The documentation and process conversion measures necessary to comply with this revision shall be completed by 2 August 2003.

INCH-POUND

MIL-PRF-19500/512F
2 May 2003
SUPERSEDING
MIL-PRF-19500/512E
23 July 2001

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING
TYPES 2N4029, 2N4033, 2N4033UA, 2N4033UB, JAN, JANTX, JANTXV, JANS AND
JANKC2N4033 AND JANHC2N4033

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 PNP silicon transistors designed for use in high speed switching and driver applications. Four levels of product assurance are provided for each encapsulated device type and two levels of product assurance for each unencapsulated specified as in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-18), figure 2 (TO-39), figure 3 and figure 4 (surface mount), and figure 5 (JANKC and JANHC) herein.

1.3 Maximum ratings.

| $V_{CBO}$ | $V_{CEO}$ | $V_{EBO}$ | $I_C$ | $T_J$ and $T_{STG}$ |
|---|---|---|---|---|
| V dc | V dc | V dc | A dc | °C |
| 80 | 80 | 5.0 | 1.0 | -65 to +200 |

| Types | $P_T$ $T_A$ = +25°C (1) (2) | $P_T$ $T_C$ = +25°C (1) (2) | $P_T$ $T_{SP(IS)}$ = +25°C (1) (2) | $R_{\theta JA}$ (2) (3) | $R_{\theta JC}$ (2) (3) | $R_{\theta JSP(IS)}$ (2) (3) | $R_{\theta JSP(AM)}$ (2) (3) |
|---|---|---|---|---|---|---|---|
| | W | W | W | °C/W | °C/W | °C/W | °C/W |
| 2N4033 | 0.800 | 5 | N/A | 175 | 30 | N/A | N/A |
| 2N4029 | 0.500 | 1 | N/A | 325 | 80 | N/A | N/A |
| 2N4033UA | 0.500 | N/A | 1.5 | 325 | N/A | 110 | 40 |
| 2N4033UB | 0.500 (4) | N/A | 1.5 | 325 | N/A | 90 | N/A |

(1) For derating, see figures 6, 7, 8 and 9.
(2) See 3.3.
(3) For thermal curves, see figures 10, 11, 12, 13, 14 and 15.
(4) For non-thermal conductive PCB or unknown PCB surface mount conditions in free air, substitute figures 7 and 14 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, Post Office 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.

AMSC N/A FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.4 Primary electrical characteristics at $T_A$ = +25°C.

| Limits | $h_{FE1}$<br>$V_{CE}$ = 5.0 V dc<br>$I_C$ = 100 µA dc | $h_{FE2}$<br>$V_{CE}$ = 5.0 V dc<br>$I_C$ = 100 mA dc | $h_{FE3}$<br>$V_{CE}$ = 5.0 V dc<br>$I_C$ = 500 mA dc | $h_{FE4}$<br>$V_{CE}$ = 5.0 V dc<br>$I_C$ = 1.0 A dc | $\|h_{fe}\|$<br>f = 100 MHz<br>$V_{CE}$ = 10 V dc<br>$I_C$ = 50 mA dc |
|---|---|---|---|---|---|
| Min<br>Max | 50 | 100<br>300 | 70 | 25 | 1.5<br>6.0 |

| Limits | $V_{CE(SAT)2}$<br>$I_C$ = 500 mA dc<br>$I_B$ = 50 mA dc | $C_{obo}$<br>$V_{CB}$ = 10 V dc<br>$I_E$ = 0<br>100 kHz ≤ f ≤ 1 MHz | $t_d$ | $t_r$ | $t_s$ | $t_f$ |
|---|---|---|---|---|---|---|
| | V dc | pF | ns | ns | ns | ns |
| Min | | | | | | |
| Max | 0.5 | 20 | 15 | 25 | 175 | 35 |

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.

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.

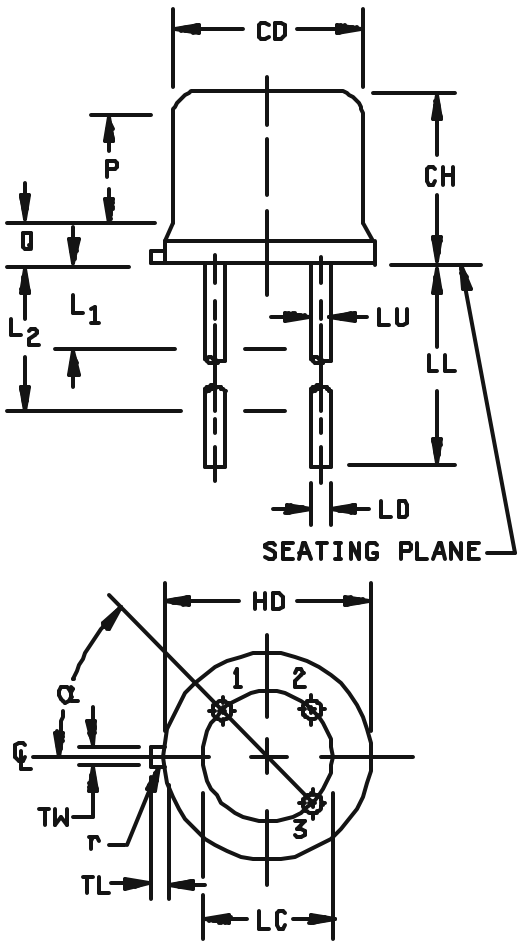
STANDARD

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.)

| Symbol | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| CD | .178 | .195 | 4.52 | 4.95 | |
| CH | .170 | .210 | 4.32 | 5.34 | |
| HD | .209 | .230 | 5.31 | 5.84 | |
| LC | .100 TP | | 2.54 TP | | 6 |
| LD | .016 | .021 | 0.41 | 0.53 | 7, 8 |
| LL | .500 | .750 | 12.70 | 19.05 | 7, 8, 12 |
| LU | .016 | .019 | 0.41 | 0.48 | 7, 8 |
| $L_1$ | | .050 | | 1.27 | 7. 8 |
| $L_2$ | .250 | | 6.35 | | 7, 8 |
| Q | | .040 | | 1.02 | 5 |
| TL | .028 | .048 | 0.71 | 1.22 | 3, 4 |
| TW | .036 | .046 | 0.91 | 1.17 | 3 |
| r | | .010 | | 0.18 | 10 |
| P | .100 | | 2.54 | | |
| α | 45°TP | | 45°TP | | 6 |

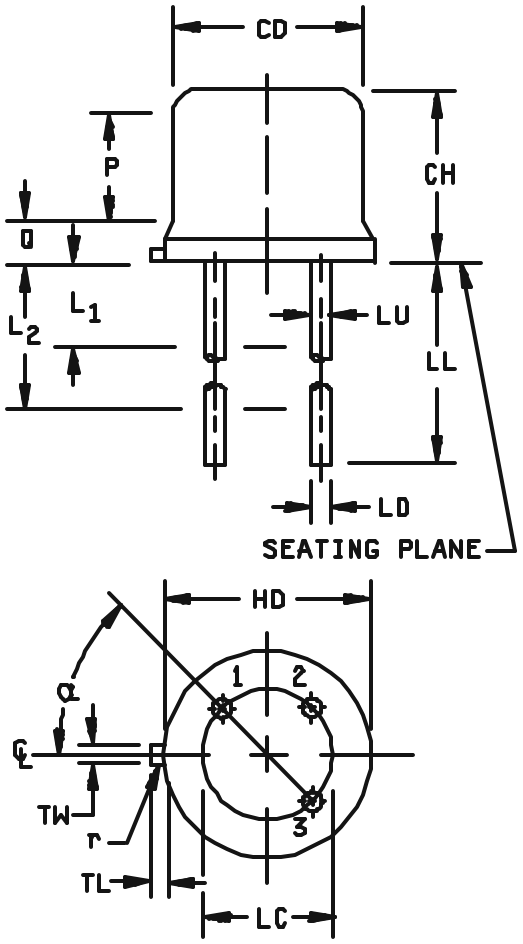



NOTES:

1. Dimensions 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 (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 $L_1$ and $L_2$. Dimension LD applies between $L_2$ and minimum. Diameter is uncontrolled in $L_1$ 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. In accordance with ASME Y14.5M, diameters are equivalent to θx symbology.
12. For “L” suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (19.05 mm) maximum.

