# MBT3946DW1T1G

# Dual General Purpose Transistor

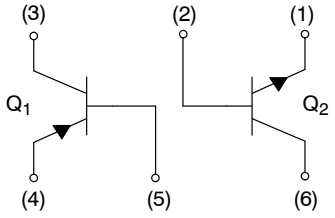
The MBT3946DW1T1G device is a spin−off of our popular SOT−23/SOT−323 three−leaded device. It is designed for general purpose amplifier applications and is housed in the SOT−363−6 surface mount package. By putting two discrete devices in one package, this device is ideal for low−power surface mount applications where board space is at a premium.

### Features

- $h_{FE}$, 100−300
- Low $V_{CE(sat)}$, ≤ 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

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**MBT3946DW1T1***
*Q1 PNP
Q2 NPN




**SOT−363−6/SC−88**
**CASE 419B**
**STYLE 1**

### MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector − Emitter Voltage (NPN) (PNP) | $V_{CEO}$ | 40 −40 | Vdc |
| Collector − Base Voltage (NPN) (PNP) | $V_{CBO}$ | 60 −40 | Vdc |
| Emitter − Base Voltage (NPN) (PNP) | $V_{EBO}$ | 6.0 −5.0 | Vdc |
| Collector Current − Continuous (NPN) (PNP) | $I_C$ | 200 −200 | mAdc |
| Electrostatic Discharge | ESD | HBM Class 2 MM Class B | |

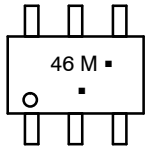
### THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Total Package Dissipation (Note 1) $T_A$ = 25°C | $P_D$ | 150 | mW |
| Thermal Resistance, Junction−to−Ambient | $R_{\theta JA}$ | 833 | °C/W |
| Junction and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to +150 | °C |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

### MARKING DIAGRAM




46 = Specific Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| MBT3946DW1T1G | SC−88 (Pb−Free) | 3000 / Tape & Reel |
| MBT3946DW1T2G | SC−88 (Pb−Free) | 3000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector – Emitter Breakdown Voltage (Note 2) | | $V_{(BR)CEO}$ | | | Vdc |
| ($I_C$ = 1.0 mAdc, $I_B$ = 0) | (NPN) | | 40 | – | |
| ($I_C$ = –1.0 mAdc, $I_B$ = 0) | (PNP) | | –40 | – | |
| Collector – Base Breakdown Voltage | | $V_{(BR)CBO}$ | | | Vdc |
| ($I_C$ = 10 μAdc, $I_E$ = 0) | (NPN) | | 60 | – | |
| ($I_C$ = –10 μAdc, $I_E$ = 0) | (PNP) | | –40 | – | |
| Emitter – Base Breakdown Voltage | | $V_{(BR)EBO}$ | | | Vdc |
| ($I_E$ = 10 μAdc, $I_C$ = 0) | (NPN) | | 6.0 | – | |
| ($I_E$ = –10 μAdc, $I_C$ = 0) | (PNP) | | –5.0 | – | |
| Base Cutoff Current | | $I_{BL}$ | | | nAdc |
| ($V_{CE}$ = 30 Vdc, $V_{EB}$ = 3.0 Vdc) | (NPN) | | – | 50 | |
| ($V_{CE}$ = –30 Vdc, $V_{EB}$ = –3.0 Vdc) | (PNP) | | – | –50 | |
| Collector Cutoff Current | | $I_{CEX}$ | | | nAdc |
| ($V_{CE}$ = 30 Vdc, $V_{EB}$ = 3.0 Vdc) | (NPN) | | – | 50 | |
| ($V_{CE}$ = –30 Vdc, $V_{EB}$ = –3.0 Vdc) | (PNP) | | – | –50 | |
| **ON CHARACTERISTICS** (Note 2) | | | | | |
| DC Current Gain | | $h_{FE}$ | | | – |
| ($I_C$ = 0.1 mAdc, $V_{CE}$ = 1.0 Vdc) | (NPN) | | 40 | – | |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 1.0 Vdc) | | | 70 | – | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc) | | | 100 | 300 | |
| ($I_C$ = 50 mAdc, $V_{CE}$ = 1.0 Vdc) | | | 60 | – | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | | | 30 | – | |
| ($I_C$ = –0.1 mAdc, $V_{CE}$ = –1.0 Vdc) | (PNP) | | 60 | – | |
| ($I_C$ = –1.0 mAdc, $V_{CE}$ = –1.0 Vdc) | | | 80 | – | |
| ($I_C$ = –10 mAdc, $V_{CE}$ = –1.0 Vdc) | | | 100 | 300 | |
| ($I_C$ = –50 mAdc, $V_{CE}$ = –1.0 Vdc) | | | 60 | – | |
| ($I_C$ = –100 mAdc, $V_{CE}$ = –1.0 Vdc) | | | 30 | – | |
| Collector – Emitter Saturation Voltage | | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | (NPN) | | – | 0.2 | |
| ($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | | – | 0.3 | |
| ($I_C$ = –10 mAdc, $I_B$ = –1.0 mAdc) | (PNP) | | – | –0.25 | |
| ($I_C$ = –50 mAdc, $I_B$ = –5.0 mAdc) | | | – | –0.4 | |
| Base – Emitter Saturation Voltage | | $V_{BE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | (NPN) | | 0.65 | 0.85 | |
| ($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | | – | 0.95 | |
| ($I_C$ = –10 mAdc, $I_B$ = –1.0 mAdc) | (PNP) | | –0.65 | –0.85 | |
| ($I_C$ = –50 mAdc, $I_B$ = –5.0 mAdc) | | | – | –0.95 | |
| **SMALL–SIGNAL CHARACTERISTICS** | | | | | |
| Current – Gain – Bandwidth Product | | $f_T$ | | | MHz |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | (NPN) | | 300 | – | |
| ($I_C$ = –10 mAdc, $V_{CE}$ = –20 Vdc, f = 100 MHz) | (PNP) | | 250 | – | |
| Output Capacitance | | $C_{obo}$ | | | pF |
| ($V_{CB}$ = 5.0 Vdc, $I_E$ = 0, f = 1.0 MHz) | (NPN) | | – | 4.0 | |
| ($V_{CB}$ = –5.0 Vdc, $I_E$ = 0, f = 1.0 MHz) | (PNP) | | – | 4.5 | |
| Input Capacitance | | $C_{ibo}$ | | | pF |
| ($V_{EB}$ = 0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | (NPN) | | – | 8.0 | |
| ($V_{EB}$ = –0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | (PNP) | | – | 10.0 | |
| Input Impedance | | $h_{ie}$ | | | kΩ |
| ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | (NPN) | | 1.0 | 10 | |
| ($V_{CE}$ = –10 Vdc, $I_C$ = –1.0 mAdc, f = 1.0 kHz) | (PNP) | | 2.0 | 12 | |
| Voltage Feedback Ratio | | $h_{re}$ | | | X $10^{-4}$ |
| ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | (NPN) | | 0.5 | 8.0 | |
| ($V_{CE}$ = –10 Vdc, $I_C$ = –1.0 mAdc, f = 1.0 kHz) | (PNP) | | 0.1 | 10 | |
| Small – Signal Current Gain | | $h_{fe}$ | | | – |
| ($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz) | (NPN) | | 100 | 400 | |
| ($V_{CE}$ = –10 Vdc, $I_C$ = –1.0 mAdc, f = 1.0 kHz) | (PNP) | | 100 | 400 | |

