

The documentation and process conversion measures necessary to comply with this document shall be completed by 30 July, 2003

INCH-POUND

MIL-PRF-19500/391H
30 April 2003
SUPERSEDING
MIL-PRF-19500/391G
15 July 2002

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, LOW-POWER
TYPES 2N3019, 2N3019S, 2N3057A, 2N3700, AND 2N3700UB
JAN, JANTX, JANTXV, JANS, JANHCA AND JANKCA

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

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, low-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 the unencapsulated device type 2N3700.

1.2 Physical dimensions. See figure 1, 2N3019 (TO-5) and 2N3019S (similar to TO-39), figure 2, 2N3057A (TO-46), figure 3, 2N3700 (TO-18), figure 4, 2N3700UB, and figure 5, JANHCA2N3700 and JANKCA2N3700.

* 1.3 Maximum ratings.

I_C	V_{CB0}	V_{EBO}	V_{CEO}	T_J and T_{STG}
A_{dc}	V_{dc}	V_{dc}	V_{dc}	$^{\circ}C$
1	140	7	80	-65 to +200

Types	P_T	P_T	P_T	$R_{\theta JA}$ (2) (3)	$R_{\theta JC}$ (2) (3)	$R_{\theta JSP(IS)}$ (2) (3)
	$T_A = +25^{\circ}C$ (1) (2)	$T_C = +25^{\circ}C$ (1) (2)	$T_{SP(IS)} = +25^{\circ}C$ (1) (2)			
	W	W	W	$^{\circ}C/W$	$^{\circ}C/W$	$^{\circ}C/W$
2N3019	0.800	5	N/A	175	30	N/A
2N3019S	0.800	5	N/A	175	30	N/A
2N3057A	0.500	1.8	N/A	325	80	N/A
2N3700	0.500	1	N/A	325	150	N/A
2N3700UB	0.500	N/A	1.5	325	N/A	90

- (1) For derating, see figures 6, 7, 8, 9, 10, 11, and 12.
- (2) See 3.3.
- (3) For thermal curves, see figures 13, 14, 15, 16, 17, 18, and 19.
- (4) For non-thermal conductive PCB or unknown PCB surface mount conditions in free air, substitute figures 7 and 12 for the UB package and use $R_{\theta JA}$.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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* 1.4 Primary electrical characteristics.

Limits	h_{FE1} $V_{CE} = 10 \text{ V dc}$ $I_C = 150 \text{ mA dc}$	h_{FE2} $V_{CE} = 10 \text{ V dc}$ $I_C = 0.1 \text{ mA dc}$	$h_{FE3} (1)$ $V_{CE} = 10 \text{ V dc}$ $I_C = 10 \text{ mA dc}$	$h_{FE4} (1)$ $V_{CE} = 10 \text{ V dc}$ $I_C = 500 \text{ mA dc}$
Min	100	50	90	50
Max	300	200		200

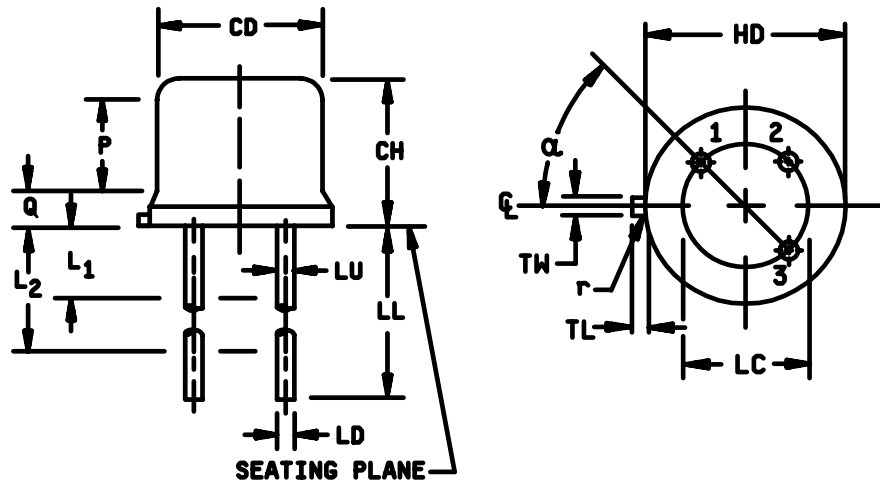
Types	Limit	$h_{FE5} (1)$ $V_{CE} = 10 \text{ V dc}$ $I_C = 1 \text{ A dc}$	$ h_{fe} $ $f = 20 \text{ MHz}$ $V_{CE} = 10 \text{ V dc}$ $I_C = 50 \text{ mA dc}$	C_{obo} $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ $V_{CB} = 10 \text{ V dc}$ $I_E = 0$
2N3019, 2N3019S 2N3057A, 2N3700 2N3700UB		<u>V dc</u>		<u>pF</u>
	Min Max	15	5 20	12

Types	Limits	$V_{CE(sat)1} (1)$ $I_C = 150 \text{ mA dc}$ $I_B = 15 \text{ mA dc}$	$V_{CE(sat)2} (1)$ $I_C = 500 \text{ mA dc}$ $I_B = 50 \text{ mA dc}$	$V_{BE(sat)} (1)$ $I_C = 150 \text{ mA dc}$ $I_B = 15 \text{ mA dc}$
2N3019, 2N3019S 2N3057A, 2N3700 2N3700UB		<u>V dc</u>	<u>V dc</u>	<u>V dc</u>
	Min Max	0.2	0.5	1.1

(1) Pulsed, see 4.5.1.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.



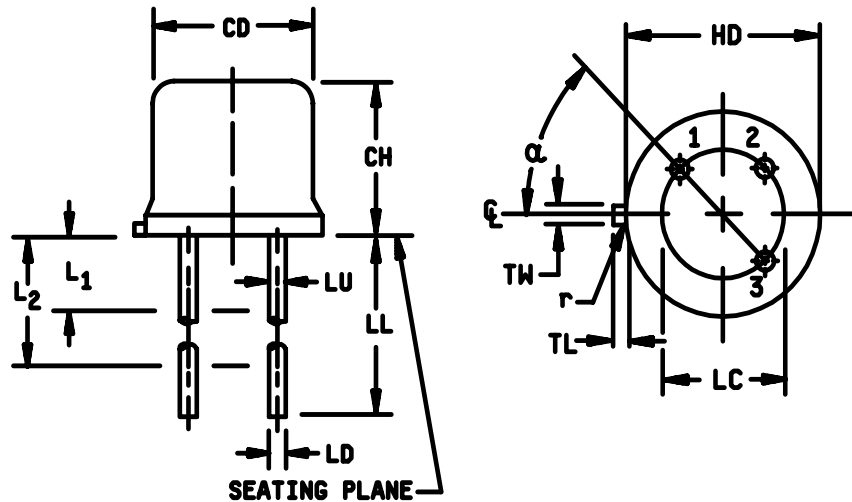
Dimensions					
Symbol	Inches		Millimeters		Notes
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.021	0.41	0.53	7, 8
LL	See notes				7, 8, 11, 12
LU	.016	.019	0.41	0.48	7, 8
L1		.050		1.27	7, 8
L2	.250		6.35		7, 8
P	.100		2.54		5
Q		.050		1.27	
r		.010		0.25	10
TL	.029	.045	0.74	1.14	4
TW	.028	.034	0.71	0.86	3
α	45° TP		45° TP		6

FIGURE 1. Physical dimensions for device types 2N3019 (TO-5) and 2N3019S (TO-39).

NOTES:

1. Dimension are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. For transistor type 2N3019, dimension LL shall be 1.5 inches (38.1 mm) minimum and 1.75 inches (44.4 mm) maximum.
12. For transistor type 2N3019S, dimension LL shall be .5 inch (12.7 mm) minimum and .75 inch (19.0 mm) maximum.
13. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.
14. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions for device types 2N3019 (TO-5) and 2N3019S (TO-39) - Continued.