FIGURE 1. Physical dimensions (type 2N4029) (TO – 18).

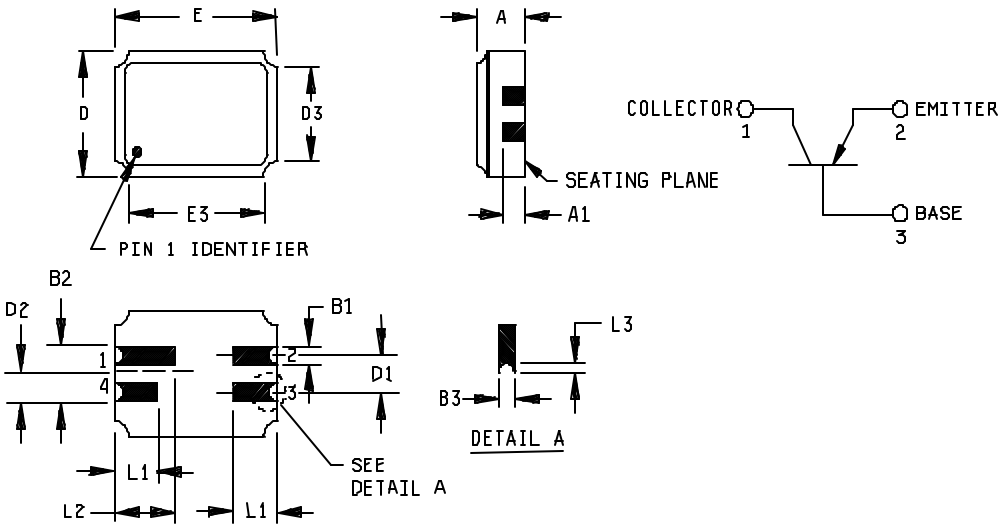
| Symbol | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| CD | .305 | .335 | 7.75 | 8.51 | |
| CH | .240 | .260 | 6.10 | 6.60 | |
| HD | .335 | .370 | 8.51 | 9.40 | |
| LC | .200 TP | | 5.08 TP | | 6 |
| LD | .016 | .021 | 0.41 | 0.53 | 7, 8 |
| LL | .500 | .750 | 12.70 | 19.05 | 7, 8, 12 |
| LU | .016 | .019 | 0.41 | 0.48 | 7, 8 |
| $L_1$ | | .050 | | 1.27 | 7, 8 |
| $L_2$ | .250 | | 6.35 | | 7, 8 |
| Q | | .050 | | 1.27 | 5 |
| TL | .029 | .045 | 0.74 | 1.14 | 3, 4 |
| TW | .028 | .034 | 0.71 | 0.86 | 3 |
| r | | .010 | | 0.18 | 10 |
| P | .100 | | 2.54 | | |
| α | 45°TP | | 45°TP | | 6 |




NOTES:

1. Dimensions 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 (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 $L_1$ and $L_2$. Dimension LD applies between $L_2$ and minimum. Diameter is uncontrolled in $L_1$ 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. In accordance with ASME Y14.5M, diameters are equivalent to θx symbology.
12. For “L” suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (19.05 mm) maximum.

FIGURE 2. Physical dimensions (type 2N4033) (TO – 39).

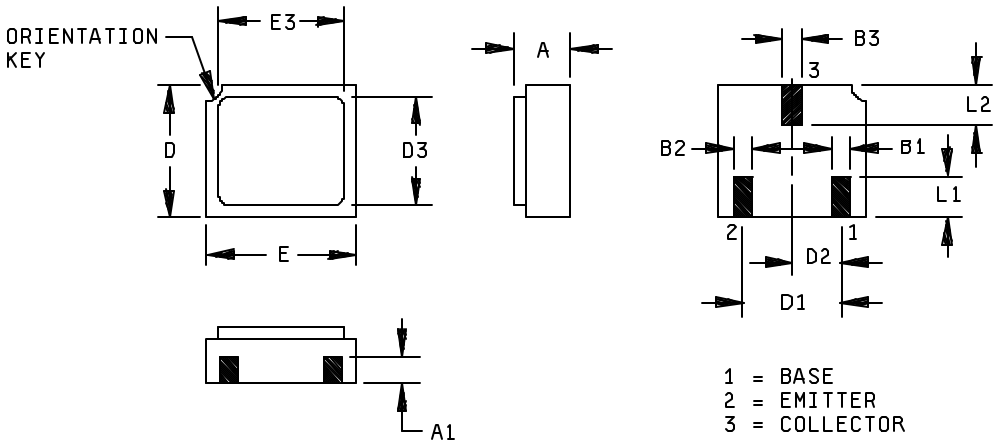



| Ltr | Dimensions | | | | Notes | Ltr | Dimensions | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | | Millimeters | | | | Inches | | Millimeter | | |
| | Min | Max | Min | Max | | | Min | Max | Min | Max | |
| A | .061 | .075 | 1.55 | 1.90 | 3 | $D_2$ | .0375 BSC | | 0.952 BSC | | |
| $A_1$ | .029 | .041 | 0.74 | 1.04 | | $D_3$ | | .155 | | 3.93 | |
| $B_1$ | .022 | .028 | 0.56 | 0.71 | | E | .215 | .225 | 5.46 | 5.71 | |
| $B_2$ | .075 REF | | 1.91 REF | | | $E_3$ | | .225 | | 5.71 | |
| $B_3$ | .006 | .022 | 0.15 | 0.56 | 5 | $L_1$ | .032 | .048 | 0.81 | 1.22 | |
| D | .145 | .155 | 3.68 | 3.93 | | $L_2$ | .072 | .088 | 1.83 | 2.23 | |
| $D_1$ | .045 | .055 | 1.14 | 1.39 | | $L_3$ | .003 | .007 | 0.08 | 0.18 | 5 |

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Dimension “A” controls the overall package thickness. When a window lid is used, dimension “A” must increase by a minimum of .010 inch (0.254 mm) and a maximum of .040 inch (1.020 mm).
4. The corner shape (square, notch, radius, etc.) may vary at the manufacturer’s option, from that shown on the drawing.
5. Dimensions “B3” minimum and “L3” minimum and the appropriately castellation length define an unobstructed three-dimensional space traversing all of the ceramic layers in which a castellation was designed. (Castellations are required on bottom two layers, optional on top ceramic layer.) Dimension “B3” maximum and “L3” maximum define the maximum width and depth of the castellation at any point on its surface. Measurement of these dimensions may be made prior to solder dipping.

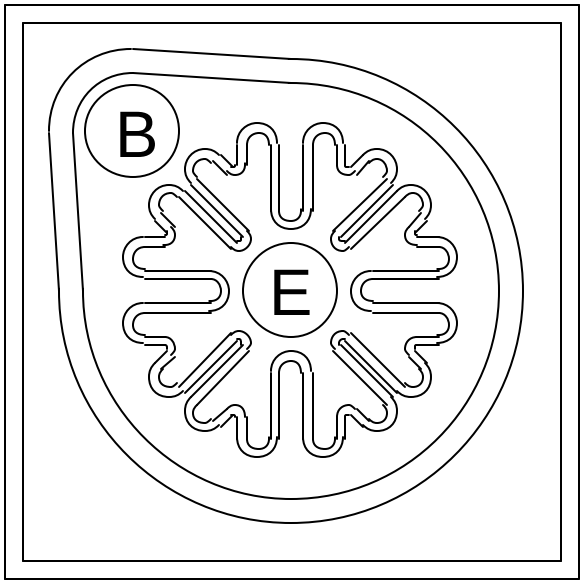
FIGURE 3. Physical dimensions, surface mount (UA version).




| Ltr | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | 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 | | | | | |
| E | .115 | .128 | 2.82 | 3.25 | |
| E3 | | | | | |
| 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 UB version.




| | |
|---|---|
| Die size: | .030 x .030 inch (0.762 x 0.762 mm). |
| Die thickness: | .008 ±.0016 inch (0.2032 ±0.04064 mm). |
| Base pad: | .005 inch diameter (0.127 mm). |
| Emitter pad: | .005 inch diameter (0.127 mm). |
| Back metal: | Gold, 6500 ± 1950 Ang. |
| Top metal: | Aluminum, 22500 ±2500 Ang. |
| Back side: | Collector. |
| Glassivation: | $SiO_2$, 7500 ± 1500 Ang. |

FIGURE 5. JANHC and JANKC (A-version) die dimensions.

