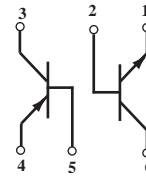
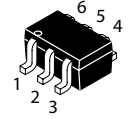


### Dual General Purpose Transistor NPN+PNP Silicon

 Lead(Pb)-Free



NPN+PNP



SOT-363(SC-88)

### 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

### Thermal Characteristics

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

### Device Marking

MBT3946DW=46

**Off Characteristics**

Collector-Emitter Breakdown Voltage <sup>(2)</sup> ( $I_C=1.0\text{mA}$ , $I_B=0$ ) (NPN) ( $I_C=-1.0\text{mA}$ , $I_B=0$ ) (PNP)	$V_{(BR)CEO}$	40 -40	- -	Vdc
Collector-Base Breakdown Voltage ( $I_C=10\text{ }\mu\text{A}$ , $I_E=0$ ) (NPN) ( $I_C=-10\text{ }\mu\text{A}$ , $I_E=0$ ) (PNP)	$V_{(BR)CBO}$	60 -40	- -	Vdc
Emitter-Base Breakdown Voltage ( $I_E=10\text{ }\mu\text{A}$ , $I_C=0$ ) (NPN) ( $I_E=-10\text{ }\mu\text{A}$ , $I_C=0$ ) (PNP)	$V_{(BR)EBO}$	6.0 -5.0	- -	Vdc
Base Cutoff Current ( $V_{CE}=30\text{ Vdc}$ , $V_{EB}=3.0\text{ Vdc}$ ) (NPN) ( $V_{CE}=-30\text{ Vdc}$ , $V_{EB}=-3.0\text{ Vdc}$ ) (PNP)	IBL	- -	50 -50	nAdc
Collector Cutoff Current ( $V_{CE}=30\text{Vdc}$ , $V_{EB}=3.0\text{Vdc}$ ) (NPN) ( $V_{CE}=-30\text{Vdc}$ , $V_{EB}=-3.0\text{Vdc}$ ) (PNP)	ICEX	- -	50 -50	nAdc

1. Device Mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

**Electrical Characteristics** ( $T_A=25^\circ\text{C}$  unless otherwise noted) (Continued)

Characteristics	Symbol	Min	Max	Unit
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**On Characteristics (2)**

DC Current Gain ( $I_C=0.1\text{ mA}$ , $V_{CE}=1.0\text{Vdc}$ ) (NPN) ( $I_C=1.0\text{ mA}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=10\text{ mA}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=50\text{ mA}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=100\text{ mA}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=-0.1\text{ mA}$ , $V_{CE}=-1.0\text{Vdc}$ ) (PNP) ( $I_C=-1.0\text{ mA}$ , $V_{CE}=-1.0\text{Vdc}$ ) ( $I_C=-10\text{ mA}$ , $V_{CE}=-1.0\text{Vdc}$ ) ( $I_C=-50\text{ mA}$ , $V_{CE}=-1.0\text{Vdc}$ ) ( $I_C=-100\text{ mA}$ , $V_{CE}=-1.0\text{Vdc}$ )	HFE	40 70 100 60 30 60 80 100 60 30	- - 300 - - - - 300 - -	-
Collector-Emitter Saturation Voltage ( $I_C=10\text{ mA}$ , $I_B=1.0\text{mA}$ ) (NPN) ( $I_C=50\text{ mA}$ , $I_B=5.0\text{mA}$ ) ( $I_C=-10\text{ mA}$ , $I_B=-1.0\text{mA}$ ) (PNP) ( $I_C=-50\text{ mA}$ , $I_B=-5.0\text{mA}$ )	$V_{CE(sat)}$	- - - -	0.20 0.30 -0.25 -0.40	Vdc
Base-Emitter Saturation Voltage ( $I_C=10\text{ mA}$ , $I_B=1.0\text{mA}$ ) (NPN) ( $I_C=50\text{ mA}$ , $I_B=5.0\text{mA}$ ) ( $I_C=-10\text{ mA}$ , $I_B=-1.0\text{mA}$ ) (PNP) ( $I_C=-50\text{ mA}$ , $I_B=-5.0\text{mA}$ )	$V_{BE(sat)}$	0.65 - -0.65 -	0.85 0.95 -0.85 -0.95	Vdc

