008 (0.20 mm) to .012 (0.30 mm).
   Top metal: Aluminum 40,000 Å minimum, 50,000 Å nominal.
   Back metal: Gold 2,500 Å minimum, 3,000 Å nominal.
   Back side: Collector.
   Bonding pad: B = .016 (0.41 mm) x .060 (1.52 mm).
   E = .016 (0.41 mm) x .070 (1.78 mm).

FIGURE 1. Physical dimensions JANC die.

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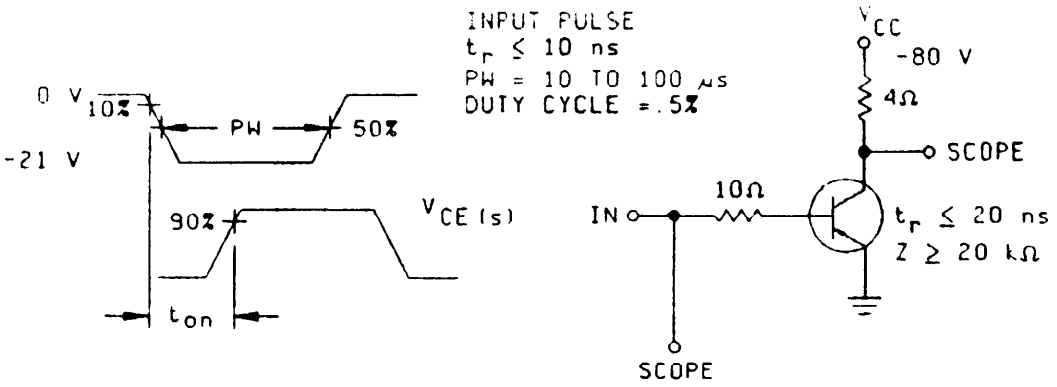
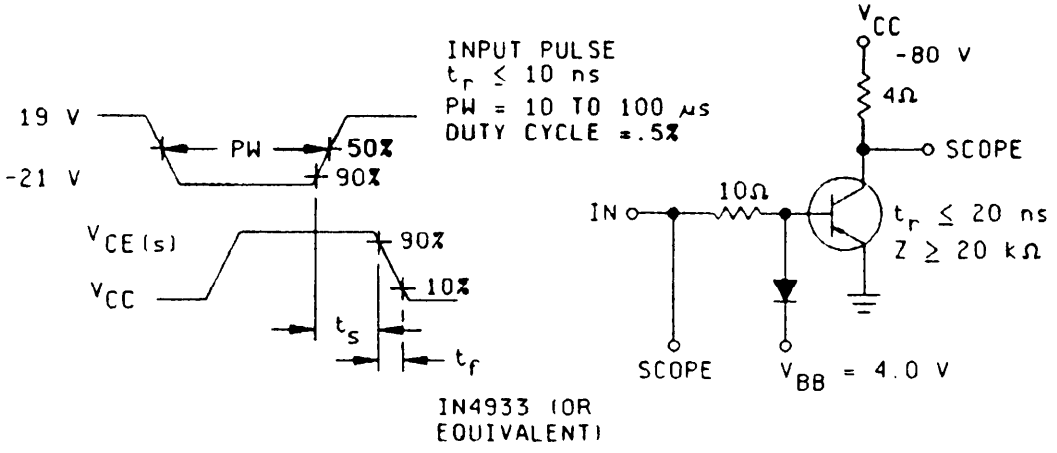


TURN-ON (t_{on}) TIME TEST CIRCUIT



TURN-OFF (t_{off}) TIME TEST CIRCUIT

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

FIGURE 2. Switching time test circuits.

