

# 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  $V_{CE(sat)}$ ,  $\leq 0.4$  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) $T_A = 25^\circ\text{C}$	$P_D$	150	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	833	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature Range	$T_J, T_{stg}$	–55 to +150	$^\circ\text{C}$

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.

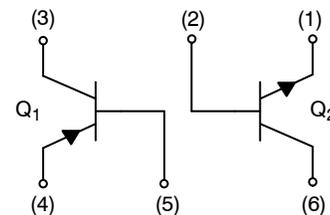


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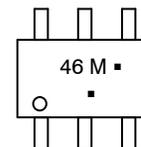
SOT-363/SC-88  
CASE 419B  
STYLE 1



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, SMT3946DW1T1G

## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

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

2. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ ; Duty Cycle  $\leq 2.0\%$ .

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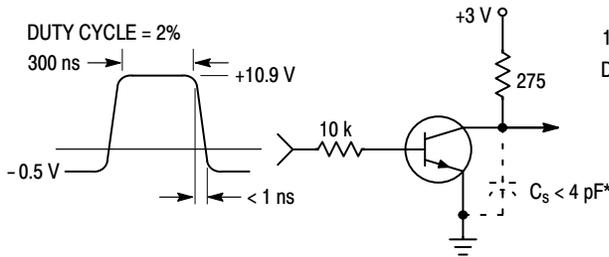
## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
Output Admittance ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -10\text{ Vdc}$ , $I_C = -1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )	$h_{oe}$ (NPN) (PNP)	1.0 3.0	40 60	$\mu\text{mhos}$
Noise Figure ( $V_{CE} = 5.0\text{ Vdc}$ , $I_C = 100\ \mu\text{A}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -5.0\text{ Vdc}$ , $I_C = -100\ \mu\text{A}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )	NF (NPN) (PNP)	- -	5.0 4.0	dB

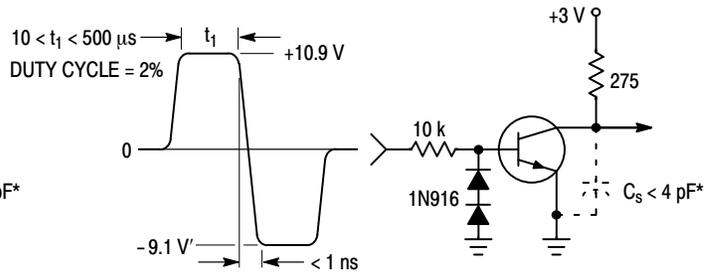
## SWITCHING CHARACTERISTICS

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

### (NPN)



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

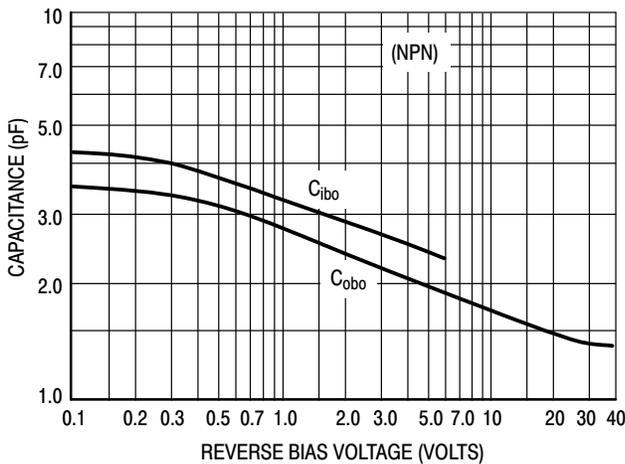


**Figure 2. Storage and Fall Time Equivalent Test Circuit**

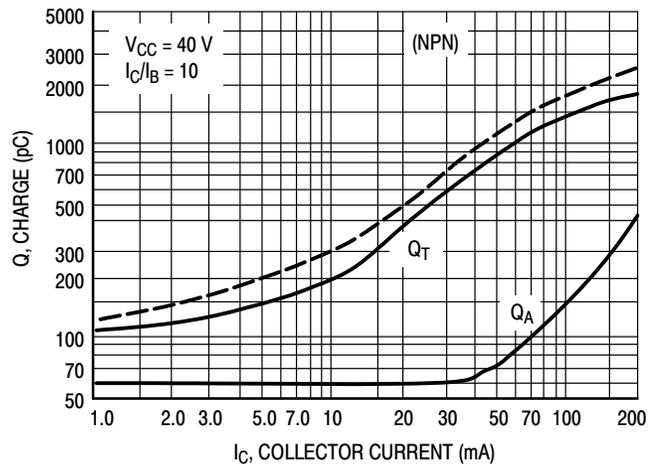
\* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

—  $T_J = 25^\circ\text{C}$   
 - - -  $T_J = 125^\circ\text{C}$



**Figure 3. Capacitance**



**Figure 4. Charge Data**

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(NPN)

