

The documentation and process conversion measures necessary to comply with this document shall be completed by 6 Aug 2004.

INCH-POUND

MIL-PRF-19500/382E
6 May 2004
SUPERSEDING
MIL-PRF-19500/382D
12 May 2003

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER,
TYPES 2N2944A, 2N2945A, 2N2945AM, AND 2N2946A, 2N2944AUB, 2N2945AUB, 2N2945AMUB,
AND 2N2946AUB, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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 low-power, high-speed chopper, PNP, silicon transistors. A 'M' and UB'M' suffix will indicate a matched pair. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type.

1.2 Physical dimensions. See figure 1 (similar to TO-46), figure 2 (surface mount), and figure 3 (die).

* 1.3 Maximum ratings, unless otherwise specified $T_A = +25^\circ\text{C}$.

Types	P_T $T_A = +25^\circ\text{C}$ (1) (2)	V_{EBO}	V_{CBO}	V_{CEO}	V_{ECO}	I_C	T_J and T_{STG}	$R_{\theta JA}$ (3) (4)	$R_{\theta SP}$
	<u>mW</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>	<u>°C/W</u>	<u>°C/W</u>
2N2944A	400	-15	-15	-10	-10	-100	-65 to	435	N/A
2N2945A, AM	400	-25	-25	-20	-20	-100	+200	435	N/A
2N2946A	400	-40	-40	-35	-35	-100		435	N/A
2N2944AUB	400	-15	-15	-10	-10	-100	-65 to	N/A	435
2N2945AUB, UBM	400	-25	-25	-20	-20	-100	+200	N/A	435
2N2946AUB	400	-40	-40	-35	-35	-100		N/A	435

(1) For derating, see figures 4, 5 and 6.

(2) See 3.3 for abbreviations.

(3) For thermal curves, see figures 7 and 8.

(4) For non-thermal conductive PCB or unknown PCB surface mount conditions in free air, substitute figure 7 for the UB package and use $R_{\theta JA}$.

* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, 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 <http://www.dodssp.daps.mil/>.

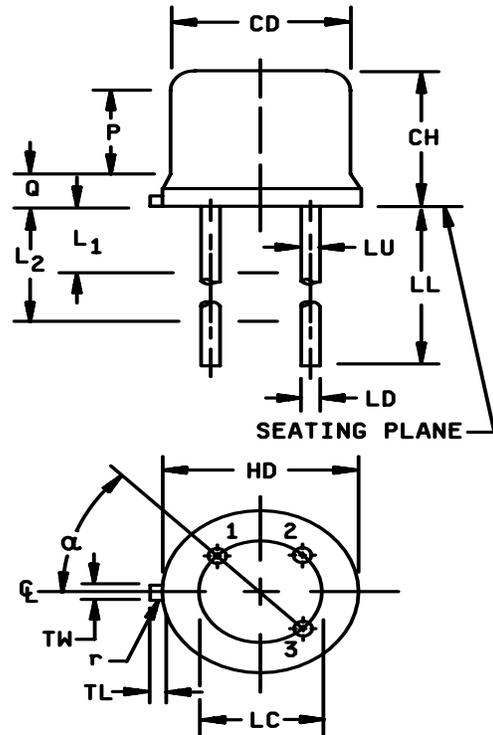
* 1.4 Primary electrical characteristics.

Limits	h_{FE1} $V_{CE} = -0.5 \text{ V dc}$ $I_C = -1 \text{ mA dc}$			$h_{FE} \text{ (inv)}_1$ $V_{EC} = -0.5 \text{ V dc}$ $I_E = -200 \mu\text{A dc}$			$r_{ec} \text{ (on)}_2$ $I_B = -1 \text{ mA dc}$ $I_e = 100 \mu\text{A ac(rms)}$ $I_E = 0; f = 1 \text{ kHz}$		
	2N2944A	2N2945A	2N2946A	2N2944A	2N2945A	2N2946A	2N2944A	2N2945A	2N2946A
Min	100	70	50	50	30	20	<u>ohms</u>	<u>ohms</u>	<u>ohms</u>
Max							4	6	8

Limits	$V_{EC} \text{ (ofs)}$						$ h_{fe} $		
	$I_B = -200 \mu\text{A dc}$ $I_E = 0$			$I_b = -1.0 \text{ mA dc}$ $I_E = 0$			$f = 1 \text{ MHz}$ $V_{CE} = -6 \text{ V dc}$ $I_C = -1 \text{ mA dc}$		
	2N2944A	2N2945A	2N2946A	2N2944A	2N2945A	2N2946A	2N2944A	2N2945A	2N2946A
Min	<u>mV dc</u>	<u>mV dc</u>	<u>mV dc</u>	<u>mV dc</u>	<u>mV dc</u>	<u>mV dc</u>	15	10	5
Max	-0.3	-0.5	-0.8	-0.6	-1.0	-2.0	55	55	55

Limits	C_{obo} $V_{CB} = -6 \text{ V dc}$ $I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ibo} $V_{EB} = -6 \text{ V dc}$ $I_C = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$
	<u>pF</u>	<u>pF</u>
Min	10	6
Max		

Symbol	Inches		Millimeter		Note
	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	.707 TP		1.80 TP		4
LD		.021		.53	2, 6
LL	.500		12.70		6
LU	.016	.019	.41	.48	3, 6
L ₁		.050		1.27	
L ₂	.250		6.35		
TL	.028	.048	.71	1.22	
TW	.036	.046	.91	1.17	
P	.100		2.54		
Q		.040		1.02	
r		.007		.18	
α	45° TP		45° TP		

