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

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SOT−363/SC−88
CASE 419B
STYLE 1

MBT3946DW1T1*
*Q1 PNP
Q2 NPN

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°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

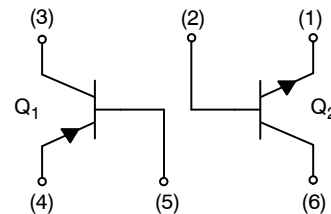1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

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.

Table 3. 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	

Table 4. 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

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

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

(NPN)

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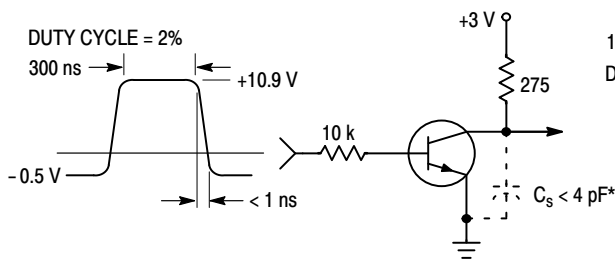
**Figure 1. Delay and Rise Time
Equivalent Test Circuit**
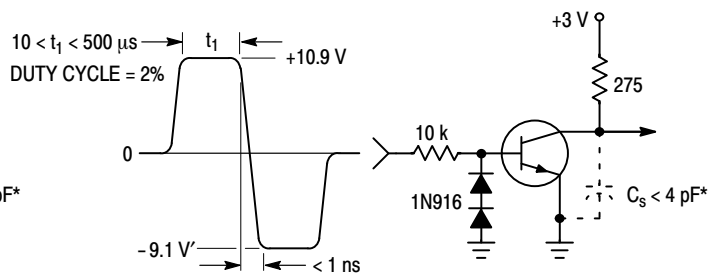
**Figure 2. Storage and Fall Time
Equivalent Test Circuit**

TYPICAL TRANSIENT CHARACTERISTICS

Figure 3. Capacitance
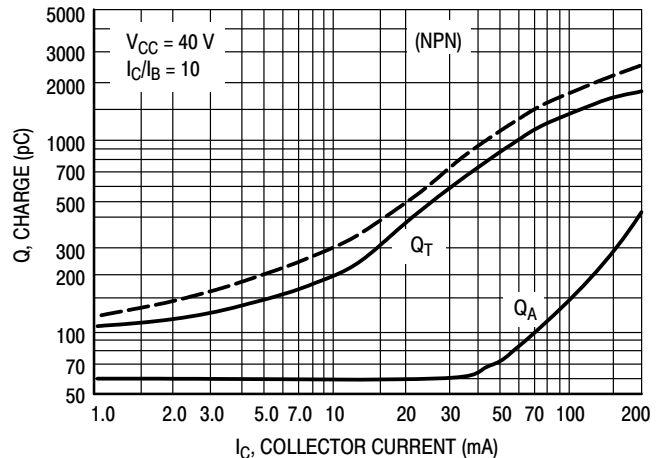
Figure 4. Charge Data

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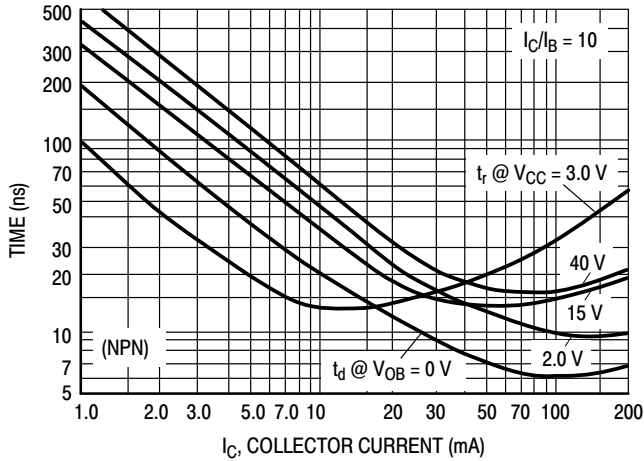
Figure 5. Turn-On Time
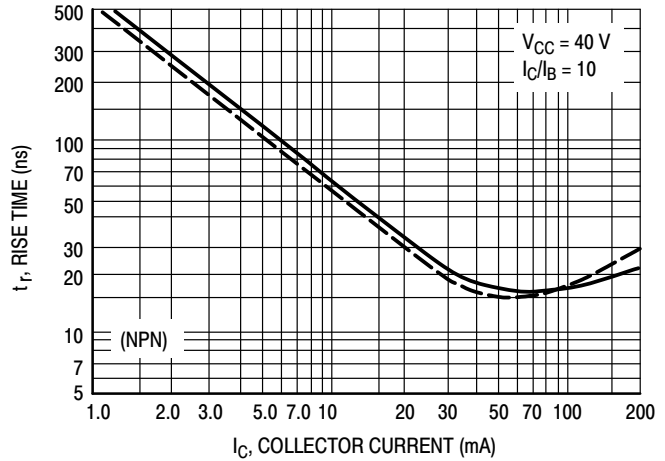
Figure 6. Rise Time
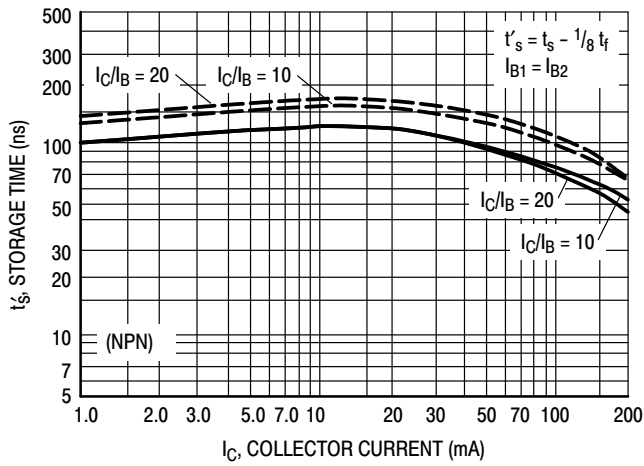
Figure 7. Storage Time
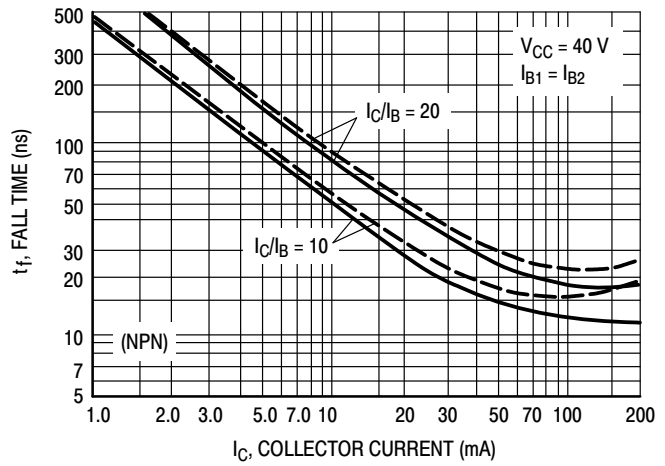
Figure 8. Fall Time

