



DATA SHEET

SEMICONDUCTOR

MMBT3904T/MMBT3906T

General Purpose Transistors

NPN and PNP Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SC-89 which is designed for low power surface mount applications.

- Pb-Free Package is available.

DEVICE MARKING AND ORDERING INFORMATION

Device	Marking	Package	Shipping
MMBT3904T	MA	SC-89	3000/Tape&Reel
MMBT3906T	2A	SC-89	3000/Tape&Reel

MAXIMUM RATINGS

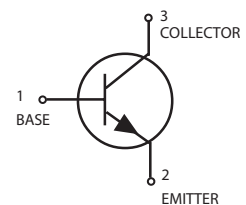
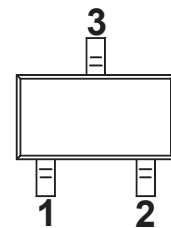
Rating	Symbol	Value	Unit	
Collector–Emitter Voltage	MMBT3904T	V_{CE0}	40	Vdc
	MMBT3906T		– 40	
Collector–Base Voltage	MMBT3904T	V_{CBO}	60	Vdc
	MMBT3906T		– 40	
Emitter–Base Voltage	MMBT3904T	V_{EBO}	6.0	Vdc
	MMBT3906T		– 5.0	
Collector Current — Continuous	MMBT3904T	I_C	200	mAdc
	MMBT3906T		– 200	

THERMAL CHARACTERISTICS

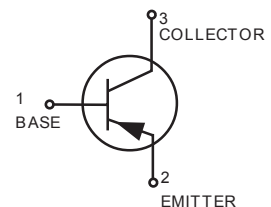
Characteristic	Symbol	Max	Unit
Total Device Dissipation (1) $T_A=25\text{ }^\circ\text{C}$	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	$^\circ\text{C/W}$
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	$^\circ\text{C}$



SC-89



MMBT3904T



MMBT3906T

MMBT3904T/MMBT3906T

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (2)					
(I _C = 1.0 mA _{dc} , I _B = 0)	MMBT3904T	V _{(BR)CEO}	40	—	V _{dc}
(I _C = -1.0 mA _{dc} , I _B = 0)	MMBT3906T		- 40	—	
Collector–Base Breakdown Voltage					
(I _C = 10 μA _{dc} , I _E = 0)	MMBT3904T	V _{(BR)CBO}	60	—	V _{dc}
(I _C = -10 μA _{dc} , I _E = 0)	MMBT3906T		- 40	—	
Emitter–Base Breakdown Voltage					
(I _E = 10 μA _{dc} , I _C = 0)	MMBT3904T	V _{(BR)EBO}	6.0	—	V _{dc}
(I _E = -10 μA _{dc} , I _C = 0)	MMBT3906T		- 5.0	—	
Base Cutoff Current					
(V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc})	MMBT3904T	I _{BL}	—	50	nA _{dc}
(V _{CE} = -30 V _{dc} , V _{EB} = -3.0 V _{dc})	MMBT3906T		—	-50	
Collector Cutoff Current					
(V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc})	MMBT3904T	I _{CEX}	—	50	nA _{dc}
(V _{CE} = -30 V _{dc} , V _{EB} = -3.0 V _{dc})	MMBT3906T		—	- 50	

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤300 μs; Duty Cycle ≤2.0%.

MMBT3904T/MMBT3906T

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS (2)				
DC Current Gain	h_{FE}			—
(I _C = 0.1 mA _{dc} , V _{CE} = 1.0 V _{dc})	MMBT3904T	40	—	
(I _C = 1.0 mA _{dc} , V _{CE} = 1.0 V _{dc})		70	—	
(I _C = 10 mA _{dc} , V _{CE} = 1.0 V _{dc})		100	300	
(I _C = 50 mA _{dc} , V _{CE} = 1.0 V _{dc})		60	—	
(I _C = 100 mA _{dc} , V _{CE} = 1.0 V _{dc})		30	—	
(I _C = -0.1 mA _{dc} , V _{CE} = -1.0 V _{dc})	MMBT3906T	60	—	
(I _C = -1.0 mA _{dc} , V _{CE} = -1.0 V _{dc})		80	—	
(I _C = -10 mA _{dc} , V _{CE} = -1.0 V _{dc})		100	300	
(I _C = -50 mA _{dc} , V _{CE} = -1.0 V _{dc})		60	—	
(I _C = -100 mA _{dc} , V _{CE} = -1.0 V _{dc})		30	—	
Collector-Emitter Saturation Voltage	V _{CE(sat)}			V _{dc}
(I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc})	MMBT3904T	—	0.2	
(I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc})		—	0.3	
(I _C = -10 mA _{dc} , I _B = -1.0 mA _{dc})	MMBT3906T	—	-0.25	
(I _C = -50 mA _{dc} , I _B = -5.0 mA _{dc})		—	-0.4	
Base-Emitter Saturation Voltage	V _{BE(sat)}			V _{dc}
(I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc})	MMBT3904T	0.65	0.85	
(I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc})		—	0.95	
(I _C = -10 mA _{dc} , I _B = -1.0 mA _{dc})	MMBT3906T	-0.65	-0.85	
(I _C = -50 mA _{dc} , I _B = -5.0 mA _{dc})		—	-0.95	