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 6.3).

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

PCB .....Printed 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.

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, 4, and 5 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 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

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

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 shall be in accordance with MIL-PRF-19500.

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 level | JANTX and JANTXV levels |
| (1) 3c | Thermal impedance method 3131 of MIL-STD-750. | Thermal impedance method 3131 of MIL-STD-750. |
| 9 | $h_{FE2}$, $I_{CBO2}$ | Not applicable |
| 11 | $I_{CBO2}$; $h_{FE2}$; $\Delta I_{CBO2}$ = 100 percent of initial value or 2 nA dc, whichever is greater; $\Delta h_{FE2}$ = 15 percent change from initial value. | $I_{CBO2}$ and $h_{FE2}$ |
| 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 2 nA dc, whichever is greater; $\Delta h_{FE2}$ = 15 percent change from initial value. | Subgroup 2 of table I herein; $\Delta I_{CBO2}$ = 100 percent of initial value or 2 nA dc, whichever is greater; $\Delta h_{FE2}$ = 15 percent change from initial value. |

(1) Thermal impedance limits $(Z_{\theta JX})$ shall not exceed figures 10, 11, 12, 13, 14, and 15.

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 – 20 V dc; full power shall be applied to the device to achieve a junction temperature, $T_J$ = 135°C minimum and a minimum power dissipation (PD) = 75 percent of $P_T$ maximum rated as defined in 1.3.

4.3.2 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.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

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

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. Electrical measurements (end-points) requirements shall be in accordance with table I, group A, subgroup 2. Delta requirements shall be in accordance with 4.5.2, delta requirements only apply to subgroups B4 and B5. See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) for JAN, JANTX, and JANTXV shall be in accordance with group A, subgroup 2. Delta requirements shall be in accordance with 4.5.2 shall be after each step in 4.4.2.2 and shall be in accordance with group A, subgroup 2 and 4.5.2.

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

| Subgroup | Method | Condition |
|---|---|---|
| B4 | 1037 | $V_{CB}$ = 10 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 V dc; $P_D \geq$ 100 percent of maximum rated $P_T$ (see 1.3).<br><br>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°C minimum.<br><br>Option 2: 216 hours, sample size = 45, c = 0; adjust $T_A$ or $P_D$ to achieve $T_J$ = +225°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 group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new “assembly lot” option is exercised, the failed assembly lot shall be scrapped.

| Step | Method | Condition |
|---|---|---|
| 1. | 1039 | Steady-state life: Test condition B, 1,000 hours minimum, $V_{CB}$ = 10 V dc. Power shall be applied to achieve $T_J$ = +150°C minimum using a minimum of $P_D$ = 75 percent of maximum rated $P_T$ as defined in 1.3 herein. 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°C, n = 22 devices, 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 (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 in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2 herein. Delta requirements shall be in accordance with 4.5.2; delta requirements only apply to subgroup C6.

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

| Subgroup | Method | Condition |
|---|---|---|
| C2 | 2036 | Test condition E; (method 2036 not applicable for UA and UB devices). |
| C6 | 1026 | 1,000 hours at $V_{CB}$ = 10 V dc; power shall be applied to achieve $T_J$ = +150°C minimum and a minimum of $P_D$ = 75 percent of maximum rated $P_T$ as defined in 1.3. |

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

| Subgroup | Method | Condition |
|---|---|---|
| C2 | 2036 | Test condition E; not applicable for UA and UB devices. |
| C5 | 3131 | $R_{\theta JA}$, see 4.5.3. |
| 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 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 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) and delta measurements shall be in accordance with table I, subgroup 2 herein.

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

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Delta requirements. Delta requirements shall be as follows:

| Step | Inspection | MIL-STD-750 | | Symbol | Limit | Unit |
|---|---|---|---|---|---|---|
| | | Method | Conditions | | | |
| 1. | Collector-base cutoff current | 3036 | Bias condition D, $V_{CB}$ = 60 V dc | $\Delta I_{CB02}$ | 100 percent of initial value or 5 nA dc, whichever is greater. | |
| 2. | Forward current transfer ratio | 3076 | $V_{CE}$ = 5 V dc; $I_C$ = 100 mA dc; pulsed see 4.5.1 | $\Delta h_{FE2}$ | ±25 percent change from initial reading. | |

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°C ≤ $T_R$ ≤ +35°C. The chosen reference temperature shall be recorded before the test is started.

e. Mounting arrangements shall be with heat sink to case.

f. $R_{\theta JC}$ = see thermal impedance curves figures 10, 11, 12, 13, 14, 15 and 16.

4.5.4 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:

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

TABLE I. Group A inspection.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|
| | Method | Conditions | | Min | Max | |
| Subgroup 1 2/ | | | | | | |
| Visual and mechanical inspection 3/ | 2071 | n = 45 devices, c = 0 | | | | |
| Solderability 3/ 4/ | 2026 | n = 15 leads, c = 0 | | | | |
| Resistance to solvents 3/ 4/ 5/ | 1022 | n = 15 devices, c = 0 | | | | |
| Temp cycling 3/ 4/ | 1051 | Test condition C, 25 cycles. N = 22 devices, c = 0 | | | | |
| Hermetic seal 4/<br>Fine leak<br>Gross leak | 1071 | n = 22 devices, c = 0 | | | | |
| Electrical measurements 4/ | | Group A, subgroup 2 | | | | |
| Bond strength 3/ 4/ | 2037 | Precondition $T_A$ = + 250°C at t = 24 hours or $T_A$ = + 300°C at t = 2 hours n = 11 wires, c = 0 | | | | |
| Subgroup 2 | | | | | | |
| Collector to base cutoff current | 3036 | Bias condition D; $V_{CB}$ = 80 V dc pulsed (see 4.5.1) | $I_{CBO1}$ | | 10 | µA dc |
| Emitter to base cutoff current | 3061 | Bias condition D; $V_{BE}$ = 5 V dc | $I_{EBO1}$ | | 10 | µA dc |
| Collector – base cutoff current | 3036 | Bias condition D; $V_{CB}$ = 60 V dc | $I_{CBO2}$ | | 10 | nA dc |
| Collector – emitter cutoff current | 3041 | Bias condition A; $V_{BE}$ = 2.0 V dc; $V_{CE}$ = 60 V dc | $I_{CEX1}$ | | 25 | nA dc |
| Base emitter cutoff current | 3061 | Bias condition D; $V_{BE}$ = 3.0 V dc | $I_{EBO2}$ | | 25 | nA dc |
| Forward-current transfer ratio | 3061 | $V_{CE}$ = 5.0 V dc; $I_C$ = 100 µA dc | $h_{FE1}$ | 50 | | |

