

The documentation and process conversion measures necessary to comply with this document shall be completed by 12 June 2013.

INCH-POUND

MIL-PRF-19500/355R
 12 March 2013
 SUPERSEDING
 MIL-PRF-19500/355P
 9 December 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, UNITIZED DUAL TRANSISTOR, NPN, SILICON,
 TYPES 2N2919, 2N2920, 2N2919L, 2N2920L, 2N2919U, AND 2N2920U,
 JAN, JANTX, JANTXV, JANS, JANSM, JANS, JANS, JANS, JANS, JANS, JANS,
 JANSF, JANS, JANS, JANSH, JANHC, JANHCM, JANHCD, JANHCP, JANHCL, JANHCR, JANHCF, JANHCG, JANHCH,
 JANKC, JANKCM, JANKCD, JANKCP, JANKCL, JANKCR, JANKCF, JANKCG, AND JANKCH.

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 two electrically isolated, matched NPN silicon transistors as one dual unit. 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 die. 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 (similar to TO-78), figure 2 (surface mount), figure 3 (JANHCA and JANKCA die), and figure 4 (JANHCB and JANKCB die).

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

Type	I_C	V_{CBO}	V_{CEO}	V_{EBO}
	<u>mA dc</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>
All types	30	70	60	6

P_T (1) $T_A = +25^\circ\text{C}$		P_T (2) $T_C = +25^\circ\text{C}$		$R_{\theta JA}$		$R_{\theta JC}$		T_J and T_{STG}
One section	Both sections	One section	Both sections	One section	Both sections	One section	Both sections	
<u>mW</u>	<u>mW</u>	<u>mW</u>	<u>mW</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C/W}$</u>	<u>$^\circ\text{C}$</u>
200	350	300	450	875	500	583	388	-65 to +200

- (1) For $T_A > +25^\circ\text{C}$, derate linearly 1.143 mW/ $^\circ\text{C}$, one section; 2.000 mW/ $^\circ\text{C}$, both sections.
- (2) For $T_C > +25^\circ\text{C}$, derate linearly 1.714 mW/ $^\circ\text{C}$, one section; 2.571 mW/ $^\circ\text{C}$, both sections.

* 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>.

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1.4 Primary electrical characteristics of each individual section. Unless otherwise specified, $T_C = +25^\circ\text{C}$.

	h_{FE1}		$ h_{fe} $	$V_{CE(SAT)}$
	$V_{CE} = 5 \text{ V dc}$ $I_C = 10 \mu\text{A dc}$		$V_{CE} = 5 \text{ V dc}$ $I_C = 0.5 \text{ mA dc}$ $f = 20 \text{ MHz}$	$I_C = 1 \text{ mA dc}$ $I_B = 100 \mu\text{A dc}$
	2N2919 2N2919L 2N2919U	2N2920 2N2920L 2N2920U		
Min	60	175	3.0	<u>V dc</u>
Max	240	600	20	0.3

* 1.5 Primary electrical matching characteristics of each individual section. Unless otherwise specified, $T_C = +25^\circ\text{C}$.

	$\frac{h_{FE2-1}}{h_{FE2-2}}$	$ V_{BE1} - V_{BE2} _1$	$ \Delta(V_{BE1} - V_{BE2})_{\Delta T_A} _1$	$ \Delta(V_{BE1} - V_{BE2})_{\Delta T_A} _2$
	$V_{CE} = 5 \text{ V dc}$ $I_C = 100 \mu\text{A dc}$ (1)	$V_{CE} = 5 \text{ V dc}$ $I_C = 10 \mu\text{A dc}$	$V_{CE} = 5 \text{ V dc}$ $I_C = 100 \mu\text{A dc}$ $T_A = +25^\circ\text{C}$ and -55°C	$V_{CE} = 5 \text{ V dc}$ $I_C = 100 \mu\text{A dc}$ $T_A = +125^\circ\text{C}$ and $+25^\circ\text{C}$
Min	0.9	<u>mV dc</u>	<u>mV dc</u>	<u>mV dc</u>
Max	1.1	5	0.8	1.0

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.

