The documentation and process conversion measures necessary to comply with this revision shall be completed by 13 June 2003.

INCH-POUND

MIL-PRF-19500/545E
13 March 2003
SUPERSEDING
MIL-PRF-19500/545D
27 July 2001

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 $T_A = +25°C$	P_T $T_C = +25°C$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C (1)	Reverse pulse (2) energy	Safe operating area	T_{stg} and T_J
	W	W	V dc	V dc	V dc	A dc	A dc	mj		°C
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 Pw ≤ 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 mW/°C for $T_A > +25°C$.
(4) Derate linearly 66.7 mW/°C for $T_C > +25°C$.
(5) Derate linearly 6.63 mW/°C for $T_A > +25°C$.
(6) Derate linearly 571 mW/°C for $T_C > +25°C$.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: 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.

AMSC N/A FSC 5961

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

1.4 Primary electrical characteristics at T_C = +25°C.

Limits	h_{FE2} (1) V_{CE} = 5 V I_C = 2.5 A dc		$\|h_{fe}\|$ V_{CE} = 5 V I_C = 500 mA dc f = 10 MHz		$V_{CE(sat)2}$ (1) I_C = 5 A dc I_B = 500 mA dc	$V_{CE(sat)2}$ (1) I_C = 5 A dc I_B = 500 mA dc	C_{obo} V_{CB} = 10 V dc I_E = 0 f = 1 Mhz	$R_{\theta JA}$	$R_{\theta JC}$
	2N5151 (2)	2N5153 (2)	2N5151 (2)	2N5153 (2)					
					V dc	V dc	pF	°C/W	°C/W
Min	30	70	6	7					
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	.305	.335	7.75	8.51	6
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		7
LD	.016	.021	0.41	0.53	8, 9
LL	See notes 8, 9, 12, 13				
LU	.016	.019	0.041	0.48	8, 9
L_1		.050		1.27	8, 9
L_2	.250		6.35		8, 9
Q		.050		1.27	6
TL	.029	.045	0.74	1.14	4, 5
TW	.028	.034	0.71	0.86	3
r		.010		0.25	11
α	45° TP		45° TP		7
P	.100		2.54		

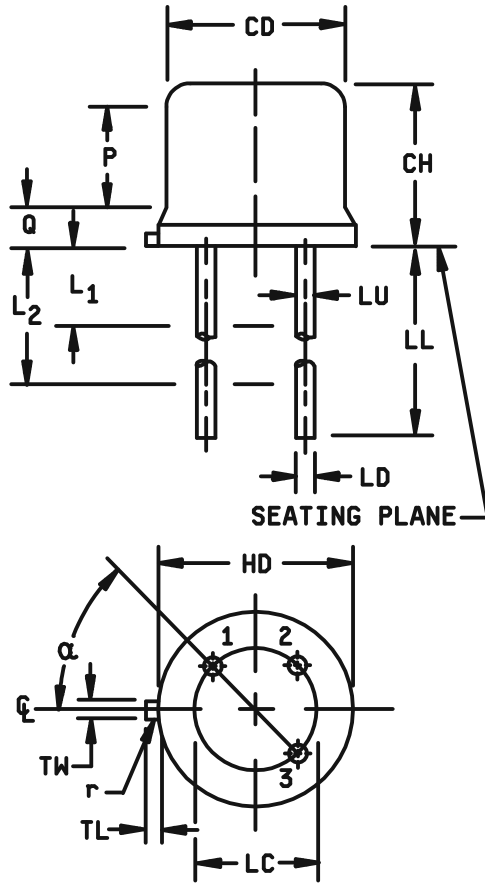
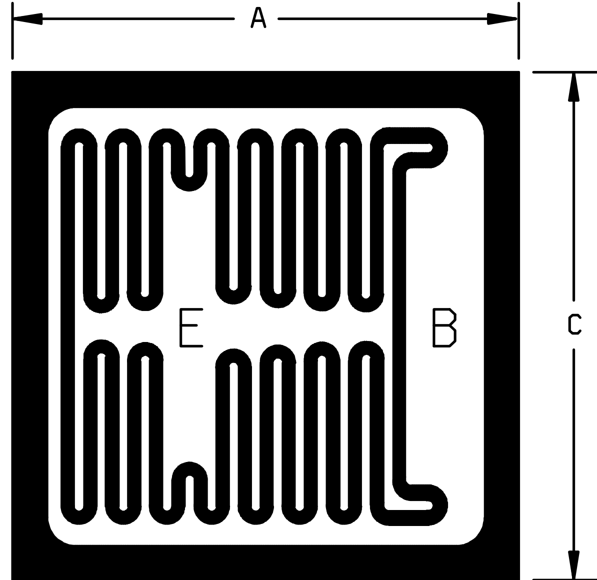