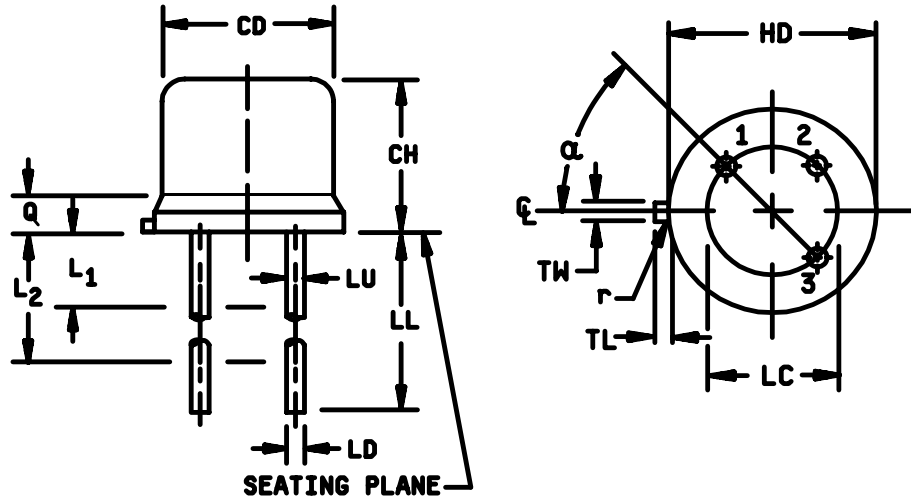


Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.065	.085	1.65	2.16	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7
LL	.500	1.750	12.70	44.45	7
LU	.016	.019	0.41	0.48	7
L1		.050		1.27	7
L2	.250		6.35		7
TL	.028	.048	0.71	1.22	3
TW	.036	.046	0.91	1.17	2
r		.007		0.18	10, 11
α	45° TP		45° TP		6

NOTES:

- Dimensions are in inches. Metric equivalents are given for general information only.
- Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
- Dimension TL measured from maximum HD.
- Leads at gauge plane $.054 +.001 -.000$ inch ($1.37 +0.03 -0.00$ mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
- Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
- All three leads.
- The collector shall be internally connected to the case.
- Dimension r (radius) applies to both inside corners of tab.
- In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
- Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 2. Physical dimensions for 2N3057A (TO-46).



Dimensions					
Symbol	Inches		Millimeters		Notes
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		5
LD	.016	.021	0.41	0.53	6, 7
LL	.500	.750	12.70	19.05	6, 7
LU	.016	.019	0.41	0.48	6, 7
L1		.050		1.27	6, 7
L2	.250		6.35		6, 7
Q		.040		1.02	4
r		.010		0.25	9
TL	.028	.048	0.71	1.22	3
TW	.036	.046	0.91	1.17	2
α	45° TP		45° TP		5

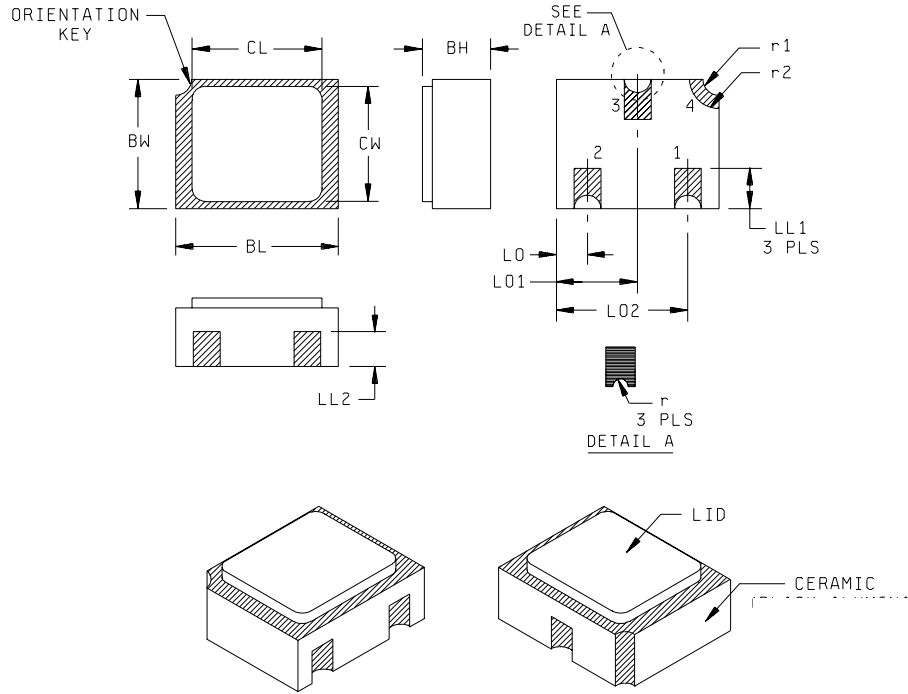
FIGURE 3. Physical dimensions for type 2N3700 (TO-18).

NOTES:

1. Dimensions are in inches. Metric equivalents are given for general information only.
2. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
3. Dimension TL measured from maximum HD.
4. Body contour optional within zone defined by HD, CD, and Q.
5. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
6. Dimension LU applies between L_1 and L_2 . Dimension LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
7. All three leads.
8. The collector shall be internally connected to the case.
9. Dimension r (radius) applies to both inside corners of tab.
10. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.
11. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 3. Physical dimensions for type 2N3700 (TO-18) - Continued.

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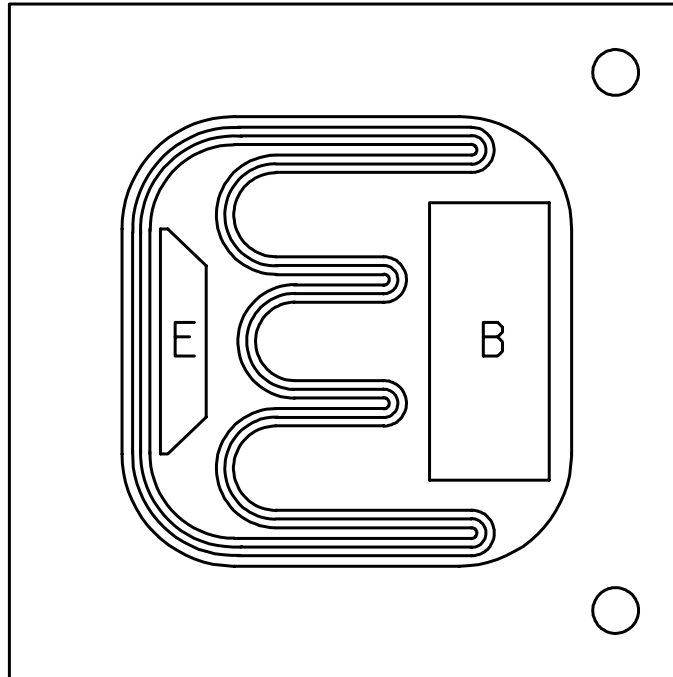


Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.046	.056	0.97	1.42
A1	.017	.035	0.43	0.89
B1	.016	.024	0.41	0.61
B2	.016	.024	0.41	0.61
B3	.016	.024	0.41	0.61
D	.085	.108	2.41	2.74
D1	.071	.079	1.81	2.01
D2	.035	.039	0.89	0.99
D3	.085	.108	2.41	2.74
E	.115	.128	2.82	3.25
E3		.128		3.25
L1	.022	.038	0.56	0.96
L2	.022	.038	0.56	0.96

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 4. Physical dimensions, surface mount (2N3700UB).



Die size: .030 x .030 inch (0.762 x 0.762 mm).
Die thickness: .008 ±.0016 inch (0.2032 mm ±0.04064 mm).
Base pad: .004 x .010 inch (0.1016 mm x 0.254 mm).
Emitter pad: .0023 x .007 inch (0.05842 mm x 0.1778 mm).
Back metal: Gold, 6500 ± 1950 Ang.
Top metal: Aluminum, 12,000 Ang. minimum; 14,500 Ang. nominal.
Back side: Collector.
Glassivation: SiO₂, 7500 ±1500 Ang.

FIGURE 5. JANHCA and JANKCA die (2N3700) dimensions.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

DEPARTMENT OF DEFENSE

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

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

2.3 Order of precedence. In the event of a conflict between the text of this 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 manufacturer's list (QML) before contract award (see 4.2 and 6.4).

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

- PCBPrinted circuit board.
- $R_{\theta JA}$ Thermal resistance junction to ambient.
- $R_{\theta JC}$ Thermal resistance junction to case.
- $R_{\theta JSP(IS)}$ Thermal resistance junction to solder pads (infinite sink mount to PCB).
- $T_{SP(IS)}$ Temperature of solder pads (infinite sink mount to PCB).
- UB.....Surface mount case outlines (see figure 4).

* 3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (2N3019, TO-5, 2N3019S, TO-39), figure 2 (2N3057A, TO-46), figure 3 (2N3700, TO-18), figure 4 (2N3700UB, surface mount) and figure 5 (JANHCA, JANKCA) 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 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3.

3.7 Marking. Marking shall be in accordance with MIL-PRF-19500, except for the UB suffix package. Marking on the UB package shall consist of an abbreviated part number, the date code, and the manufacturers symbol or logo. The prefixes JAN, JANTX, JANTXV, and JANS can be abbreviated as J, JX, JV, and JS respectively. The "2N" prefix can also be omitted.

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

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4).

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

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

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

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* 4.3 Screening (JANTX, JANTXV, and JANS only). Screening shall be in accordance with table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement	
	JANS	JANTX and JANTXV levels
* 3c	Thermal impedance method 3131 of MIL-STD-750. (1)	Thermal impedance method 3131 of MIL-STD-750. (1)
9	I_{CES1} and h_{FE1}	Not applicable
10	48 hours minimum	48 hours minimum
11	I_{CES1} ; h_{FE1} ; ΔI_{CES1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE1} = ± 15 percent.	I_{CES1} and h_{FE1}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 & 3 of table I herein; ΔI_{CES1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE1} = ± 15 percent.	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE1} = ± 15 percent.