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|
| | Method | Conditions | | Min | Max | |
| Subgroup 2 – Continued | | | $h_{FE2}$ | 100 | 300 | |
| Forward-current transfer ratio | 3076 | $V_{CE}$ = 5.0 V dc; $I_C$ = 100 mA dc | | | | |
| Forward-current transfer ratio | 3076 | $V_{CE}$ = 5.0 V dc; $I_C$ = 500 mA dc pulsed (see 4.5.1) | $h_{FE3}$ | 70 | | |
| Forward-current transfer ratio | 3076 | $V_{CE}$ = 5.0 V dc; $I_C$ = 1.0 A dc; pulsed (see 4.5.1) | $h_{FE4}$ | 25 | | |
| Collector – emitter saturated voltage | 3071 | $I_C$ = 150 mA dc; $I_B$ = 15 mA dc pulsed (see 4.5.1) | $V_{CE(SAT)1}$ | | 0.15 | V dc |
| Collector – emitter saturated voltage | 3071 | $I_C$ = 500 mA dc; $I_B$ = 50 mA dc; pulsed (see 4.5.1) | $V_{CE(SAT)2}$ | | 0.50 | V dc |
| Collector – emitter saturated voltage | 3071 | $I_C$ = 1.0 A dc; $I_B$ = 100 mA dc; pulsed (see 4.5.1) | $V_{CE(SAT)3}$ | | 1.0 | V dc |
| Base – emitter Saturated voltage | 3066 | Test condition A; $I_C$ = 150 mA dc; $I_B$ = 15 mA dc pulsed (see 4.5.1) | $V_{BE(SAT)1}$ | | 0.9 | V dc |
| Base – emitter Saturated voltage | 3066 | Test condition A; $I_C$ = 500 mA dc; $I_B$ = 50 mA dc; pulsed (see 4.5.1) | $V_{BE(SAT)2}$ | | 1.2 | V dc |
| Subgroup 3 | | | | | | |
| High-temperature operation: | | $T_A$ = +150°C | | | | |
| Collector –base cutoff current | 3036 | Bias condition D; $V_{CB}$ = 60 V dc | $I_{CBO3}$ | | 25 | µA dc |
| Low-temperature operation: | | $T_A$ = -55°C | | | | |
| Forward-current transfer ratio | 3076 | $V_{CE}$ = 5.0 V dc; $I_C$ = 500 mA dc pulsed (see 4.5.1) | $h_{FE5}$ | 30 | | |

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|
| | Method | Conditions | | Min | Max | |
| Subgroup 4 | | | | | | |
| Magnitude of common emitter small-signal short-circuit forward-current transfer ratio | 3306 | $V_{CE}$ = 10 V dc; $I_C$ = 50 mA dc; f = 100 MHz | $\lvert h_{fe} \rvert$ | 1.5 | 6.0 | |
| Open circuit output capacitance | 3236 | $V_{CB}$ = 10 V dc; $I_E$ = 0 100 kHz ≤ f ≤ 1 MHz | $C_{obo}$ | | 20 | pF |
| Input capacitance (output open-circuited) | 3240 | $V_{EB}$ = 0.5 V dc; $I_C$ = 0; 100 kHz ≤ f ≤ 1 MHz | $C_{ibo}$ | | 80 | pF |
| Pulse response | | | | | | |
| On-time | 3251 | Test condition A; $I_C$ = 500 mA dc; $I_{B1}$ = 50 mA dc; (see figure 17) | $t_d$ | | 15 | ns |
| Rise time | 3251 | Test condition A; $I_C$ = 500 mA dc; $I_{B1}$ = 50 mA dc; (see figure 17) | $t_r$ | | 25 | ns |
| Storage time | 3251 | Test condition A; $I_C$ = 500 mA dc; $I_{B1}$ = 50 mA dc; (see figure 18) | $t_s$ | | 175 | ns |
| Fall time | 3251 | Test condition A; $I_C$ = 500 mA dc; $I_{B1}$ = 50 mA dc; (see figure 18) | $t_f$ | | 35 | Ns |
| Subgroups 5, 6, and 7 | | | | | | |
| Not applicable | | | | | | |

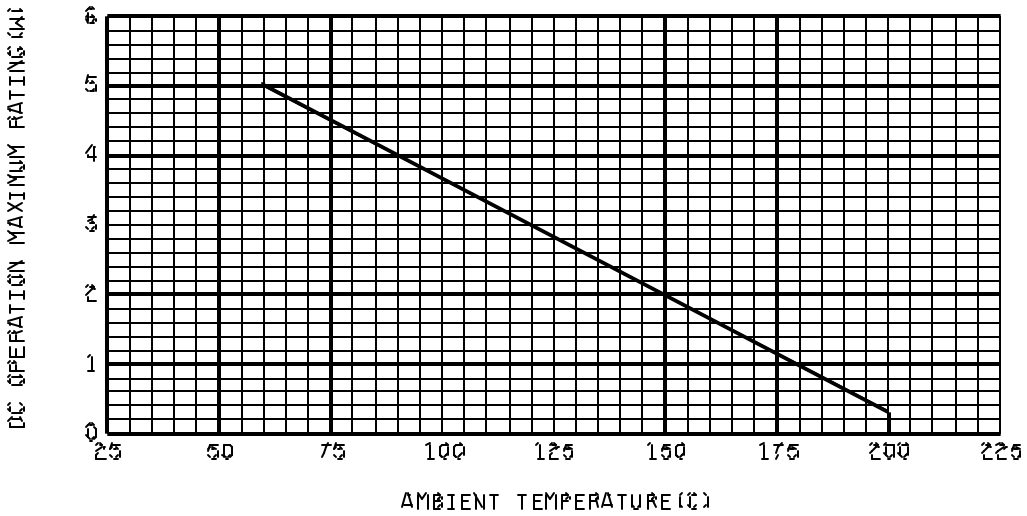
1/ For sampling plan see MIL-PRF-19500.
2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in table I, group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.
3/ Separate samples may be used.
4/ Not required for JANS devices.
5/ Not required for laser marked devices.

TABLE II. Group E inspection (all quality levels) – for qualification and re-qualification only.

*

| Inspection | MIL-STD-750 | | Qualification |
|---|---|---|---|
| | Method | Conditions | |
| Subgroup 1 | | | 45 devices<br>c = 0 |
| Temperature cycling (air to air) | 1051 | Test condition C, 500 cycles | |
| Hermetic seal | | | |
| Fine leak<br>Gross leak | 1071 | | |
| Electrical measurements | | See table I, group A, subgroup 2 herein. | |
| Subgroup 2 | | | 45 devices<br>c = 0 |
| Intermittent life | 1037 | $V_{CB}$ = 10 V dc, 6,000 cycles. | |
| Electrical measurements | | See table I, group A, subgroup 2 herein. | |
| Subgroups 3 | | | |
| DPA | 2102 | | 3 devices<br>c = 0 |
| Subgroups 4, and 5 | | | |
| Not applicable | | | |
| Subgroups 7 | | | |
| Not applicable | | | |
| Subgroups 3, 4 and 5 | | | |
| Not applicable | | | |
| Subgroup 6 | | | 3 devices<br>c = 0 |
| ESD | 1020 | | |
| Subgroup 7 | | | |
| Not applicable | | | |
| Subgroup 8 | | | 45 devices<br>c = 0 |
| Reverse stability | 1033 | Condition A for devices ≥ 400 V<br>Condition B for devices < 400 V | |

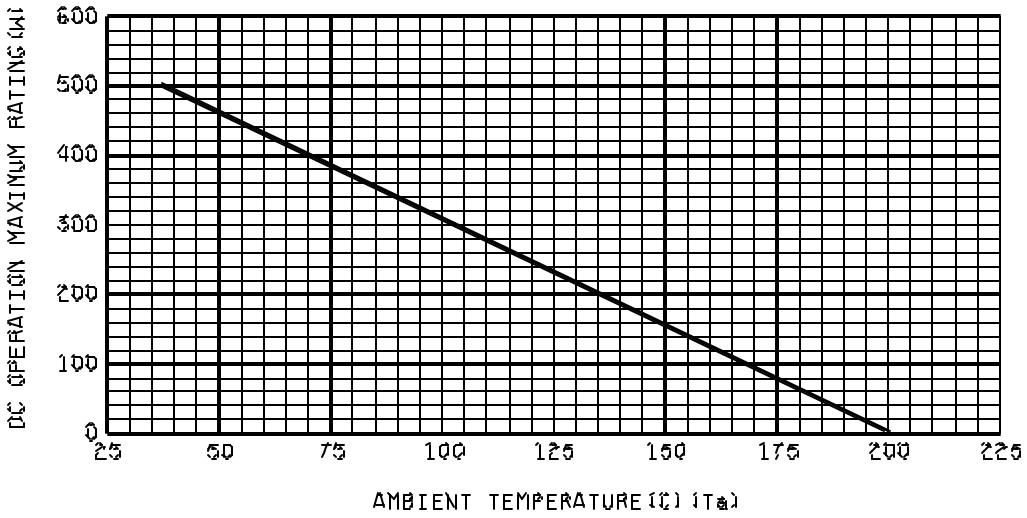
Temperature-Power Derating Curve




Thermal resistance $R_{\theta JC}$ = 30.0°C/W
Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 6. Derating for 2N4033 ($R_{\theta JC}$), base case mounted (TO-39).