## Small-signal Characteristics

Current-Gain-Bandwidth Product ( $I_C=10\text{ mAdc}$ , $V_{CE}=20\text{ Vdc}$ , $f=100\text{ MHz}$ ) (NPN) ( $I_C=-10\text{ mAdc}$ , $V_{CE}=-20\text{ Vdc}$ , $f=100\text{ MHz}$ ) (PNP)	$f_T$	300 250	- -	MHz
Output Capacitance ( $V_{CB}=5.0\text{ Vdc}$ , $I_E=0$ , $f=1.0\text{ MHz}$ ) (NPN) ( $V_{CB}=-5.0\text{ Vdc}$ , $I_E=0$ , $f=1.0\text{ MHz}$ ) (PNP)	$C_{obo}$	- -	4.0 4.5	pF
Input Capacitance ( $V_{EB}=0.5\text{ Vdc}$ , $I_C=0$ , $f=1.0\text{ MHz}$ ) (NPN) ( $V_{EB}=-0.5\text{ Vdc}$ , $I_C=0$ , $f=1.0\text{ MHz}$ ) (PNP)	$C_{ibo}$	- -	8.0 10.0	pF
Input Impedance ( $V_{CE}=10\text{ Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (NPN) ( $V_{CE}=-10\text{ Vdc}$ , $I_C=-1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (PNP)	$h_{ie}$	1.0 2.0	10 12	k ohms
Voltage Feedback Ratio ( $V_{CE}=10\text{ Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (NPN) ( $V_{CE}=-10\text{ Vdc}$ , $I_C=-1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (PNP)	$h_{re}$	0.5 0.1	8.0 10	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE}=10\text{ Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (NPN) ( $V_{CE}=-10\text{ Vdc}$ , $I_C=-1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (PNP)	$h_{fe}$	100 100	400 400	-
Output Admittance ( $V_{CE}=10\text{ Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (NPN) ( $V_{CE}=-10\text{ Vdc}$ , $I_C=-1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ ) (PNP)	$h_{oe}$	1.0 3.0	40 60	$\mu\text{mhos}$
Noise Figure ( $V_{CE}=5.0\text{ Vdc}$ , $I_C=100\text{ }\mu\text{A}$ , $R_S=1.0\text{ k ohms}$ , $f=1.0\text{ kHz}$ ) (NPN) ( $V_{CE}=-5.0\text{ Vdc}$ , $I_C=-100\text{ }\mu\text{A}$ , $R_S=1.0\text{ k ohms}$ , $f=1.0\text{ kHz}$ ) (PNP)	NF	- -	5.0 4.0	dB