* (1) Thermal impedance limits shall not exceed figures 13, 14, 15, 16, 17, 18, and 19.

* 4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = room ambient as defined in the general requirements of 4.5 of MIL-STD-750. V_{CB} = 10 - 30 V dc, power shall be applied to achieve T_J = +135°C minimum and minimum power dissipation of P_D = 75 percent of maximum rated P_T as defined in 1.3.

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 group A1 and A2 inspection only (table 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 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 VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta requirements shall be in accordance with the steps of table III herein as specified in the notes for table III. 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, group A, subgroup 2. Delta requirements shall be in accordance with the steps of table III herein as specified in the notes for table III.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B4	1037	$V_{CB} = 10 \text{ V dc}$, 2,000 cycles.
B5	1027	NOTE: If a failure occurs, resubmission shall be at the test conditions of the original sample. $V_{CB} = 10 \text{ V dc}$, $P_D \geq 100$ percent of maximum rated P_T (see 1.3). Option 1: 96 hours minimum, sample size in accordance with MIL-PRF-19500, table 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 A.
B6		Not applicable.

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 and /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	1039	Steady-state life: Test condition B, 1000 hours minimum, $V_{CB} = 10 \text{ V dc}$, 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, $c = 0$.
2	1039	HTRB: Test condition A, 48 hours minimum. $n = 45$ devices, $c = 0$.
3	1032	High-temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

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

- a. For JAN, JANTX and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. For JANS, samples shall be selected from each inspection lot. See MIL-PRF-19500.
- b. Must be chosen from an inspection lot that has been submitted to and passed table I, group A, subgroup 2 conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (table VIa, subgroups B4 and B5 for JANS, and table VIb, group B for JAN, JANTX and JANTXV) may be pulled prior to the application of final lead finish.

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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 VII of MIL-PRF-19500, and in 4.4.3.1 herein (JANS). See 4.4.3.2 herein for JAN, JANTX, and JANTXV group C testing. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2. Delta requirements shall be in accordance with the steps of table III herein as specified in the notes for table III.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E; not applicable for UB devices.
C6	1026	Steady-state life: Test condition B, 1,000 hours, $V_{CB} = 10V$ dc. $n = 45$ devices, $c = 0$. Power shall be applied to the device to achieve a $T_J = +150^\circ C$ minimum and a minimum power dissipation $P_D = 75$ percent of max rated P_T as defined in 1.3 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E; not applicable for UB devices.
C5	3131	See 4.5.3, $R_{\theta JC}$.
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, group A 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. Delta requirements shall be in accordance with the steps of table III herein as specified in the notes for table III.

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

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 Collector-base time constant. This parameter may be determined by applying an rf signal voltage of 1.0 volt (rms) across the collector-base terminals, and measuring the ac voltage drop (V_{eb}) with a high-impedance rf voltmeter across the emitter-base terminals. With $f = 79.8$ MHz used for the 1.0 volt signal, the following computation applies:

$$r'_b, C_{c(ps)} = 2 \times V_{eb} \text{ (millivolts)}$$

* 4.5.3 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3131 of MIL-STD-750. The following details shall apply:

- a. Collector current magnitude during power application shall be 0.15 A dc.
- b. Collector to emitter voltage magnitude shall be 20 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference point temperature shall be $+25^{\circ}\text{C} \leq T_R \leq +35^{\circ}\text{C}$. The chosen reference temperature shall be recorded before the test is started.
- e. Mounting arrangements shall be with heat sink to case.
- f. Maximum $R_{\theta\text{JC}}$ limit see figures 13, 14, 15, 16, 17, 18, and 19.

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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>		Group A, subgroup 2				
Bond strength <u>3/ 4/</u>	2037	Precondition $T_A = +250^\circ\text{C}$ at t = 24 hrs or $T_A = +300^\circ\text{C}$ at t = 2 hrs n = 11 wires, c = 0				
<u>Subgroup 2</u>						
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 140$ V dc	I_{CBO1}		10	μA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 7$ V dc	I_{EBO1}		10	μA dc
Collector to emitter breakdown voltage	3011	Bias condition D; $I_C = 30$ mA dc pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C; $V_{CE} = 90$ V dc	I_{CES1}		10	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 5$ V dc	I_{EBO2}		10	nA dc
Forward current transfer ratio	3076	$V_{CE} = 10$ V dc; $I_C = 150$ mA dc; pulsed (see 4.5.1)	h_{FE1}	100	300	
Forward current transfer ratio	3076	$V_{CE} = 10$ V dc; $I_C = 0.1$ mA dc; pulsed (see 4.5.1)	h_{FE2}	50	200	

See footnotes at end of table.

*TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> – Continued						
Forward current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}; I_C = 10 \text{ mA dc};$ pulsed (see 4.5.1)	h_{FE3}	90		
Forward current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}; I_C = 500 \text{ mA dc};$ pulsed (see 4.5.1)	h_{FE4}	50	200	
Forward current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}; I_C = 1 \text{ A dc};$ pulsed (see 4.5.1)	h_{FE5}	15		
Collector to emitter voltage (saturated)	3071	$I_C = 150 \text{ mA dc}; I_B = 15 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.2	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 500 \text{ mA dc}; I_B = 50 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.5	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 150 \text{ mA dc}; I_B = 15 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{BE(sat)}$		1.1	V dc
<u>Subgroup 3</u>						
High-temperature operation		$T_A = +150^\circ\text{C}$				
*Collector to emitter cutoff current	3041	Bias condition C; $V_{CE} = 90 \text{ V dc}$	I_{CES2}		5	$\mu\text{A dc}$
Low-temperature operation		$T_A = -55^\circ\text{C}$				
Forward current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}; I_C = 150 \text{ mA dc};$ pulsed (see 4.5.1)	h_{FE6}	40		
<u>Subgroup 4</u>						
Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = 5 \text{ V dc}; I_C = 1 \text{ mA dc},$ $f = 1 \text{ kHz}$	h_{fe}	80	400	
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 10 \text{ V dc}; I_C = 50 \text{ mA dc};$ $f = 20 \text{ MHz}$	$ h_{fe} $	5	20	

See footnotes at end of table.

*TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - continued						
Input capacitance (output open circuited)	3240	$V_{EB} = 0.5 \text{ V dc}; I_C = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ibo}		60	pF
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}		12	pF
Noise figure	3246	$V_{CE} = 10 \text{ V dc}; I_C = 100 \mu\text{A dc}; R_g =$ $1 \text{ k}\Omega;$ power bandwidth = 200 Hz	NF		4	dB
Collector to base time constant		$V_{CB} = 10 \text{ V dc}; I_C = 10 \text{ mA dc}; f =$ 79.8 MHz (see 4.5.2)	$r'_{b,Cc}$		400	ps
*Pulse response		See figure 20	$t_{on} + t_{off}$		30	ns
<u>Subgroup 5</u>						
*Safe operating area (continuous dc)	3051	$T_C = +25^\circ\text{C}; t = 10 \text{ ms}, 1 \text{ cycle}$ (see figure 21)				
<u>Test 1</u>		$V_{CE} = 10 \text{ V dc};$				
2N3019, 2N3019S		$I_C = 500 \text{ mA dc}$				
2N3057A, 2N3700, 2N3700UB		$I_C = 180 \text{ mA dc}$				
<u>Test 2</u>		$V_{CE} = 40 \text{ V dc};$				
2N3019, 2N3019S		$I_C = 125 \text{ mA dc}$				
2N3057A, 2N3700, 2N3700UB		$I_C = 45 \text{ mA dc}$				
<u>Test 3</u>		$V_{CE} = 80 \text{ V dc};$				
2N3019, 2N3019S		$I_C = 60 \text{ mA dc}$				
2N3057A, 2N3700, 2N3700UB		$I_C = 22.5 \text{ mA dc}$				
Electrical measurements		See table I, subgroup 2 herein				

See footnotes at end of table.

*TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroups 6 and 7</u>						
Not applicable						

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

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

3/ Separate samples may be used.

4/ Not required for JANS devices.

5/ Not required for laser marked devices.

