MBT3946DW1T1G, SMBT3946DW1T1G

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
- AEC−Q101 Qualified and PPAP Capable
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant*

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.

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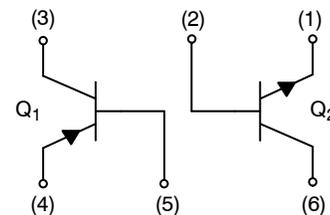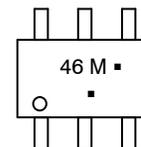
ON Semiconductor®

http://onsemi.com

SOT−363/SC−88
CASE 419B
STYLE 1

MBT3946DW1T1*
*Q1 PNP
Q2 NPN

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)	3,000 / Tape & Reel
SMBT3946DW1T1G	SC−88 (Pb−Free)	3,000 / Tape & Reel
MBT3946DW1T2G	SC−88 (Pb−Free)	3,000 / 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.

MBT3946DW1T1G, SMBT3946DW1T1G

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

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

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

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

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

SWITCHING CHARACTERISTICS

			Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = −0.5 Vdc) (V_{CC} = −3.0 Vdc, V_{BE} = 0.5 Vdc)	(NPN) (PNP)	t_d	– –	35 35	ns
Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc) (I_C = −10 mAdc, I_{B1} = −1.0 mAdc)	(NPN) (PNP)	t_r	– –	35 35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc) (V_{CC} = −3.0 Vdc, I_C = −10 mAdc)	(NPN) (PNP)	t_s	– –	200 225	ns
Fall Time	(I_{B1} = I_{B2} = 1.0 mAdc) (I_{B1} = I_{B2} = −1.0 mAdc)	(NPN) (PNP)	t_f	– –	50 75	

(NPN)

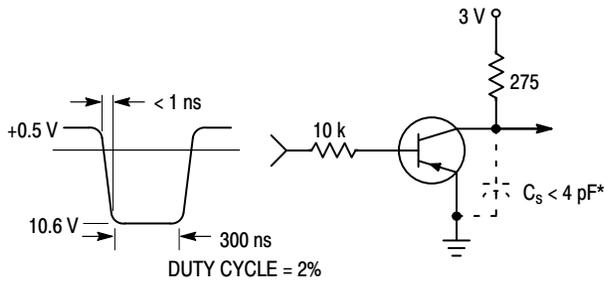

* Total shunt capacitance of test jig and connectors
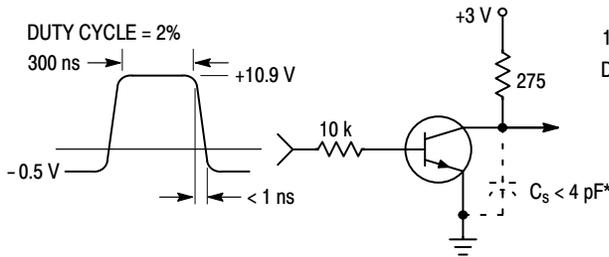
Figure 1. Delay and Rise Time Equivalent Test Circuit
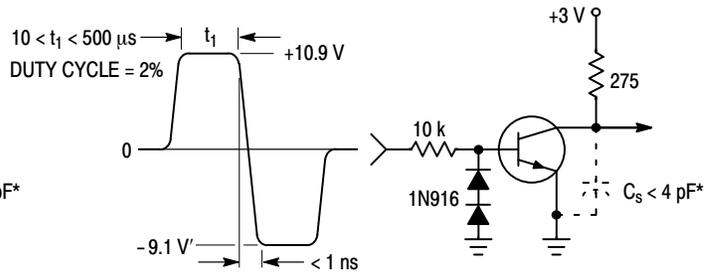
Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

Figure 3. Capacitance
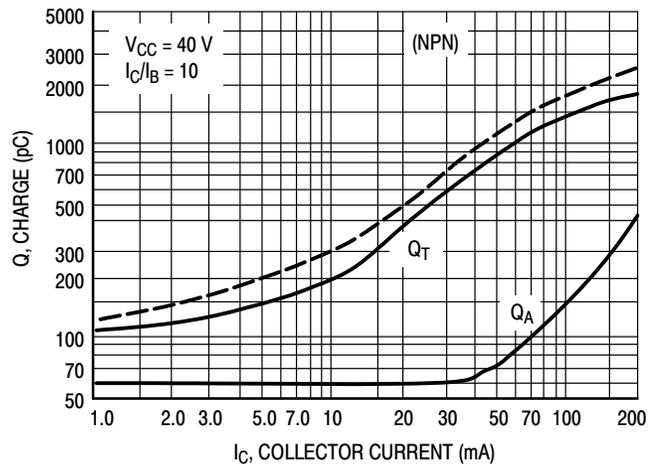
Figure 4. Charge Data