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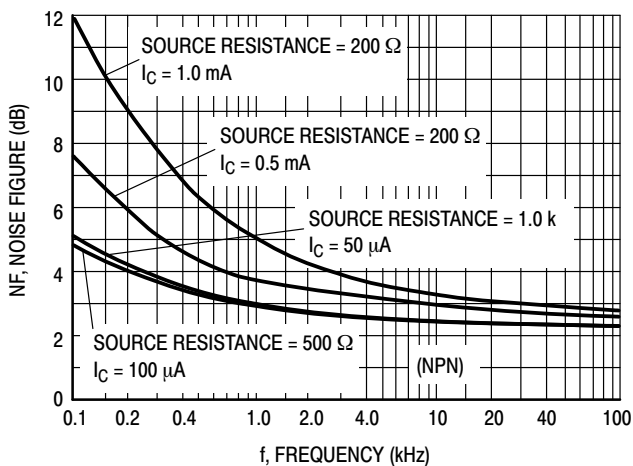
Figure 9. Noise Figure
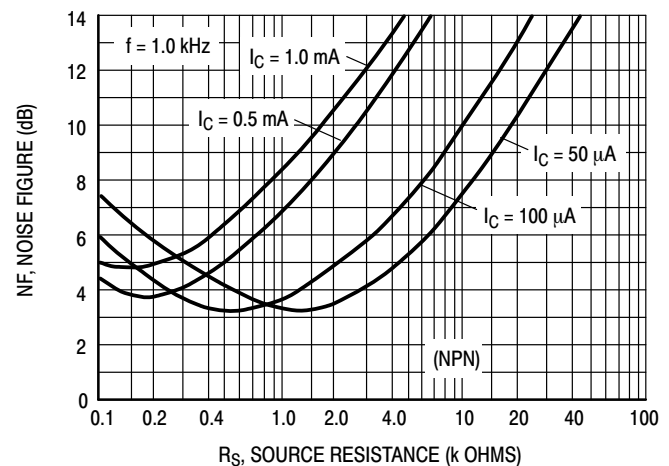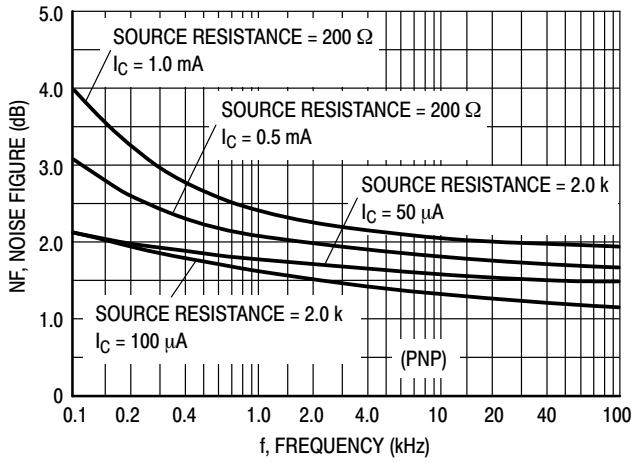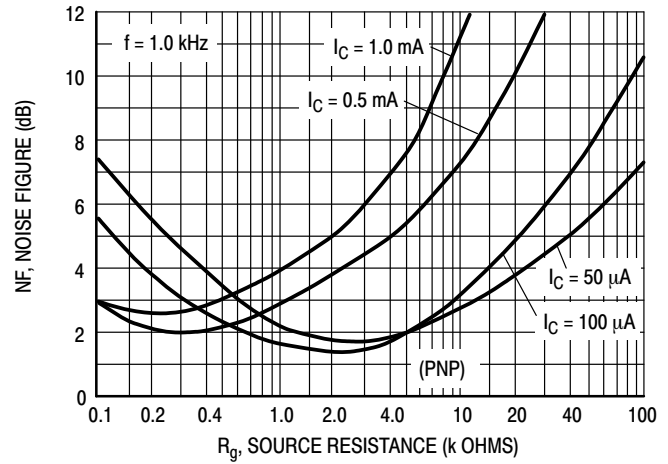

