The documentation and process conversion measures necessary to comply with this document shall be completed by 13 February 2014.

INCH-POUND

MIL-PRF-19500/538G
13 December 2013
SUPERSEDING
MIL-PRF-19500/538F
10 February 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER,
TYPES 2N6676, 2N6678, 2N6676T1, 2N6678T1, 2N6676T3, 2N6678T3, 2N6691, AND 2N6693,
JAN, JANTX, JANTXV, JANS, JANSM, JANSD, JANSP, JANSL, JANSR, JANSF, JANSG, JANSH, JANHCA,
JANKCA, JANKCAM, JANKCAD, JANKCAP, JANKCAL, JANKCAR, JANKCAF, JANKCAG, AND JANKCAH

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

The requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-19500.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN silicon, power transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type. Provisions for radiation hardness assurance (RHA) to eight radiation levels is provided for JANS and JANKC product assurance levels. RHA level designators “M”, “D”, “P“, “L”, “R”, “F”, “G”, and “H” are appended to the device prefix to identify devices, which have passed RHA requirements.

1.2 Physical dimensions. See figure 1 (TO-3) - 2N6676, 2N6678; figure 2 (TO-61) - 2N6691, 2N6693, figure 3 (TO-254AA) - 2N6676T1, 2N6678T1, figure 4 (TO-257AA) - 2N6676T3, 2N6678T3, and figure 5 (JANHC and JANKC).

1.3 Maximum ratings.

Types	P_T T_A = +25°C	P_T (1) T_C = +25°C	$R_{\theta JC}$ (2)	V_{CBO} and V_{CEX}	V_{CEO}	T_J and T_{STG}	V_{EBO}	I_B	I_C
	W	W	°C/W	V dc	V dc	°C	V dc	A dc	A dc
2N6676, 2N6676T1	6	175	1.0	450	300	-65 to +200	8.0	5	15
2N6678, 2N6678T1	6	175	1.0	650	400	-65 to +200	8.0	5	15
2N6676T3	4	(3) 125	1.3	450	300	-65 to +200	8.0	5	15
2N6678T3	4	(3) 125	1.3	650	400	-65 to +200	8.0	5	15
2N6691	6	175	1.0	450	300	-65 to +200	8.0	5	15
2N6693	6	175	1.0	650	400	-65 to +200	8.0	5	15

(1) See figures 6 and 7 for temperature-power derating curves.
(2) See figures 8 through 11, thermal impedance curves.
(3) For TO-257 devices with typical mounting and small footprint, conservatively rated at 125 W and 1.3°C/W only.

* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil .

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

Limits	h_{FE1} V_{CE} = 3 V dc I_C = 1 A dc (1)	h_{FE2} V_{CE} = 3 V dc I_C = 15 A dc (1)	$V_{BE(sat)}$ I_C = 15 A dc I_B = 3 A dc	$V_{CE(sat)}$ I_C = 15 A dc I_B = 3 A dc
			V dc	V dc
Min	15	8		
Max	40	20	1.5	1.0

Limits	$\|h_{fe}\|$	C_{obo}	Switching (2)				
	V_{CE} = 10 V dc I_C = 1 A dc f = 5 MHz	V_{CB} = 10 V dc I_E = 0 100 KHz < f < 1 MHz	t_c	t_d	t_r	t_s	t_f
		pF	µs	µs	µs	µs	µs
Min	3	150					
Max	10	500	0.5	0.1	0.6	2.5	0.5

(1) Pulsed (see 4.5.1).
(2) See figure 12 (pulse response circuits).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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 of documents cited in sections 3, 4, or 5 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

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

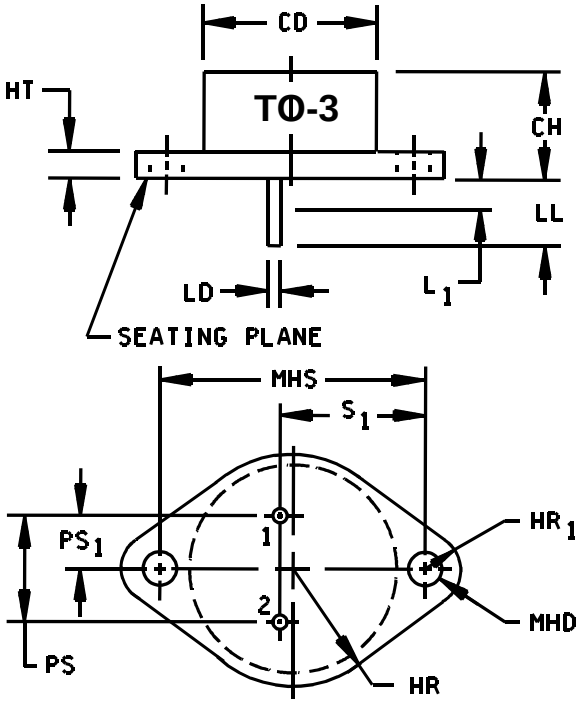
DEPARTMENT OF DEFENSE STANDARDS

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

* (Copies of these documents are available online at http://quicksearch.dla.mil/ or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

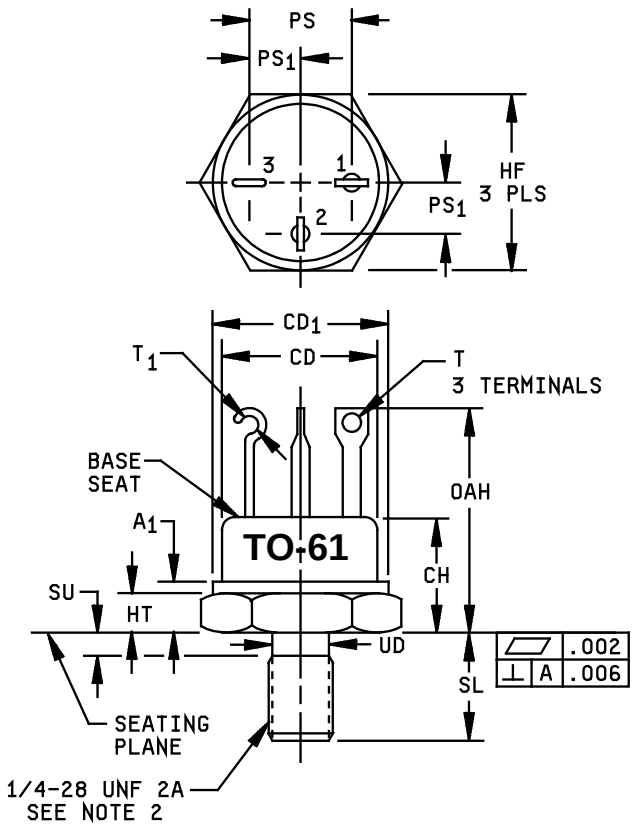
* 2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a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

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.875		22.22	3
CH	.270	.380	6.86	9.65	
HR	.495	.525	12.57	13.34	
HR_1	.131	.188	3.33	4.78	
HT	.060	.135	1.52	3.43	
L_1		.050		1.27	5, 9
LD	.038	.043	0.97	1.09	5, 9
LL	.312	.500	7.92	12.70	5
MHD	.151	.161	3.84	4.09	7
MHS	1.177	1.197	29.90	30.40	
PS	.420	.440	10.67	11.18	4
PS_1	.205	.225	5.21	5.72	4, 5
S_1	.655	0.675	16.64	17.14	4



NOTES:
1. Dimensions are in inches.
2. Millimeters 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 seating plane. Measurement shall be made at seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. Terminal 1 is the emitter, terminal 2 is base. The collector shall be electrically connected to the case.
9. LD applies between L_1 and LL. Diameter is uncontrolled in L_1.
10. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions (TO-3) for 2N6676 and 2N6678.