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted) (Continued)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| Output Admittance<br>($V_{CE}$ = 10 Vdc, $I_C$ = 1.0 mAdc, f = 1.0 kHz)<br>($V_{CE}$ = −10 Vdc, $I_C$ = −1.0 mAdc, f = 1.0 kHz) | <br>(NPN)<br>(PNP) | $h_{oe}$ | <br>1.0<br>3.0 | <br>40<br>60 | μmhos |
| Noise Figure<br>($V_{CE}$ = 5.0 Vdc, $I_C$ = 100 μAdc, $R_S$ = 1.0 kΩ, f = 1.0 kHz)<br>($V_{CE}$ = −5.0 Vdc, $I_C$ = −100 μAdc, $R_S$ = 1.0 kΩ, f = 1.0 kHz) | <br>(NPN)<br>(PNP) | NF | <br>–<br>– | <br>5.0<br>4.0 | dB |

**SWITCHING CHARACTERISTICS**

| | | | | | | |
|---|---|---|---|---|---|---|
| Delay Time | ($V_{CC}$ = 3.0 Vdc, $V_{BE}$ = −0.5 Vdc)<br>($V_{CC}$ = −3.0 Vdc, $V_{BE}$ = 0.5 Vdc) | (NPN)<br>(PNP) | $t_d$ | –<br>– | 35<br>35 | ns |
| Rise Time | ($I_C$ = 10 mAdc, $I_{B1}$ = 1.0 mAdc)<br>($I_C$ = −10 mAdc, $I_{B1}$ = −1.0 mAdc) | (NPN)<br>(PNP) | $t_r$ | –<br>– | 35<br>35 | |
| Storage Time | ($V_{CC}$ = 3.0 Vdc, $I_C$ = 10 mAdc)<br>($V_{CC}$ = −3.0 Vdc, $I_C$ = −10 mAdc) | (NPN)<br>(PNP) | $t_s$ | –<br>– | 200<br>225 | ns |
| Fall Time | ($I_{B1}$ = $I_{B2}$ = 1.0 mAdc)<br>($I_{B1}$ = $I_{B2}$ = −1.0 mAdc) | (NPN)<br>(PNP) | $t_f$ | –<br>– | 50<br>75 | |