SMALL-SIGNAL CHARACTERISTICS

	Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product	f _T			MHz
(I _C = 10 mA _{dc} , V _{CE} = 20 V _{dc} , f = 100 MHz)	MMBT3904T	300	—	
(I _C = -10 mA _{dc} , V _{CE} = -20 V _{dc} , f = 100 MHz)	MMBT3906T	250	—	
Output Capacitance	C _{obo}			pF
(V _{CB} = 5.0 V _{dc} , I _E = 0, f = 1.0 MHz)	MMBT3904T	—	4.0	
(V _{CB} = -5.0 V _{dc} , I _E = 0, f = 1.0 MHz)	MMBT3906T	—	4.5	
Input Capacitance	C _{ibo}			pF
(V _{EB} = 0.5 V _{dc} , I _C = 0, f = 1.0 MHz)	MMBT3904T	—	8.0	
(V _{EB} = -0.5 V _{dc} , I _C = 0, f = 1.0 MHz)	MMBT3906T	—	10.0	
Input Impedance	h _{ie}			kΩ
(V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz)	MMBT3904T	1.0	10	
(V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz)	MMBT3906T	2.0	12	
Voltage Feedback Ratio	h _{re}			X 10 ⁻⁴
(V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz)	MMBT3904T	0.5	8.0	
(V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz)	MMBT3906T	0.1	10	
Small-Signal Current Gain	h _{fe}			—
(V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz)	MMBT3904T	100	400	
(V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz)	MMBT3906T	100	400	
Output Admittance	h _{oe}			μhos
(V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz)	MMBT3904T	1.0	40	
(V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz)	MMBT3906T	3.0	60	
Noise Figure	NF			dB
(V _{CE} = 5.0V _{dc} , I _C = 100μA _{dc} , R _S = 1.0 kΩ, f = 1.0kHz)	MMBT3904T	—	5.0	
(V _{CE} = -5.0V _{dc} , I _C = -100 μA _{dc} , R _S = 1.0 kΩ, f = 1.0kHz)	MMBT3906T	—	4.0	

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

SWITCHING CHARACTERISTICS

		Symbol	Min	Max	Unit
Delay Time ($V_{CC} = 3.0 \text{ Vdc}$, $V_{BE} = -0.5 \text{ Vdc}$)	MMBT3904T	t_d	—	35	ns
	($V_{CC} = -3.0 \text{ Vdc}$, $V_{BE} = 0.5 \text{ Vdc}$)	MMBT3906T	—	35	
Rise Time ($I_C = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$)	MMBT3904T	t_r	—	35	ns
	($I_C = -10 \text{ mAdc}$, $I_{B1} = -1.0 \text{ mAdc}$)	MMBT3906T	—	35	
Storage Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_C = 10 \text{ mAdc}$)	MMBT3904T	t_s	—	200	ns
	($V_{CC} = -3.0 \text{ Vdc}$, $I_C = -10 \text{ mAdc}$)	MMBT3906T	—	225	
Fall Time ($I_{B1} = I_{B2} = 1.0 \text{ mAdc}$)	MMBT3904T	t_f	—	50	ns
	($I_{B1} = I_{B2} = -1.0 \text{ mAdc}$)	MMBT3906T	—	75	