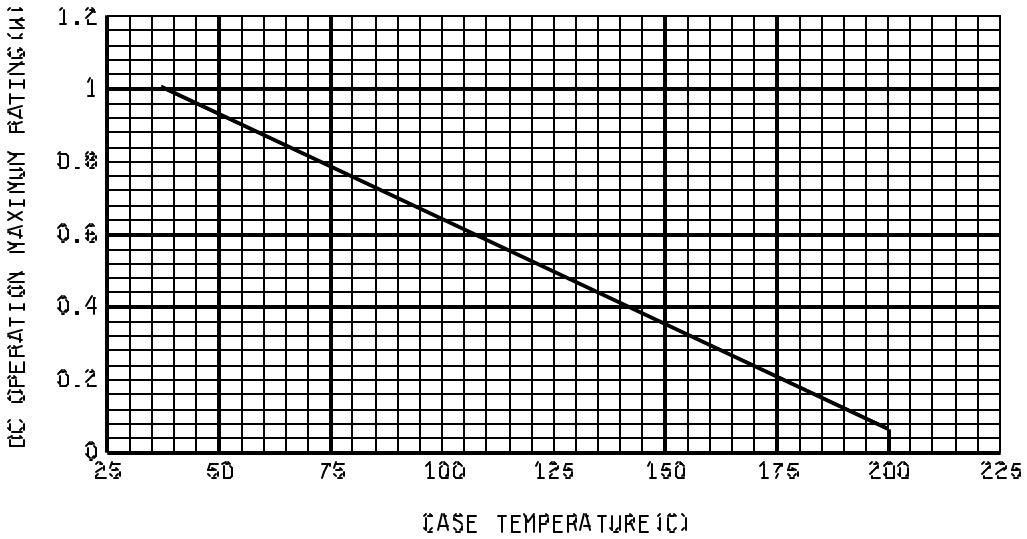
Temperature-Power Derating Curve




Thermal resistance $R_{\theta JA}$ = 325.0°C/W
Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 7. Derating for 2N4029 ($R_{\theta JA}$) (TO-18), leads .125 inch (3.17 mm).

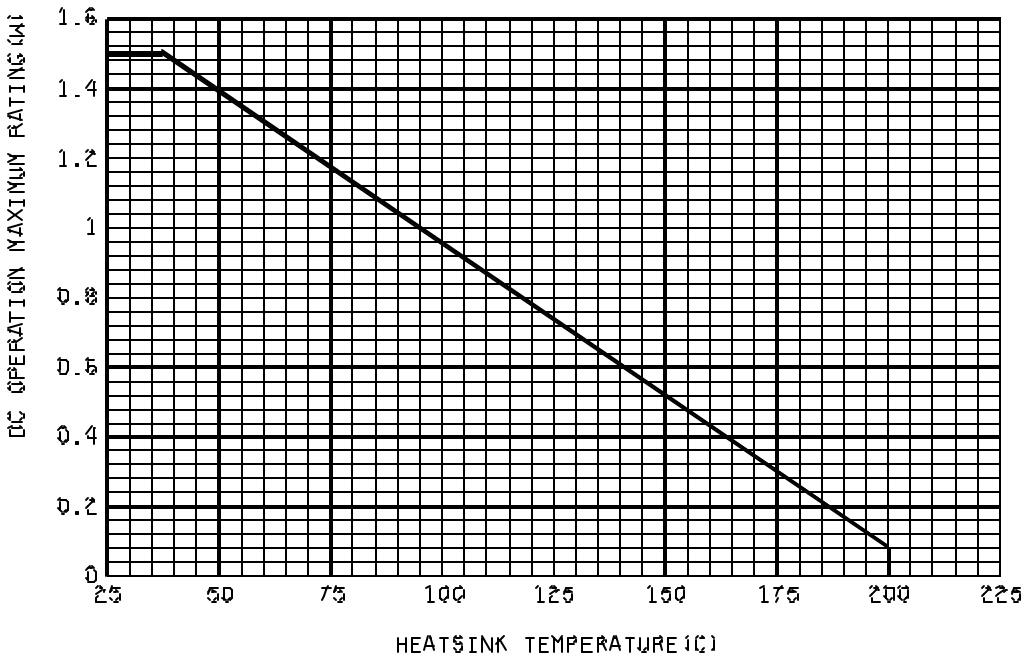
Temperature-Power Derating Curves




Thermal resistance $R_{\theta JC}$ = 150.0°C/W
Caution: Max finish temperature = +175°C for solder alloy.

*FIGURE 8. Derating for 2N4029 ($R_{\theta JC}$) (TO-18), base case mounted.

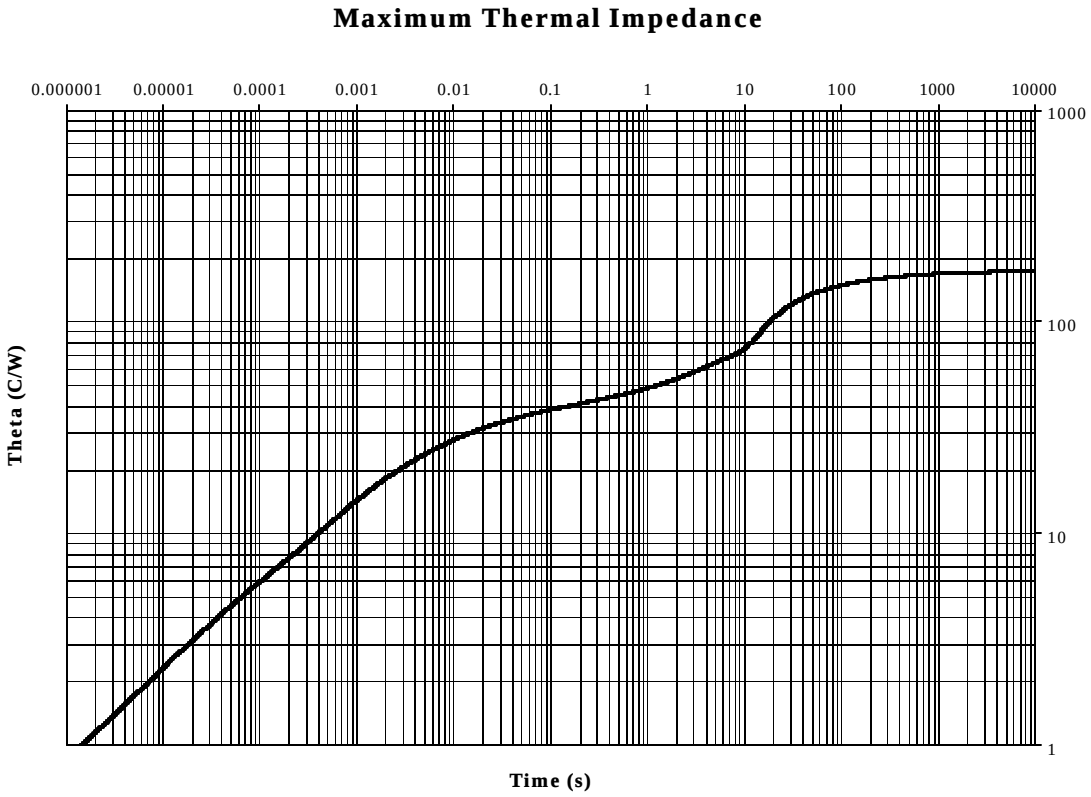
Temperature-Power Derating Curve




Thermal resistance $R_{\theta SP(IS)}$ = 90.0°C/W  Caution: Max finish temperature = +175°C for solder alloy.