**(NPN)**

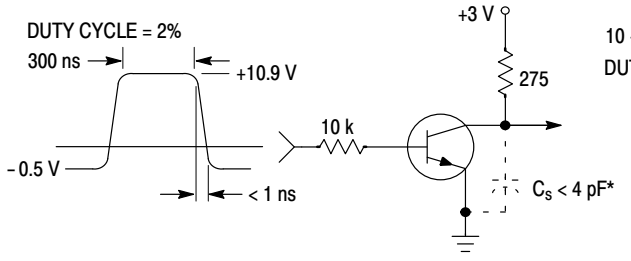



**Figure 1. Delay and Rise Time Equivalent Test Circuit**

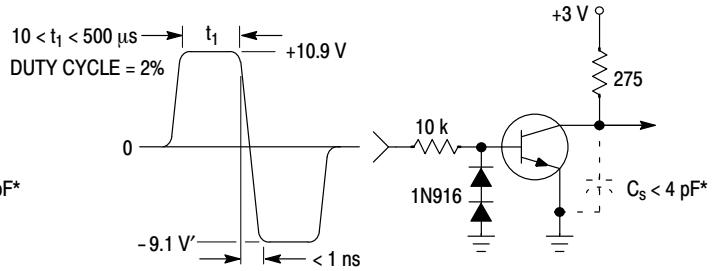



**Figure 2. Storage and Fall Time Equivalent Test Circuit**

* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

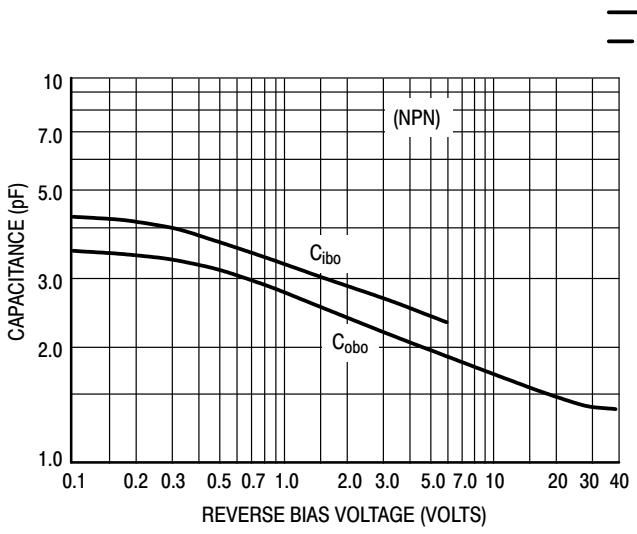



**Figure 3. Capacitance**

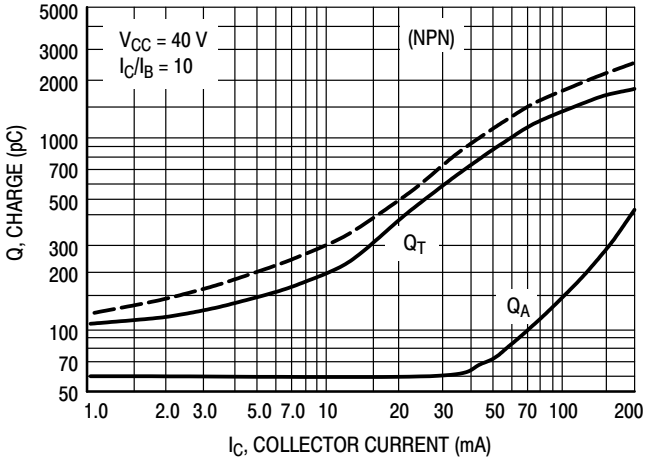



**Figure 4. Charge Data**

**(NPN)**

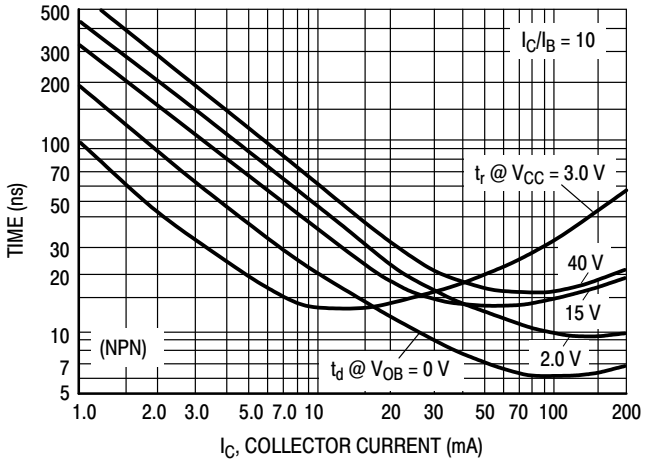



**Figure 5. Turn – On Time**

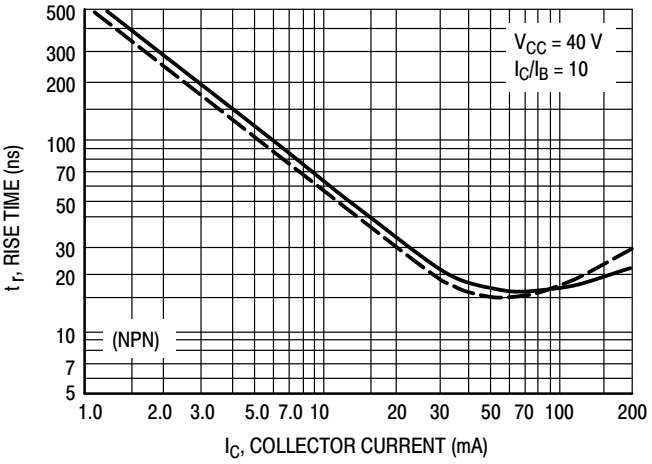



**Figure 6. Rise Time**

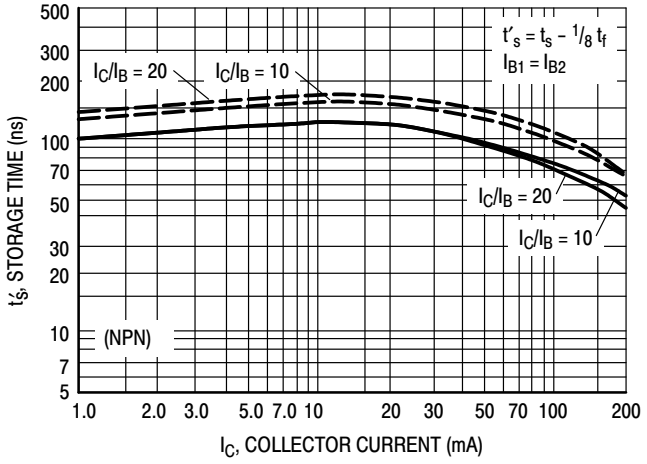



**Figure 7. Storage Time**

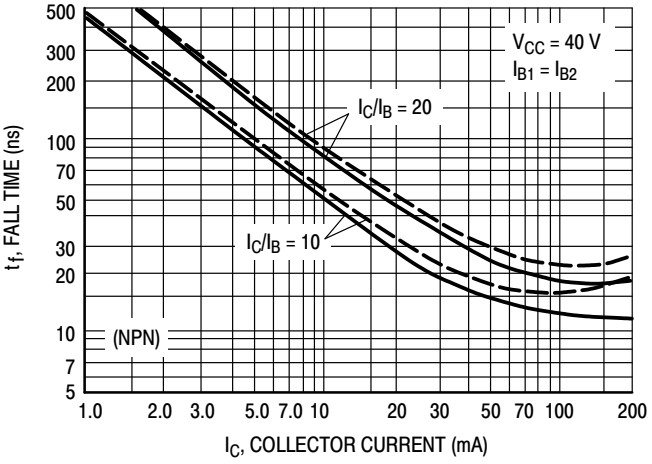



**Figure 8. Fall Time**

## TYPICAL AUDIO SMALL – SIGNAL CHARACTERISTICS
## NOISE FIGURE VARIATIONS

($V_{CE}$ = 5.0 Vdc, $T_A$ = 25°C, Bandwidth = 1.0 Hz)