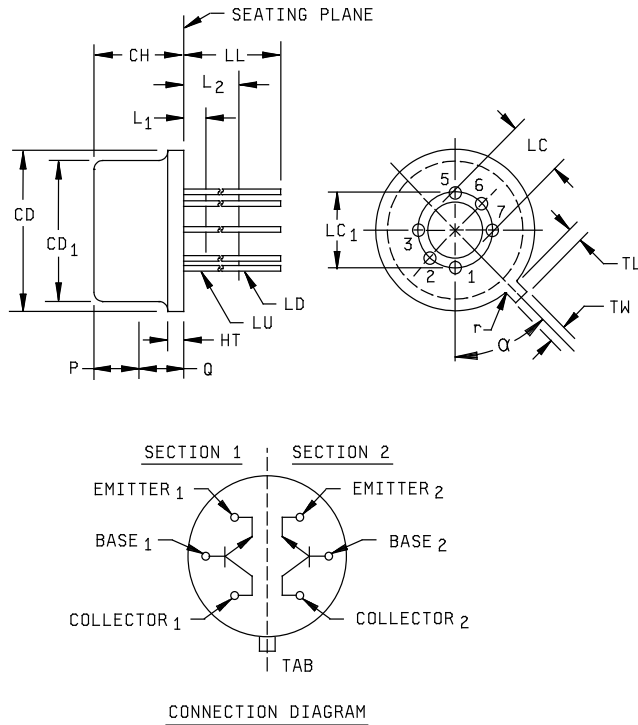
DEPARTMENT OF DEFENSE STANDARDS

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

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

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

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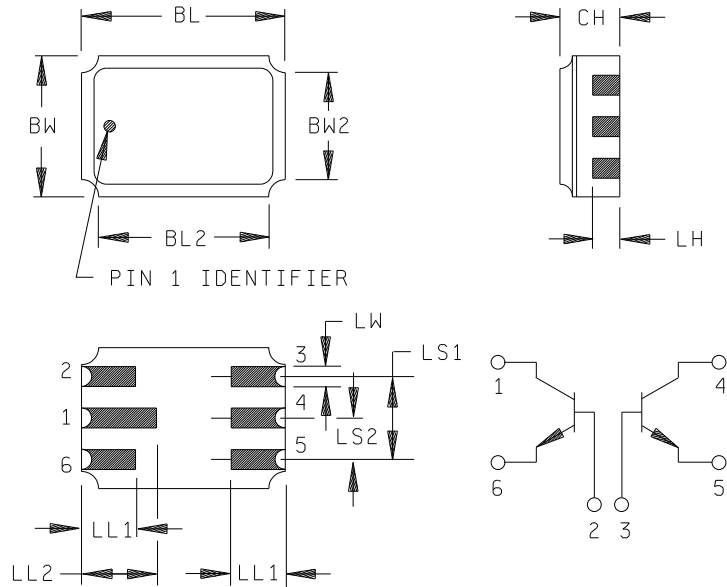
Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.335	.370	8.51	9.40	
CD ₁	.305	.335	7.75	8.51	
CH	.140	.260	3.56	6.60	
HT	.009	.041	0.23	1.04	
LC	.140	.160	3.56	4.06	
LC ₁	.200 TP		5.08 TP		9
LD	.016	.021	.041	0.53	10
LL	See notes 10, 11, and 12				
LU	.016	.019	0.41	0.48	10
L ₁		.050		1.27	10
L ₂	.250		6.35		10
P	.100		2.54		8
Q		.050		1.27	7
TL	.029	.045	0.74	1.14	5, 6
TW	.028	.034	0.71	0.86	4, 5
r		.010		0.25	
α	45°TP		45°TP		9

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Tab shown omitted.
4. Lead numbers 4 and 8 are omitted on this variation.
5. Beyond r maximum, TW shall be held to a minimum length of .21 inch (5.33 mm).
6. TL shall be measured from maximum CD.
7. Details of outline in this zone are optional.
8. CD₁ shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
9. Leads at gauge plane .054 - .055 inch (1.37 - 1.40 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at a maximum material condition (MMC) relative to the tab at MMC. The device may be measured by direct methods or by the gauge and gauging procedures described on gauge drawing GS-1.
10. LU applies between L₁ and L₂. LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
11. For transistor types 2N2919 and 2N2920, LL is .500 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum.
12. For transistor type 2N2919L and 2N2920L, LL is 1.500 inches (38.10 mm) minimum and 1.750 inches (44.45 mm) maximum.
13. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions 2N2919, 2N2919L, 2N2920, and 2N2920L (TO-78).

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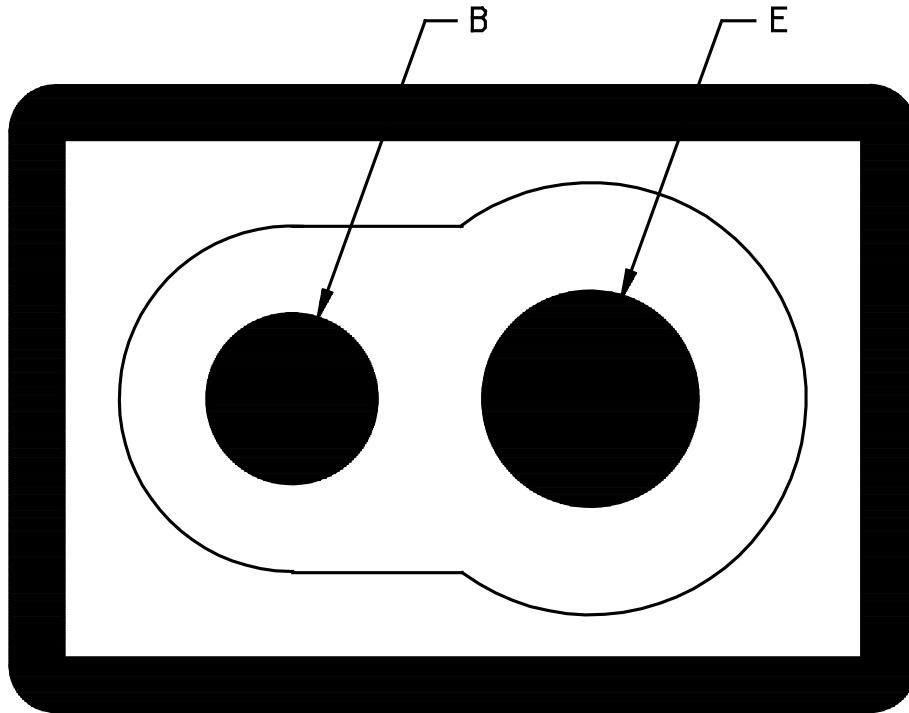
Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.240	.250	6.10	6.35
BL ₂		.250		6.35
BW	.165	.175	4.19	4.44
BW ₂		.175		4.44
CH	.044	.080	1.12	2.03
LH	.026	.039	0.66	0.99
LL ₁	.060	.070	1.52	1.78
LL ₂	.082	.098	2.08	2.49
LS ₁	.095	.105	2.41	2.67
LS ₂	.045	.055	1.14	1.39
LW	.022	.028	0.56	0.71