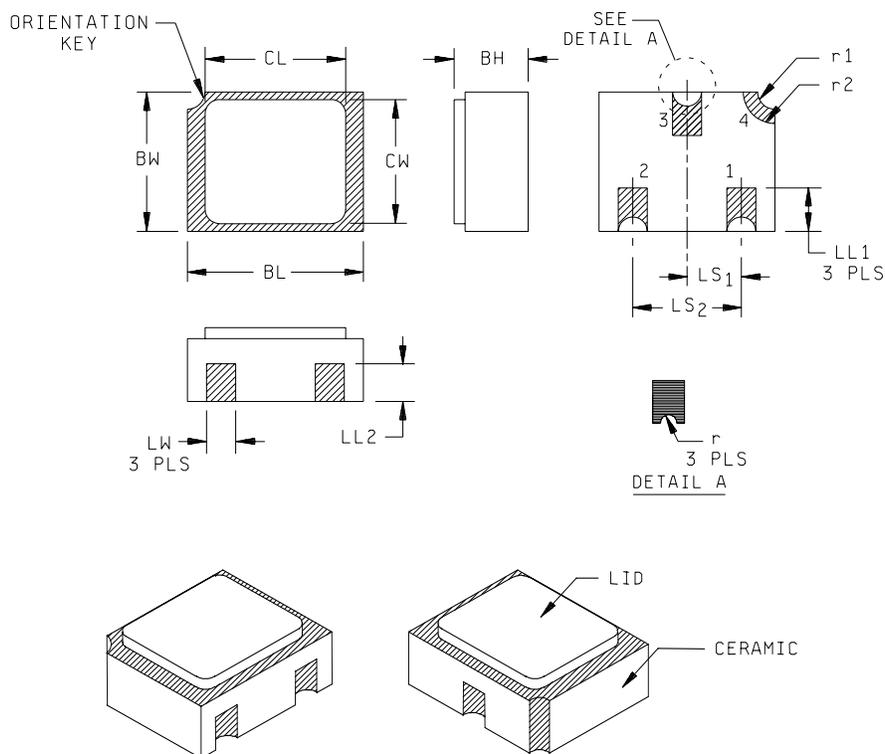


NOTES:

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 inch (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 TP relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LU applies between L₁ and L₂. Dimensions LD applies between L₂ and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L₁ and beyond LL minimum.
8. Lead designation, shall be as follows:
1 - Emitter; 2 - Base; 3 - Collector.
9. Collector 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 φx symbology.

* FIGURE 1. Physical dimensions (similar to TO-46).

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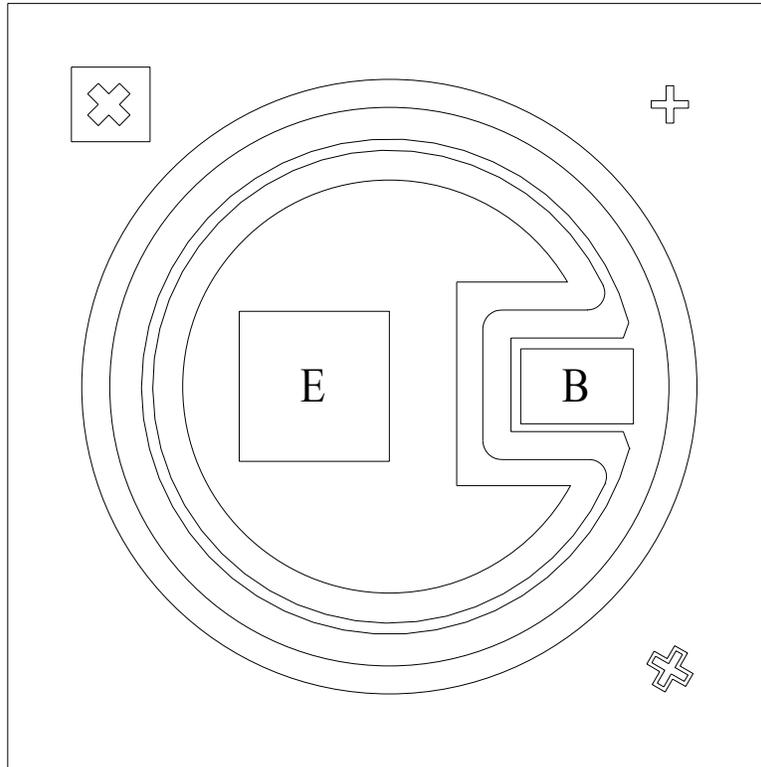


Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
BH	.046	.056	1.17	1.42	
BL	.115	.128	2.92	3.25	
BW	.085	.108	2.16	2.74	
CL		.128		3.25	
CW		.108		2.74	
LL1	.022	.038	0.56	0.96	
LL2	.017	.035	0.43	0.89	
LS1	.036	.040	0.91	1.02	
LS2	.071	.079	1.81	2.01	
LW	.016	.024	0.41	0.61	
r		.008		.203	
r1		.012		.305	
r2		.022		.559	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metallized areas (tungsten with gold plating 60 micro inches min over 80 micro inches min nickel).
4. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Shielding connected to the lid.

* FIGURE 2. Physical dimensions for UB, surface mount.



Die size: .020 x .020 inch (0.508 mm x 0.508 mm).
Die thickness: .008 ± .0016 inch (0.203 mm ± 0.041 mm).
Base pad: .002 x .003 inch (0.051 mm x 0.076 mm).
Emitter pad: .004 x .004 inch (0.102 mm x 0.102 mm).
Back metal: Gold, 6500 ± 1950 Ang.
Top metal: Aluminum, 14500 ± 2500 Ang.
Back side: Collector.
Glassivation: SiO₂, 7500 ± 1500 Ang.

FIGURE 3. Physical dimensions, JANKCA2N2944A through 2N2946A die (also valid for JANHCA2N2944A through 2N2946A).

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

* 2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

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

DEPARTMENT OF DEFENSE STANDARDS

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

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://www.dodssp.daps.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, 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 manufacturers list before contract award (see 4.2 and 6.3).

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

h_{FE} (inv)	Forward-current transfer ratio except that the collector and emitter shall be interchanged in the test circuit, i.e., I_E/I_B .
I_e	Emitter current (rms).
M	Matched pair.
$r_{ec(on)}$	Small-signal emitter-collector on-state resistance.
$V_{(BR)ECO}$	Breakdown voltage, emitter to collector, with base open-circuited.
$V_{EC(ofs)}$	Emitter to collector offset voltage, i.e., open-circuit voltage between emitter collector when the base-collector junction is forward-biased.
V_{ec}	Emitter to collector voltage (rms).

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (similar to TO-46), figure 2 (surface mount), and figure 3 (die).

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 as specified in table I, and herein.