Figure 10. Noise Figure

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4

(NPN)
h PARAMETERS
(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)
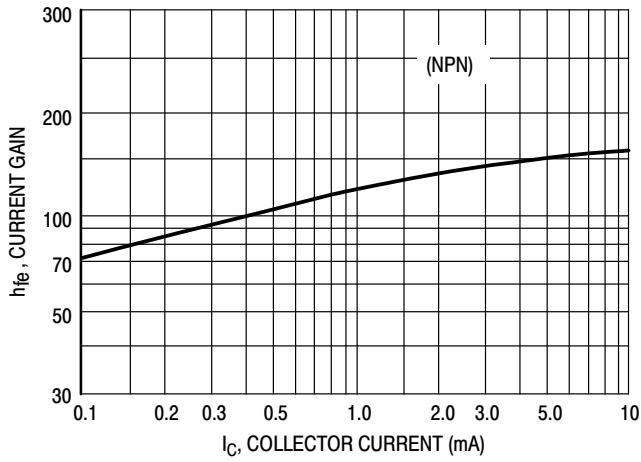
Figure 11. Current Gain
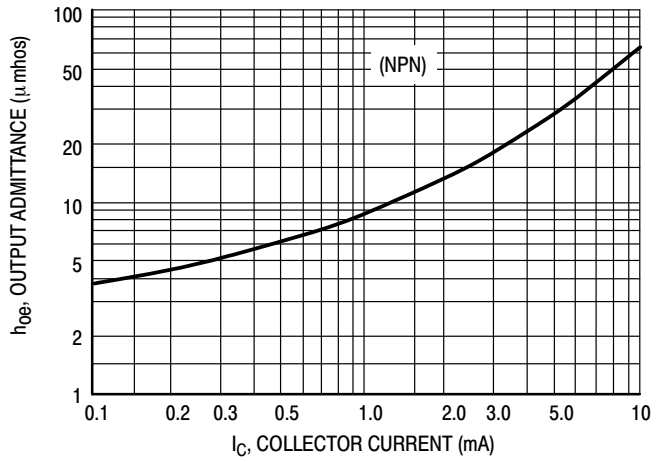
Figure 12. Output Admittance
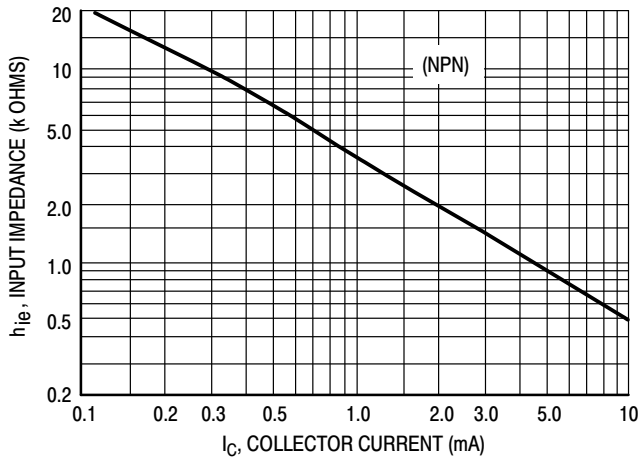
Figure 13. Input Impedance
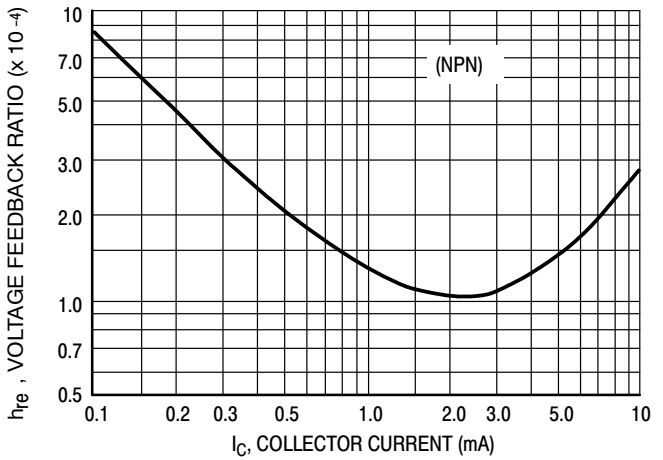
Figure 14. Voltage Feedback Ratio
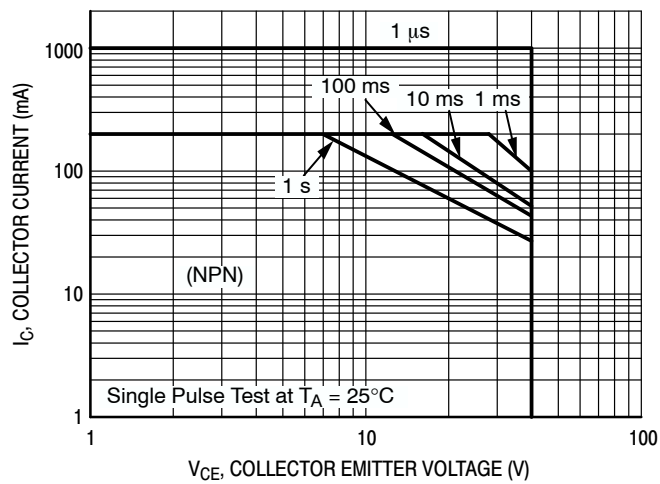
Figure 15. Safe Operating Area