Pin no.	Transistor
1	Collector no. 1
2	Base no. 1
3	Base no. 2
4	Collector no. 2
5	Emitter no. 2
6	Emitter no. 1

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.

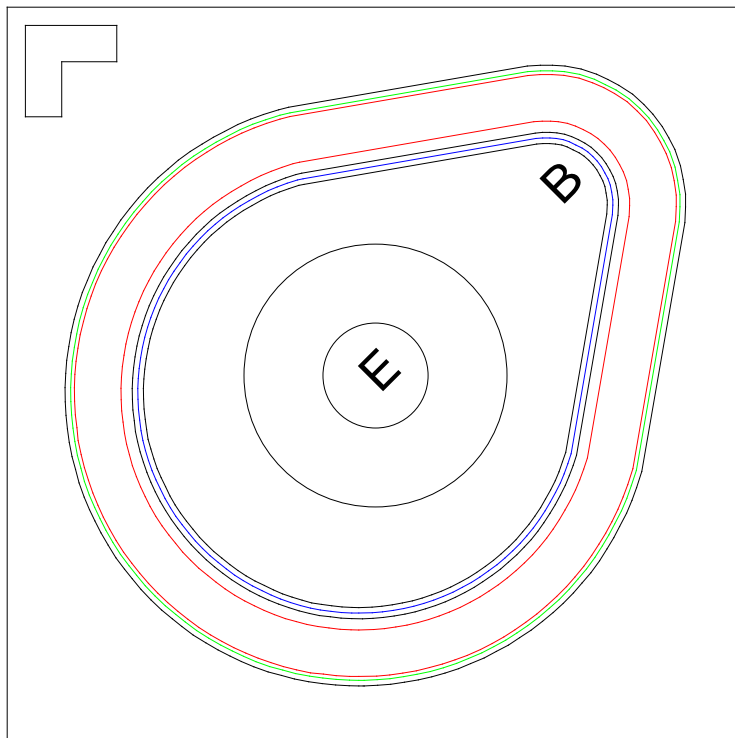
FIGURE 2. Physical dimensions (2N2919U and 2N2920U) surface mount.



NOTES:

1. Chip size..... .015 x .019 inch \pm .001 inch (0.381 x 0.4826 mm \pm 0.0254 mm).
2. Chip thickness..... .010 \pm .0015 inch (0.254 \pm 0.0381 mm).
3. Top metal Aluminum 15,000Å minimum, 18,000Å nominal.
4. Back metal..... A. Gold 2,500Å minimum, 3,000Å nominal.
B. Eutectic Mount - No Gold.
5. Backside..... Collector.
6. Bonding pad B = .003 inch (0.0762 mm), E = .004 inch (0.1016 mm) diameter.
7. Passivation..... Si₃N₄ (Silicon Nitride) 2 kÅ min, 2.2 kÅ nom.

FIGURE 3. Physical dimensions (JANHCA and JANKCA die).



NOTES:

1. Die size----- .018 x .018 inch (0.457 mm x 0.457 mm).
2. Die thickness--- .008 ±.0016 inch (0.203 mm ±0.04 mm).
3. Base pad----- .0025 inch diameter (0.06 mm).
4. Emitter pad----- .003 inch diameter (0.076 mm).
5. Back metal----- Gold, 6,500 ±1,950Å.
6. Top metal----- Aluminum, 19,500 ±2,500Å.
7. Back side----- Collector.
8. Glassivation--- SiO₂, 7,500 ±1,500Å.

FIGURE 4. Physical dimensions (JANHCB and JANKCB) B version die.