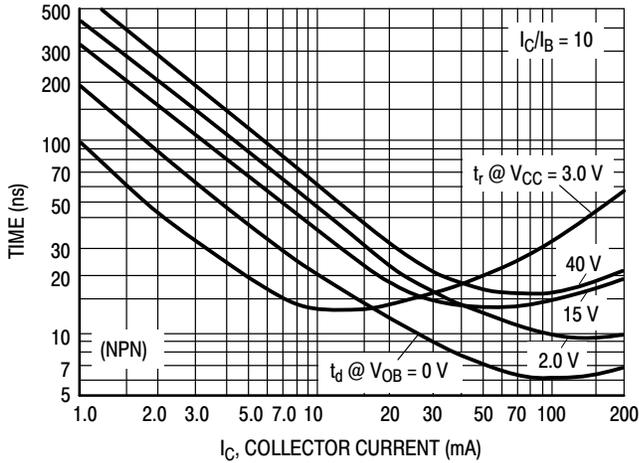


Figure 5. Turn-On Time

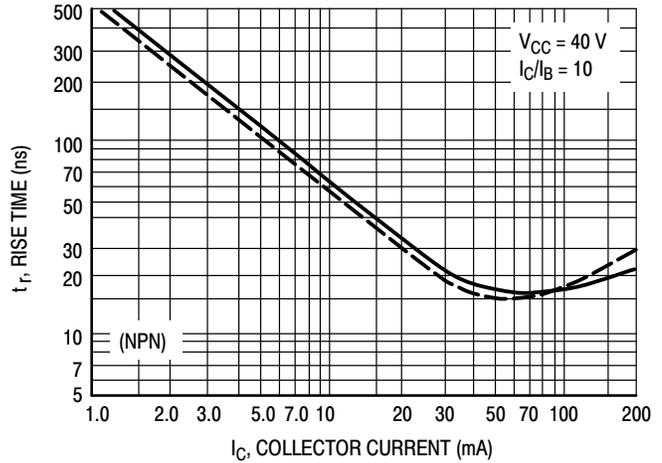


Figure 6. Rise Time

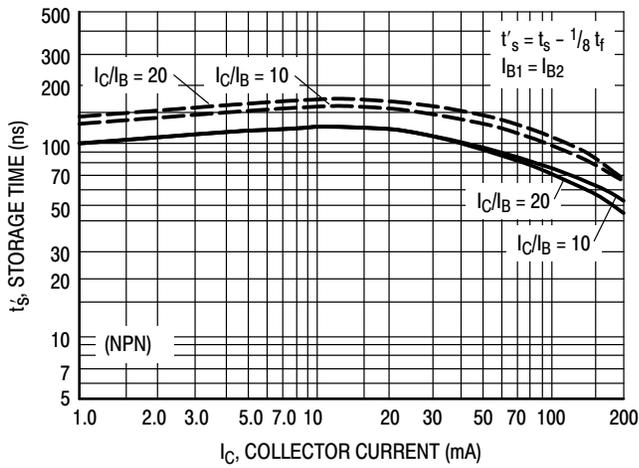


Figure 7. Storage Time

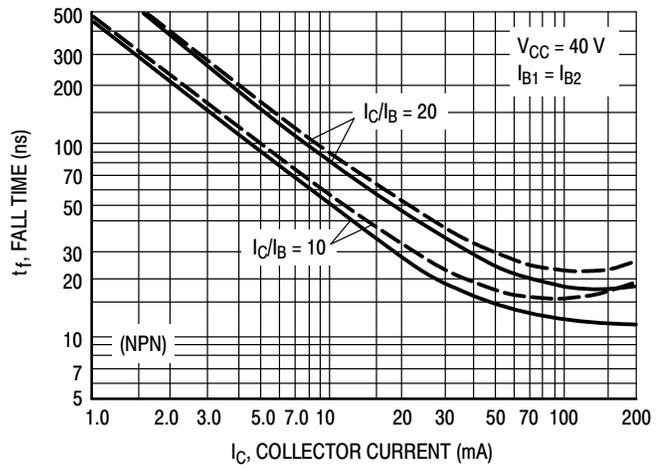


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

( $V_{CE} = 5.0$  Vdc,  $T_A = 25^\circ\text{C}$ , Bandwidth = 1.0 Hz)