(NPN)
TYPICAL STATIC CHARACTERISTICS
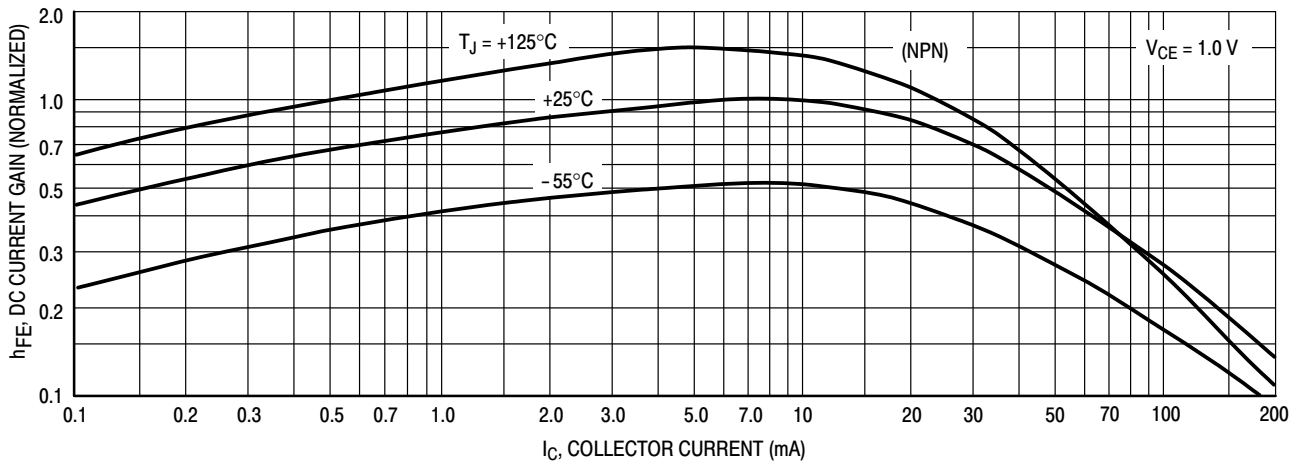
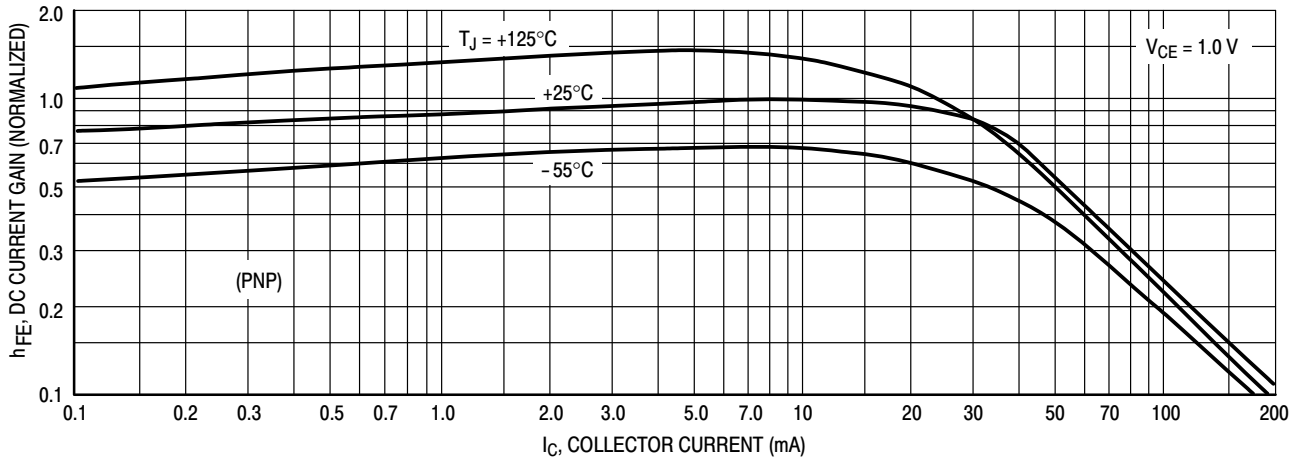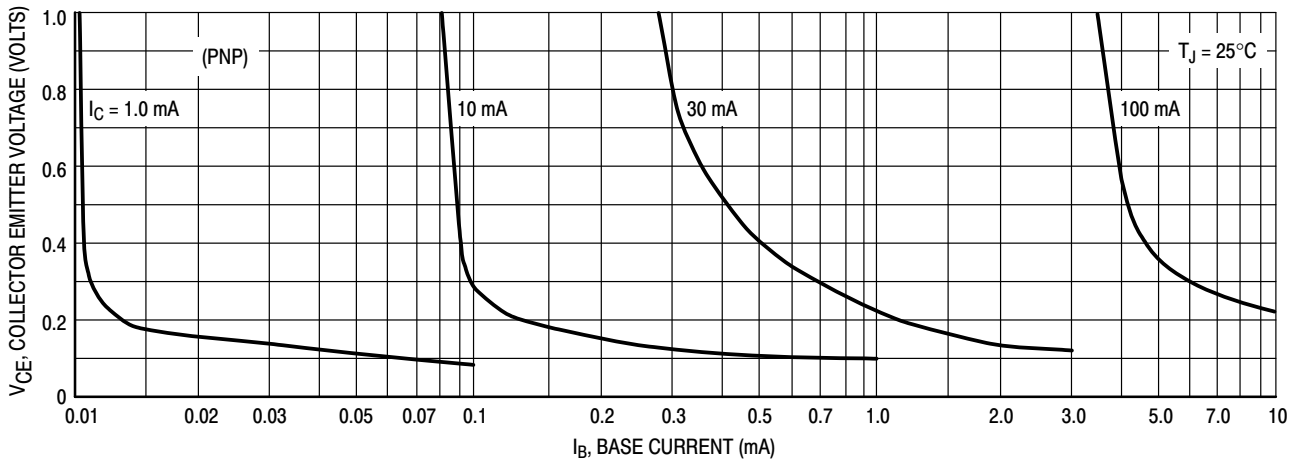**Figure 16. DC Current Gain**
