

The documentation and process conversion measures necessary to comply with this document shall be completed by 2 January 2011.

INCH-POUND

MIL-PRF-19500/560K
 2 October 2010
 SUPERSEDING
 MIL-PRF-19500/560J
 2 May 2009

PERFORMANCE SPECIFICATION SHEET

* SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING,
 TYPE 2N5339 AND 2N5339U3, JAN, JANTX, JANTXV, JANS, JANSM, JANSJ, JANSK, JANSR,
 JANSF, JANSJ, JANSK, JANHCC, JANKCC, JANKCCM, JANKCCD, JANKCCP,
 JANKCCL, JANKCCR, JANKCCF, JANKCCG, and JANKCCH

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 switching transistors. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500 and two levels of product assurance are provided for each unencapsulated device type as specified in MIL-PRF-19500. 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-39), figure 2 for U3 devices (TO-276AA) and figures 3 and 4 for JANHC and JANKC (die) dimensions.

1.3 Maximum ratings Unless specified, $T_A = 25^\circ\text{C}$.

Types	P_T (1) $T_A = +25^\circ\text{C}$	P_T (1) $T_C = +25^\circ\text{C}$	$R_{\theta JA}$	$R_{\theta JC}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_J and T_{STG}
	<u>W</u>	<u>W</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>$^\circ\text{C}$</u>
2N5339	1.0	17.5	175	10	100	100	6.0	5.0	1.0	-65 to +200
2N5339U3	1.0	75		2.3	100	100	6.0	5.0	1.0	-65 to +200

(1) For derating, see figures 5, 6, and 7.

1.4 Primary electrical characteristics $T_A = +25^\circ\text{C}$. (Unless otherwise indicated, applies to all devices.)

Limits	h_{FE1} (1) $V_{CE} = 2.0 \text{ V dc}; I_C = 0.5 \text{ A dc}$	h_{FE2} (1) $V_{CE} = 2.0 \text{ V dc}; I_C = 2.0 \text{ A dc}$	h_{FE3} (1) $V_{CE} = 2.0 \text{ V dc}; I_C = 5.0 \text{ A dc}$
Min	60	60	40
Max		240	

(1) See note at end of 1.4.

* 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@dsc.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.daps.dla.mil>.

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1.4 Primary electrical characteristics $T_A = +25^\circ\text{C}$. - Continued.

Limits	$ h_{FE} $ f = 10 MHz $V_{CE} = 10\text{ V dc}$ $I_C = 0.5\text{ A dc}$	C_{obo} $V_{CE} = 10\text{ V dc}$ $I_E = 0$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	Switching		$V_{CE(SAT)1}$ $I_C = 2.0\text{ A dc}$ $I_B = 0.2\text{ A dc}$ (1)	$V_{BE(SAT)1}$ $I_C = 2.0\text{ A dc}$ $I_B = 0.2\text{ A dc}$ (1)
			t_{on}	t_{off}		
Min	3.0	μF	μs	μs	V dc	V dc
Max	15.0	250	0.2	2.2	0.7	1.2

(1) Pulsed (see 4.5.1).

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 <https://assist.daps.dla.mil/quicksearch> or <https://assist.daps.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.

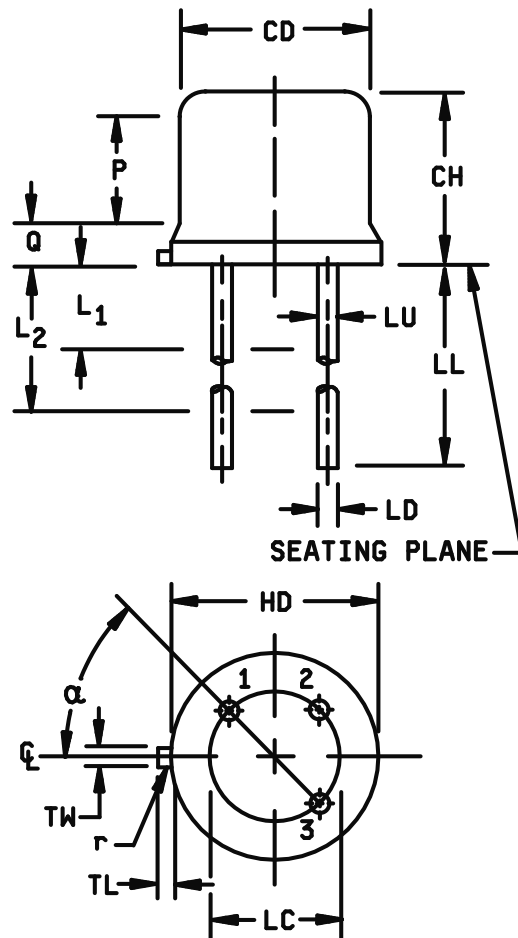


FIGURE 1. Physical dimensions (TO-39).

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Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.355	7.75	9.02	5
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	3
LC	.200 TP		5.08 TP		6
LD	.016	.021	.41	.53	7
LL	.500	.750	12.70	19.05	7
LU	.016	.019	.41	.48	7
L1		.050		1.27	7
L2	.250		6.35		7
TL	.029	.045	.74	1.14	3
TW	.028	.034	.71	.86	10
P	.100		2.54		5
Q		.050		1.27	4
r		.010		.25	10, 11
α	45° TP		45° TP		6
Notes	1, 2, 8, 9		1, 2, 8, 9		

NOTES:

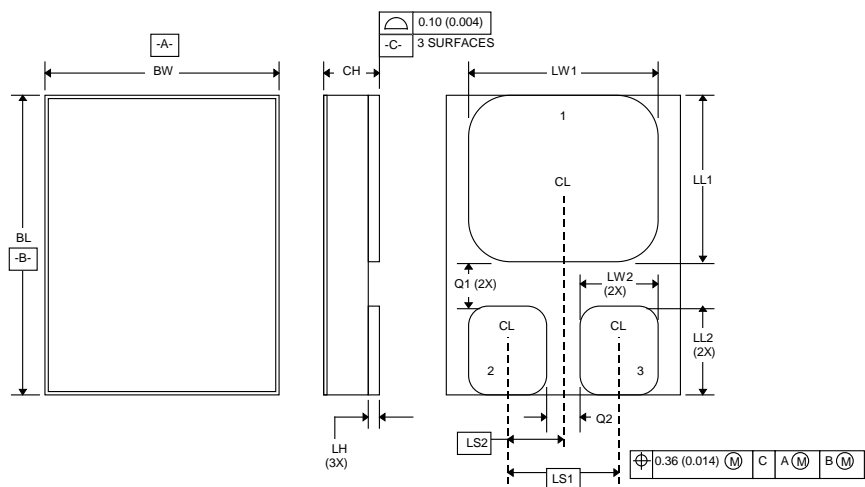
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LD applies between L1 and L2. Dimension LD applies between L2 and LL minimum.
8. Lead designation, depending on device type, shall be as follows:

Lead number	TO-39
1	Emitter
2	Base
3	Collector

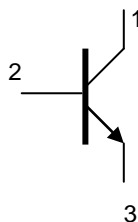
9. Lead number three is electrically connected to case.
10. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
11. Symbol r applied to both inside corners of tab.
12. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Physical dimensions (TO-39) - Continued.

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SCHEMATIC

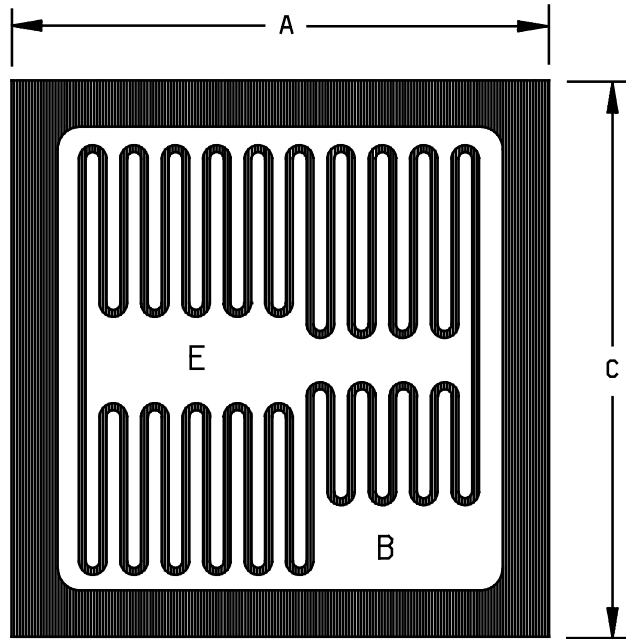


Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.395	.405	10.03	10.29
BW	.291	.301	7.40	7.65
CH	.1085	.1205	2.76	3.06
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.39
LW2	.090	.100	2.29	2.54
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.92	3.18
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
Q1	.030		0.762	
Q2	.030		0.762	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.
4. Terminal 1 - collector, terminal 2 -base, terminal 3 - emitter.

* FIGURE 2. Physical dimensions and configuration (U3) (SMD 5) (TO-276AA).

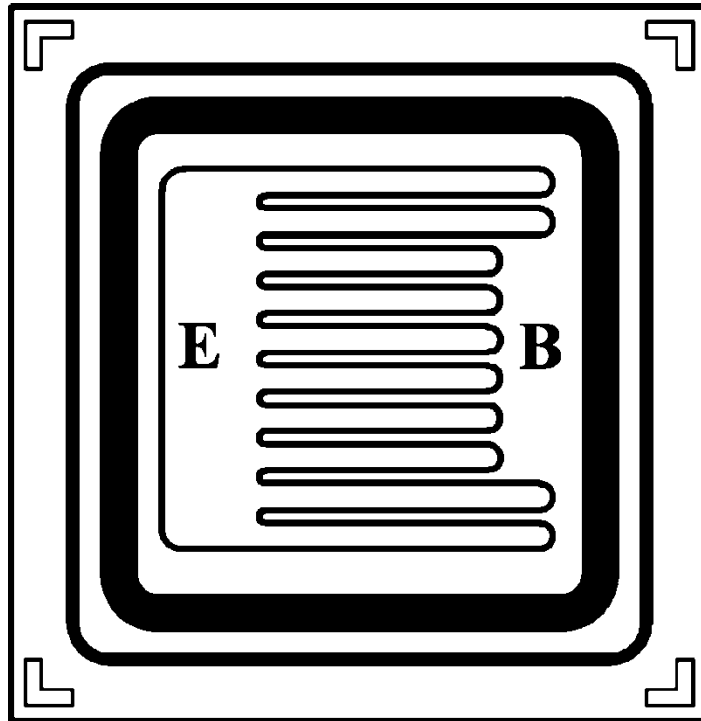


Letter	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.098	.102	2.49	2.59
C	.098	.102	2.49	2.59

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The physical characteristics of the die are:
 Thickness: .006 inch (0.15 mm) to .010 inch (0.25 mm).
 Top metal: Aluminum 25,000 Å minimum, 37,500 Å nominal.
 Back metal: Gold 1,500 Å minimum, 6,500 Å nominal.
 Back side: Collector.
4. Unless otherwise specified, tolerance is $\pm .005$ inch (0.13 mm).
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 3. Physical dimensions JANHCB and JANKCB.



NOTES:

1. Chip size: .128 x .128 inch \pm .002 inch (3.25 x 3.25 \pm 0.051 mm).
2. Chip thickness: .010 \pm .002 inch (0.254 \pm 0.0508 mm) nominal.
3. Top metal: Aluminum 30,000Å minimum, 33,000Å nominal.
4. Back metal: Gold 3,500Å minimum, 5,000Å nominal.
5. Backside: Collector.
6. Bonding pad: B = .052 x .012 inch (1.321 x 0.305 mm), E = .084 x .012 inch (2.134 x 0.305 mm).

FIGURE 4. JANHC and JANKC D-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.