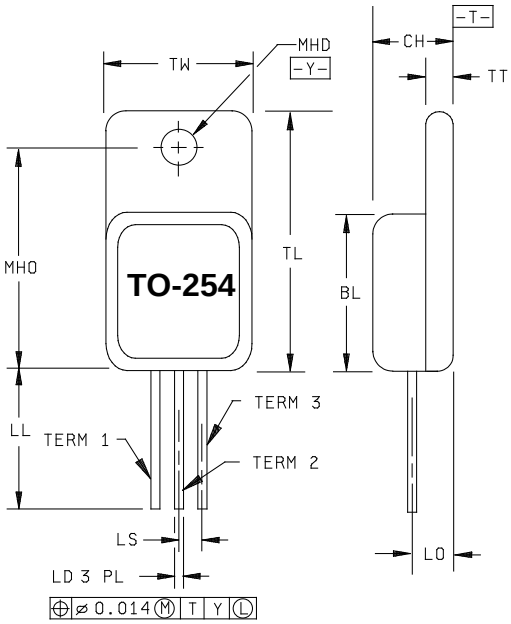


Ltr	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A_1		.270		6.86	
CD	.570	.610	14.48	15.49	
CD_1	.610	.687	15.49	17.45	
CH	.325	.460	8.26	11.68	
HF	.667	.687	16.94	17.45	
HT	.090	.150	2.29	3.81	
OAH	.640	.875	16.26	22.22	4
PS	.340	.415	8.64	10.54	3, 6
PS_1	.170	.213	4.32	5.41	3, 6
SL	.422	.455	10.72	11.56	
SU		.090		2.29	7
T	.047	.072	1.19	1.83	
T_1	.046	.077	1.17	1.96	
UD	.220	.249	5.59	6.32	

NOTES:

1. Dimensions are in inches, millimeters are given for general information only.
2. See NSB Handbook H28, “Screw-Thread Standards for Federal Services”.
3. The orientation of the terminals in relation to the hex flats is not controlled.
4. All three terminals.
5. The case temperature may be measured anywhere on the seating plane within .125 inch (3.18 mm) of the stud.
6. Terminal spacing measured at the base seat only.
7. This dimension applies to the location of the center line of the terminals.
8. Terminal - 1, emitter; terminal - 2, base; terminal - 3, collector. All leads are isolated from the case.
9. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 2. Physical dimensions (TO-61) for 2N6691 and 2N6693.

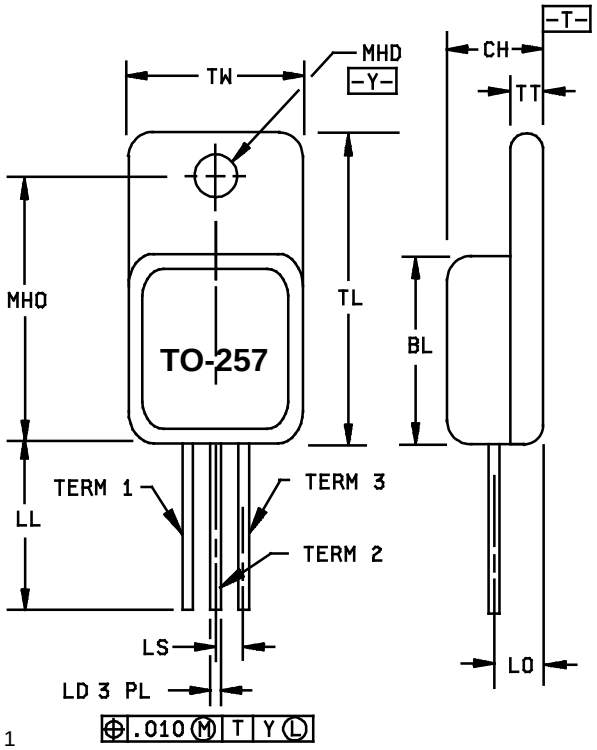


Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.84
CH	.249	.260	6.32	6.60
LD	.035	.045	0.89	1.14
LL	.510	.570	12.95	14.48
LO	.150 BSC		3.81 BSC	
LS	.150 BSC		3.81 BSC	
MHD	.139	.149	3.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.84
Term 1	Base			
Term 2	Collector			
Term 3	Emitter			

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Methods used for electrical isolation of the terminals feedthroughs shall employ materials that contain a minimum of 90 percent AL2O3 (ceramic).
4. All terminals are isolated from case.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 3. Dimensions and configuration for 2N6676T1 and 2N6678T1 (TO-254AA).



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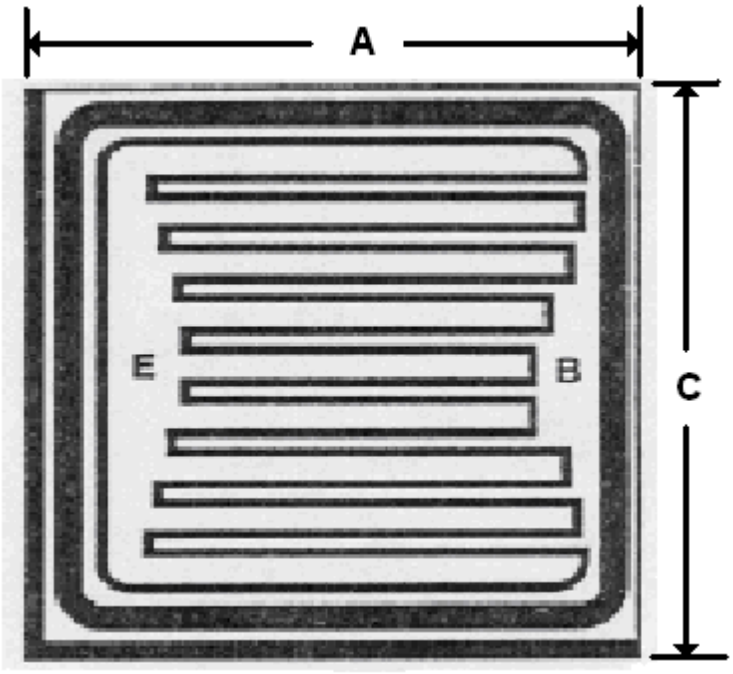
Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.410	.430	10.41	10.92
CH	.190	.200	4.83	5.08
LD	.025	.035	0.64	0.89
LL	.500	.750	12.70	19.05
LO	.120 BSC		3.05 BSC	
LS	.100 BSC		2.54 BSC	
MHD	.140	.150	3.56	3.81
MHO	.527	.537	13.39	13.63
TL	.645	.665	16.38	16.89
TT	.035	.045	0.89	1.14
TW	.410	.420	10.41	10.67
Term 1	Base			
Term 2	Collector			
Term 3	Emitter			

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Methods used for electrical isolation of the terminals feedthroughs shall employ materials that contain a minimum of 90 percent AL2O3 (ceramic).
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 4. Dimensions and configuration for 2N6676T3 and 2N6678T3 (TO-257AA).



Ltr.	Dimensions			
	Inch		Millimeters	
	Min	Max	Min	Max
A, C	.205	.215	5.21	5.46

DESIGN DATA
Metalization:
Top: Aluminum 54,000 Å minimum, 60,000 Å nominal.
Back: Al/Ti/Ni/Au 10,000 Å minimum, 12,500 Å nominal.
Back side: Collector.
Chip thickness: .012 inch (0.305 mm) ±.002 inch (0.051 mm).
Bonding pad: B = .018 inch (0.46 mm) x .040 (1.02 mm).
E = .018 inch (0.46 mm) x .040 (1.02 mm).

* FIGURE 5. JANHCA and JANKCA (A version) die dimensions.