3. REQUIREMENTS

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

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

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

h_{FE-1}/h_{FE-2}	Static forward-current-gain-ratio. The matching ratio of the static forward-current transfer ratio of each section.
$R_{\theta JA}$	Thermal resistance junction to ambient.
$R_{\theta JSP(IS)}$	Thermal resistance junction to solder pads (infinite sink mount to PCB).
$ V_{BE1} - V_{BE2} $	Absolute value of base-emitter-voltage differential between the individual sections.
$ \Delta V_{BE1-2}(T1) - \Delta V_{BE1-2}(T2) $	Absolute value of the algebraic difference between the base-emitter-voltage differentials between the individual sections at two different temperatures.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figures 1, 2, 3, and 4. No lead (Pb) shall be used in the construction of the die bonds.

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, 1.5, and table I.

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

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, II, and III).

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 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.

4.2.1.1 Group E thermal response. With extremely small junction devices such as this one, a true thermal impedance cannot be measure, only calculated. While “thermal response” has been substituted for “thermal impedance” herein, the terms, units and procedure are essentially unchanged. Each supplier shall submit a thermal response ($Z_{\theta JX}$) histogram of the entire qualification lot. The histogram data shall be taken prior to the removal of devices that are atypical for thermal response. Thermal response curves (from $Z_{\theta JX}$ test pulse time to $R_{\theta JX}$ minimum steady-state time) of the best device in the qual lot and the worst device in the qual lot (that meets the supplier proposed screening limit), or from the thermal grouping, shall be submitted. The optimal test conditions and proposed initial thermal response screening limit shall be provided in the qualification report. Data indicating how the optimal test conditions were derived for $Z_{\theta JX}$ shall also be submitted. The proposed maximum thermal response $Z_{\theta JX}$ screening limit shall be submitted. The qualifying activity may approve a different $Z_{\theta JX}$ limit for conformance inspection end-point measurements as applicable. Equivalent data, procedures, or statistical process control plans may be used for part, or all, of the above requirements. The approved thermal response conditions and limit for $Z_{\theta JX}$ shall be used by the supplier in screening and table I, subgroup 2. The approved thermal resistance conditions for $R_{\theta JX}$ shall be used by the supplier for conformance inspection. For product families with similar thermal characteristics based on the same physical and thermal die, package, and construction combination (thermal grouping), the supplier may use the same thermal response curves.

4.2.2 JANHC and JANKC die. Qualification shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANS, JANTXV, and JANTX 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 table E-IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal response, method 3131 of MIL-STD-750	Thermal response, method 3131 of MIL-STD-750
9	I_{CBO2} , h_{FE3} , $\frac{h_{FE2-1}}{h_{FE2-2}}$	Not applicable
10	48 hours minimum	48 hours minimum
11	I_{CBO2} , h_{FE3} , $\frac{h_{FE2-1}}{h_{FE2-2}}$ $\Delta I_{CBO2} = 100$ percent of initial value or 1 nA dc, whichever is greater. $\Delta h_{FE3} = \pm 20$ percent	I_{CBO2} , h_{FE3} , $\frac{h_{FE2-1}}{h_{FE2-2}}$
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; $\Delta I_{CBO2} = 100$ percent of initial value or 1 nA dc, whichever is greater; $\Delta h_{FE3} = \pm 25$ percent	Subgroup 2 of table I herein; $\Delta I_{CBO2} = 100$ percent of initial value or 1 nA dc, whichever is greater; $\Delta h_{FE3} = \pm 25$ percent

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

4.3.1 Power burn-in conditions. $V_{CB} = 10 - 30$ V dc. Power shall be applied to achieve $T_J = 135^\circ\text{C}$ minimum and using a minimum $P_D = 75$ percent of P_T maximum rated 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 Thermal response. For very small junction devices such as this, the term "thermal response" shall be used in lieu of "thermal impedance" although measurements shall be performed the same manner as thermal impedance in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} (V_C and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. See table II, group E, subgroup 4 and figures 5 and 6 herein.

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

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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 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 MIL-PRF-19500, and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 and 4.5.8 herein. See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) and delta requirements 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 and 4.5.8 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
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B4	1037	$V_{CB} = 10 \text{ V dc.}$
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B5	1027	$V_{CB} = 10 \text{ V dc, } P_D \geq 100 \text{ percent of maximum rated } P_T \text{ (see 1.3). (NOTE: If a failure occurs, resubmission shall be at the test conditions of the original sample.)}$
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Option 1: 96 hours min, sample size in accordance with table E-VIa of MIL-PRF-19500, adjust T_A or P_D to achieve $T_J = +275^\circ\text{C}$ minimum.

Option 2: 216 hours min., sample size = 45, $c = 0$; adjust T_A to achieve $T_J = +225^\circ\text{C}$ minimum.

