

The documentation process conversion measures necessary to comply with this revision shall be completed by 23 August 1997

INCH POUND

MIL-PRF-19500/501C  
23 May 1997  
SUPERSEDING  
MIL-S-19500/501B  
25 March 1995

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER  
TYPE 2N6051, 2N6052 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 are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-3).

1.3 Maximum ratings.

	P <sub>T</sub> 1/		V <sub>CBO</sub>	V <sub>CEO</sub>	V <sub>EBO</sub>	I <sub>C</sub>	I <sub>B</sub>	T <sub>p</sub> and T <sub>STG</sub>
	T <sub>C</sub> = +25°C	T <sub>C</sub> = +100°C						
	W	W	V dc	V dc	V dc	A dc	A dc	°C
2N6051	150	75	80	80	5	12	0.2	-55 to +175
2N6052	150	75	100	100	5	12	0.2	-55 to +175

1/ Derate linearly at 1.00 W/°C above T<sub>C</sub> > +25°C.

1.4 Primary electrical characteristics.

	h <sub>FE2</sub> 1/	h <sub>FE3</sub> 1/	h <sub>fe</sub>	h <sub>fe</sub>	C <sub>obo</sub>	Pulse response	
	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 6 A dc	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 12 A dc	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 5 A dc	V <sub>CE</sub> = 3 V dc I <sub>C</sub> = 5 A dc	100 kHz ≤ f ≤ 1 MHz	t <sub>on</sub>	t <sub>off</sub>
			f = 1 kHz	f = 1 MHz	V <sub>CB</sub> = 10 V dc, I <sub>E</sub> = 0	μs	μs
Min	1,000	150	1,000	10	pF		
Max	18,000			250	300	2	10

	V <sub>BE(sat)</sub>	V <sub>CE(sat)1</sub>	V <sub>CE(sat)2</sub>	R <sub>θJC</sub>
	I <sub>C</sub> = 12 A dc I <sub>B</sub> = 120 mA dc 1/	I <sub>C</sub> = 12 A dc I <sub>B</sub> = 120 mA dc 1/	I <sub>C</sub> = 6 A dc I <sub>B</sub> = 24 mA dc 1/	
	V dc	V dc	V dc	°C/W
Min				
Max	4.0	3.0	2.0	1.00

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/ 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 6.3).

3.2 Associated detail 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 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified on figure 1 herein

