# MBT3904DW1,
# MBT3904DW2,
# SMBT3904DW1,
# NSVMBT3904DW1

## ON Semiconductor®

# Dual General Purpose Transistors

The MBT3904DW1 and MBT3904DW2 devices are 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 six−leaded 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
- Available in 8 mm, 7−inch/3,000 Unit Tape and Reel
- S and NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
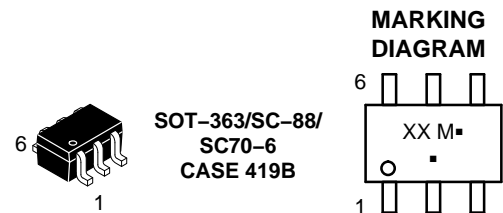- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

### MARKING DIAGRAM



SOT−363/SC−88/
SC70−6
CASE 419B

XX = MA for MBT3904DW1T1G
    MJ for MBT3904DW2T1G
M = Date Code
■ = Pb−Free Package
(Note: Microdot may be in either location)



**MBT3904DW1T1
STYLE 1**



**MBT3904DW2T1
STYLE 27**

## MAXIMUM RATINGS

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

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
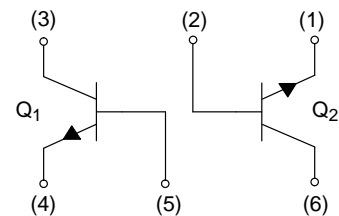
## THERMAL CHARACTERISTICS

| 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 |

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

## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| MBT3904DW1T1G, MBT3904DW2T1G | SOT−363 (Pb−Free) | 3000 / Tape & Reel |
| SMBT3904DW1T1G | SOT−363 (Pb−Free) | 3000 / Tape & Reel |
| NSVMBT3904DW1T3G | SOT−363 (Pb−Free) | 10000 / 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.

**June, 2015 – Rev. 11**

**1**

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

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

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

**SWITCHING CHARACTERISTICS**

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| Delay Time | ($V_{CC}$ = 3.0 Vdc, $V_{BE}$ = −0.5 Vdc) | $t_d$ | – | 35 | ns |
| Rise Time | ($I_C$ = 10 mAdc, $I_{B1}$ = 1.0 mAdc) | $t_r$ | – | 35 | |
| Storage Time | ($V_{CC}$ = 3.0 Vdc, $I_C$ = 10 mAdc) | $t_s$ | – | 200 | ns |
| Fall Time | ($I_{B1}$ = $I_{B2}$ = 1.0 mAdc) | $t_f$ | – | 50 | |



* Total shunt capacitance of test jig and connectors
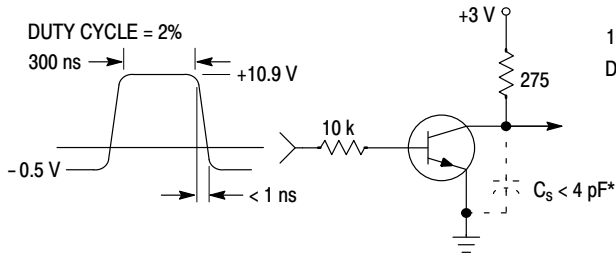
**Figure 1. Delay and Rise Time
Equivalent Test Circuit**
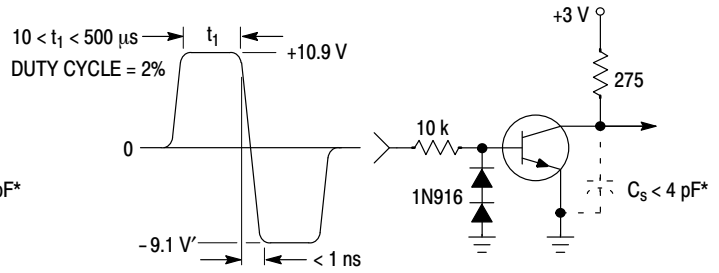
**Figure 2. Storage and Fall Time
Equivalent Test Circuit**