## Switching Characteristics

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

## (NPN)

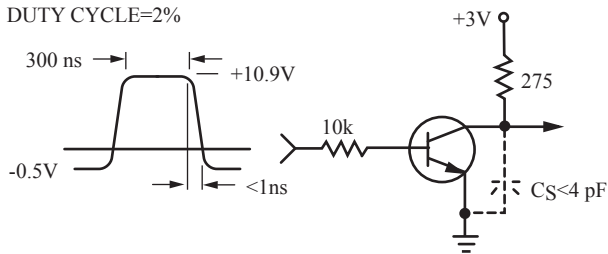


Figure 1. Delay and Rise Time Equivalent Test Circuit

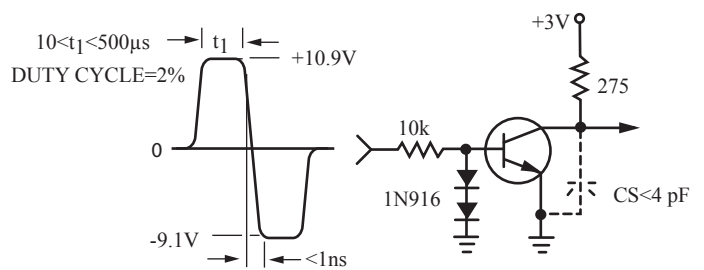


Figure 2. Storage and Fall Time Equivalent Test Circuit

\*Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

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

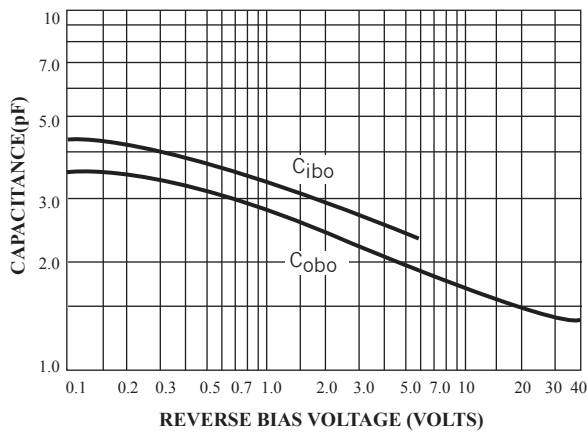


Figure 3. Capacitance

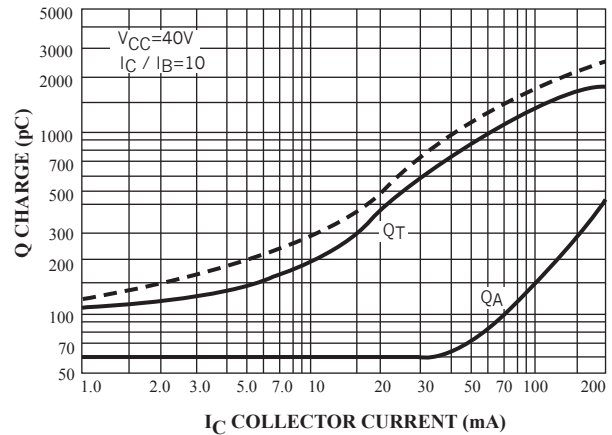


Figure 4. Charge Data

## (NPN)

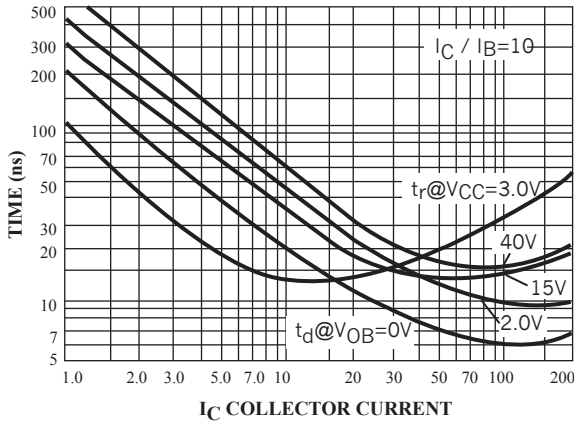


Figure 5. Turn-On Time

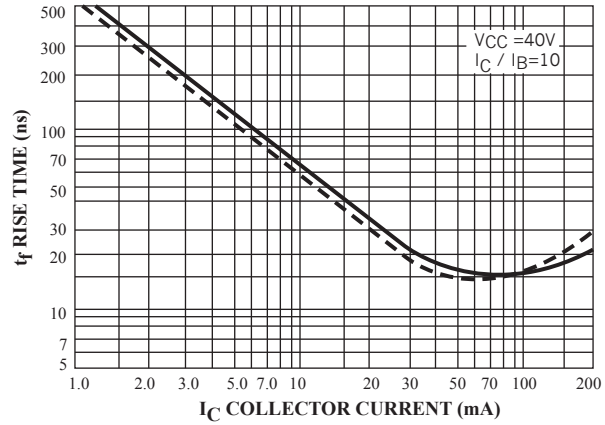


Figure 6. Rise Time

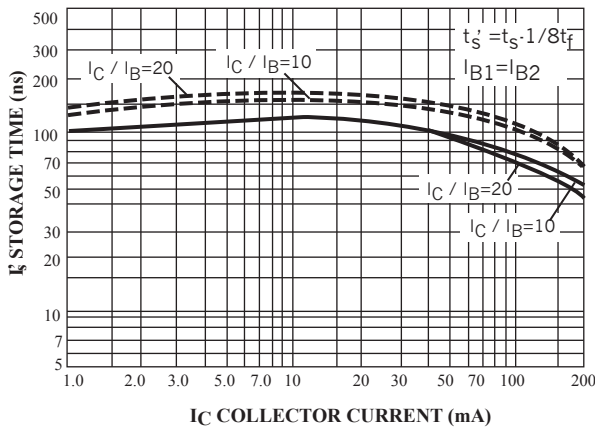


Figure 7. Storage Time

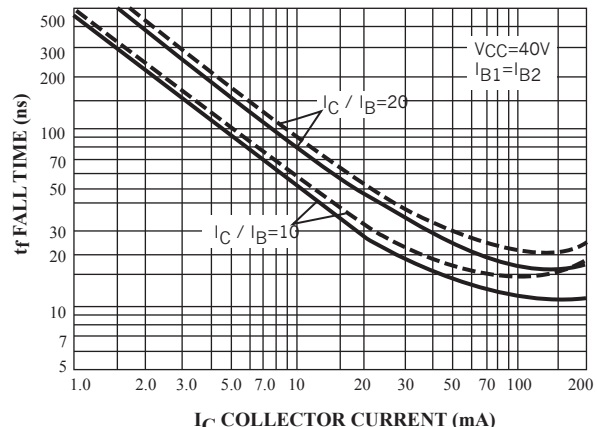


Figure 8. Fall Time

### TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

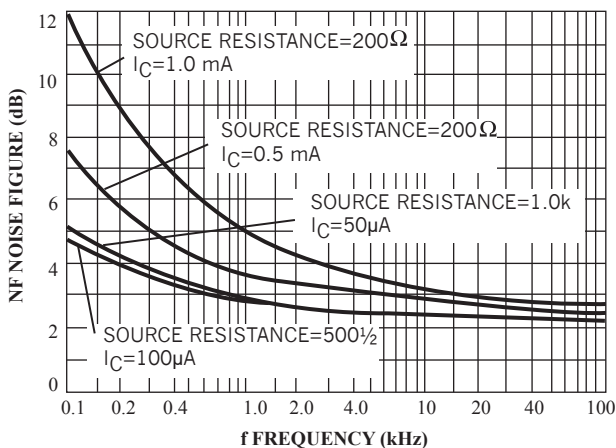


Figure 9.

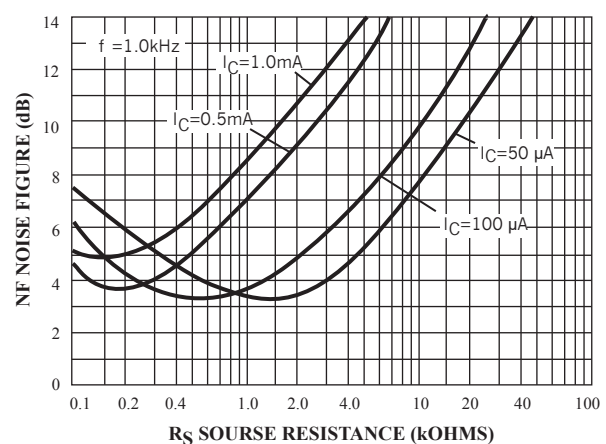


Figure 10.