FIGURE 1. Physical dimensions (T0-205).

NOTES:
1. Dimensions 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 .011 (0.28 mm).
4. TL measured from maximum HD.
5. Outline in this zone is not controlled.
6. CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
7. Leads at gauge plane .054 + .001 - .000 (1.37 + 0.03 - 0.00 mm) below seating plane shall be within .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 ASME Y14.5M, diameters are equivalent to ∅x symbology.
13. For transistor types 2N5151 and 2N5153, LL is .5 (12.70 mm) minimum, and .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

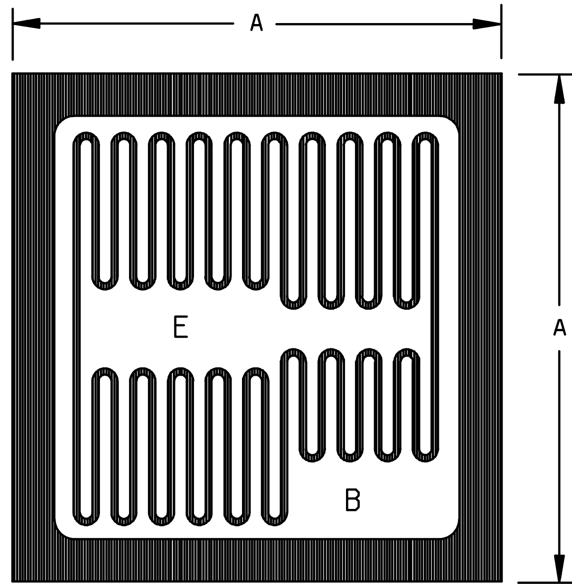
FIGURE 1. Physical dimensions (T0-205) - Continued.



Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.117	.127	2.97	3.23	
C	.117	.127	2.97	3.23	

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), tolerance is ± .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 = .015 (0.38 mm) x .0072 (0.183 mm).
   E = .015 (0.38 mm) x .0060 (0.152 mm).

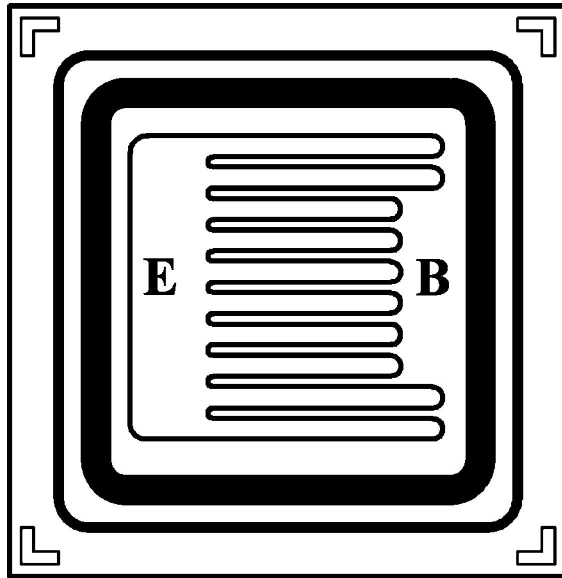
FIGURE 2. JANHCA and JANKCA die dimensions.



Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.1	.105	2.54	2.67	

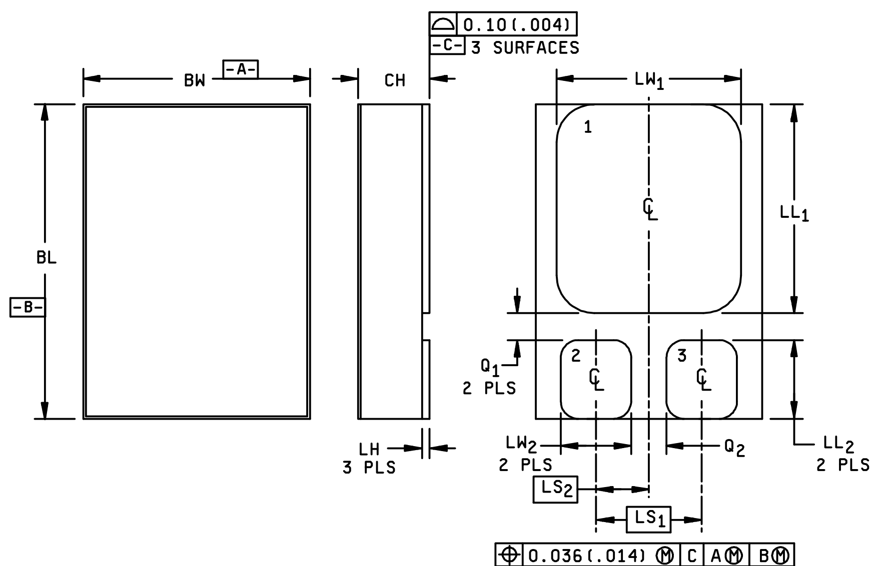
NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±0.005 (0.13 mm).
4. The physical characteristics of the die are;
5. Thickness: .0078 (0.198 mm) nominal, tolerance is ±.005 (0.13 mm).
   Top metal: Aluminum, 25,000 Å minimum, 33,000 Å nominal.
   Back metal: Gold 1,500 Å minimum, 2,500 Å nominal.
   Back side: Collector.
   Bonding pad: .012 (0.305 mm) min. x .030 (0.761 mm) minimum.

FIGURE 3. JANHCB and JANKCB die dimensions.



1. Chip size	.128 x .128 inches (3.25 mm x 3.25 mm) ±.002 inches (0.05 mm).
2. Chip thickness	.010 inches (0.254 mm) ± .0015 inches (0.04 mm) nominal.
3. Top metal	Aluminum 30,000Å minimum, 33,000Å nominal.
4. Back metal	A.Al/Ti/Ni/Ag15kÅ/2kÅ/7kÅ/7kÅmin.18kÅ/3kÅ/10kÅ/10kÅ nom. B. Gold 2,500Å minimum, 3,000Å nominal.
5. Backside	Collector
6. Bonding pad	B = .052 x .012 inches (1.32 mm x 0.30 mm). E = .084 x .012 inches (2.13 mm x 0.30 mm).

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



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.395	.405	10.04	10.28
BW	.291	.301	7.40	7.64
CH	.1085	.1205	2.76	3.06
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.41
LW2	.090	.100	2.29	2.54
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.93	3.17
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
Q1	.030		0.762	
Q2	.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 ASme Y14.5M.
4. Terminal 1 - collector, terminal 2 - base, terminal 3 – emitter.

SCHEMATIC

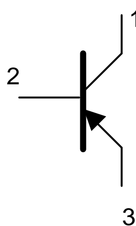


FIGURE 5. Physical dimensions and configuration for surface mount (U3).

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

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.

* 4.2.2 Group E qualification. Group E qualification shall be performed herein for qualification or requalification only. In case qualification was awarded to a prior revision of the associated specification that did not request the performance of table II tests, the tests specified in table II herein shall be performed by the first inspection lot to this revision to maintain qualification.

