



# MMBT3904

## NPN GENERAL PURPOSE SWITCHING TRANSISTOR

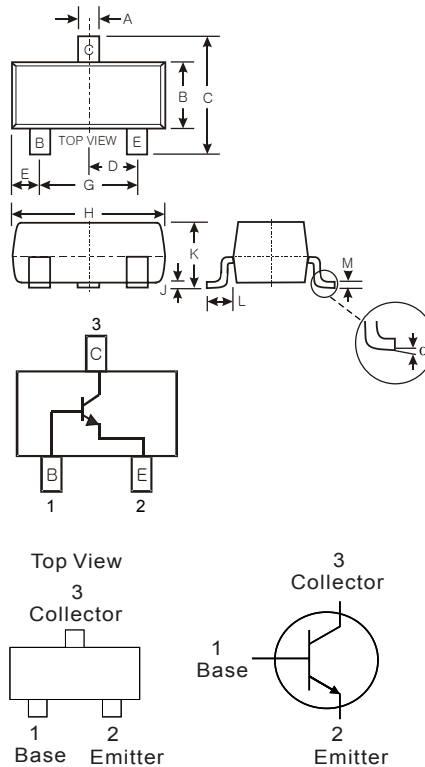
Voltage - 40 Volts    Power Dissipation - 300 mWatt

### FEATURES

- Epitaxial Planar Die Construction
- Complementary PNP Type Available (MMBT3906)
- Ideal for Medium Power Amplification and Switching

### MECHANICAL DATA

- Case: SOT-23, Molded Plastic
- Case Material - UL Flammability Rating Classification 94V-0
- Terminals: Solderable per MIL-STD-202, Method 208
- Marking: Device Code
- Weight: 0.008 grams (approx.)



SOT-23		
Dim	Min	Max
A	0.37	0.51
B	1.20	1.40
C	2.30	2.50
D	0.89	1.03
E	0.45	0.60
G	1.78	2.05
H	2.80	3.00
J	0.013	0.10
K	0.903	1.10
L	0.45	0.61
M	0.085	0.180
$\alpha$	0°	8°
All Dimensions in mm		

### ● MAXIMUM RATING ( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Limits	Unit
Collector-Emitter Voltage	$V_{CE0}$	40	Vdc
Collector-Base Voltage	$V_{CB0}$	60	Vdc
Emitter-Base Voltage	$V_{EB0}$	6	Vdc
Collector Current — Continuous	$I_C$	200	mAdc

### ● THERMAL CHARACTERISTICS

Total Device Dissipation, FR-5 Board (Note 1) @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	225	mW
		1.8	mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient (Note 1)	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation, Alumina Substrate (Note 2) @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	300	mW
		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient (Note 2)	$R_{\theta JA}$	417	$^\circ\text{C}/\text{W}$
Junction and Storage temperature	$T_J, T_{stg}$	-55 ~ +150	$^\circ\text{C}$

1. FR-5 = 1.0×0.75×0.062 in.

2. Alumina = 0.4×0.3×0.024 in. 99.5% alumina.



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Voltage - 40 Volts    Power Dissipation - 300 mWatt

### ● ELECTRICAL CHARACTERISTICS (Ta = 25 °C)

#### OFF CHARACTERISTICS

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Collector–Emitter Breakdown Voltage (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , I <sub>B</sub> = 0)	V <sub>BR(CEO)</sub>	40	–	–	V
Collector–Base Breakdown Voltage (I <sub>C</sub> = 10 μA <sub>dc</sub> , I <sub>E</sub> = 0)	V <sub>BR(CBO)</sub>	60	–	–	V
Emitter–Base Breakdown Voltage (I <sub>E</sub> = 10 μA <sub>dc</sub> , I <sub>C</sub> = 0)	V <sub>BR(EBO)</sub>	6	–	–	V
Collector Cutoff Current (V <sub>CE</sub> = 30 Vdc, V <sub>EB</sub> = 3.0Vdc)	I <sub>CEX</sub>	–	–	50	nA
Base Cutoff Current (V <sub>CE</sub> = 30 Vdc, V <sub>EB</sub> = 3.0 Vdc)	I <sub>BL</sub>	–	–	50	nA

