

The documentation and process conversion measures necessary to comply with this revision shall be completed by 27 October 2001.

INCH-POUND

MIL-PRF-19500/545D
27 July 2001
SUPERSEDING
MIL-PRF-19500/545C
21 July 2000

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER
TYPES 2N5151, 2N5153, 2N5151L, 2N5153L, 2N5151U3, AND 2N5153U3
JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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, silicon, power transistors for use in high-speed power-switching applications. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type.

1.2 Physical dimensions. See figure 1 (similar to T0-205), figures 2, 3, and 4 (JANHC and JANKC), and figure 5 (U3).

1.3 Maximum ratings.

Types	P_T $T_A = +25^\circ\text{C}$	P_T $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C (1)	Reverse pulse (2) energy	Safe operating area	T_{stg} and T_J
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>mi</u>		<u>°C</u>
2N5151, L	1 (3)	11.8 (4)	100	80	5.5	2	10	15	See figure 6	-65 to + 200
2N5153, L	1 (3)	11.8 (4)	100	80	5.5	2	10	15		
2N5151U3	1.16 (5)	100 (6)	100	80	5.5	2	10	15	See figure 6	-65 to + 200
2N5153U3	1.16 (5)	100 (6)	100	80	5.5	2	10	15		

- (1) This value applies for $P_w \leq 8.3$ ms, duty cycle ≤ 1 percent.
- (2) This rating is based on the capability of the transistors to operate safely in the unclamped inductive load energy test circuit of figure 7.
- (3) Derate linearly $5.7 \text{ mW}/^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.
- (4) Derate linearly $66.7 \text{ mW}/^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.
- (5) Derate linearly $6.67 \text{ mW}/^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.
- (6) Derate linearly $571 \text{ mW}/^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.

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-VAC, P. O. Box 3990, 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 at $T_C = +25^\circ\text{C}$.

Limits	h_{FE2} (1) $V_{CE} = 5\text{ V}$ $I_C = 2.5\text{ A dc}$		$ h_{fe} $ $V_{CE} = 5\text{ V}$ $I_C = 500\text{ mA dc}$ $f = 10\text{ MHz}$		$V_{CE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$	$V_{CE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$	C_{obo} $V_{CB} = 10\text{ V dc}$ $I_E = 0$ $f = 1\text{ MHz}$	$R_{\theta JA}$	$R_{\theta JC}$
	2N5151 (2)	2N5153 (2)	2N5151 (2)	2N5153 (2)					
Min	30	70	6	7	<u>V dc</u>	<u>V dc</u>	<u>pF</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>
Max (TO-205)	90	200			2.2	1.5	250	175	15
Max (U3)	90	200			2.2	1.5	250	150	1.75

(1) Pulsed (see 4.5.1)

(2) The limits specified apply to all package outlines unless otherwise stated.

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 section 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

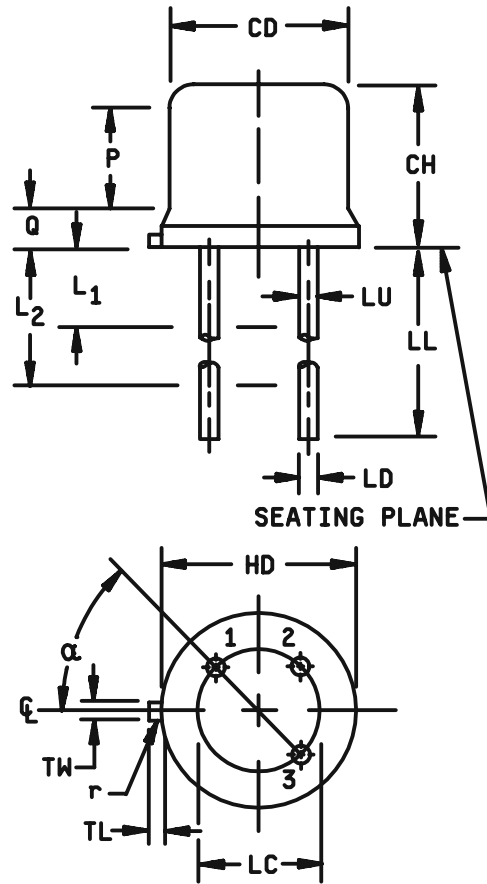
DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