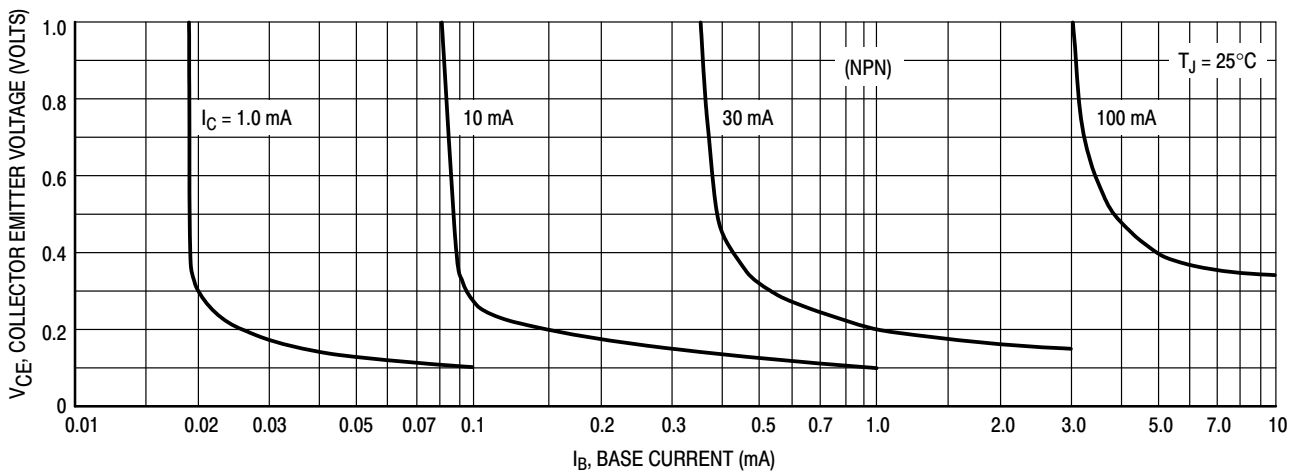
Figure 17. Collector Saturation Region
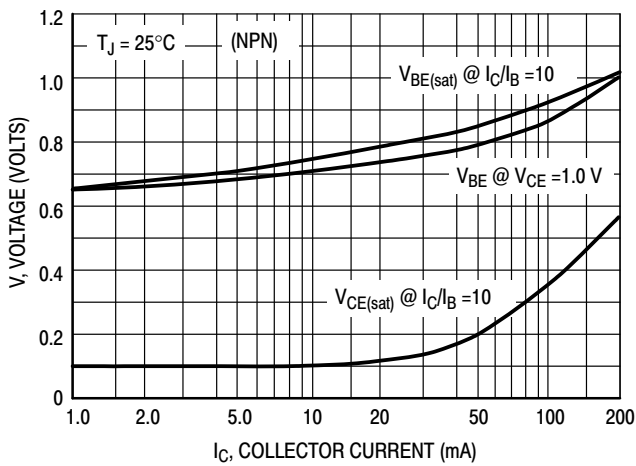
Figure 18. "ON" Voltages
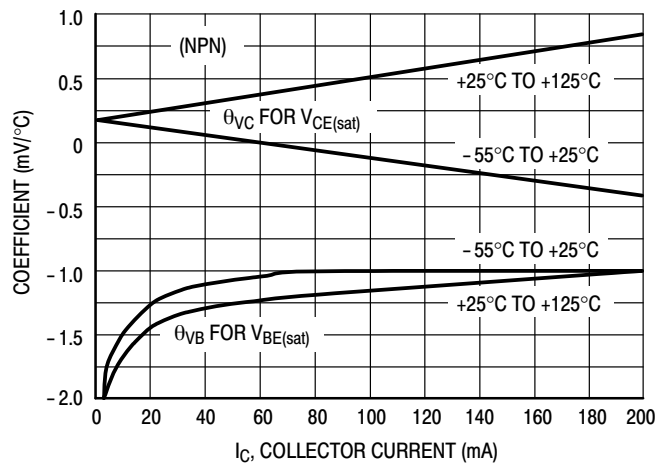
Figure 19. Temperature Coefficients