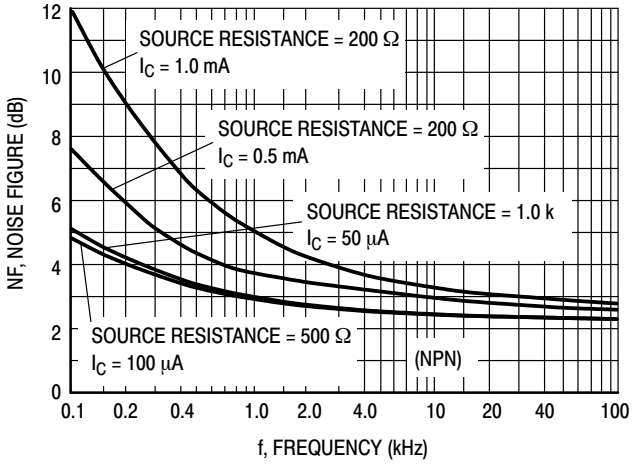



**Figure 9. Noise Figure**

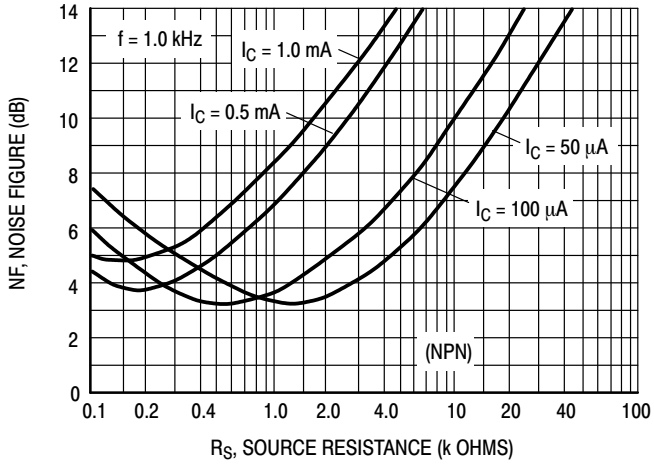



**Figure 10. Noise Figure**

**(NPN)**
**h PARAMETERS**
($V_{CE}$ = 10 Vdc, f = 1.0 kHz, $T_A$ = 25°C)

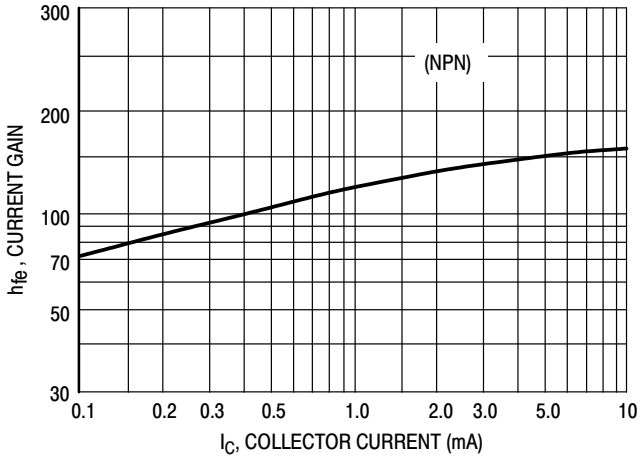



**Figure 11. Current Gain**

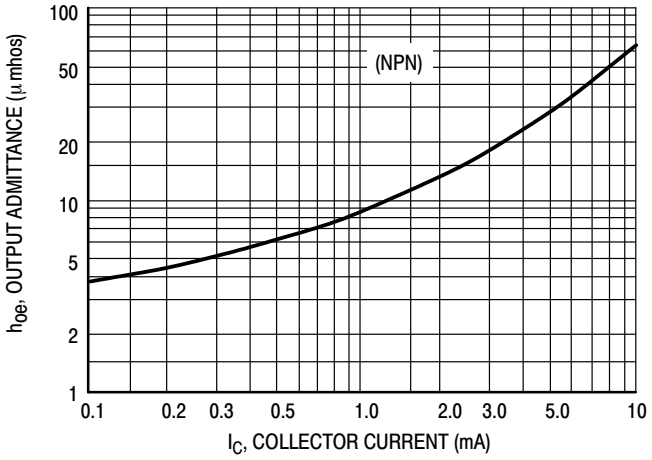



**Figure 12. Output Admittance**

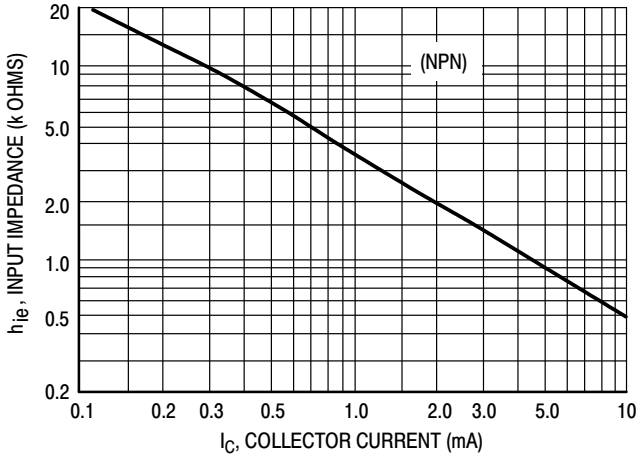



**Figure 13. Input Impedance**

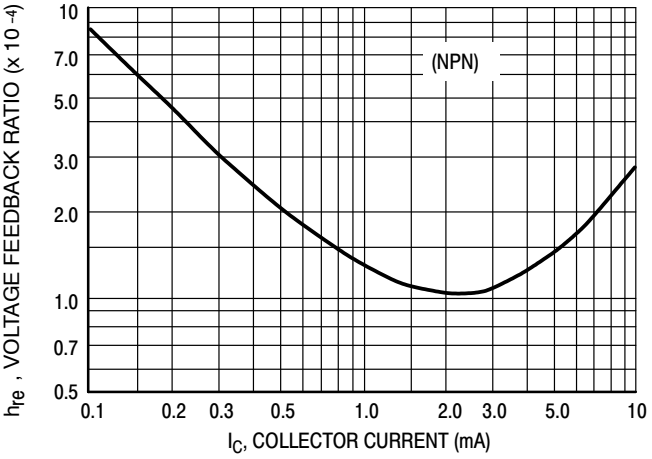



**Figure 14. Voltage Feedback Ratio**

## (NPN)
## TYPICAL STATIC CHARACTERISTICS

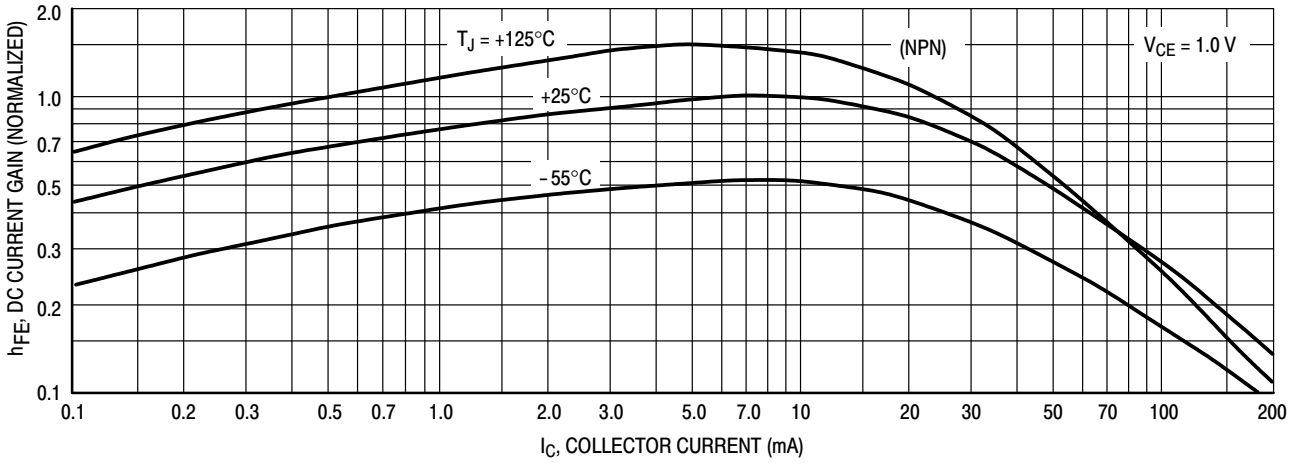