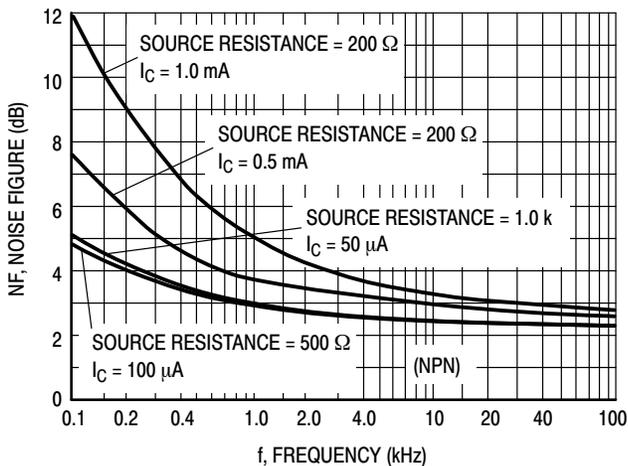


Figure 9. Noise Figure

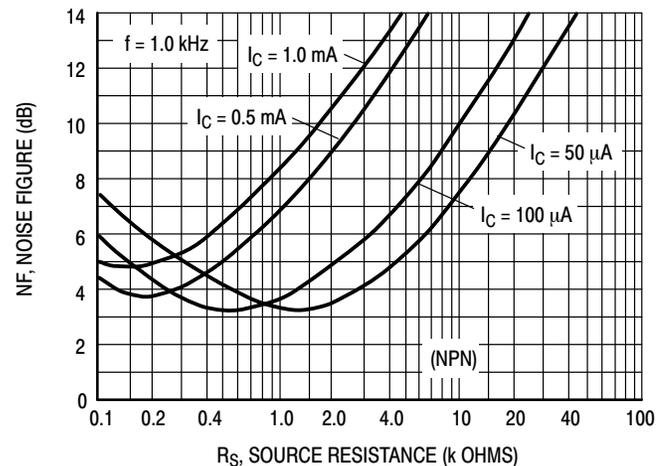


Figure 10. Noise Figure

# MBT3946DW1T1G, SMBT3946DW1T1G

## (NPN) h PARAMETERS

( $V_{CE} = 10 \text{ Vdc}$ ,  $f = 1.0 \text{ kHz}$ ,  $T_A = 25^\circ\text{C}$ )