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

MMBT3904T

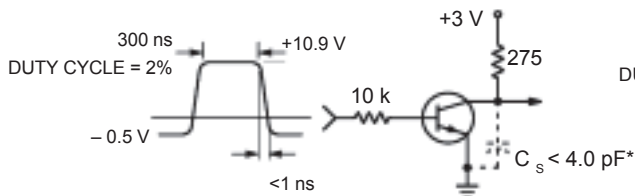


Figure 1. Delay and Rise Time
Equivalent Test Circuit

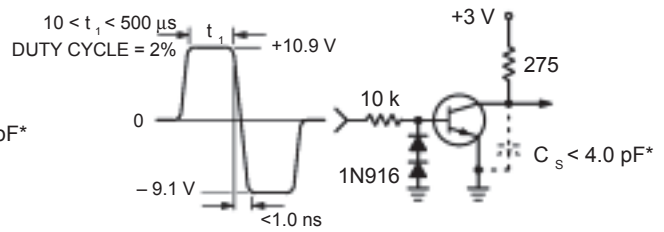


Figure 2. Storage and Fall Time
Equivalent Test Circuit

*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

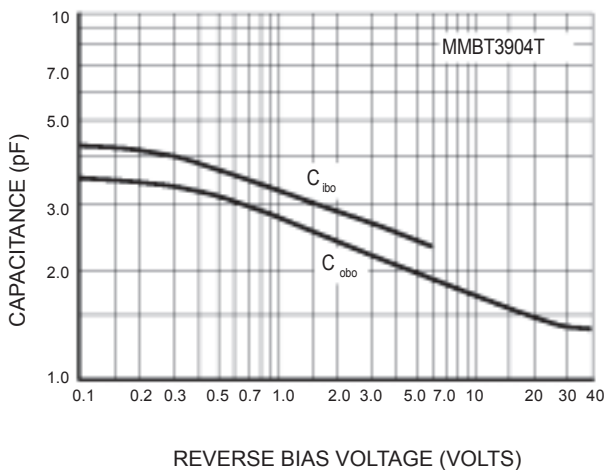


Figure 3. Capacitance

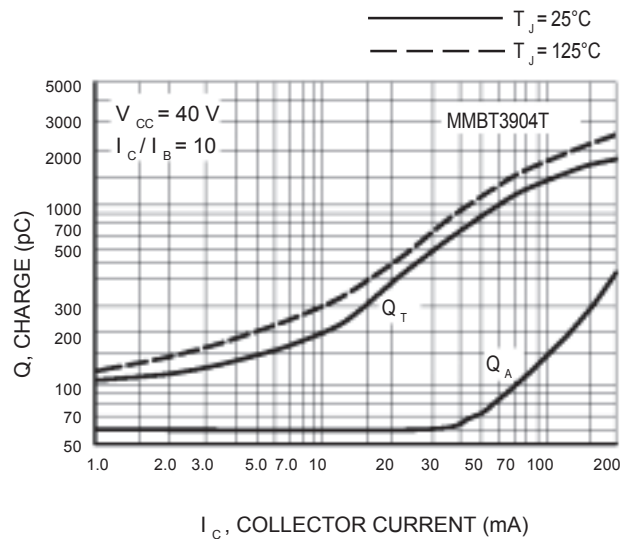


Figure 4. Charge Data

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

MMBT3904T

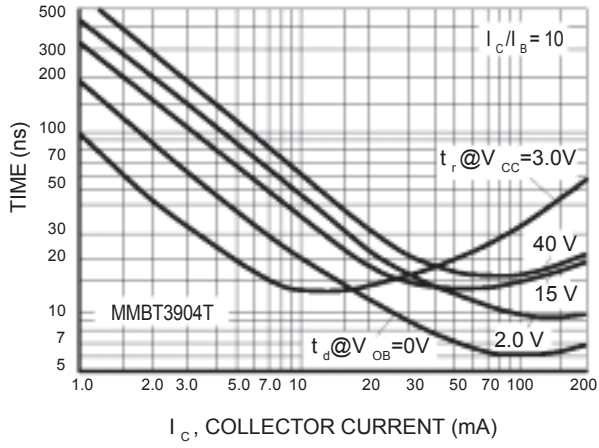


Figure 5. Turn-On Time

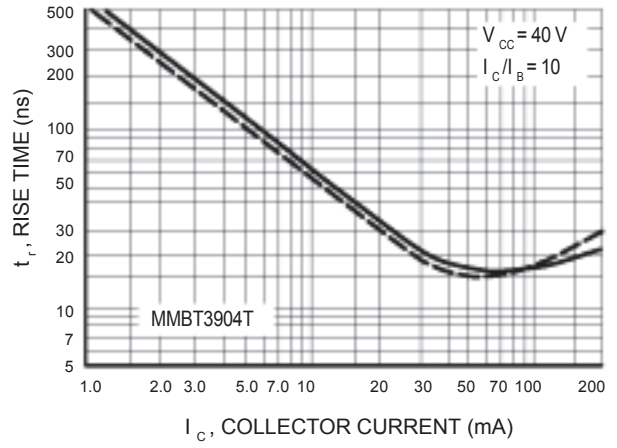