3.7 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking may be omitted from the body, but shall be retained on the initial container.

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 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 II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

* 4.3 Screening (JANS, JANTX, and JANTXV levels 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
3c	Required, method 3131 of MIL-STD-750.	Required, method 3131 of MIL-STD-750.
7	Optional	Optional
9	I_{CBO1} and $h_{FE} (inv)_1$	Not applicable
11	I_{CBO1} ; $h_{FE} (inv)_1$; ΔI_{CBO1} = 100 percent of initial value or 0.2 nA dc for 2N2944 and 2N2945, 0.5 nA dc for 2N2946 $\Delta h_{FE} (inv)_1$ = 25 percent of initial value.	I_{CBO1} and $h_{FE} (inv)_1$
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CBO1} = 100 percent of initial value or 0.2 nA dc for 2N2944 and 2N2945, 0.5 nA dc for 2N2946; $\Delta h_{FE} (inv)_1$ = 25 percent of initial value.	Subgroups 2 of table I herein; ΔI_{CBO1} = 100 percent of initial value or 0.2 nA dc for 2N2944A and 2N2945A, 0.5 nA dc for 2N2946A; $\Delta h_{FE} (inv)_1$ = 25 percent of initial value.
14 a and b	Required	Required

* 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 MIL-STD-750, paragraph 4.5. T_J = +135°C minimum. 75 percent of rated power minimum.

2N2944A: V_{CB} = 10V - 30V dc.
 2N2945A: V_{CB} = 10V - 30V dc.
 2N2946A: V_{CB} = 10V - 30V dc.

* 4.3.2 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{MD} , (and V_C where appropriate). The $Z_{\theta JX}$ limit used in screen 3c of 4.3 shall comply with the thermal impedance graph in figures 7 and 8 (less than or equal to the curve value at the same t_H time) and/or shall be less than the process determined statistical maximum limit as outlined in method 3131.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

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 VIa (JANS) of 19500 and 4.4.2.1 herein. Electrical measurements (end-points) requirements shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with 4.5.6 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. Delta requirements shall be in accordance with 4.5.6 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	2037	Condition A.
* B4	1037	2,000 cycles. No heat sink or forced air cooling on the devices shall be permitted. $V_{CB} = 10$ V dc. $t_{on} = t_{off} = 3$ minutes, power = 400 mW.
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 maximum rated P_T (see 1.3). Option 1: 96 hours minimum, sample size in accordance with table VIa of MIL-PRF-19500, adjust T_A or P_D to achieve $T_J = +275^\circ\text{C}$ minimum. Option 2: 216 hours, sample size = 45, $c = 0$; adjust T_A or P_D to achieve $T_J = +225^\circ\text{C}$ minimum.

* 4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV), table VIb of MIL-PRF-19500. 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. Electrical end-points shall be in accordance with table I subgroup 2, herein.

<u>Step</u>	<u>Method</u>	<u>Condition</u>
1	1039	Steady-state life: Test condition B, 1,000 hours, $V_{CB} = 10$ V dc, power shall be applied and ambient temperature adjusted to achieve $T_J = +150^\circ\text{C}$ minimum, and a minimum of $P_D = 75$ percent of P_T as defined in 1.3. $n = 45$, $c = 0$.
2	1039	HTRB: Test condition A, 48 hours minimum. $n = 45$, $c = 0$.
3	1032	High- temperature life (non-operating), $T_A = +200^\circ\text{C}$, $t = 340$ hours, $n = 22$, $c = 0$.

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, 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 tests and conditions specified for subgroup testing in table VII of MIL-PRF-19500, and 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 4.5.6 herein.

* 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 to UB).
* C5	3131	$R_{\theta JA} = 435^{\circ}\text{C/W}$. See thermal impedance curves on figures 7 and 8.
C6	1026	Steady-state life: Test condition B, 1,000 hours, $V_{CB} = 10\text{ V dc}$. Use minimum $P_d = 300\text{ mW}$ and ambient temperature adjusted to achieve $T_j = +150^{\circ}\text{C min}$. No heat sink on the device shall be permitted. $n = 45, c = 0$.

4.4.3.2 Group C inspection, table 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 UB).
* C5	3131	$R_{\theta JA} = 435^{\circ}\text{C/W}$. See thermal impedance curves on figures 7 and 8.
C6	1037	Not applicable.

4.4.3.3 Group C inspection. Group C inspection shall be conducted in accordance with the test and conditions specified for subgroup testing in table VII of MIL-PRF-19500, and in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANJ, 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 4.5.6 herein; delta requirements only apply to subgroup C6.

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 and as specified herein. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2 herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Input capacitance. This test shall be conducted in accordance with method 3240 of MIL-STD-750, except the output capacitor shall be omitted.

4.5.2 Emitter to collector breakdown voltage. Method of test shall be in accordance with method 3011 of MIL-STD-750, test condition D, except that all references to the collector and the emitter of the transistor shall be interchanged.

4.5.3 Forward-current transfer ratio (inverted connection). Method of test shall be in accordance with method 3076 of MIL-STD-750, except that all references to the collector and the emitter of the transistor shall be interchanged in the test circuit. Then: $h_{FE} (inv) = I_E / I_B$

* 4.5.4 Emitter to collector offset voltage. The transistor shall be tested in the circuit of figure 9. The base current shall be adjusted to the specified value. The voltage between the emitter and collector shall then be measured using a voltmeter with an input impedance high enough that halving it does not change the measured value within the required accuracy of the measurement.

* 4.5.5 Small-signal emitter-collector on-state resistance. The transistor shall be tested in the circuit of figure 10. The base current shall be adjusted to the specified value and an ac sinusoidal signal current, I_e , of the specified rms value shall be applied between the emitter and collector. The rms voltage, V_{ec} , between the emitter and collector shall be measured using an ac voltmeter with an input impedance high enough that halving it does not change the measured value within the required accuracy of the measurement. The small-signal emitter-collector on-state resistance shall then be determined as follows:

$$r_{ec} (on) = V_{ec} / I_e$$

Where V_{ec} is the rms voltage between the emitter and collector.