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

3.4 Marking. Marking shall be in accordance with 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).

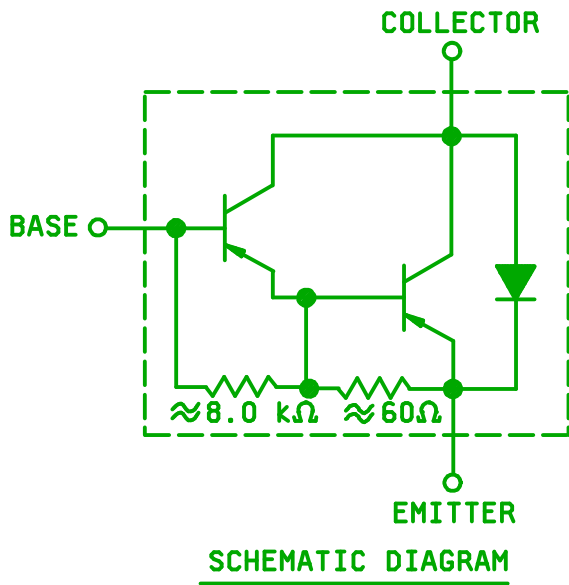
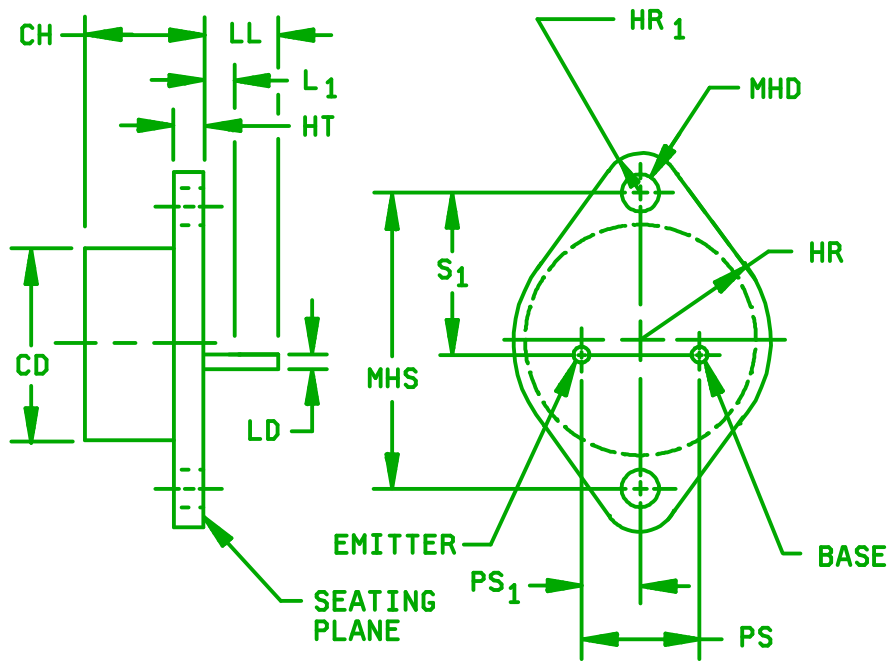


FIGURE 1. Physical dimensions and schematic circuit.

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Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.250	.328	6.35	8.33	
LD	.038	.043	0.97	1.09	5,9,11
CD		.875		22.23	3,11
PS	.420	.440	10.67	11.18	4, 10
PS <sub>1</sub>	.205	.225	5.21	5.72	4,5,10
HT	.060	.135	1.52	3.43	
LL	.312	.500	7.92	12.70	5
L <sub>1</sub>		.050		1.27	5, 9
MHD	.151	.161	3.84	4.09	7,11
MHS	1.177	1.197	29.90	30.40	
HR	.495	.525	12.57	13.34	
HR <sub>1</sub>	.131	.188	3.33	4.78	6
s <sub>1</sub>	.655	.675	16.64	17.15	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 .050 inch (1.27 mm) to .055 inch (1.40 mm) below the seating plane. When gauge is not used, measurement shall be made at 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 L<sub>1</sub> and LL. Diameter is uncontrolled in L<sub>1</sub>.
10. 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.
11. In accordance with ANSI Y14.5M, diameters are equivalent to Øx symbology.

FIGURE 1. Physical dimensions and schematic circuit - Continued.

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

4.3 Screening (JANTX and JANTXV levels 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 appendix E, table IV of MIL-PRF-19500)	Measurements
	JANTX and JANTXV levels
9	$I_{CEX1}$
11	$I_{CEX1}$ , $h_{FE2}$ ; $\Delta I_{CEX1}$ = 100 percent of initial value or 100 $\mu$ A dc; whichever is greater.
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. $\Delta h_{FE2}$ = $\pm$ 40 percent of initial value.

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

$$T_J = +162.5^\circ\text{C} \pm 12.5^\circ\text{C}; V_{CE} \geq 10 \text{ V dc}, T_A \leq +100^\circ\text{C}.$$

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 (JAN, 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 (JAN, JANTX and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Conditions
B3	1037	$V_{CB} \geq 10 \text{ V dc}$ ; $\Delta T_J$ = between cycles $\geq +100^\circ\text{C}$ . $t_{on} = t_{off} = 3$ minutes for 2,000 cycles. No heat sink or forced-air cooling on the devices shall be permitted.
B5	3151	$R_{\theta JC} = 1^\circ\text{C/W}$ (maximum).

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in 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.