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

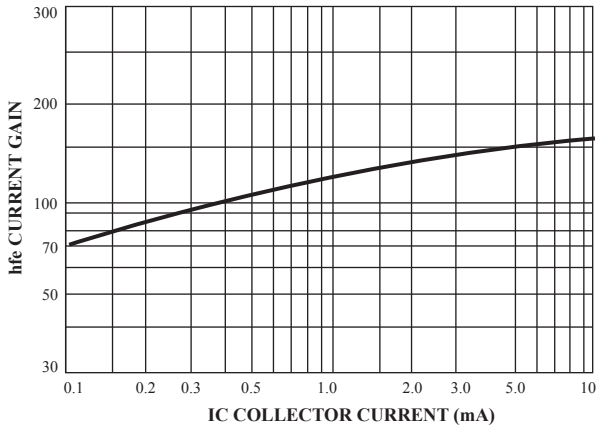


Figure 11. Current Gain

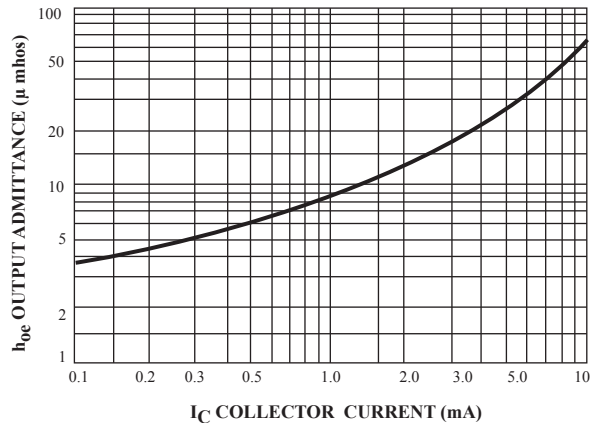


Figure 12. Output Admittance

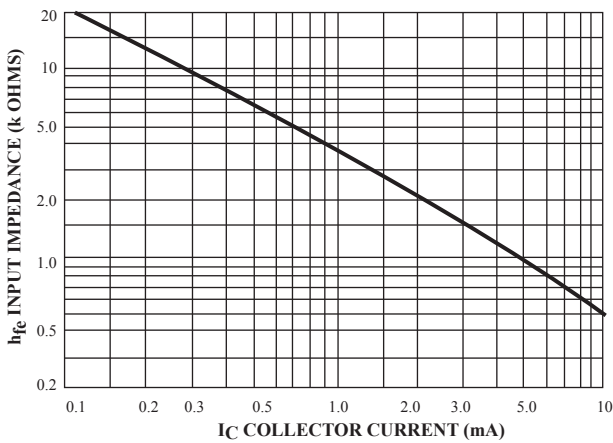


Figure 13. Input Impedance

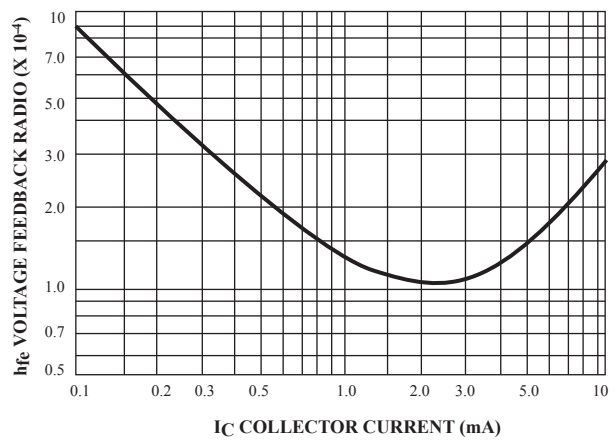


Figure 14. Voltage Feedback Ratio

## TYPICAL STATIC CHARACTERISTICS

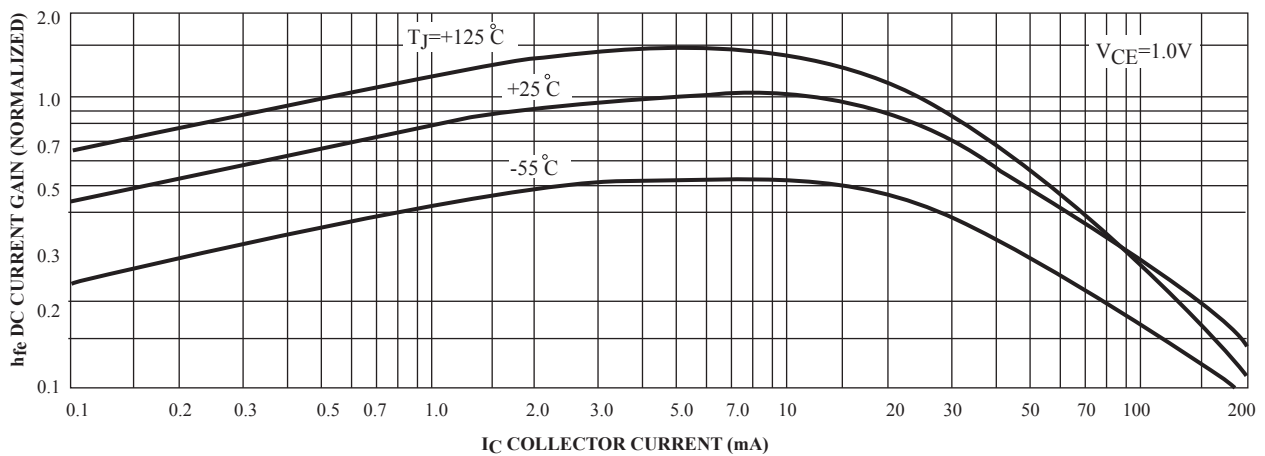


Figure 15. DC Current Gain

## (NPN)

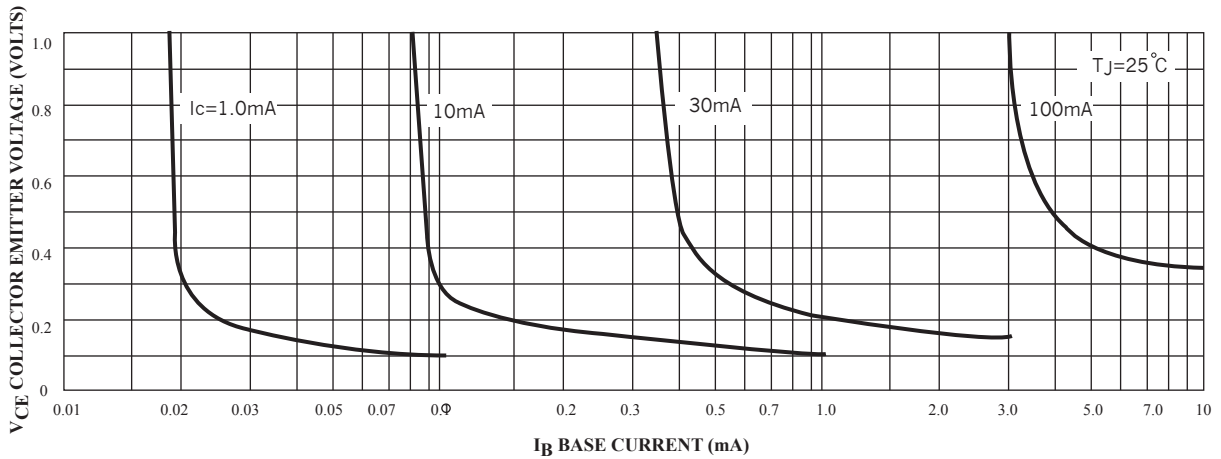


Figure 16. Collector Saturation Region