* 3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 (TO-39), figure 2 for U3 (TO-276AA), and figures 3 and 4 (JANHC and JANKC) devices 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).

* 3.4.2 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 the subgroups specified in table I, group A herein.

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 4.44 and tables I, II and III)

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

* 4.2.1 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.

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

4.3 Screening (JANTX, JANTXV, and JANS levels only). 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 MIL-PRF-19500)	Measurements	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance, method 3131 of MIL-STD-750.	Thermal impedance, method 3131 of MIL-STD-750.
9	I_{CBO1} and h_{FE2}	Not applicable
11	I_{CBO1} ; h_{FE2} , $\Delta I_{CBO1} = \pm 100$ percent of initial value or 200 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 15$ percent	I_{CBO1} and h_{FE2}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; $\Delta I_{CBO1} = \pm 100$ percent of initial value or 200 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 15$ percent.	Subgroup 2 of table I herein; $\Delta I_{CBO1} = \pm 100$ percent of initial value or 200 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 15$ percent.

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

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: $V_{CB} = 10 - 30$ V dc. $T_A =$ room ambient as defined in the general requirements of 4.5 of MIL-STD-750. Power shall be applied to the device to achieve $T_J =$ minimum $+175^\circ\text{C}$ and minimum power dissipation of $P_D = 75$ percent P_T maximum as defined in 1.3. 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.

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

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). Measurement delay time (t_{MD}) = 70 μs max. See table II, subgroup 4 and figures 8, 9, and 10 herein.

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 MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of subgroup 1 and 2, of table I herein, inspection only (table E-VIb, group B, subgroup 1 is not required to be performed since solderability and resistance to solvents testing is performed in subgroup 1 of table I herein).

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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. Electrical measurements (end-points) requirements 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 of MIL-PRF-19500 (JANS) and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. See 4.4.2.2 herein for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) requirements 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.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B4	1037	$V_{CB} = 10$ V dc, 2,000 cycles, adjust device current, or power, to achieve a minimum ΔT_J of $+100^\circ\text{C}$.
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 rated P_T (see 1.3). Option 1: 96 hours minimum sample size in accordance with MIL-PRF-19500, table E-VIa, adjust T_A or P_D to achieve $T_J = +275^\circ\text{C}$ minimum. Option 2: 216 hours minimum, sample size = 45, $c = 0$; adjust T_A or P_D to achieve $T_J = +225^\circ\text{C}$ minimum.
B5	2037	Test condition D.

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. Whenever a failure is identified as wafer lot or wafer processing related, the entire wafer lot and related devices assembled from the wafer lot shall be rejected unless an appropriate determined corrective action to eliminate the failures mode has been implemented and the devices from the wafer lot are screened to eliminate the failure mode.

<u>Step</u>	<u>Method</u>	<u>Condition</u>
1	1026	Steady-state life: 1,000 hours minimum, $V_{CB} = 10$ V dc, power shall be applied to achieve $T_J = +150^\circ\text{C}$ minimum using a minimum of $P_D = 75$ percent of maximum rated P_T as defined in 1.3. $n = 45$ devices, $c = 0$. 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	$n = 45$, $c = 0$. Blocking life, $T_A = +150^\circ\text{C}$, $V_{CB} = 80$ percent of rated voltage, 48 hours minimum. $n = 45$ devices, $c = 0$.
3	1032	High- temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

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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.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E, N/A for U3 devices.
C5	3131	See 4.3.3.
C6	1037	For solder die attach: $V_{CB} \geq 10$ V dc, T_A = room ambient as defined in the general requirements of MIL-STD-750. 6,000 cycles. For JANS only.
C6	1026	For JANS only. For eutectic die attach: $V_{CB} \geq 10$ V dc, adjust P_T to achieve $T_J = +175^\circ\text{C}$ min, 1,000 hours.

* 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.f herein), except group D, subgroup 2 may be performed separate from other subgroups. Group D inspection may also be performed ahead of the screening lot using die selected in accordance with MIL-PRF-19500 and related documents. Alternate package options may also be substituted for the testing provided there is no adverse effect 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. 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 Input capacitance. This test shall be conducted in accordance with method 3240 of MIL-STD-750, except the output capacitor shall be omitted.

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TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 2/</u>						
Visual and mechanical examination <u>3/</u>	2071	n = 45 devices, c = 0				
Solderability <u>3/ 4/</u>	2026	n = 15 leads, c = 0				
Resistance to solvents <u>3/ 4/ 5/</u>	1022	n = 15 devices, c = 0				
Temp cycling <u>3/ 4/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal <u>4/</u>	1071	n = 22 devices, c = 0				
Fine leak Gross leak						
Electrical measurements <u>4/</u>		Table I, subgroup 2				
Bond strength <u>3/ 4/</u>	2037	Precondition T _A = +250°C at t = 24 hrs or T _A = +300°C at t = 2 hrs n = 11 wires, c = 0				
Decap internal visual (design verification) <u>4/</u>	2075	n = 4 device, c = 0				
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.3	Z _{θJX}			°C/W
Breakdown voltage, collector to emitter	3011	Bias condition D; I _C = 50 mA dc; pulsed (see 4.5.1)	V _{(BR)CEO}	100		V dc
Collector to emitter cutoff current	3041	Bias condition D; V _{CE} = 100 V dc	I _{CEO}		100	μA dc
Collector to emitter cutoff current	3041	Bias condition A; V _{BE} = 1.5 V dc; V _{CE} = 90 V dc	I _{CEX1}		1	μA dc
Collector to base cutoff current	3036	Bias condition D; V _{CB} = 100 V dc	I _{CBO}		1	μA dc

