The documentation and process conversion measures necessary to comply with this revision shall be completed by 14 February 2015.

INCH-POUND

MIL-PRF-19500/534H
14 November 2014
SUPERSEDING
MIL-PRF-19500/534G
27 July 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER, TYPES 2N5002 AND 2N5004, JAN, JANTX, JANTXV, JANS, JANSM, JANSD, JANSP, JANSL, JANSR, JANSF, JANSG, JANSH, JANHCB, JANKCB, JANKCBM, JANKCBD, JANKCBP, JANKCBL, JANKCBR, JANKCBF, JANKCBG, AND JANKCBH.

Reactivated after (27 October 2011) and may be used for new and existing designs and acquisitions.

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 for use in high-speed power-switching applications. Four levels of product assurance (JAN, JANTX, JANTXV, and JANS) are provided for each encapsulated device type as specified in MIL-PRF-19500. Two levels of product assurance (JANHC and JANKC) for each unencapsulated device type die.

* 1.2 Package outlines. The device package outlines are as follows: T6-C, similar to TO-59 in accordance with figure 1 for all encapsulated device types. The dimensions and topography for JANHC and JANKC unencapsulated die are in accordance with figure 2.

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

P_T (1) T_A = 25°C	P_T (2) T_C = 25°C	$R_{\theta JA}$	$R_{\theta JC}$ (3)	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C (4)	Reverse pulse energy	T_{stg} and T_J
W	W	°C/W	°C/W	V dc	V dc	V dc	A dc	A dc	mJ	°C
2	58	88	3	100	80	5.5	5	10	15	-65 to +200

(1) Derate linearly 11.4 mW/°C for T_A > 25°C.
(2) For derating see figure 3.
(3) For thermal impedance see figure 4.
(4) This value applies for Pw ≤ 8.3 ms, duty cycle ≤ 1 percent.

* 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_{FE2} (1) V_{CE} = 5 V I_C = 2.5 A		$\|h_{fe}\|$ V_{CE} = 5 V I_C = 500 mA dc f = 10 MHz		$V_{BE(sat)2}$ (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
	2N5002	2N5004	2N5002	2N5004			
					V dc	V dc	pF
Min	30	70	6	7			
Max	90	200			2.2	1.5	250

(1) Pulsed (see 4.5.1).

* 1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.5 for PIN construction example and 6.6 for a list of available PINs.

* 1.5.1 JAN brand and quality level designators for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JAN", “JANTX”, “JANTXV" and "JANS".

* 1.5.2 Quality level designators for unencapsulated devices (die). The quality level designators for unencapsulated devices (die) that are applicable for this specification sheet from the lowest to the highest level are as follows: "JANHC" and "JANKC".

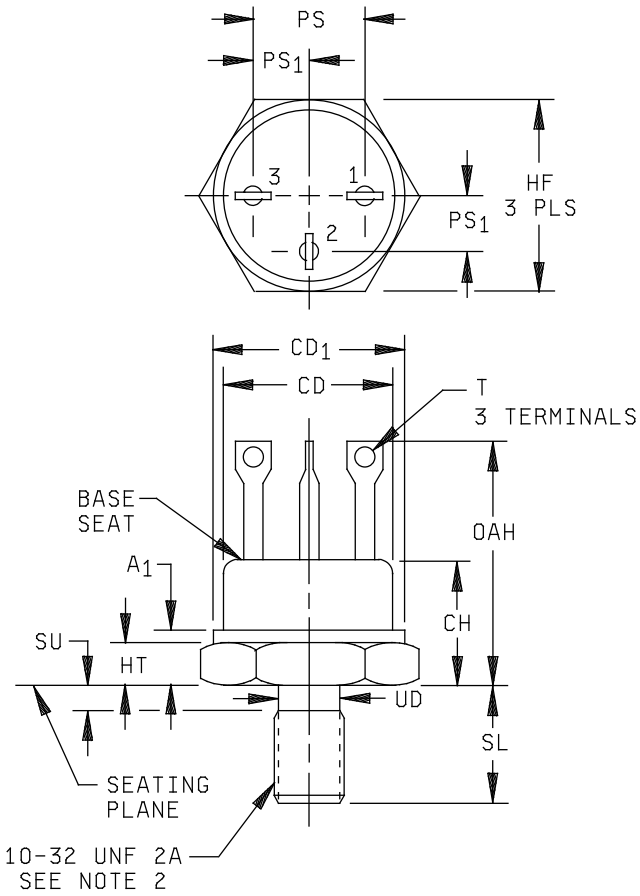
* 1.5.3 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest for JANTXV and JANS quality levels are as follows: “ M”, “D”, “P“, “L”, “R”, “F”, “G”, and “H".

* 1.5.4 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

* 1.5.4.1 First number and first letter symbols. The transistors of this specification sheet are identified by the first number and letter symbols "2N".

* 1.5.4.2 Second number symbols. The second number symbols for the transistor covered by this specification sheet are as follows: "5002" and “5004”.