# MBT3904DW1, MBT3904DW2, SMBT3904DW1, NSVMBT3904DW1

## TYPICAL TRANSIENT CHARACTERISTICS

$T_J = 25°C$
$T_J = 125°C$
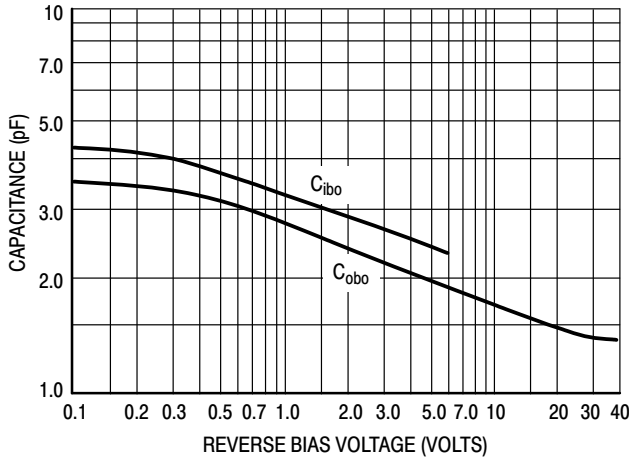


Figure 3. Capacitance
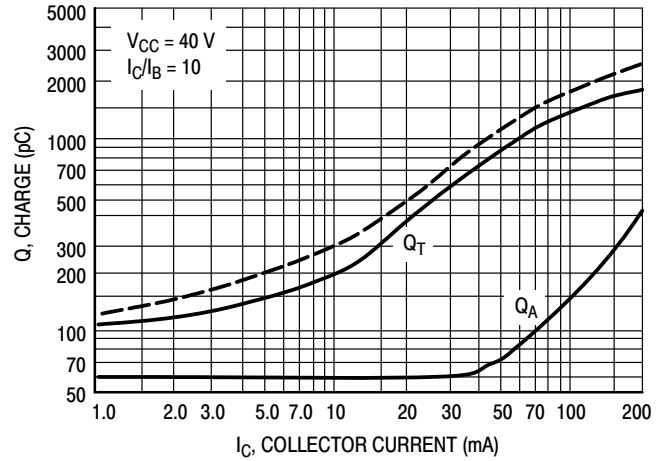


Figure 4. Charge Data
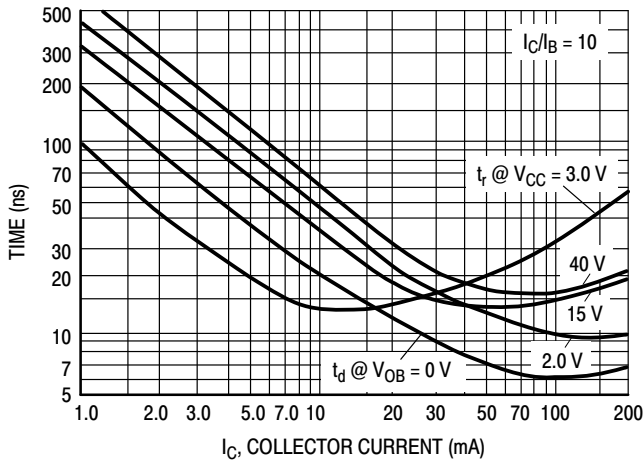


Figure 5. Turn–On Time
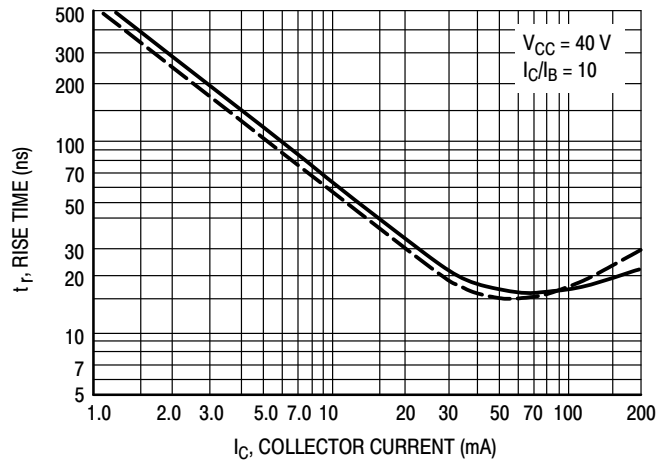


Figure 6. Rise Time
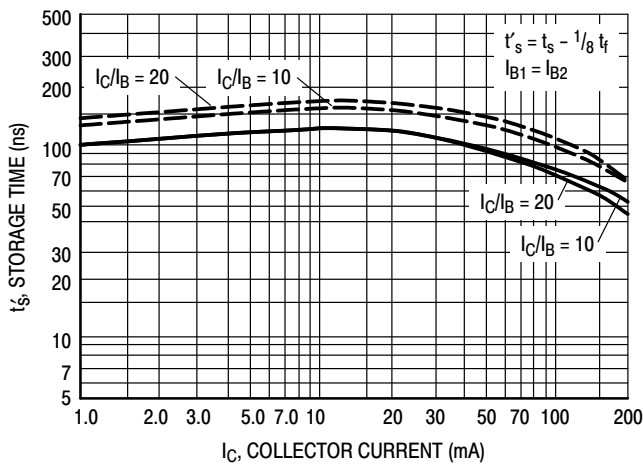