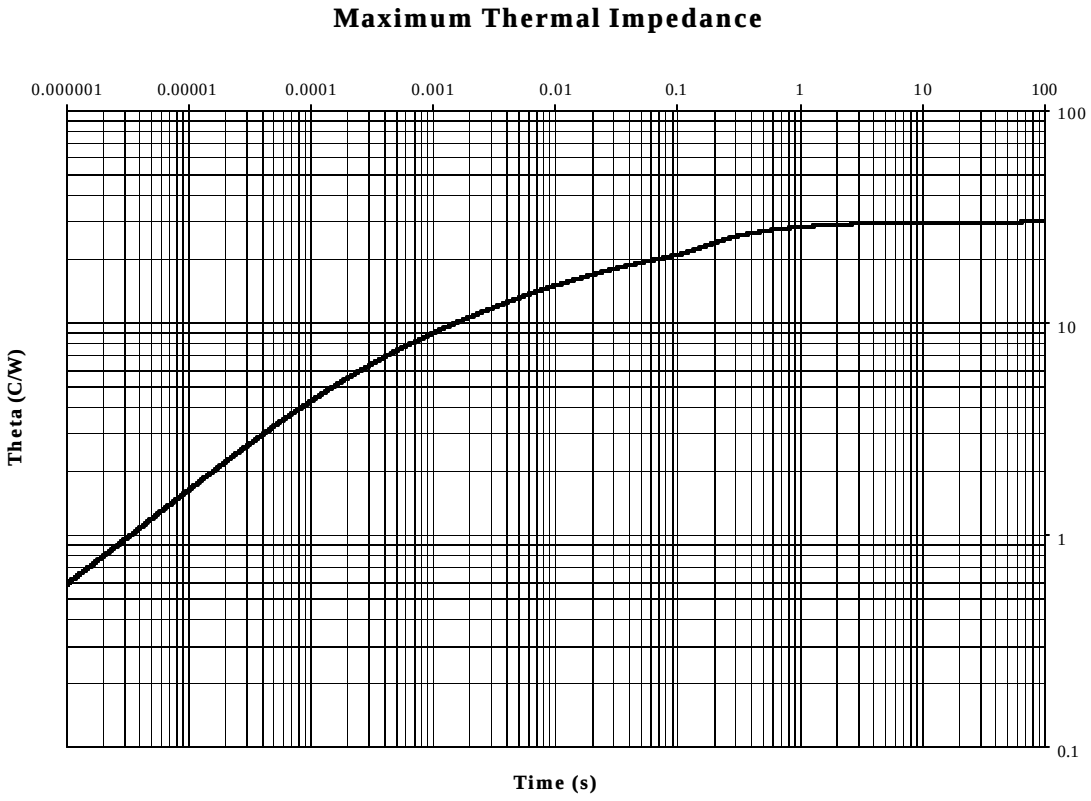
UB Temperature-power derating curve

*FIGURE 9. Derating for 2N4003UB ($R_{\theta JSP(IS)}$), infinite sink 3-points.




Steel header .125 lead mount to PCB $P_T$ = 500 mw

*FIGURE 10. Thermal impedance graph ($R_{\theta JA}$) for 2N4033 (TO-39).

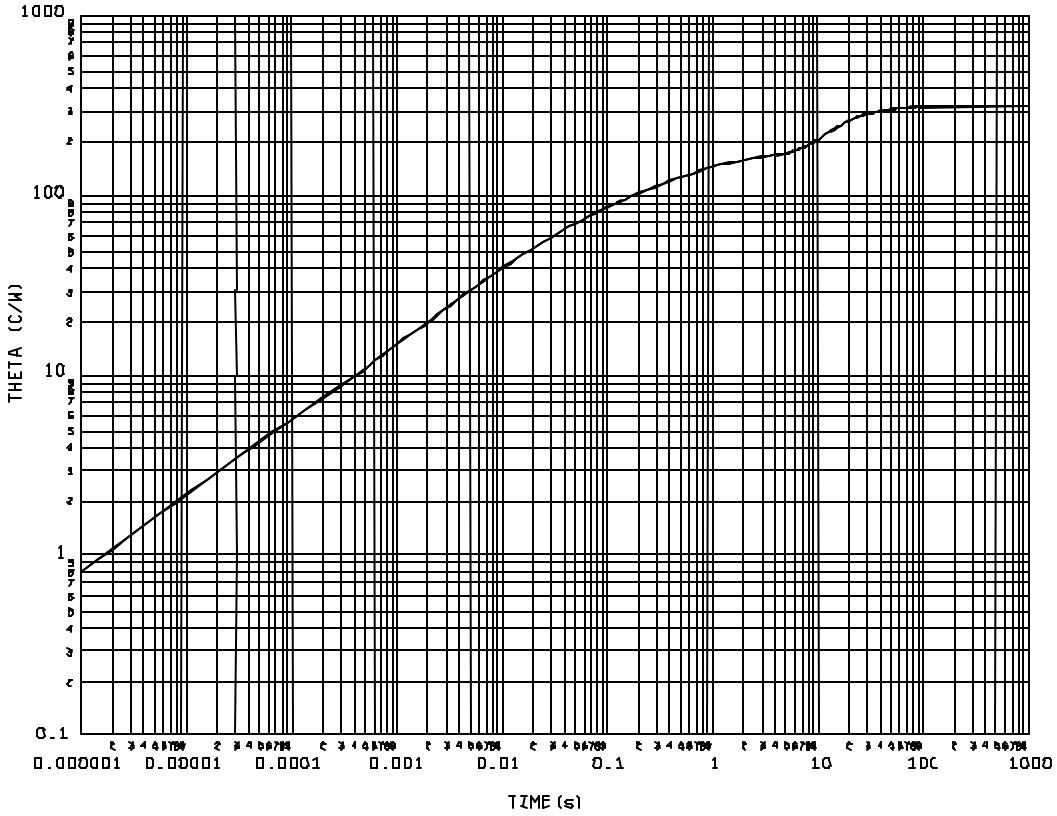



Steel header case mounted $T_C$ = 25°C

$R_{\theta JC}$ = 30°C/W

*FIGURE 11. Thermal impedance graph ($R_{\theta JC}$) for 2N4033 (TO-39).