Symbol 11	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	0.305	0.335	7.75	8.51	6
CH	0.240	0.260	6.10	6.60	
HD	0.335	0.370	8.51	9.40	
LC	0.200 TP		5.08 TP		7
LD	0.016	0.021	0.41	0.53	8, 9
LL	See notes 8, 9, 12, 13				
LU	0.016	0.019	0.041	0.48	8, 9
L ₁		0.050		1.27	8, 9
L ₂	0.250		6.35		8, 9
Q		0.050		1.27	6
TL	0.029	0.045	0.74	1.14	4, 5
TW	0.028	0.034	0.71	0.86	3
r		0.010		0.25	11
α	45° TP		45° TP		7
P	0.100		2.54		

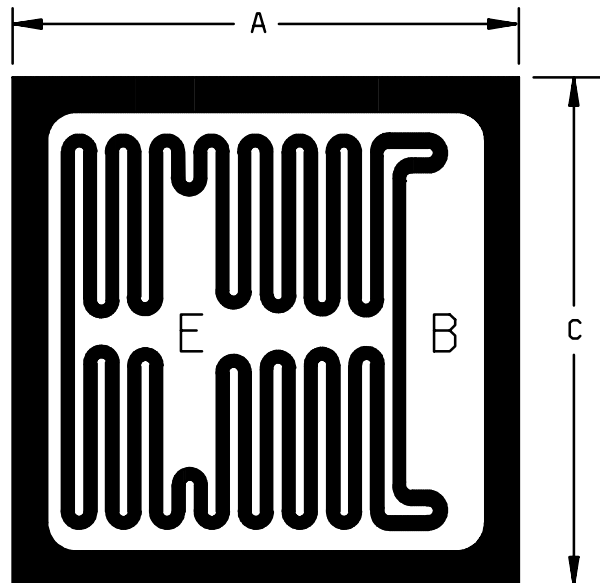
FIGURE 1. Physical dimensions (T0-205).

NOTES:

1. Dimension are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of 0.011 (.28 mm).
4. TL measured from maximum HD.
5. Outline in this zone is not controlled.
6. CD shall not vary more than 0.010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
7. Leads at gauge plane $0.054 + 0.001 - 0.000$ ($1.37 + 0.03 - 0.00$ mm) below seating plane shall be within 0.007 (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC
8. LU applied between L_1 and L_2 . LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
9. All three leads.
10. The collector shall be electrically and mechanically connected to the case.
11. r (radius) applies to both inside corners of tab.
12. In accordance with ANSI Y14.5M, diameters are equivalent to \varnothing x symbology.
13. For transistor types 2N5151 and 2N5153, LL is 0.5 (12.70 mm) minimum, and 0.75 (19.05 mm) maximum.
14. For transistor types 2N5151L and 2N5153L, LL is 1.5 (38.10 mm) minimum and 1.75 (44.45 mm) maximum.
15. Lead designation, depending on device type, shall be as follows:

Lead number	TO-205
1	Emitter
2	Base
3	Collector

FIGURE 1. Physical dimensions (T0-205) - continued.

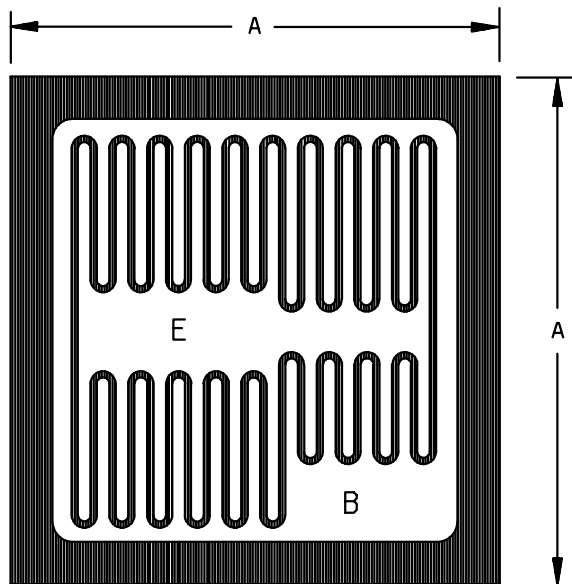


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	0.117	0.127	02.97	3.23	

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ± 0.005 (0.13 mm).
4. The physical characteristics of the die are;
 Thickness: 0.008 (0.20 mm) to 0.012 (0.30 mm), tolerance is ± 0.005 (0.13 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 = 0.015 (0.38 mm) x 0.0072 (0.183).
 E = 0.015 (0.38 mm) x 0.0060 (0.152).

FIGURE 2. JANHCA and JANKCA die dimensions.