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued.						
Emitter to base, cutoff current	3061	Bias condition D; $V_{EB} = 6.0$ V dc	I_{EBO}		100	μ A dc
Forward - current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 0.5$ A dc, pulsed (see 4.5.1)	h_{FE1}	60		
Forward - current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 2.0$ A dc; pulsed (see 4.5.1)	h_{FE2}	60	240	
Forward - current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 5.0$ A dc; pulsed (see 4.5.1)	h_{FE3}	40		
Collector to emitter voltage (saturated)	3071	$I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)1}$		0.7	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)2}$		1.2	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.2	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)2}$		1.8	V dc
<u>Subgroup 3</u>						
High - temperature operation		$T_A = +150^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A; $V_{CE} = 90$ V dc; $V_{BE} = 1.5$ V dc;	I_{CEX2}		1.0	mA dc
Low-temperature operation		$T_A = -55^\circ\text{C}$				
Forward - current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 2.0$ A dc; pulsed (see 4.5.1)	h_{FE4}	12		

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection ^{1/}	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u>						
Small - signal short - circuit forward - current transfer ratio	3306	$V_{CE} = 10 \text{ V dc}; I_C = 0.5 \text{ A dc}; f = 10 \text{ MHz}$	$ h_{fe} $	3	15	
Open circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}; I_E = 0; 100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		250	pF
Input capacitance (output open - circuited)	3240	$V_{BE} = 2.0 \text{ V dc}; I_C = 0; 100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ (see 4.5.2)	C_{ibo}		1,000	pF
Pulse response						
Pulse delay time	3251	See figure 11	t_d		100	ns
Pulse rise time	3251	See figure 11	t_r		100	ns
Pulse storage time	3251	See figure 12	t_s		2	μs
Pulse fall time	3251	See figure 12	t_f		200	ns
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3051	$T_C = +25^\circ\text{C}; t \geq 0.5 \text{ s}; 1 \text{ cycle}$				
Test 1		$V_{CE} = 2.0 \text{ V dc}; I_C = 5.0 \text{ A dc}$				
Test 2		$V_{CE} = 5.0 \text{ V dc}; I_C = 2.0 \text{ A dc}$				
Test 3		$V_{CE} = 90 \text{ V dc}; I_C = 55 \text{ mA dc}$				
End-point electrical measurements		See table I, subgroup 2				
<u>Subgroups 6 and 7</u>						
Not applicable						

^{1/} For sampling plan see MIL-PRF-19500.

^{2/} For resubmission of failed subgroup 1, 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.

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* TABLE II. Group D inspection.

Inspection <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 4/</u>						
Neutron irradiation	1017	Neutron exposure $V_{ces} = 0$ V				
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 50$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	100		V dc
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 100$ V dc	I_{CEO}		200	μ A dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5$ V dc; $V_{CE} = 90$ V dc	I_{CEX1}		2	μ A dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 100$ V dc	I_{CBO}		2	μ A dc
Emitter to base, cutoff current	3061	Bias condition D; $V_{EB} = 6.0$ V dc	I_{EBO}		200	μ A dc
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 0.5$ A dc, pulsed (see 4.5.1)	h_{FE1}	[30]		
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 2.0$ A dc; pulsed (see 4.5.1)	h_{FE2}	[30]	240	
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 5.0$ A dc; pulsed (see 4.5.1)	h_{FE3}	[20]		
Collector to emitter voltage (saturated)	3071	$I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)1}$		0.81	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)2}$		1.38	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.38	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)2}$		2.07	V dc
<u>Subgroup 2</u>						
Total dose irradiation	1019	Gamma exposure $V_{ces} = 80$ V				
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 50$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	100		V dc
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 100$ V dc	I_{CEO}		200	μ A dc
Collector to emitter cutoff current	3041	Bias condition A; $V_{BE} = 1.5$ V dc; $V_{CE} = 90$ V dc	I_{CEX1}		2	μ A dc

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* TABLE II. Group D inspection.

Inspection <u>1/</u> <u>2/</u> <u>3/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued.						
Collector to base cutoff Current	3036	Bias condition D; $V_{CB} = 100$ V dc	I_{CBO}		2	μ A dc
Emitter to base, cutoff current	3061	Bias condition D; $V_{EB} = 6.0$ V dc	I_{EBO}		200	μ A dc
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 0.5$ A dc, pulsed (see 4.5.1)	h_{FE1}	[30]		
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 2.0$ A dc; pulsed (see 4.5.1)	h_{FE2}	[30]	240	
Forward current transfer ratio	3076	$V_{CE} = 2.0$ V dc; $I_C = 5.0$ A dc; pulsed (see 4.5.1)	h_{FE3}	[20]		
Collector to emitter voltage (saturated)	3071	$I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)1}$		0.81	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{CE(SAT)2}$		1.38	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 2.0$ A dc; $I_B = 0.2$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.38	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 5.0$ A dc; $I_B = 0.5$ A dc; pulsed (see 4.5.1)	$V_{BE(SAT)2}$		2.07	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.