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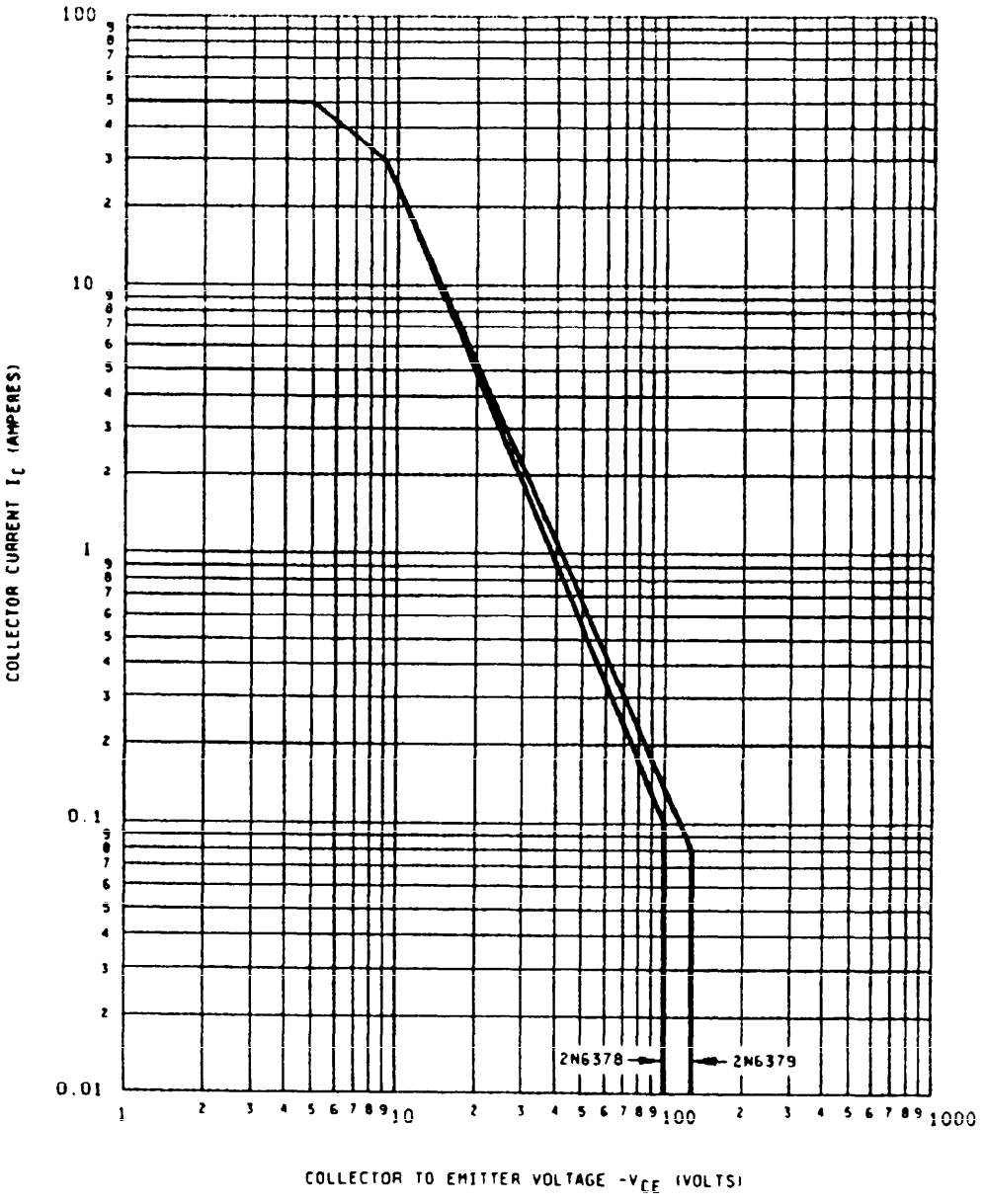

FIGURE 3. Maximum safe operating graph (continuous dc).