(NPN)
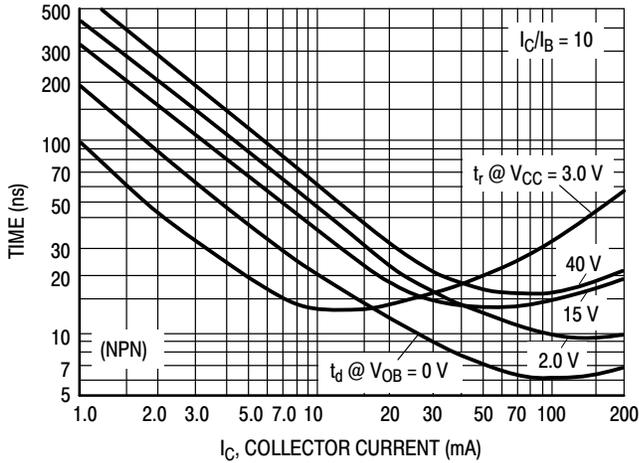
Figure 5. Turn–On Time
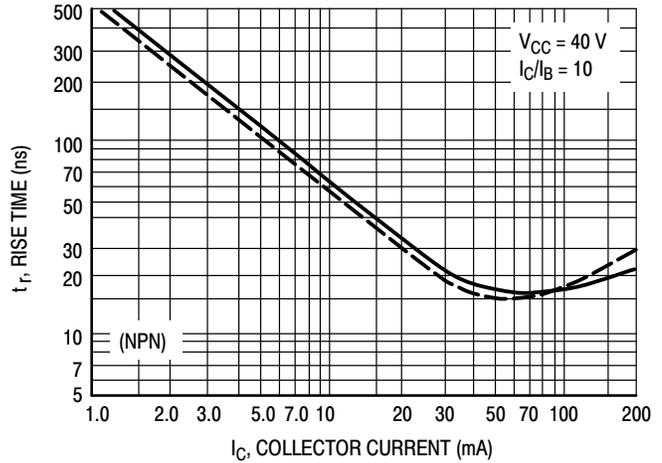
Figure 6. Rise Time
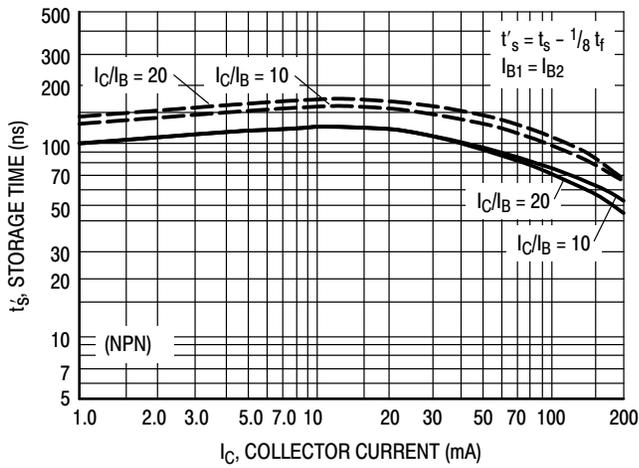
Figure 7. Storage Time
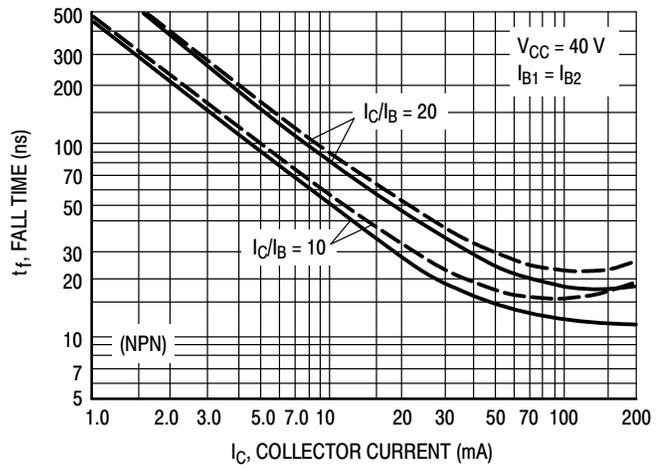
Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)
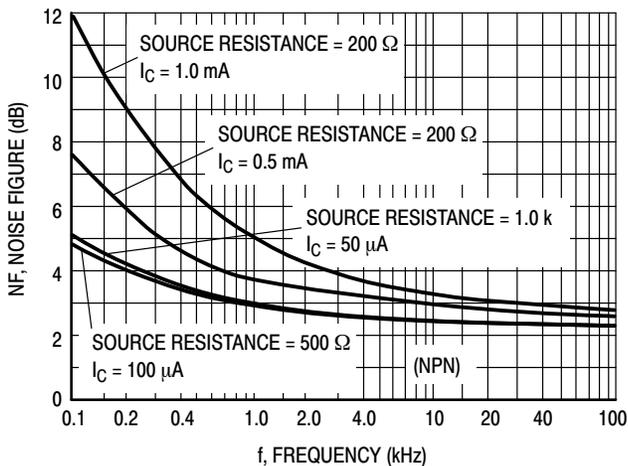
Figure 9. Noise Figure
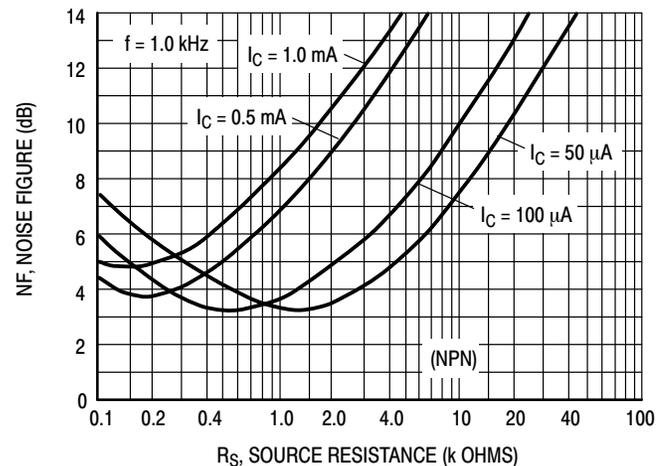
Figure 10. Noise Figure