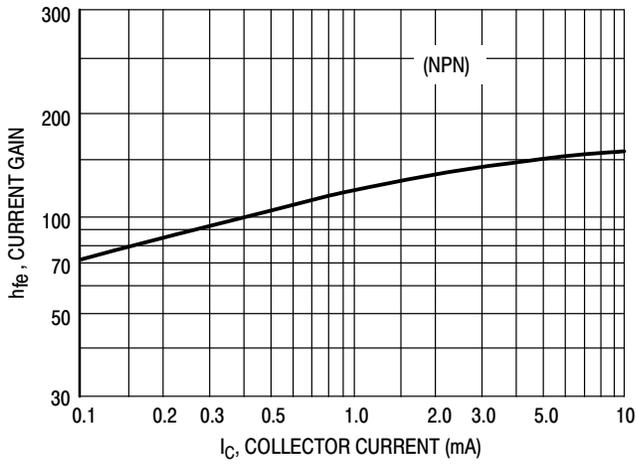


Figure 11. Current Gain

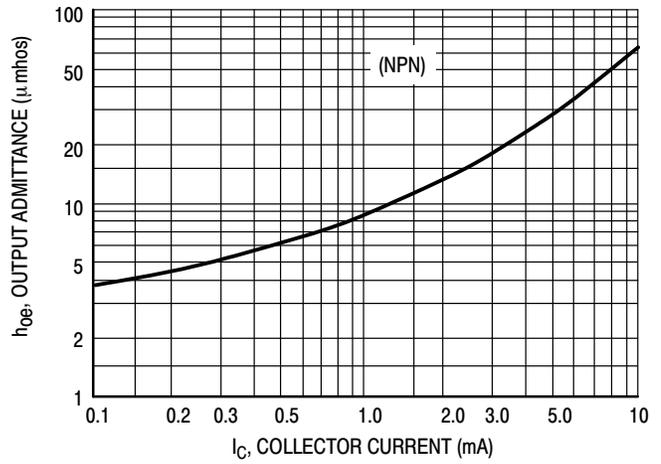


Figure 12. Output Admittance

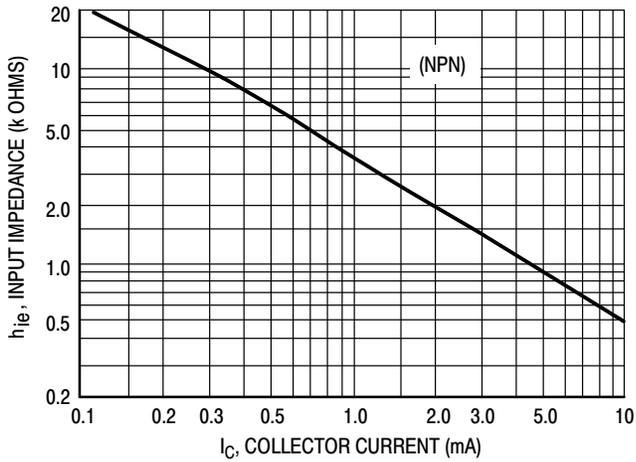


Figure 13. Input Impedance

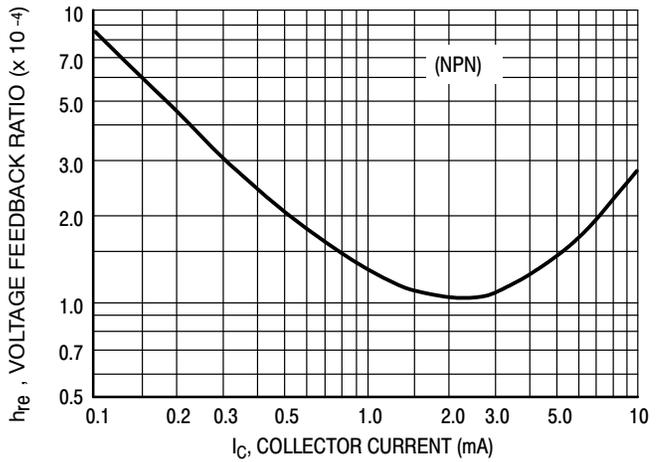


Figure 14. Voltage Feedback Ratio

# MBT3946DW1T1G, SMBT3946DW1T1G

## (NPN) TYPICAL STATIC CHARACTERISTICS

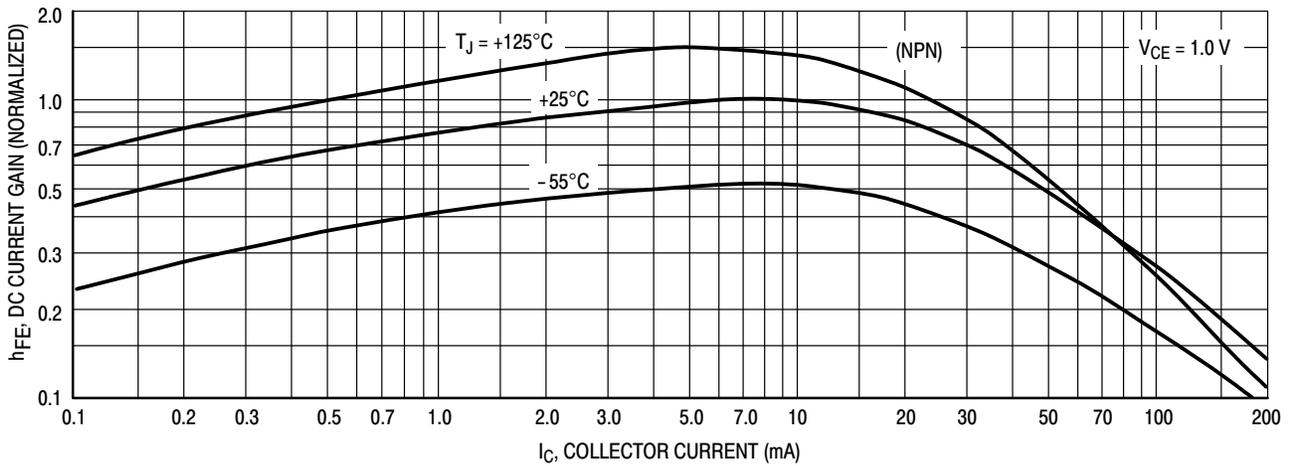


Figure 15. DC Current Gain

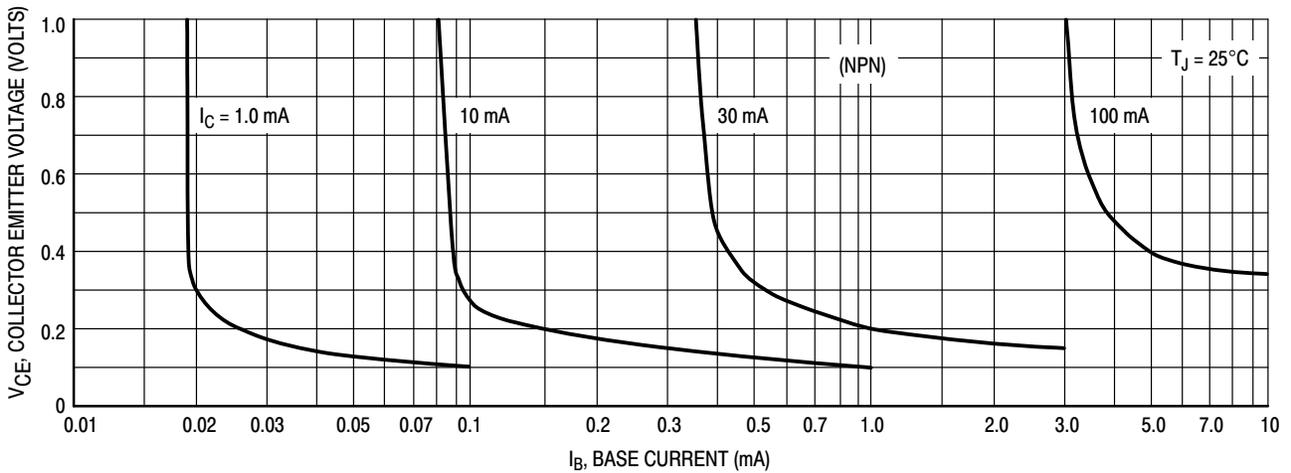


Figure 16. Collector Saturation Region