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

* Total shunt capacitance of test jig and connectors
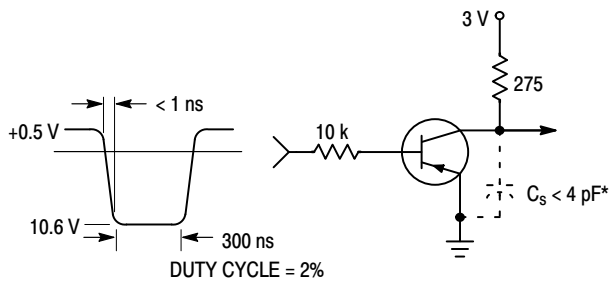
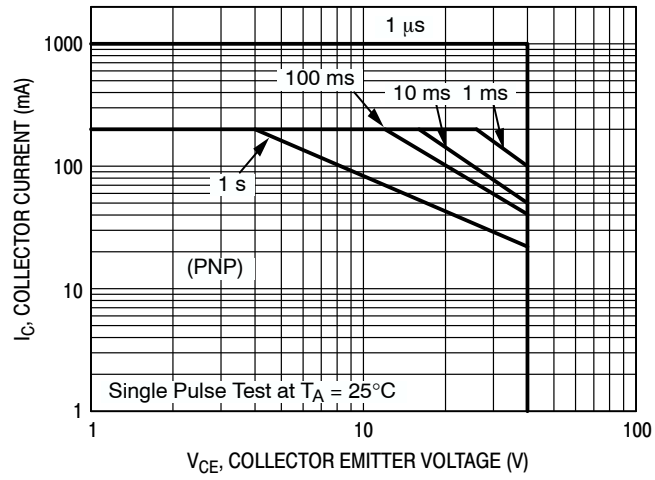**Figure 20. Delay and Rise Time Equivalent Test Circuit**
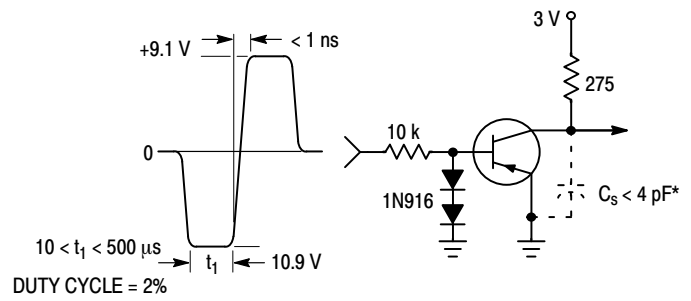
Figure 21. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

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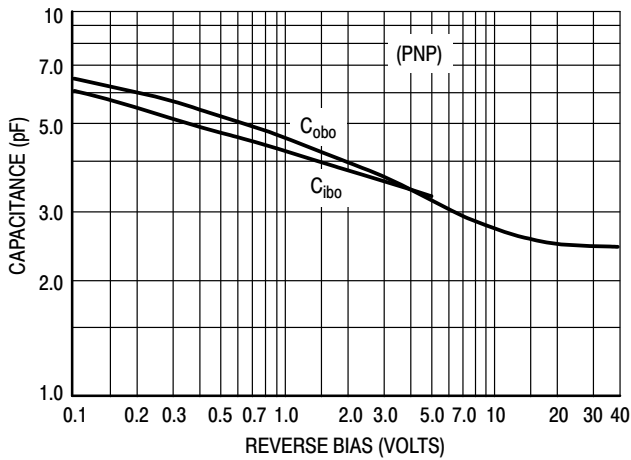
Figure 22. Capacitance
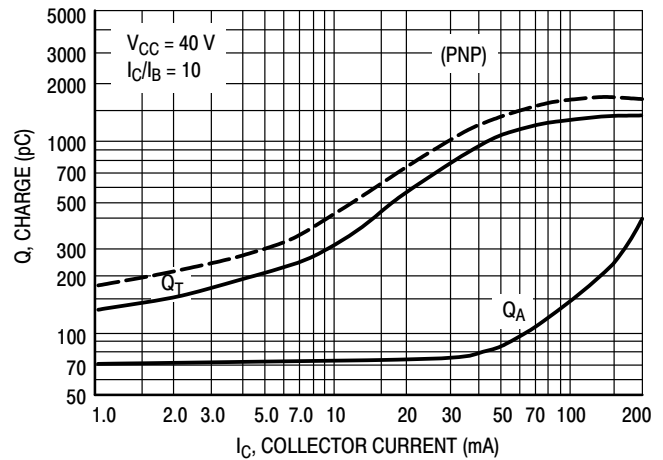
Figure 23. Charge Data
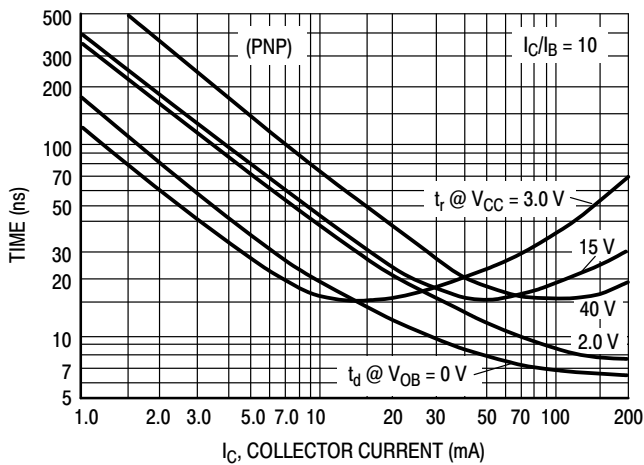
Figure 24. Turn-On Time