Figure 6. Rise Time

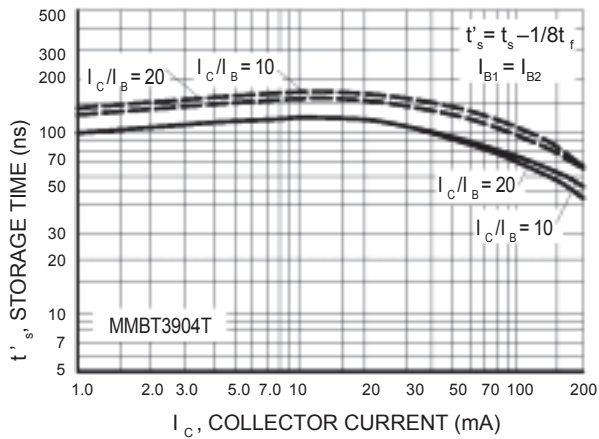


Figure 7. Storage Time

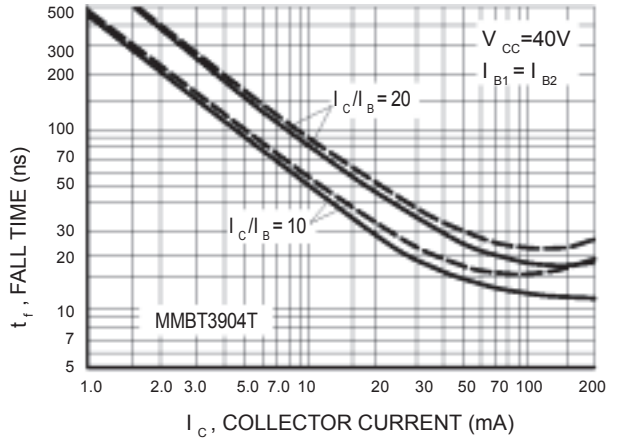


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

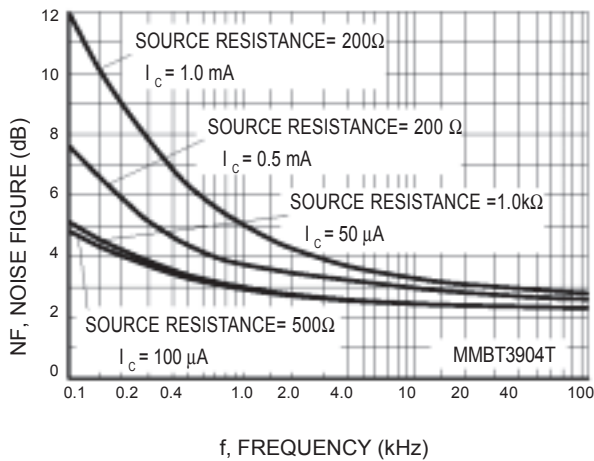


Figure 9. Noise Figure

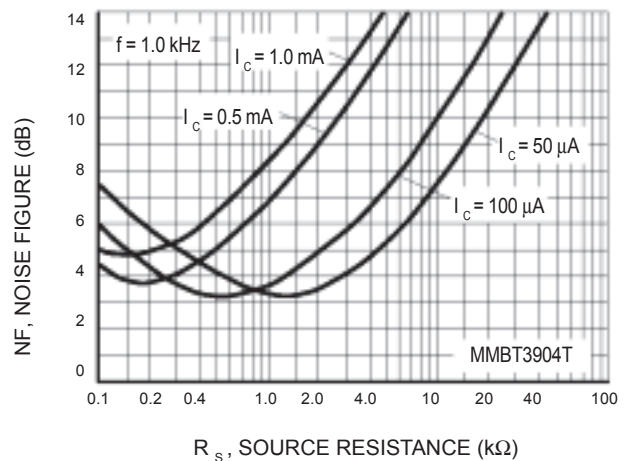


Figure 10. Noise Figure

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

h PARAMETERS

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

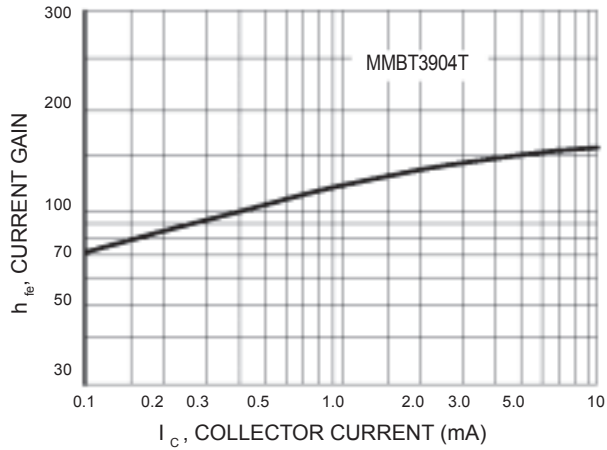


Figure 11. Current Gain

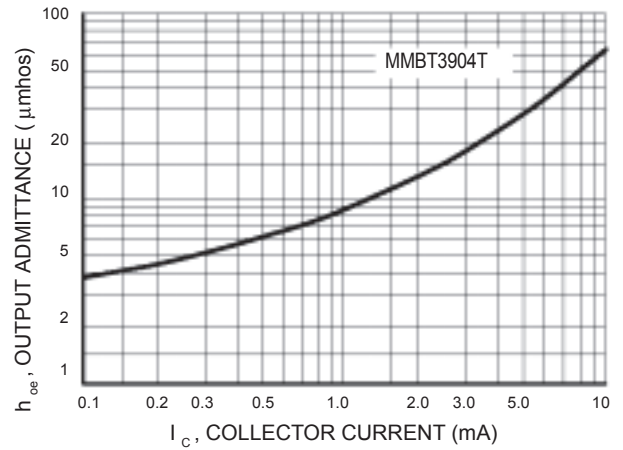


Figure 12. Output Admittance

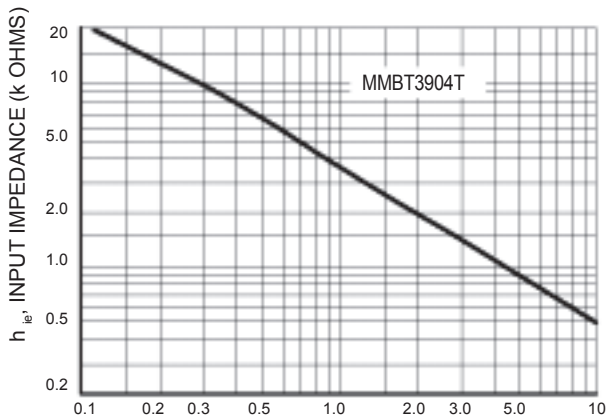