#### ON CHARACTERISTICS (Note 3.)

DC Current Gain (I <sub>C</sub> = 0.1 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 Vdc)	h <sub>FE</sub>	40	–	–	
(I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 Vdc)		70	–	–	
(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 Vdc)		100	–	300	
(I <sub>C</sub> = 50 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 Vdc)		60	–	–	
(I <sub>C</sub> = 100 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 Vdc)		30	–	–	
Collector–Emitter Saturation Voltage(3) (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> )	V <sub>CE(sat)</sub>	–	–	0.2	V
(I <sub>C</sub> = 50mA <sub>dc</sub> , I <sub>B</sub> = 5.0 mA <sub>dc</sub> )		–	–	0.3	
Base–Emitter Saturation Voltage (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> )	V <sub>BE(sat)</sub>	0.65	–	0.85	V
(I <sub>C</sub> = 50mA <sub>dc</sub> , I <sub>B</sub> = 5.0 mA <sub>dc</sub> )		–	–	0.95	

#### SMALL–SIGNAL CHARACTERISTICS

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Current–Gain — Bandwidth Product (I <sub>C</sub> = 10mA <sub>dc</sub> , V <sub>CE</sub> = 20Vdc, f = 100MHz)	f <sub>T</sub>	300	–	–	MHz
Output Capacitance (V <sub>CB</sub> = 5.0 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)	C <sub>obo</sub>	–	–	4	pF
Input Capacitance (V <sub>EB</sub> = 0.5 Vdc, I <sub>C</sub> = 0, f = 1.0 MHz)	C <sub>ibo</sub>	–	–	8	pF
Input Impedance (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz)	h <sub>ie</sub>	1	–	10	kΩ
Voltage Feedback Ratio (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz)	h <sub>re</sub>	0.5	–	8	X 10 <sup>-4</sup>
Small–Signal Current Gain (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz)	h <sub>fe</sub>	100	–	400	
Output Admittance (V <sub>CE</sub> = 10 Vdc, I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz)	h <sub>oe</sub>	1	–	40	μmhos
Noise Figure (V <sub>CE</sub> = 5V, I <sub>C</sub> = 100μA, R <sub>S</sub> = 1.0kΩ, f = 1.0kHz)	NF	–	–	5	dB

3. Pulse Test: Pulse Width <300 μs, Duty Cycle <2.0%.



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## RATINGS AND CHARACTERISTIC CURVES

### ● ELECTRICAL CHARACTERISTICS (Ta= 25°C)

#### SWITCHING CHARACTERISTICS

Delay Time	(V <sub>CC</sub> = 3.0 Vdc, V <sub>BE</sub> = -0.5 Vdc, I <sub>C</sub> = 10 mA, I <sub>B1</sub> = 1.0 mA)	t <sub>d</sub>	-	-	35	ns
Rise Time		t <sub>r</sub>	-	-	35	
Storage Time	(V <sub>CC</sub> = 3.0 Vdc, I <sub>C</sub> = 10 mA, I <sub>B1</sub> = I <sub>B2</sub> = 1.0 mA)	t <sub>s</sub>	-	-	200	
Fall Time		t <sub>f</sub>	-	-	50	