* 1.5.5 Lead finish. The lead finishes applicable to this specification sheet are listed on QML-19500.

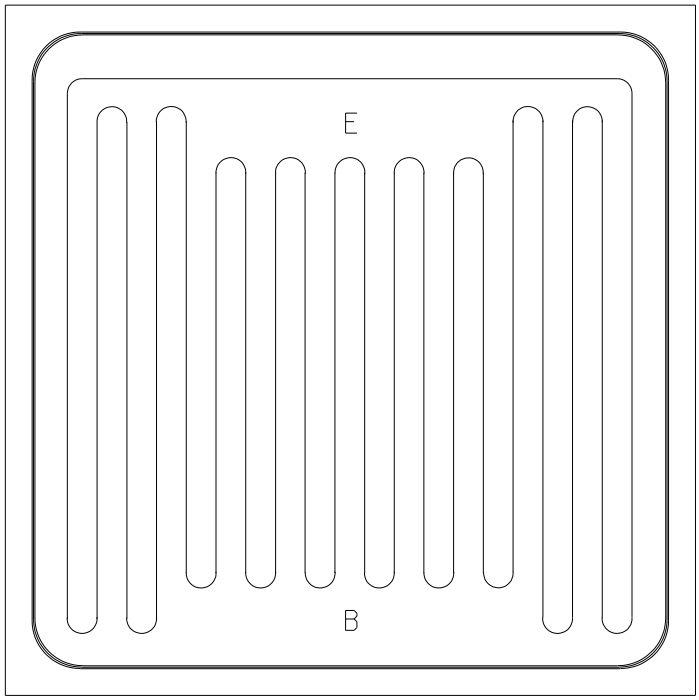


Ltr	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A_1		.250		6.35	
CD	.330	.360	8.38	9.14	
CD_1	.370	.437	9.40	11.10	
CH	.320	.468	8.13	11.89	
HF	.424	.437	10.77	11.10	
HT	.090	.150	2.29	3.81	
OAH	.575	.763	14.61	19.38	5
PS	.185	.215	4.70	5.46	4, 8
PS_1	.090	.110	2.29	2.79	4, 8
SL	.400	.455	10.16	11.56	
SU		.078		1.98	7
T	.040	.065	1.02	1.65	
UD	.155	.189	3.94	4.80	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Reference: Screw thread standards for Federal Standard H28/1 , (FED-STD-H28/1).
4. The orientation of the terminals in relation to the hex flats is not controlled.
5. All three terminals.
6. The case temperature may be measured anywhere on the seating plane within .125 inch (3.18 mm) of the stud.
7. Terminal spacing measured at the base seat only.
8. This dimension applies to the location of the center line of the terminals.
9. Terminal - 1, emitter; terminal - 2, base; terminal - 3, collector. Collector lead is isolated from the case.
10. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions of transistor types 2N5002 and 2N5004 (T6-C, similar to TO-59).



1.	Die size	.120 inch (3.05 mm) x .120 inch (3.05 mm) ±.002 inch (±0.05 mm).
2.	Die thickness	.014 inch (0.35 mm) ±.0015 inch nominal (±0.04 mm).
3.	Top metal	Aluminum, 54,000Å minimum, 60,000Å nominal.
4.	Back metal	Gold 6,000Å minimum, 8,000Å nominal.
5.	Backside	Collector
6.	Bonding pad	B = .060 x .012 inch (1.5 mm x 0.30 mm). E = .050 x .012 inch (1.27 mm x 0.30 mm).

FIGURE 2. JANHC and JANKC (B-version) die dimensions.

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 of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those 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/).

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.

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 manufacturers list 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.

$R_{\theta JA}$ Thermal resistance junction to ambient.
$R_{\theta JC}$ Thermal resistance junction to case.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (T6-C, similar to TO-59) and 2 (die) herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with 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 Radiation hardness assurance (RHA). Radiation hardness assurance requirements, PIN designators, and test levels shall be as defined in MIL-PRF-19500.

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

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

3.8 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).

3.9 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 tables I and II).

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.

* 4.3.1 Screening. Screening of packaged devices 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	Measurement	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance method 3131 of MIL-STD-750 (see 4.3.3)	Thermal impedance method 3131 of MIL-STD-750 (see 4.3.3)
9	I_{CES1} and h_{FE2}	Not applicable
11	I_{CES1} and h_{FE2} ΔI_{CES1} = 100 percent or 100 nA, whichever is greater; Δh_{FE2} = ±20 percent	I_{CES1} and h_{FE2}
12	See 4.3.4	See 4.3.4
13	Subgroups 2 and 3 of table I herein; ΔI_{CES1} = +100 percent of initial value or 100 nA, whichever is greater. Δh_{FE2} = ±20 percent	Subgroup 2 of table I herein; ΔI_{CES1} = +100 percent of initial value or 100 nA, whichever is greater. Δh_{FE2} = ±20 percent

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

* 4.3.2 Screening of unencapsulated die (JANHC and JANKC). Screening of JANHC and JANKC unencapsulated die shall be in accordance with appendix G of MIL-PRF-19500.