Maximum thermal impedance

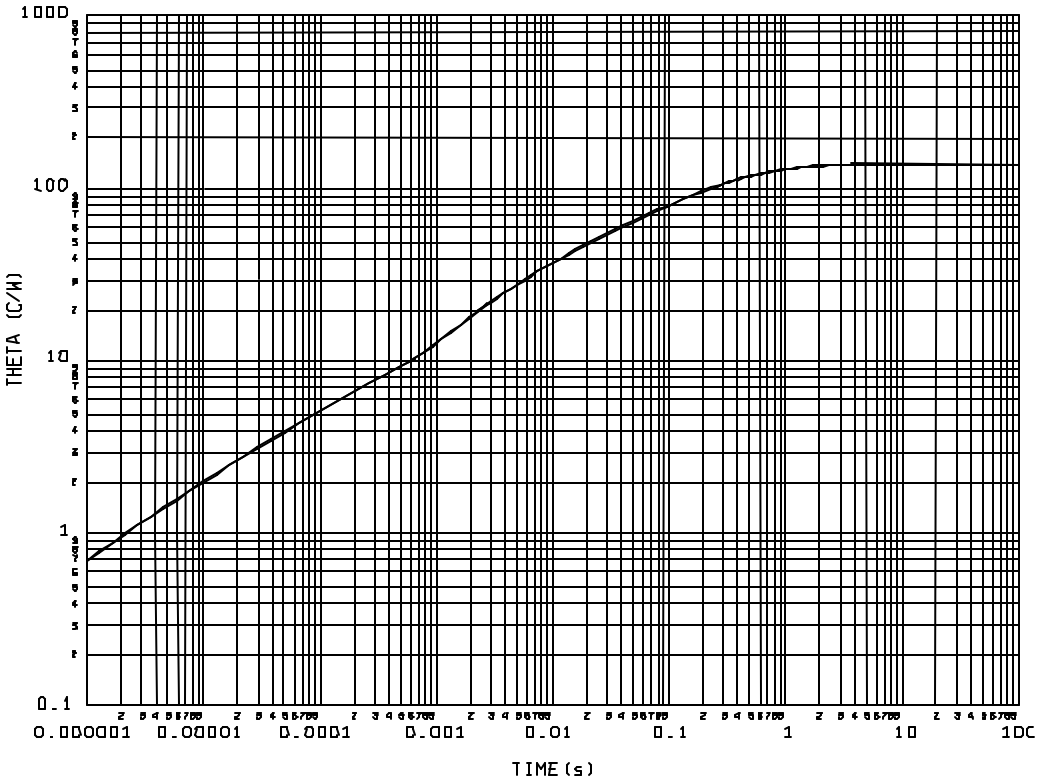



.125 inches (3.13 mm) lead mount to PCB $P_T$ = 500 mw

$R_{\theta JA}$ = 325°C/W

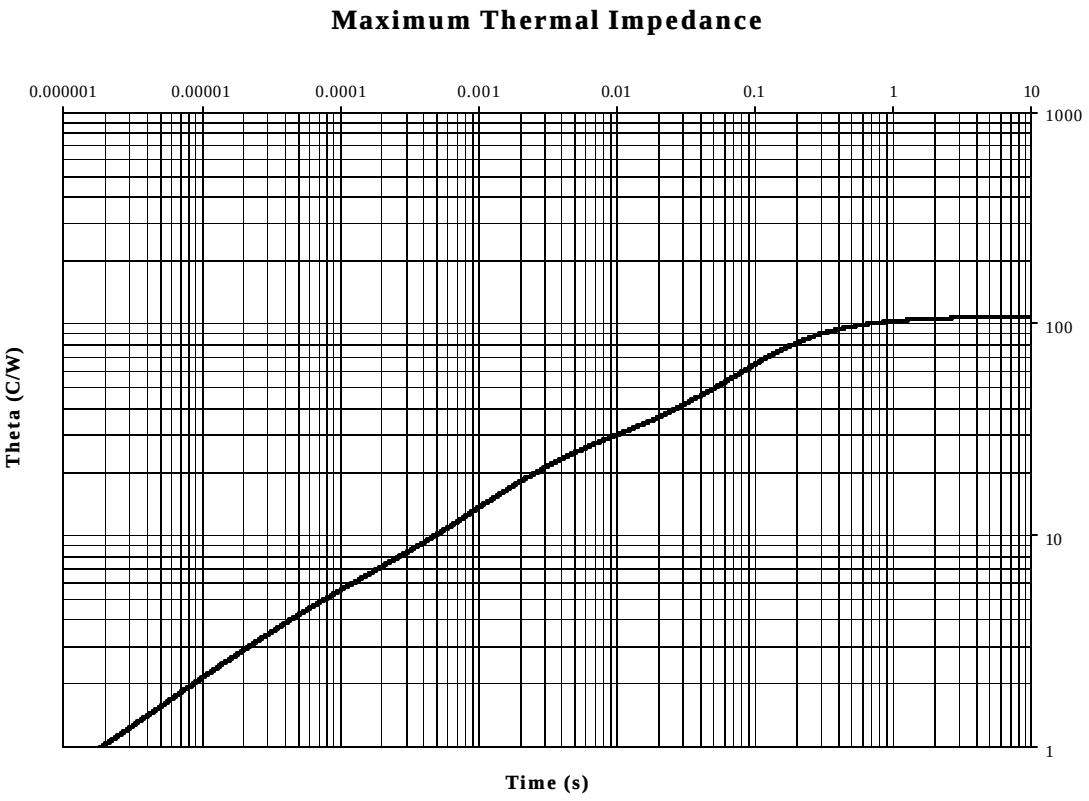
*FIGURE 12. Thermal impedance graph ($R_{\theta JA}$) for 2N4029 (TO-18).

Maximum thermal impedance




Case mounted steel base, $T_C$ = 25°C, $P_t$ = 500 mW.

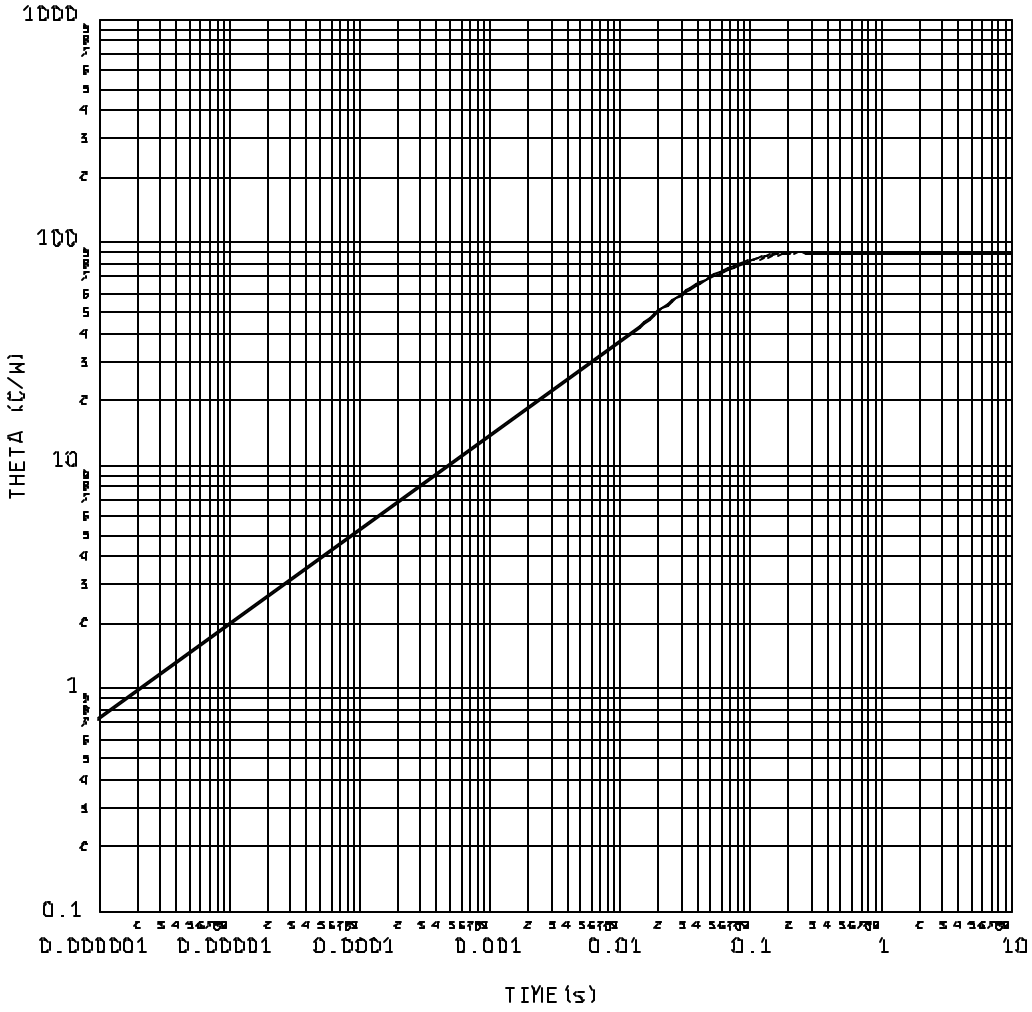
*FIGURE 13. Thermal impedance graph ($R_{\theta Jc}$) for 2N4029 (TO-18).




2N4033UA 4 points solder pads (infinite sink mount to PCB)

*FIGURE 14. Thermal impedance graph ($R_{\theta JSP(IS)}$) for 2N4033 (UA).