**Figure 15. DC Current Gain**

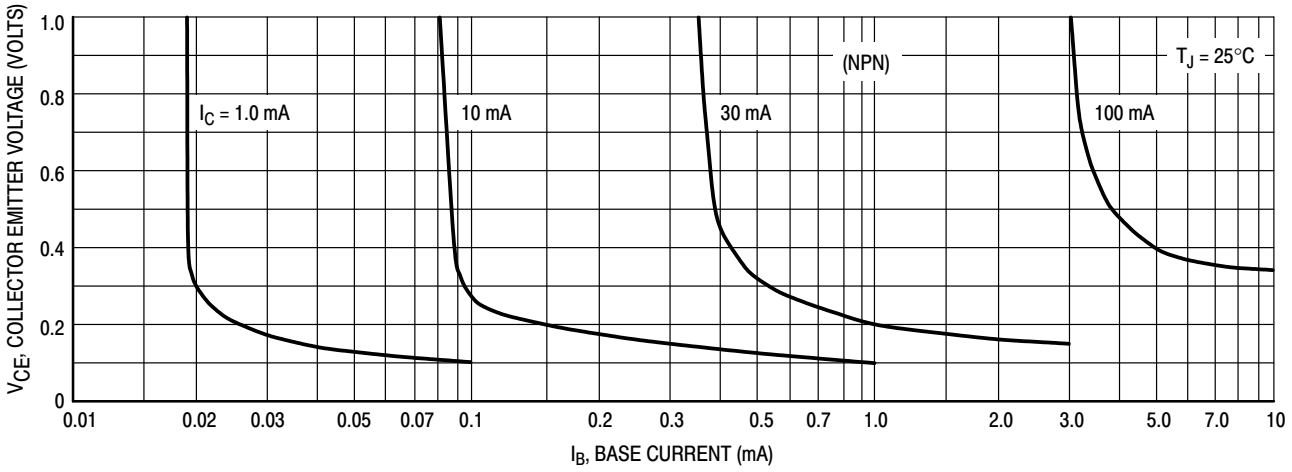



**Figure 16. Collector Saturation Region**

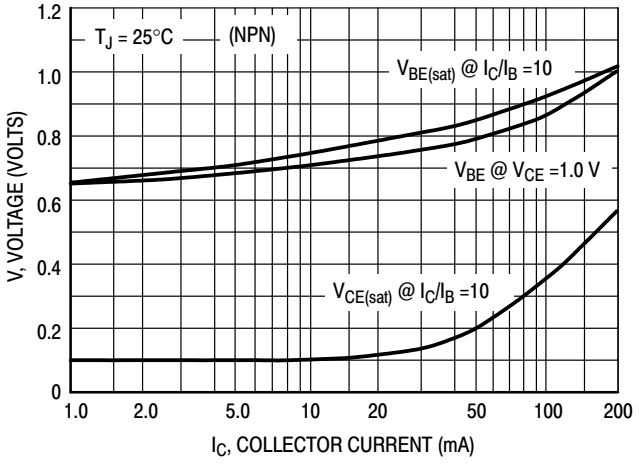



**Figure 17. "ON" Voltages**

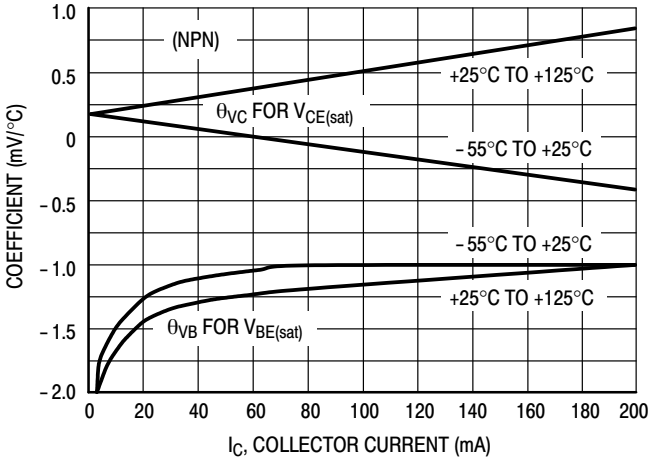



**Figure 18. Temperature Coefficients**

**(PNP)**

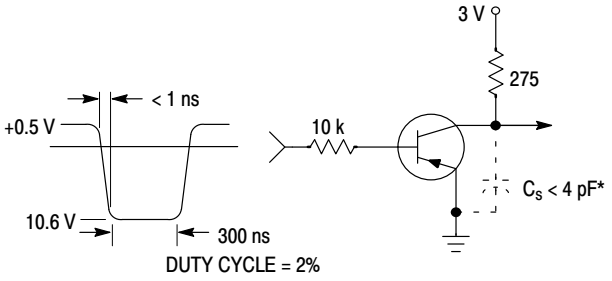



**Figure 19. Delay and Rise Time Equivalent Test Circuit**

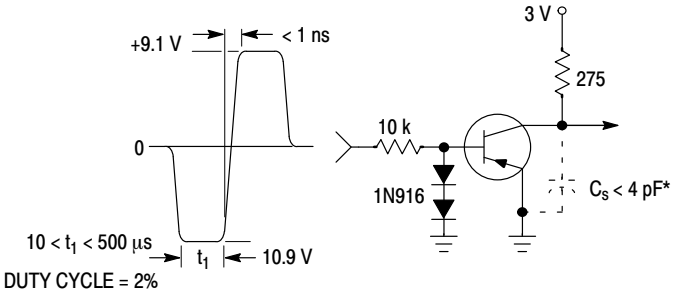



**Figure 20. Storage and Fall Time Equivalent Test Circuit**

* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