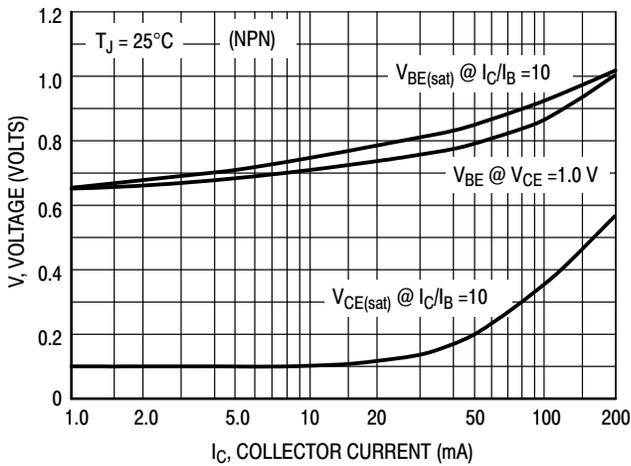


Figure 17. "ON" Voltages

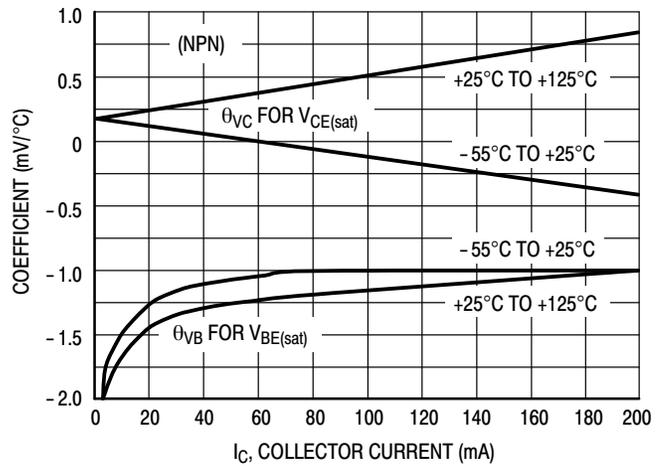


Figure 18. Temperature Coefficients

# MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

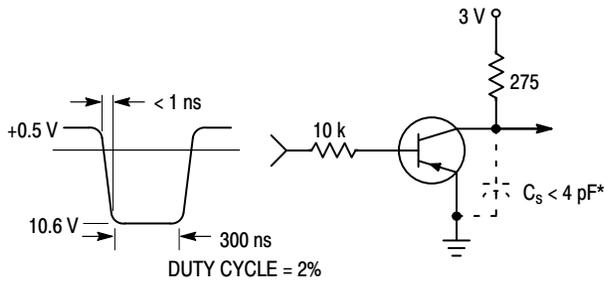


Figure 19. Delay and Rise Time Equivalent Test Circuit

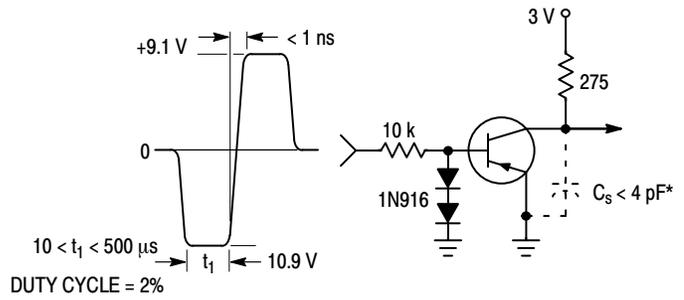


Figure 20. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

—  $T_J = 25^\circ\text{C}$   
 - - -  $T_J = 125^\circ\text{C}$

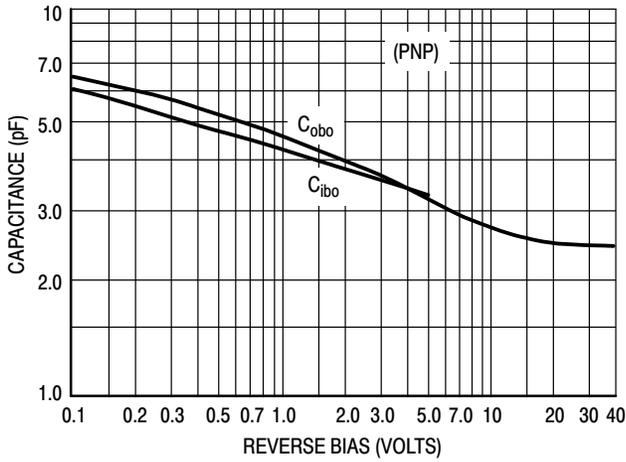


Figure 21. Capacitance