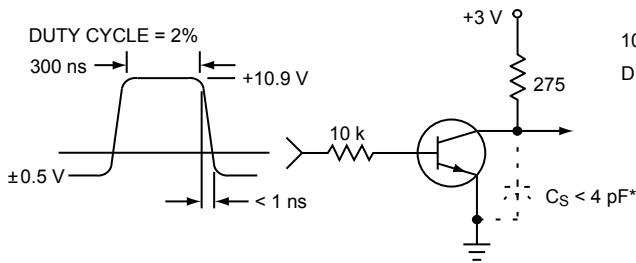


Figure 1. Delay and Rise Time Equivalent Test Circuit

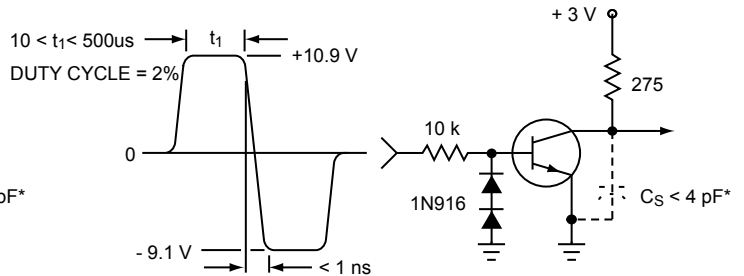


Figure 2. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

### TYPICAL TRANSIENT CHARACTERISTICS

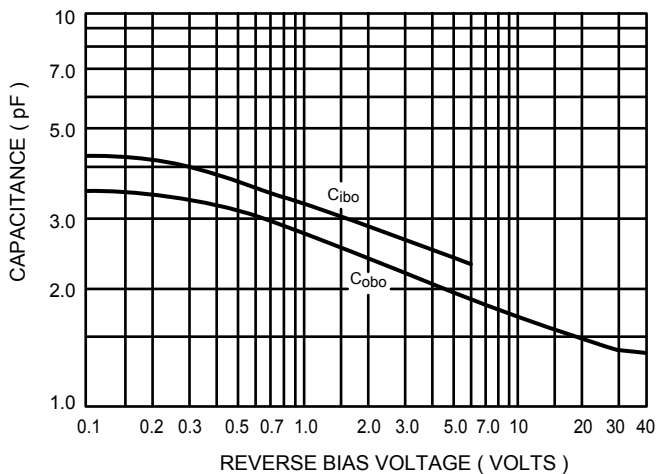


Figure 3. Capacitance

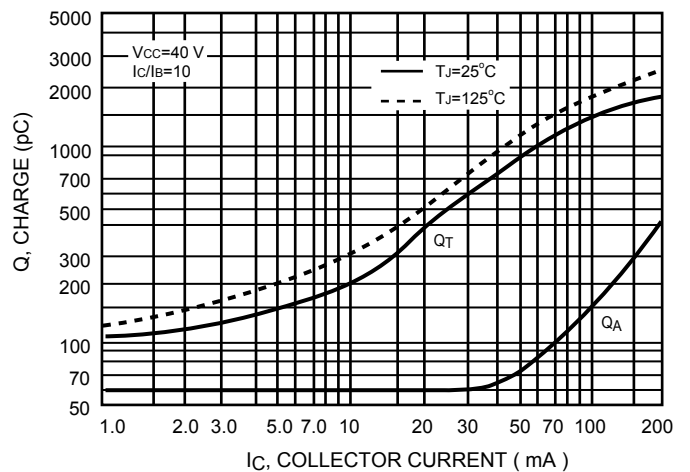


Figure 4. Charge Data



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## RATINGS AND CHARACTERISTIC CURVES