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

Subgroup	Method	Conditions
C6	1037	$V_{CB} \geq 10$ 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.

## MIL-PRF-1900/501C

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		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; $I_C = 100 \text{ mA dc}$ ; pulsed (see 4.5.1)	$V_{(BR)CEO}$	80 100		V dc V dc
2N6051						
2N6052						
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5 \text{ V dc}$ ;	$I_{CEX1}$		0.5	mA dc
2N6051		$V_{CE} = 80 \text{ V dc}$			0.5	mA dc
2N6052		$V_{CE} = 100 \text{ V dc}$				
Collector - emitter cutoff current	3041	Bias condition D	$I_{CEO}$			
2N6051		$V_{CE} = 40 \text{ V dc}$			1.0	mA dc
2N6052		$V_{CE} = 50 \text{ V dc}$			1.0	mA dc
Emitter - base cutoff current	3061	Bias condition D; $V_{EB} = 5 \text{ V dc}$	$I_{EBO}$		2.0	mA dc
Base - emitter voltage (nonsaturated)	3066	Test condition B; $V_{CE} = 3 \text{ V dc}$ ; $I_C = 6 \text{ A dc}$	$V_{BE}$		2.8	V dc
Base - emitter voltage (saturated)	3066	Test condition A; $I_C = 12 \text{ A dc}$ ; $I_B = 120 \text{ mA dc}$ ; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector - emitter voltage (saturated)	3071	$I_C = 12 \text{ A dc}$ ; $I_B = 120 \text{ mA dc}$ ; pulsed (see 4.5.1)	$V_{CE(sat)1}$		3.0	V dc
Collector - emitter voltage (saturated)	3071	$I_C = 6 \text{ A dc}$ ; $I_B = 24 \text{ mA dc}$ ; pulsed (see 4.5.1)	$V_{CE(sat)2}$		2.0	V dc
Forward-current transfer ratio	3076	$V_{CE} = 3 \text{ V dc}$ ; $I_C = 1 \text{ A dc}$ ; pulsed (see 4.5.1)	$h_{FE1}$	1,000		
Forward-current transfer ratio	3076	$V_{CE} = 3 \text{ V dc}$ ; $I_C = 6 \text{ A dc}$ ; pulsed (see 4.5.1)	$h_{FE2}$	1,000	18,000	
Forward-current transfer ratio	3076	$V_{CE} = 3 \text{ V dc}$ ; $I_C = 12 \text{ A dc}$ ; pulsed (see 4.5.1)	$h_{FE3}$	150		

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		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; $V_{BE} = 1.5\text{ V dc};$ $V_{CE} = 80\text{ V dc}$	$I_{CEX2}$		5.0	mA dc
2N6051		$V_{CE} = 80\text{ V dc}$			5.0	mA dc
2N6052		$V_{CE} = 100\text{ V dc}$			5.0	mA dc
Collector - emitter voltage (saturated)	3071	$I_C = 6\text{ A dc}; I_B = 24\text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(sat)}$		2.0	V dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 3\text{ V dc}; I_C = 6\text{ A dc};$ pulsed (see 4.5.1)	$h_{FE4}$	300		
<u>Subgroup 4</u>						
Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 3\text{ V dc};$ $I_C = 5\text{ A dc};$ $f = 1\text{ kHz}$	$h_{fe}$	1,000		
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 3\text{ V dc};$ $I_C = 5\text{ A dc};$ $f = 1.0\text{ MHz}$	$ h_{fe} $	10	250	
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
Pulse response						
Turn-on time		(See figure 3); $V_{CC} = 30\text{ V dc};$ $I_C = 5\text{ A dc}; I_B = 20\text{ mA dc}$	$t_{on}$		2.0	$\mu\text{s}$
Turn-off time		(See figure 4); $V_{CC} = 30\text{ V dc};$ $I_C = 5\text{ A dc}; I_{B1} = I_{B2} = 20\text{ mA dc}$	$t_{off}$		10	$\mu\text{s}$
<u>Subgroup 5</u>						
Safe operating area (dc)	3051	$T_C = +25^\circ\text{C} +10^\circ\text{C} -0^\circ\text{C};$ $t \geq 1\text{ s}; 1\text{ cycle};$ (see figure 3)				
Test 1		$V_{CE} = 12.5\text{ V dc}; I_C = 12\text{ A dc}$				
Test 2		$V_{CE} = 30\text{ V dc}; I_C = 5\text{ A dc}$				

See footnote at end of table.