Figure 7. Storage Time
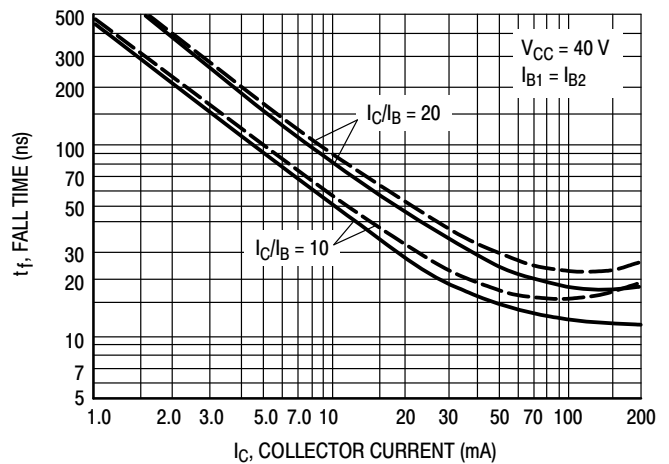


Figure 8. Fall Time

# MBT3904DW1, MBT3904DW2, SMBT3904DW1, NSVMBT3904DW1

## TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
### NOISE FIGURE VARIATIONS
($V_{CE}$ = 5.0 Vdc, $T_A$ = 25°C, Bandwidth = 1.0 Hz)
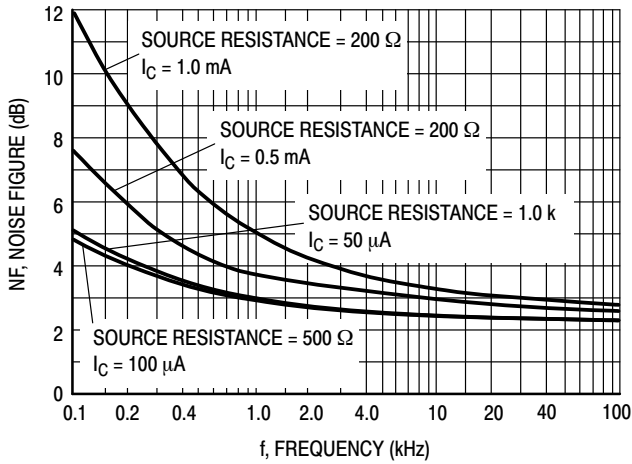
**Figure 9. Noise Figure**
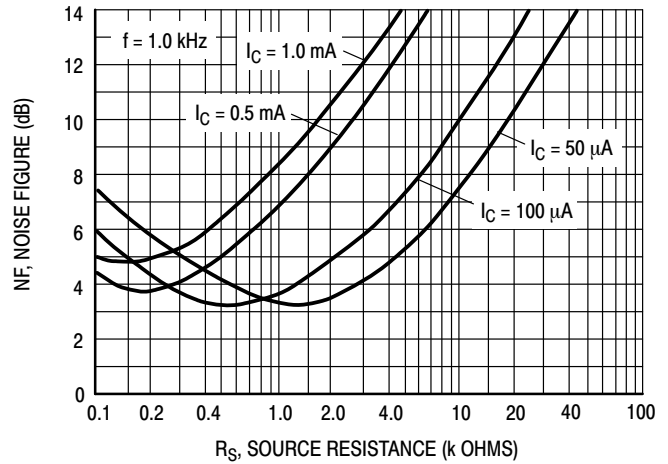
**Figure 10. Noise Figure**