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*TABLE II. Group E inspection (all quality levels) – for qualification and re-qualification 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	1071		
Gross leak			
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.	
Electrical measurements		See table I, subgroup 2 herein.	
<u>Subgroup 3</u>			
Destructive physical analysis (DPA)	2102		3 devices c = 0
<u>Subgroups 4 and 5</u>			
Not applicable			
<u>Subgroup 6</u>			
ESD	1020		3 devices c = 0
<u>Subgroup 7</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V Condition B for devices < 400 V	

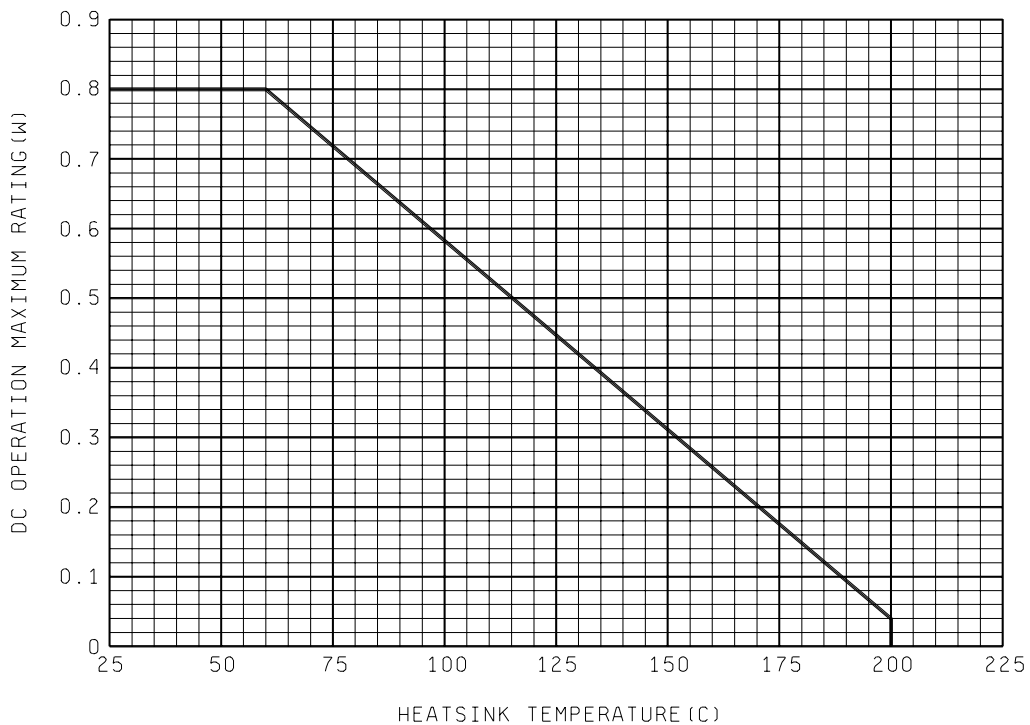
MIL-PRF-19500/391H

TABLE III. Groups B and C delta measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector-emitter cutoff current	3041	Bias condition C; $V_{CE} = 90$ V dc; pulsed (see 4.5.1)	ΔI_{CES1}	±100 percent of initial value or 8 nA dc, whichever is greater.		
2.	Forward-current transfer ratio	3076	$V_{CE} = 10$ V dc; $I_C = 0.1$ mA dc; pulsed (see 4.5.1)	Δh_{FE2}	±25 percent change from initial reading.		
3.	Forward-current transfer ratio	3076	$V_{CE} = 10$ V dc; $I_C = 150$ mA dc; pulsed (see 4.5.1)	Δh_{FE1}	±25 percent change from initial reading.		
4.	Collector-emitter voltage (saturated)	3071	$I_C = 150$ mA dc; $I_B = 15$ mA dc; pulsed (see 4.5.1)	$\Delta V_{CE(sat)1}$ <u>4/</u>	±50 mV dc change from previous measured value.		

- 1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:
a. Subgroup 4, see table III herein, step 4.
b. Subgroup 5, see table III herein, steps 1 and 3.
- 2/ The delta measurements for group B, (JAN, JANTX, and JANTXV), see 4.4.2.2 herein, are as follows: Steps 1 and 2 of 4.4.2.2 herein, see table III herein, steps 1, 3 and 4.
- 3/ The delta measurements for table VII (for JANS only) of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, steps 1 and 3.
- 4/ Measured within .125 inch (3.175 mm) from the body of the device.

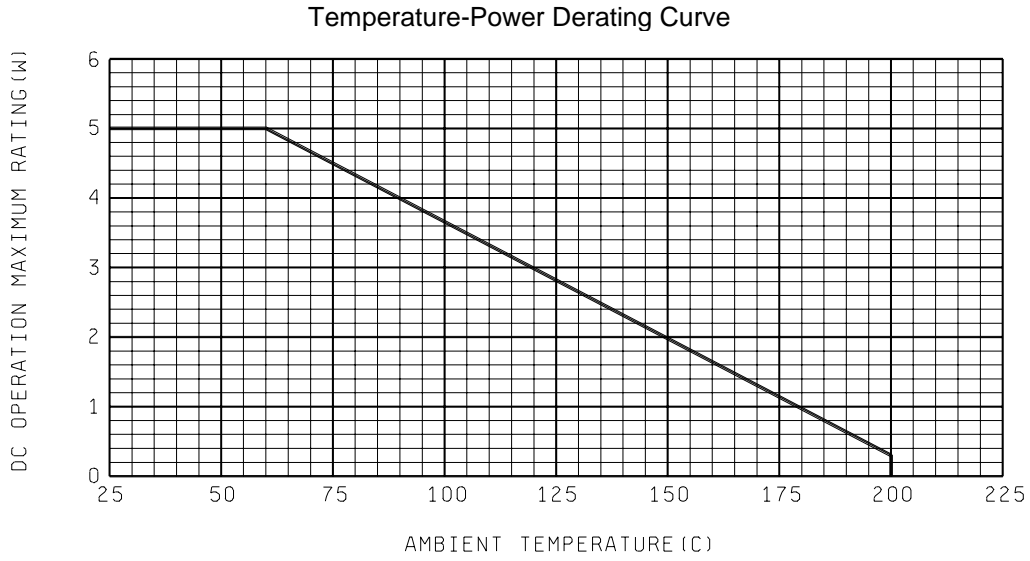
Temperature-Power Derating Curve



Thermal resistance $R_{\theta JA} = 175.0^{\circ}\text{C/W}$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 6. Derating for 2N3019 ($R_{\theta JA}$) leads .125 inch (3.175 mm) PCB (TO-5 and TO-39).

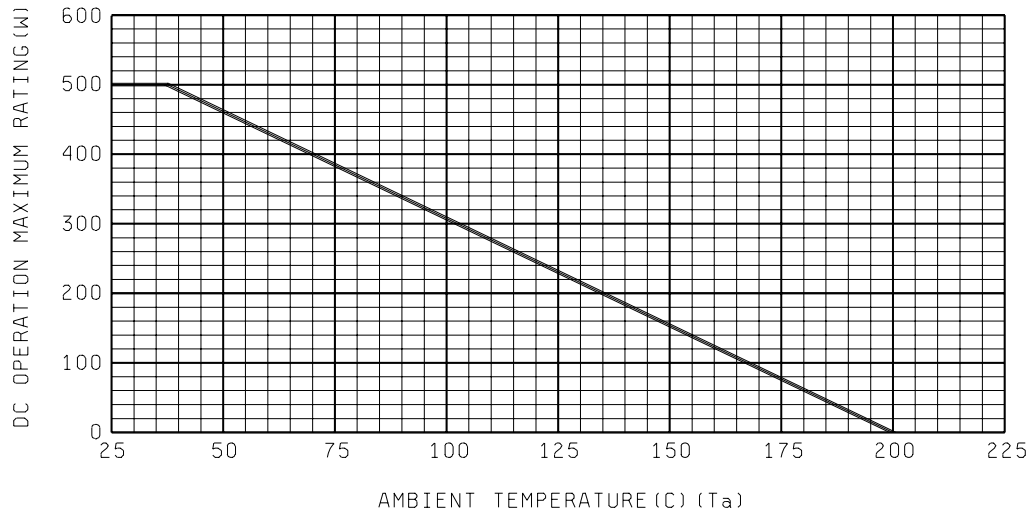


Thermal resistance $R_{\theta JC} = 30.0^{\circ}\text{C/W}$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 7. Derating for 2N3019 ($R_{\theta JC}$), base case mounted (TO-5 and TO-39).

Temperature-Power Derating Curve

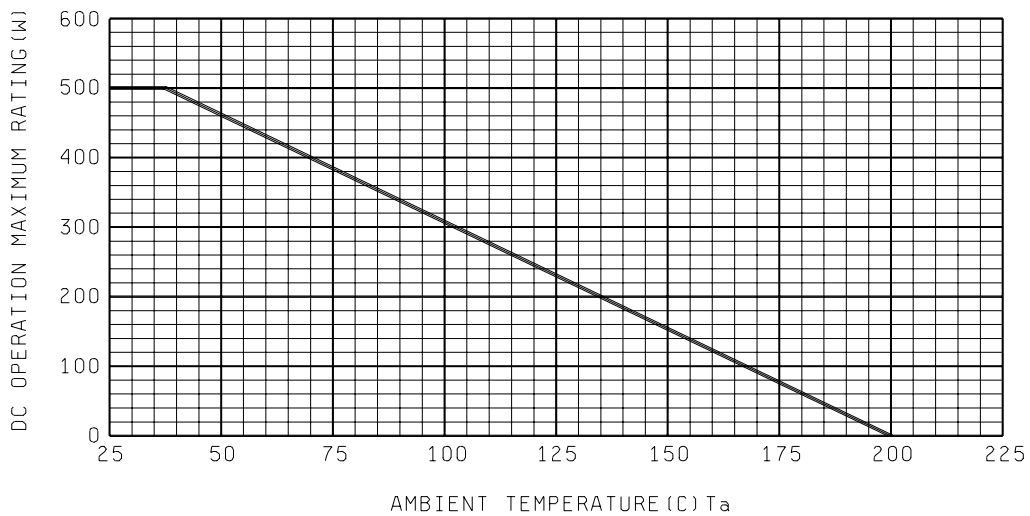


Thermal resistance $R_{\theta JA} = 325.0^{\circ}\text{C/W}$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 8. Derating for 2N3700 ($R_{\theta JA}$) (TO-18), leads .125 inch.

