RoHS
*Available on commercial versions*

# PNP SWITCHING SILICON TRANSISTOR

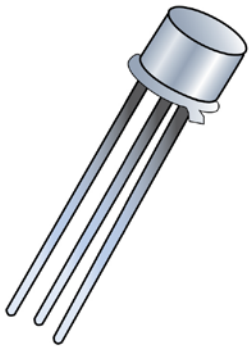
***Qualified per MIL-PRF-19500/290***

*Qualified Levels:*
*JAN, JANTX, JANTXV and JANS*

## DESCRIPTION

This family of 2N2904 and 2N2905A switching transistors are military qualified up to the JANS level for high-reliability applications. These devices are also available in a TO-5 package. Microsemi also offers numerous other transistor products to meet higher and lower power ratings with various switching speed requirements in both through-hole and surface-mount packages.

**Important:** For the latest information, visit our website http://www.microsemi.com.



**TO-39 (TO-205AD) Package**

Also available in:

**TO-5 package**
**(long-leaded)**
2N2904AL & 2N2905AL

## FEATURES

- JEDEC registered 2N2904 through 2N2905A series.
- JAN, JANTX, JANTXV, and JANS qualifications are available per MIL-PRF-19500/290. (See part nomenclature for all available options.)
- RoHS compliant versions available (commercial grade only).

## APPLICATIONS / BENEFITS

- General purpose transistors for high speed switching applications.
- Military and other high-reliability applications.

## MAXIMUM RATINGS

| Parameters / Test Conditions | Symbol | Value | | Unit |
|---|---|---|---|---|
| | | 2N2904 2N2905 | 2N2904A 2N2905A | |
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | 60 | V |
| Collector-Base Voltage | $V_{CBO}$ | 60 | | V |
| Emitter-Base Voltage | $V_{EBO}$ | 5.0 | | V |
| Thermal Resistance Junction-to-Ambient | $R_{\Theta JA}$ | 195 | | °C/W |
| Thermal Resistance Junction-to-Case | $R_{\Theta JC}$ | 50 | | °C/W |
| Collector Current | $I_C$ | 600 | | mA |
| Total Power Dissipation @ $T_A$ = +25 °C (1)<br>@ $T_C$ = +25 °C (2) | $P_T$ | 0.8<br>3.0 | | W |
| Operating & Storage Junction Temperature Range | $T_J$ & $T_{stg}$ | -65 to +200 | | °C |

**Notes:** 1. For derating, see figures 1 and 2.
2. For thermal impedance, see figures 3 and 4.

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## MECHANICAL and PACKAGING

- CASE: Hermetically sealed, kovar base, nickel cap.
- TERMINALS: Leads are kovar, nickel plated, and finish is solder dip (Sn63/Pb37). Can be RoHS compliant with pure matte-tin (commercial grade only).
- MARKING: Part number, date code, manufacturer's ID.
- POLARITY: PNP (see package outline).
- WEIGHT: Approximately 1.064 grams.
- See Package Dimensions on last page.

## PART NOMENCLATURE

**JAN 2N2904 A (e3)**

**Reliability Level**
JAN = JAN Level
JANTX = JANTX Level
JANTXV = JANTXV Level
JANS = JANS Level
Blank = Commercial

**JEDEC type number**
(see Electrical Characteristics table)

**RoHS Compliance**
e3 = RoHS compliant (available on commercial grade only)
Blank = non-RoHS compliant

**Electrical Parameter Modifier**

## SYMBOLS & DEFINITIONS

| Symbol | Definition |
|---|---|
| $C_{obo}$ | Common-base open-circuit output capacitance. |
| $I_{CEO}$ | Collector cutoff current, base open. |
| $I_{CEX}$ | Collector cutoff current, circuit between base and emitter. |
| $I_{EBO}$ | Emitter cutoff current, collector open. |
| $h_{FE}$ | Common-emitter static forward current transfer ratio. |
| $V_{CEO}$ | Collector-emitter voltage, base open. |
| $V_{CBO}$ | Collector-emitter voltage, emitter open. |
| $V_{EBO}$ | Emitter-base voltage, collector open. |