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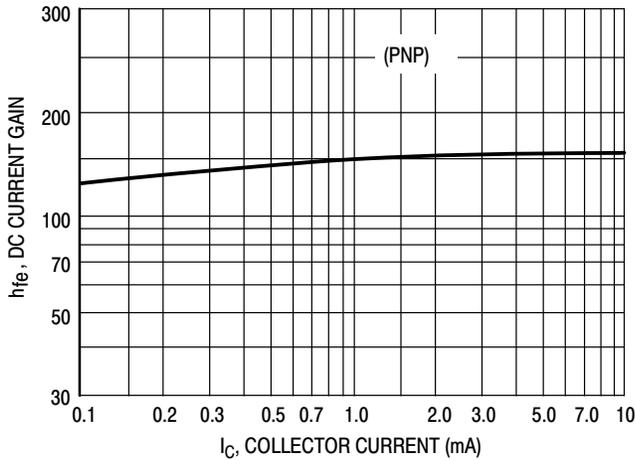(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)
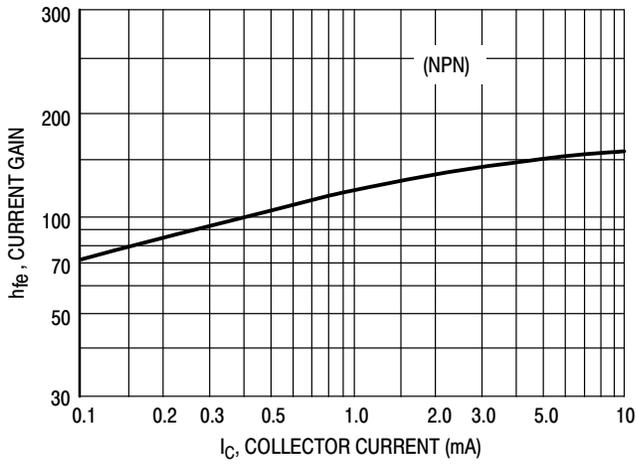
Figure 11. Current Gain
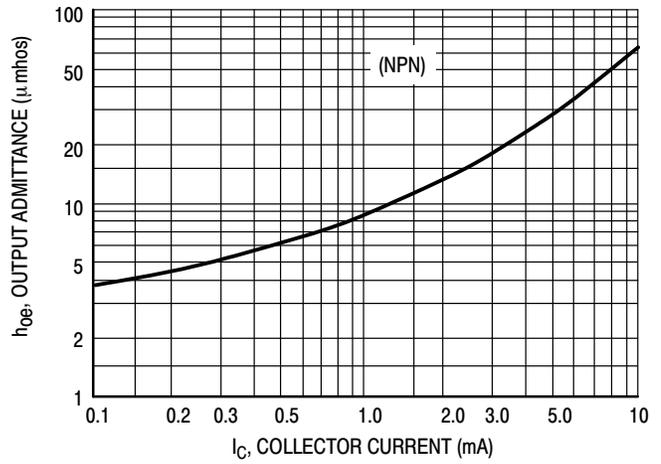
Figure 12. Output Admittance
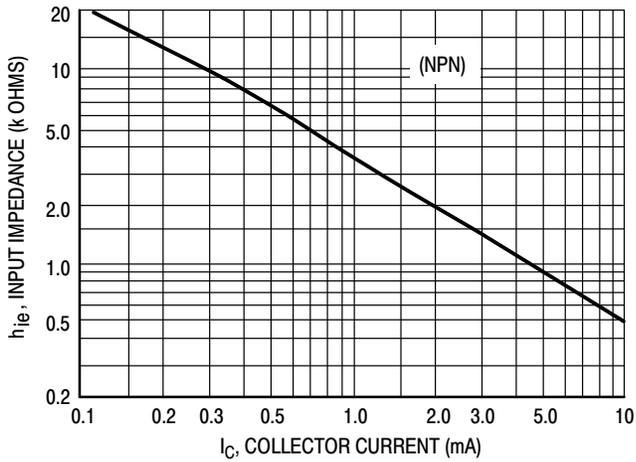
Figure 13. Input Impedance
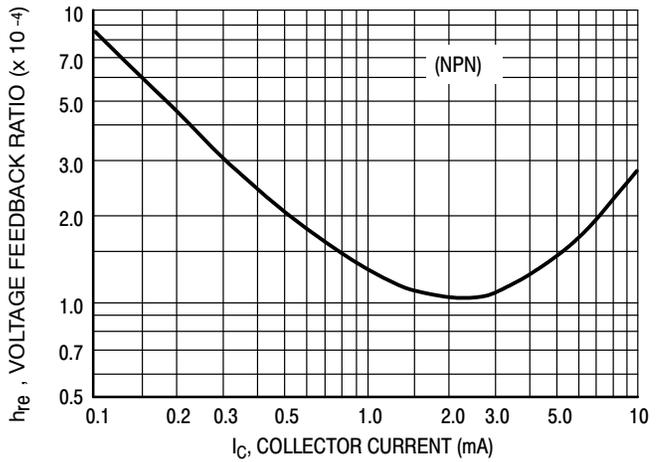
Figure 14. Voltage Feedback Ratio