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 and as follows:

V_{CEX} - Collector cutoff voltage (dc) with specified circuit between base and emitter.
R_{ISO} - Resistance between device case and leads

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (TO-3) - 2N6676, 2N6678; figure 2 (TO-61) - 2N6691, 2N6693; figure 3 (TO-254AA) - 2N6678T1, 2N6676T1, and figure 4 (TO-257AA) - 2N6676T3 and 2N6678T3 herein, and figure 5.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4.2 Construction. These devices shall be constructed in a manner and using materials which enable the devices to meet the applicable requirements of MIL-PRF-19500 and this document.

3.5 Radiation hardness assurance (RHA). Radiation hardness assurance requirements, PIN designators, and test levels shall be as defined in MIL-PRF-19500.

3.6 Marking. Marking shall be in accordance with MIL-PRF-19500. The radiation hardened designator M, D, P, L, R, F, G, or H shall immediately precede (or replace) the device “2N” identifier (depending upon degree of abbreviation required).

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

3.8 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.9 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 and table I, II, and III).

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 inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

* 4.3 Screening. Screening shall be in accordance with table E-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 E-IV of MIL-PRF-19500)	Measurements	
	JANS	JANTX and JANTXV levels
(1) 3c	Thermal impedance, method 3131 of MIL-STD-750 (see 4.3.1)	Thermal impedance, method 3131 of MIL-STD-750 (see 4.3.1)
9	I_{CEX1} and h_{FE2}	I_{CEX1} and h_{FE2}
11	I_{CEX1} and h_{FE2} ΔI_{CEX1} = 100 percent of initial value or 500 nA dc, whichever is greater; Δh_{FE2} = ±15 percent of initial value.	I_{CEX1} and h_{FE2} ΔI_{CEX1} = 100 percent of initial value or 500 nA dc, whichever is greater; Δh_{FE2} = ±25 percent of initial value.
12	See 4.3.2	See 4.3.2
13	Subgroup 2 and 3 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 500 nA dc, whichever is greater; Δh_{FE2} = ±25 percent of initial value.	Subgroup 2 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 500 nA dc, whichever is greater; Δh_{FE2} = ±25 percent of initial value.
* 17	For TO-254AA packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.	For TO-254AA packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.

* (1) Shall be performed anytime after temperature cycling, screen 3a; JANTX and JANTXV levels do not need to be repeated in screening requirements.

* 4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M, I_H, t_H, t_{SW}, (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. The thermal impedance limit shall comply with the thermal impedance graph on figures 8, 9, 10, and 11 (less than or equal to the curve value at the same t_H time) and shall be less than the process determined statistical maximum limit as outlined in method 3131 of MIL-STD-750. See table III, subgroup 4 herein.

4.3.2 Power burn-in conditions. Power burn-in conditions are: T_J = + 175 °C minimum, $V_{CB} \geq$ 100 V dc; T_A = +30°C maximum.

4.3.3 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.

* 4.3.4 Dielectric withstanding voltage.

a. Magnitude of test voltage……..900 V dc.

b. Duration of application of test voltage……..15 seconds (min).

c. Points of application of test voltage……...All leads to case (bunch connection).

d. Method of connection……..Mechanical.

e. Kilovolt-ampere rating of high voltage source…….1,200 V/1.0 mA (min).

f. Maximum leakage current……...1.0 mA.

g. Voltage ramp up time.....500 V/second.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and 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 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 E-VIA (JANS) and table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

* 4.4.2.1 Group B inspection, table E-VIA (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	2037	Test condition D, all internal leads for each device shall be pulled separately.
* B4	1037	$V_{CB} \geq 100$ V dc.
B5	1027	V_{CB} = 100 V dc; adjust T_A and P_D to achieve T_J = +275°C minimum. P_D = 100 percent of rated P_T minimum; T_A = +100°C maximum.

4.4.2.2 Group B inspection, table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1027	For eutectic die attach: $V_{CB} \geq 100$ V dc; adjust P_T to achieve T_J = +175°C minimum; T_A = +30°C maximum
B3	1037	For solder die attach: 2,000 cycles, $V_{CB} \geq 100$ V dc.

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

	Subgroup	Method	Condition
	C2	2036	Test condition A; weight = 10 pounds; time = 15 s.
	C2	2036	Test condition D1; torque = 6 inch-ounce; time =15 s (2N6691, 2N6693 only).
	C2	2036	Stud torque (2N6691, 2N6693 only), test condition D2; torque = 15 inch-pound; time = 15 s.
	C5	3131	See 4.3.1, $R_{\theta JC}$ = 1.0°C for 2N6676, 2N6676T1, 2N6678, 2N6678T1, 2N6691, 2N6693; $R_{\theta JC}$ = 1.3°C for 2N6676T3, 2N6678T3.
	C6	1026	For eutectic die attach: $V_{CB} \geq 100$ V dc; adjust P_T to achieve T_J = +175°C minimum; T_A = +30°C maximum.
*	C6	1037	For solder die attach: $V_{CB} \geq 100$ V dc.

4.4.4 Group D inspection. Conformance inspection for hardness assured JANS, JANJ, and JANTXV types shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and method 1019 of MIL-STD-750, for total ionizing dose or method 1017 of MIL-STD-750 for neutron fluence as applicable (see 6.2 herein), except group D, subgroup 2 may be performed separate from other subgroups.

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

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.

4.5.2 Insulation resistance test. Insulation resistance test conditions are as follows: Method 1016 of MIL-STD-750, short collector, emitter and base terminals together. Limit is 10^9 Ω minimum.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Thermal impedance	3131	See 4.3.1	$Z_{\theta JX}$			°C/W
Collector to base breakdown voltage	3011	Bias condition D, I_C = 200 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6676, 2N6676T1 2N6676T3, 2N6691				300		V dc
2N6678, 2N6678T1 2N6678T3, 2N6693				400		V dc
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX1}		1	µA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 650 V dc				
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX2}			
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 300 V dc			500	nA
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 400 V dc			500	nA
Collector to base cutoff current	3036	Bias condition D;	I_{CBO}		1.0	mA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CBO} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CBO} = 650 V dc				
Emitter-base cutoff current	3061	Bias condition D, V_{EB} = 8 V dc	I_{EBO}		2.0	mA dc
Base emitter voltage	3066	Test condition A; I_C = 15 A dc; pulsed (see 4.5.1); I_B = 3 A dc	$V_{BE(sat)}$		1.5	V dc
Collector to emitter saturated voltage	3071	I_C = 15 A dc; pulsed (see 4.5.1) I_B = 3 A dc	$V_{CE(sat)1}$		1.0	V dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	h_{FE1}	15	40	
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 15 A dc; pulsed (see 4.5.1)	h_{FE2}	8	20	