4.3.3 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_{MD} (and V_C where appropriate). The thermal impedance limit used in screen 3c of 4.3 and the subgroup 2 of table I herein shall comply with the thermal impedance graph in figure 4 (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. See table III, subgroup 4 herein.

4.3.4 Power burn-in conditions. Power burn-in conditions are as follows: V_{CB} = 10 - 30 V dc. Power shall be applied to achieve T_J = +135°C minimum using a minimum P_D = 75 percent of P_T maximum, T_A ambient rated as defined in 1.3. $T_A \leq 35°C$. With approval of the qualifying activity and preparing activity, alternate burn-in criteria (hours, bias conditions, T_J, and mounting conditions) may be used for JANTX and JANTXV quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing site's burn-in data and performance history will be essential criteria for burn-in modification approval. Use method 3100 of MIL-STD-750 to measure T_J.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. If alternate screening is being performed in accordance with E.5.3.1d of MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of group A1 and A2 inspection only (table E-VIB, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of MIL-PRF-19500 and table I herein.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIA (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Delta requirements shall be in accordance with the steps of 4.5.3 herein as specified in the notes for 4.5.3. See 4.4.2.2 herein for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) for JAN, JANTX, and JANTXV shall be after each step in 4.4.2.2 and shall be in accordance with table I, subgroup 2. Delta requirements shall be in accordance with the steps of 4.5.3 herein as specified in the notes for 4.5.3.

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

Subgroup	Method	Condition
* B4	1037	V_{CB} = 10 V dc minimum, P_T = 2.5 W minimum, T_A = +25°C ±3°C; No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	V_{CB} = 20 V dc, T_J = +275°C minimum for 96 hours; adjust the chosen T_A and P_T to give an average lot T_J = +275°C. Marking legibility requirements shall not apply.
B6	3131	See 4.3.3 herein.

4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a lot failure, the resubmission requirements of MIL-PRF-19500 shall apply. In addition, all catastrophic failures during CI shall be analyzed to the extent possible to identify root cause and corrective action.

Step	Method	Condition
1	1026	Steady-state life: 1,000 hours minimum, V_{CB} = 10 V dc, power shall be applied to achieve T_J = +150°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. The sample size may be increased and the test time decreased as long as the devices are stressed for a total of 45,000 device hours minimum, and the actual time of test is at least 340 hours.
2	1048	Blocking life, T_A = +150°C, V_{CB} = 80 percent of rated voltage, 48 hours minimum. n = 45 devices, c = 0.
3	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. For JANS, samples shall be selected from each inspection lot. See MIL-PRF-19500.

b. Shall be chosen from an inspection lot that has been submitted to and passed table I, 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 (subgroups B4 and B5 for JANS, and group B for JAN, JANJ, 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 tests and conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Delta requirements shall be in accordance with the steps of 4.5.3 herein as specified in the notes for 4.5.3.

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

Subgroup	Method	Condition
C2	2036	Tension: Test condition A, weight = 7 pounds, ±5 ounces, application time = 15 s. Terminal torque: Test condition D1, torque = 6 inch-ounce, application time = 15 s. Stud torque: Test condition D2, torque = 15 inch-pounds, application time = 15 s.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3) and applied thermal impedance curves.
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 n = 45, c = 0. The sample size may be increased and the test time decreased as long as the devices are stressed for a total of 45,000 device hours minimum, and the actual time of test is at least 340 hours.

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

Subgroup	Method	Condition
C2	2036	Tension: Test condition A, weight = 7 pounds, ±5 ounces, application time = 15 s. Terminal torque: Test condition D1, torque = 6 inch-ounce, application time = 15 s. Stud torque: Test condition D2, torque = 15 inch-pounds, application time = 15 s.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3) and in accordance with thermal impedance curves.
C6		Not applicable.

4.4.3.3 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes table I tests herein for conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for C6 life test may be pulled prior to the application of final lead finish. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

4.4.4 Group D inspection. Conformance inspection for hardness assured JANS and JANKC 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. Alternate package options may also be substituted for the testing provided there is no adverse effects to the fluence profile.

* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Delta measurements shall be in accordance with the applicable steps of 4.5.3.

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 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted at a case temperature (T_C) of +25°C.

* 4.5.3 Delta requirements. Delta requirements shall be as specified below: (1) (2) (3) (4) (5)

Steps	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 60 V dc	ΔI_{CES1}	100 percent of initial value or 100 nA, whichever is greater.		
2.	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 E-VIA (JANS) of MIL-PRF-19500 are as follows:
   a. Subgroup 3, see 4.5.3 herein, steps 1 and 2.
   b. Subgroup 4, see 4.5.3 herein, steps 1 and 2.
(2) The delta measurements for group B, (see 4.4.2.2 herein, JAN, JANTX, and JANTXV) are as follows: After each step in 4.4.2.2, see 4.5.3 herein, steps 1 and 2.
(3) The delta measurements for table E-VII of MIL-PRF-19500 are as follows: Subgroup 6, see 4.5.3 herein, steps 1 and 2.
(4) Devices which exceed the table I limits for this test shall not be accepted.
(5) Group E, table III herein, subgroups 1 and 2, see 4.5.3 herein, steps 1 and 2.

* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1 2/						
Visual and mechanical examination 3/	2071					
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.				
Hermetic seal 4/ 6/ Fine leak Gross leak	1071	n = 22 devices, c = 0.				
Electrical measurements 4/		Table I, subgroup 2.				
Bond strength 3/ 4/	2037	Precondition T_A = +250°C at t = 24 hours or T_A = +300°C at t = 2 hours n = 11 wires, c = 0.				
Decap internal visual (design verification) 4/	2075	n = 4 devices, c = 0.				
Subgroup 2						
Thermal impedance 7/	3131	See 4.3.3.	$Z_{\theta JX}$			°C/W
Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 100 mA, 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	mA 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.	h_{FE1}			
2N5002 2N5004				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}			
2N5002 2N5004				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}			
2N5002 2N5004				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} = 0.	I_{CES3}		500	µA dc
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}			
2N5002 2N5004				15 25		

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 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}			
2N5002				20		
2N5004				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.	$\lvert h_{fe} \rvert$			
2N5002				6		
2N5004				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,	t_f		0.5	µs
		R_L = 6Ω, (see figure 5).	t_{off}		1.5	µs
Subgroup 5						
Safe operating area (dc)	3051	Pre-pulse condition for each test: V_{CE} = 0, I_C = 0, T_C = +25°C. Pulse condition for each test, t_p = 1 sec. 1 cycle T_C = +25°C, (see figure 6).				
Test #1		V_{CE} = 12 V dc, I_C = 5 A dc.				
Test #2		V_{CE} = 32 V dc, I_C = 1.7 A dc.				
Test #3		V_{CE} = 80 V dc, I_C = 100 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 5 - Continued.						
Safe operating area (unclamped inductive)	3053	T_C = +25°C, R_{BB1} = 10Ω, R_{BB2} = 100Ω, L = 0.3 mH, RL = 0.1Ω, V_{CC} = 10 V dc, V_{BB1} = 10 V dc, V_{BB2} = 4 V dc, I_{CM} = 10 A dc (see figure 7).				
End-point electrical measurements		See subgroup 2 of table I.				
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.
2/ For resubmission of failed in subgroup 1 of table I, double the sample size of the failed test or sequence of tests. A failure in table I, 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/ This hermetic seal test is an end-point to temp-cycling in addition to electrical measurements.
7/ This test is required for the following end-point measurements only:
Group B, subgroups 3, 4, and 5 (JANS).
Group B, step 1 (JAN, JANTX, and JANTXV).
Group C, subgroups 2 and 6.
Group E, subgroups 1 and 2.

* 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 V_{CES} = 0 V				
	Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 100 mA, 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}		2.0	µA dc
	Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 100 V dc, V_{BE} = 0.	I_{CES2}		2.0	mA dc
	Collector to emitter cutoff current	3041	Bias condition D, V_{CE} = 40 V dc, I_B = 0.	I_{CEO}		100	µA dc
*	Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 4 V dc, I_C = 0.	I_{EBO1}		2.0	mA dc
*	Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 5.5 V dc, I_C = 0.	I_{EBO2}		2.0	mA dc
	Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 50 mA dc.	[h_{FE1}] 5/			
	2N5002 2N5004				[10] [25]		
	Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 2.5 A dc, pulsed (see 4.5.1).	[h_{FE2}] 5/			
	2N5002 2N5004				[15] [35]	90 200	
	Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 5 A dc, pulsed (see 4.5.1).	[h_{FE3}] 5/			
	2N5002 2N5004				[10] [20]		
	Base-emitter voltage (nonsaturated)	3066	Test condition B, V_{CE} = 5 V dc, I_C = 2.5 A dc, pulsed (see 4.5.1).	V_{BE}		1.67	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).	$V_{BE(sat)1}$		1.67	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).	$V_{BE(sat)2}$		2.53	V dc