## ELECTRICAL CHARACTERISTICS @ $T_A$ = +25 °C, unless otherwise noted

| Parameters / Test Conditions | | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Breakdown Current | | | | | |
| $I_C$ = 10 mA | 2N2904, 2N2905 | $V_{(BR)CEO}$ | 40 | | V |
| | 2N2904A, 2N2905A | | 60 | | |
| Collector-Emitter Cutoff Voltage | | | | | |
| $V_{CE}$ = 40 V | 2N2904, 2N2905 | $I_{CES}$ | | 1.0 | µA |
| $V_{CE}$ = 60 V | 2N2904A, 2N2905A | | | | |
| Collector-Base Cutoff Current | | | | | |
| $V_{CB}$ = 60 V | All Types | $I_{CBO1}$ | | 10 | µA |
| $V_{CB}$ = 50 V | 2N2904, 2N2905 | $I_{CBO2}$ | | 20 | nA |
| | 2N2904A, 2N2905A | | | 10 | nA |
| $V_{CB}$ = 50 V @ $T_A$ = +150 ºC | 2N2904, 2N2905 | $I_{CBO3}$ | | 20 | µA |
| | 2N2904A, 2N2905A | | | 10 | µA |
| Emitter-Base Cutoff Current | | | | | |
| $V_{EB}$ = 3.5 V | | $I_{EBO}$ | | 50 | nA |
| $V_{EB}$ = 5.0 V | | | | 10 | µA |

| **ON CHARACTERISTICS** (1) | | | | | |
|---|---|---|---|---|---|
| Forward-Current Transfer Ratio | | | | | |
| $I_C$ = 0.1 mA, $V_{CE}$ = 10 V | 2N2904 | $h_{FE}$ | 20 | | |
| | 2N2905 | | 35 | | |
| | 2N2904A | | 40 | | |
| | 2N2905A | | 75 | | |
| $I_C$ = 1.0 mA, $V_{CE}$ = 10 V | 2N2904 | | 25 | 175 | |
| | 2N2905 | | 50 | 450 | |
| | 2N2904A | | 40 | 175 | |
| | 2N2905A | | 100 | 450 | |
| $I_C$ = 10 mA, $V_{CE}$ = 10 V | 2N2904 | | 35 | | |
| | 2N2905 | | 75 | | |
| | 2N2904A | | 40 | | |
| | 2N2905A | | 100 | | |
| $I_C$ = 150 mA, $V_{CE}$ = 10 V | 2N2904, 2N2904A | | 40 | 120 | |
| | 2N2905, 2N2905A | | 100 | 300 | |
| $I_C$ = 500 mA, $V_{CE}$ = 10 V | 2N2904 | | 20 | | |
| | 2N2905 | | 30 | | |
| | 2N2904A | | 40 | | |
| | 2N2905A | | 50 | | |

**ELECTRICAL CHARACTERISTICS** @ $T_A$ = +25 °C, unless otherwise noted (continued)

| Parameters / Test Conditions | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| **ON CHARACTERISTICS (1) (continued)** | | | | |
| Collector-Emitter Saturation Voltage<br>$I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA | $V_{CE(sat)}$ | | 0.4<br>1.6 | V |
| Base-Emitter Saturation Voltage<br>$I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA | $V_{BE(sat)}$ | | 1.3<br>2.6 | V |

(1) Pulse Test: Pulse Width = 300 µs, duty cycle ≤ 2.0%.

**DYNAMIC CHARACTERISTICS**

| Parameters / Test Conditions | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Small-Signal Short-Circuit Forward-Current Transfer Ratio<br>$I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz<br>2N2904<br>2N2905<br>2N2904A, 2N2905A | $h_{fe}$ | | 25<br>50<br>40 | |
| Small-Signal Short-Circuit Forward-Current Transfer Ratio<br>$I_C$ = 50 mA, $V_{CE}$ = 20 V, f = 100 MHz | $\|h_{fe}\|$ | | 2.0 | |
| Output Capacitance<br>$V_{CB}$ = 10 V, $I_E$ = 0, 100 kHz ≤ f ≤ 1.0MHz | $C_{obo}$ | | 8.0 | pF |
| Iutput Capacitance<br>$V_{EB}$ = 2.0 V, $I_C$ = 0, 100 kHz ≤ f ≤ 1.0MHz | $C_{ibo}$ | | 30 | pF |

**SWITCHING CHARACTERISTICS**

| Parameters / Test Conditions | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Turn-On Time | $t_{on}$ | | 45 | ns |
| Turn-Off Time | $t_{off}$ | | 300 | ns |