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T_A = +125°C				
Collector to emitter cutoff current	3041	Bias condition A; V_{BE} = -1.5 V dc	I_{CEX3}		50	µA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 650 V dc				
Collector to emitter saturated voltage	3071	I_C = 15 A dc; I_B = 3 A dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		2.0	V dc
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX4}			
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 300 V dc			90	µA
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 400 V dc			90	µA
Low-temperature operation :		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 3 V dc I_C = 15 A dc; pulsed (see 4.5.1)	h_{FE3}	4		
Subgroup 4						
Magnitude of common emitter small-signal short-circuit forward- current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 1 A dc; f = 5 MHz	$\|h_{fe}\|$	3	10	
Open capacitance (open circuit)	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1.0 MHz	C_{obo}	150	500	pF
Pulse response:	3251	T_A = +25°C; Test condition A, except test circuit and pulse requirement in accordance with figure 12				
Pulse delay time			t_d		0.1	µs
Pulse rise time			t_r		0.6	µs
Pulse storage time			t_s		2.5	µs
Pulse fall time			t_f		0.5	µs
Cross over time			t_c		0.5	µs
Subgroup 5		T_C = +25°C				
Safe operating area (dc operation)	3051	t = 1 s; 1 cycle; (see figure 13)				
Test 1 (All device types)		V_{CE} = 11.7 V dc; I_C = 15 A dc				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued						
Test 2 (2N6676, 2N6678, 2N6676T1, 2N6676T3, 2N6678T1, 2N6678T3)		V_{CE} = 30 V dc; I_C = 5.9 A dc				
Test 3 (All device types)		V_{CE} = 100 V dc; I_C = 0.25 A dc				
Test 4 (2N6691, 2N6693)		V_{CE} = 25 V dc; I_C = 7 A dc				
Test 5 (2N6676, 2N6678, 2N6676T1, 2N6676T3, 2N6678T1, 2N6678T3) (2N6691, 2N6693)		V_{CE} = 300 V dc; I_C = 20 mA dc V_{CE} = 400 V dc; I_C = 10 mA dc				
Safe operating area (clamped switching)	3053	T_A = +25°C, V_{CC} = 15 V dc (see figure 14); Load condition B, V_{BB2} = 5.0 V, R_{BB1} = 5 Ω; R_{BB2} = 1.5 Ω; L = 50 μH; R of inductor = 0.05 Ω, R_{load} =R of inductor				
2N6676, 2N6676T1, 2N6676T3, 2N6691		Clamp voltage = 350 V dc; I_C = 15 A dc				
2N6678, 2N6678T1, 2N6678T3, 2N6693		Clamp voltage = 450 V dc; I_C = 15 A dc				
Electrical measurements		Table I, subgroup 2 herein.				
Subgroup 6						
Not applicable						
Subgroup 7						
Insulation resistance (2N6676T1, 2N6676T3, 2N6678T1, 2N6678T3, 2N6691 and 2N6693 only)	1016	See 4.5.2	R_{ISO}	$1x10^9$		Ω

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

TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1 4/						
Neutron irradiation	1017	Neutron exposure Vces = 0V				
Collector to base breakdown voltage	3011	Bias condition D, I_C = 200 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6676, 2N6676T1 2N6676T3, 2N6691				300		V dc
2N6678, 2N6678T1 2N6678T3, 2N6693				400		V dc
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX1}		2	µA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 650 V dc				
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX2}			
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 300 V dc			1.0	uA
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 400 V dc			1.0	uA
Collector to base cutoff current	3036	Bias condition D;	I_{CBO}		2.0	mA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CBO} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CBO} = 650 V dc				
Emitter-base cutoff current	3061	Bias condition D, V_{EB} = 8 V dc	I_{EBO}		4.0	mA dc
Base emitter voltage	3066	Test condition A; I_C = 15 A dc; pulsed (see 4.5.1); I_B = 3 A dc	$V_{BE(sat)}$		1.73	V dc
Collector to emitter saturated voltage	3071	I_C = 15 A dc; pulsed (see 4.5.1) I_B = 3 A dc	$V_{CE(sat)1}$		1.15	V dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	[h_{FE1}] 5/	[7.5]	40	
Forward-current transfer Ratio	3076	V_{CE} = 3 V dc; I_C = 15 A dc; pulsed (see 4.5.1)	[h_{FE2}] 5/	[4]	20	

See footnotes at end of table.

TABLE II. Group D inspection - Continued.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2						
Total dose irradiation	1019	Gamma exposure				
2N6676, 2N6676T1 2N6676T3, 2N6691		Vces = 240V				
2N6678, 2N6678T1 2N6678T3, 2N6693		Vces = 320V				
Collector to base breakdown voltage	3011	Bias condition D, I_C = 200 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6676, 2N6676T1 2N6676T3, 2N6691				300		V dc
2N6678, 2N6678T1 2N6678T3, 2N6693				400		V dc
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX1}		2	µA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 650 V dc				
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc	I_{CEX2}			
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CEX} = 300 V dc			1.0	uA
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CEX} = 400 V dc			1.0	uA
Collector to base cutoff current	3036	Bias condition D;	I_{CBO}		2.0	mA dc
2N6676, 2N6676T1 2N6676T3, 2N6691		V_{CBO} = 450 V dc				
2N6678, 2N6678T1 2N6678T3, 2N6693		V_{CBO} = 650 V dc				
Emitter-base cutoff current	3061	Bias condition D, V_{EB} = 8 V dc	I_{EBO}		4.0	mA dc
Base emitter voltage	3066	Test condition A; I_C = 15 A dc; pulsed (see 4.5.1); I_B = 3 A dc	$V_{BE(sat)}$		1.73	V dc
Collector to emitter saturated voltage	3071	I_C = 15 A dc; pulsed (see 4.5.1) I_B = 3 A dc	$V_{CE(sat)1}$		1.15	V dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	$[h_{FE1}]$ 5/	[7.5]	40	
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 15 A dc; pulsed (see 4.5.1)	$[h_{FE2}]$ 5/	[4]	20	

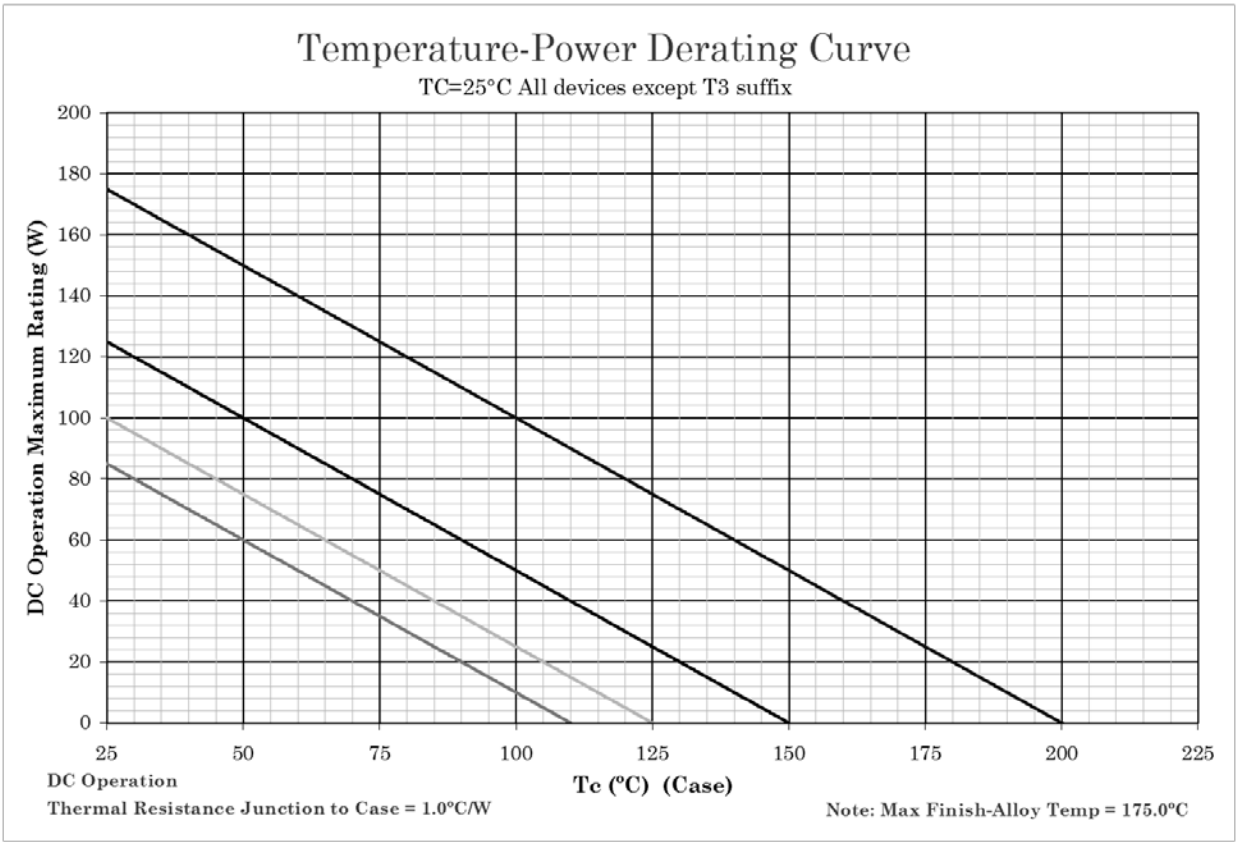
See footnotes at end of table.