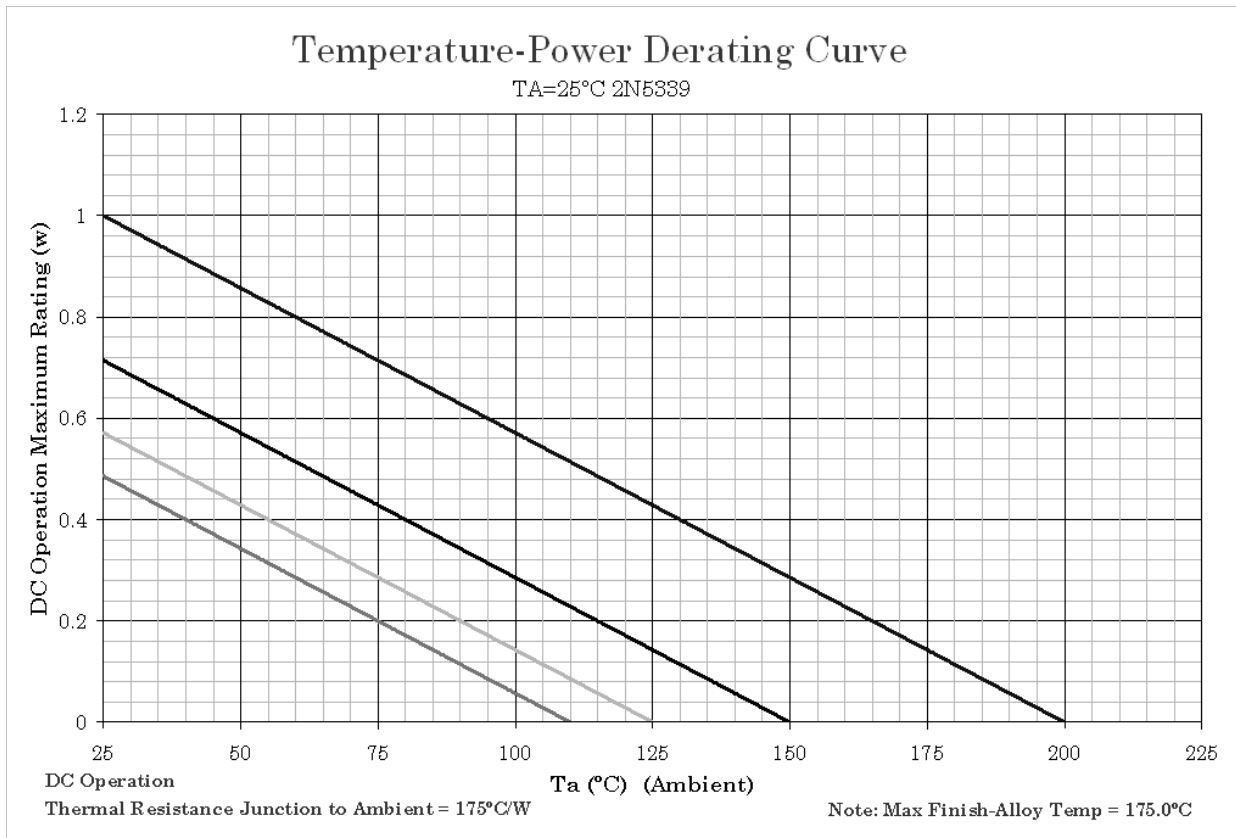
4/ See 6.2.e herein.

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} . Note 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.

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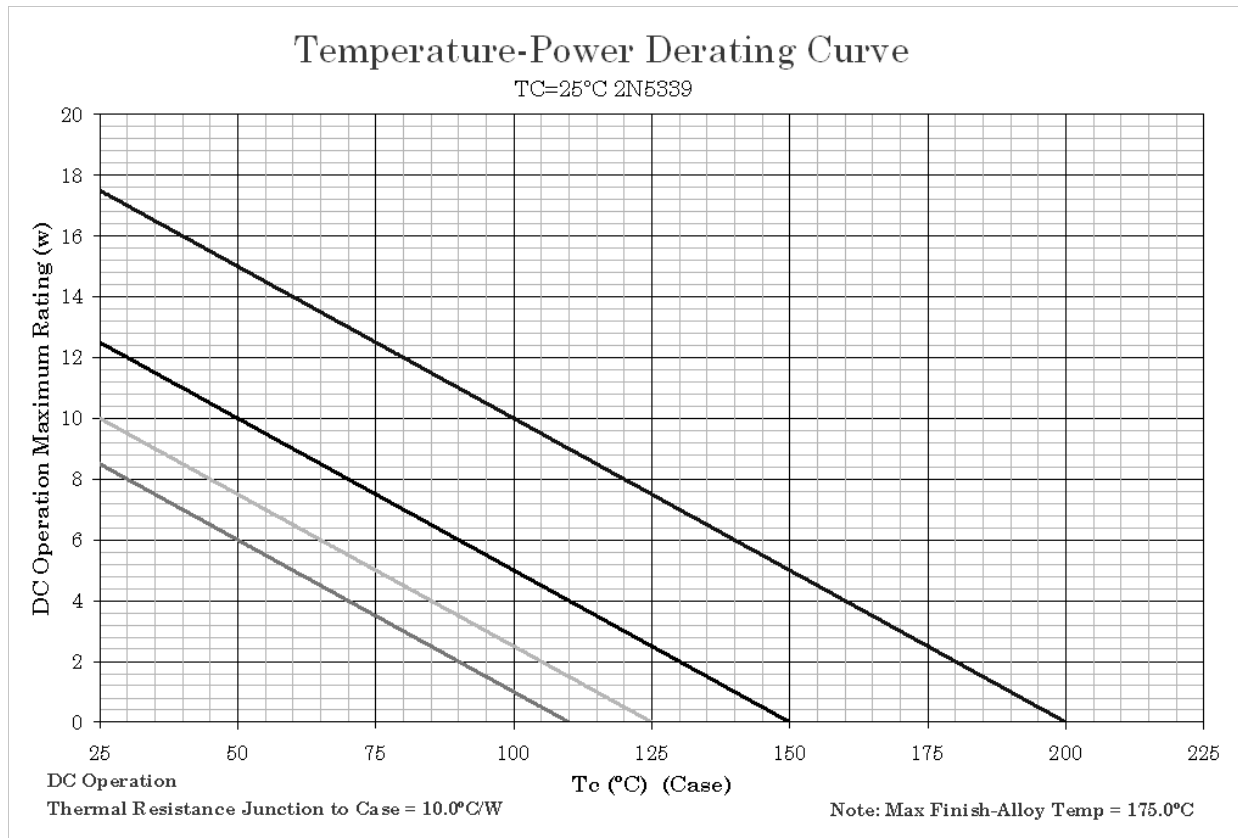
* TABLE III. Group E inspection (all quality levels) - for qualification and requalification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			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 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	$V_{CB} = 10$ 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 herein.	
<u>Subgroups 4</u>			
Thermal impedance curves		See table E-IX of MIL-PRF-19500, group E, subgroup 4.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

**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 ($T_J \leq 200^\circ\text{C}$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq 150^\circ\text{C}$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq 125^\circ\text{C}$, and 110°C to show power rating where most users want to limit T_J in their application.

