

MBT3946DW1T1G, SMBT3946DW1T1G

Complementary 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
- S 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

Table 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	

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.

Table 2. 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	$^\circ\text{C/W}$
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	$^\circ\text{C}$

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

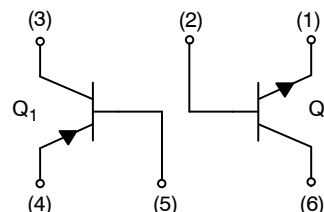


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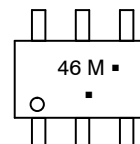
SOT-363/SC-88
CASE 419B
STYLE 1



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.

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Table 3. ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 2) ($I_C = 1.0\text{ mA}$, $I_B = 0$) ($I_C = -1.0\text{ mA}$, $I_B = 0$)	(NPN) (PNP) $V_{(BR)CEO}$	40 –40	– –	Vdc
Collector–Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{A}$, $I_E = 0$) ($I_C = -10\text{ }\mu\text{A}$, $I_E = 0$)	(NPN) (PNP) $V_{(BR)CBO}$	60 –40	– –	Vdc
Emitter–Base Breakdown Voltage ($I_E = 10\text{ }\mu\text{A}$, $I_C = 0$) ($I_E = -10\text{ }\mu\text{A}$, $I_C = 0$)	(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
ON CHARACTERISTICS (Note 2)				
DC Current Gain ($I_C = 0.1\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 10\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 50\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 100\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = -0.1\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$) ($I_C = -1.0\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$) ($I_C = -10\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$) ($I_C = -50\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$) ($I_C = -100\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)	(NPN) (PNP) 	h_{FE} 40 70 100 60 30 60 80 100 60 30	– – 300 – – – – 300 – –	–
Collector–Emitter Saturation Voltage ($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) ($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$) ($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$) ($I_C = -50\text{ mA}$, $I_B = -5.0\text{ mA}$)	(NPN) (PNP) 	$V_{CE(sat)}$ – – – –	0.2 0.3 –0.25 –0.4	Vdc
Base–Emitter Saturation Voltage ($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) ($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$) ($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$) ($I_C = -50\text{ mA}$, $I_B = -5.0\text{ mA}$)	(NPN) (PNP) 	$V_{BE(sat)}$ 0.65 – –0.65 –	0.85 0.95 –0.85 –0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product ($I_C = 10\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$) ($I_C = -10\text{ mA}$, $V_{CE} = -20\text{ Vdc}$, $f = 100\text{ MHz}$)	(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 ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) ($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$)	(NPN) (PNP) h_{ie}	1.0 2.0	10 12	k Ω
Voltage Feedback Ratio ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) ($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$)	(NPN) (PNP) h_{re}	0.5 0.1	8.0 10	$\times 10^{-4}$
Small–Signal Current Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) ($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$)	(NPN) (PNP) h_{fe}	100 100	400 400	–

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Table 4. 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	μmhos
Noise Figure ($V_{CE} = 5.0\text{ Vdc}$, $I_C = 100\text{ }\mu\text{A}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) ($V_{CE} = -5.0\text{ Vdc}$, $I_C = -100\text{ }\mu\text{A}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$)	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	($I_C = 10\text{ mA}$, $I_{B1} = 1.0\text{ mA}$) ($I_C = -10\text{ mA}$, $I_{B1} = -1.0\text{ mA}$)	(NPN) (PNP)	t_r	— —	35 35	
Storage Time	($V_{CC} = 3.0\text{ Vdc}$, $I_C = 10\text{ mA}$) ($V_{CC} = -3.0\text{ Vdc}$, $I_C = -10\text{ mA}$)	(NPN) (PNP)	t_s	— —	200 225	ns
Fall Time	($I_{B1} = I_{B2} = 1.0\text{ mA}$) ($I_{B1} = I_{B2} = -1.0\text{ mA}$)	(NPN) (PNP)	t_f	— —	50 75	

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

(NPN)