## GRAPHS

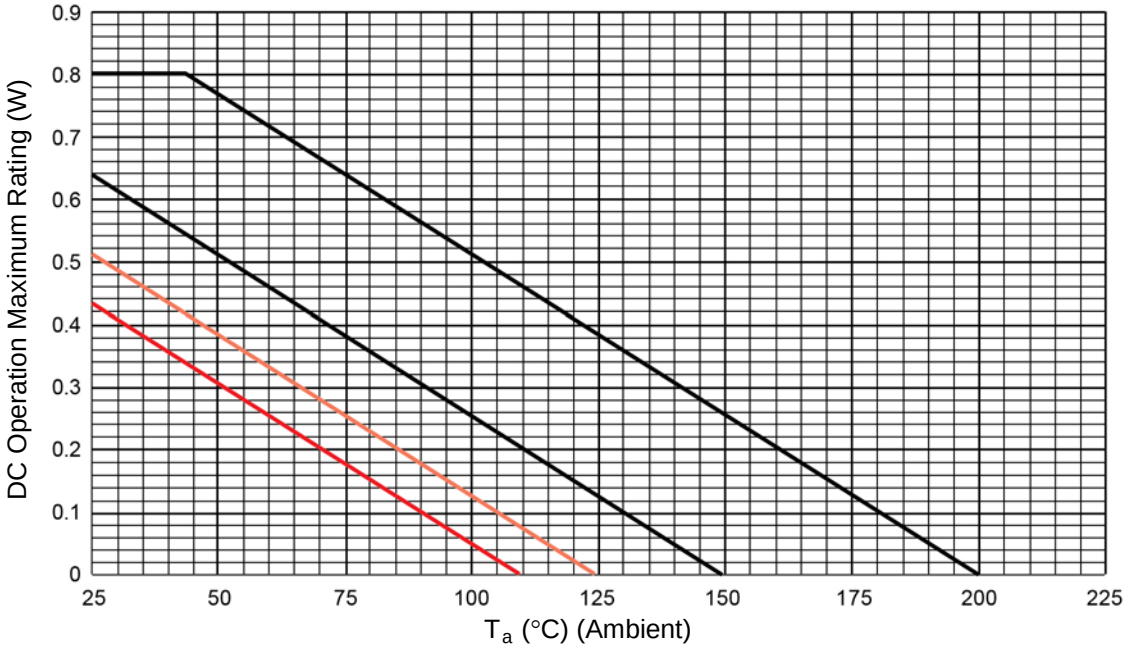



**FIGURE 1**
Derating ($R_{\theta JA}$) PCB

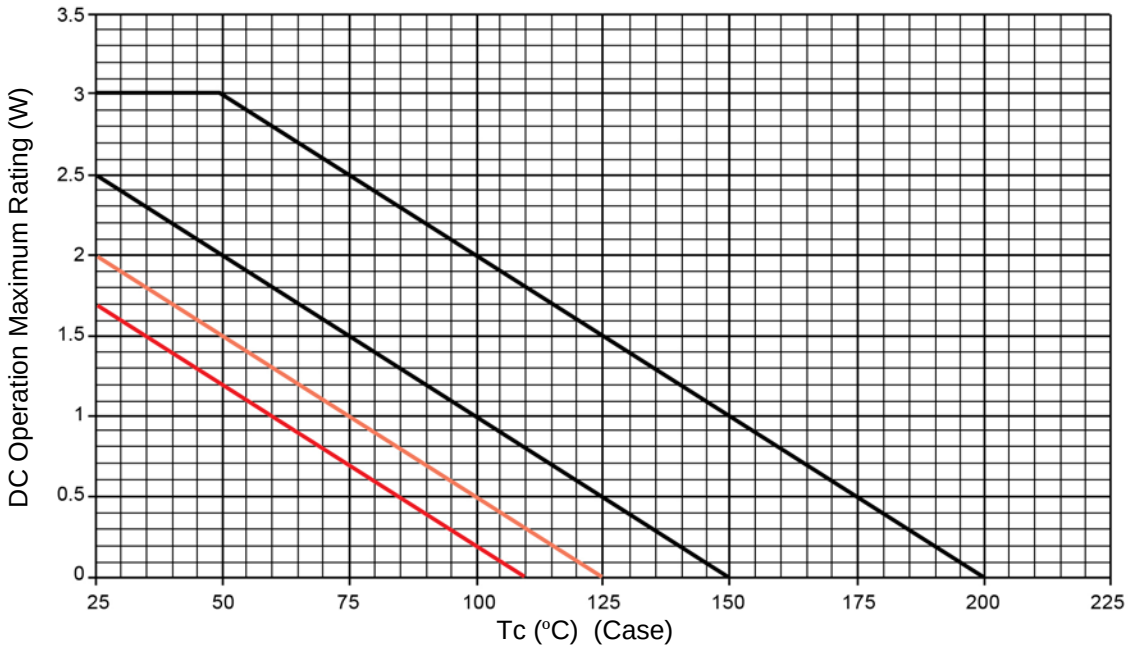