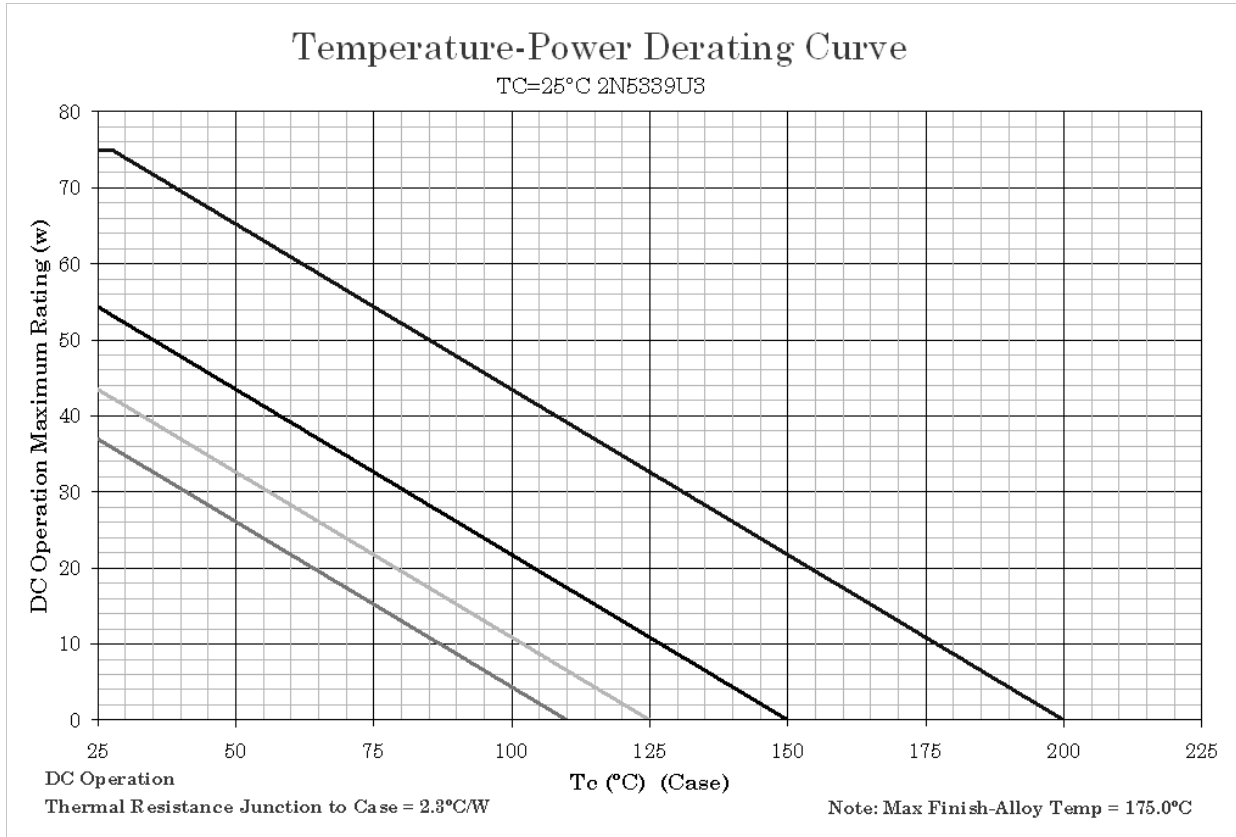
FIGURE 5. Derating for 2N5339 ($R_{\theta JA}$) (TO-39).



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 ($T_J \leq 200^\circ\text{C}$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq 150^\circ\text{C}$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq 125^\circ\text{C}$, and 110°C to show power rating where most users want to limit T_J in their application.

FIGURE 6. Derating for 2N5339 ($R_{\theta JC}$) (TO-39).

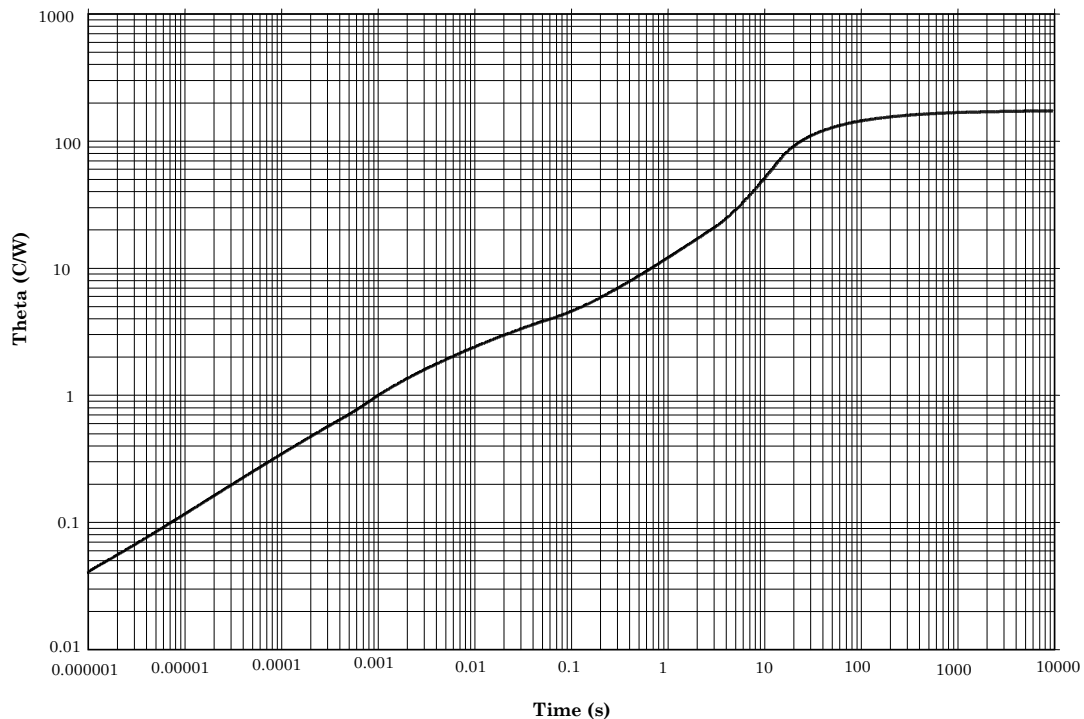


NOTES:

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 ($T_J \leq 200^\circ\text{C}$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq 150^\circ\text{C}$, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq 125^\circ\text{C}$, and 110°C to show power rating where most users want to limit T_J in their application.