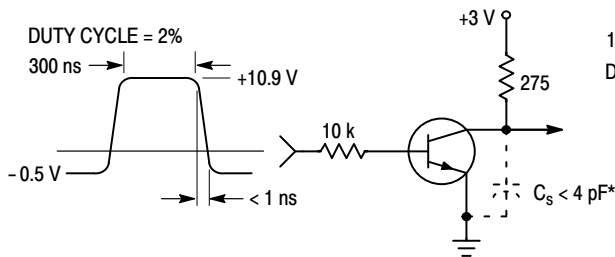


Figure 1. Delay and Rise Time Equivalent Test Circuit

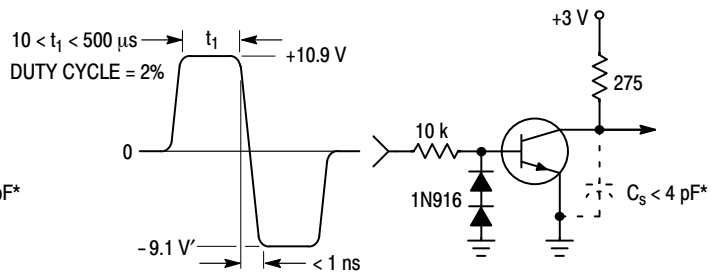


Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

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

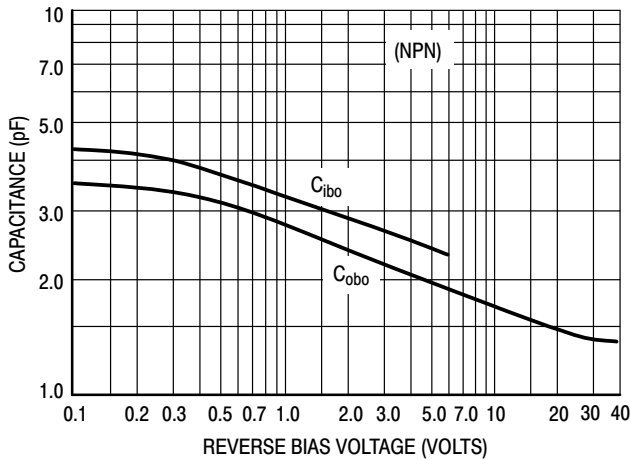


Figure 3. Capacitance

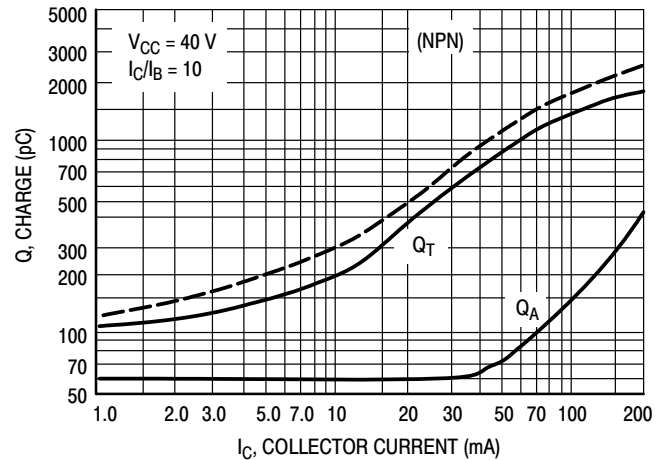


Figure 4. Charge Data

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(NPN)