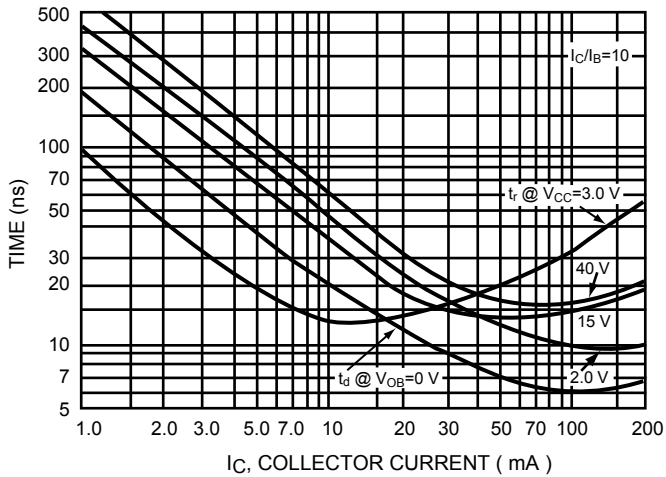


Figure 5. Turn-On Time

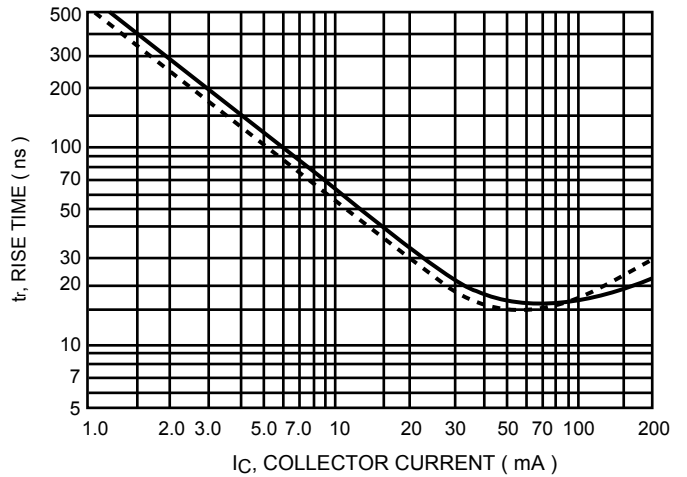


Figure 6. Rise Time

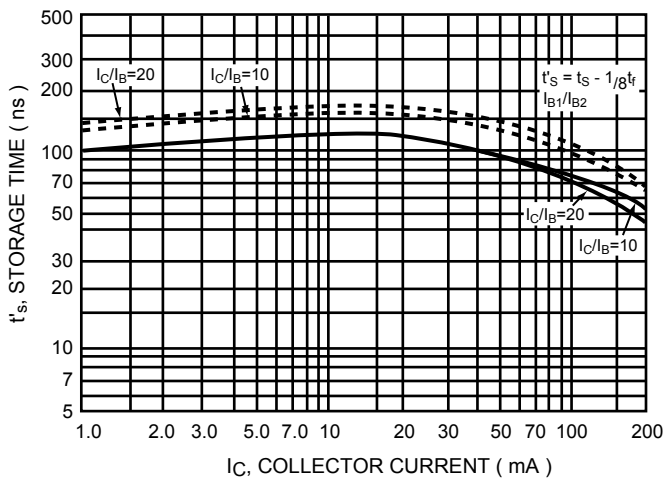


Figure 7. Storage Time

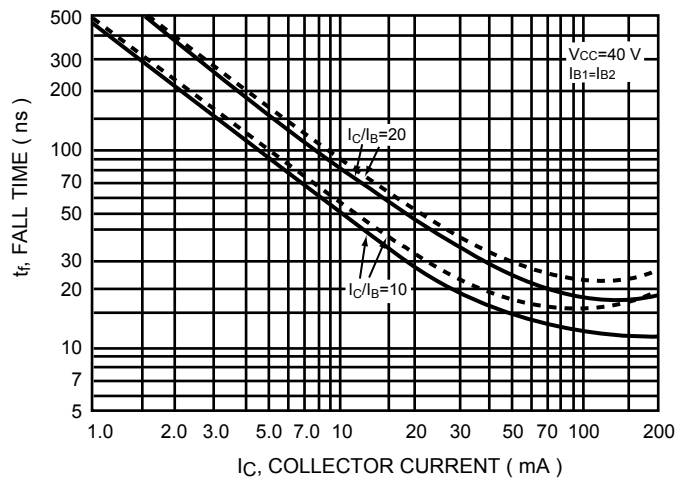


Figure 8. Fall Time

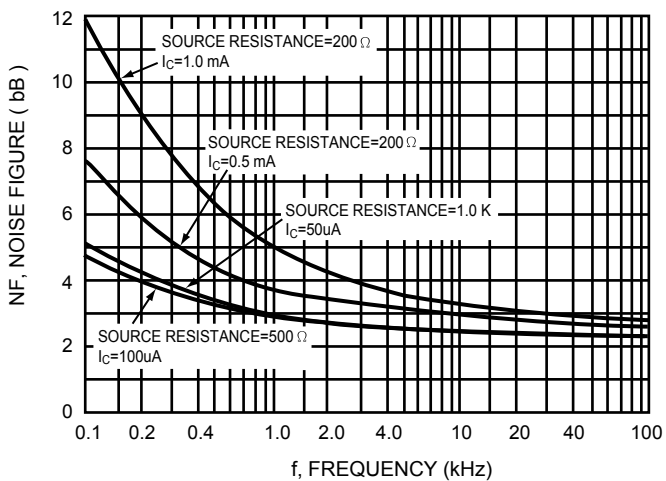


Figure 9.