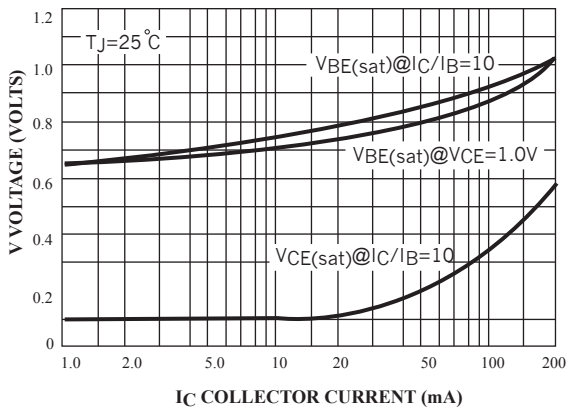


Figure 17. "ON" Voltage

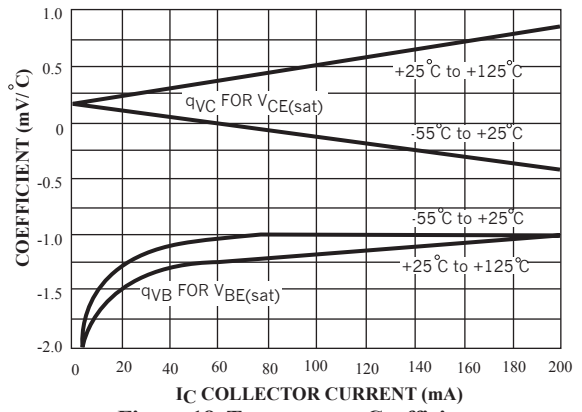


Figure 18. Temperature Coefficients

## (PNP)

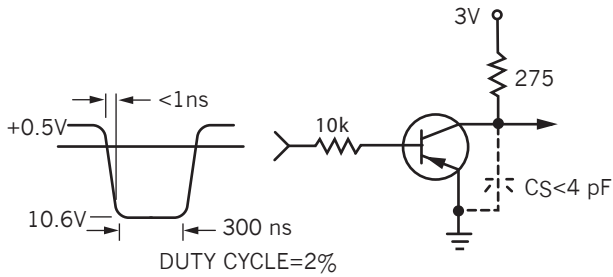


Figure 19. Delay and Rise Time Equivalent Test Circuit

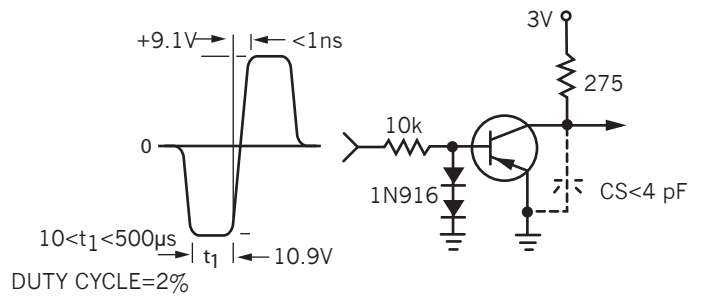


Figure 20 . Storage and Fall Time Equivalent Test Circuit

\*Total shunt capacitance of test jig and connectors

### TYPICAL TRANSIENT CHARACTERISTICS

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