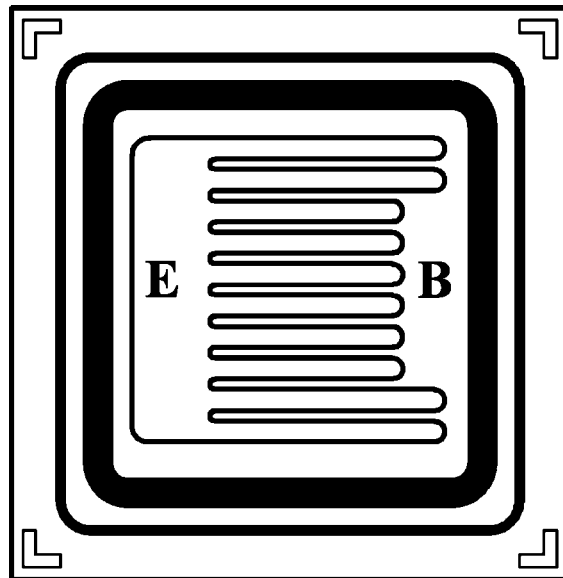


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	0.1		2.54		

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ± 0.005 (0.13 mm).
4. The physical characteristics of the die are;
5. Thickness: 0.0078 (0.198 mm) nominal, tolerance is ± 0.005 (0.13 mm).
 Top metal: Aluminum, 25,000 Å minimum, 33,000 Å nominal.
 Back metal: Gold 1,500 Å minimum, 2,500 Å nominal.
 Back side: Collector.
 Bonding pad: 0.012 (0.305 mm) min. x .030 (0.761 mm) minimum.

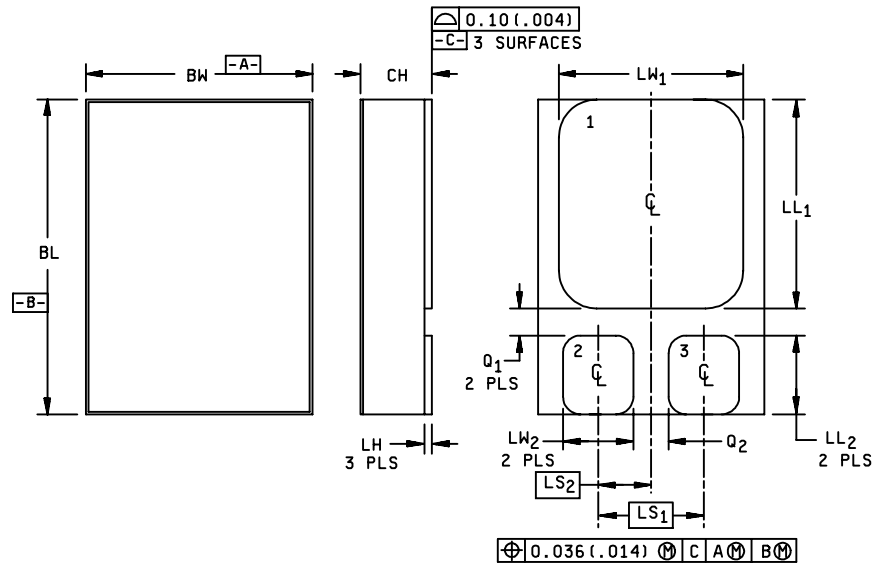
FIGURE 3. JANHCB and JANKCB die dimensions.



1. Chip size..... 0.128 x 0.128 inches ± 0.002 inches
2. Chip thickness..... 0.010 ± 0.0015 inches nominal
3. Top metal..... Aluminum 30,000Å minimum, 33,000Å nominal
4. Back metal..... A. Al/Ti/Ni/Ag 15kÅ/2kÅ/7kÅ/7kÅ min. 18kÅ/3kÅ/10kÅ/10kÅ nom.
B. Gold 2,500Å minimum, 3,000Å nominal
5. Backside..... Collector
6. Bonding pad..... B = 0.052 x 0.012 inches, E = 0.084 x 0.012 inches

FIGURE 4. JANHC and JANKC C-version die dimensions.

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Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	0.395	0.405	10.04	10.28
BW	0.291	0.301	7.40	7.64
CH	0.1085	0.1205	2.76	3.06
LH	0.010	0.020	0.25	0.51
LW1	0.281	0.291	7.14	7.41
LW2	0.090	0.100	2.29	2.54
LL1	0.220	0.230	5.59	5.84
LL2	0.115	0.125	2.93	3.17
LS1	0.150 BSC		3.81 BSC	
LS2	0.075 BSC		1.91 BSC	
Q1	0.030	---	0.762	---
Q2	0.030	---	0.762	---
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Dimensions and tolerances shall be in accordance with ANSI Y14.5M-1982.
4. Terminal 1 - collector, terminal 2 - base, terminal 3 - emitter.