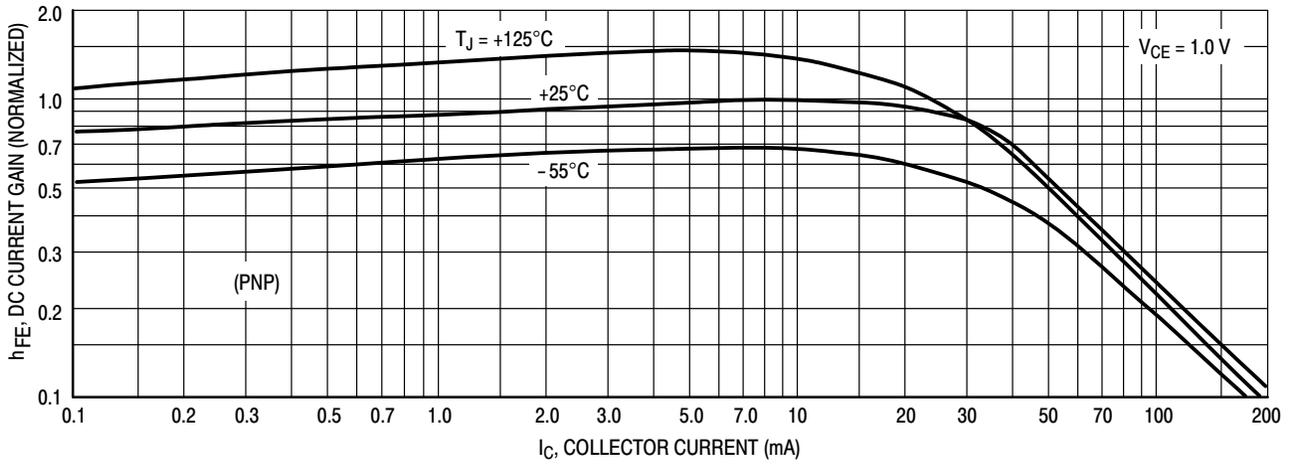## (NPN)
## TYPICAL STATIC CHARACTERISTICS