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 1 - Continued.						
Collector-emitter saturation voltage	3071	I_C = 2.5 A dc, I_B = 250 mA dc, pulsed (see 4.5.1).	$V_{CE(sat)1}$		.86	V dc
Collector-emitter saturation voltage	3071	I_C = 5 A dc, I_B = 500 mA dc, pulsed (see 4.5.1).	$V_{CE(sat)2}$		1.73	V dc
Subgroup 2						
Total dose irradiation	1019	Gamma exposure V_{CES} = 64 V				
Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 100 mA, 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}		2.0	µA dc
Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 100 V dc, V_{BE} = 0.	I_{CES2}		2.0	mA dc
Collector to emitter cutoff current	3041	Bias condition D, V_{CE} = 40 V dc, I_B = 0.	I_{CEO}		100	µA dc
Emitter to base cutoff current	3061	Bias condition C, V_{EB} = 4 V dc, I_C = 0.	I_{EBO1}		2.0	mA dc
* Emitter to base cutoff current	3061	Bias condition C, V_{EB} = 5.5 V dc, I_C = 0.	I_{EBO2}		2.0	mA dc
Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 50 mA dc.	[h_{FE1}] 5/			
2N5002 2N5004				[10] [25]		
Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 2.5 A dc, pulsed (see 4.5.1).	[h_{FE2}] 5/			
2N5002 2N5004				[15] [35]	90 200	
Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 5 A dc, pulsed (see 4.5.1).	[h_{FE3}] 5/			
2N5002 2N5004				[10] [20]		
* Base-emitter voltage (non-saturated)	3066	Test condition A, V_{CE} = 5 V dc, I_C = 2.5 A dc, pulsed (see 4.5.1).	V_{BE}		1.67	V dc

See footnotes at end of table.

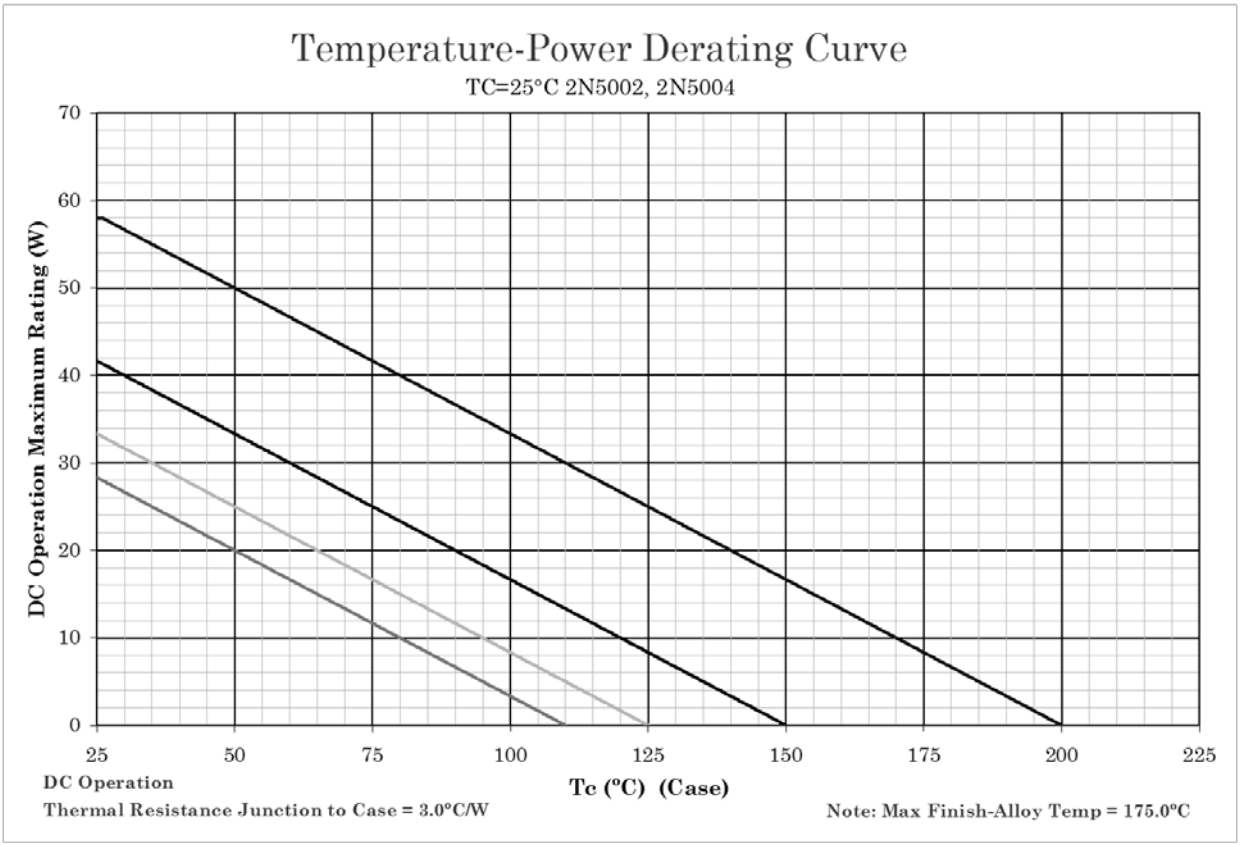
* TABLE II. Group D inspection - Continued.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued.						
Base-emitter saturation voltage	3066	Test condition B, I_C = 2.5 A dc, I_B = 250 mA dc, pulsed (see 4.5.1).	$V_{BE(sat)1}$		1.67	V dc
Base-emitter saturation voltage	3066	Test condition B, I_C = 5 A dc, I_B = 500 mA dc, pulsed (see 4.5.1).	$V_{BE(sat)2}$		2.53	V dc
Collector-emitter saturation voltage	3071	I_C = 2.5 A dc, I_B = 250 mA dc, pulsed (see 4.5.1).	$V_{CE(sat)1}$		.86	V dc
Collector-emitter saturation voltage	3071	I_C = 5 A dc, I_B = 500 mA dc, pulsed (see 4.5.1).	$V_{CE(sat)2}$		1.73	V dc