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>
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1	1026	Steady-state life: 1,000 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 $P_D = 75 \text{ percent of maximum rated } P_T$ as defined in 1.3. $n = 45 \text{ devices, } c = 0$. 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.
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2	1048	Blocking life, $T_A = +150^\circ\text{C}$, $V_{CB} = 80 \text{ percent of rated voltage}$, 48 hours minimum. $n = 45 \text{ devices, } c = 0$.
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3	1032	High-temperature life (non-operating), $t = 340 \text{ hours, } T_A = +200^\circ\text{C}$. $n = 22, c = 0$.
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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. 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, 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 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. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 and 4.5.8 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E, not applicable to surface mount.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3) and 4.3.2.
C6	1026	1,000 hours at $V_{CB} = 10$ V dc; power shall be applied to achieve $T_J = +150^\circ\text{C}$ 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, table E-VII (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E, not applicable to surface mount.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only, as applicable (see 1.3) and 4.3.2.
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 JANTXV types shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and method 1019 of MIL-STD-750 for total ionizing dose or method 1017 of MIL-STD-750 for neutron fluence, as applicable (see 6.2 herein) except group D, subgroup 2 may be performed separate from other subgroups. Alternate package options may also be substituted for the testing provided there is no adverse effect to the fluence profile.

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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; delta measurements shall be in accordance with the applicable steps of 4.5.8.

4.5 Methods 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 Testing of units. All specified electrical tests, including end-point tests, shall be performed equally on both sections of the transistor types covered herein, except where the electrical characteristic being evaluated applies to the transistor as a device entity.

4.5.3 Disposition of leads when testing characteristics of each section. During the measurement of the characteristics of each section, the leads of the section not under test shall be open-circuited.

4.5.4 Forward-current-gain ratio. The value for the forward-current-gain ratio for each individual section of a dual unit shall be measured using method 3076 of MIL-STD-750. The forward-current-gain ratio shall be calculated by dividing one of the values by the other. If possible, this ratio shall be measured directly to improve accuracy.

4.5.5 Base-emitter-voltage differential. The base-emitter-voltage differential shall be determined by connecting the emitters of the individual sections together, applying specified electrical test conditions to each individual section in accordance with method 3066 of MIL-STD-750, test condition B, and measuring the absolute value of the voltage between the bases of the individual sections of a dual unit.

4.5.6 Base-emitter-voltage differential change with temperature. The value of the base-emitter-voltage differential shall be measured at the two specified temperatures in accordance with 4.5.5 except that the polarities of the differentials and identities of the individual sections shall be maintained. The absolute value of the algebraic difference between the values at the two temperature extremes shall be calculated. A mathematical formula for this parameter is:

$$|(V_{BE1}(T_1) - V_{BE2}(T_1)) - (V_{BE1}(T_2) - V_{BE2}(T_2))|$$

4.5.7 Noise figure test. Noise figure shall be measured using Quan Tech Laboratories test set model no. 2173C/2181, or equivalent. Conditions shall be as specified in table I.

4.5.8 Delta requirements. Delta requirements shall be as specified below:

Step	Inspection	MIL-STD-750		Symbol	Limit	
		Method	Conditions		Min	Max
1	Collector-base cutoff current	3036	Bias condition D, $V_{CB} = 45 \text{ V dc}$	ΔI_{CBO2}	100 percent of initial value or 1 nA dc, whichever is greater.	
2	Forward current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 1 \text{ mA dc}$; pulsed, see 4.5.1	Δh_{FE3}	± 25 percent change from initial reading.	

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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					
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/ 6/</u> Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements <u>4/</u>		Table I, subgroup 2				
Bond strength <u>3/ 4/</u>	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) <u>4/</u>	2075	N = 4 devices, c = 0				
<u>Subgroup 2</u>						
Thermal response	3131	See 4.3.2.	Z _{θJX}			°C/W
Collector to base cutoff current	3036	Bias condition D, V _{CB} = 70 V dc	I _{CB01}		10	μA dc
Emitter to base cutoff current	3061	Bias condition D, V _{EB} = 6 V dc	I _{EBO1}		10	μA dc
Breakdown voltage, collector to emitter	3011	Bias condition D; I _C = 10 mA dc; pulsed (see 4.5.1)	V _{(BR)CEO}	60		V dc
Collector to base cutoff current	3036	Bias condition D; V _{CB} = 45 V dc	I _{CBO2}		2	nA dc
Collector to emitter cutoff current	3041	Bias condition D; V _{CE} = 5 V dc	I _{CEO1}		2	nA dc
Emitter to base cutoff current	3061	Bias condition D; V _{EB} = 5 V dc	I _{EBO2}		2	nA dc
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 10 μA dc	h _{FE1}			
2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U				60 175	240 600	
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 100 μA dc	h _{FE2}			
2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U				100 235	325 800	