Temperature-Power Derating Curve

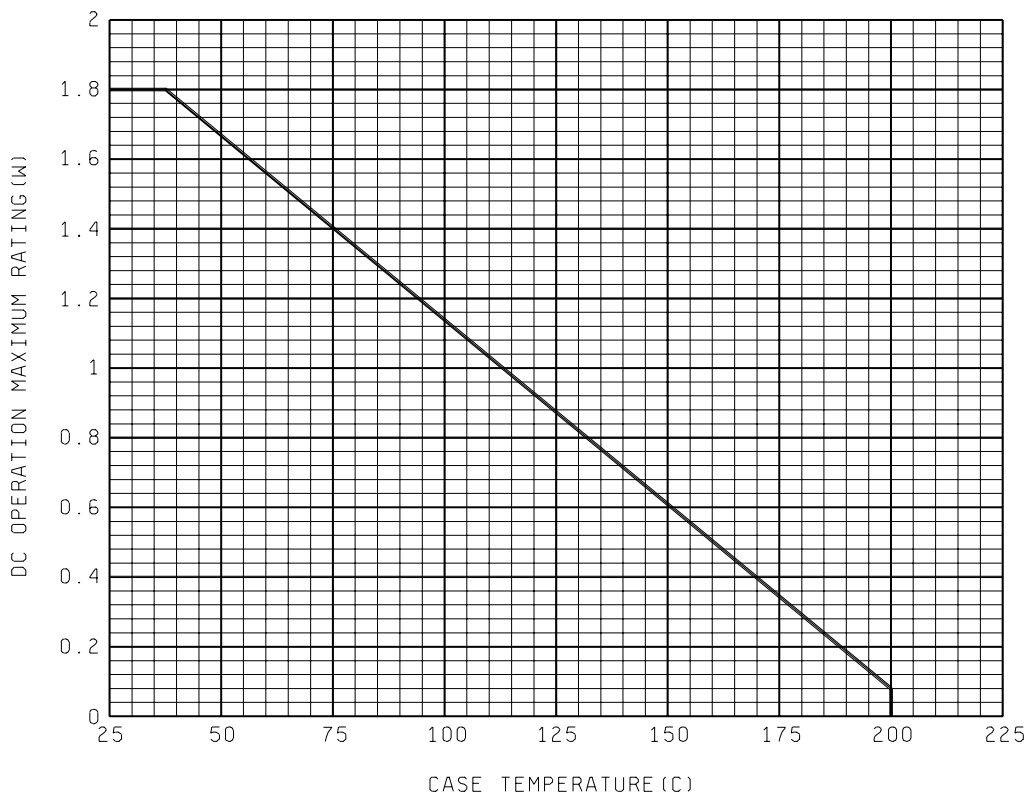


Thermal resistance $R_{\theta JA} = 325.0^\circ\text{C/W}$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 9. Derating for 2N3057A ($R_{\theta JA}$) (TO-46), leads .125 inch.

Temperature-Power Derating Curve

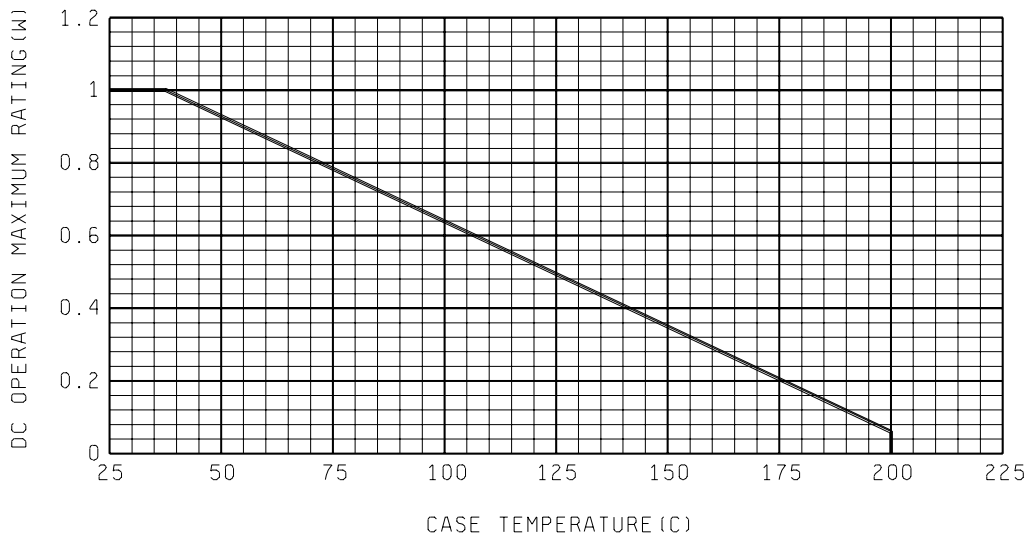


Thermal resistance $R_{\theta JC} = 80.0^{\circ}\text{C/W}$

Caution: Max finish temperature = $+175^{\circ}\text{C}$ for solder alloy.

*FIGURE 10. Derating for 2N3057A ($R_{\theta JC}$) (TO-46), base case mounted.

Temperature-Power Derating Curves

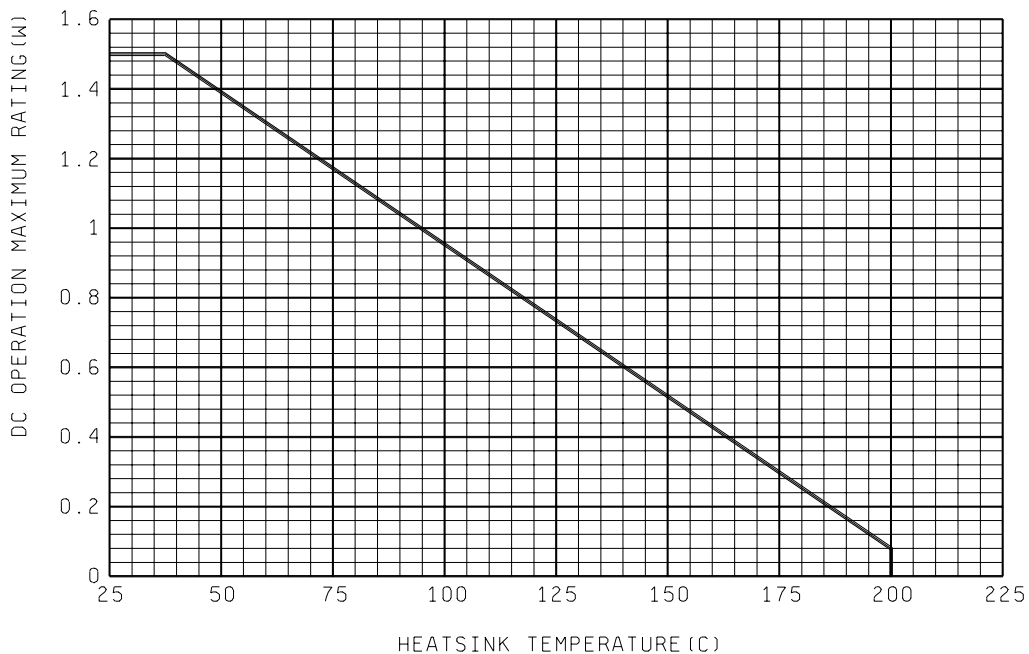


Thermal resistance $R_{\theta JC} = 150.0^{\circ}\text{C/W}$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 11. Derating for 2N3700 ($R_{\theta JC}$) (TO-18), base case mounted.