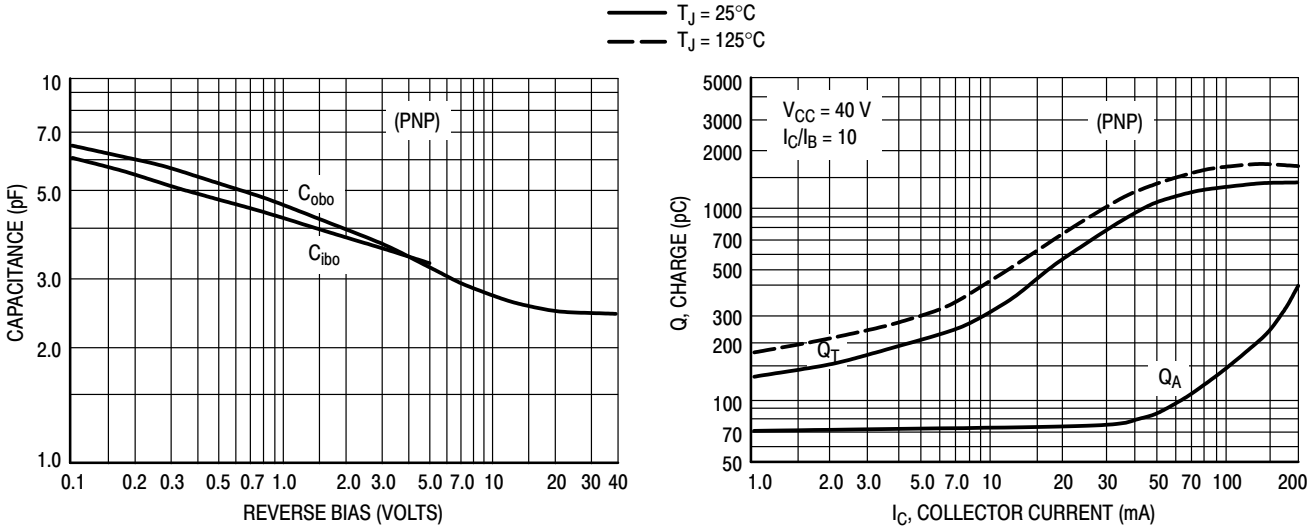



**Figure 21. Capacitance**

**Figure 22. Charge Data**

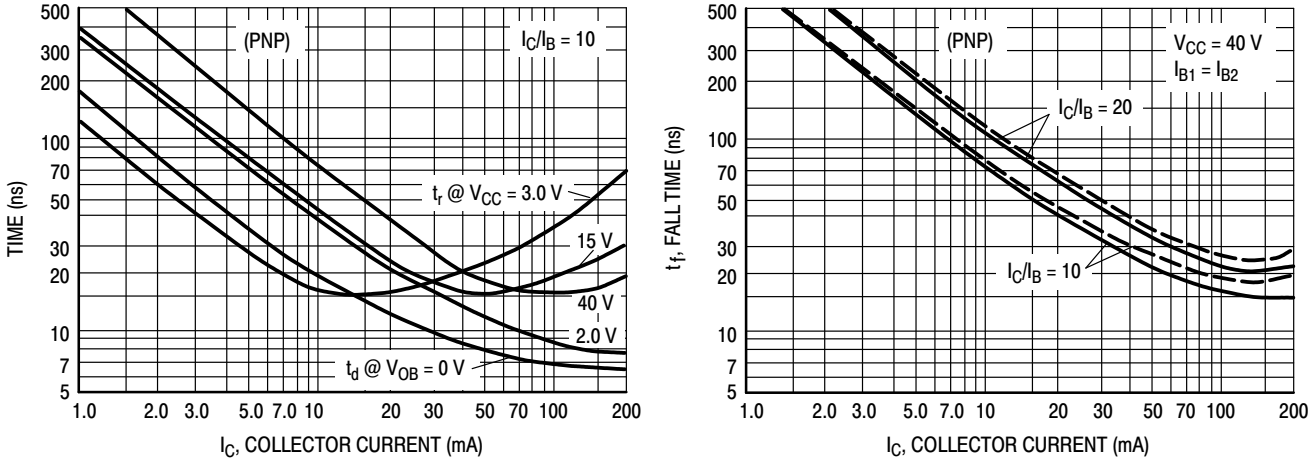



**Figure 23. Turn – On Time**

**Figure 24. Fall Time**

**(PNP)**

## TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
## NOISE FIGURE VARIATIONS

($V_{CE}$ = −5.0 Vdc, $T_A$ = 25°C, Bandwidth = 1.0 Hz)

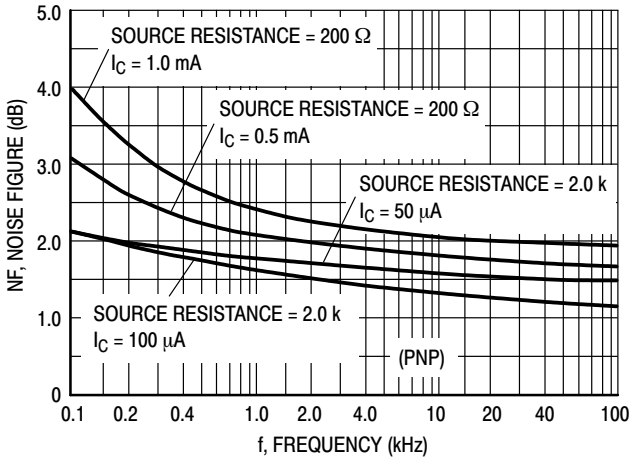



**Figure 25.**

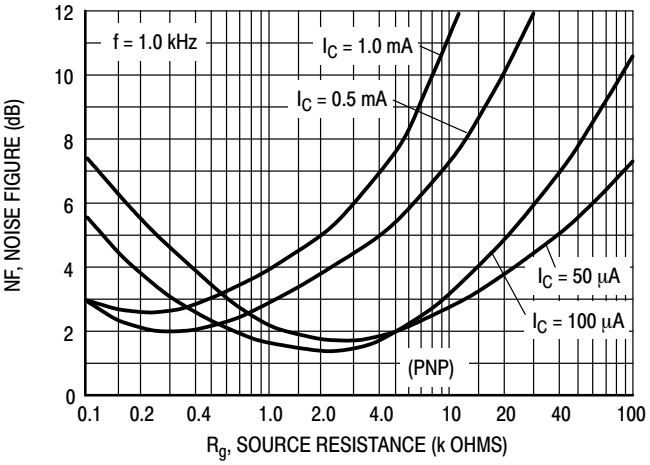



**Figure 26.**

## h PARAMETERS

($V_{CE}$ = −10 Vdc, f = 1.0 kHz, $T_A$ = 25°C)