* 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 impedance, method 3131 of MIL-STD-750.	Required Not applicable Thermal impedance, method 3131 of MIL-STD-750.
4	Required	Optional
5	Required	Not applicable
7a and 7b	Optional	Optional
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 or100 nA dc, whichever is greater. Δh_{FE2} = ± 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} = ± 20 percent.	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = ± 20 percent.
14a and 14b	Required	Required
15	Required	Not required
16	Required	Not required

* 4.3.1 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500 Discrete Semiconductor Die/Chip Lot Acceptance. Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

* 4.3.2 Power burn-in conditions. Power burn-in conditions are as follows: V_{CB} = 10 V dc, T_A = room ambient as defined in the general requirements, 4.5 of MIL-STD-750. Power shall be applied to the device to achieve a Junction temperature, T_J = 175 °C minimum and a minimum P_D = 75 percent of P_T maximum rated as defined in 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 III herein. See 4.4.2.2 herein 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 III herein.

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

Subgroup	Method	Conditions
B4	1037	V_{CB} = 40 V dc ± 1 V.
B5	1027	(NOTE: If a failure occurs, resubmission shall be at the test conditions of the original sample). V_{CB} = 10 V dc; $P_D \geq$ 100 percent of maximum rated P_T (see 1.3). $T_A \leq$ 35°C. Option 1: 96 hours minimum, sample size in accordance with table VIa of MIL-PRF-19500, adjust P_D to achieve T_J = +275°C minimum. Option 2: 216 hours., sample size = 45, c = 0; adjust P_D to achieve T_J = +225°C minimum.
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.

Step	Method	Conditions
1	1039	Steady-state life: Test condition B, 340 hours min., V_{CB} = 10 V dc, power shall be applied to achieve T_J = +175°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	HTRB test condition A; 48 hours minimum. n = 45, c = 0.
3	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.
4	1032	High-temperature life (non-operating), t = 340 hours, T_A = +200°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 test and conditions specified for subgroup testing in table VII of MIL-PRF-19500, and in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANJ, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 and table III herein; delta requirements only apply to subgroup C6.

* 4.4.3.1 Group C inspection, table VII (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E; (method 2036 not applicable for UA and UB devices).
C6	1026	1,000 hours at V_{CB} = 10 V dc; power shall be applied to achieve T_J = +150°C minimum and a minimum of P_D = 75 percent of maximum rated P_T as defined in 1.3.

* 4.4.3.2 Group C inspection, table VII (JAN, JANJ, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E; not applicable for UA and UB devices.
C5	3131	$R_{\theta JA}$ (see 1.3).
C6		Not applicable.

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 and table II herein.

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 $+25°C \leq T_R \leq +35°C$. 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).

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1 2/						
Visual and mechanical examination 3/	2071	n = 45 devices, c = 0				
Solderability 3/ 4/	2026	n = 15 leads, c = 0				
Resistance to solvents 3/ 4/ 5/	1022	n = 15 devices, c = 0				
Temp cycling 3/ 4/	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Electrical measurements 4/		Group A, subgroup 2				
Hermetic Seal 4/ 6/	1071	n = 22 devices, c = 0				
Fine leak Gross leak						
Bond strength 3/ 4/	2037	Precondition T_A = +250°C at t = 24 hrs or T_A = +300°C at t = 2 hrs n = 11 wires, c = 0				
Subgroup 2						
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 footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Forward current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 50 mA dc, pulsed (see 4.5.1)	h_{FE1}			
2N5151 2/ 2N5153				20 50		
Forward current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 2.5 A dc, pulsed (see 4.5.1)	h_{FE2}			
2N5151 2/ 2N5153				30 70	90 200	
Forward current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 5 A dc, pulsed (see 4.5.1)	h_{FE3}			
2N5151 2/ 2N5153				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
Subgroup 3						
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}		100	µA 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	
Subgroup 4 continued						
Low temperature operation		T_C = -55°C				
Forward - current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 2.5 A dc; pulsed (see 4.5.1).	h_{FE4}			
2N5151 2/				15		
2N5153				25		
Subgroup 4						
Common-emitter, small-signal, short-circuit, forward-current transfer ratio	3206	V_{CE} = 5 V dc; I_C = 100 mA dc; f = 1 KHz	h_{fe}			
2N5151 2/				20		
2N5153				50		
Magnitude of common-emitter, small-signal short-circuit, forward-current, transfer ratio	3306	V_{CE} = 5 V dc; I_C = 500 mA dc, f = 10 MHz	$\|h_{fe}\|$			
2N5151 2/				6		
2N5153				7		
Open-circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0, f = 1 MHz	C_{obo}		250	pf
Switching time		I_C = 5 A dc; I_{B1} = 500 mA dc	t_{on}		0.5	µs
		I_{B2} = -500 mA dc	t_s		1.4	µs
		$V_{BE(off)}$ = 3.7 V dc	t_f		0.5	µs
		R_L = 6 Ω, (see figure 7)	t_{off}		1.5	µs