## h PARAMETERS
($V_{CE}$ = 10 Vdc, f = 1.0 kHz, $T_A$ = 25°C)
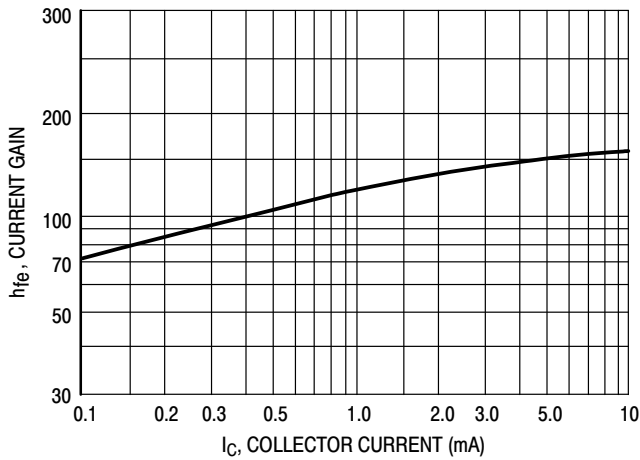
**Figure 11. Current Gain**
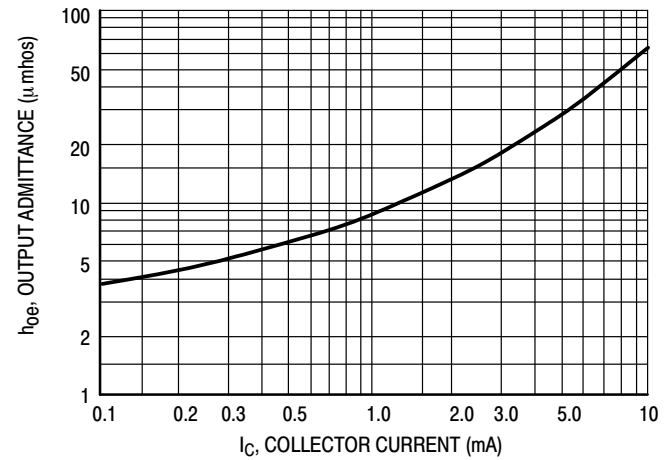
**Figure 12. Output Admittance**
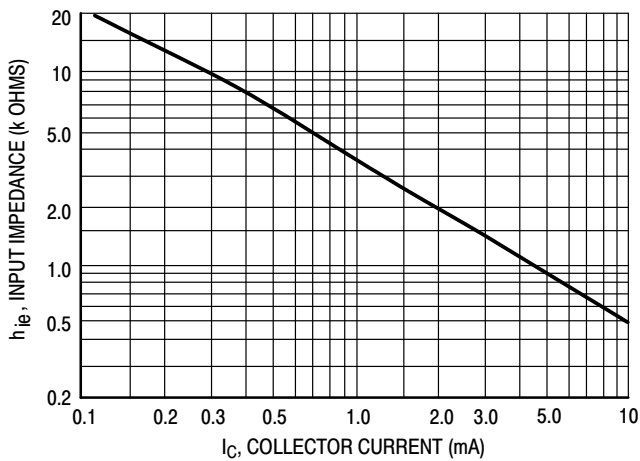
**Figure 13. Input Impedance**
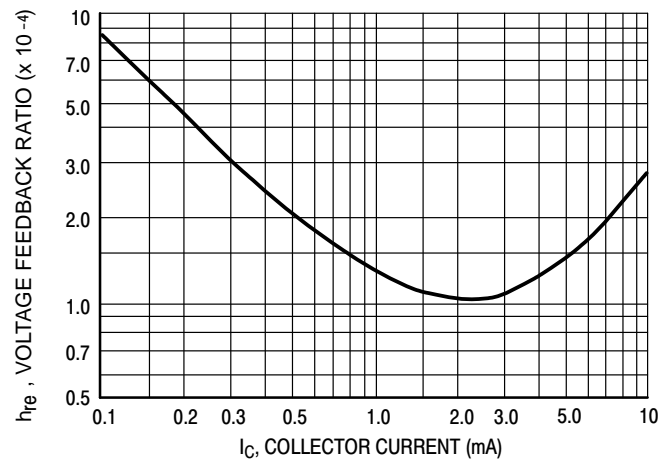
**Figure 14. Voltage Feedback Ratio**