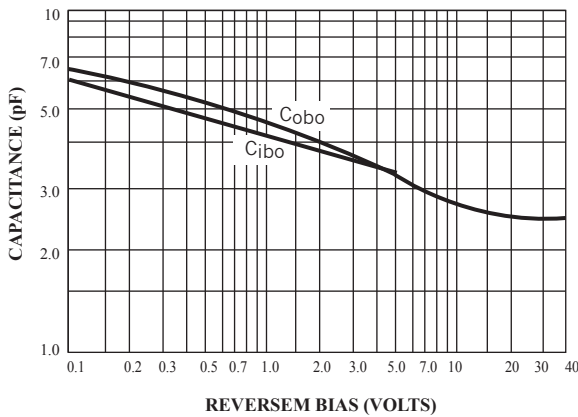


Figure 21. Capacitance

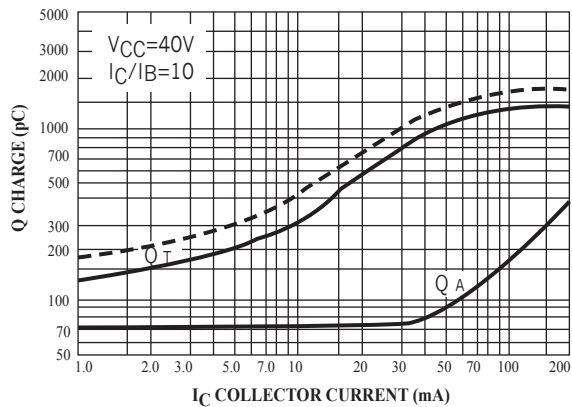


Figure 22. Charge Data

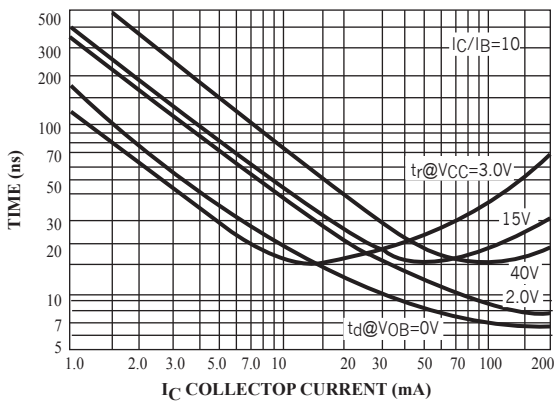


Figure 23. Turn-On Time

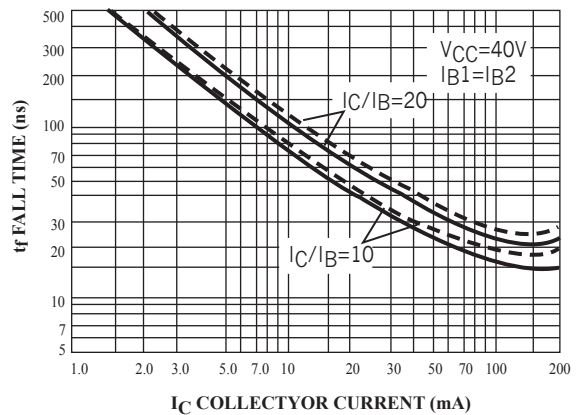


Figure 24. Fall Time



**(PNP)**

**TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS**  
 ( $V_{CE} = -5.0$  Vdc,  $T_A = 25^\circ\text{C}$ , Bandwidth= 1.0Hz)

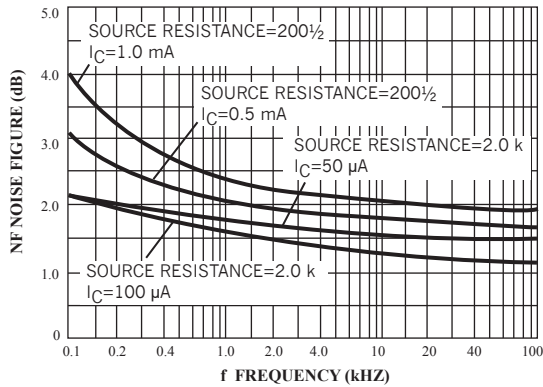


Figure 25.

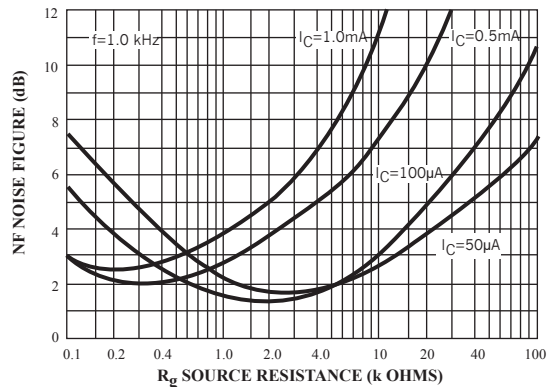


Figure 26.