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						
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2020U	3076	$V_{CE} = 5 \text{ V dc}; I_C = 1 \text{ mA dc};$	h_{FE3}	150 300	600 1,000	
Base-emitter saturation voltage	3066	Test condition A; $I_C = 1.0 \text{ mA dc}; I_B = 100 \mu\text{A dc};$	$V_{BE(sat)1}$	0.5	1.0	V dc
Collector-emitter saturation voltage	3071	$I_C = 1.0 \text{ mA dc}; I_B = 100 \mu\text{A dc};$	$V_{CE(sat)1}$		0.3	V dc
* Forward-current transfer ratio (gain ratio)	3076	$V_{CE} = 5 \text{ V dc}, I_C = 100 \mu\text{A dc}$ (see 4.5.4)	$\frac{h_{FE2-1}}{h_{FE2-2}}$	0.9	1.1	
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc},$ $I_C = 10 \mu\text{A dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _1$		5	mV dc
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc},$ $I_C = 100 \mu\text{A dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _2$		3	mV dc
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc},$ $I_C = 1 \text{ mA dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _3$		5	mV dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
* Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature) <u>g</u> /	3066	Test condition B; $V_{CE} = 5 \text{ V dc},$ $I_C = 100 \mu\text{A dc}$ $T_A = +125^\circ\text{C}$ and $+25^\circ\text{C}$ (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} \Delta T_A _1$		0.8	mV dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 45 \text{ V dc}$	I_{CBO3}		2.5	$\mu\text{A dc}$
Low temperature operation		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5 \text{ V dc}; I_C = 10 \mu\text{A dc}$	h_{FE4}	20 50		
* Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature) <u>g</u> /	3066	Test condition B; $V_{CE} = 5 \text{ V dc},$ $I_C = 100 \mu\text{A dc}$ $T_A = +25^\circ\text{C}$ and -55°C (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} \Delta T_A _2$		1	mV 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 4</u>						
Small-signal short-circuit input impedance	3201	$V_{CE} = 5 \text{ V dc}; I_C = 1 \text{ mA dc}; f = 1 \text{ kHz}$	h_{ie}	3	30	$k\Omega$
Small-signal open-circuit reverse voltage transfer ratio	3211	$V_{CE} = 5 \text{ V dc}; I_C = 1 \text{ mA dc}; f = 1 \text{ kHz}$	h_{re}		1×10^{-3}	
Small-signal open-circuit output admittance	3216	$V_{CE} = 5 \text{ V dc}; I_C = 1 \text{ mA dc}; f = 1 \text{ kHz}$	h_{oe}		60	μmhos
Small-signal short-circuit forward current transfer ratio (magnitude h_{fe})	3306	$V_{CE} = 5 \text{ V dc}; I_C = 0.5 \text{ mA dc}; f = 20 \text{ MHz}$	$ h_{fe} $	3	20	
Open circuit output capacitance	3236	$V_{CB} = 5 \text{ V dc}; I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		5	pF
Noise figure	3246	$V_{CE} = 5 \text{ V dc}; I_C = 10 \mu\text{A dc}$ $R_g = 10 \text{ k}\Omega$, (see 4.5.7)				
Test 1		$f = 100 \text{ Hz}$	F1		5	dB
Test 2		$f = 1 \text{ kHz}$	F2		3	dB
Test 3		$f = 10 \text{ kHz}$	F3		3	dB
<u>Subgroup 5</u>						
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 40 \text{ V dc}$	I_{CES}		20	nA dc
<u>Subgroups 6 and 7</u>						
Not required						

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

2/ For resubmission of failed test 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/ When using table I, subgroup 2 as electrical end-points, this test is only required for JANS end-points.

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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				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 70$ V dc	I_{CBO1}		20	μ A dc
Cutoff current, emitter to base	3061	Bias condition D; $V_{EB} = 6$ V dc	I_{EBO1}		20	μ A dc
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 10$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	60		V dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 45$ V dc	I_{CBO2}		4	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{CE} = 5$ V dc	I_{CEO1}		4	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 5$ V dc	I_{EBO2}		4	nA dc
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 10$ μ A dc	$[h_{FE1}]$ <u>5/</u>	[30] [87.5]	240 600	
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 100$ μ A dc	$[h_{FE2}]$ <u>5/</u>	[50] [117.5]	325 800	
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 1$ mA dc;	$[h_{FE3}]$ <u>5/</u>	[75] [150]	600 1,000	
Base-emitter saturation voltage	3066	Test condition A; $I_C = 1.0$ mA dc; $I_B = 100$ μ A dc;	$V_{BE(sat)1}$	0.50	1.15	V dc
Collector-emitter saturation voltage	3071	$I_C = 1.0$ mA dc; $I_B = 100$ μ A dc;	$V_{CE(sat)1}$		0.35	V dc
* Forward-current transfer ratio (gain ratio)	3076	$V_{CE} = 5$ V dc, $I_C = 100$ μ A dc (see 4.5.4)	$\frac{h_{FE2-1}}{h_{FE2-2}}$	0.8	1.2	
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5$ V dc, $I_C = 10$ μ A dc (see 4.5.5)	$ V_{BE1} - V_{BE2} _1$		5.8	mV dc
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5$ V dc, $I_C = 100$ μ A dc (see 4.5.5)	$ V_{BE1} - V_{BE2} _2$		3.5	mV dc

See footnotes at end of table.

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* TABLE II. Group D inspection - Continued.