## TYPICAL STATIC CHARACTERISTICS
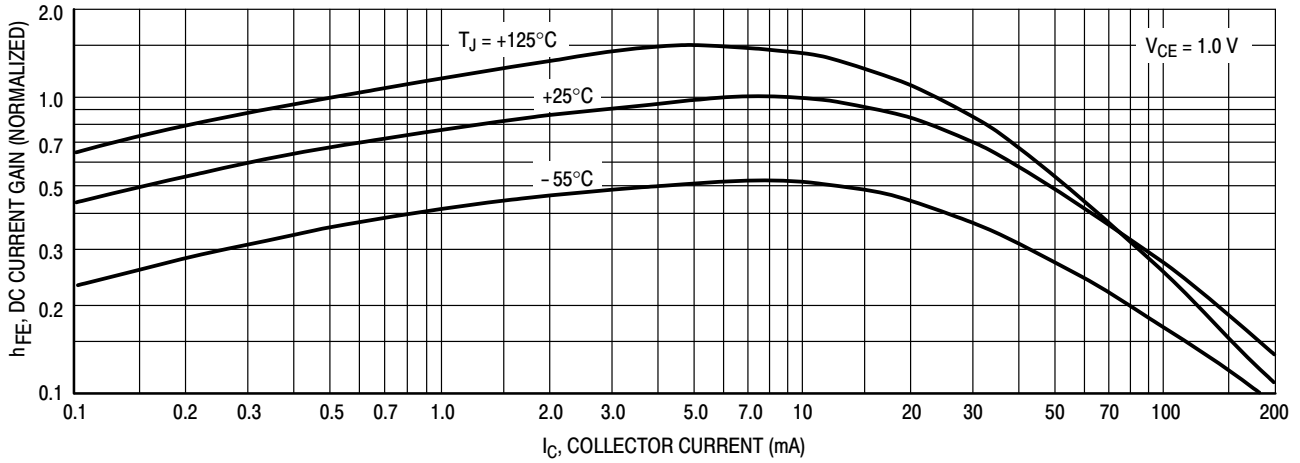
**Figure 15. DC Current Gain**
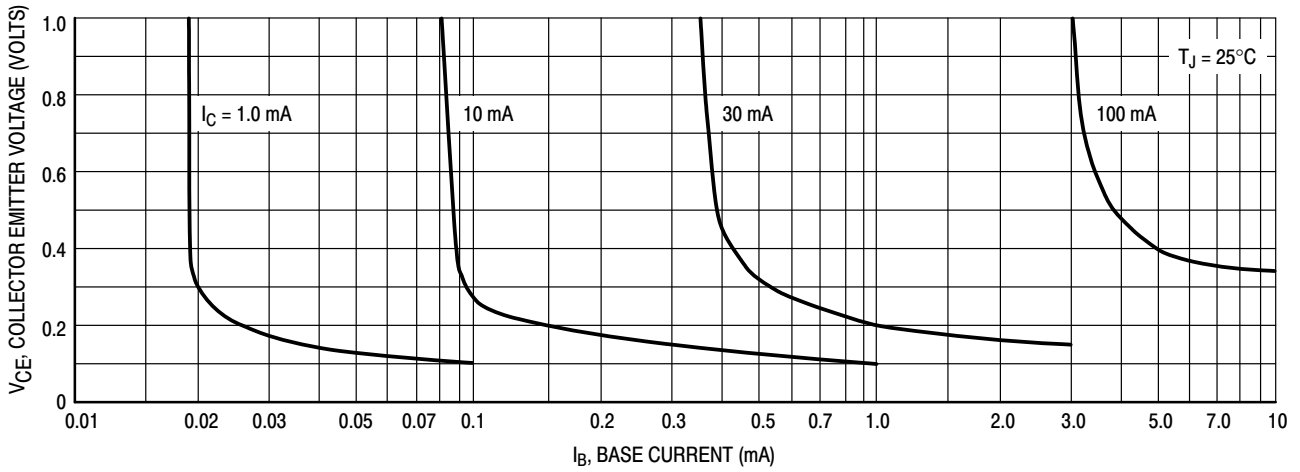
**Figure 16. Collector Saturation Region**
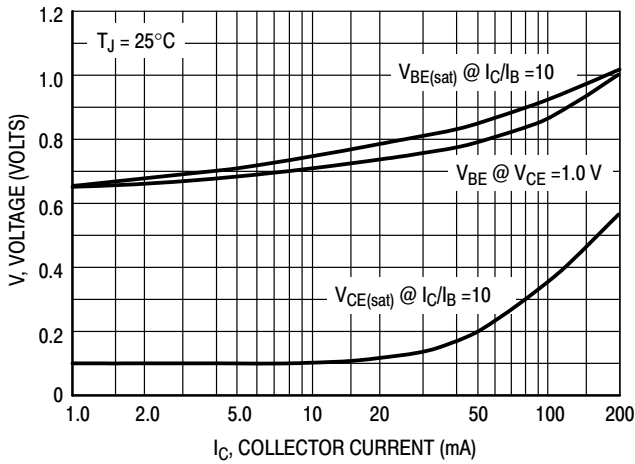
**Figure 17. "ON" Voltages**
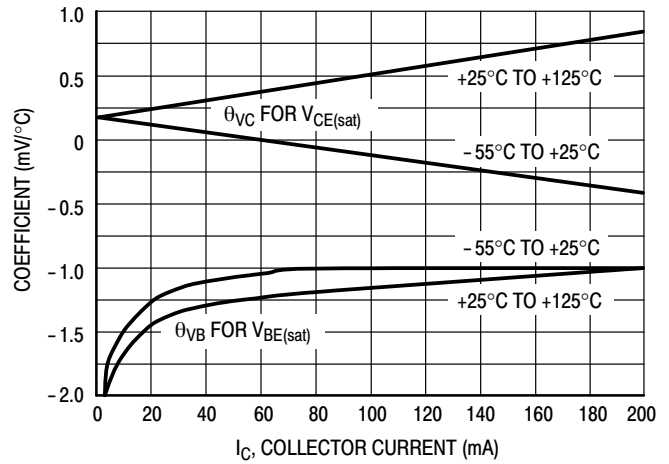
**Figure 18. Temperature Coefficients**