* 4.5.6 Delta requirements. Delta requirements shall be as specified below: (1) (2) (3)

Step	Inspection	MIL-STD-750		Symbol	Limit	Unit
		Method	Conditions			
1	Collector to base cutoff current 2N2944A 2N2945A 2N2946A	3036	Bias condition D: $I_E = 0$ $V_{CE} = -15$ V dc $V_{CE} = -25$ V dc $V_{CE} = -40$ V dc	ΔI_{CBO1}	100 percent of initial value. .2 nA .2 nA .5 nA	
2	Forward-current transfer ratio (inverted connection)	3076	$V_{EC} = -0.5$ V dc; $I_E = 200$ μ A dc; (see 4.5.3)	$\Delta h_{FE}(inv)_1$	25 percent of initial value.	

- (1) The electrical measurements for table VIa (JANS) of MIL-PRF-19500 are as follows: Subgroup 5, see 4.5.6, steps 1 and 2.
- (2) The electrical measurements for 4.4.2.2 all steps are as follows: see 4.5.6, step 2.
- (3) The electrical measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, step 1 and step 2 (JANS).

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* TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 2/</u>						
Visual and mechanical <u>3/</u> examination	2071	n = 45 devices, c = 0				
Solderability <u>3/ 4/</u>	2026	n = 15 leads, c = 0				
Resistance to <u>3/ 4/ 5/</u> solvent	1022	n = 15 devices, c = 0				
Temp cycling <u>3/ 4/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Electrical measurements <u>4/</u>		Table I, subgroup 2 herein				
Hermetic seal <u>4/ 6/</u>	1071	n = 22 devices, c = 0				
Fine leak Gross leak						
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 devices, c = 0				
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.2	Z _{θJX}			°C/W
Breakdown voltage collector to emitter	3011	Bias condition D; I _C = -10 μA dc	V _{(BR)CEO}			
2N2944A, UB				-10		V dc
2N2945A, UB				-20		V dc
2N2946A, UB				-35		V dc
Collector to base cutoff current	3036	Bias condition D	I _{CBO1}			
2N2944A, UB		V _{CB} = -15 V dc			10	μA dc
2N2945A, UB		V _{CB} = -25 V dc			10	μA dc
2N2946A, UB		V _{CB} = -40 V dc			10	μA dc

See footnotes at the end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - continued.						
Emitter to base cutoff current 2N2944A, UB 2N2945A, UB 2N2946A, UB	3061	Bias condition D $V_{EB} = -15$ V dc $V_{EB} = -25$ V dc $V_{EB} = -40$ V dc	I_{EBO1}		10	μ A dc
Breakdown voltage, emitter to collector 2N2944A, UB 2N2945A, UB 2N2946A, UB	3011	Bias condition B; $I_E = -10$ μ A dc; $I_B = 0$; (see 4.5.2)	$V_{(BR)ECO}$	-10 -20 -35		V dc V dc V dc
Collector to base cutoff current 2N2944A, UB 2N2945A, UB 2N2946A, UB	3036	Bias condition D $V_{CB} = -12$ V dc $V_{CB} = -20$ V dc $V_{CB} = -32$ V dc	I_{CBO2}		-0.1 -0.2 -0.5	nA dc nA dc nA dc
Emitter to base cutoff current 2N2944A, UB 2N2945A, UB 2N2946A, UB	3061	Bias condition D $V_{EB} = -12$ V dc $V_{EB} = -20$ V dc $V_{EB} = -32$ V dc	I_{EBO2}		-0.1 -0.2 -0.5	nA dc nA dc nA dc
Forward-current transfer ratio 2N2944A, UB 2N2945A, UB 2N2945AM, UBM <u>7/</u> 2N2946A, UB	3076	$V_{CE} = -0.5$ V dc; $I_C = -1.0$ mA dc	h_{FE1}	100 70 70 50	200	
Forward-current transfer ratio (inverted connection) 2N2944A, UB 2N2945A, UB 2N2946A, UB	3076	$V_{EC} = -0.5$ V dc; $I_E = -200$ μ A dc (see 4.5.3)	$h_{FE} (inv)_1$	50 30 20		

See footnotes at the end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - continued.						
Emitter to collector offset voltage 2N2944A, UB 2N2945A, UB 2N2946A, UB		$I_B = -200 \mu\text{A dc}; I_E = 0;$ (see 4.5.4 and figure 9).	$V_{EC} (\text{ofs})_1$		-0.3 -0.5 -0.8	mV dc mV dc mV dc
Emitter to collector offset voltage 2N2944A, UB 2N2945A, UB 2N2946A, UB		$I_B = -1 \text{ mA dc}; I_E = 0;$ (see 4.5.4 and figure 9).	$V_{EC} (\text{ofs})_2$		-0.6 -1.0 -2.0	mV dc mV dc mV dc
Emitter to collector offset voltage 2N2944A, UB 2N2945A, UB 2N2946A, UB		$I_B = -2 \text{ mA dc}; I_E = 0;$ (see 4.5.4 and figure 9).	$V_{EC} (\text{ofs})_3$		-1.0 -1.6 -2.5	mV dc mV dc mV dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +100^\circ\text{C}$				
Collector to base cutoff current 2N2944A, UB 2N2945A, UB 2N2946A, UB	3036	Bias condition D; $I_C = 0$ $V_{CB} = -15 \text{ V dc}$ $V_{CB} = -25 \text{ V dc}$ $V_{CB} = -40 \text{ V dc}$	I_{CBO3}		10 20 25	nA dc nA dc nA dc
Emitter to base cutoff current 2N2944A, UB 2N2945A, UB 2N2946A, UB	3061	Bias condition D; $I_C = 0$ $V_{CB} = -15 \text{ V dc}$ $V_{CB} = -25 \text{ V dc}$ $V_{CB} = -40 \text{ V dc}$	I_{EBO3}		10 15 20	nA dc nA dc nA dc