Figure 25. 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 26.

Figure 27.

h PARAMETERS
(V_{CE} = − 10 Vdc, f = 1.0 kHz, T_A = 25°C)
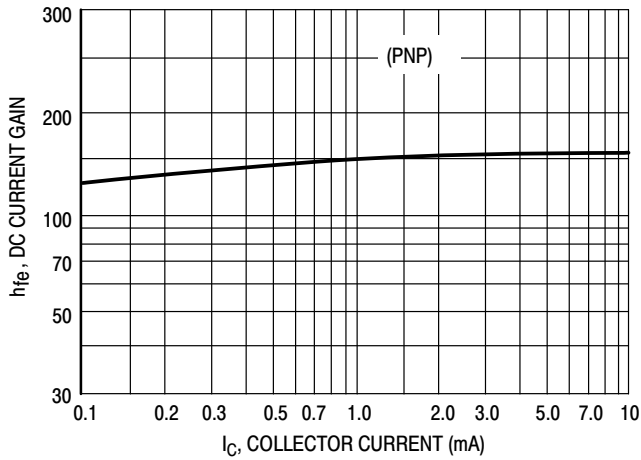
Figure 28. Current Gain
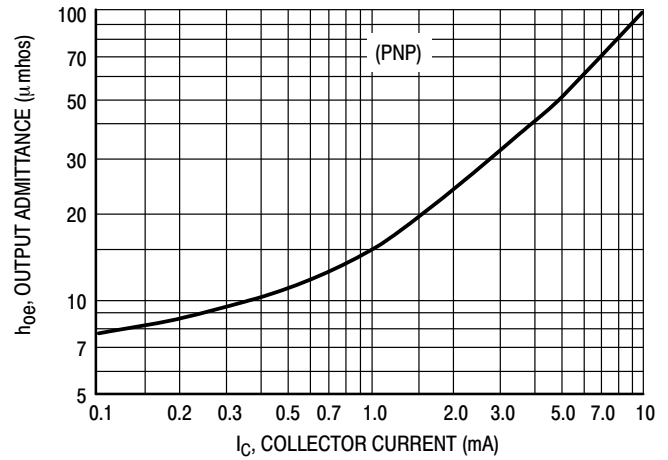
Figure 29. Output Admittance
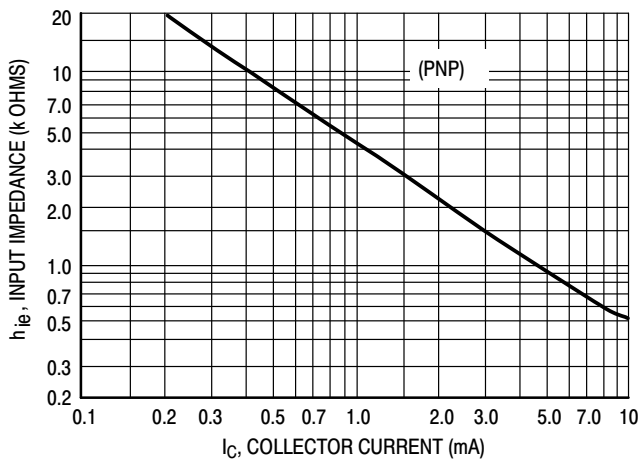
Figure 30. Input Impedance
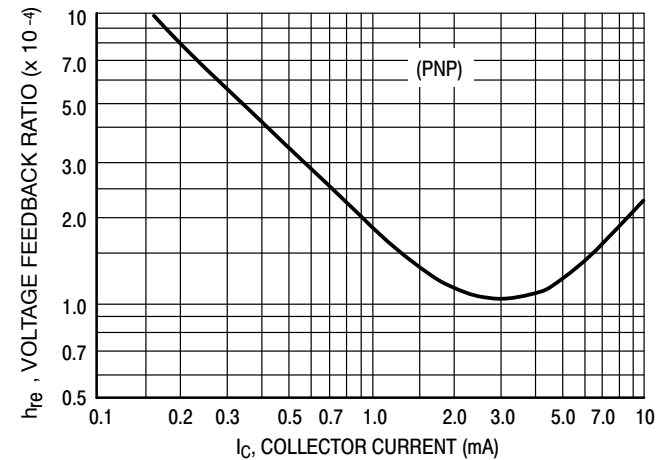
Figure 31. Voltage Feedback Ratio