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.
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 the [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 or re-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	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2 and 4.5.3 herein.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	Intermittent operation life: V_{CB} = 10 V dc, 6,000 cycles. Adjust device current, or power, to achieve a minimum ΔT_J of +100°C.	
Electrical measurements		See table I, subgroup 2 and 4.5.3 herein.	
Subgroup 4			
Thermal impedance curves		See table E-IX of MIL-PRF-19500, group E, subgroup 4.	
Subgroup 5			
Not applicable			
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition B.	



NOTES:

1. Top curve is thermal runaway loci and cannot be used as a derate design curve since it exceeds the maximum ratings for this part. Operating under this curve using these mounting conditions assures the device will not have a thermal runaway. This is the true inverse of the worst case thermal resistance value extrapolated out to the thermal runaway point.
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 curve 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 3. Temperature-power derating for ($R_{\theta JC}$) for 2N5002 and 2N5004 (similar to TO-59).

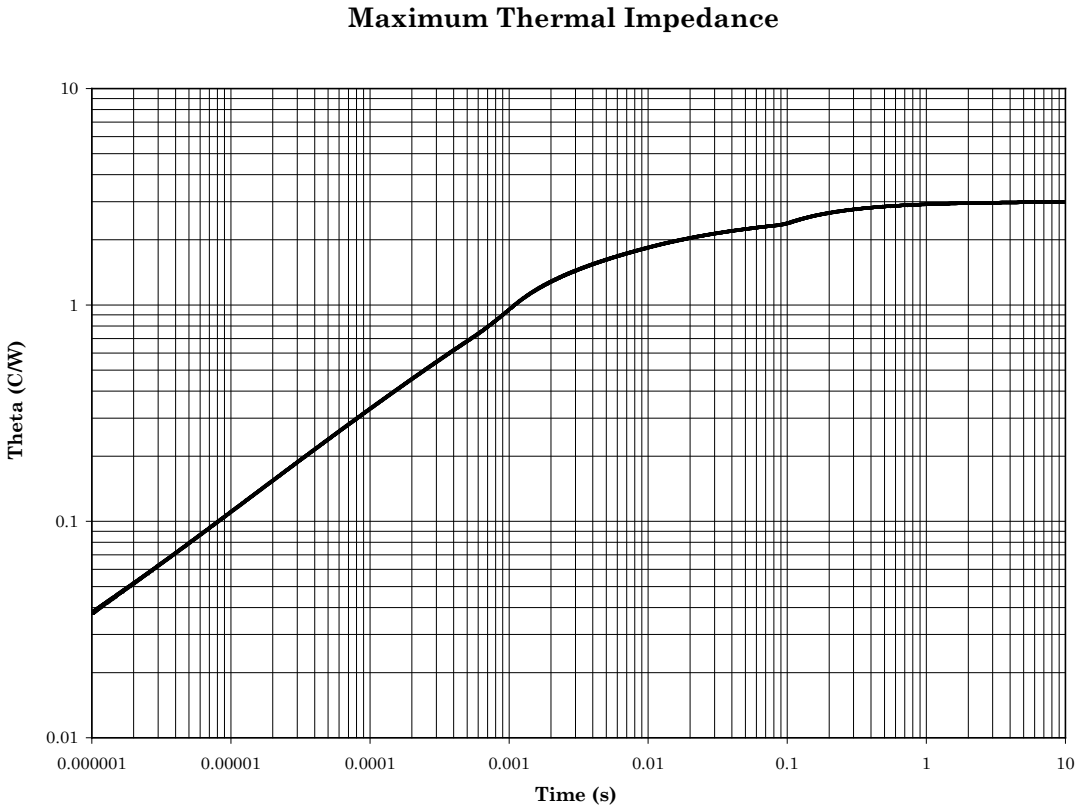
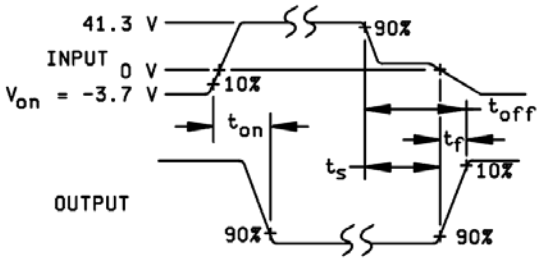
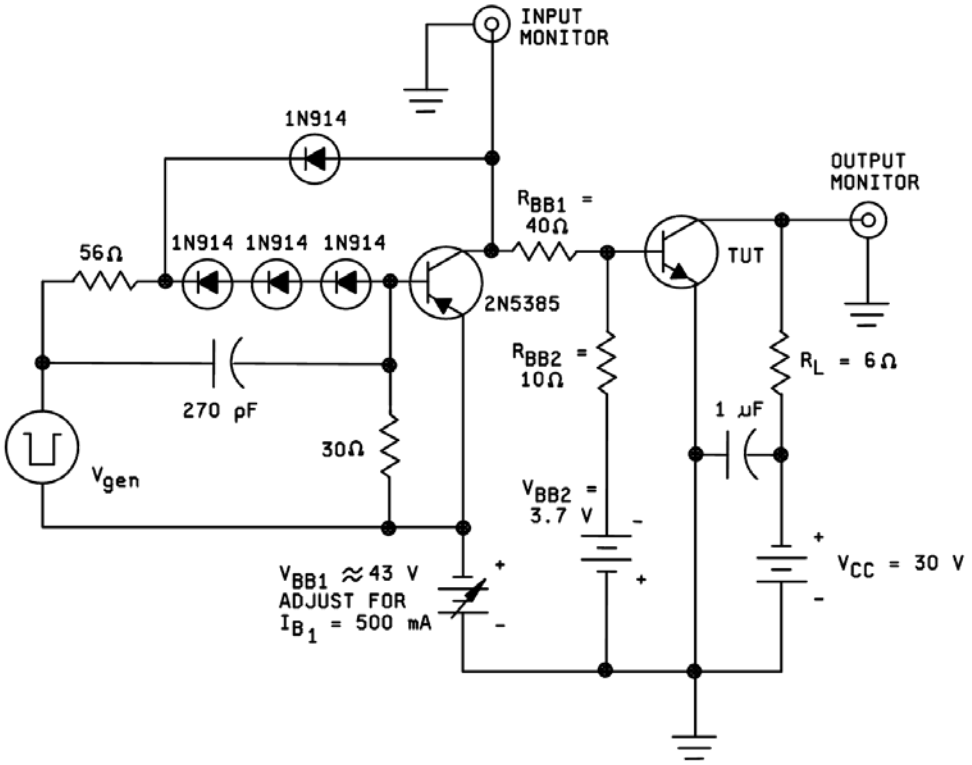