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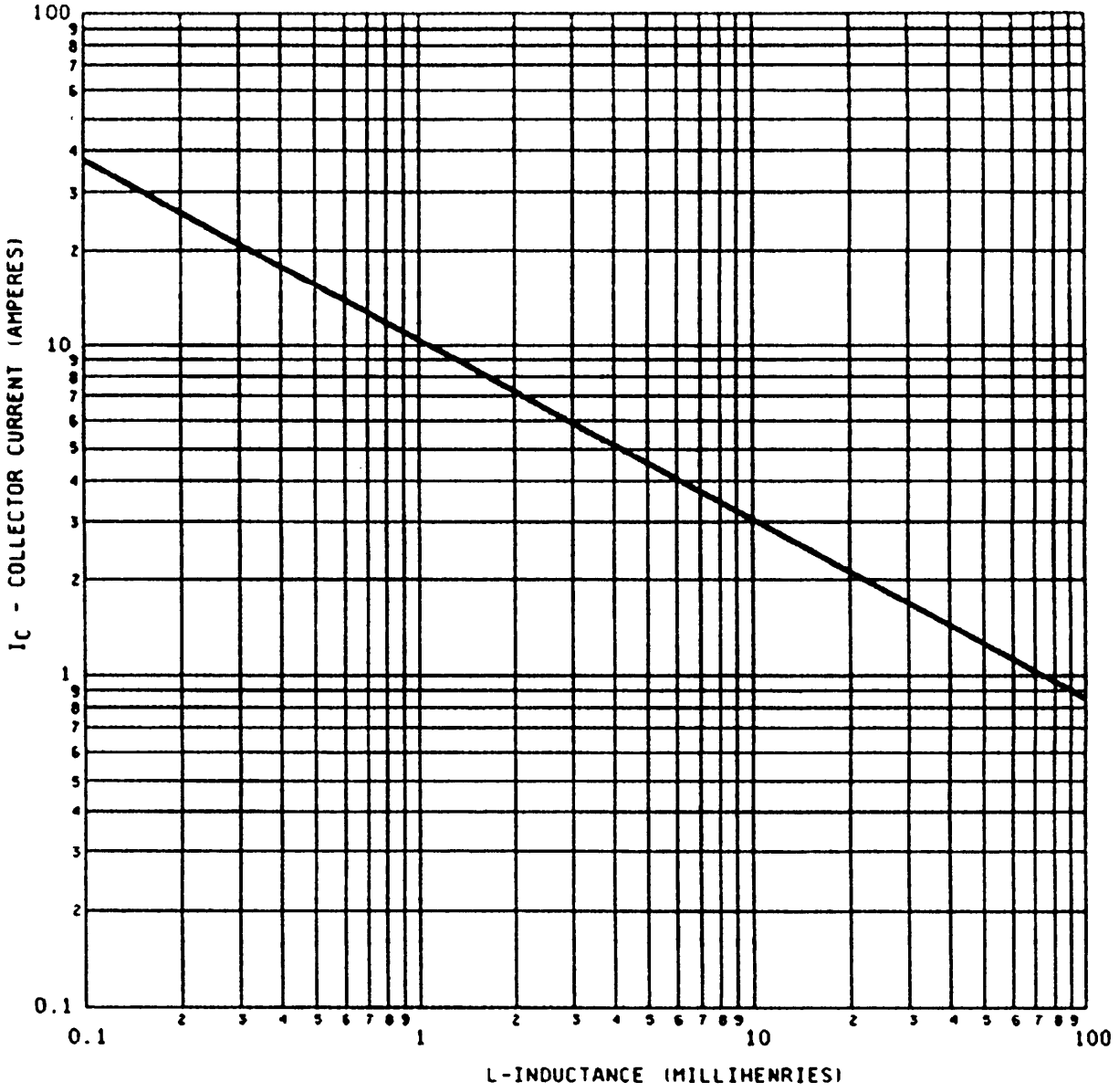

FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

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6.3 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PIN's are suitable as a substitute for the military PIN.

6.4 Suppliers of JANC die. The qualified JANC suppliers with the applicable letter version (example JANCA) will be identified on the QPL.

JANC ordering information		
	Manufacturer	
PIN	33178	
2N6378	A6378	
2N6379	A6379	

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 extensiveness of the changes.

CONCLUDING MATERIAL

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

Review activities:
Army - MI
Air Force - 85, 99

User activities:
Army - AV, SM
Navy - AS, CG, MC, SH
Air Force - 13, 15, 19

Preparing activity:
Army - ER

Agent:
DLA - ES

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