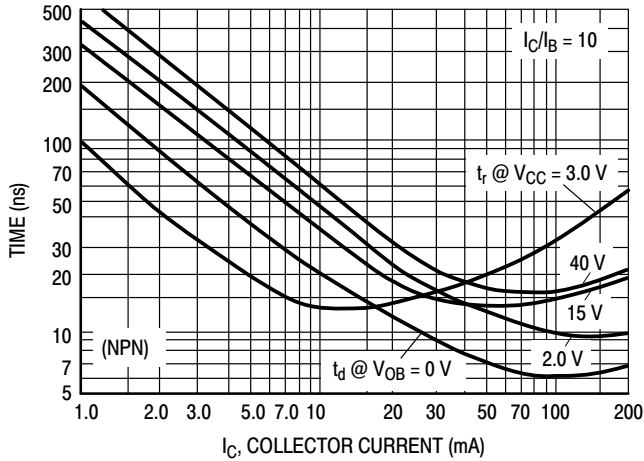


Figure 5. Turn-On Time

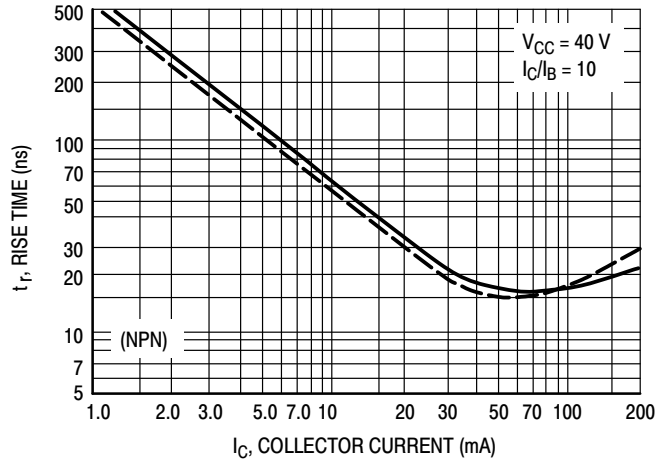


Figure 6. Rise Time

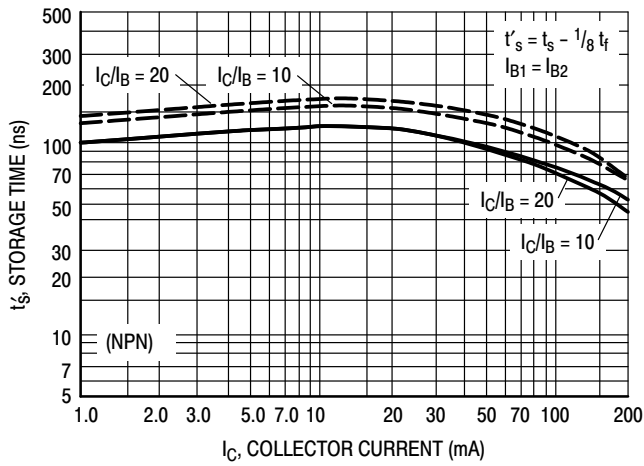


Figure 7. Storage Time

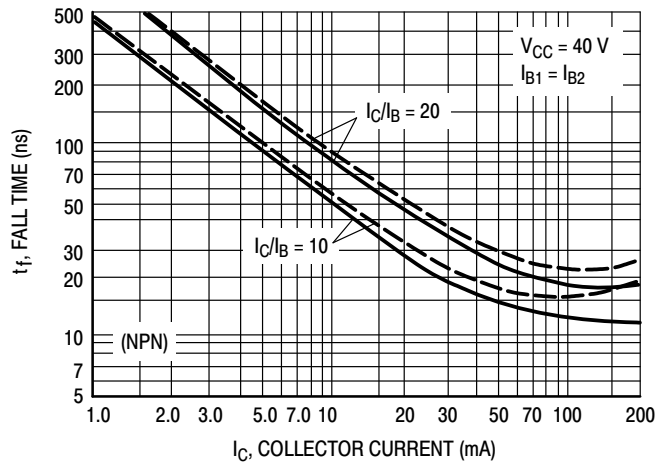


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

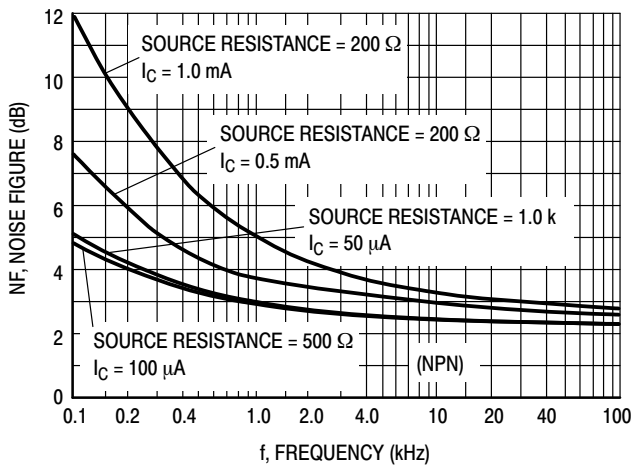


Figure 9. Noise Figure

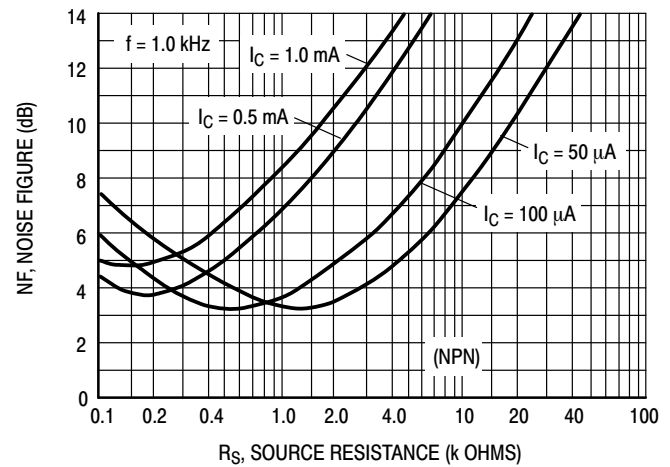


Figure 10. Noise Figure

MBT3946DW1T1G, SMBT3946DW1T1G

(NPN) h PARAMETERS

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