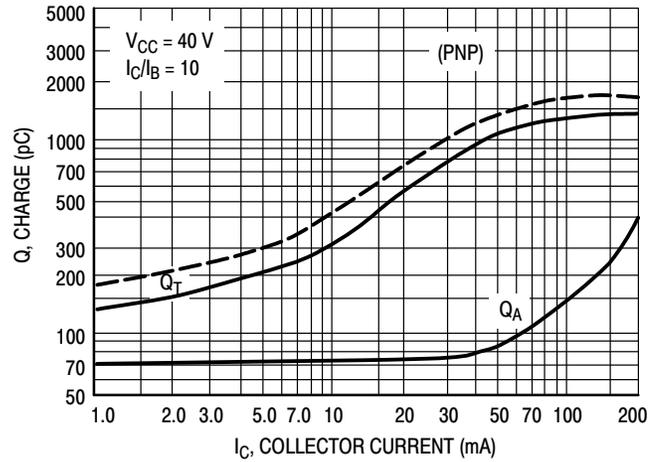


Figure 22. Charge Data

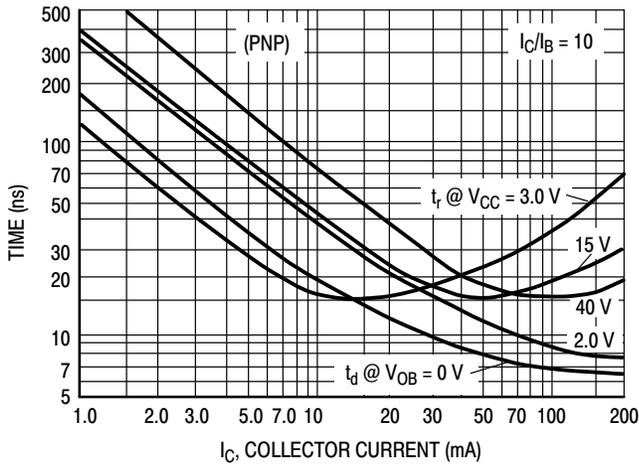


Figure 23. Turn-On Time

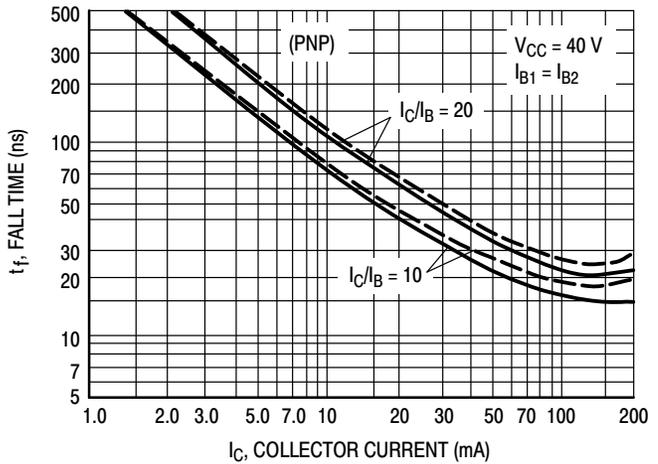


Figure 24. Fall Time

# MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

( $V_{CE} = -5.0$  Vdc,  $T_A = 25^\circ\text{C}$ , Bandwidth = 1.0 Hz)

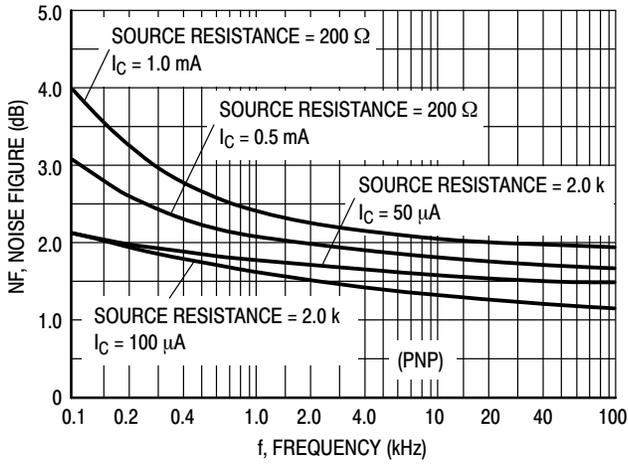


Figure 25.

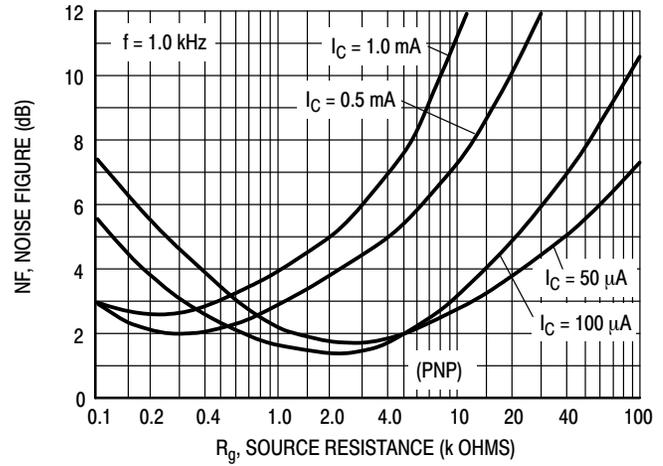


Figure 26.

## h PARAMETERS

( $V_{CE} = -10$  Vdc,  $f = 1.0$  kHz,  $T_A = 25^\circ\text{C}$ )