SCHEMATIC

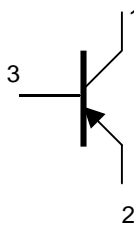


FIGURE 5. Physical dimensions and configuration for surface mount (U3).

3. REQUIREMENTS

3.1. General. The requirements for acquiring the product described herein shall consist of this document and MIL-PRF-19500.

3.2. Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

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

3.4. Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (TO-205), figures 2, 3, and 4 for JANHC and JANKC, figure 5 for U3 herein.

3.4.1. Current density. Current density of internal conductors shall be as specified in MIL-PRF-19500.

3.4.2. Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

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

3.6. Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

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

3.8. Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

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 and as specified herein.

4.2.1. JANHC and JANKC qualification. JANHC and JANKC qualification inspection shall be in accordance with MIL-PRF-19500.

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4.3. Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with 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 table IV of MIL-PRF-19500)	Measurement	
	JANS levels	JANTX and JANTXV levels
1a 1b	Not required Required	Not required Required for JANTXV only
2	Optional	Optional
3a 3b 3c	Required Not applicable Thermal response (see 4.5.3)	Required Not applicable Thermal response (see 4.5.3)
4	Required	Optional
5	Required	Not applicable
7a and 7b	Required	Required
8	Required	Not required
9	I_{CES1} and h_{FE2}	Not applicable
10	48 hours minimum	48 hours minimum
11	I_{CES1} and h_{FE2} ; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = \pm 20 percent.	I_{CES1} and h_{FE2}
12	See 4.3.2	See 4.3.2
13	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = \pm 20 percent.	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = \pm 20 percent.
14a and 14b	Optional	Optional
15	Required	Not required
16	Required	Not required

4.3.1. Screening (JANHNC and JANKC). Screening of JANC die shall be in accordance with MIL-PRF-19500. Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

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4.3.2. Power burn-in conditions. Power burn-in conditions are as follows: $V_{CB} = 10 - 30 \text{ V dc}$ $T_A = \text{room ambient}$ as defined in the general requirements, paragraph 4.5 of MIL-STD-750. Power shall be applied to the device to achieve a Junction temperature, $T_J = 175^\circ\text{C}$ minimum and a minimum $P_D = 75\%$ of P_T maximum rated as defined in paragraph 1.3 herein.

4.4. Conformance inspection. Conformance inspection shall be as specified herein.

4.4.1. Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500 and table I herein. Electrical measurements (end-points) shall be in accordance with the inspections of table I, subgroup 2 herein.

4.4.2. Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIa of MIL-PRF-19500 (JANS) and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein. See 4.4.2.2 herein and table VIb of MIL-PRF-19500 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) requirements shall be in accordance with group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.4.2.1. Group B inspection table VIa (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B4	1037	$V_{CB} = 40 \text{ V dc} \pm 1 \text{ V}.$
B5	1027	$V_{CB} = 10 \text{ V dc}$; 96 hours with $P_T = P_T (\text{max})$ at $T_A = 25^\circ\text{C}$, adjust T_A to give $T_J = +275^\circ\text{C}$ minimum. Optionally the test may be performed for a minimum of 216 hours with P_T adjusted to achieve a $T_J = +225^\circ\text{C}$ minimum; sample size = 45, $c = 0$. In this case the ambient temperature shall be adjusted such that a minimum 75 percent of maximum rated P_T (see 1.3) is applied to the device under test. (NOTE: If a failure occurs, resubmission shall be at the test conditions of the original sample.)
B6	3131	see 4.5.2.

4.4.2.2. Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new "assembly lot" option is exercised, the failed assembly lot shall be scrapped.

<u>Step</u>	<u>Method</u>	<u>Conditions</u>
1	1039	Steady-state life: Test condition B, 340 hours min., $V_{CB} = 10 - 30 \text{ V dc}$, Power shall be applied to achieve $T_J = +175^\circ\text{C}$ minimum using a minimum of $P_D = 75\%$ percent of maximum rated P_T as defined in 1.3. $n = 45$ devices, $c = 0$.
2	1039	The steady-state life test of step 1 shall be extended to 1,000 hrs for each die design. Samples shall be selected from a wafer lot every twelve months of wafer production. Group B step 2 shall not be required more than once for any single wafer lot. $n = 45$, $c = 0$.
3	1032	High-temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- a. For JAN, JANTX, and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. See MIL-PRF-19500.
- b. Must be chosen from an inspection lot that has been submitted to and passed group A, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

4.4.3. Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	2036	Test condition E, (not applicable for U3 packages).
C6	1037	$V_{CB} = 10 - 30 \text{ V dc}$, 6,000 cycles.