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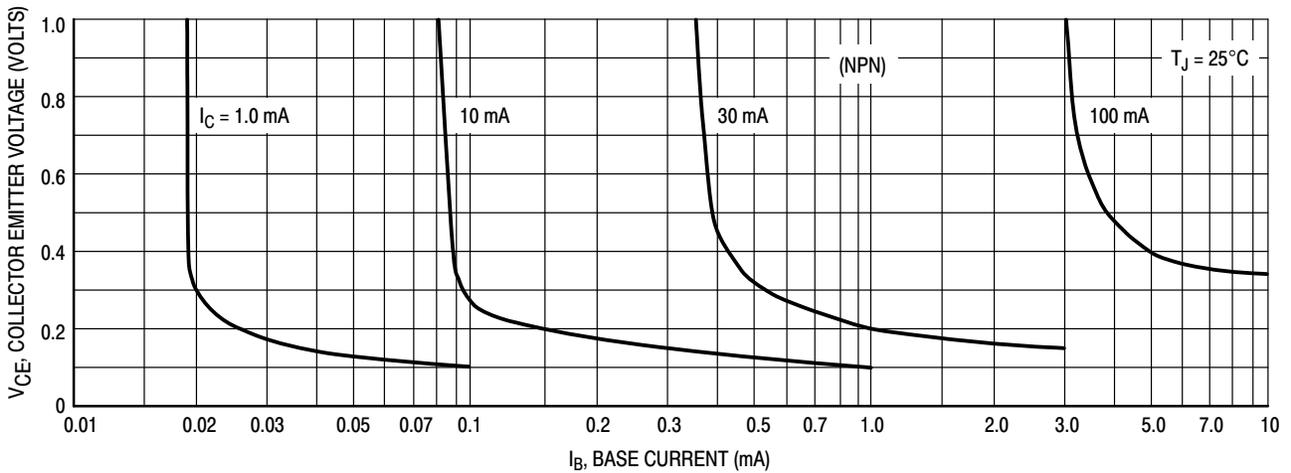
Figure 16. Collector Saturation Region
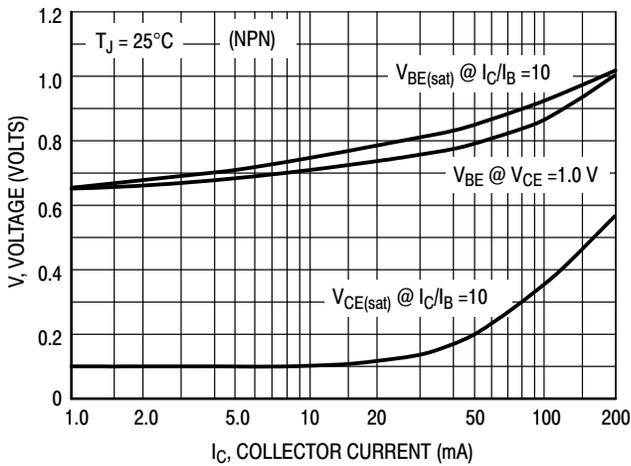
**Figure 17. "ON" Voltages**
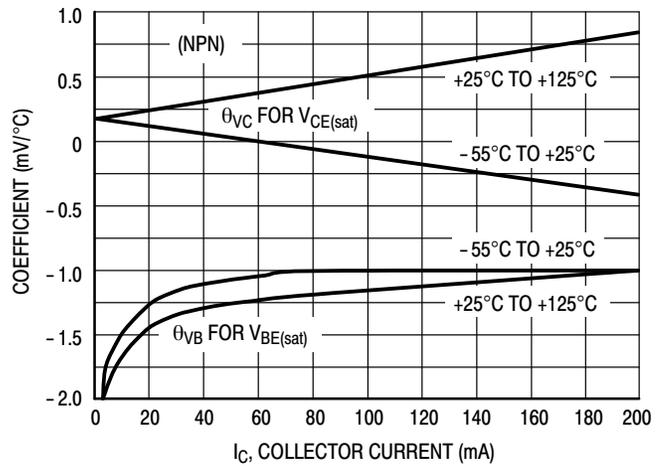
Figure 18. Temperature Coefficients

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(PNP)

* Total shunt capacitance of test jig and connectors

Figure 19. Delay and Rise Time Equivalent Test Circuit
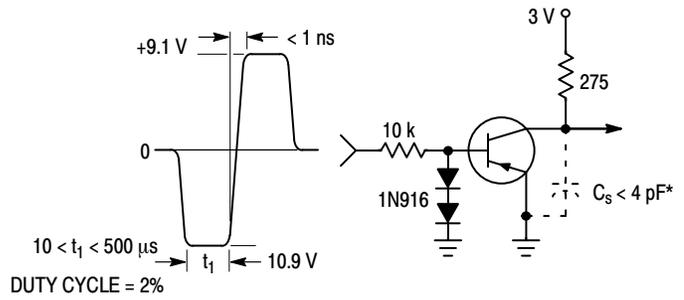
Figure 20. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