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

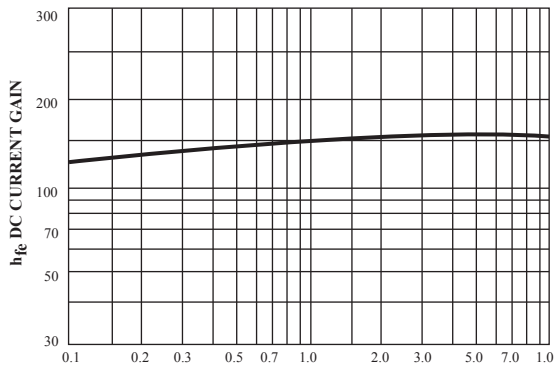


Figure 27. Current Gain

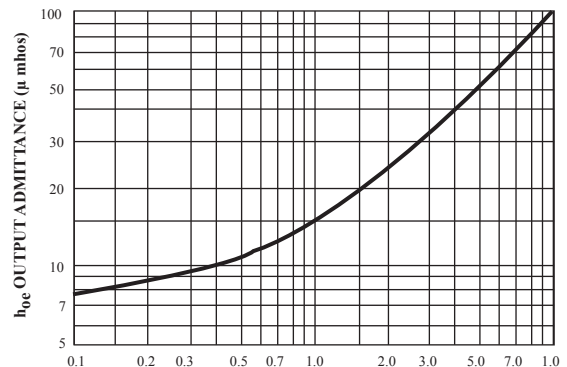


Figure 28. Input Impedance

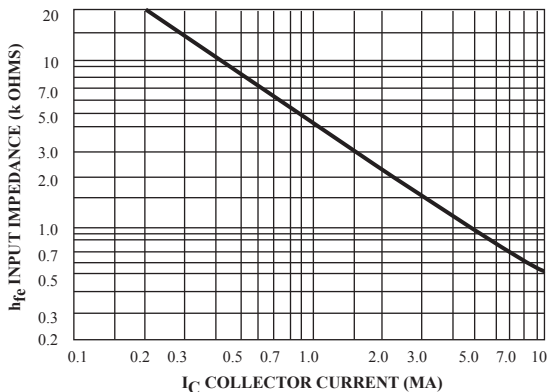


Figure 29. Input Impedance

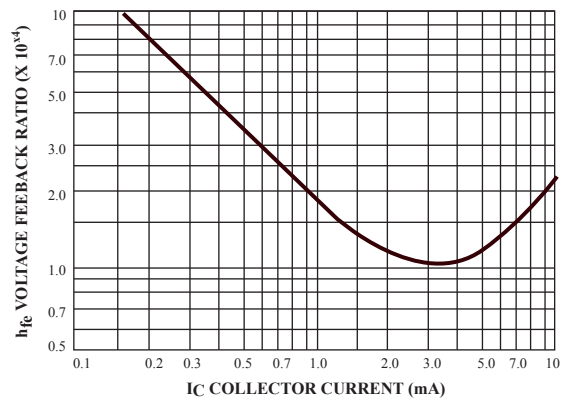
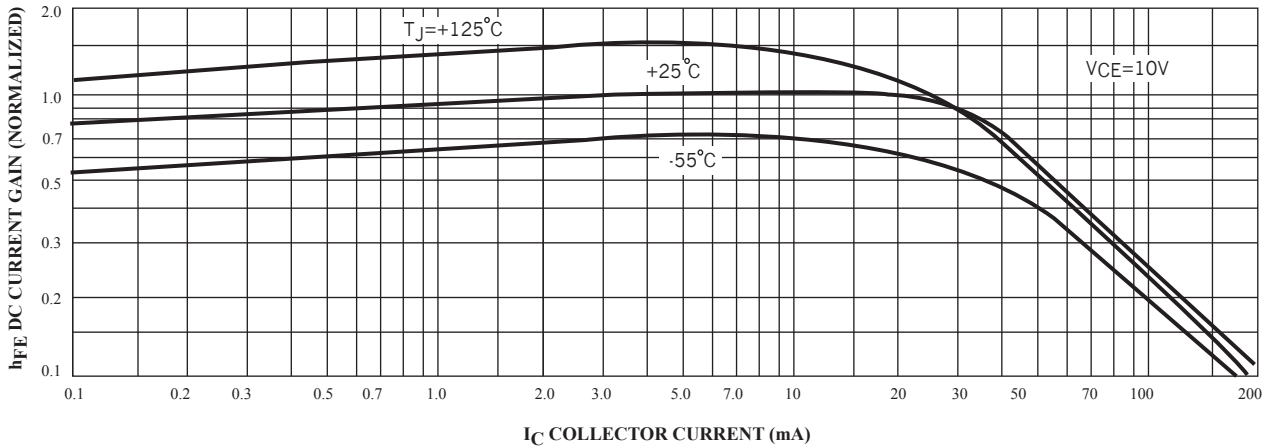