## TYPICAL STATIC CHARACTERISTICS
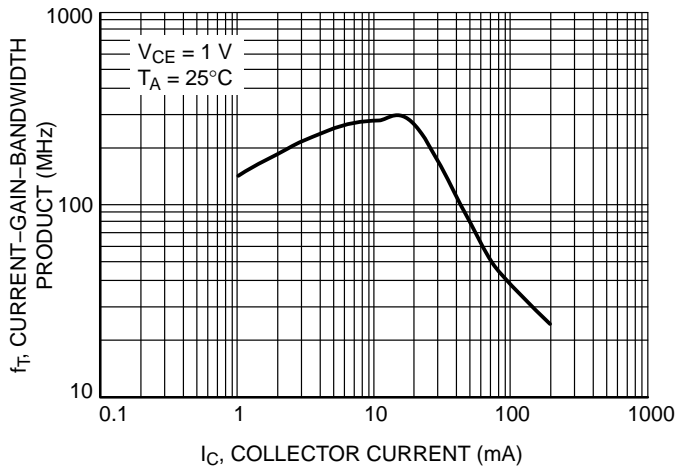


Figure 19. Current Gain Bandwidth Product
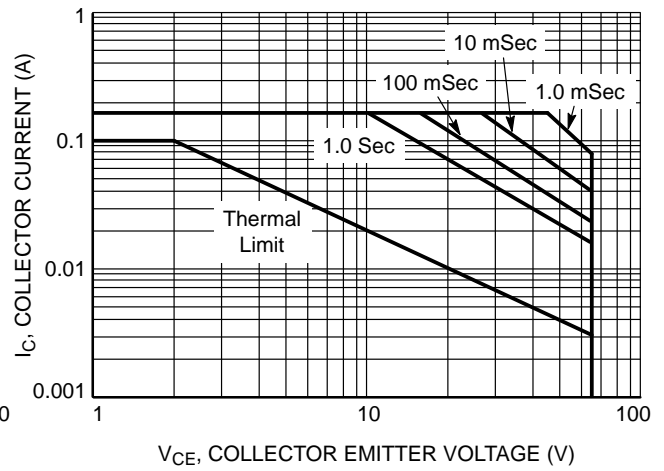