4.4.4. Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>	<u>Sampling plan</u>
E1	1051	500 cycles	45 devices, $c = 0$
E2	1039	Condition A: 500 hours	45 devices, $c = 0$
E3		Not applicable	
E4	3131	$R_{\theta JC} = 15^\circ\text{C/W}$ maximum (TO-205) $R_{\theta JC} = 1.75^\circ\text{C/W}$ maximum (U3) See 4.5.2	22 devices, $c = 0$ (See 4.5.2) 22 devices, $c = 0$ (See 4.5.2)
E5		Not applicable	

4.5. Methods of inspection and test. Methods of inspection and test shall be as specified in the 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 application shall be 500 mA minimum dc.
- b. Collector to emitter voltage magnitude shall be 10 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference temperature measuring point shall be within the range $+25^{\circ}\text{C} \leq T_R \leq +35^{\circ}\text{C}$. The chosen reference temperature shall be recorded before the test is started.
- e. Mounting arrangement shall be with heat sink to case.
- f. Maximum limit of $R_{\theta JC}$ shall be 15.0°C/W for (TO-205) and 1.75°C/W for (U3).

4.5.3. Thermal response (ΔV_{BE} measurements). The ΔV_{BE} measurements shall be performed in accordance with method 3131 of MIL-STD-750. The ΔV_{BE} conditions (I_H and V_H) and maximum limit shall be derived by each vendor. The chosen ΔV_{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 appropriate conditions of temperature, time, current, and voltage to achieve die attach integrity are approved by the qualifying activity. The following parameter measurements shall apply:

- a. I_M measurement 10 mA.
- b. V_{CE} measurement voltage 16 V (same as V_H).
- c. I_H collector heating current 1 A minimum.
- d. V_H collector-emitter heating voltage 16 V minimum.
- e. t_H heating time 10 ms.
- f. t_{MD} measurement delay time 50 μs .
- g. t_{SW} sample window time 10 μs maximum.

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TABLE I. Group A inspection.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u> <u>2</u> /						
Visual and mechanical <u>3</u> / examination	2071	n = 45 devices, c = 0				
Solderability <u>3</u> /, <u>4</u> /	2026	n = 15 leads, c = 0				
Resistance to solvents <u>3</u> /, <u>4</u> /, <u>5</u> /	1022	n = 15 devices, c = 0				
Temp cycling <u>3</u> /, <u>4</u> /	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal <u>4</u> / Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements <u>4</u> / Bond strength <u>3</u> /, <u>4</u> /	2037	Group A, subgroup 2 Precondition T _A = +250°C at t = 24 hrs or T _A = +300°C at t = 2 hrs n = 11 wires, c = 0				
<u>Subgroup 2</u>						
Breakdown voltage, collector to emitter	3011	Bias condition D, I _C = 100 mA dc; I _B = 0, pulsed (see 4.5.1)	V _{(BR)CEO}	80		V dc
Collector to emitter cutoff current	3041	Bias condition C, V _{CE} = 60 V dc; V _{BE} = 0	I _{CES1}		1.0	μA dc
Collector to emitter cutoff current	3041	Bias condition C, V _{CE} = 100 V dc; V _{BE} = 0	I _{CES2}		1.0	mA dc
Collector to emitter cutoff current	3041	Bias condition D, V _{CE} = 40 V dc; I _B = 0	I _{CEO}		50	μA dc
Emitter to base cutoff current	3061	Bias condition D, V _{EB} = 4 V dc; I _C = 0	I _{EBO1}		1.0	μA dc
Emitter to base cutoff current	3061	Bias condition D, V _{EB} = 5.5 V dc; I _C = 0	I _{EBO2}		1.0	mA dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward current transfer ratio 2N5151 <u>2</u> / 2N5153	3076	V _{CE} = 5 V dc; I _C = 50 mA dc, pulsed (see 4.5.1)	h _{FE1}	20 50		
Forward current transfer ratio 2N5151 <u>2</u> / 2N5153	3076	V _{CE} = 5 V dc; I _C = 2.5 A dc, pulsed (see 4.5.1)	h _{FE2}	30 70	90 200	
Forward current transfer ratio 2N5151 <u>2</u> / 2N5153	3076	V _{CE} = 5 V dc; I _C = 5 A dc, pulsed (see 4.5.1)	h _{FE3}	20 40		
Base-emitter voltage (non-saturated)	3066	Test condition B, V _{CE} = 5 V dc; I _C = 2.5 A dc, pulsed (see 4.5.1)	V _{BE}		1.45	V dc
Base-emitter saturation voltage	3066	Test condition A, I _C = 2.5 A dc; I _B = 250 mA dc, pulsed (see 4.5.1)	V _{BE(sat)1}		1.45	V dc
Base-emitter saturation voltage	3066	Test condition A, I _C = 5 A dc; I _B = 500 mA dc; pulsed (see 4.5.1)	V _{BE(sat)2}		2.2	V dc
Collector-emitter saturation voltage	3071	I _C = 2.5 A dc; I _B = 250 mA dc, pulsed (see 4.5.1)	V _{CE(sat)1}		0.75	V dc
Collector-emitter saturation voltage	3071	I _C = 5 A dc; I _B = 500 mA dc, pulsed (see 4.5.1)	V _{CE(sat)2}		1.5	V dc
<u>Subgroup 3</u>						
High temperature operation:		T _C = +150°C				
Collector to emitter cutoff current	3041	Bias condition A, V _{CE} = 60 V dc; V _{BE} = +2 V dc	I _{CEX}		500	µA dc