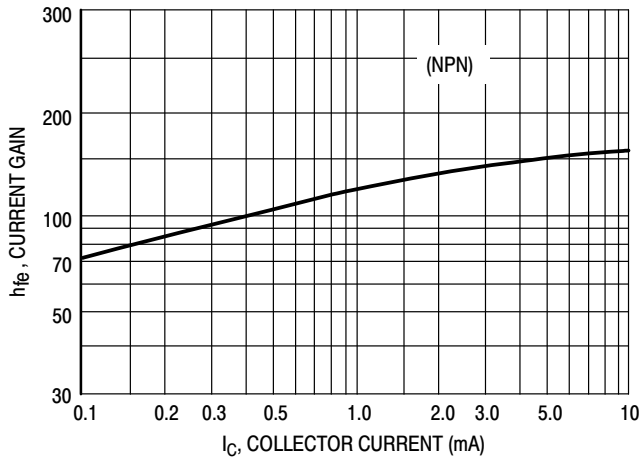


Figure 11. Current Gain

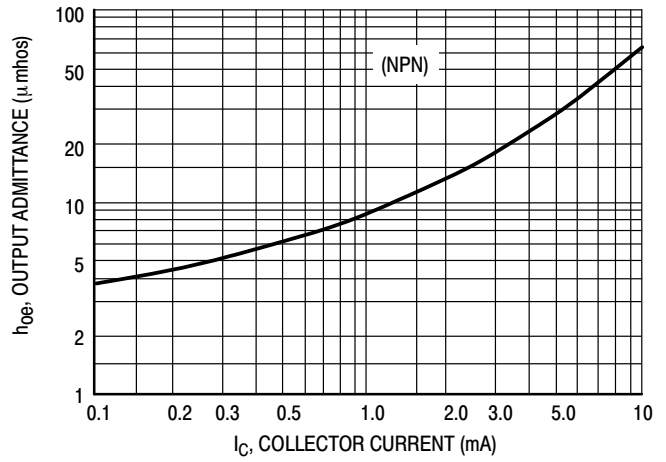


Figure 12. Output Admittance

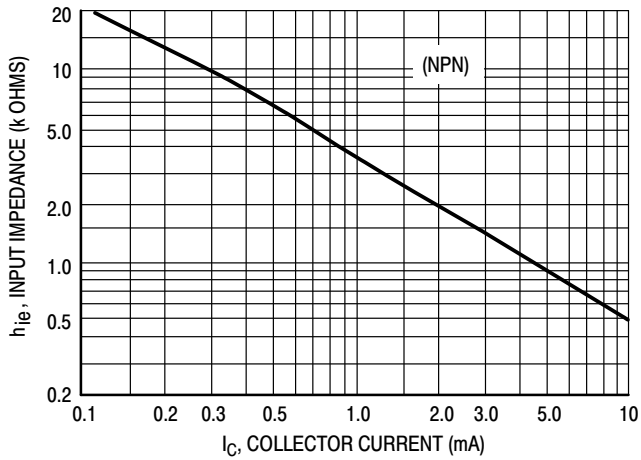


Figure 13. Input Impedance

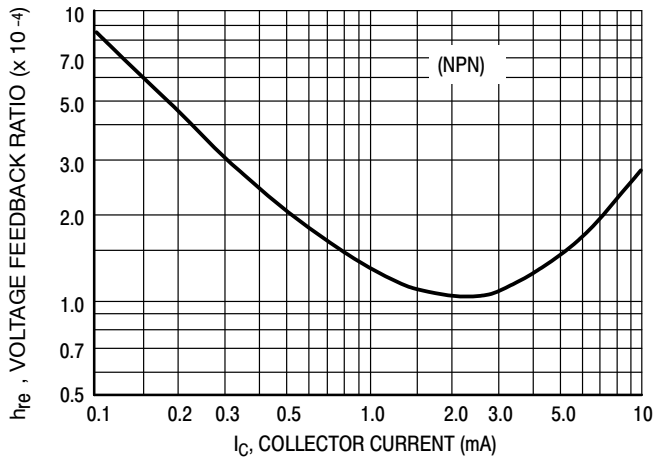


Figure 14. Voltage Feedback Ratio

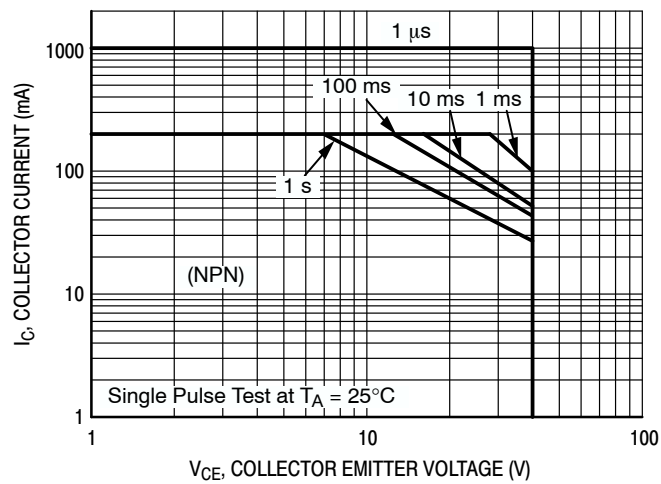


Figure 15. Safe Operating Area

MBT3946DW1T1G, SMBT3946DW1T1G

(NPN) TYPICAL STATIC CHARACTERISTICS

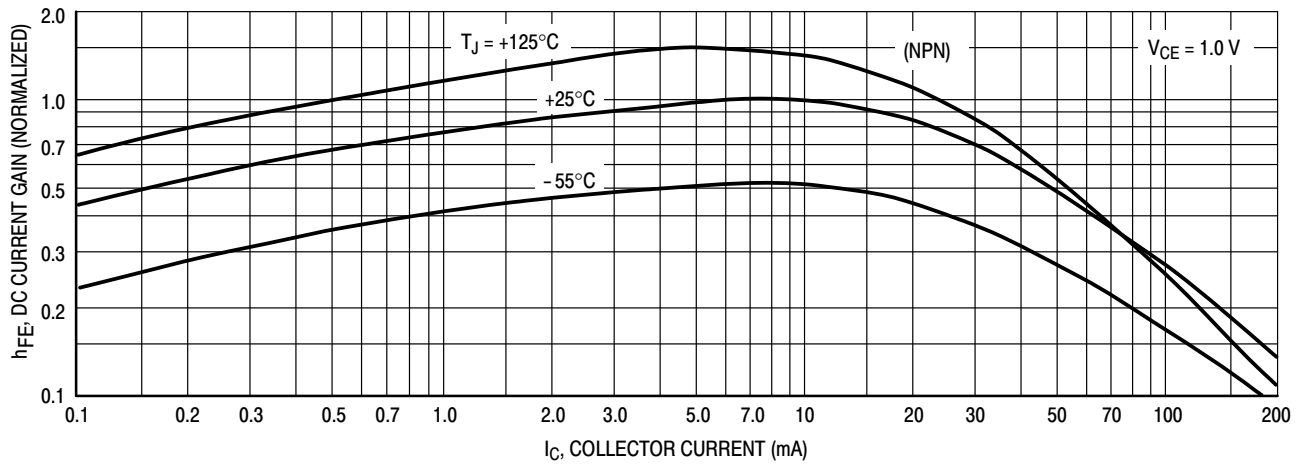


Figure 16. DC Current Gain