Figure 20. Safe Operating Area

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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

DATE 11 DEC 2012

1
SCALE 2:1



**TOP VIEW**

**DETAIL A**

**SIDE VIEW**

**END VIEW**

**SEATING PLANE**

**GAGE PLANE**

2X 3 TIPS
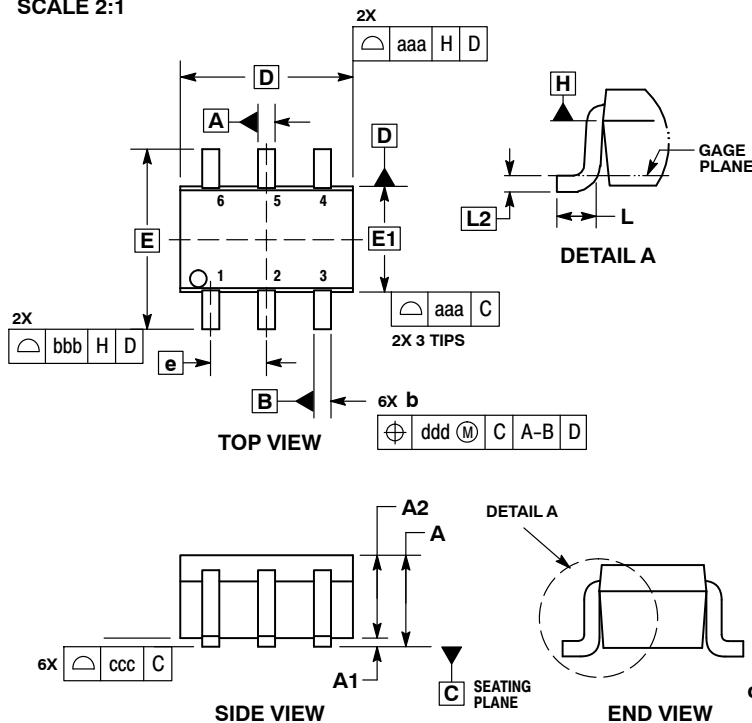
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF DIMENSION b AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

| DIM | MILLIMETERS | | | INCHES | | |
|-----|-----|-----|-----|-----|-----|-----|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | --- | --- | 1.10 | --- | --- | 0.043 |
| A1 | 0.00 | --- | 0.10 | 0.000 | --- | 0.004 |
| A2 | 0.70 | 0.90 | 1.00 | 0.027 | 0.035 | 0.039 |
| b | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| C | 0.08 | 0.15 | 0.22 | 0.003 | 0.006 | 0.009 |
| D | 1.80 | 2.00 | 2.20 | 0.070 | 0.078 | 0.086 |
| E | 2.00 | 2.10 | 2.20 | 0.078 | 0.082 | 0.086 |
| E1 | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| L | 0.26 | 0.36 | 0.46 | 0.010 | 0.014 | 0.018 |
| L2 | 0.15 BSC | | | 0.006 BSC | | |
| aaa | 0.15 | | | 0.006 | | |
| bbb | 0.30 | | | 0.012 | | |
| ccc | 0.10 | | | 0.004 | | |
| ddd | 0.10 | | | 0.004 | | |

## RECOMMENDED SOLDERING FOOTPRINT*

6X
0.30

6X
0.66

2.50

0.65
PITCH

DIMENSIONS: MILLIMETERS

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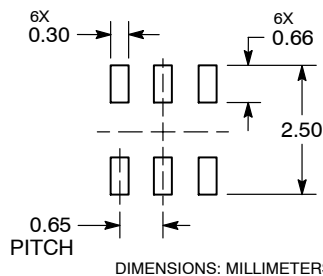
## GENERIC MARKING DIAGRAM*