TABLE II. Group D inspection - Continued.

1/ Tests to be performed on all devices receiving radiation exposure.
2/ For sampling plan, see MIL-PRF-19500.
3/ Electrical characteristics apply to all device types unless otherwise noted.
4/ See 6.2.e herein.
5/ See method 1019, of MIL-STD-750, for how to determine [h_{FE}] by first calculating the delta($1/h_{FE}$) from the pre and post radiation h_{FE}. Notice that [h_{FE}] is not the same as h_{FE} and cannot be measured directly. The [h_{FE}] value can never exceed the pre-radiation minimum h_{FE} that it is based upon.

* TABLE III. Group E inspection (all quality levels) - for qualification and re-qualification only.

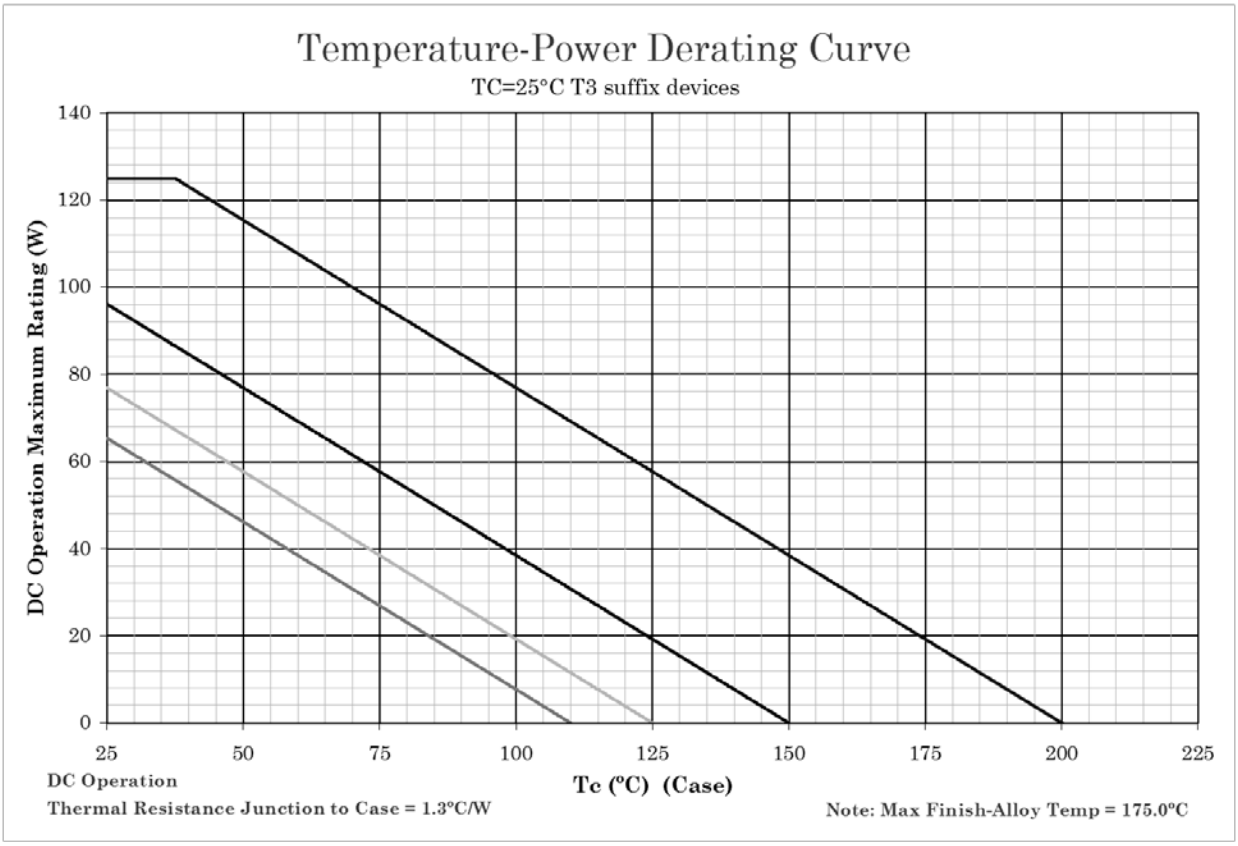
Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices c = 0
Thermal shock glass strain	1056	0°C to +100°C, 100 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 2			45 devices c = 0
Blocking life	1048	1,000 hours minimum, T_A = 150°C, V_{CB} = 80 percent of rated, without going over the maximum rated V_{CEO}.	
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 4			
Thermal impedance curves		See table E-IX of MIL-PRF-19500.	
Subgroup 5			3 devices c = 0
Barometric pressure	1001	Test condition C, see 1.3. Unless otherwise specified, the device shall be subjected to the maximum voltage it would be subjected to under rated operating conditions.	
Subgroup 6			
ESD	1020		
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition A.	



NOTES:

1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq +125°C$, and +110°C to show power rating where most users want to limit T_J in their application.

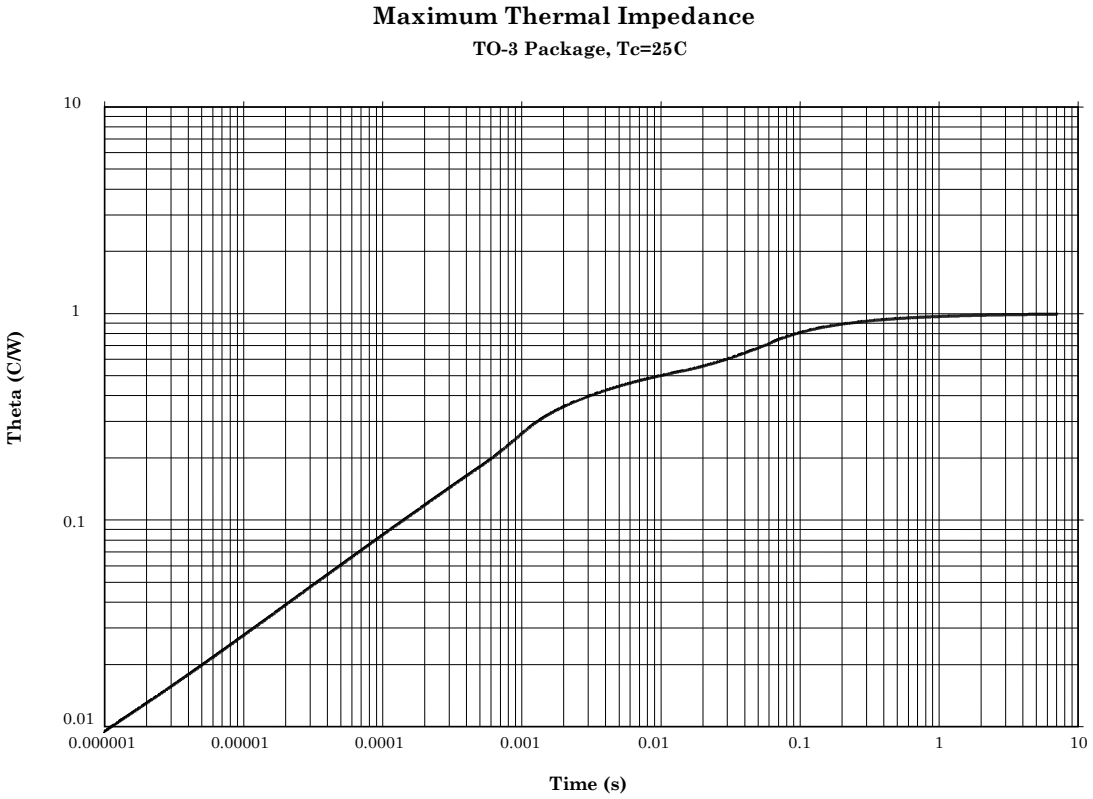
FIGURE 6. Temperature derating graph (all except T3 (TO-257AA) packages).