See footnotes at the end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u> - continued						
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = -0.5 \text{ V dc};$ $I_C = -1 \text{ mA dc}$	h_{FE2}	35 25 20		
2N2944A, UB 2N2945A, UB 2N2946A, UB						
Forward-current transfer ratio (inverted connection)	3076	$V_{EC} = -0.5 \text{ V dc};$ $I_E = -200 \mu\text{A dc}$ (see 4.5.3)	$h_{FE} (\text{inv})_2$	25 15 10		
2N2944A, UB 2N2945A, UB 2N2946A, UB						
<u>Subgroup 4</u>						
Small-signal emitter-collector on-state resistance		$I_B = -100 \mu\text{A dc}; I_E = 0;$ $I_e = 100 \mu\text{A ac (rms)}$ $f = 1 \text{ kHz}$ (see 4.5.5 and figure 10)	$r_{ec} (\text{on})_1$		10 12 14	ohm ohm ohm
2N2944A, UB 2N2945A, UB 2N2946A, UB						
Small-signal emitter-collector on-state resistance		$I_B = -1 \text{ mA dc}; I_E = 0;$ $I_e = 100 \mu\text{A ac (rms)}$ $f = 1 \text{ kHz}$ (see 4.5.5 and figure 10).	$r_{ec} (\text{on})_2$		4 6 8	ohm ohm ohm
2N2944A, UB 2N2945A, UB 2N2946A, UB						

See footnotes at the end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - continued						
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio		$V_{CE} = -6 \text{ V dc};$ $I_C = -1 \text{ mA dc};$ $f = 1 \text{ MHz}$	$ h_{fe} $			
2N2944A, UB				15	55	
2N2945A, UB				10	55	
2N2946A, UB				5	55	
Open circuit output capacitance	3236	$V_{CB} = -6 \text{ V dc}; I_E = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		10	pF
Input capacitance (output open-circuited)	3240	$V_{EB} = -6 \text{ V dc}; I_C = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ (see 4.5.1)	C_{ibo}		6.0	pF
Pulse response:						
Delay time	3251	Test condition B (see figure 11)	t_d		50	ns
Rise time	3251	Test condition B (see figure 11)	t_r		100	ns
Storage time	3251	Test condition B (see figure 11)	t_s		350	ns
Fall time	3251	Test condition B (see figure 11)	t_f		100	ns
<u>Subgroups 5, 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.

3/ Separate samples may be used.

4/ Not required for JANS.

5/ Not required for laser marked devices.

6/ Hermetic seal test is an end-point to temperature cycling in addition to electrical measurements.

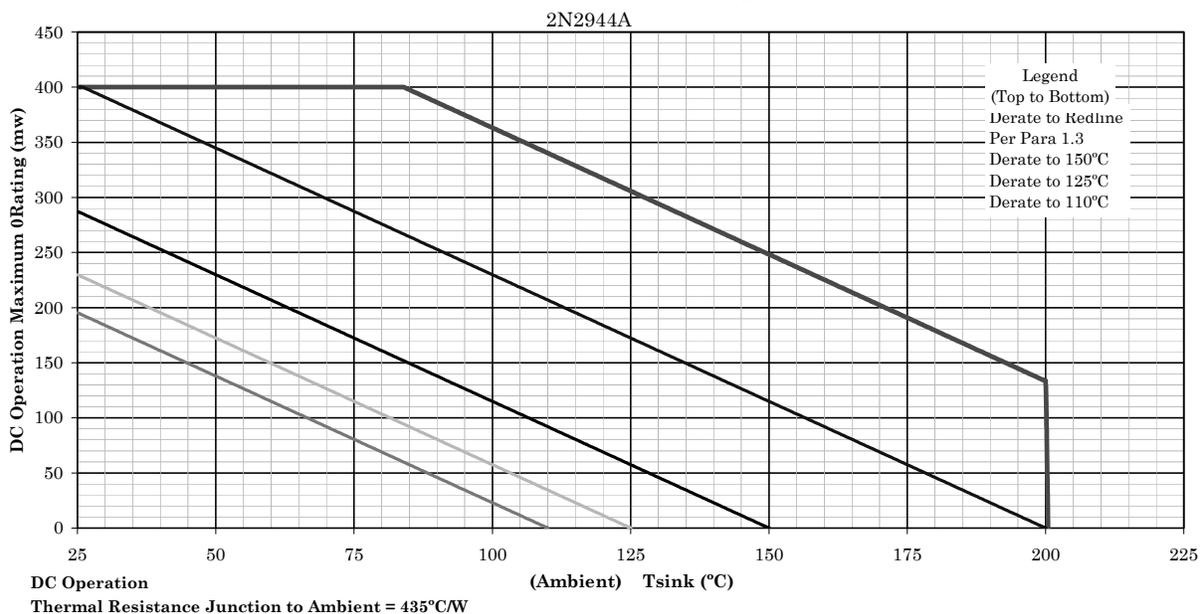
* 7/ 2N2945AM, UBM shall meet all other requirements as specified in accordance with table I for 2N2945A, UB.

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* TABLE II. Group E inspection (all quality levels) – for qualification or 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 Gross leak	1071		
Electrical measurements		See table I, subgroup 2 and 4.5.6 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	$V_{CB} = 10 \text{ V dc}$, $t_{on} = t_{off} = 3 \text{ minutes minimum}$ $P_t = 400\text{mW}$, 6,000 cycles.	
Electrical measurements		See table I, subgroup 2 and 4.5.6 herein.	
<u>Subgroup 3</u>			3 devices c = 0
DPA	2102		
<u>Subgroup 4</u>			
Thermal resistance	3131	The following applies for qualification $R_{JSP(1S)}$ can be calculated but shall be measured once in the same package with a similar die size to confirm calculations (can apply to multiple specification sheets).	
Thermal resistance and thermal impedance curves		Each supplier shall submit their (typical) maximum design thermal impedance curves. In addition, optimal test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report	
<u>Subgroup 5</u>			Not applicable
Not applicable			
<u>Subgroup 6</u>			3 devices c = 0
ESD	1020		
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition A for devices $\geq 400 \text{ V}$ Condition B for devices $< 400 \text{ V}$	