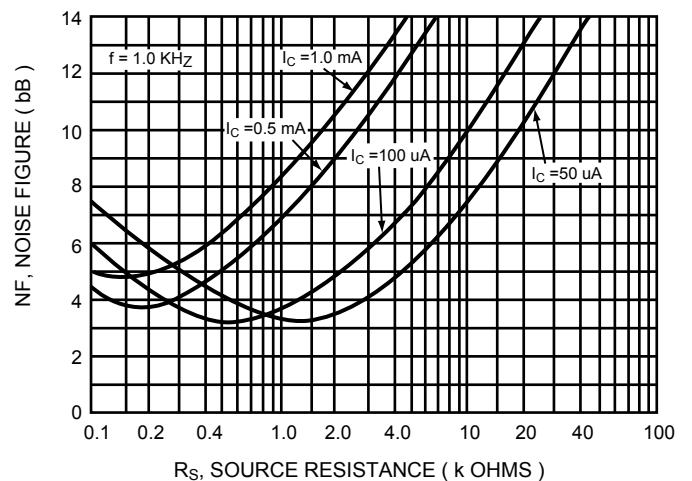


Figure 10.



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## RATINGS AND CHARACTERISTIC CURVES

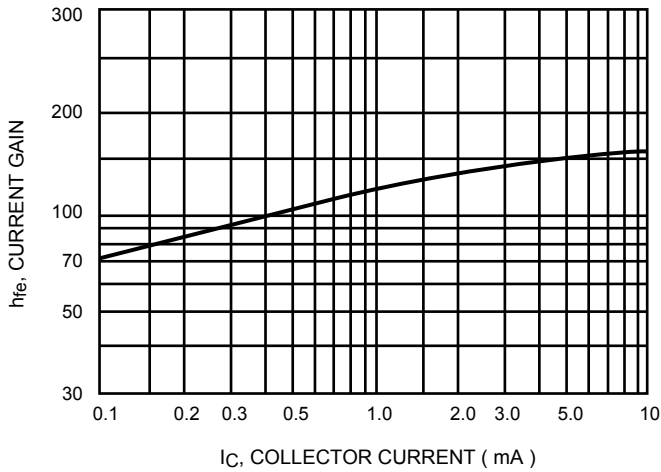


Figure 11. Current Gain

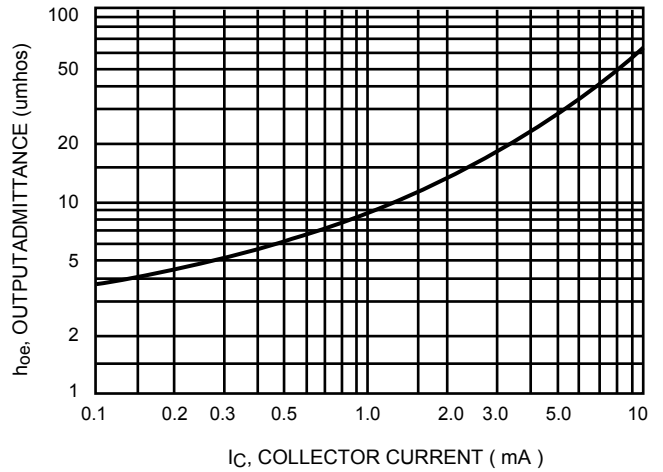


Figure 12. Output Admittance

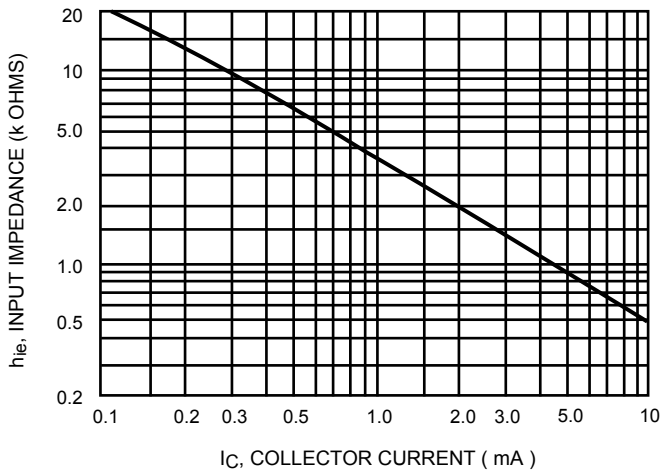