FIGURE 4. Thermal impedance graph ($R_{\theta JC}$) for 2N5002 and 2N5004 (similar to TO-59).





NOTES:

1. V_{gen} is a -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, $t_f \leq 15$ 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 must 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 5. Switching time test circuit.

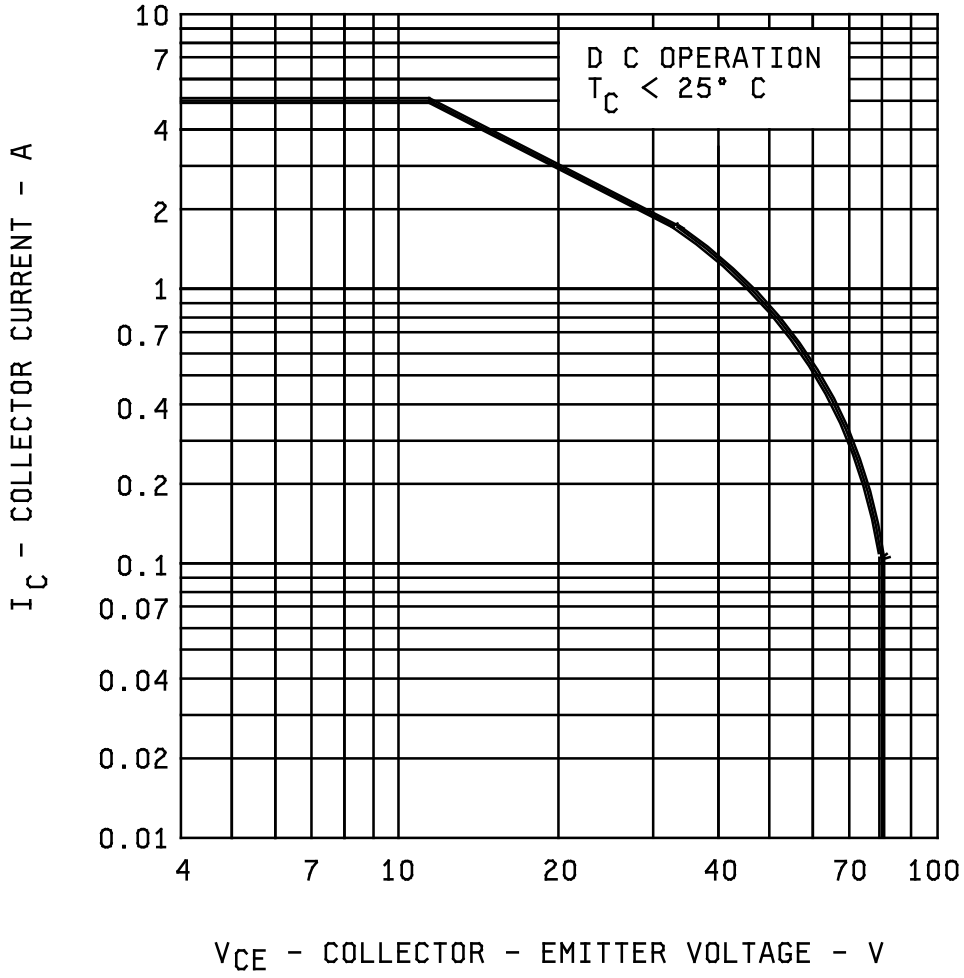


FIGURE 6. Maximum safe operating area.