Figure 13. Input Impedance

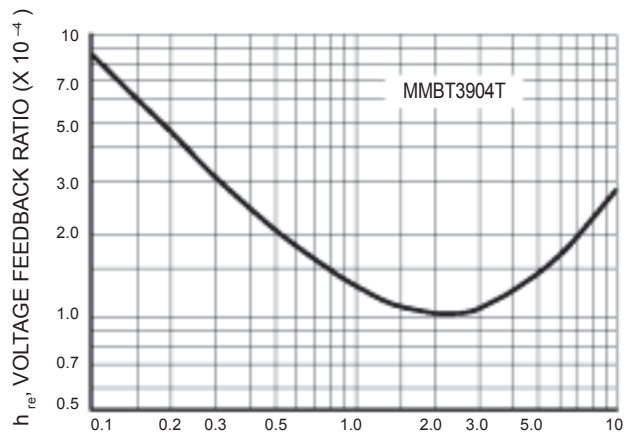


Figure 14. Voltage Feedback Ratio

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

MMBT3904T
TYPICAL STATIC CHARACTERISTICS

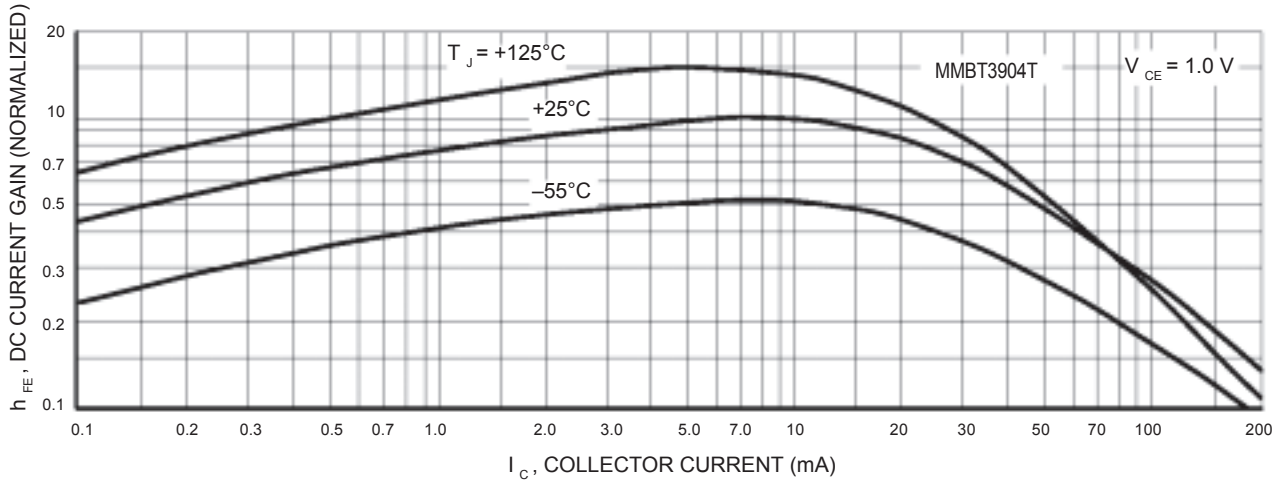


Figure 15. DC Current Gain

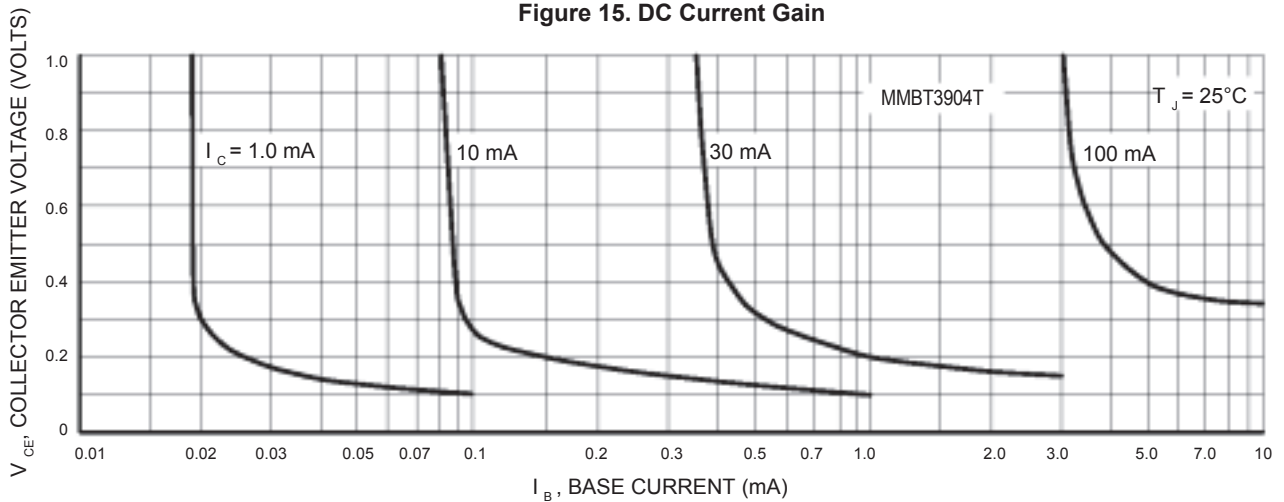


Figure 16. Collector Saturation Region

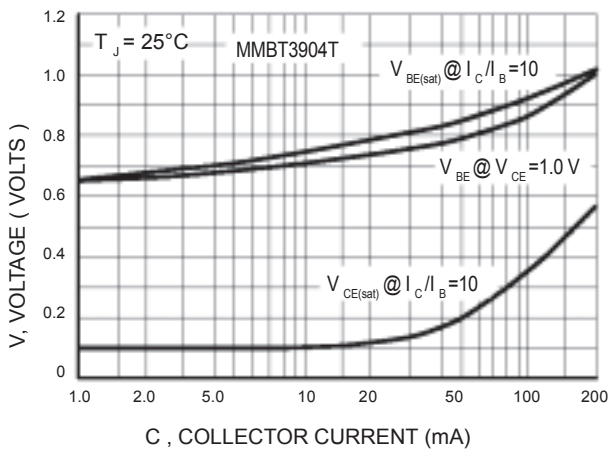


Figure 17. "ON" Voltages

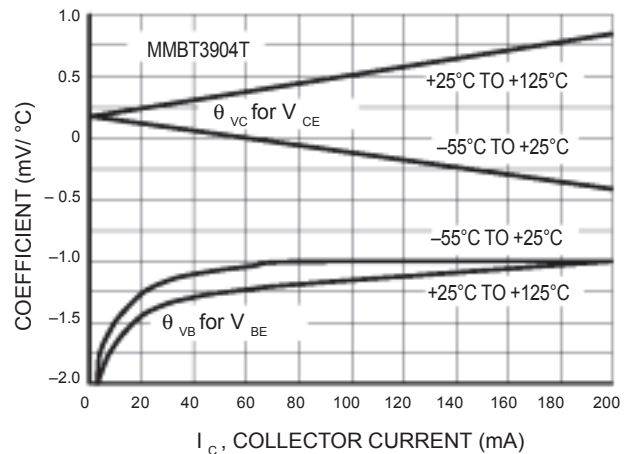
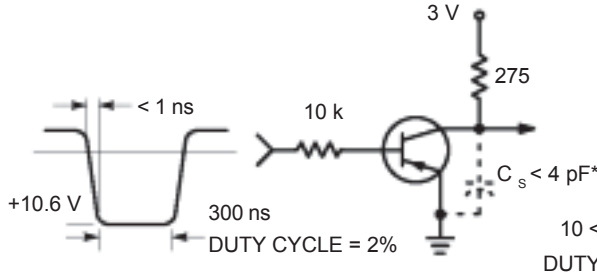


Figure 18. Temperature Coefficients

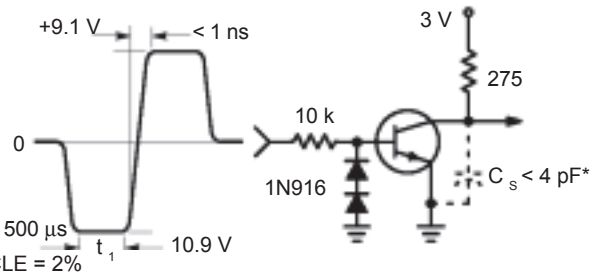
DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