FIGURE 7. Derating for 2N5339U3 ($R_{\theta JC}$).

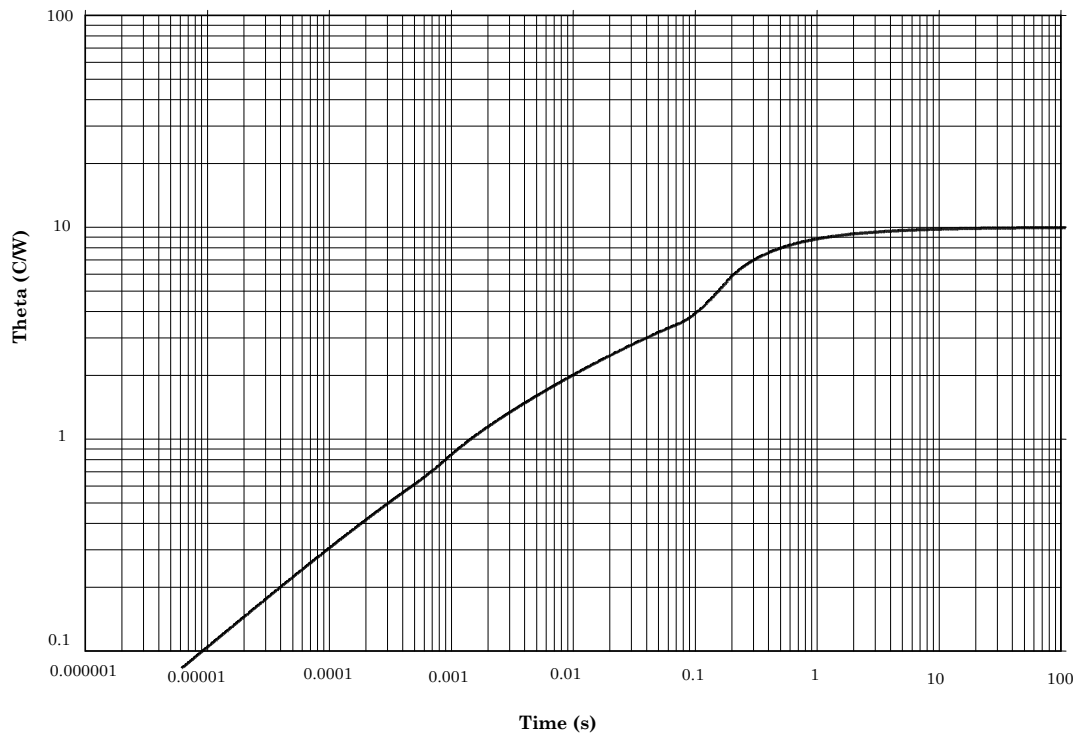
Maximum Thermal



$T_A = +25^\circ\text{C}$, $P_{\text{diss}} = 1 \text{ W}$, thermal resistance = 175°C/W (ambient thermal resistance varies with power).

FIGURE 8. Thermal impedance graph ($R_{\theta\text{JA}}$) for 2N5339 (TO-39).

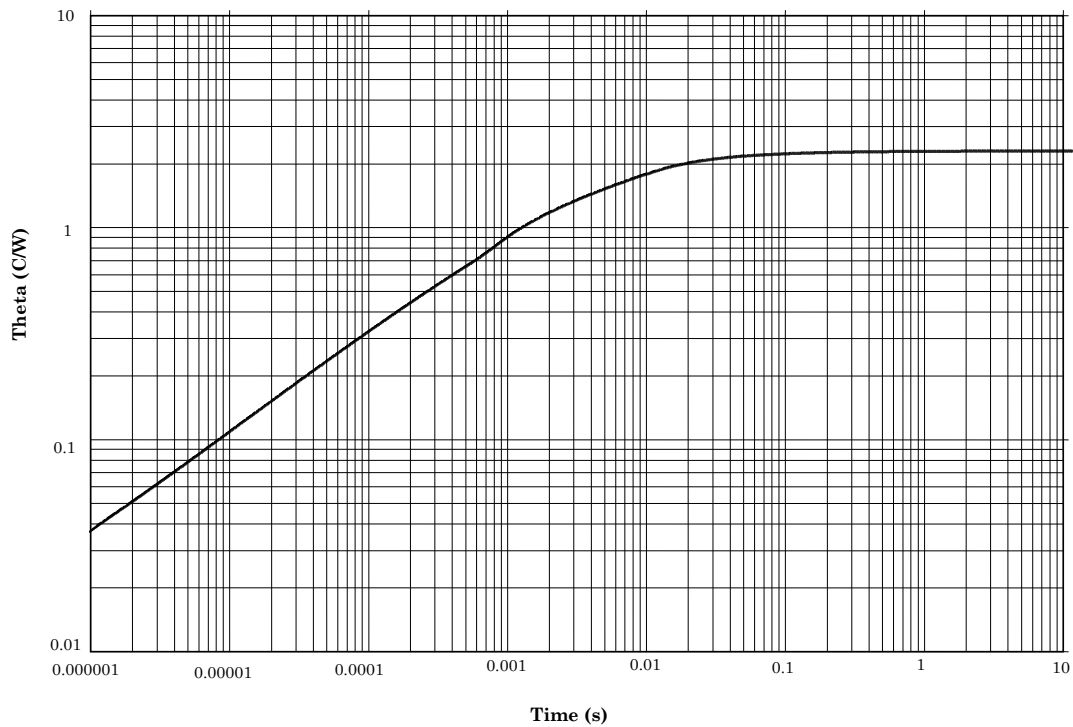
Maximum Thermal



$T_C = +25^\circ\text{C}$, $P_c = 17.5\text{ W}$, thermal resistance = 10°C/W .