Temperature-Power Derating Curves

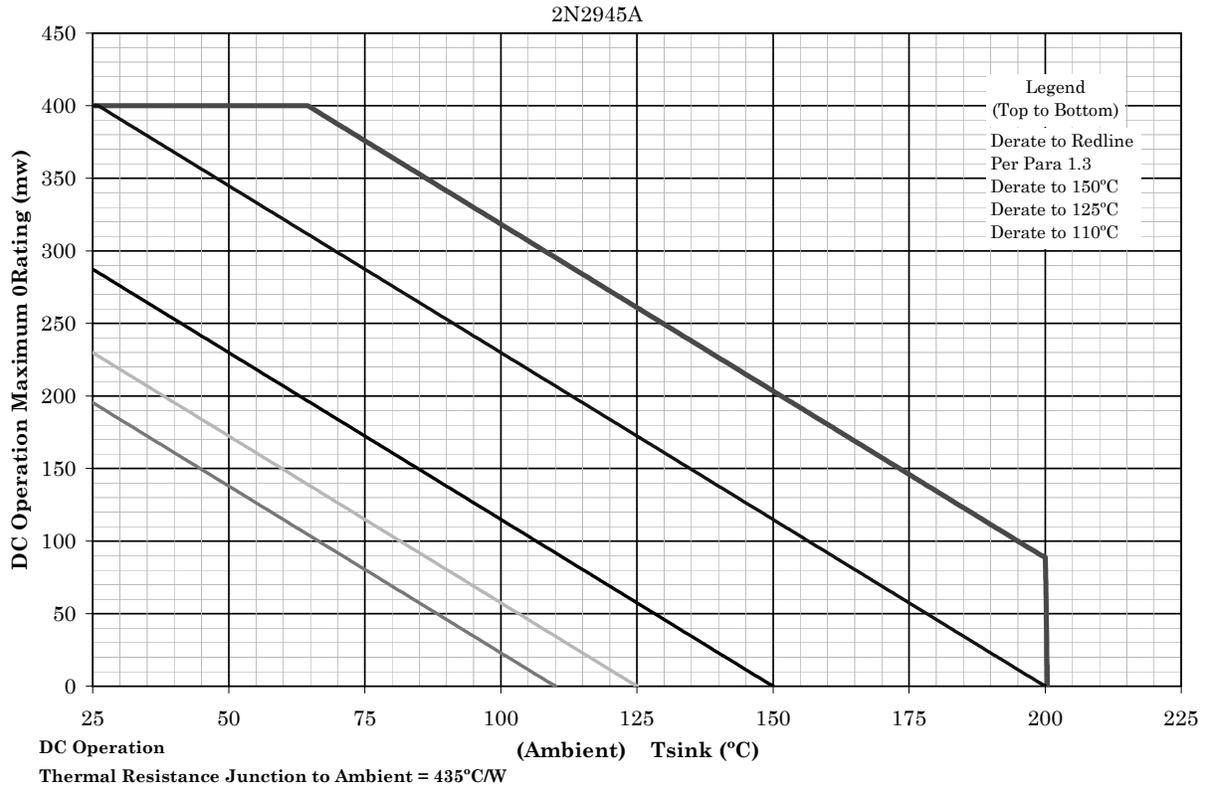


NOTES:

1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. 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 temperatures and power rating specified. (See 1.3)
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 curve 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 4. Derating for 2N2944A ($R_{\theta JA}$), base case mounted (TO-46).

Temperature-Power Derating Curves

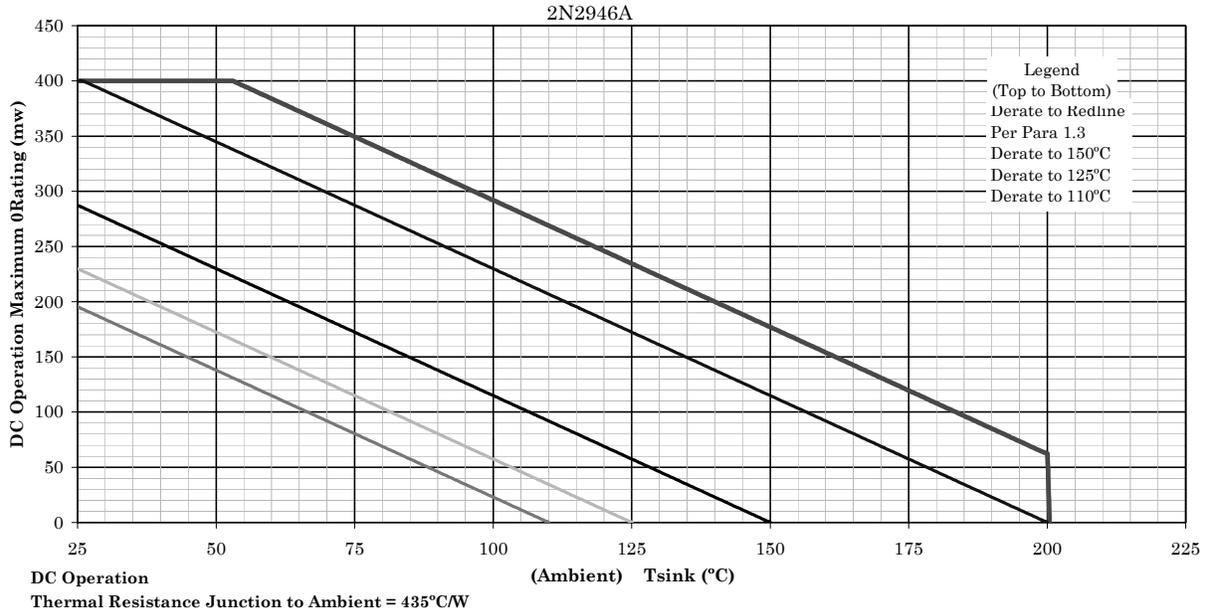


NOTES:

1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. 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 temperatures and power rating specified. (See 1.3)
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 curve 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 2N2945A ($R_{\theta JA}$), base case mounted (TO-46).