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 A
V_{BB1} = 10 V dc
V_{BB2} = 4 V dc

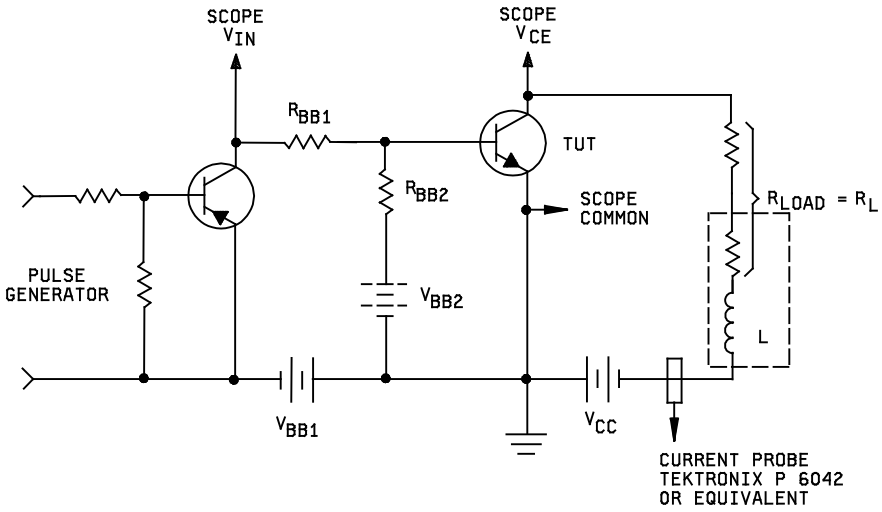


FIGURE 7. Unclamped inductive load energy test circuit.

5. PACKAGING

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

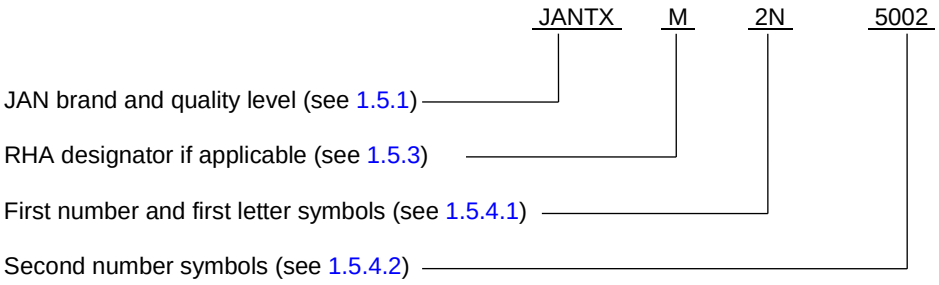
* d. The complete Part or Identifying Number (PIN), see 1.5.

e. For acquisition of RHA designated devices, table II, subgroup 1 testing of group D herein is optional. If subgroup 1 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 Complementary use. The devices specified herein are designed for complementary use with the 2N5003 and 2N5005.

* 6.5 PIN construction example. The PINs for encapsulated devices are construction using the following form.



* 6.6 List of PINs.

* 6.6.1 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for devices of the base quality level	PINs for devices of the "TX" quality level	PINs for devices of the "TXV" quality level	PINs for devices of the "S" quality level
JAN2N5002	JANTX2N5002	JANTXV#2N5002	JANS#2N5002
JAN2N5004	JANTX2N5004	JANTXV#2N5004	JANS#2N5004

(#) The number sign (#) represent one of eight RHA designators available (M, D, P, L, R, F, G, of H).

6.6.2 PINs for unencapsulated devices (die). The following is a list of possible PINs for unencapsulated devices available on this specification sheet.

Quality level HC	Quality level HC w/ RHA	Quality level KC	Quality level KC w/ RHA
JANHCB2N5002	JANHCB#2N5002	JANKCB2N5002	JANKHCB#2N5002
JANHCB2N5004	JANHCB#2N5004	JANKCB2N5004	JANKHCB#2N5004

(#) The number sign (#) represent one of eight RHA designators available (M, D, P, L, R, F, G, of H).

* 6.7 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCB2N5002) will be identified on the QML.

Die ordering information (1)	
PIN	Manufacturer
	43611
2N5002 2N5004	JANHCB2N5002 JANHCB2N5004

(1) For JANKC level, replace JANHC with JANKC.

6.8 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.

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

Review activities:
Air Force - 19

Preparing activity:
DLA - CC

(Project 5961-2014-110)

* 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/.