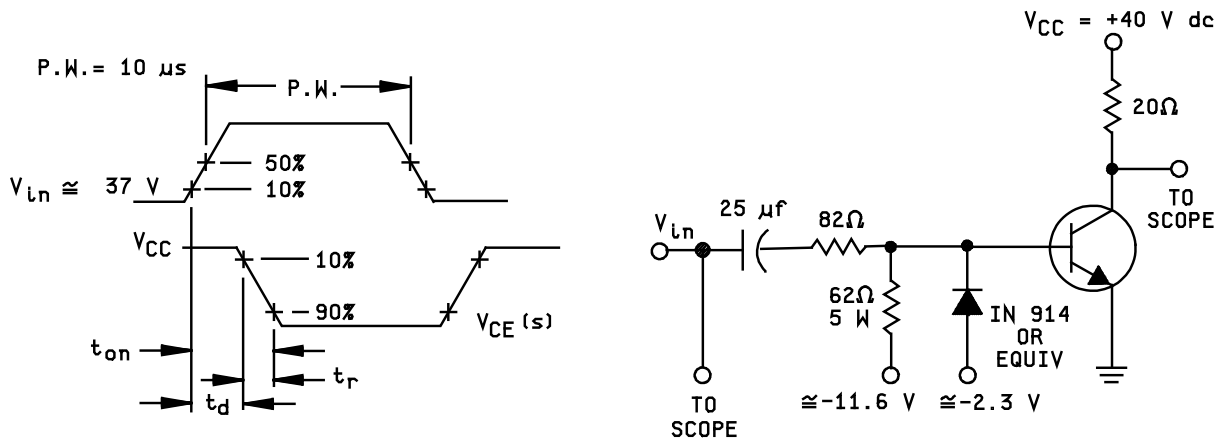
FIGURE 9. Thermal impedance graph ($R_{\theta JC}$) for 2N5339 (TO-39).

Maximum Thermal



$T_C = +25^\circ\text{C}$, $P_C = 75\text{ W}$, thermal resistance = 2.3°C/W .

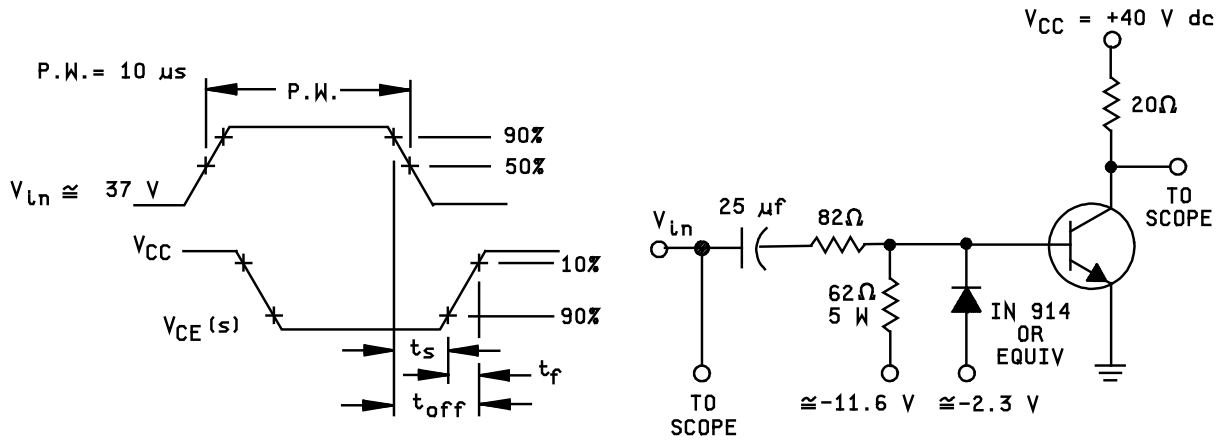
FIGURE 10. Thermal impedance graph ($R_{\theta JC}$) for 2N5339U3 (U3).



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 20 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .
2. Sampling oscilloscope: $Z_{in} \geq 1 M\Omega$, $C_{in} \leq 20$ pF, rise time ≤ 20 ns.
3. t_{on} conditions: $I_C = 2 A$, $I_{B1} = 200$ mA.

FIGURE 11. Saturated turn-on switching waveform and time test circuit.



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 20 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .
2. Sampling oscilloscope: $Z_{in} \geq 1 M\Omega$, $C_{in} \leq 20$ pF, rise time ≤ 20 ns.
3. t_{on} conditions: $I_C = 2 A$, $I_{B1} = I_{B2} = 200$ mA.

FIGURE 12. Saturated turn-off switching time waveform and 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. Product assurance level and type designator.

e. For die acquisition, the JANHC or JANKC letter version shall be specified (see figures 3 and 4).

* f. For acquisition of RHA designated 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.daps.dla.mil>.

6.4 Application guidance. The following PNP type transistor is complimentary to the NPN device listed herein.

<u>NPN</u>	<u>PNP</u>
2N5339	2N6193

6.5 Suppliers of JANHC and JANKC die. The qualified die suppliers with the applicable letter version (example, JANHCA2N6193) will be identified on the QML.

JANC ordering information			
PIN	Manufacturers		
	33178 (1)	34156	43611
2N5339	JANHCA2N5339 (1) JANKCA2N5339 (1)	JANHCB2N5339 JANKCB2N5339	JANHCC2N5339 (2) JANKCC2N5339 (2)
2N5339			JANHCD2N5339 JANKCD2N5339

- (1) The JANHCA2N5339 and the JANKCA2N5339 die was qualified from March 26, 1987 to April 25, 1994, but is obsolete at this time.
- (2) The JANHCC2N5339 and the JANKCC2N5339 die was qualified from November 29, 1999 to January 22, 2004, but is obsolete at this time.

6.6 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 - CR
 Air Force - 85
 DLA - CC

Preparing activity:
 DLA - CC

(Project 5961-2010-038)

Review activities:
 Army - MI
 Air Force - 19, 71, 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.daps.dla.mil>.