NOTES:

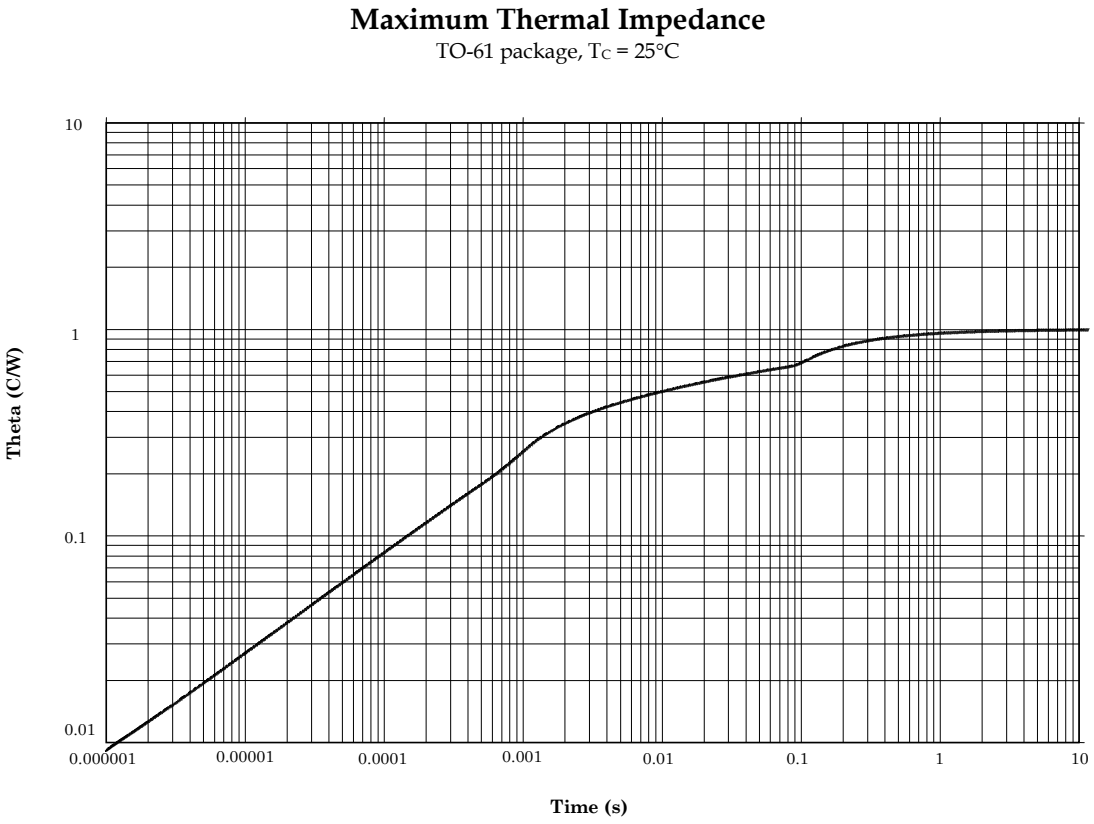
1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq +125°C$, and +110°C to show power rating where most users want to limit T_J in their application.

FIGURE 7. Temperature derating graph for T3 (TO-257AA) packages.



$R_{\theta JC}$ = 1.0 °C/W max.

FIGURE 8. Thermal impedance graphs (2N6676 and 2N6678).



$R_{\theta JC}$ = 1.0 °C/W max.

FIGURE 9. Thermal impedance graphs (2N6691 and 2N6693).

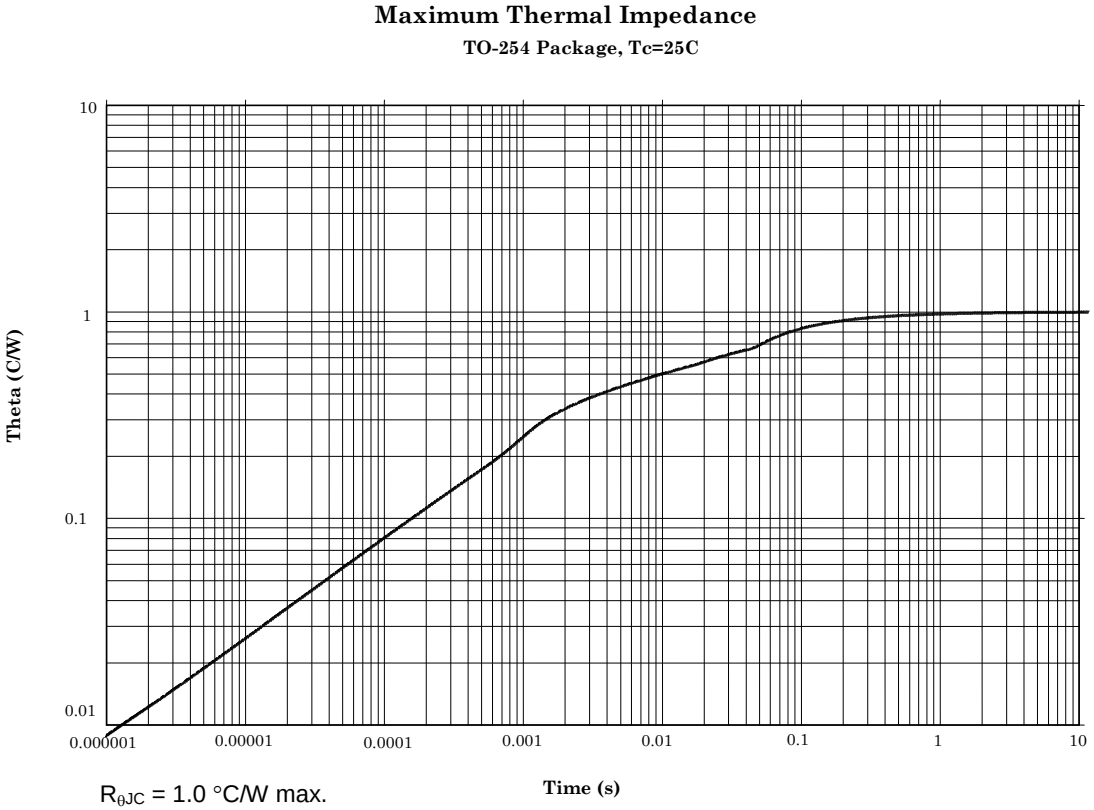
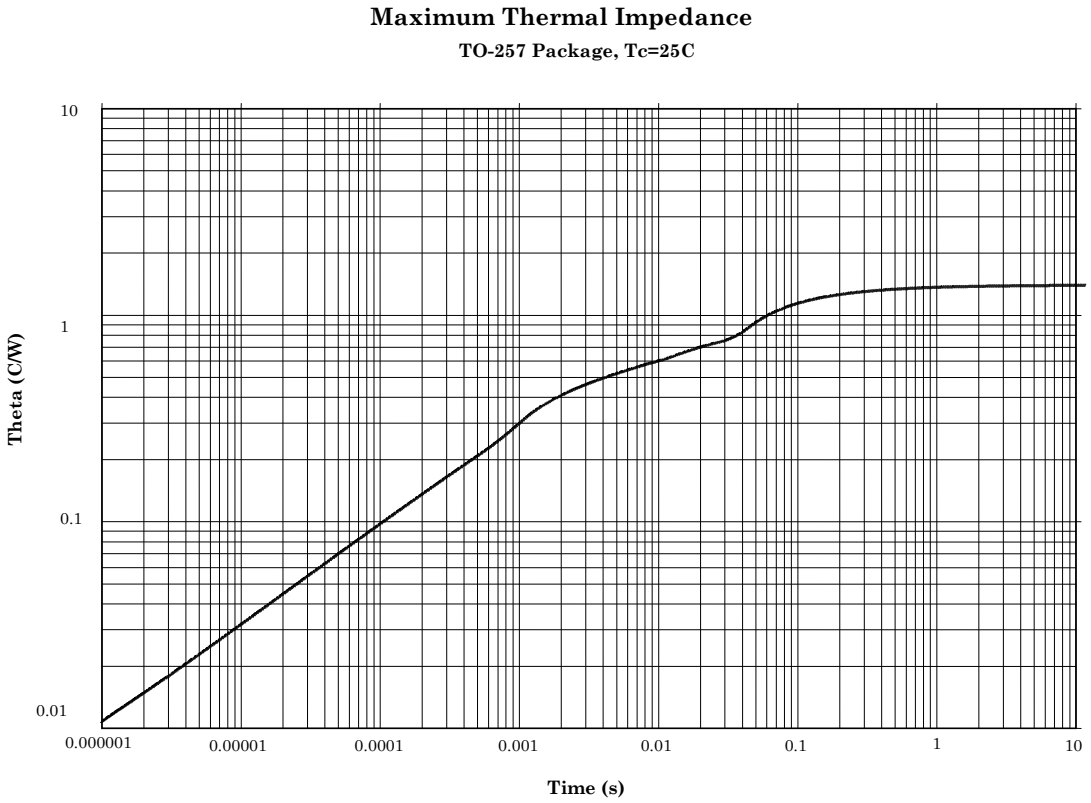