See footnote at end of table.

TABLE I, Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4 continued</u> Low temperature operation Forward - current transfer ratio 2N5151 <u>2</u> / 2N5153 <u>Subgroup 4</u> Common-emitter, small-signal, short-circuit, forward-current transfer ratio 2N5151 <u>2</u> / 2N5153 Magnitude of common-emitter, small-signal short-circuit, forward-current, transfer ratio 2N5151 <u>2</u> / 2N5153 Open-circuit output capacitance Switching time	3076	$T_C = -55^{\circ}\text{C}$	h_{FE4}	15 25		
		$V_{CE} = 5 \text{ V dc}; I_C = 2.5 \text{ A dc};$ pulsed (see 4.5.1)				
	3206	$V_{CE} = 5 \text{ V dc}; I_C = 100 \text{ mA dc};$ $f = 1 \text{ KHz}$	h_{fe}	20 50		
	3306	$V_{CE} = 5 \text{ V dc}; I_C = 500 \text{ mA dc},$ $f = 10 \text{ MHz}$	$ h_{fe} $	6 7		
	3236	$V_{CB} = 10 \text{ V dc}; I_E = 0, f = 1 \text{ MHz}$	C_{obo}		250	pf
		$I_C = 5 \text{ A dc}; I_{B1} = 500 \text{ mA dc}$	t_{on}		0.5	μs
		$I_{B2} = -500 \text{ mA dc}$	t_s		1.4	μs
		$V_{BE(off)} = 3.7 \text{ V dc}$	t_f		0.5	μs
		$R_L = 6 \Omega, (\text{see figure 4})$	t_{off}		1.5	μs

See footnote at end of table.

TABLE I, Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (D.C.)	3051	Pre-pulse condition for each test: $V_{CE} = 0$; $I_C = 0$; $T_C = +25^\circ\text{C}$				
Test # 1		Pulse condition for each test: $t_p = 1$ sec. 1 cycle. $T_C = +25^\circ\text{C}$, (see figure 8) $V_{CE} = 5.0$ V dc, $I_C = 2$ A dc for TO39/5 $V_{CE} = 5.8$ V dc, $I_C = 2$ A dc for U3, unheatsunk (see note 3) or TBD				
Test # 2		$V_{CE} = 32$ V dc, $I_C = 310$ mA dc for TO39/5 $V_{CE} = 32$ V dc, $I_C = 360$ mA dc for U3, unheatsunk (see note 3) or TBD				
Test # 3		$V_{CE} = 80$ V dc, $I_C = 12.5$ mA dc for TO39/5 $V_{CE} = 80$ V dc, $I_C = 14.5$ mA dc for U3, unheatsunk (see note 3) or TBD				
Safe operating area (unclamped inductive)		$T_C = +25^\circ\text{C}$; $R_{BB1} = 10 \Omega$; $R_{BB2} = 100 \Omega$; $L = 0.3$ mH; $R_L = 0.1 \Omega$; $V_{CC} = 10$ V dc; $V_{BB1} = 10$ V dc; $V_{BB2} = 4$ V dc; $I_{CM} = 10$ A dc (see figure 6)				
End point electrical measurements		See table I, Subgroup 2				
<u>Subgroups 6 and 7</u>						
Not applicable						

1/ For sampling plan see MIL-PRF-19500.