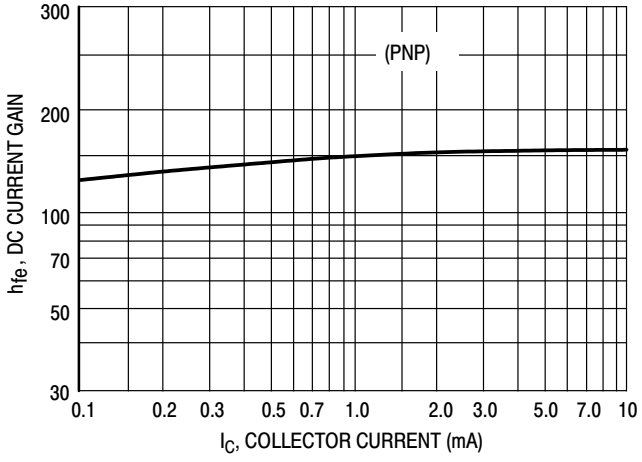



**Figure 27. Current Gain**

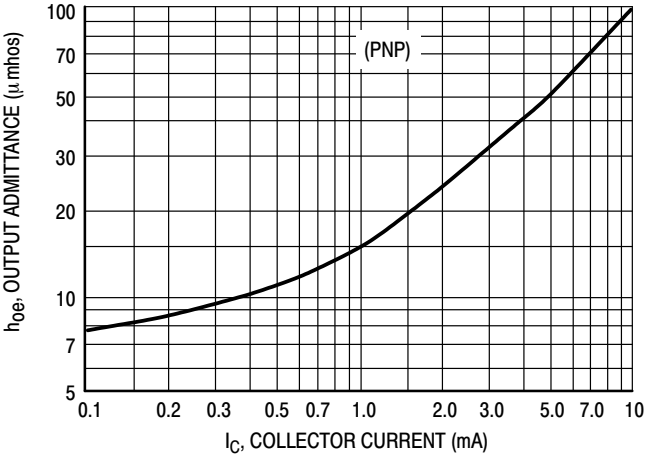



**Figure 28. Output Admittance**

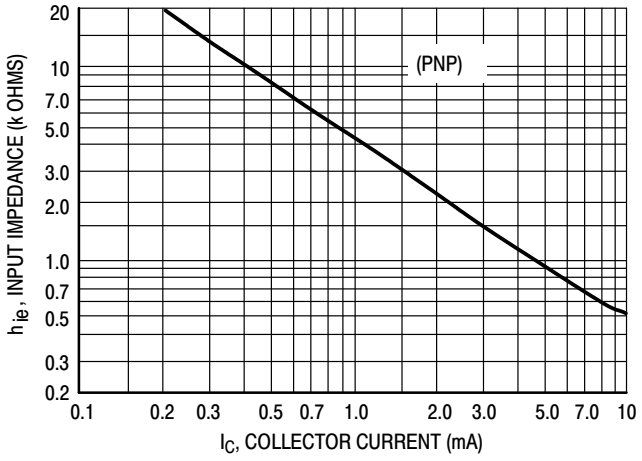



**Figure 29. Input Impedance**

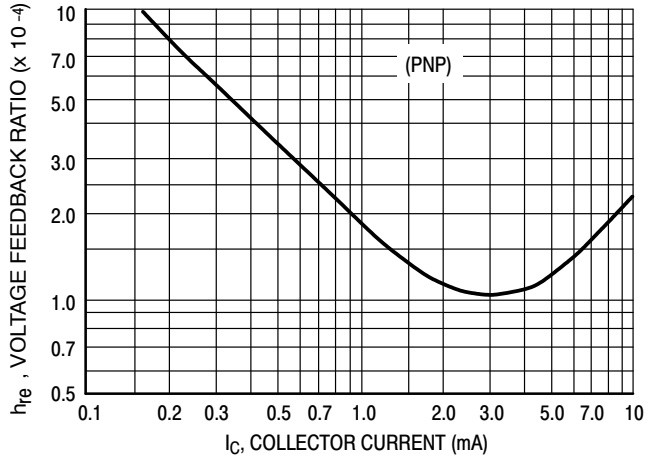



**Figure 30. Voltage Feedback Ratio**

## (PNP)

## TYPICAL STATIC CHARACTERISTICS

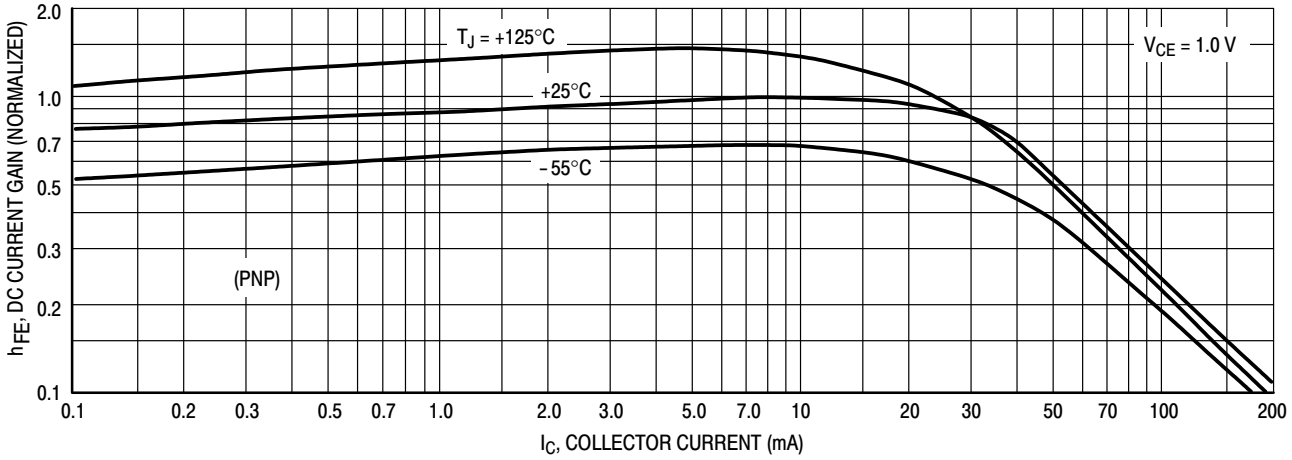



**Figure 31. DC Current Gain**

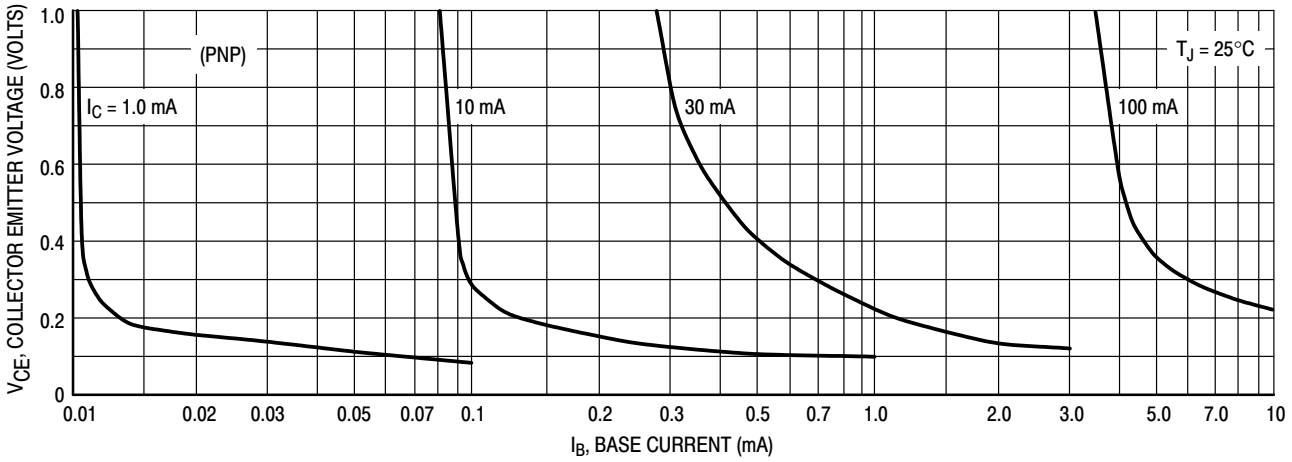



**Figure 32. Collector Saturation Region**

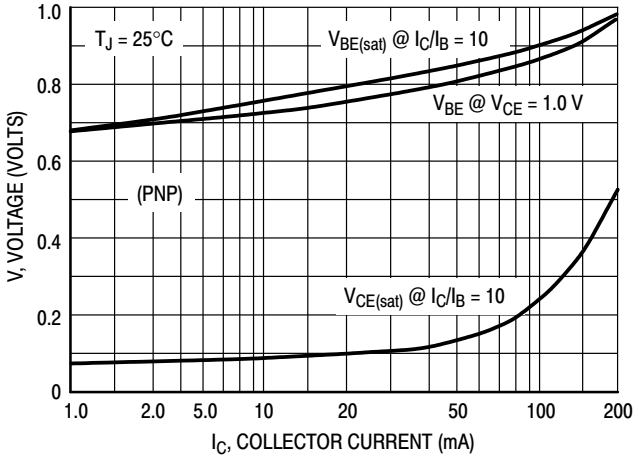



**Figure 33. “ON” Voltages**

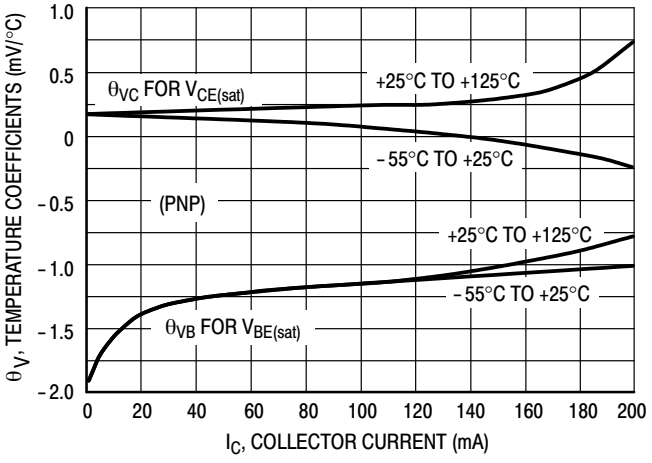
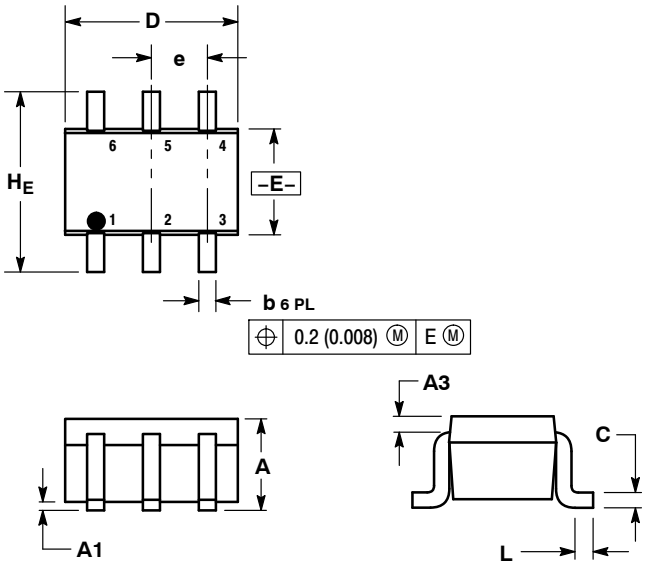



**Figure 34. Temperature Coefficients**

## PACKAGE DIMENSIONS

**SC−88/SC70−6/SOT−363**
CASE 419B−02
ISSUE W





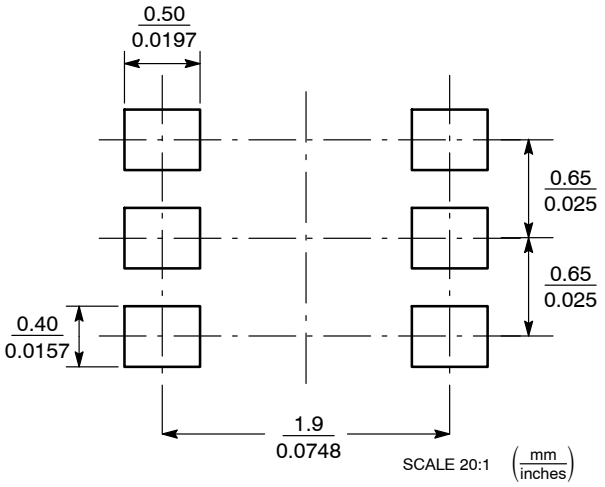


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419B−01 OBSOLETE, NEW STANDARD 419B−02.

| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.80 | 0.95 | 1.10 | 0.031 | 0.037 | 0.043 |
| A1 | 0.00 | 0.05 | 0.10 | 0.000 | 0.002 | 0.004 |
| A3 | | 0.20 REF | | | 0.008 REF | |
| b | 0.10 | 0.21 | 0.30 | 0.004 | 0.008 | 0.012 |
| C | 0.10 | 0.14 | 0.25 | 0.004 | 0.005 | 0.010 |
| D | 1.80 | 2.00 | 2.20 | 0.070 | 0.078 | 0.086 |
| E | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | | 0.65 BSC | | | 0.026 BSC | |
| L | 0.10 | 0.20 | 0.30 | 0.004 | 0.008 | 0.012 |
| $H_E$ | 2.00 | 2.10 | 2.20 | 0.078 | 0.082 | 0.086 |

STYLE 1:
PIN 1. EMITTER 2
2. BASE 2
3. COLLECTOR 1
4. EMITTER 1
5. BASE 1
6. COLLECTOR 2

## SOLDERING FOOTPRINT*




*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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