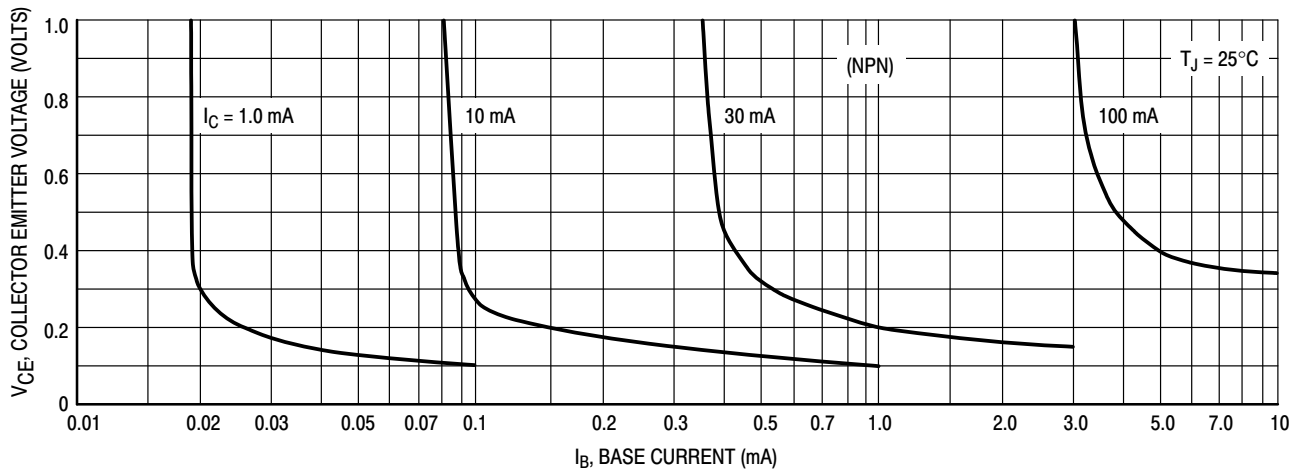


Figure 17. Collector Saturation Region

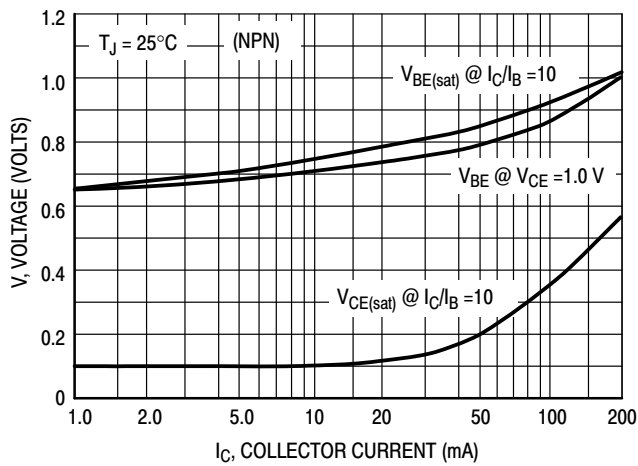


Figure 18. "ON" Voltages

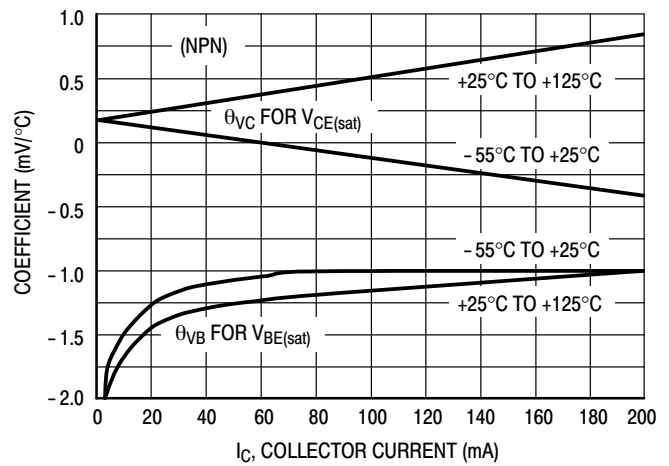


Figure 19. Temperature Coefficients

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

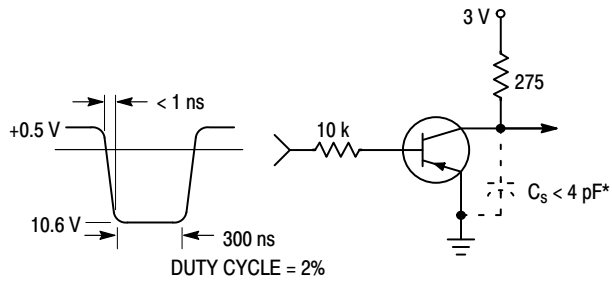


Figure 20. Delay and Rise Time Equivalent Test Circuit

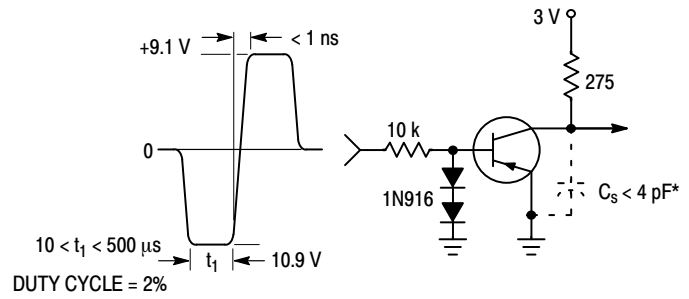


Figure 21. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