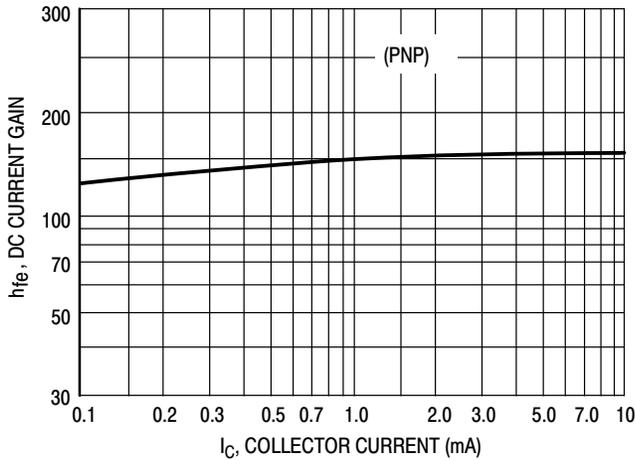


Figure 27. Current Gain

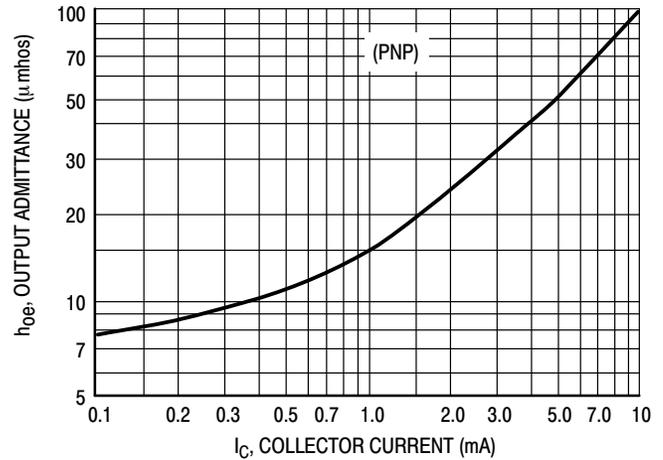


Figure 28. Output Admittance

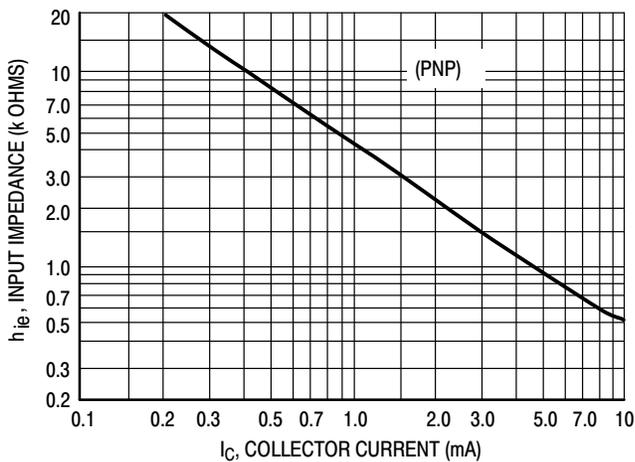


Figure 29. Input Impedance

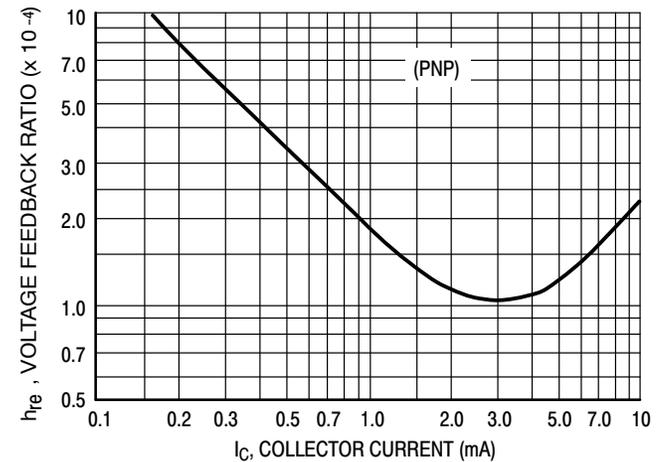


Figure 30. Voltage Feedback Ratio

# MBT3946DW1T1G, SMT3946DW1T1G

(PNP)