Figure 13. Input Impedance

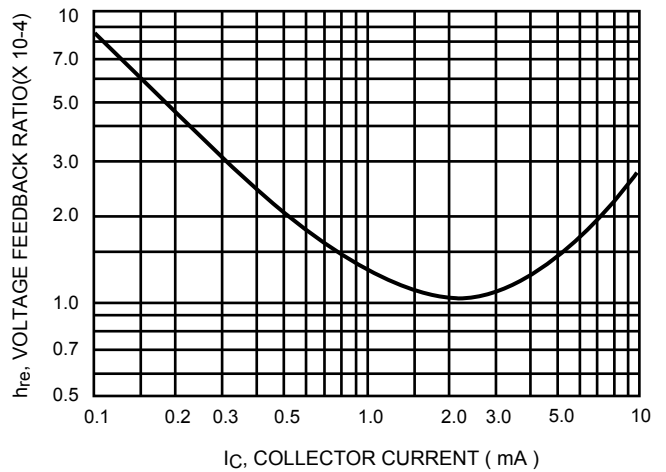


Figure 14. Voltage Feedback Ratio

### TYPICAL STATIC CHARACTERISTICS

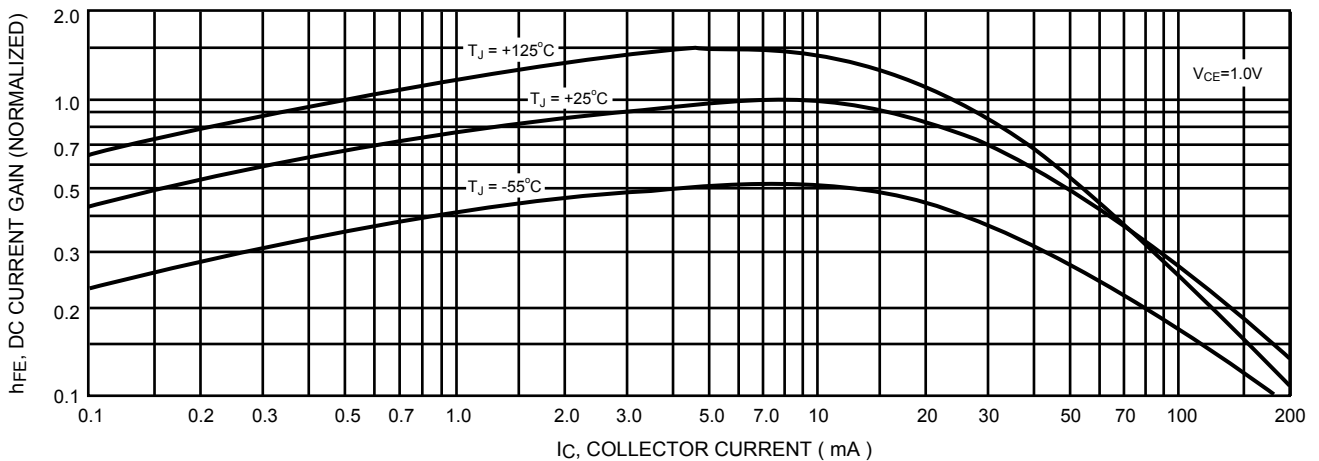


Figure 15. DC Current Gain



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## RATINGS AND CHARACTERISTIC CURVES