FIGURE 10. Thermal impedance graphs (2N6676T1 and 2N6678T1).



$R_{\theta JC}$ = 1.3 °C/W max.

FIGURE 11. Thermal impedance graphs (2N6676T3 and 2N6678T3).

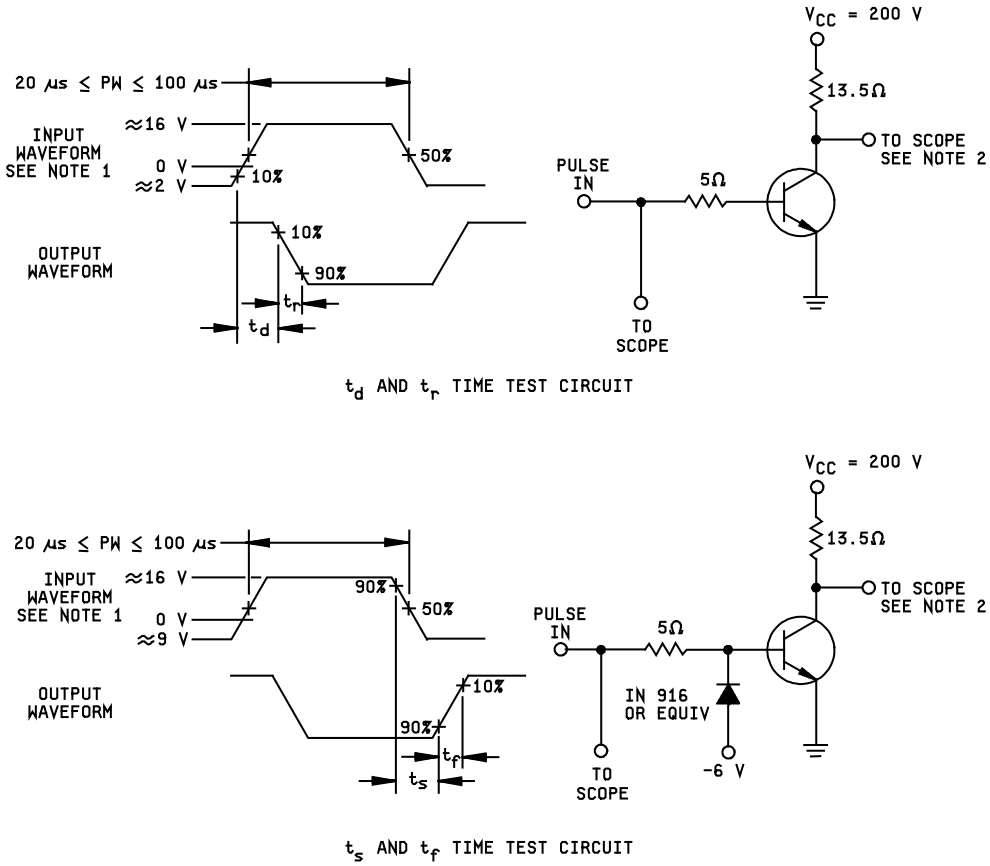
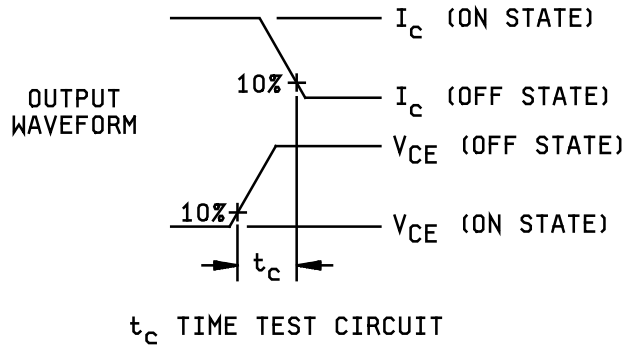
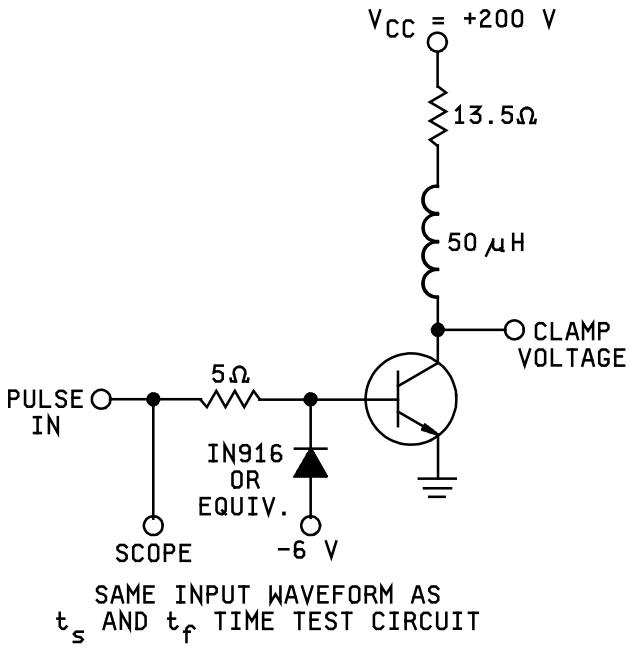


FIGURE 12. Pulse response test circuit.



t_c TIME TEST CIRCUIT



SAME INPUT WAVEFORM AS t_s AND t_f TIME TEST CIRCUIT

NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 20 ns; duty cycle ≤ 2 percent; generator source impedance shall be 50 ohms.
2. Output sampling oscilloscope: $Z_{in} \geq 100$ k ohms; $C_{in} \leq 12$ pF; rise time ≤ 5 ns.