2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.

3/ Separate samples may be used.

4/ Not required for JANS devices.

5/ Not required for laser marked devices.

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TABLE II. Groups B, C and E delta electrical measurements. 1/ 2/ 3/

Steps	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward - current transfer ratio	3076	$I_C = 2.5 \text{ V dc}; V_{CE} = 5 \text{ V dc}$, pulsed (see 4.5.1)	Δh_{FE2}	± 20 percent change from initial reading.		

1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows: Subgroups 4 and 5, see table II herein, step 1.

2/ The delta measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows: All subgroups, see table II herein, step 1.

3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein, step 1.

4/ The delta measurements for 4.4.4 are as follows: Subgroups 1 and 2, see table II herein, step 1.

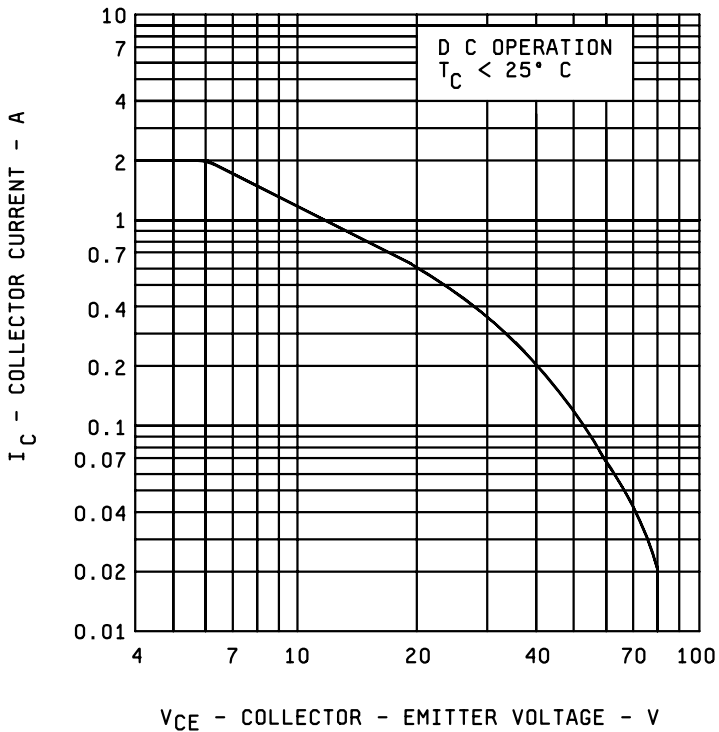


FIGURE 6. Maximum safe operating area.