Inspection <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 4/</u> - Continued.						
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5$ V dc, $I_C = 1$ mA dc (see 4.5.5)	$ V_{BE1} - V_{BE2} _3$		5.8	mV dc
Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature)	3066	Test condition B; $V_{CE} = 5$ V dc, $I_C = 100$ μ A dc $T_A = +25^\circ\text{C}$ and -55°C (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} _{\Delta T_A 1}$		0.92	mV dc
Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature)	3066	Test condition B; $V_{CE} = 5$ V dc, $I_C = 100$ μ A dc $T_A = +125^\circ\text{C}$ and $+25^\circ\text{C}$ (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} _{\Delta T_A 2}$		1.15	mV dc
<u>Subgroup 2</u>						
Total dose irradiation	1019	Gamma exposure VCES = 40 V				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 70$ V dc	I_{CBO1}		20	μ A dc
Cutoff current, emitter to base	3061	Bias condition D; $V_{EB} = 6$ V dc	I_{EBO1}		20	μ A dc
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 10$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	60		V dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 45$ V dc	I_{CBO2}		4	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{CE} = 5$ V dc	I_{CEO1}		4	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 5$ V dc	I_{EBO2}		4	nA dc
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 10$ μ A dc	$[h_{FE1}] \underline{5/}$	[30] [87.5]	240 600	
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 100$ μ A dc	$[h_{FE2}] \underline{5/}$	[50] [117.5]	325 800	
Forward-current transfer ratio 2N2919, 2N2919L, 2N2919U 2N2920, 2N2920L, 2N2920U	3076	$V_{CE} = 5$ V dc; $I_C = 1$ mA dc;	$[h_{FE3}] \underline{5/}$	[75] [150]	600 1,000	

See footnotes at end of table.

* TABLE II. Group D inspection - Continued.

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.						
Base-emitter saturation voltage	3066	Test condition A; $I_C = 1.0 \text{ mA dc}$; $I_B = 100 \text{ } \mu\text{A dc}$;	$V_{BE(sat)1}$	0.50	1.15	V dc
Collector-emitter saturation voltage	3071	$I_C = 1.0 \text{ mA dc}$; $I_B = 100 \text{ } \mu\text{A dc}$;	$V_{CE(sat)1}$		0.35	V dc
* Forward-current transfer ratio (gain ratio)	3076	$V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ } \mu\text{A dc}$ (see 4.5.4)	$\frac{h_{FE2-1}}{h_{FE2-2}}$	0.8	1.2	
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc}$, $I_C = 10 \text{ } \mu\text{A dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _1$		5.8	mV dc
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ } \mu\text{A dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _2$		3.5	mV dc
Absolute value of base-emitter-voltage differential	3066	Test condition B; $V_{CE} = 5 \text{ V dc}$, $I_C = 1 \text{ mA dc}$ (see 4.5.5)	$ V_{BE1} - V_{BE2} _3$		5.8	mV dc
Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature)	3066	Test condition B; $V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ } \mu\text{A dc}$ $T_A = +25^\circ\text{C}$ and -55°C (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} _1$		0.92	mV dc
Base-emitter-voltage (nonsaturated) (absolute value of differential change with temperature)	3066	Test condition B; $V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ } \mu\text{A dc}$ $T_A = +125^\circ\text{C}$ and $+25^\circ\text{C}$ (see 4.5.6)	$ \Delta V_{BE1} - V_{BE2} _2$		1.15	mV 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 the corresponding L and U suffix versions unless otherwise noted.

4/ See 6.2.e herein.

5/ See method 1019 of MIL-STD-750 for how to determine $[h_{FR}]$ 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.

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

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			12 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 4.5.8 herein.	
<u>Subgroup 2</u>			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 4.5.8 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal response curves		See 4.2.1.1.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 6</u>			
Electrostatic discharge (ESD)	1020		
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