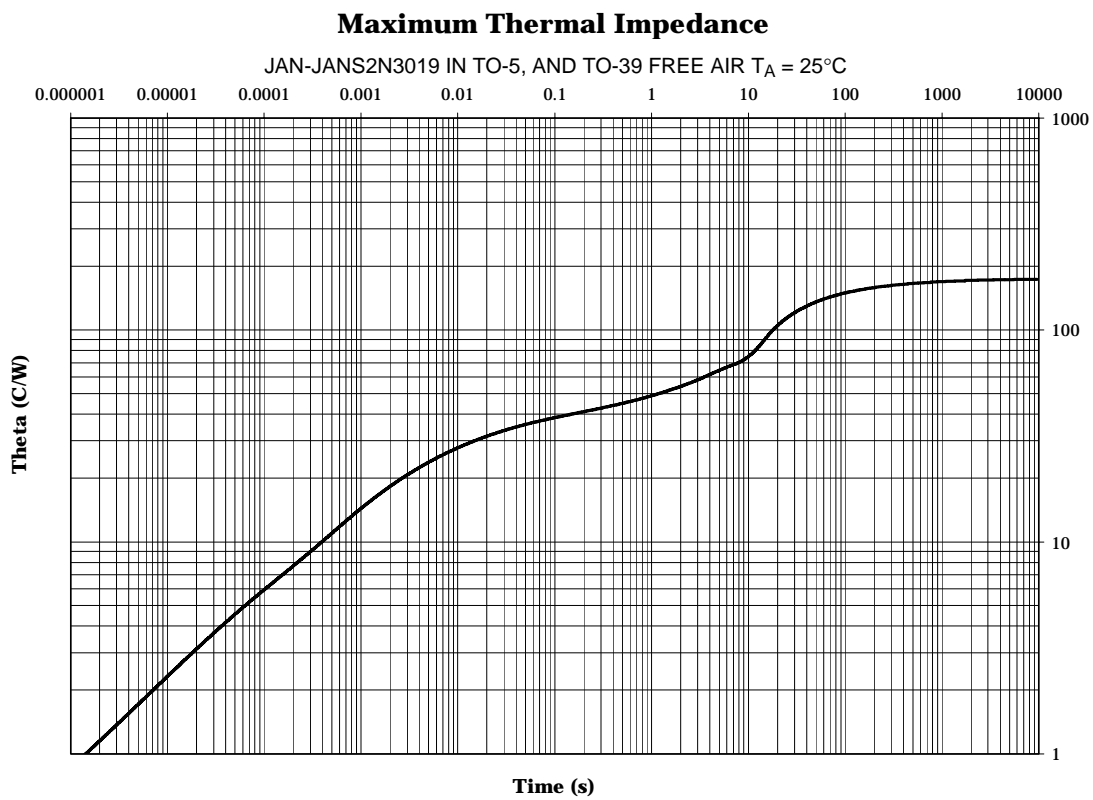
Temperature-Power Derating Curve



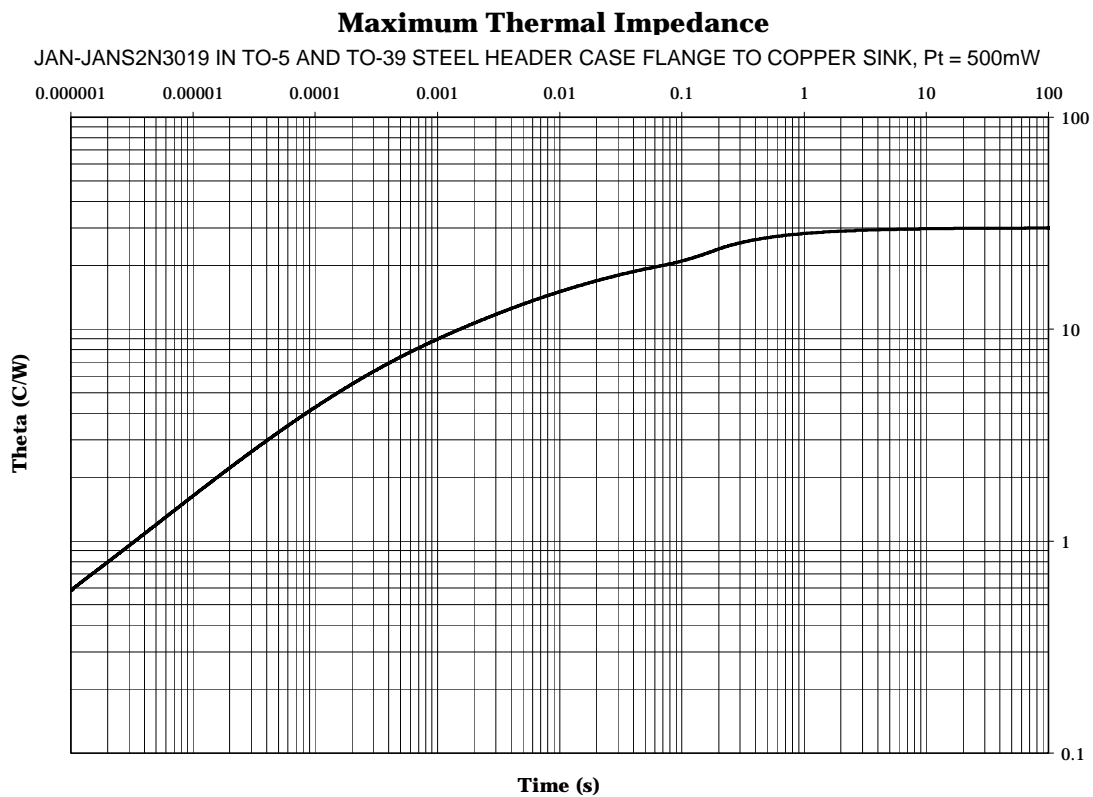
Thermal resistance $R_{\theta SP(IS)} = 90.0^{\circ}C/W$

Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 12. Derating for 2N3700UB ($R_{\theta SP(IS)}$), infinite sink 3-points.

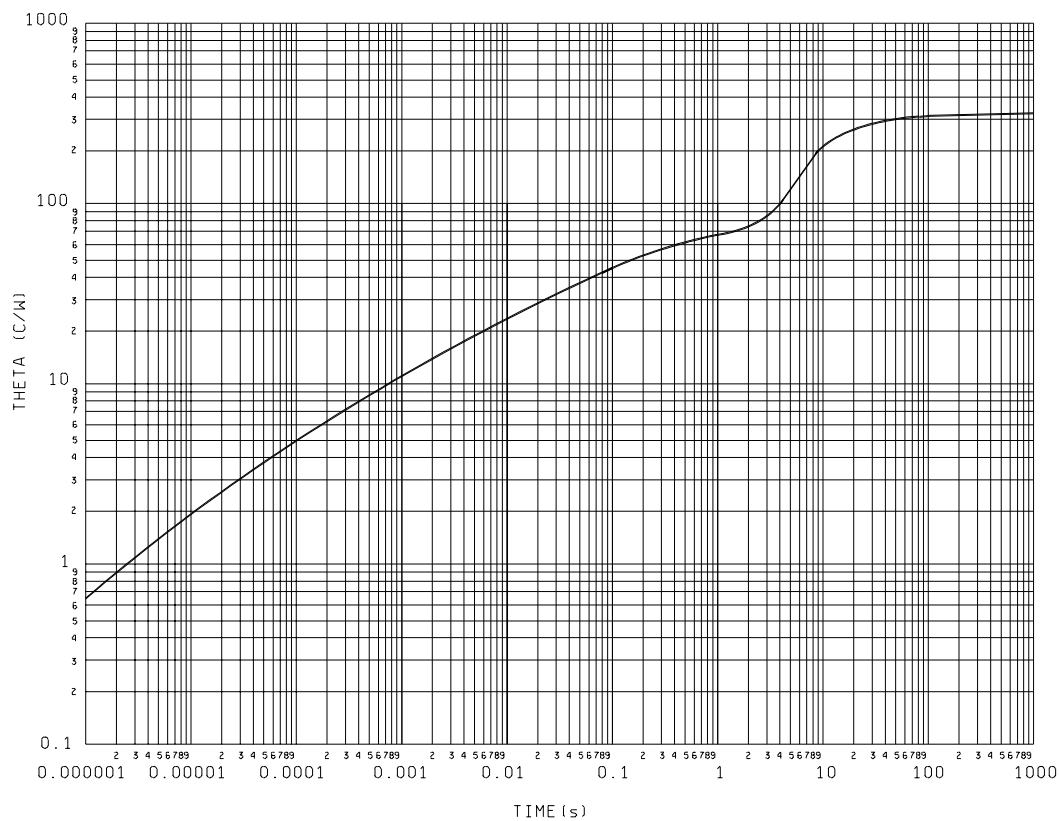


*FIGURE 13. Thermal impedance graph ($R_{\theta JA}$) for 2N3019 (TO-5 and TO-39).