Temperature-Power Derating Curves

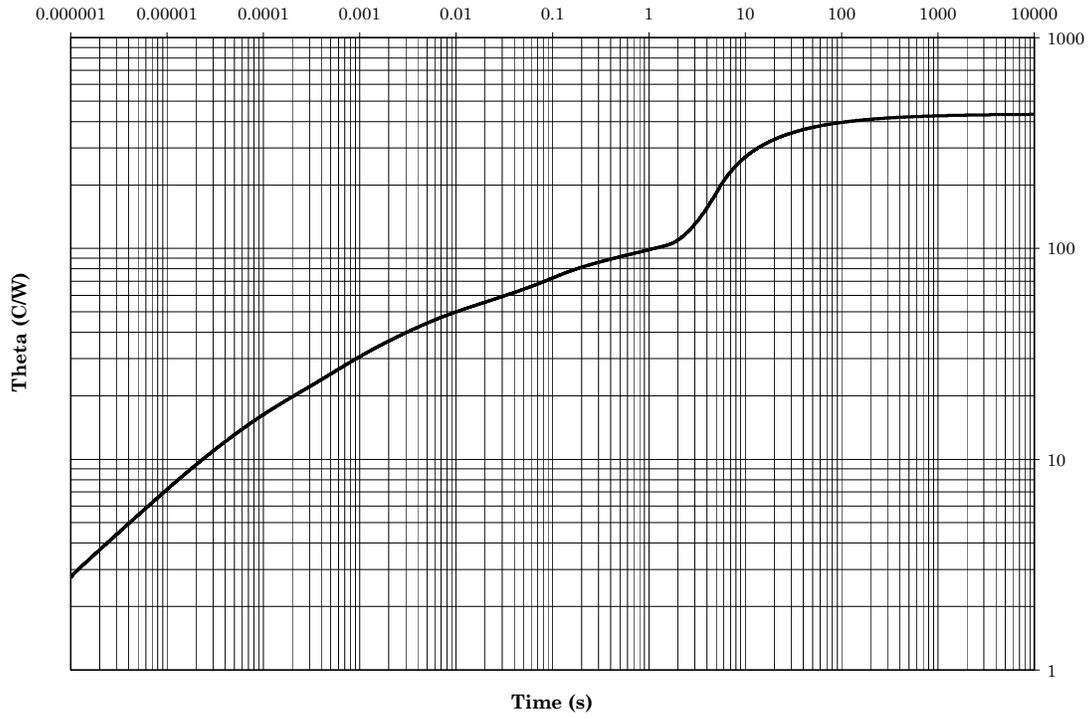


NOTES:

1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. 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 temperatures and power rating specified. (See 1.3)
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 curve 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 2N2946A ($R_{\theta JA}$), base case mounted (TO-46).

Maximum Thermal Impedance

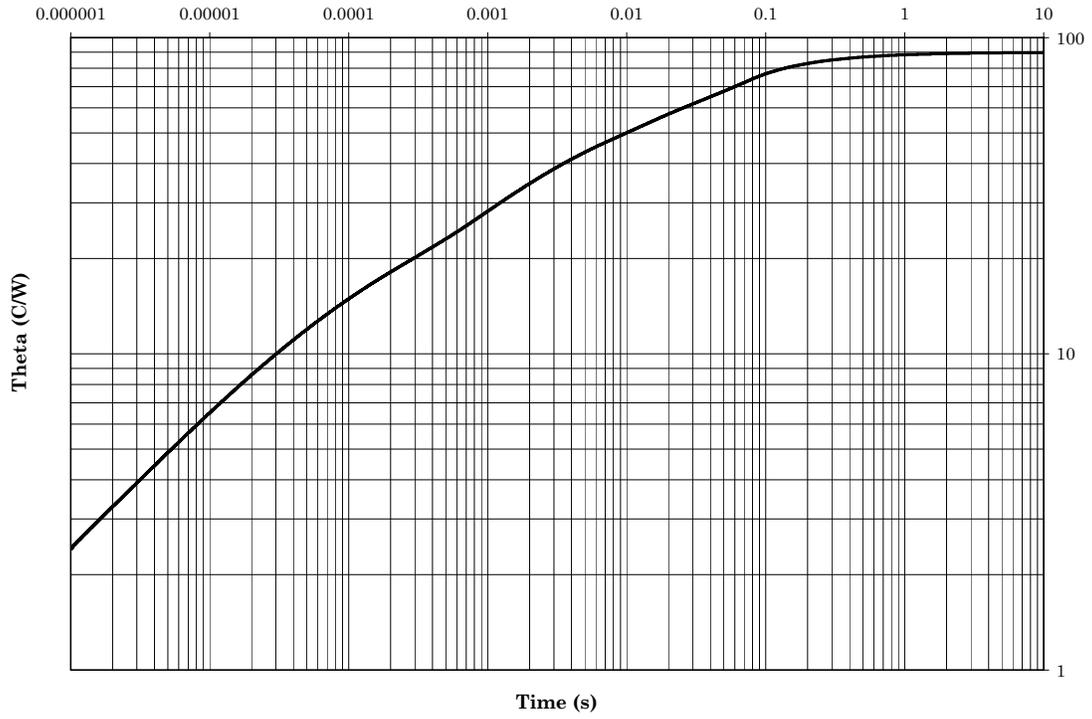


TO-46 Free Air $T_A = +25^\circ\text{C}$ with 16x23 mil chip.

$T_A = +25^\circ\text{C}$, $P_{\text{diss}} = 400\text{mW}$, 435°C/W (ambient thermal resistance varies with power)

FIGURE 7. Thermal impedance graph ($R_{\theta JA}$) for (TO-46).

Maximum Thermal Impedance



Thermal resistance = 90°C/W

Solder mounted to heavy copper clad PCB at $T_C = +25^\circ\text{C}$.

FIGURE 8. Thermal impedance graph (UB).