Maximum Thermal Impedance

Calculated Thermal Impedance per Side Reflecting True Peak Tj

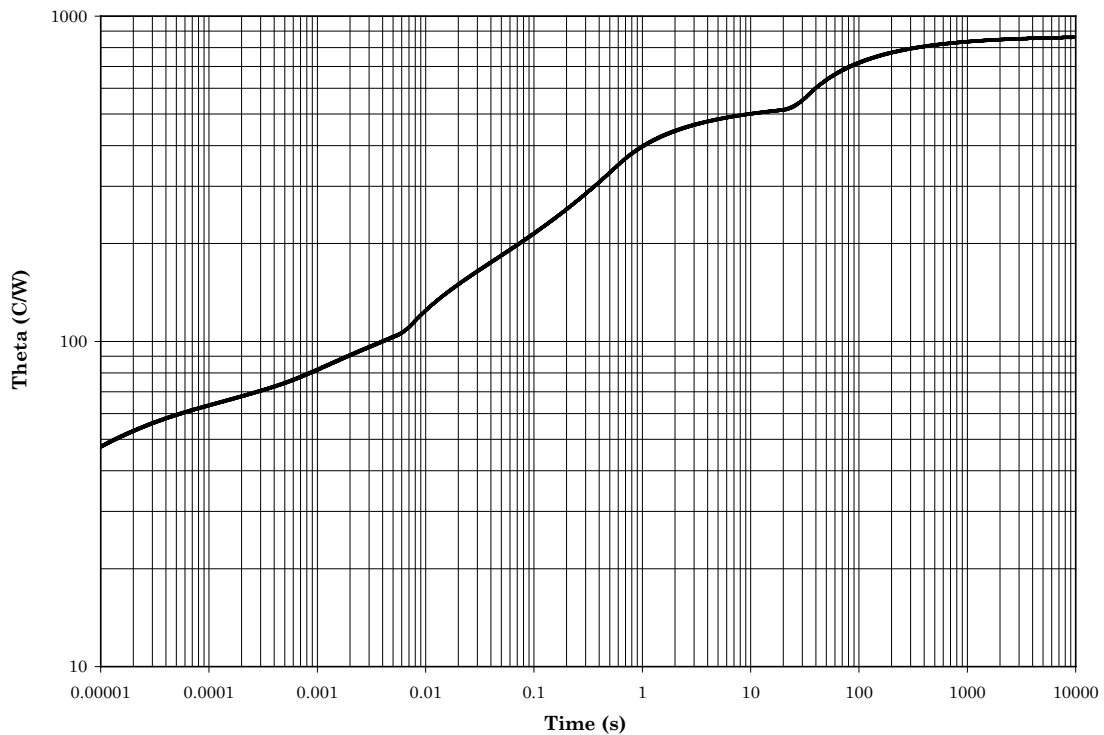


FIGURE 5. For each side: Thermal resistance = 875°C/W, Pt = 200 mW.

Maximum Thermal Impedance
Calculated Thermal Impedance Both Sides Reflecting True Peak Tj

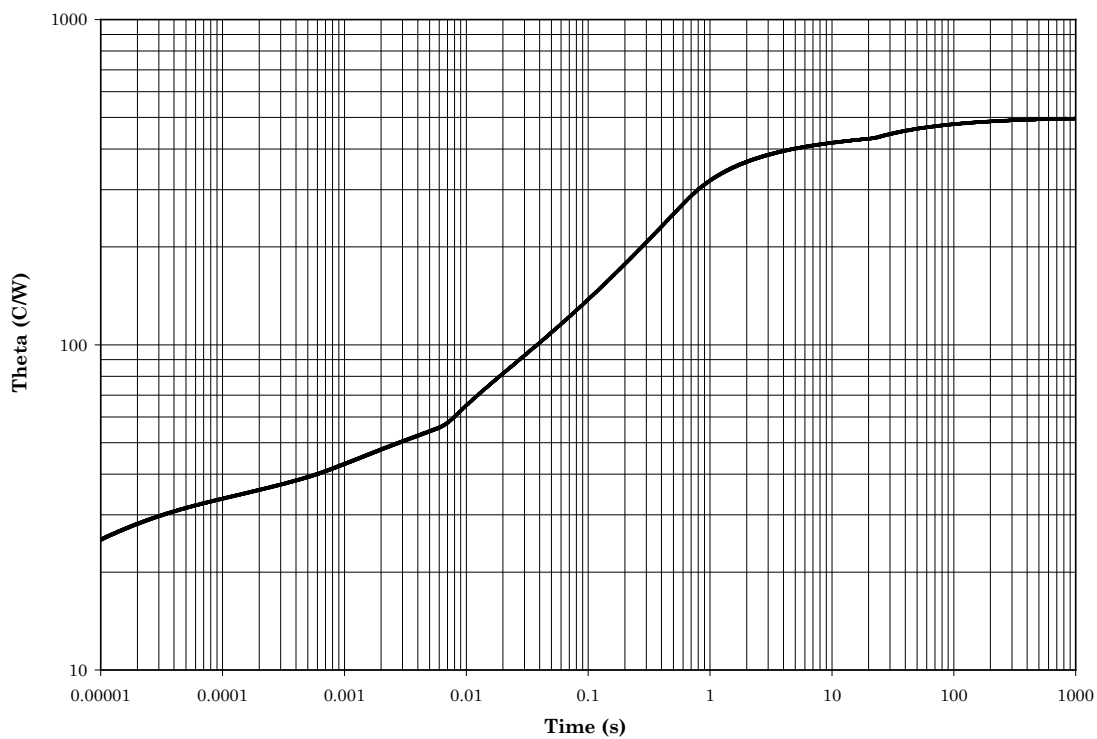


FIGURE 6. Both sides: Thermal resistance = 500°C/W, Pt = 350 mW.

5. PACKAGING

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

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

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

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. Product assurance level and type designator.
- e. For acquisition of RHA 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, Columbus, 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 Suppliers of JANHC die. The qualified JANHC suppliers with the applicable letter version (example JANHCA2N2919) will be identified on the QML.

JANHC and JANKC ordering information		
PIN	Manufacturer	
	43611	34156
2N2919	JANHCA2N2919	JANHCB2N2919, JANHCB2N2920
	JANKCA2N2919	JANKCB2N2919, JANKCB2N2920