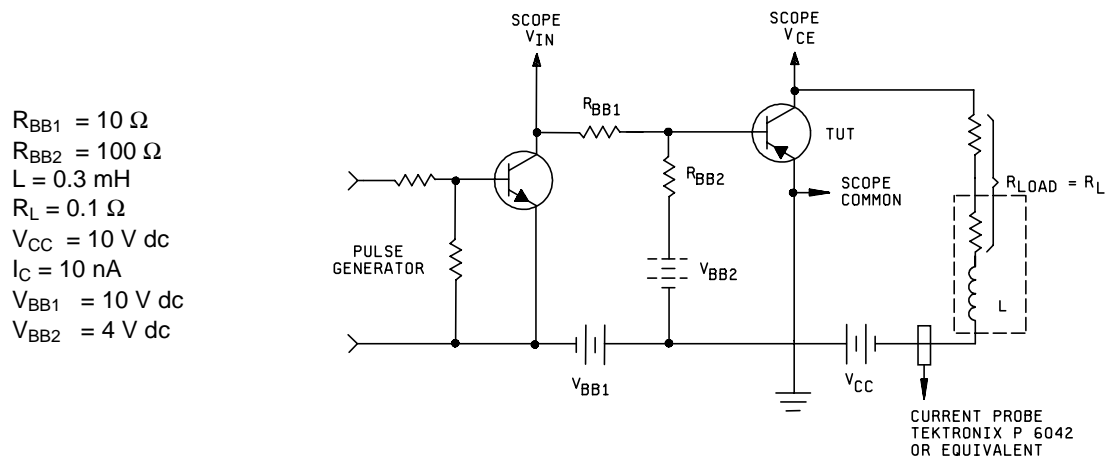
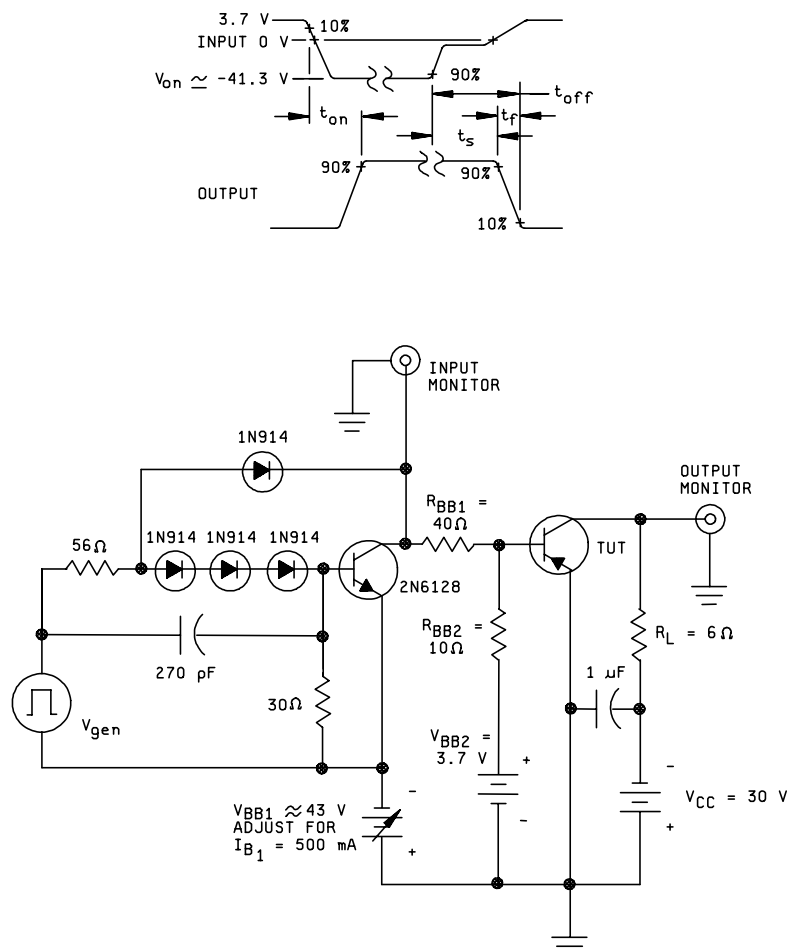


FIGURE 7. Unclamped inductive load energy test circuit.



NOTES:

1. V_{gen} is -30 pulse (from 0 V) into a 50 ohm termination.
2. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f = 15$ ns, $Z_{OUT} = 50$ ohm, duty cycle ≤ 2 percent.
3. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{IN} \geq 10$ M Ω , $C_{IN} \leq 11.5$ pF.
4. Resistors shall be noninductive types.
5. The dc power supplies may require additional bypassing in order to minimize ringing.
6. An equivalent circuit may be used.

FIGURE 8. Switching time test circuit.

5. PACKAGING

5.1. Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel 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.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1. Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2. Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation and, if required, the specified issue of individual documents referenced (see 2.2.1).
- c. Lead finish (see 3.4.2).
- d. Type designation and product assurance level.
- e. Packaging requirements (see 5.1).

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 Manufacturers List QML-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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC-VQE, P.O. Box 3990, Columbus, OH 43216-5000.

6.4. Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N5151) will be identified on the QML.

JANHC and JANKC ordering information			
PIN	Manufacturer		
	33178	34156	43611
2N5151	JANHCA2N5151	JANHCB2N5151	JANHCC2N5151
2N5153	JANHCA2N5153	JANHCB2N5153	JANHCC2N5153
2N5151	JANKCA2N5151	JANKCB2N5151	JANHCC2N5151
2N5153	JANKCA2N5153	JANKCB2N5153	JANHCC2N5153

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.

MIL-PRF-19500/545D

Custodians:
Air Force - 11
Navy - NW
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2399)

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-19500/545D

2. DOCUMENT DATE
010727

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER TYPES 2N5151, 2N5153, 2N5151L, 2N5153L, 2N5151U3, AND 2N5153U3 JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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)
COMMERCIAL
DSN
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EMAIL

7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. Point of Contact
Alan Barone

b. TELEPHONE
Commercial DSN FAX EMAIL
614-692-0510 850-0510 614-692-6939 alan.barone@dscclia.mil

c. ADDRESS
Defense Supply Center Columbus,
ATTN: DSCC-VAC, P. O. Box 3990,
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