## TYPICAL STATIC CHARACTERISTICS

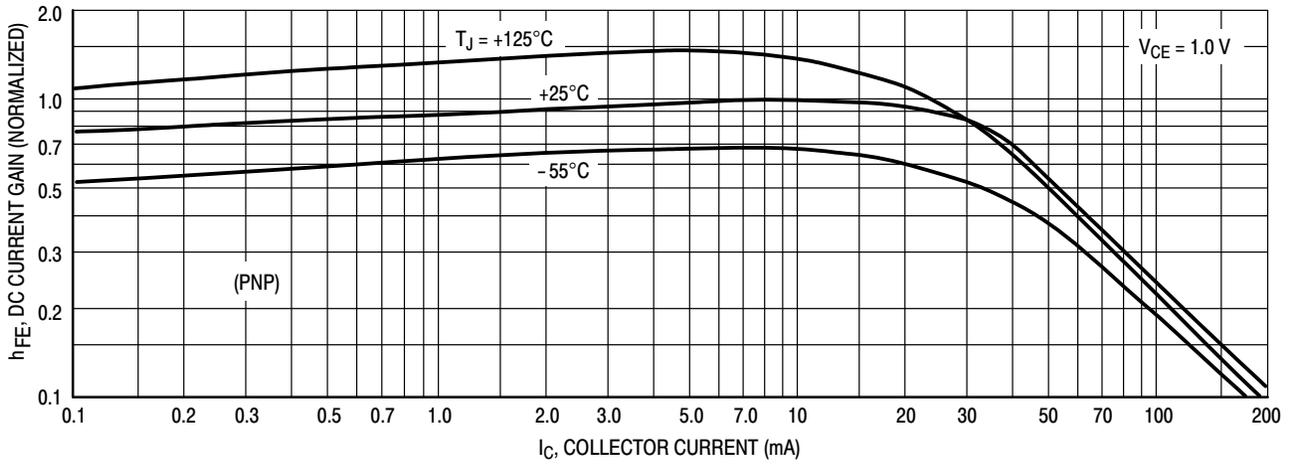


Figure 31. DC Current Gain

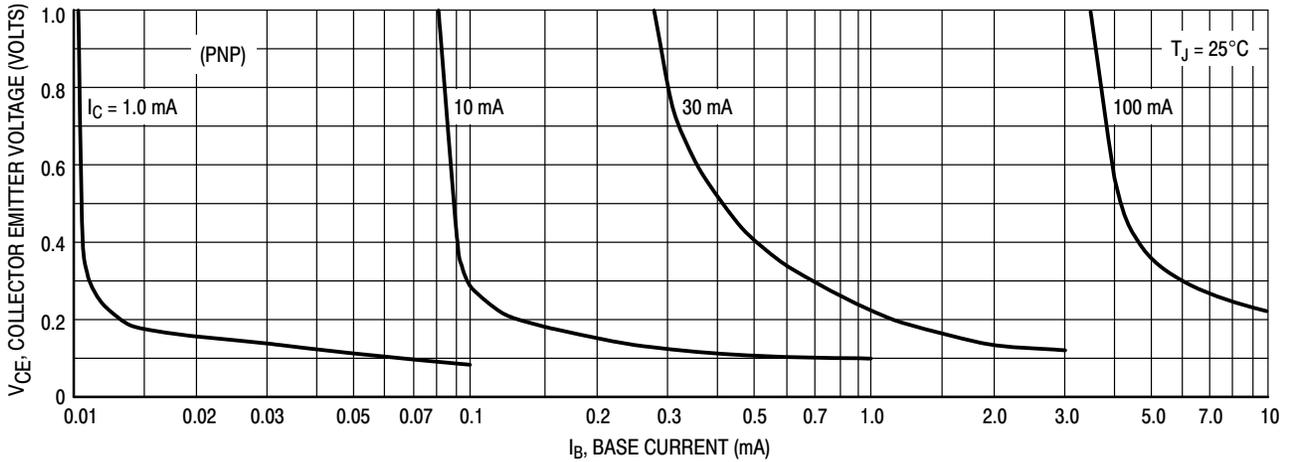


Figure 32. Collector Saturation Region

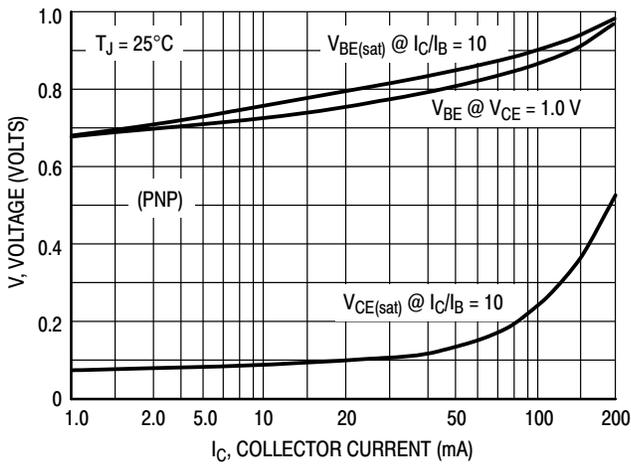


Figure 33. "ON" Voltages

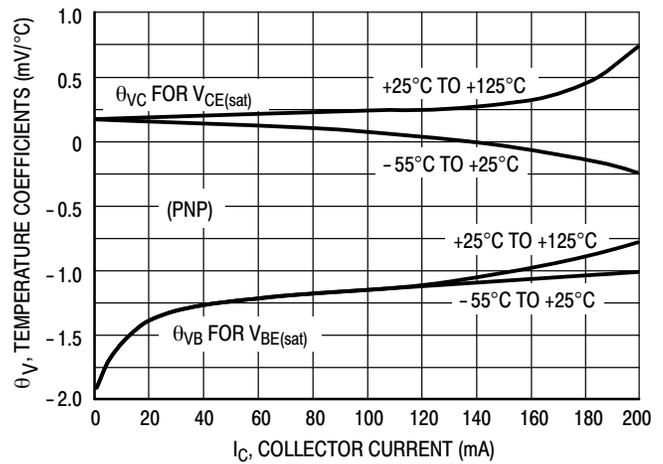
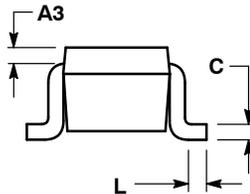
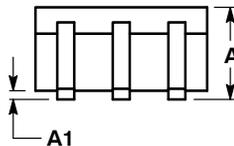
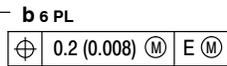
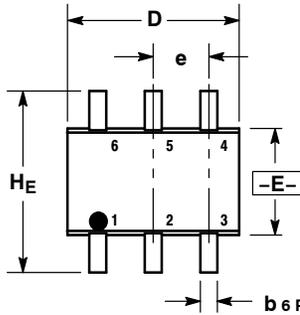


Figure 34. Temperature Coefficients

# MBT3946DW1T1G, SMT3946DW1T1G

## PACKAGE DIMENSIONS

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



NOTES:

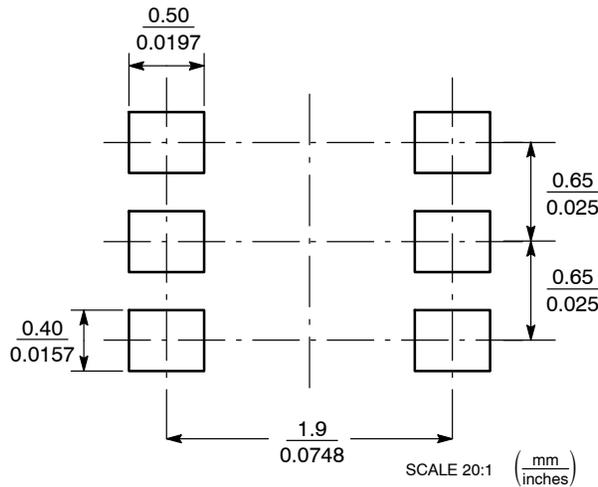
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419B-01 OBSOLETE, NEW STANDARD 419B-02.

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
HE	2.00	2.10	2.20	0.078	0.082	0.086

STYLE 1:

- PIN 1. EMITTER 2
- BASE 2
- COLLECTOR 1
- EMITTER 1
- BASE 1
- 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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