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
* Safe operating area (D.C.) (2N5151, L; 2N5153, L)	3051	Pre-pulse condition for each test: T_C = +25°C, see figure 6. Pulse condition for each test: t_p = 1 sec. 1 cycle. T_C = +25°C.				
* Test # 1		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.				
* 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.				
* 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.				
Safe operating area (unclamped inductive)		T_C = +25°C; R_{BB1} = 10 Ω; R_{BB2} = 100 Ω; L = 0.3 mH; RL = 0.1 Ω; V_{CC} = 10 V dc; V_{BB1} = 10 V dc; V_{BB2} = 4 V dc; I_{CM} = 10 A dc (see figure 8)				
End point electrical measurements		See table I, subgroup 2				
Subgroups 6 and 7						
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.
*6/ Hermetic seal test is an end-point to temperature cycling in addition to electrical measurements.

* TABLE II. Group E inspection (all quality levels) – for qualification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal			
Fine leak Gross leak	1071		
Electrical measurements		See table I, subgroup 2 and table III herein.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	V_{CB} = 10 V dc, 6,000 cycles.	
Electrical measurements		See table I, subgroup 2 and table III herein.	
Subgroups 3			
Not applicable			
* Subgroup 4			22 devices c = 0
Thermal impedance	3131	Suppliers shall submit thermal impedance curves to the qualifying activity.	
Subgroups 5, 6 and 7			
Not applicable			
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V. Condition B for devices < 400 V.	

TABLE III. 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 A dc; V_{CE} = 5 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 III herein, step 1.
2/ The delta measurements for 4.4.2.2 (JAN, JANTX and JANTXV) for all steps; see table III herein, step 1.
3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, step 1.
4/ The delta measurements for 4.4.4 are as follows: Subgroups 1 and 2, see table III herein, step 1.