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

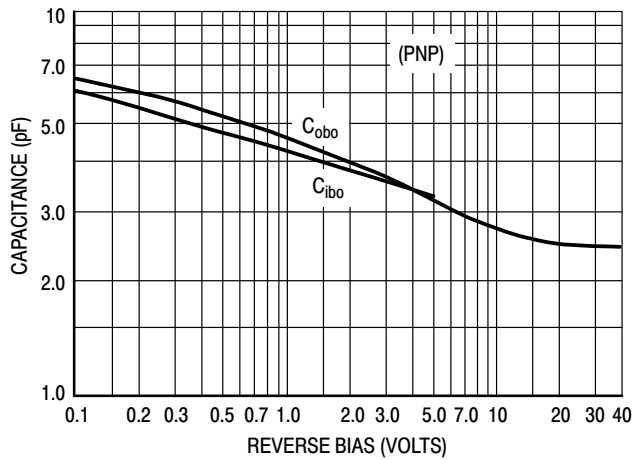


Figure 22. Capacitance

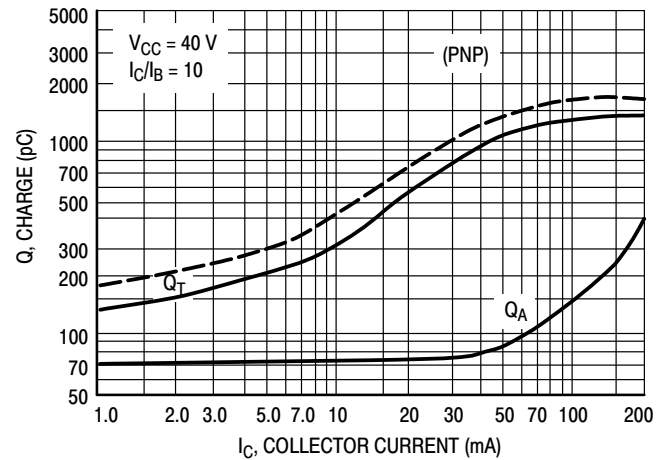


Figure 23. Charge Data

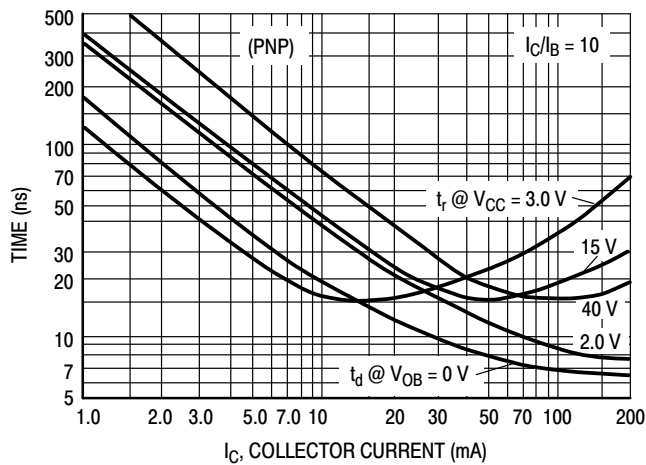


Figure 24. Turn-On Time

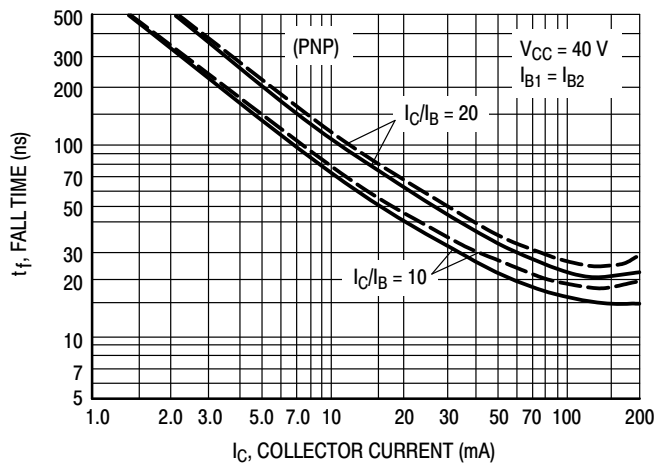


Figure 25. Fall Time

MBT3946DW1T1G, SMT3946DW1T1G

(PNP)

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

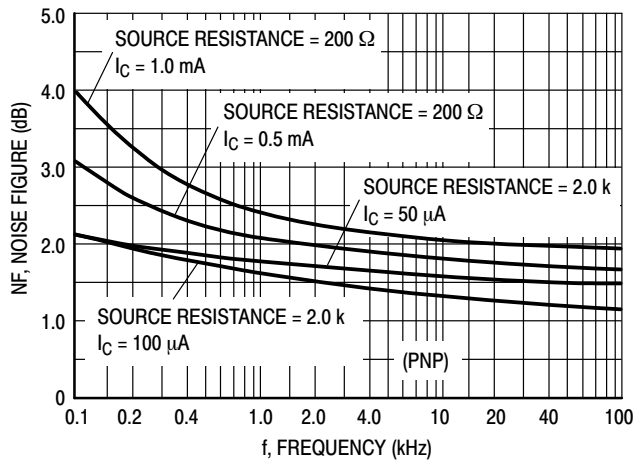


Figure 26.

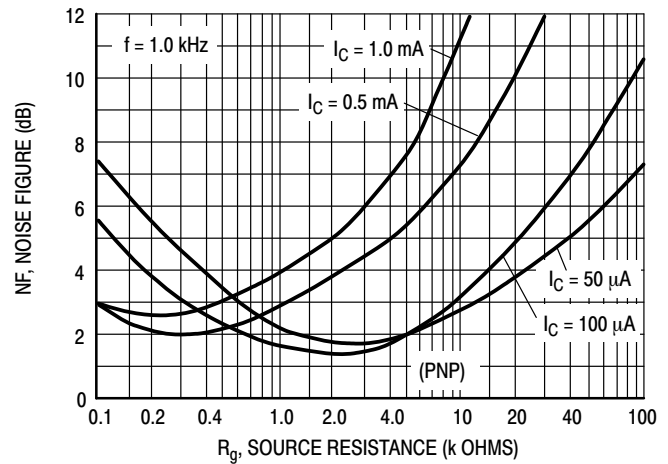


Figure 27.