MBT3946DW1T1G, SMBT3946DW1T1G

(PNP)

TYPICAL STATIC CHARACTERISTICS

Figure 32. DC Current Gain

Figure 33. Collector Saturation Region
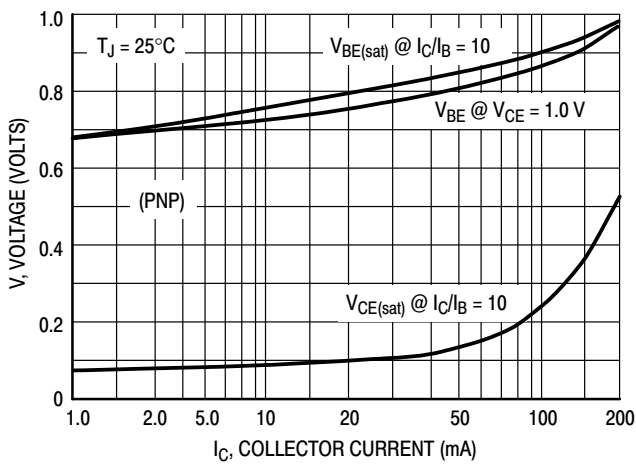
Figure 34. "ON" Voltages
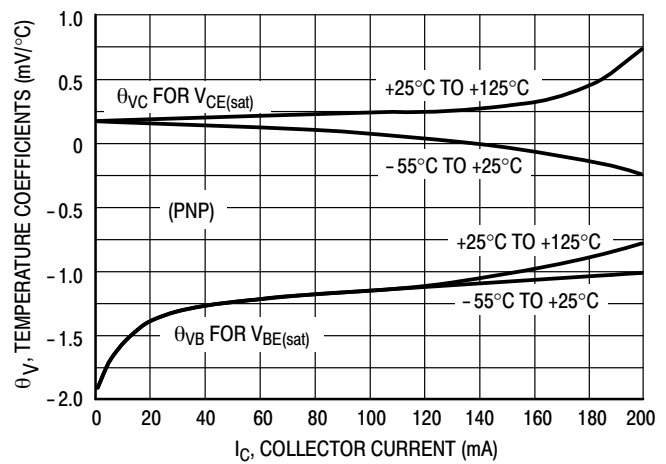
Figure 35. Temperature Coefficients

Figure 36. Safe Operating Area

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

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SCALE 2:1

DATE 11 DEC 2012

TOP VIEW

DETAIL A
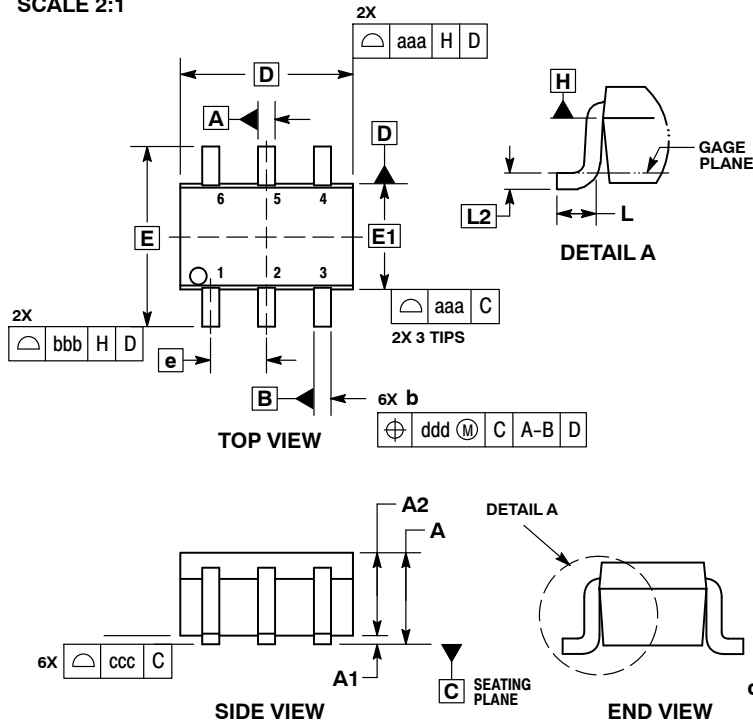
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRU-SIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF 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 CONDI-TION. 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		

SIDE VIEW

DETAIL A

END VIEW

GENERIC MARKING DIAGRAM*

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.

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XXXM■
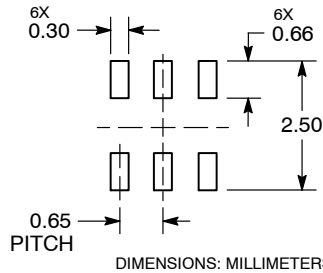1

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

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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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