FIGURE 12. Pulse response test circuits - Continued.

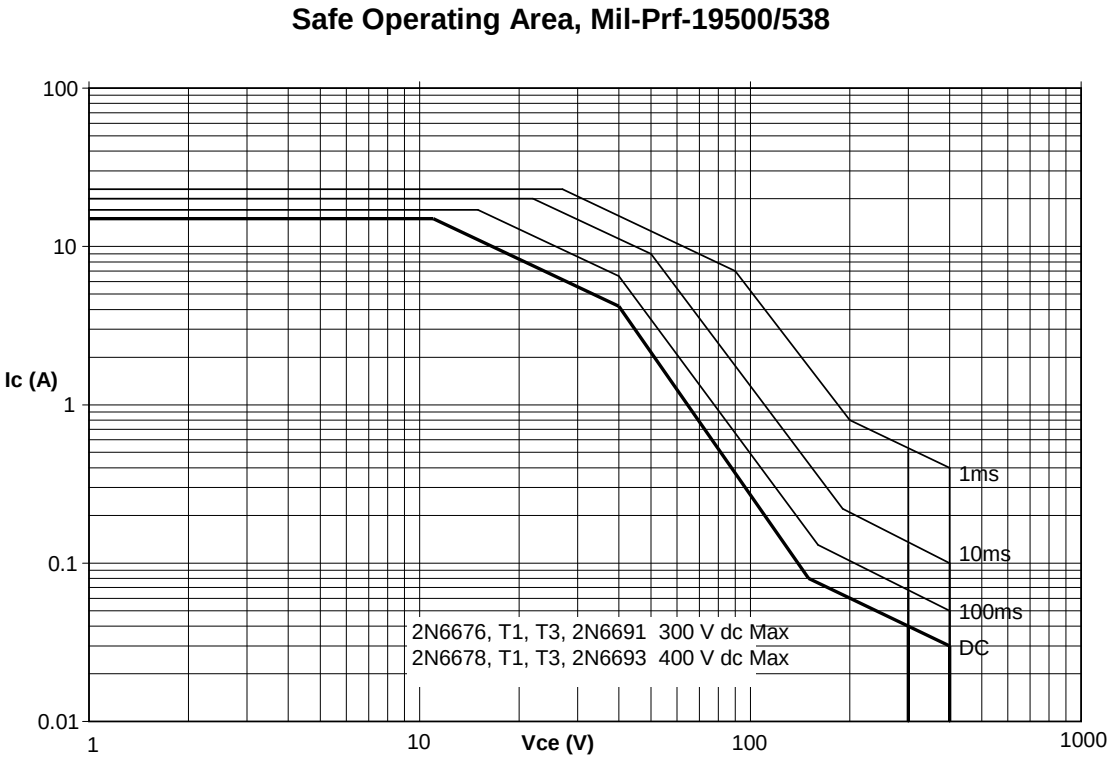


FIGURE 13. Maximum safe operating graph (dc).

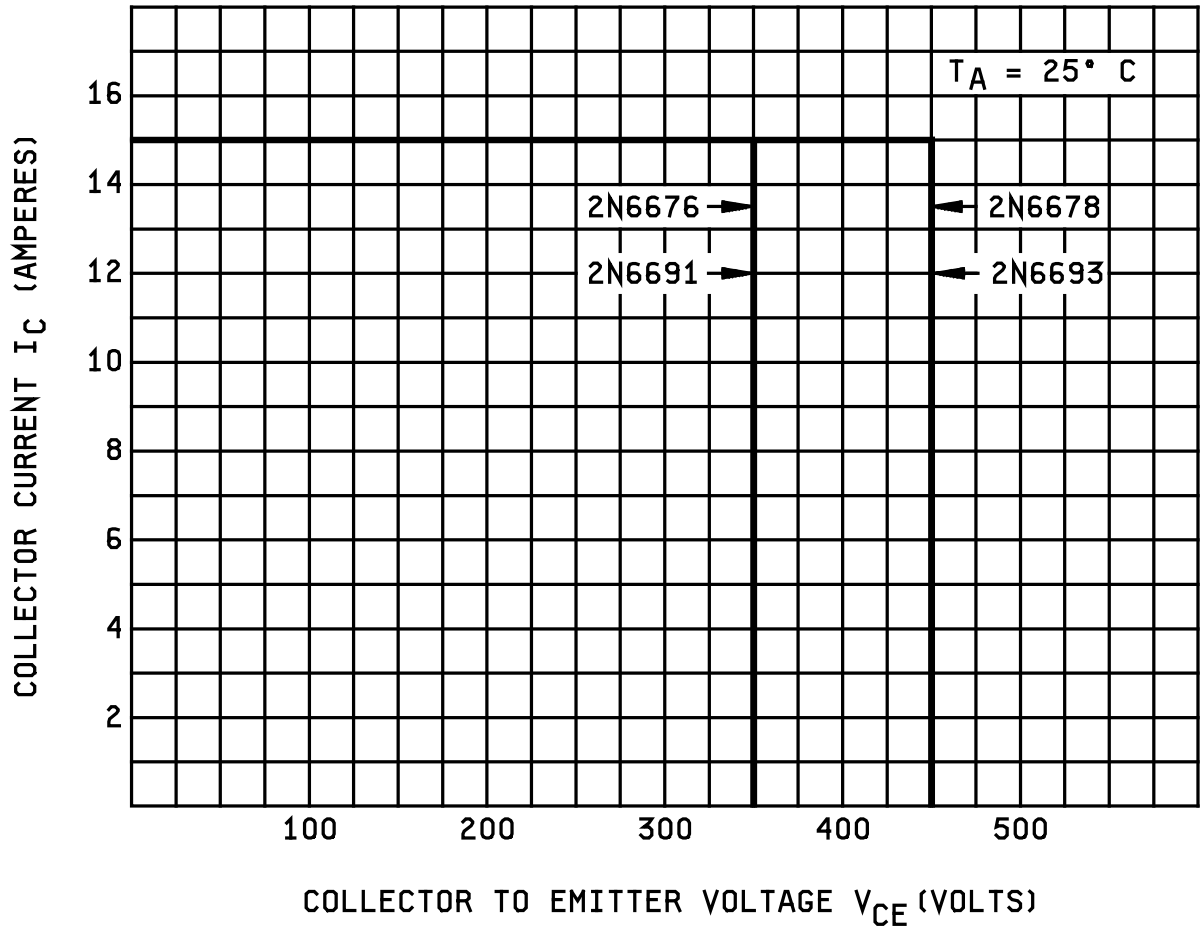


FIGURE 14. Safe operating area for switching between saturation and cutoff (clamped inductive load) (all devices).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's 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. The notes specified in MIL-PRF-19500 are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Packaging requirements (see 5.1).

c. Lead finish (see 3.4.1).

d. Product assurance level and type designator.

e. For acquisition of RHA designed devices, table II, subgroup 1 testing of group D is optional. If subgroup 1 testing is desired, it should be specified in the contract.

* 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 DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue 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 issue.

6.5 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHC2N2434A) will be identified on the QML.

JANC ordering information	
PIN	Manufacturer
	43611
2N6676	JANHCA2N6676 JANKCA2N6676
2N6678	JANHCA2N6678 JANKCA2N6678

Custodians:
Army - CR
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2014-029)

Review activities:
Army - MI
Air Force - 19, 99

* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.