h PARAMETERS

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

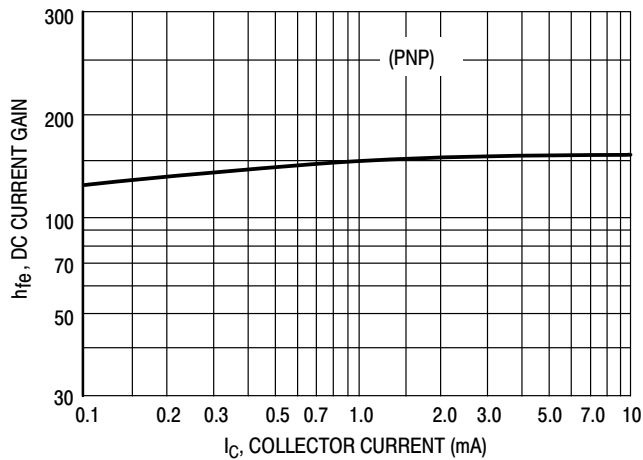


Figure 28. Current Gain

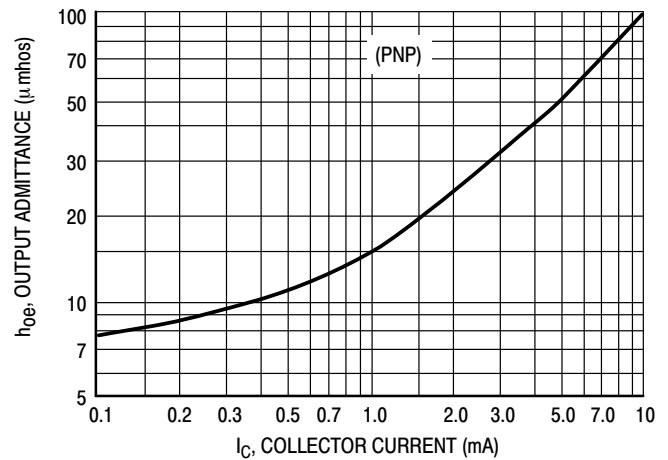


Figure 29. Output Admittance

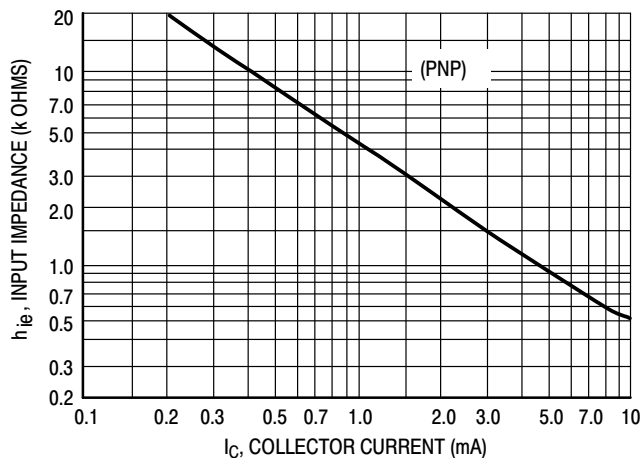


Figure 30. Input Impedance

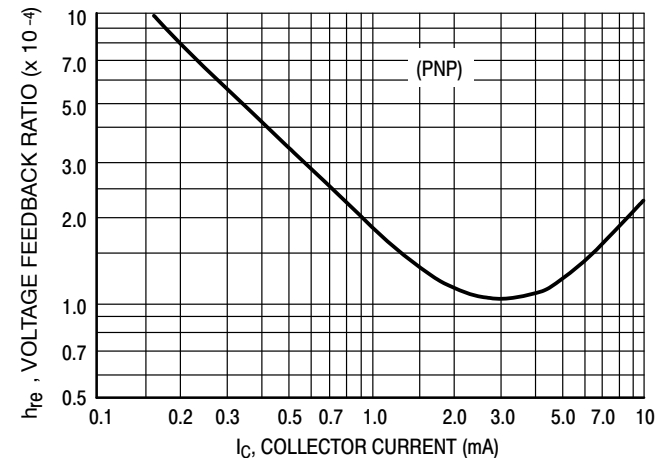


Figure 31. Voltage Feedback Ratio

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

TYPICAL STATIC CHARACTERISTICS

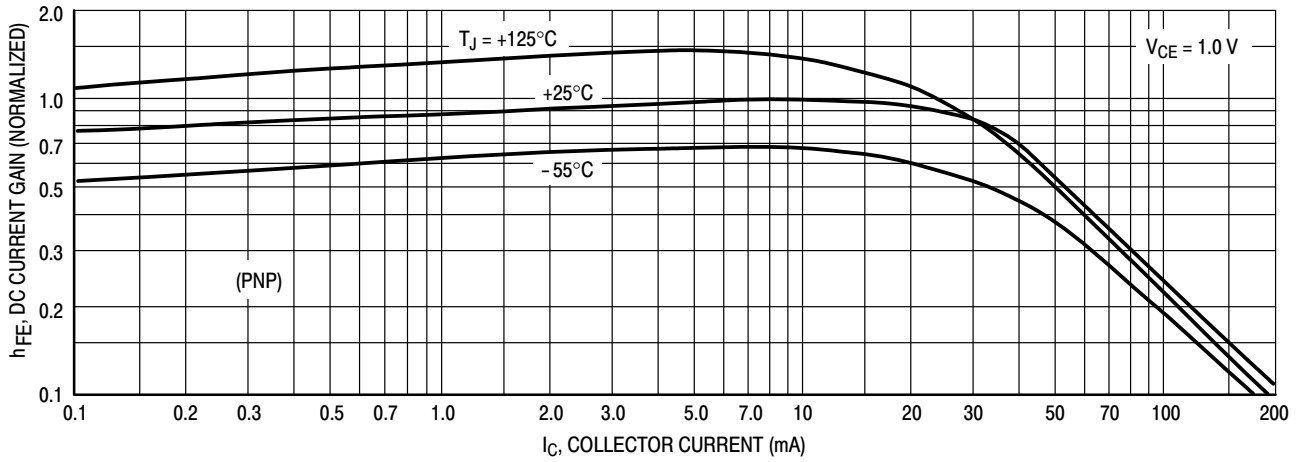


Figure 32. DC Current Gain

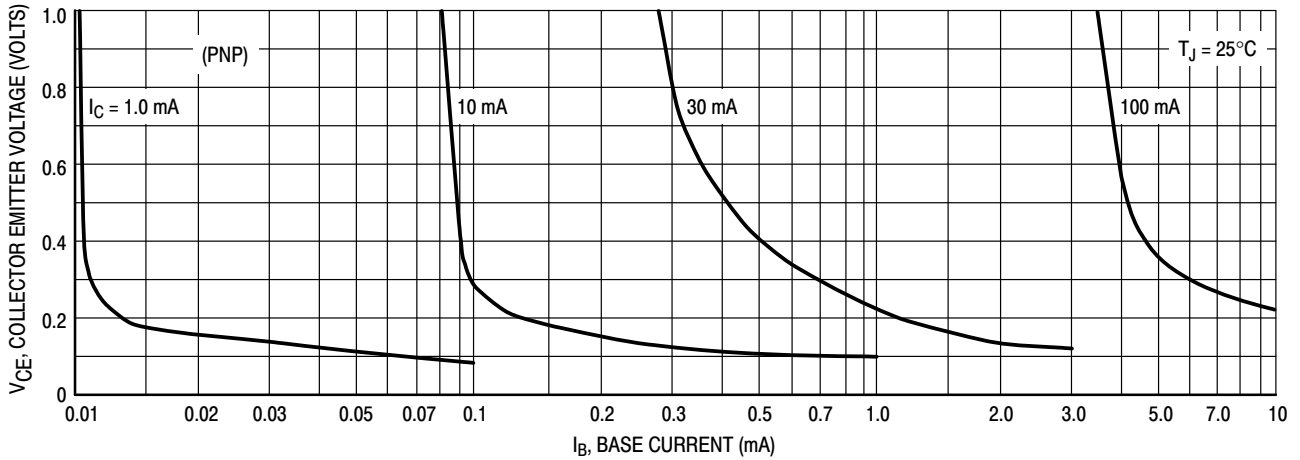


Figure 33. Collector Saturation Region

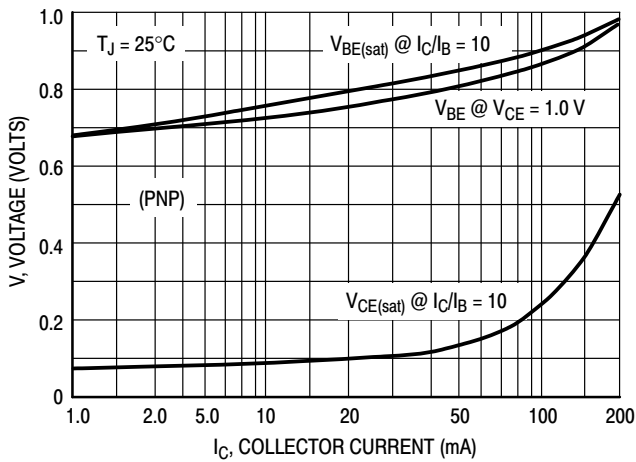