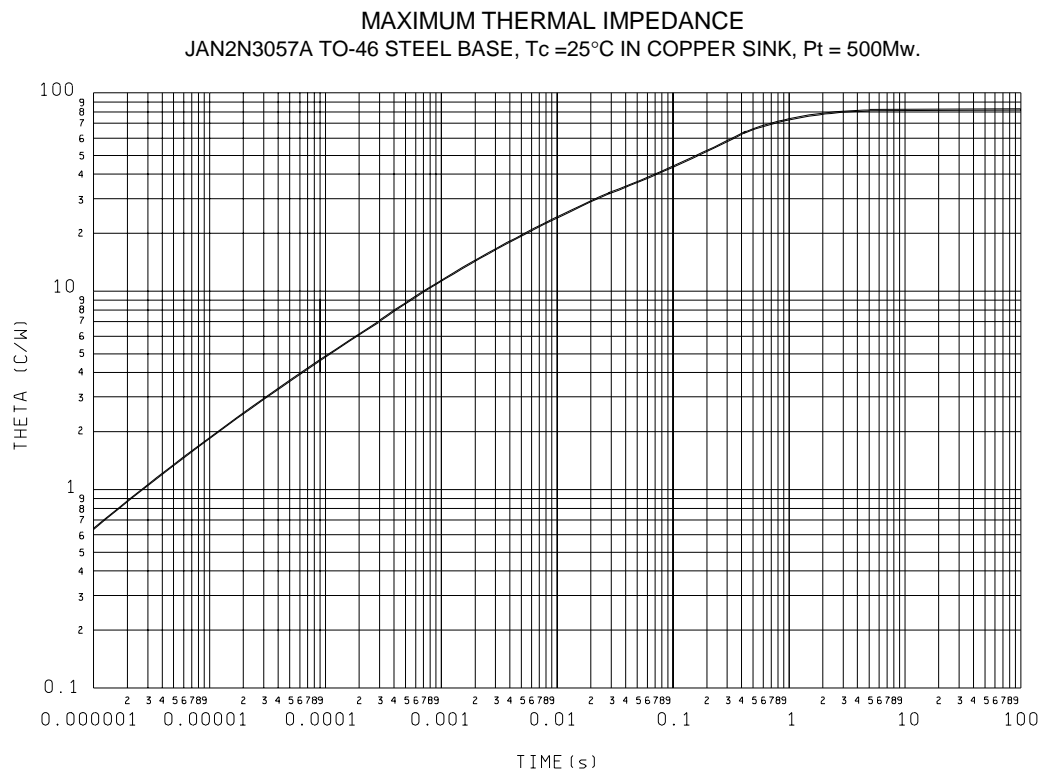


*FIGURE 14. Thermal impedance graph ($R_{\theta JC}$) for 2N3019 (TO-5 AND TO-39).

MAXIMUM THERMAL IMPEDANCE
JAN2N3057A TO-46 STEEL BASE, $T_c = 25^\circ\text{C}$ IN FREE AIR, $P_t = 500\text{mW}$.

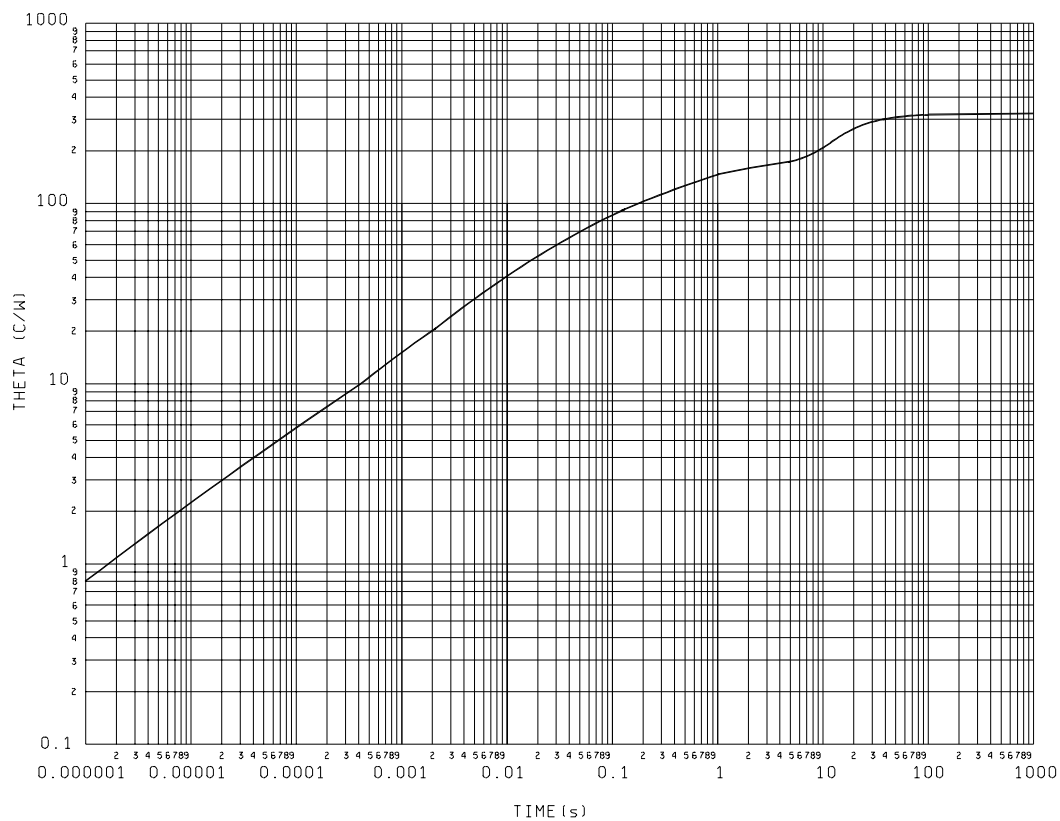


*FIGURE 15. Thermal impedance graph ($R_{\theta JA}$) 2N3057A (TO-46).

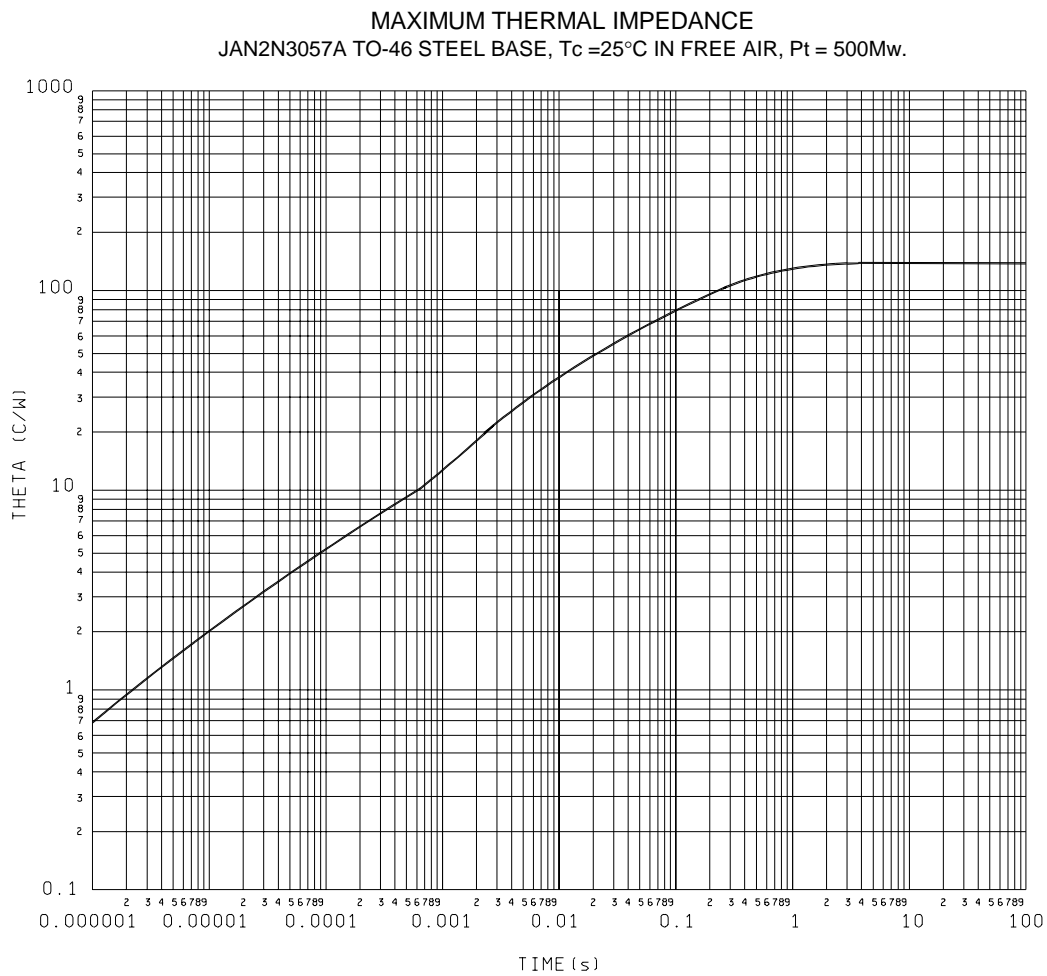


*FIGURE 16. Thermal impedance graph ($R_{\theta Jc}$) for 2N3057A (TO-46).

MAXIMUM THERMAL IMPEDANCE
JAN2N3700 TO-18 WITH 0.125" LEAD MOUNT TO PCB, Pt = 500Mw.