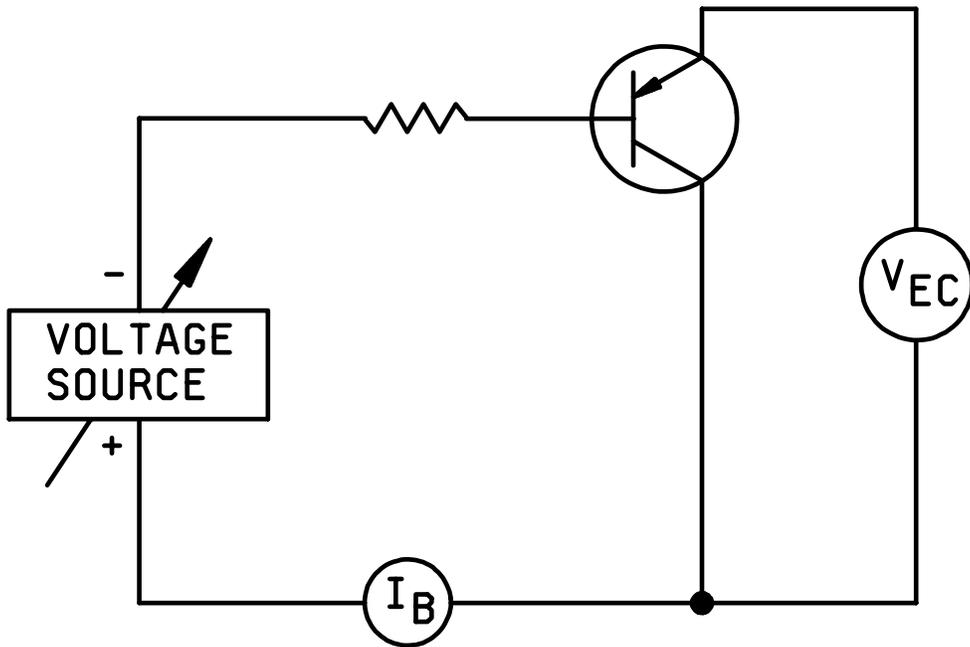


FIGURE 9. Emitter to collector offset voltage test circuit.

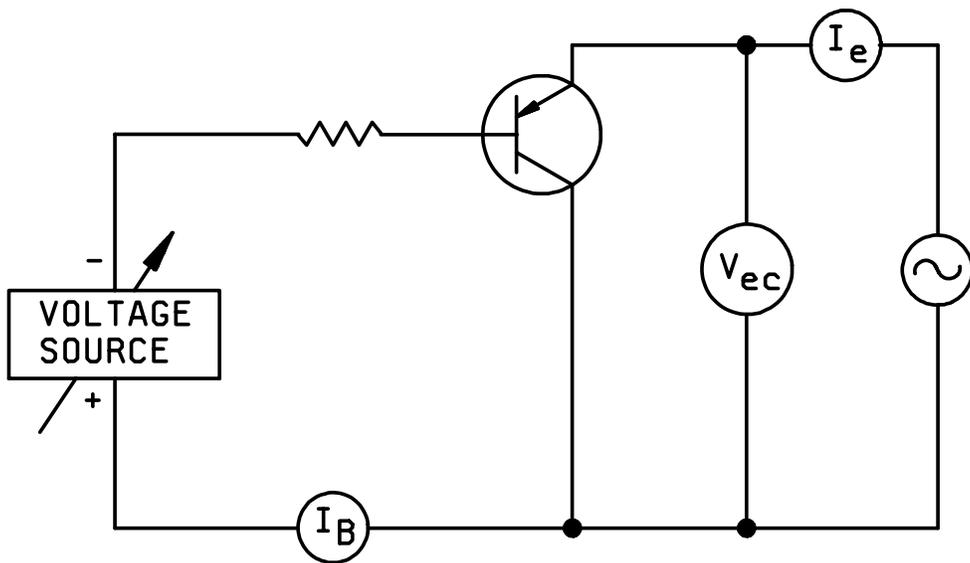
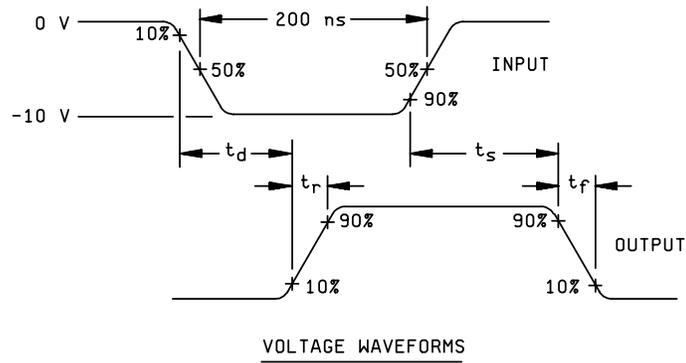
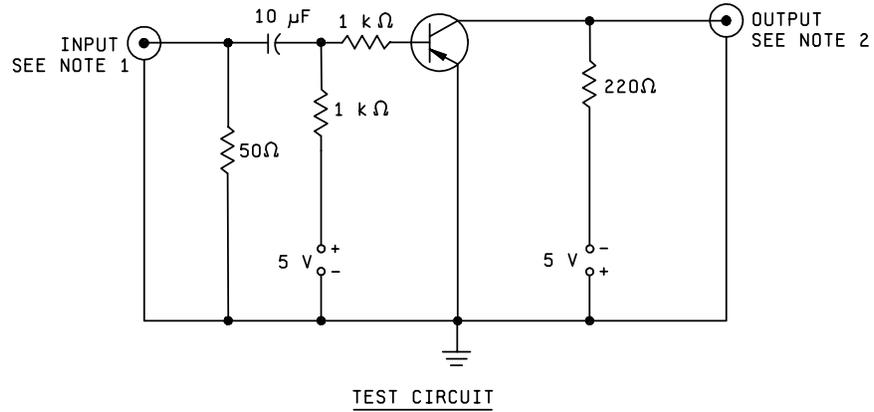


FIGURE 10. Small-signal emitter to collector on set voltage test circuit.



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be ≤ 10 ns, duty cycle ≤ 2 percent. The input pulse width shall be 200 ns.
2. Output monitored with an oscilloscope with the following characteristics: $Z_{in} \leq 1$ M Ω , $t_r \leq 1$ ns.

FIGURE 11. Pulse response 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 actual 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.)

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

* 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.

* 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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000 or e-mail vqe.chief@dla.mil.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N2945) will be identified on the QML.

Die ordering information	
PIN	Manufacturer
2N2944A	JANHCA2N2944A, JANKCA2N2944A
2N2945A	JANHCA2N2945A, JANKCA2N2945A
2N2946A	JANHCA2N2946A, JANKCA2N2946A

6.5 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
Navy - EC
Air Force - 11
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2867)

Review activities:

Army - AV, 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 <http://www.dodssp.daps.mil/> .