$T_J = 25°C$
$T_J = 125°C$
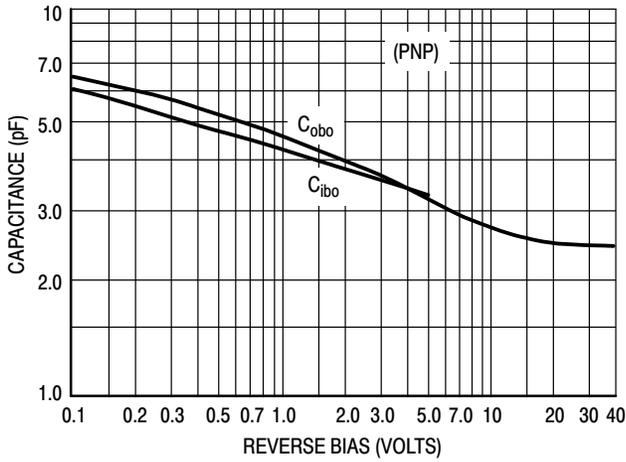
Figure 21. Capacitance
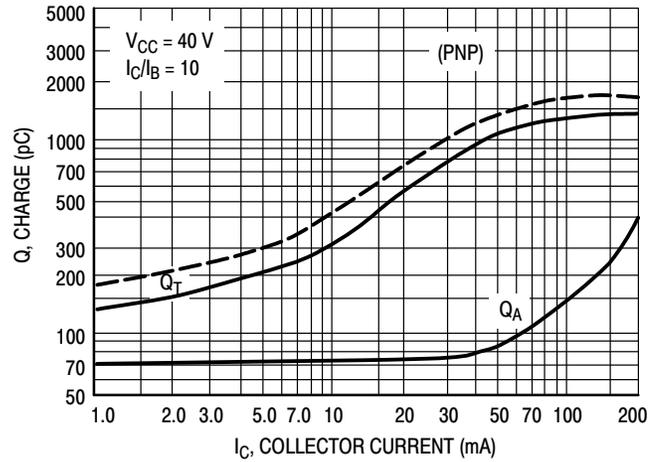
Figure 22. Charge Data
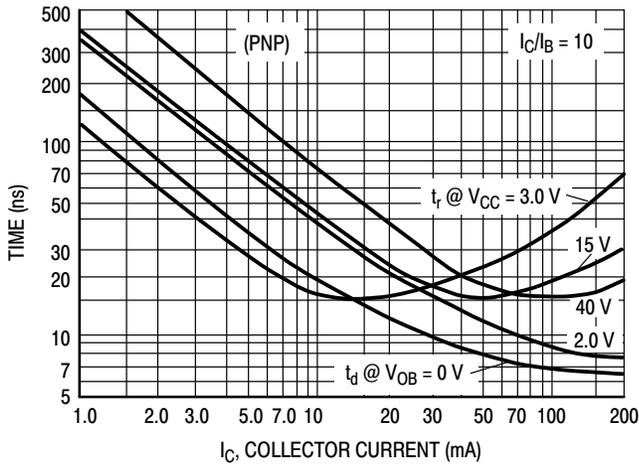
Figure 23. Turn–On Time
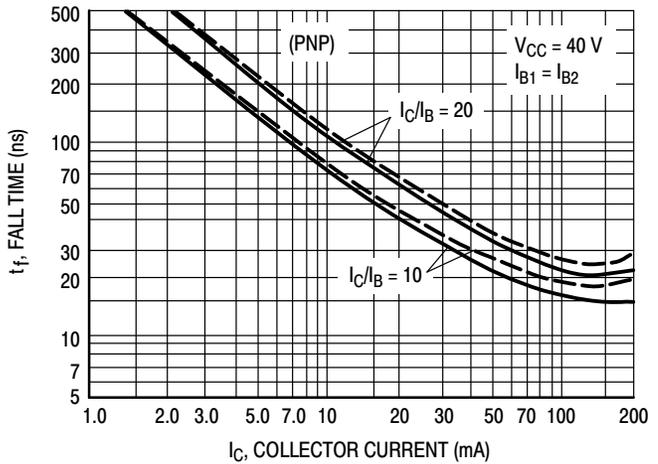
Figure 24. Fall Time

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS
(V_{CE} = − 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)
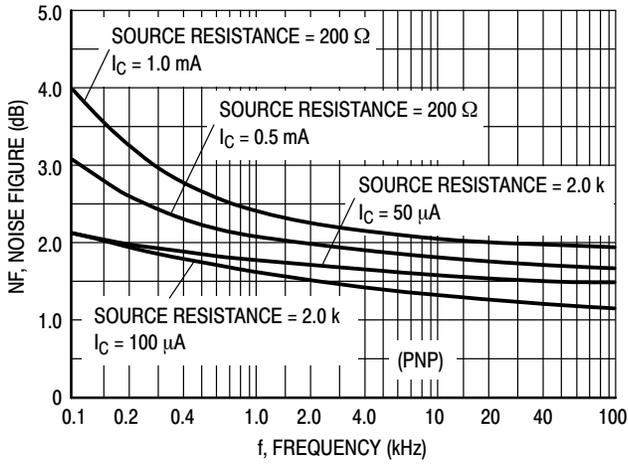
Figure 25.
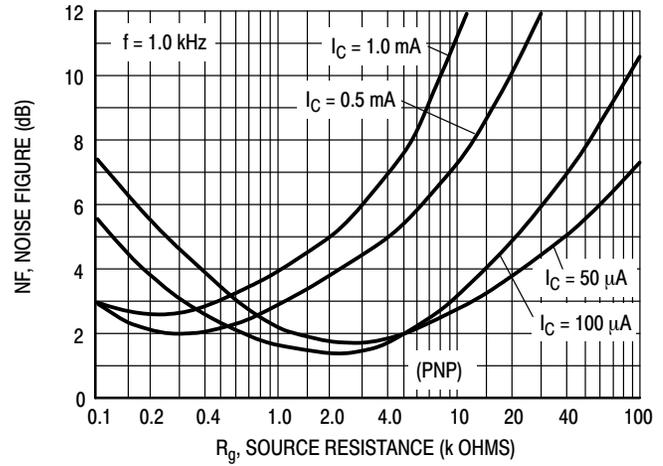
Figure 26.