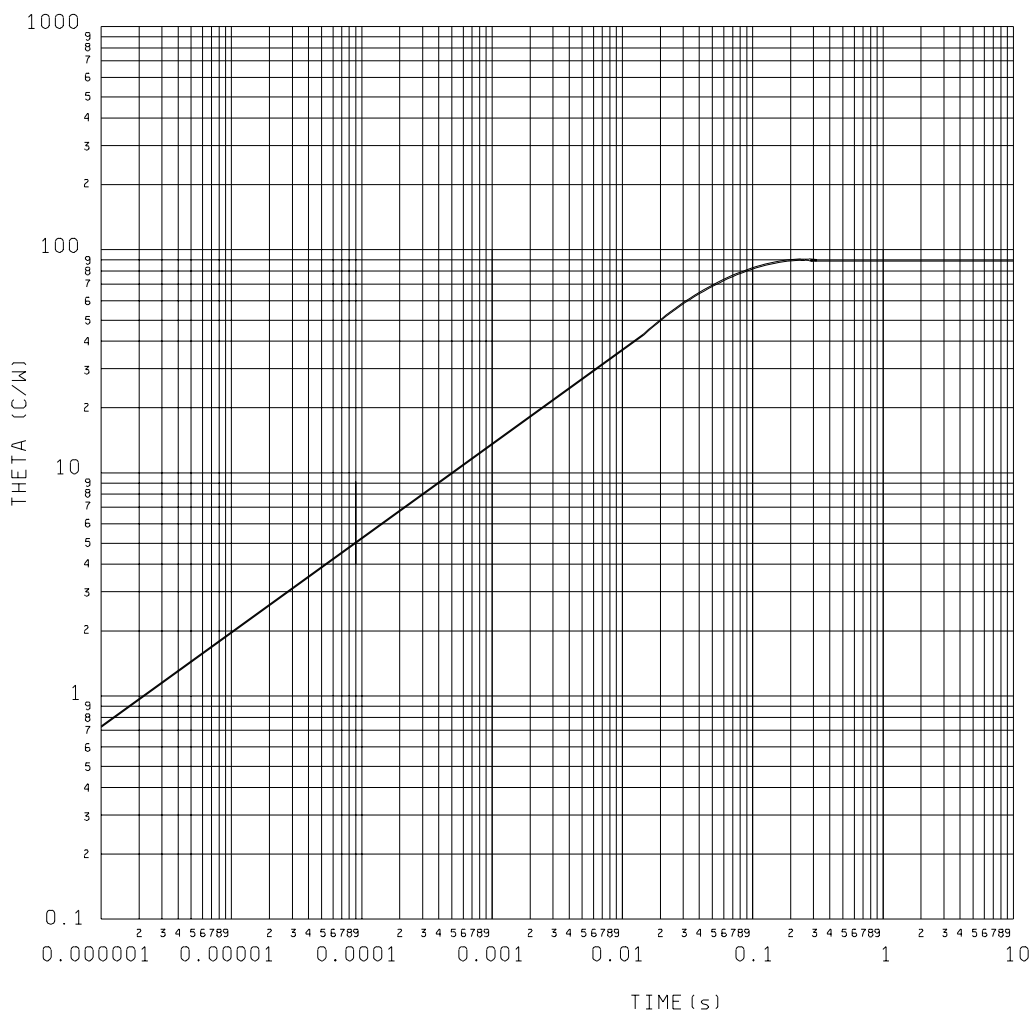


*FIGURE 17. Thermal impedance graph ($R_{\theta JA}$) for 2N3700 (TO-18).

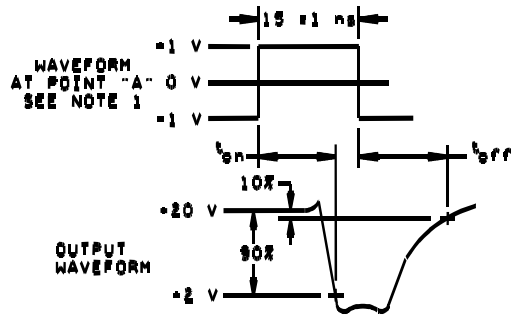
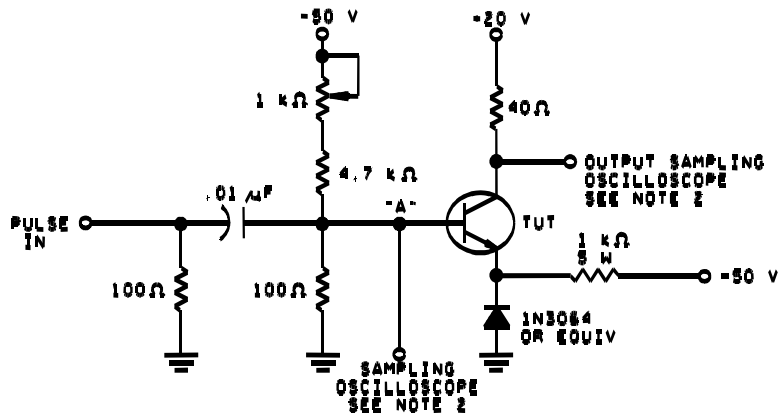


*FIGURE 18. Thermal impedance graph ($R_{\theta JA}$) for 2N3057A (TO-46).

MAXIMUM THERMAL IMPEDANCE
JAN2N3700 CERAMIC UB PACKAGE SOLDERED TO PCB.



*FIGURE 19. Thermal impedance graph ($R_{\theta JSP(I S)}$) for 2N3700 (UB).

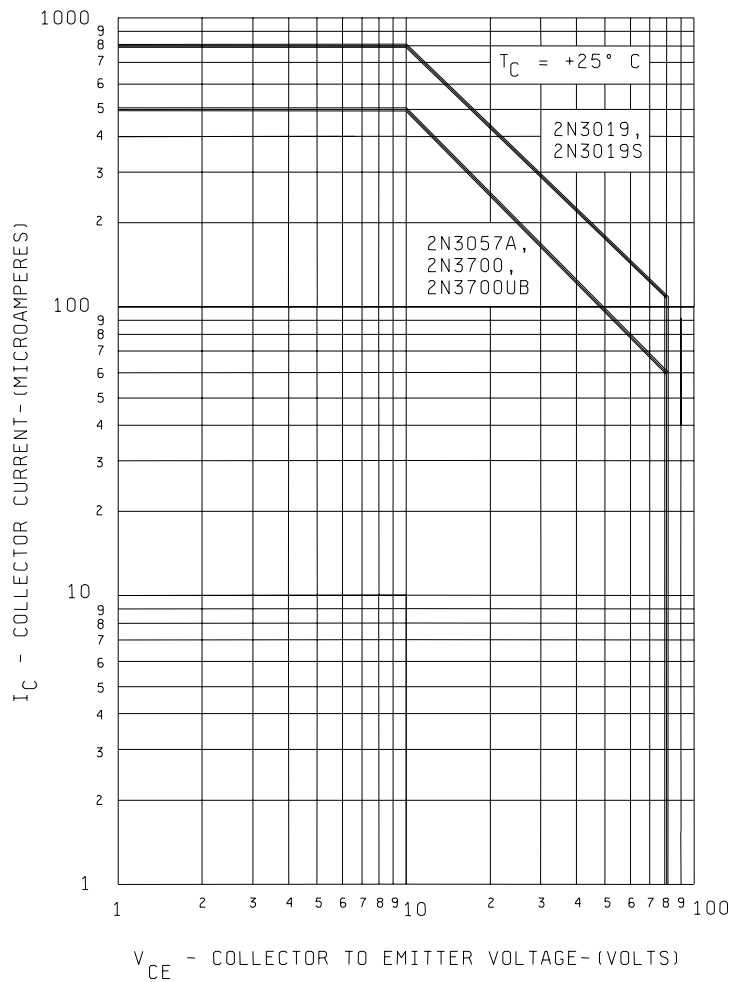


NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 2.0 ns, duty cycle ≤ 2 percent and the generator source impedance shall be 50 ohms.
2. Sampling oscilloscope: $Z_{IN} \geq 100$ k Ω , $C_{IN} \leq 12$ pF, rise time ≤ 2.0 ns.

*FIGURE 20. Nonsaturated switching-time test circuit.

*



*FIGURE 21. Maximum safe operating graph (10 ms).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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.)

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

6.2 Acquisition requirements. The acquisition requirements are as specified in MIL-PRF-19500.

6.3 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N3700) will be identified on the QML.

Die ordering information	
PIN	Manufacturer
	34156
2N3700	JANHCA2N3700 JANKCA2N3700

6.4 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) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000.

6.5 Changes from previous issue. The margins of this revision are marked with an asterisk 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
 Navy - EC
 Air Force - 11
 NASA - NA
 DLA - CC

Preparing activity:
 DLA - CC
 (Project 5961-2702)

Review activities:
 Army - AR, MI, SM
 Navy - AS, MC
 Air Force - 19

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/391H	2. DOCUMENT DATE 30 April 2003
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, LOW-POWER TYPES 2N3019, 2N3019S, 2N3057A, 2N3700, AND 2N3700UB JAN, JANTX, JANTXV, JANS, JANHCA2N3700 AND JANHCA2N3700.		
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		
5. REASON FOR RECOMMENDATION		
6. SUBMITTER		
a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) COMMERCIAL DSN FAX EMAIL	7. DATE SUBMITTED
8. PREPARING ACTIVITY		
a. Point of Contact Alan Barone	b. TELEPHONE Commercial DSN FAX EMAIL 614-692-0510 850-0510 614-692-6939 alan.barone@dla.mil	
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888	