Figure 34. "ON" Voltages

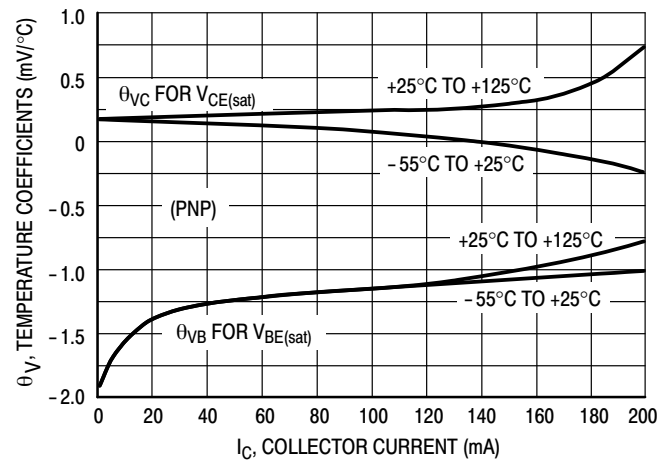


Figure 35. Temperature Coefficients

MBT3946DW1T1G, SMT3946DW1T1G

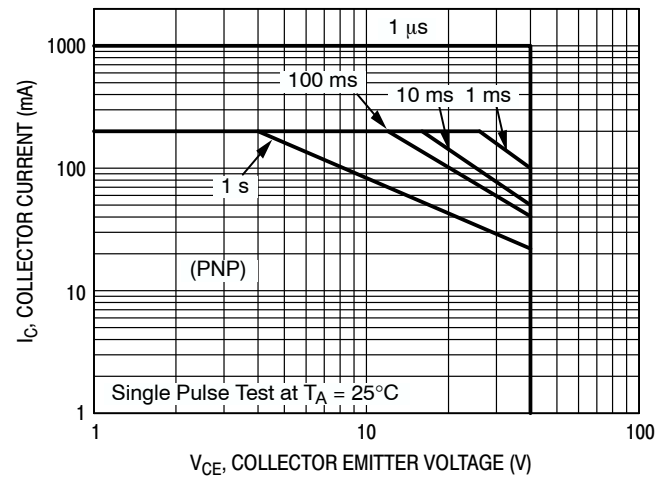
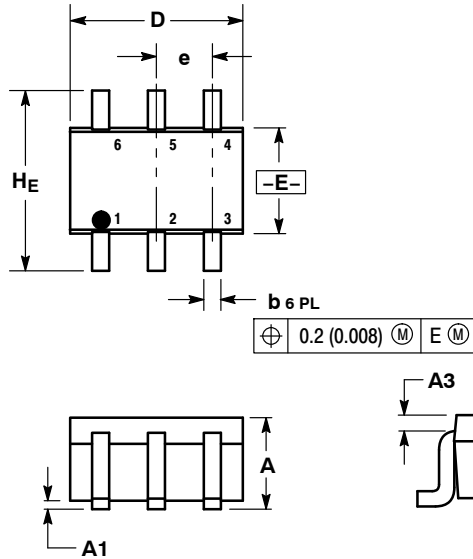


Figure 36. Safe Operating Area

MBT3946DW1T1G, SMT3946DW1T1G

PACKAGE DIMENSIONS

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



NOTES:

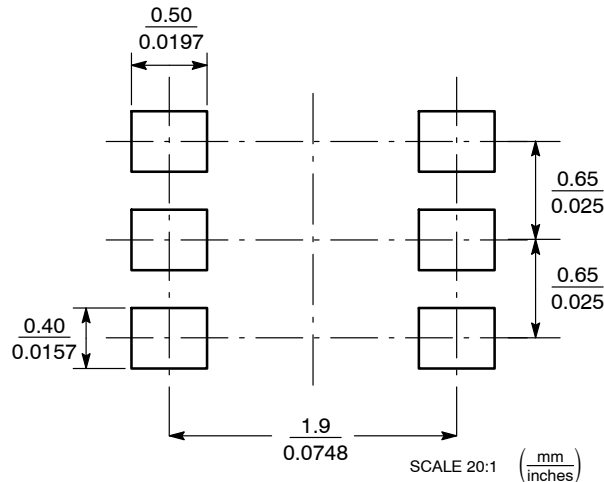
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419B-01 OBSOLETE, NEW STANDARD 419B-02.

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:

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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