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TABLE I. Group A inspection - Continued.

Inspection <sup>1/</sup>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5 Continued</u>						
Test 3						
2N6051		$V_{CE} = 70 \text{ V dc}; I_C = 200 \text{ mA dc}$				
2N6052		$V_{CE} = 90 \text{ V dc}; I_C = 155 \text{ mA dc}$				
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 $\leq 2$ percent; $t_p = 1 \text{ ms};$ (vary to obtain $I_C$ ); $R_S = 0.10 \Omega; R_{BB1} = 80 \Omega$ $V_{BB1} = 16 \text{ V dc};$ $R_{BB2} = 100 \Omega;$ $V_{BB2} = 1.5 \text{ V dc};$ $I_C = 12 \text{ A dc};$ $V_{CC} = 20 \text{ V dc};$ $R_L \leq 2 \Omega; L = 10 \text{ mH};$ (Stancor C-2688 or equivalent)				
2N6051		clamp voltage = $80 +0, -5 \text{ V dc}$				
2N6052		clamp voltage = $100 +0,$ $-5 \text{ V dc}$ Device fails if clamp voltage not reached				
Endpoint electrical measurements		See table II, steps 1 and 5				
<u>Subgroups 6 and 7</u>						
Not applicable						

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

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

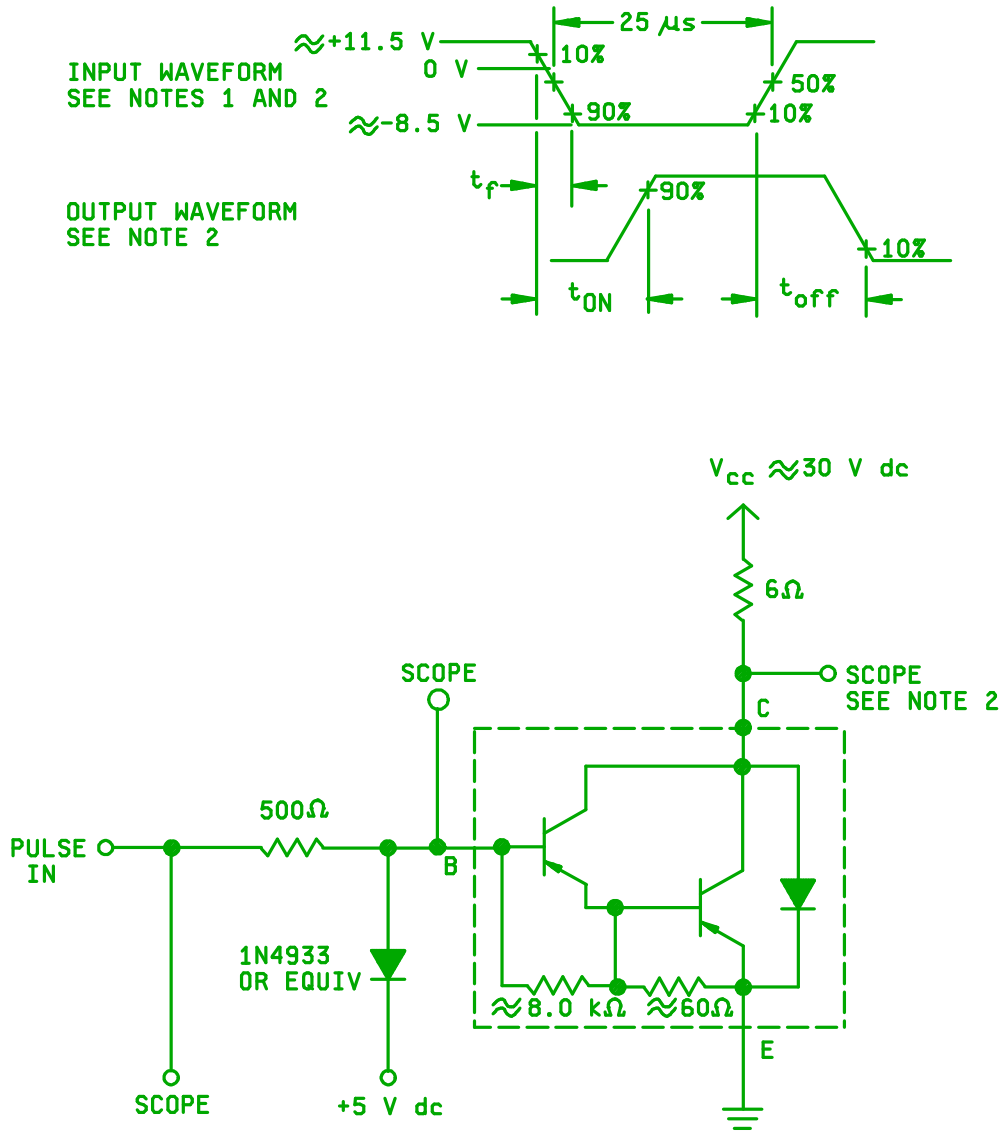
Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current 2N6051 2N6052	3041	Bias condition A; $V_{BE} = 1.5$ V dc; $V_{CE} = 80$ V dc $V_{CE} = 100$ V dc	$I_{CEX1}$		0.5	mA dc
2.	Collector - emitter cutoff current 2N6051 2N6052	3041	Bias condition A; $V_{BE} = 1.5$ V dc; $V_{CE} = 80$ V dc $V_{CE} = 100$ V dc	$I_{CEX1}$		1.0	mA dc
3.	Forward-current transfer ratio	3076	$V_{CE} = 3$ V dc; $I_C = 6$ A dc; pulsed (see 4.5.1)	$h_{FE2}$	1,000	18,000	
4.	Forward-current transfer ratio	3076	$V_{CE} = 3$ V dc; $I_C = 6$ A dc; pulsed (see 4.5.1)	$\Delta h_{FE2}$	$\pm 40$ percent		

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

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



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:  $t_r \leq 20 \text{ ns}$ ,  $t_f \leq 20 \text{ ns}$ ,  $Z_{out} = 50 \Omega$ ,  $PW = 2.0 \mu\text{s}$ , duty cycle  $\leq 2$  percent.
2. Output wave forms are monitored on an oscilloscope with the following characteristics:  $t_r \leq 2.0 \text{ ns}$ ,  $Z_{in} \geq 20 \text{ k}\Omega$ ,  $C_{in} \leq 11.5 \text{ pF}$ .
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.