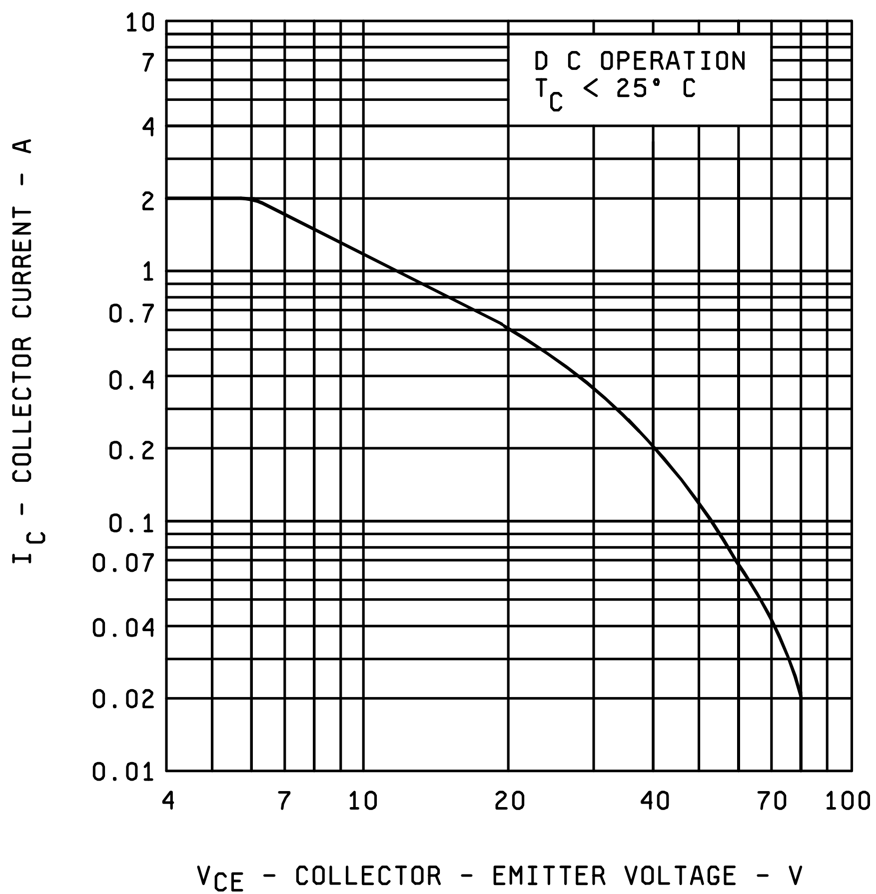
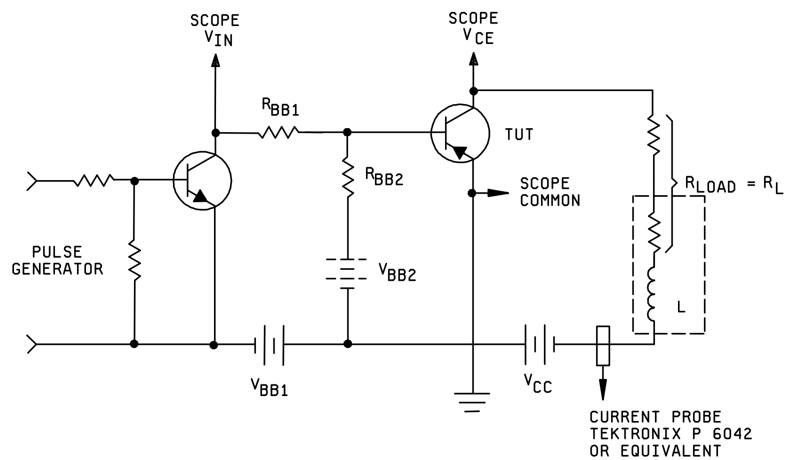


FIGURE 6. Maximum safe operating area.

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, $R_{IN} \geq 10$ MΩ, $C_{IN} \leq 11.5$ 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 7. Switching time test circuit.



R_{BB1} = 10 Ω
R_{BB2} = 100 Ω
L = 0.3 mH
R_L = 0.1 Ω
V_{CC} = 10 V dc
I_C = 10 nA
V_{BB1} = 10 V dc
V_{BB2} = 4 V dc

FIGURE 8. Unclamped inductive load energy 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 2N5153	JANHCA2N5151 JANHCA2N5153	JANHCB2N5151 JANHCB2N5153	JANHCC2N5151 JANHCC2N5153
2N5151 2N5153	JANKCA2N5151 JANKCA2N5153	JANKCB2N5151 JANKCB2N5153	JANHCC2N5151 JANHCC2N5153

6.5 Changes from previous issue. The margins of this revision are marked with an asterisk to indicate where changes from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous revision.

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

Review activities:
Army - MI

Preparing activity:
DLA - CC

(Project 5961-2530)

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.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/545E	2. DOCUMENT DATE 13 March 2003

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 FAX EMAIL	7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. Point of Contact Alan Barone	b. TELEPHONE Commercial: 614-692-0510 DSN: 850-0510 FAX: 614-692-6939 EMAIL: alan.barone@dla.mil
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, P. O. Box 3990, Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888