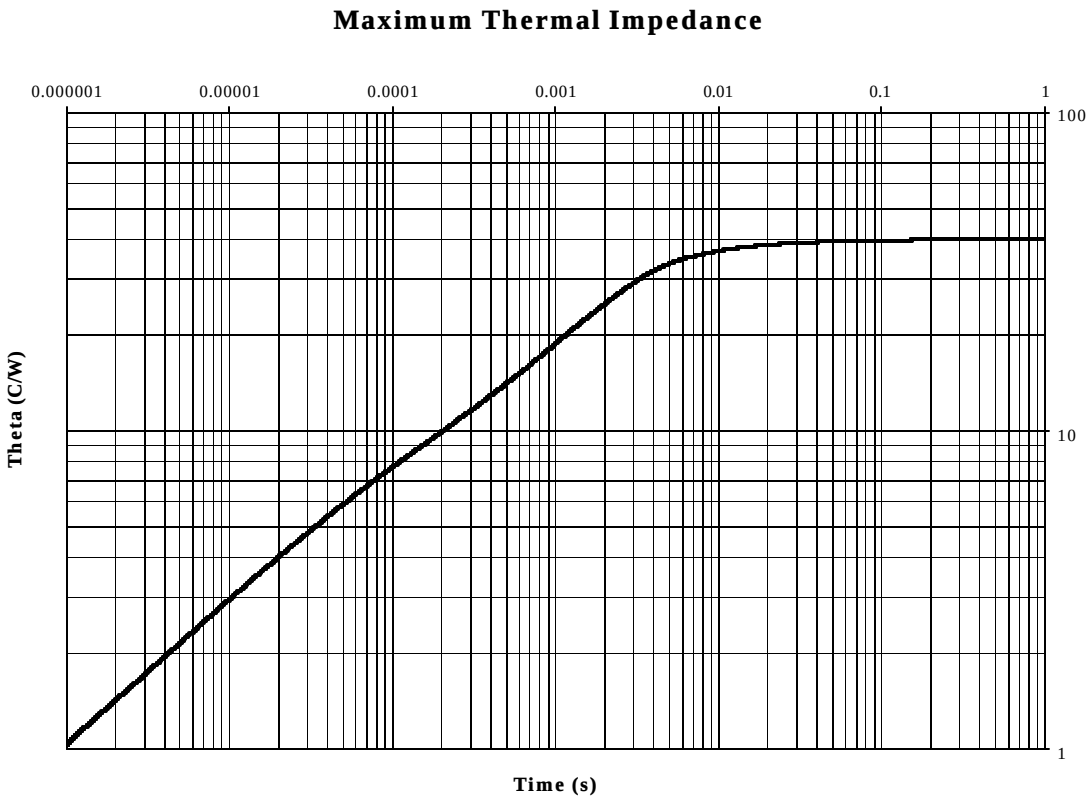
Maximum thermal impedance




Ceramic UB package soldered to PCB 3 points solder pad (infinite sink to PCB).

$R_{\theta JSP(IS)}$ = 90°C/W

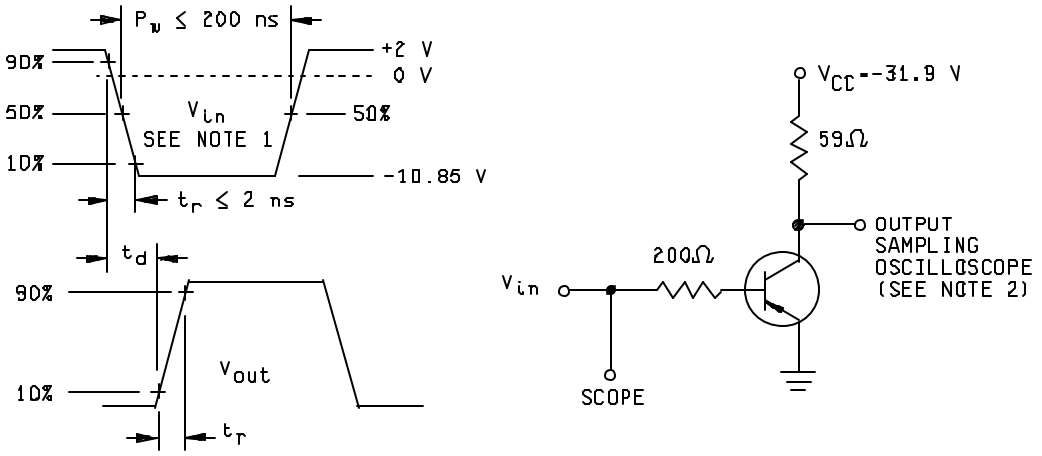
*FIGURE 15. Thermal impedance graph ($R_{\theta JSP(IS)}$) for 2N4029 (UB).




2N4033UA 4 point solder pad (adhesive mount to PCB)

$R_{\theta JSP(AM)}$ = 40°C/W

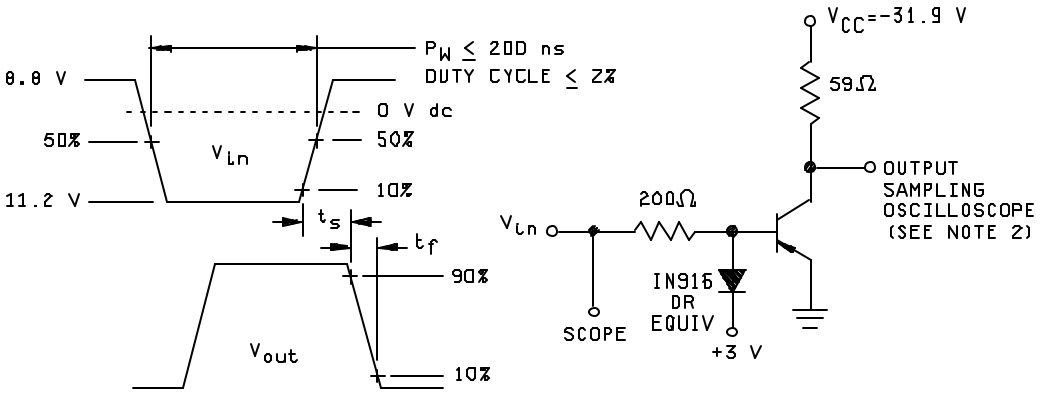
*FIGURE 16. Thermal impedance graph $R_{\theta JSP(AM)}$ for 2N4033UA.




NOTES:

1. The rise time ($t_r$) of the applied pulse shall be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source Z shall be 50 Ω.
2. Sampling oscilloscope: $Z_{IN}$ ≥ 100 kΩ; $C_{in}$ ≤ 12 pF, rise time($t_r$) ≤ 5 ns.

FIGURE 17. Delay and rise time, test circuit.




NOTES:

1. The rise time ($t_r$) of the applied pulse shall be ≤ 20 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω.
2. Sampling oscilloscope: $Z_{IN}$ ≥ 100 kΩ; $C_{in}$ ≤ 12 pF, rise time($t_r$) ≤ 5 ns.

FIGURE 18. Storage and fall time, test circuit.

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. 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 Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' 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 must specify the following:

a. Title, number, and date of this specification.

b Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).

c. The lead finish as specified (see 3.4.1).

d. Type designation and quality assurance level.

e. Packaging requirements (see 5.1).

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) 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.

6.4. Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N4033) will be identified on the QML.

| Die ordering information | |
|---|---|
| PIN | Manufacturer |
| | 34156 |
| 2N4033 | JANHCA2N4033<br>JANKCA2N4033 |

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
DLA - CC

Review activities:
Army – AV, MI
Air Force - 19, 71, 99

Preparing activity:
DLA - CC

(Project 5961-2528)

**STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL**

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| **I RECOMMEND A CHANGE:** | 1. DOCUMENT NUMBER<br>MIL-PRF-19500/512F | 2. DOCUMENT DATE<br>2 May 2003 |
|---|---|---|

3. **DOCUMENT TITLE**
SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING TYPES 2N4029, 2N4033, 2N4033UA, 2N4033UB, JAN, JANTX, JANTXV, JANS AND JANKC2N4033 AND JANHC2N4033

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)<br>COMMERCIAL<br>DSN<br>FAX<br>EMAIL | 7. DATE SUBMITTED |

8. PREPARING ACTIVITY

| a. Point of Contact<br>Alan Barone | b. TELEPHONE<br>Commercial 614-692-0510 DSN 850-0510 FAX 614-692-6939 EMAIL alan.barone@dla.mil |
|---|---|
| c. ADDRESS<br>Defense Supply Center Columbus,<br>ATTN: DSCC-VAC<br>P.O. Box 3990<br>Columbus, OH 43216-5000 | IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:<br>Defense Standardization Program Office (DLSC-LM)<br>8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221<br>Telephone (703) 767-6888 DSN 427-6888 |

**DD Form 1426, Feb 1999 (EG)** Previous editions are obsolete WHS/DIOR, Feb 99