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

Figure 27. Current Gain
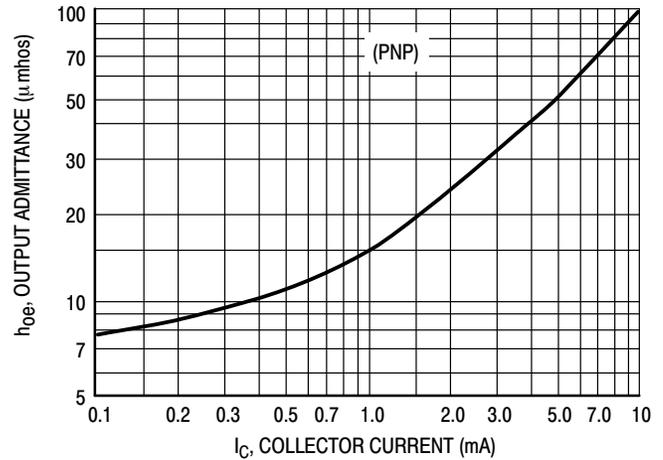
Figure 28. Output Admittance
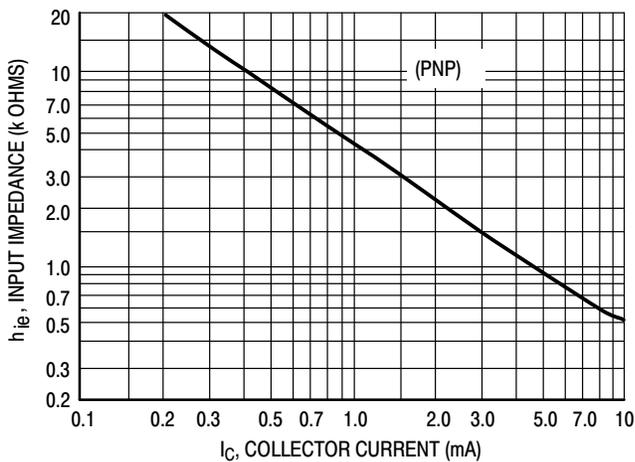
Figure 29. Input Impedance
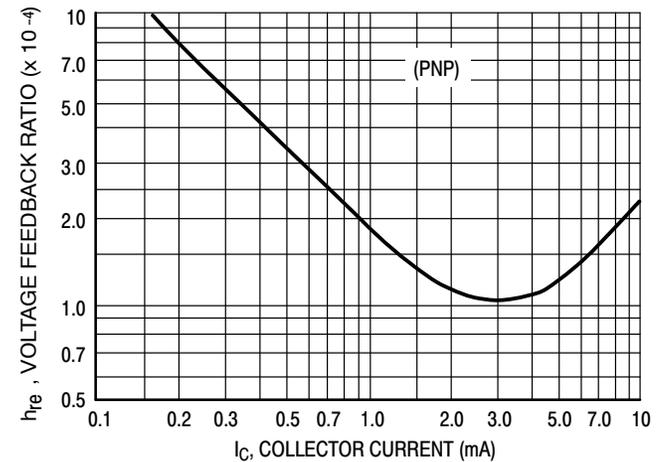
Figure 30. Voltage Feedback Ratio