MMBT3906T



**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

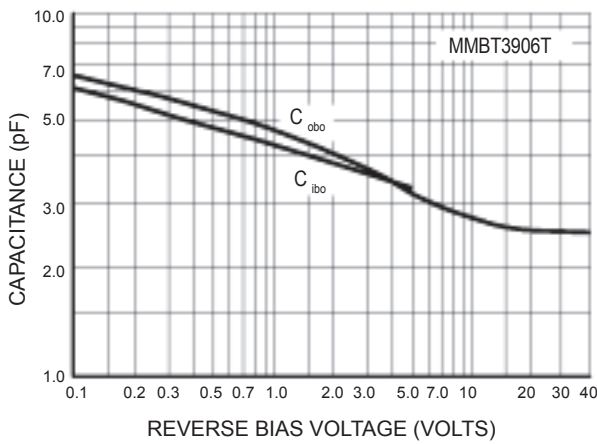


Figure 21. Capacitance

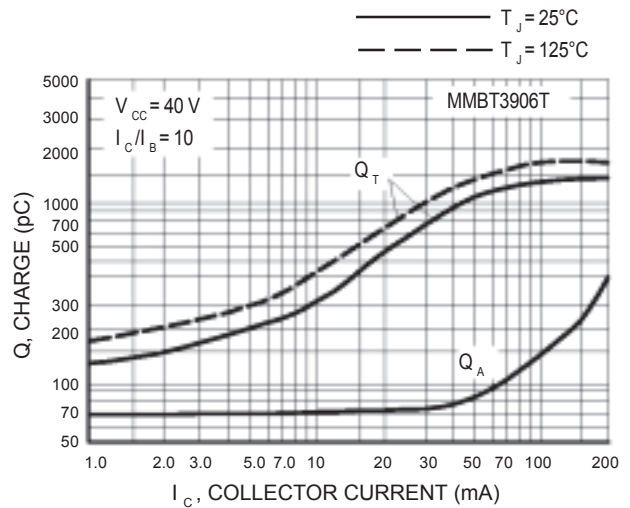


Figure 22. Charge Data

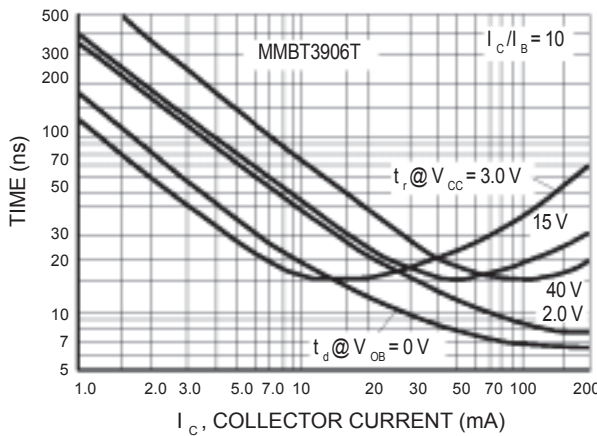


Figure 23. Turn-On Time

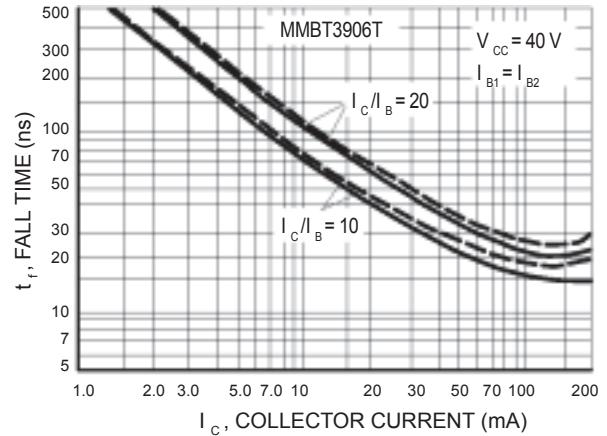


Figure 24. Fall Time

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

MMBT3906T

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

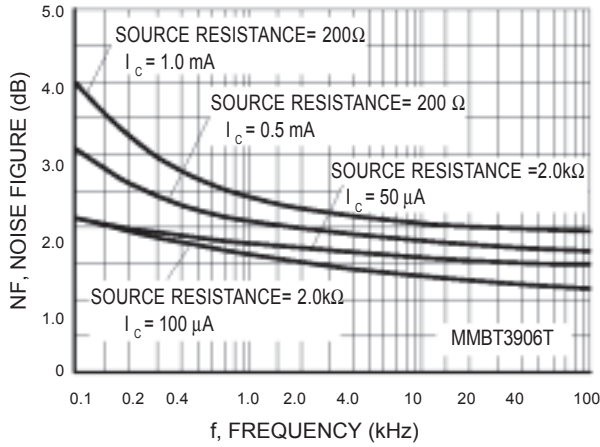


Figure 25

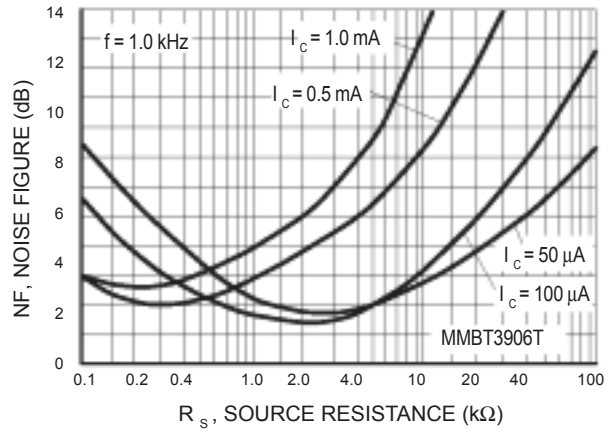


Figure 26

h PARAMETERS

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

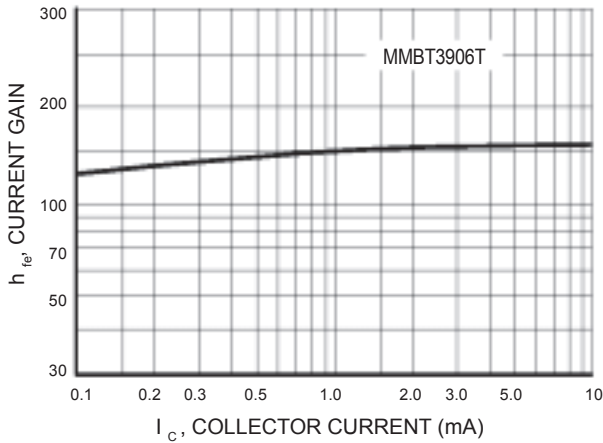