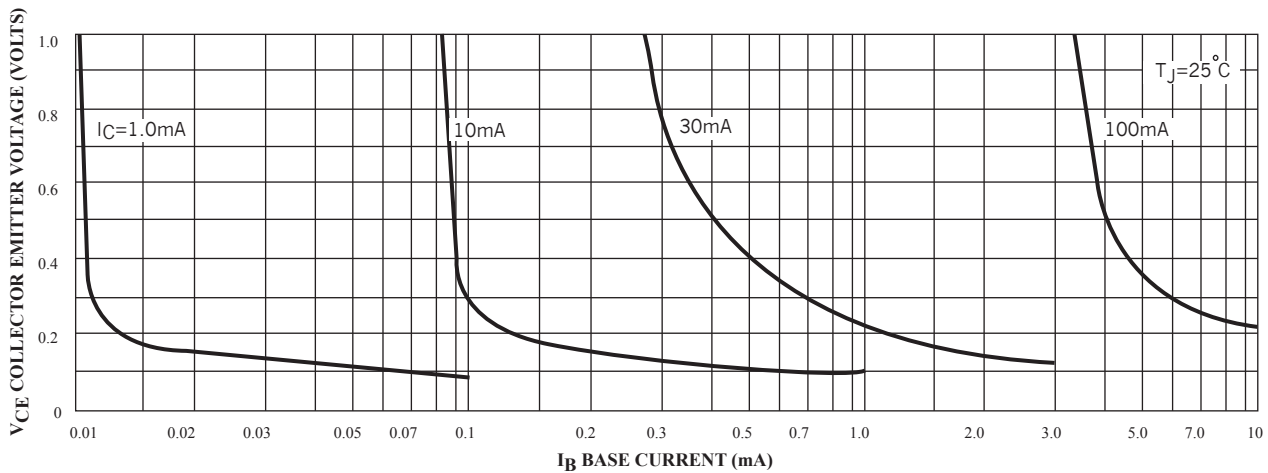
Figure 30. Voltage Feedback Ratio

**(PNP)**

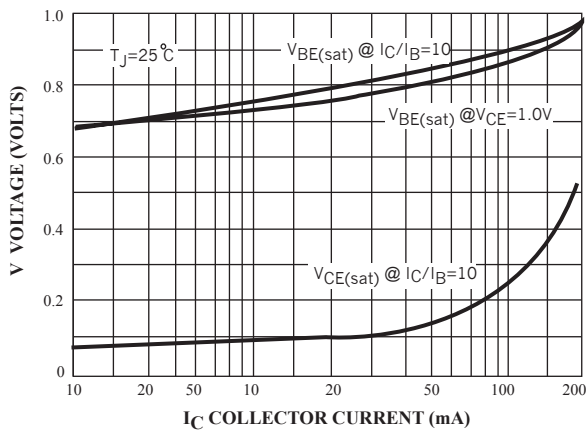
**TYPICAL STATIC CHARACTERISTICS**



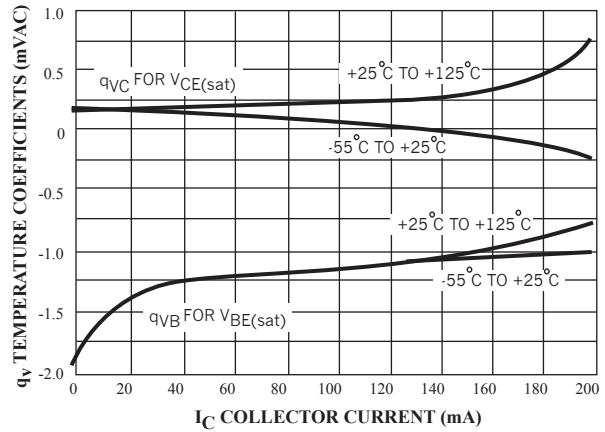
**Figurer 31. DC Current Gain**



**Figure 32. Collector Saturation Region**



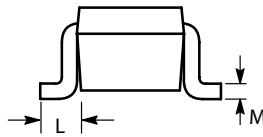
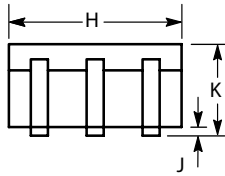
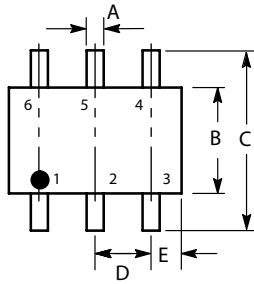
**Figure 33. "ON" Voltages**



**Figure 34. Temperature Coefficients**

**SOT-363 Package Outline Dimensions**

Unit:mm



**SOT-363**

Dim	Min	Max
<b>A</b>	0.10	0.30
<b>B</b>	1.15	1.35
<b>C</b>	2.00	2.20
<b>D</b>	0.65 REF	
<b>E</b>	0.30	0.40
<b>H</b>	1.80	2.20
<b>J</b>	-	0.10
<b>K</b>	0.80	1.10
<b>L</b>	0.25	0.40
<b>M</b>	0.10	0.25