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

TYPICAL STATIC CHARACTERISTICS

Figure 31. DC Current Gain
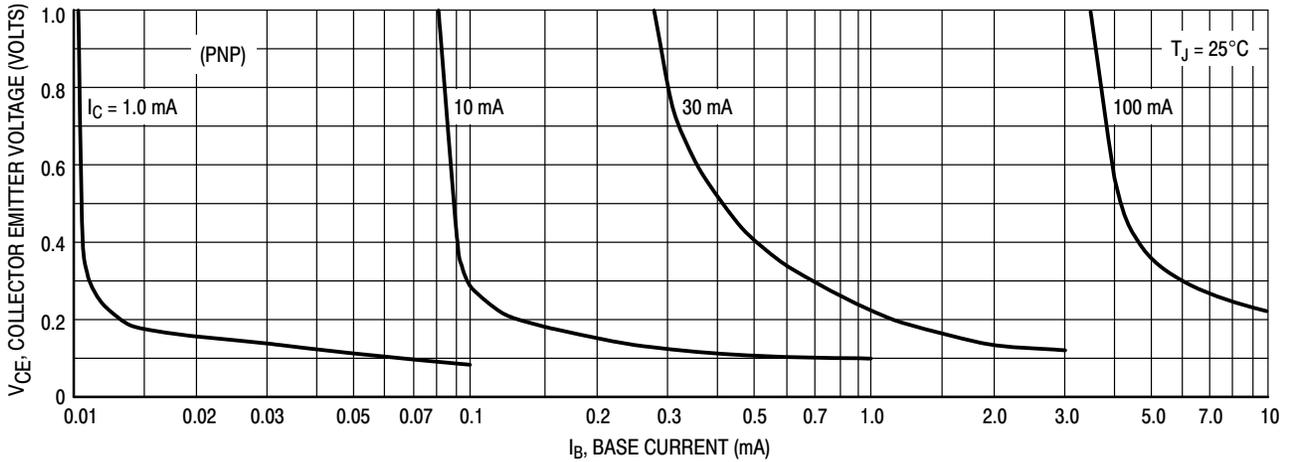
Figure 32. Collector Saturation Region
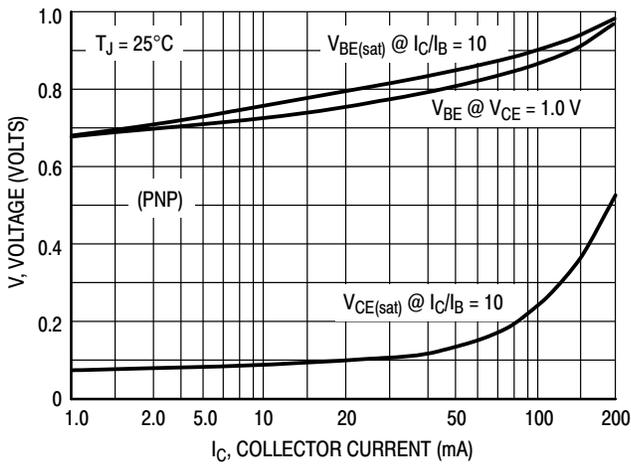
Figure 33. "ON" Voltages
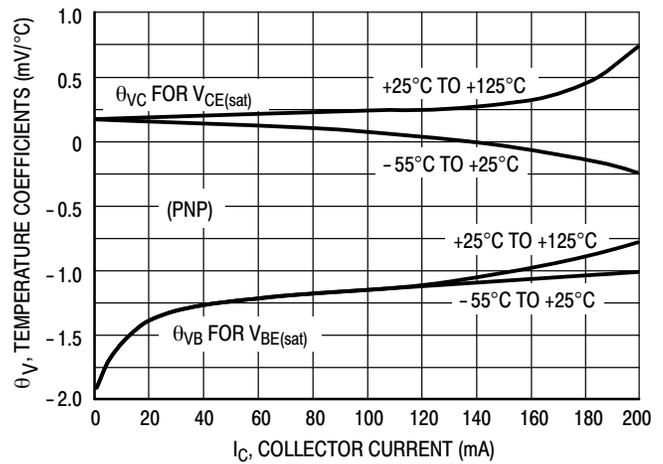
Figure 34. Temperature Coefficients

PACKAGE DIMENSIONS

SC−88/SC70−6/SOT−363
CASE 419B−02
ISSUE W
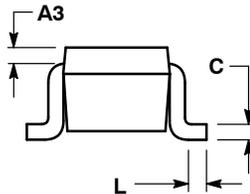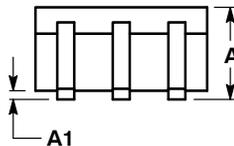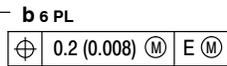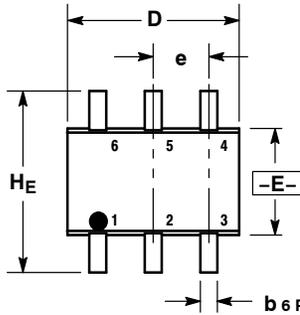
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419B−01 OBSOLETE, NEW STANDARD 419B−02.

DIM	MILLIMETERS			INCHES		
	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

⊕ | 0.2 (0.008) Ⓜ | E Ⓜ

SOLDERING FOOTPRINT*

0.50 / 0.0197
0.65 / 0.025
0.65 / 0.025
0.40 / 0.0157
1.9 / 0.0748

SCALE 20:1 $\left(\dfrac{mm}{inches}\right)$

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