6

XXXM▪

1

XXX = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

## STYLES ON PAGE 2

# SC−88/SC70−6/SOT−363
## CASE 419B−02
## ISSUE Y

DATE 11 DEC 2012

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

STYLE 2:
CANCELLED

STYLE 3:
CANCELLED

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

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

STYLE 6:
PIN 1. ANODE 2
2. N/C
3. CATHODE 1
4. ANODE 1
5. N/C
6. CATHODE 2

STYLE 7:
PIN 1. SOURCE 2
2. DRAIN 2
3. GATE 1
4. SOURCE 1
5. DRAIN 1
6. GATE 2

STYLE 8:
CANCELLED

STYLE 9:
PIN 1. EMITTER 2
2. EMITTER 1
3. COLLECTOR 1
4. BASE 1
5. BASE 2
6. COLLECTOR 2

STYLE 10:
PIN 1. SOURCE 2
2. SOURCE 1
3. GATE 1
4. DRAIN 1
5. DRAIN 2
6. GATE 2

STYLE 11:
PIN 1. CATHODE 2
2. CATHODE 2
3. ANODE 1
4. CATHODE 1
5. CATHODE 1
6. ANODE 2

STYLE 12:
PIN 1. ANODE 2
2. ANODE 2
3. CATHODE 1
4. ANODE 1
5. ANODE 1
6. CATHODE 2

STYLE 13:
PIN 1. ANODE
2. N/C
3. COLLECTOR
4. EMITTER
5. BASE
6. CATHODE

STYLE 14:
PIN 1. VREF
2. GND
3. GND
4. IOUT
5. VEN
6. VCC

STYLE 15:
PIN 1. ANODE 1
2. ANODE 2
3. ANODE 3
4. CATHODE 3
5. CATHODE 2
6. CATHODE 1

STYLE 16:
PIN 1. BASE 1
2. EMITTER 2
3. COLLECTOR 2
4. BASE 2
5. EMITTER 1
6. COLLECTOR 1

STYLE 17:
PIN 1. BASE 1
2. EMITTER 1
3. COLLECTOR 2
4. BASE 2
5. EMITTER 2
6. COLLECTOR 1

STYLE 18:
PIN 1. VIN1
2. VCC
3. VOUT2
4. VIN2
5. GND
6. VOUT1

STYLE 19:
PIN 1. I OUT
2. GND
3. GND
4. V CC
5. V EN
6. V REF

STYLE 20:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. EMITTER
5. COLLECTOR
6. COLLECTOR

STYLE 21:
PIN 1. ANODE 1
2. N/C
3. ANODE 2
4. CATHODE 2
5. N/C
6. CATHODE 1

STYLE 22:
PIN 1. D1 (i)
2. GND
3. D2 (i)
4. D2 (c)
5. VBUS
6. D1 (c)

STYLE 23:
PIN 1. Vn
2. CH1
3. Vp
4. N/C
5. CH2
6. N/C

STYLE 24:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE

STYLE 25:
PIN 1. BASE 1
2. CATHODE
3. COLLECTOR 2
4. BASE 2
5. EMITTER
6. COLLECTOR 1

STYLE 26:
PIN 1. SOURCE 1
2. GATE 1
3. DRAIN 2
4. SOURCE 2
5. GATE 2
6. DRAIN 1

STYLE 27:
PIN 1. BASE 2
2. BASE 1
3. COLLECTOR 1
4. EMITTER 1
5. EMITTER 2
6. COLLECTOR 2

STYLE 28:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. SOURCE
5. DRAIN
6. DRAIN

STYLE 29:
PIN 1. ANODE
2. ANODE
3. COLLECTOR
4. EMITTER
5. BASE/ANODE
6. CATHODE

STYLE 30:
PIN 1. SOURCE 1
2. DRAIN 2
3. DRAIN 2
4. SOURCE 2
5. GATE 1
6. DRAIN 1

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

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|---|---|---|---|
| DESCRIPTION: | SC−88/SC70−6/SOT−363 | | PAGE 2 OF 2 |

## PUBLICATION ORDERING INFORMATION

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