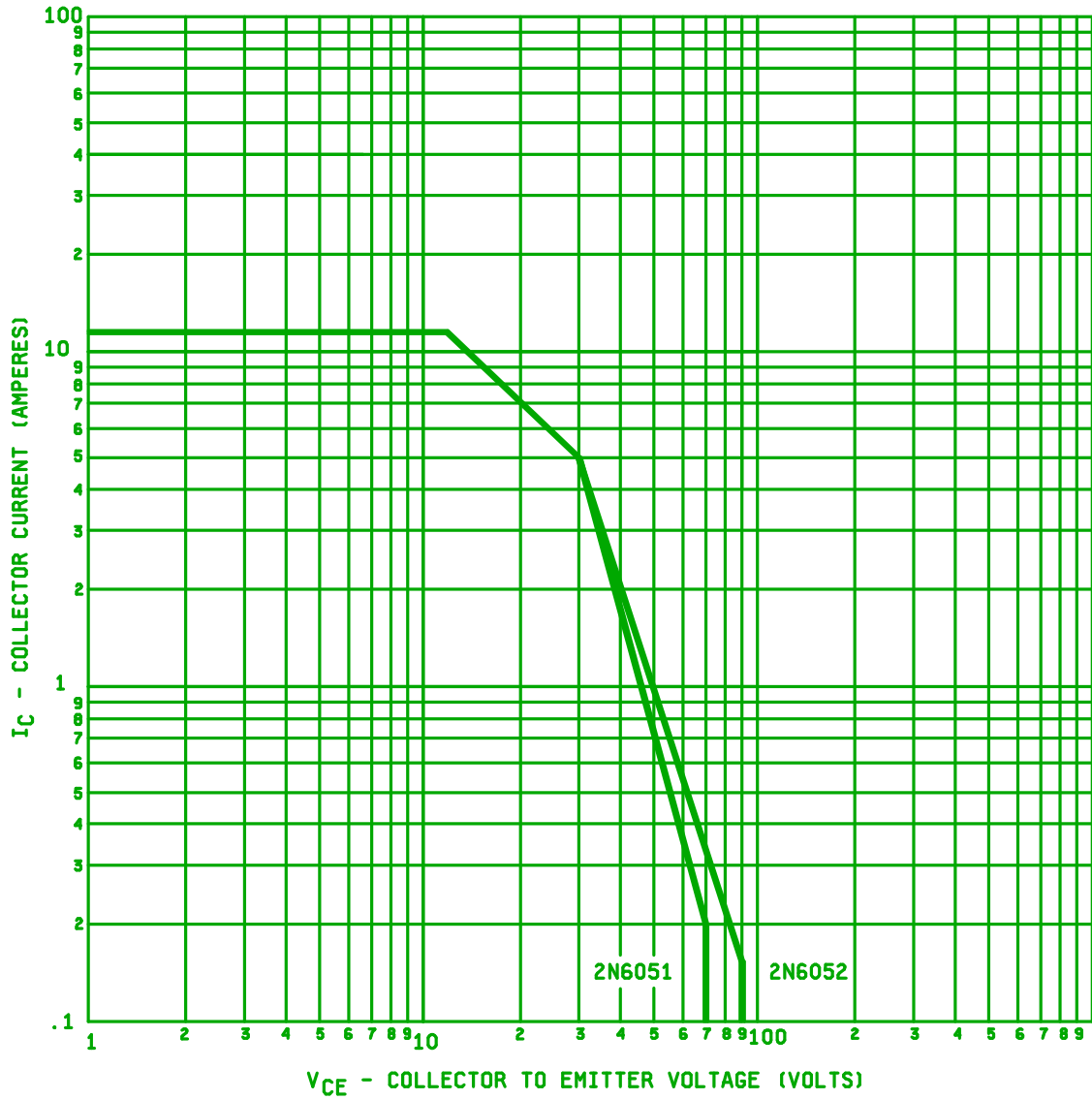


FIGURE 3. Maximum safe operating area graph (continuous dc).