**FIGURE 2**
Derating ($R_{\theta JA}$) PCB

## GRAPHS (continued)

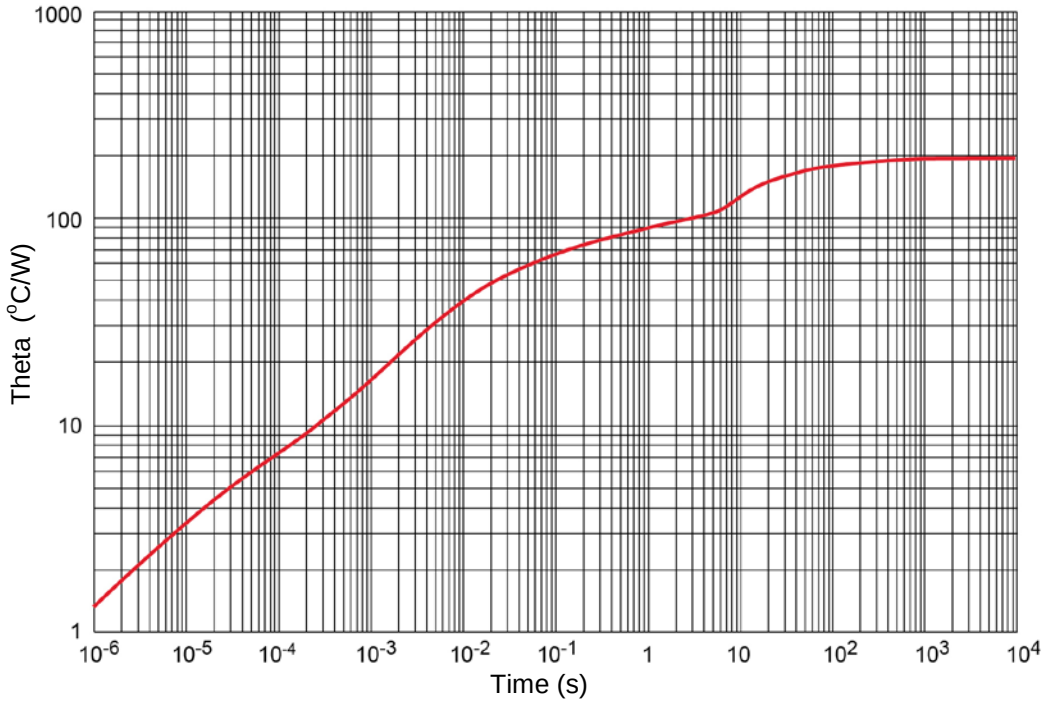



**FIGURE 3**

Thermal impedance graph ($R_{\theta JA}$)