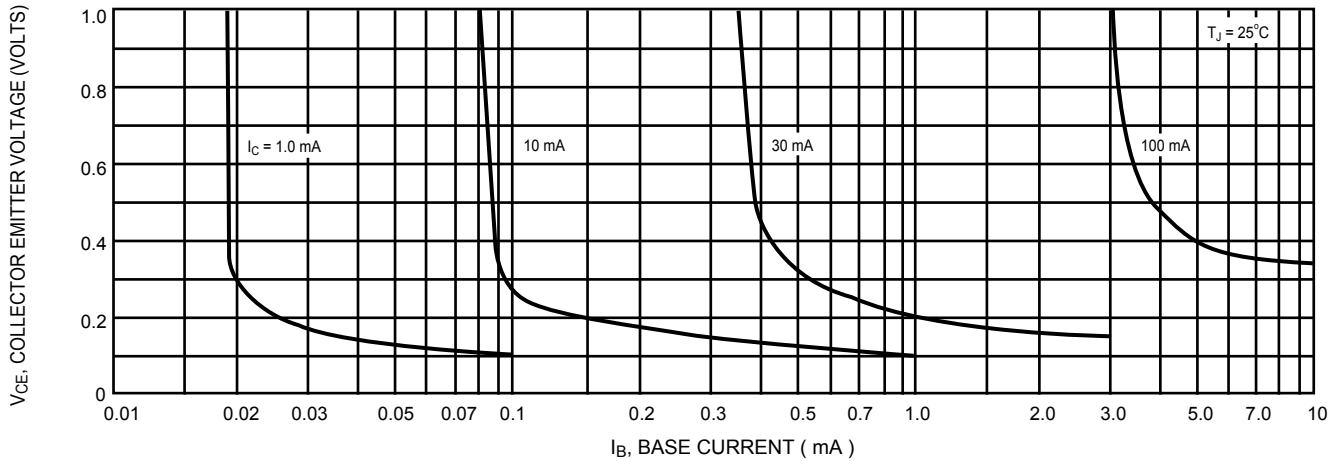


Figure 16. Collector Saturation Region

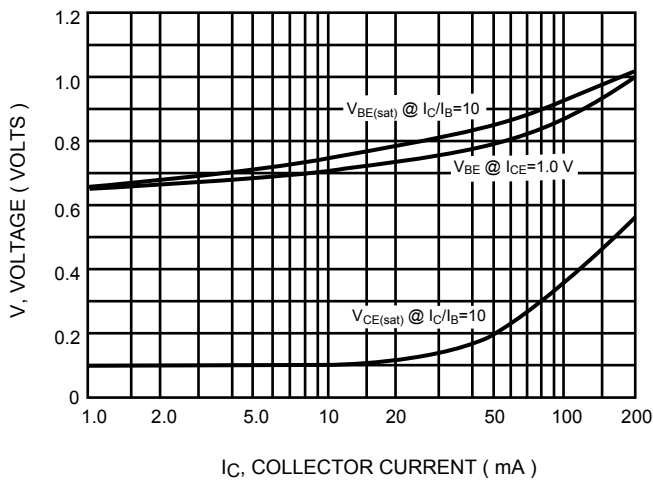


Figure 17. " ON " Voltage

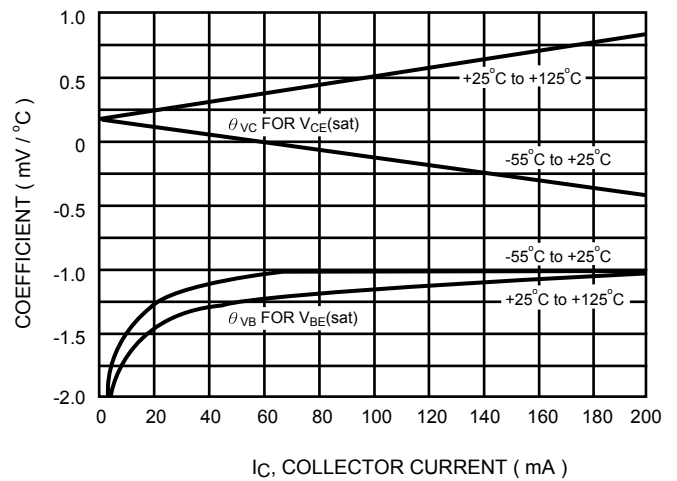


Figure 18. Temperature Coefficients