Figure 27. Current Gain

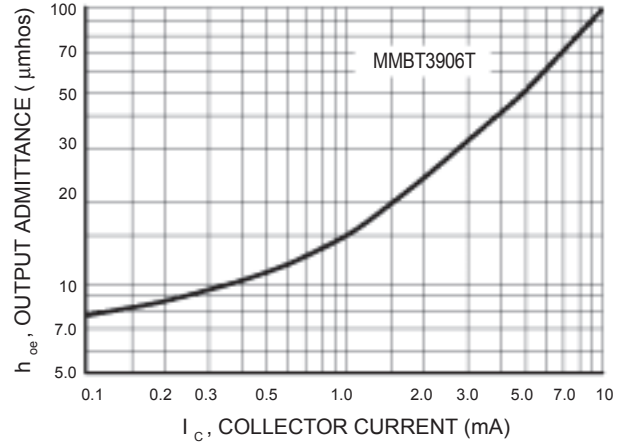


Figure 28. Output Admittance

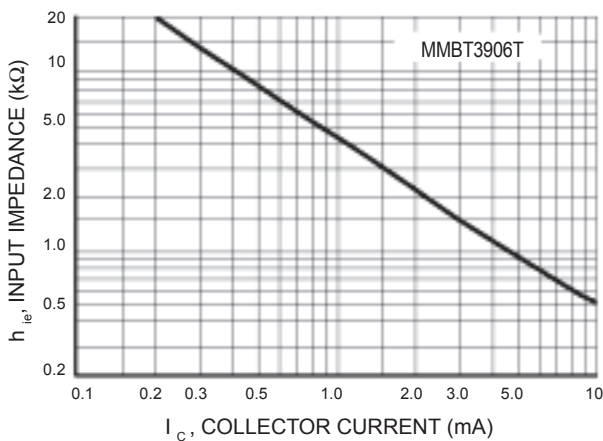


Figure 29. Input Impedance

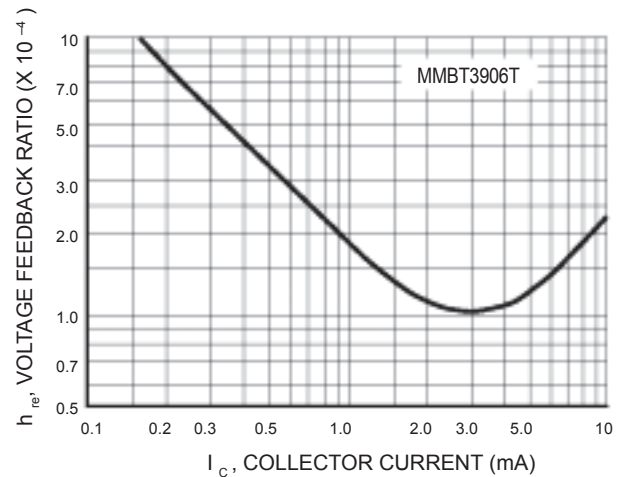


Figure 30. Voltage Feedback Ratio

DEVICE CHARACTERISTICS

MMBT3904T/MMBT3906T

MMBT3906T STATIC CHARACTERISTICS

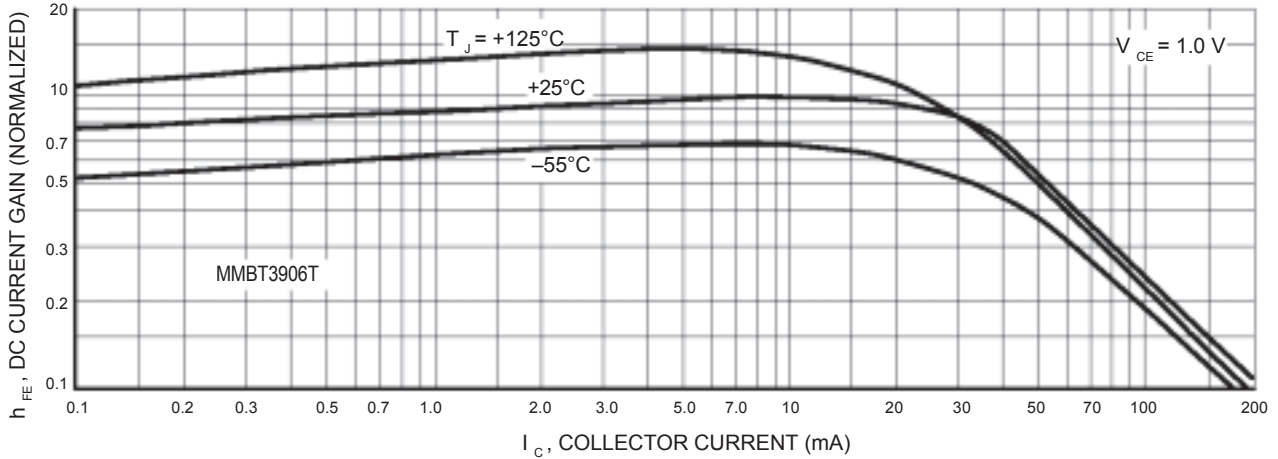


Figure 31. DC Current Gain

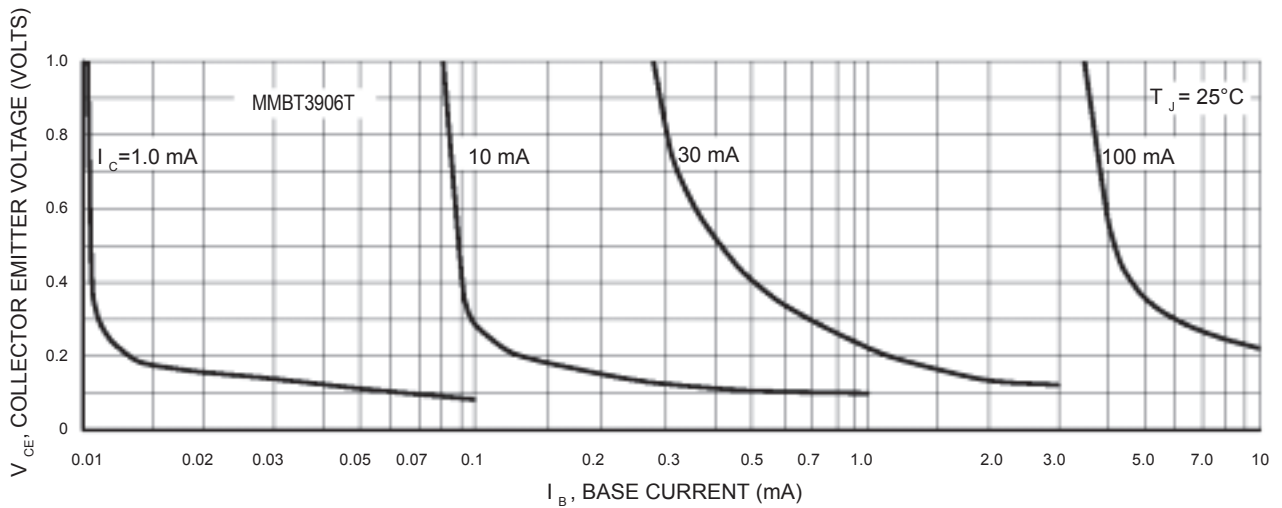


Figure 32. Collector Saturation Region

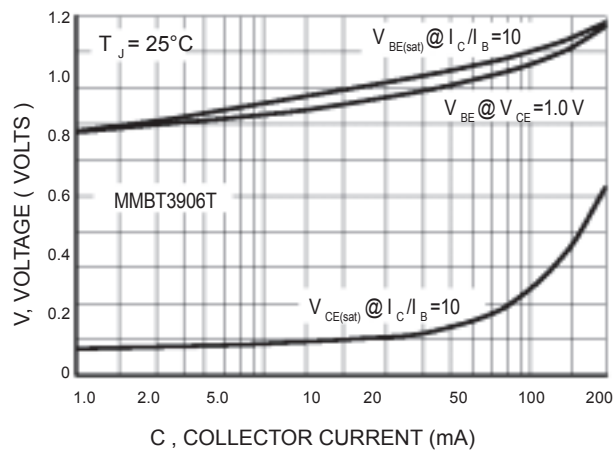


Figure 33. "ON" Voltages

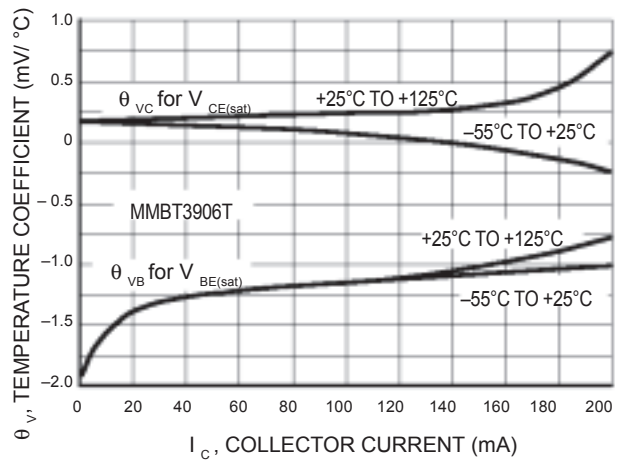
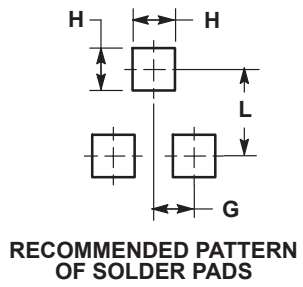
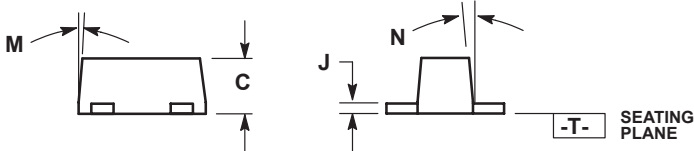