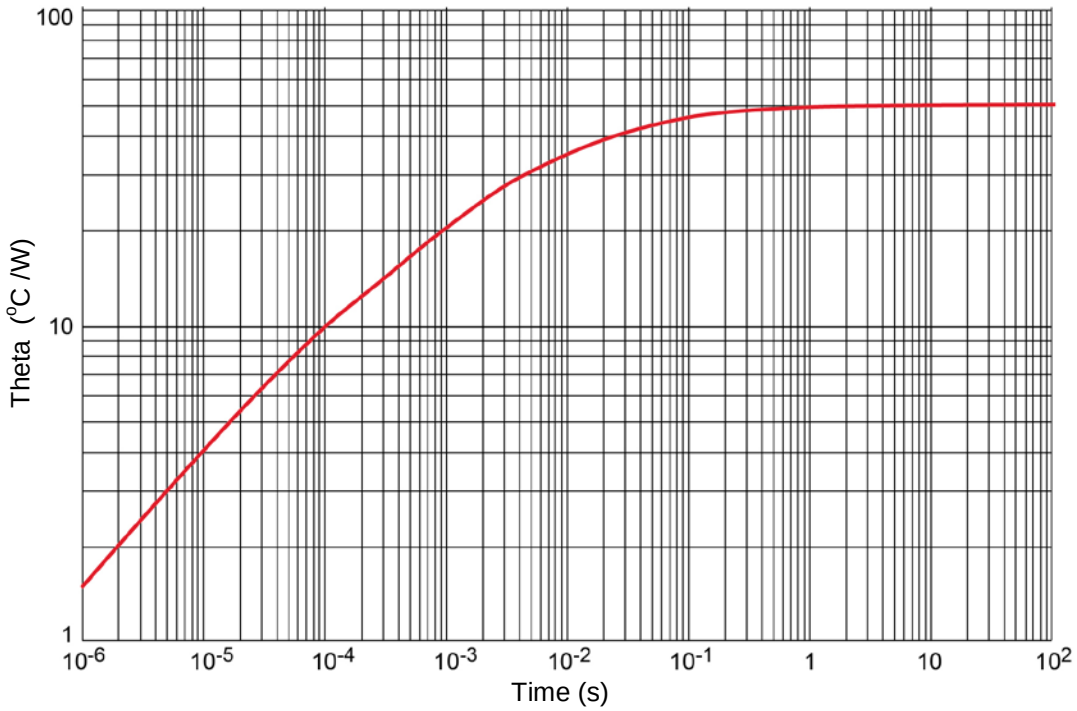
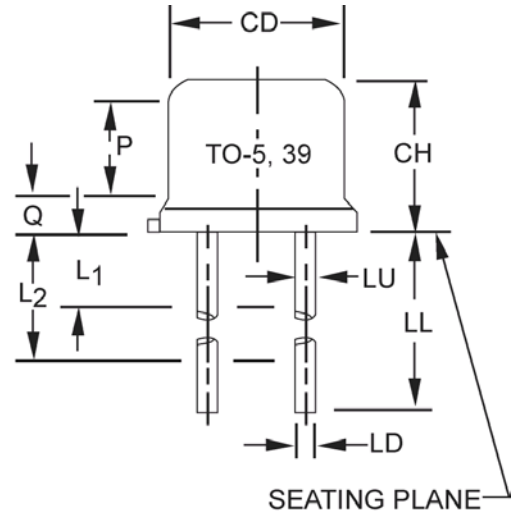
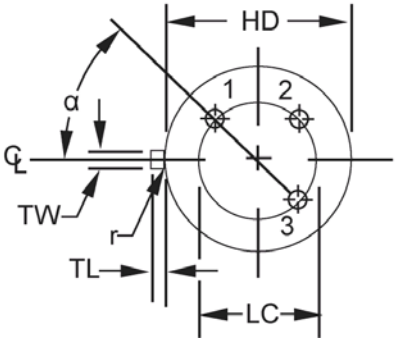



**FIGURE 4**

Thermal impedance graph ($R_{\theta JA}$)

## PACKAGE DIMENSIONS




| Symbol | Dimensions | | | | Note |
|---|---|---|---|---|---|
| | Inch | | Millimeters | | |
| | Min | Max | Min | Max | |
| **CD** | 0.305 | 0.335 | 7.75 | 8.51 | |
| **CH** | 0.240 | 0.260 | 6.10 | 6.60 | |
| **HD** | 0.335 | 0.370 | 8.51 | 9.40 | |
| **LC** | 0.200 TP | | 5.08 TP | | 6 |
| **LD** | 0.016 | 0.021 | 0.41 | 0.53 | 7, 8 |
| **LL** | 0.500 | 0.750 | 12.70 | 19.05 | 7, 8, 12 |
| **LU** | 0.016 | 0.019 | 0.41 | 0.48 | 7, 8 |
| **L1** | | 0.050 | | 1.27 | 7, 8 |
| **L2** | 0.250 | | 6.35 | | 7, 8 |
| **P** | 0.100 | | 2.54 | | |
| **Q** | | 0.050 | | 1.27 | 5 |
| **TL** | 0.029 | 0.045 | 0.74 | 1.14 | 4 |
| **TW** | 0.028 | 0.034 | 0.71 | 0.86 | 3 |
| **r** | | 0.010 | | 0.25 | 10 |
| **α** | 45° TP | | 45° TP | | 6 |

**NOTES:**

1. Dimensions are in inches.
2. Millimeters 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.
7. Dimension LU applies between L1 and L2. Dimension LD applies between L2 and LL minimum. Diameter is uncontrolled in L1 and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.
12. For “L” suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (44.45 mm) maximum.
13. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

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