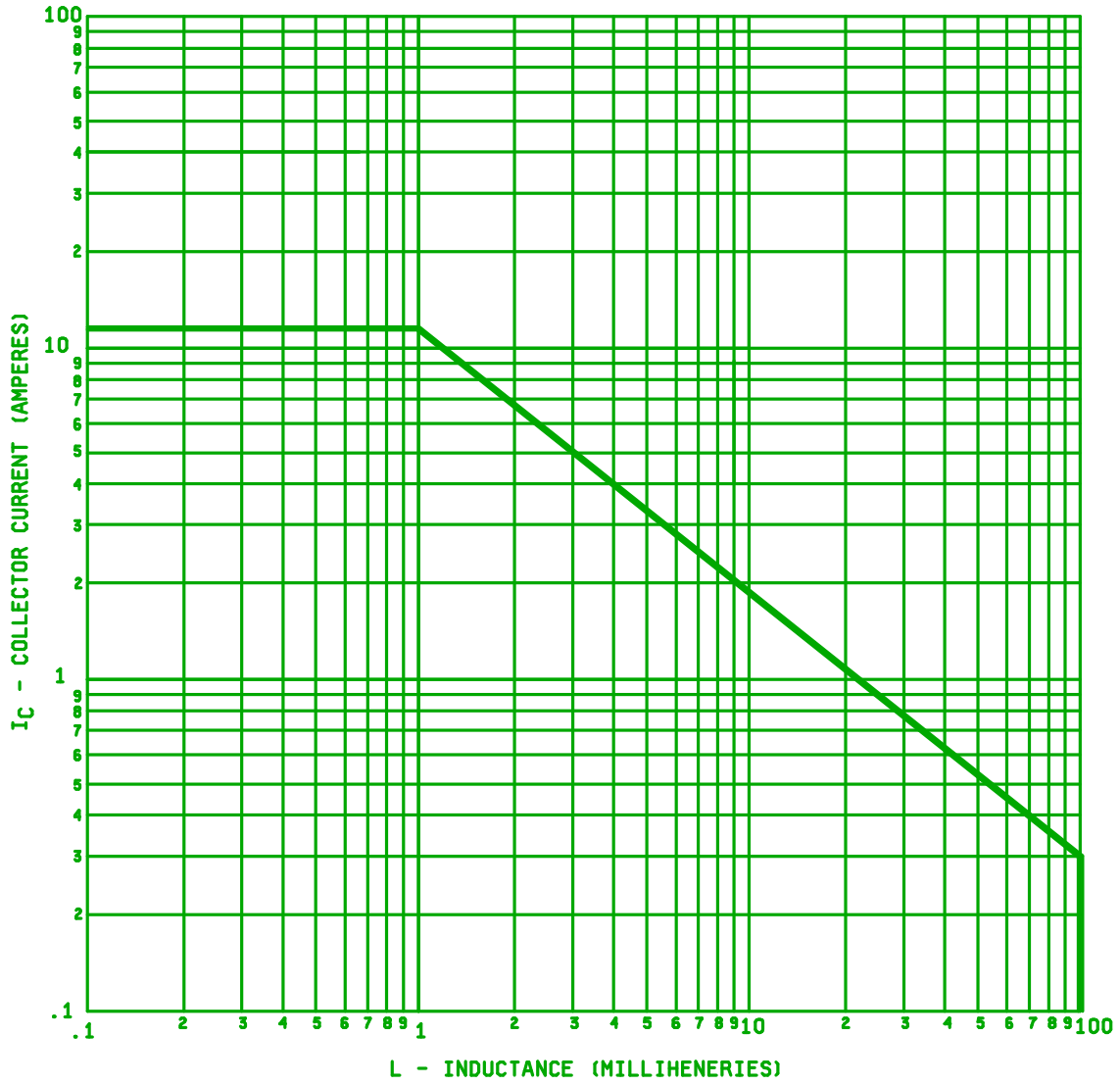


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

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 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 Defense Supply Center Columbus, ATTN: DSCC-VAT, 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 extensiveness of the changes.

CONCLUDING MATERIAL

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

Preparing activity:  
DLA - CC

Review activities:  
Air Force - 13, 19, 85, 99

(Project 5961- 1902-10)

**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.

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**I RECOMMEND A CHANGE:**

**1. DOCUMENT NUMBER**  
MIL-PRF-19500/501C

**2. DOCUMENT DATE (YYMMDD)**  
970523

**3. DOCUMENT TITLE**

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER, TYPE 2N6051, 2N6052 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**

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b. TELEPHONE (Include Area Code)  
(1) Commercial (2) AUTOVON  
(614) 692-0510 850-0510

c. ADDRESS (Include Zip Code) Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000

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