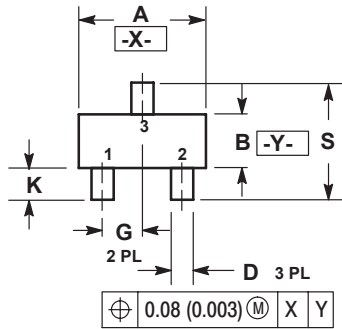


Figure 34. Temperature Coefficients

PACKAGE OUTLINE & DIMENSIONS

MMBT3904T/MMBT3906T

SC-89



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 463C-01 OBSOLETE, NEW STANDARD 463C-02.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.50	1.60	1.70	0.059	0.063	0.067
B	0.75	0.85	0.95	0.030	0.034	0.040
C	0.60	0.70	0.80	0.024	0.028	0.031
D	0.23	0.28	0.33	0.009	0.011	0.013
G	0.50 BSC			0.020 BSC		
H	0.53 REF			0.021 REF		
J	0.10	0.15	0.20	0.004	0.006	0.008
K	0.30	0.40	0.50	0.012	0.016	0.020
L	1.10 REF			0.043 REF		
M	---	---	10 °	---	---	10 °
N	---	---	10 °	---	---	10 °
S	1.50	1.60	1.70	0.059	0.063	0.067