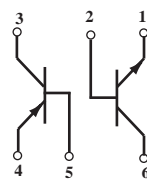
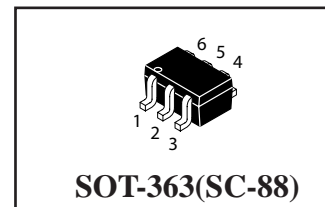


## Dual General Purpose Transistor NPN+PNP Silicon


**NPN+PNP**

**SOT-363(SC-88)**

### Maximum Ratings

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (NPN) (PNP)	V <sub>CEO</sub>	40 -40	V <sub>dc</sub>
Collector-Base Voltage (NPN) (PNP)	V <sub>CBO</sub>	60 -40	V <sub>dc</sub>
Emitter-Base Voltage (NPN) (PNP)	V <sub>EBO</sub>	6.0 -5.0	V <sub>dc</sub>
Collector Current-Continuous (NPN) (PNP)	I <sub>C</sub>	200 -200	mA <sub>dc</sub>

### Thermal Characteristics

Characteristics	Symbol	Max	Unit
Total Package Dissipation <sup>(1)</sup> T <sub>A</sub> =25°C	P <sub>D</sub>	150	mW
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	833	°C/W
Junction and Storage, Temperature	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C

## 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 <sup>(2)</sup>

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

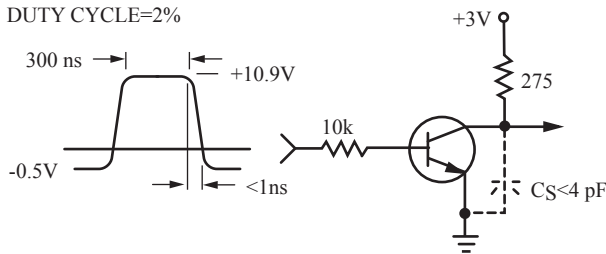
## Small-signal Characteristics

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 ( $V_{CE} = 5.0 \text{ Vdc}$ , $I_C = 100 \mu\text{A}$ , $R_S = 1.0 \text{ k ohms}$ , $f = 1.0 \text{ kHz}$ ) (NPN) ( $V_{CE} = -5.0 \text{ Vdc}$ , $I_C = -100 \mu\text{A}$ , $R_S = 1.0 \text{ k ohms}$ , $f = 1.0 \text{ kHz}$ ) (PNP)	NF	- -	5.0 4.0	dB

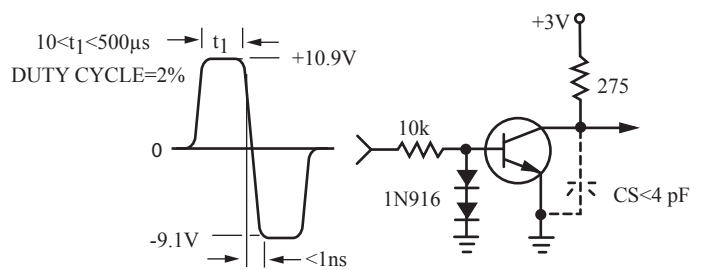
## Switching Characteristics

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**

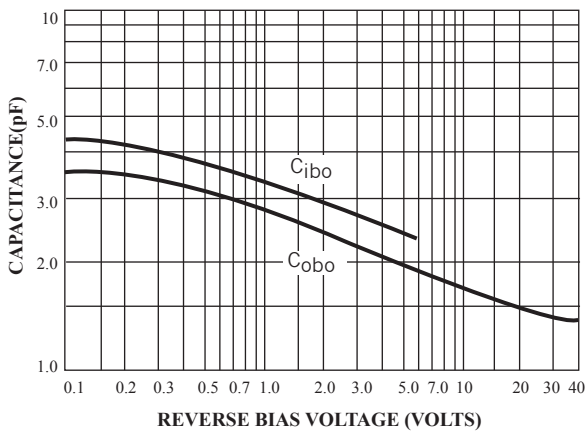


**Figure 2. Storage and Fall Time Equivalent Test Circuit**

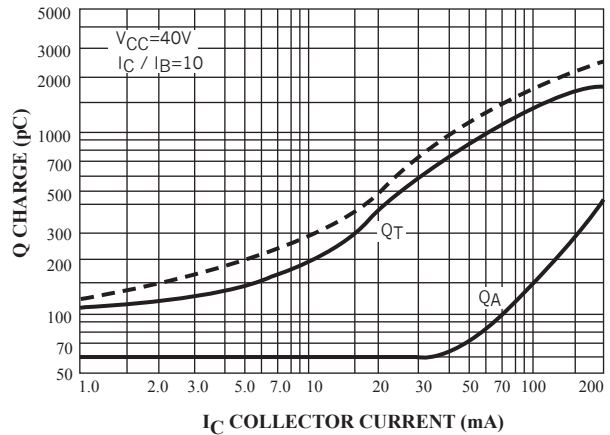
\*Total shunt capacitance of test jig and connectors

**TYPICAL TRANSIENT CHARACTERISTICS**

—  $T_J=25^\circ C$     - - -  $T_J=125^\circ C$



**Figure 3. Capacitance**



**Figure 4. Charge Data**

## (NPN)

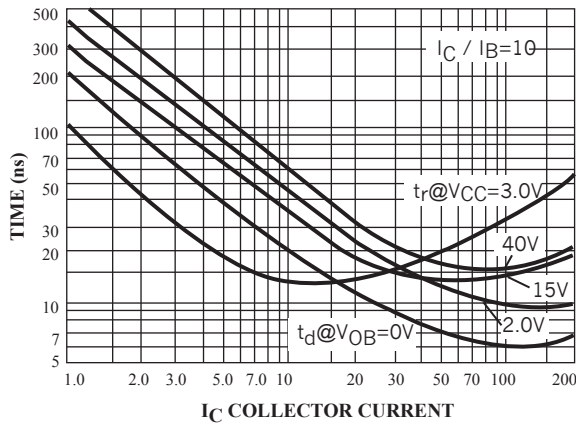


Figure 5. Turn-On Time

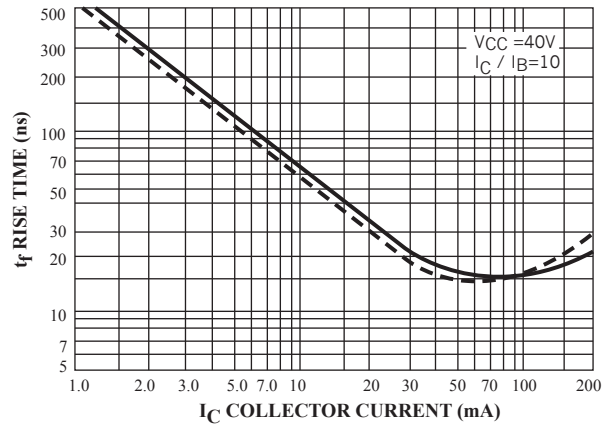


Figure 6. Rise Time

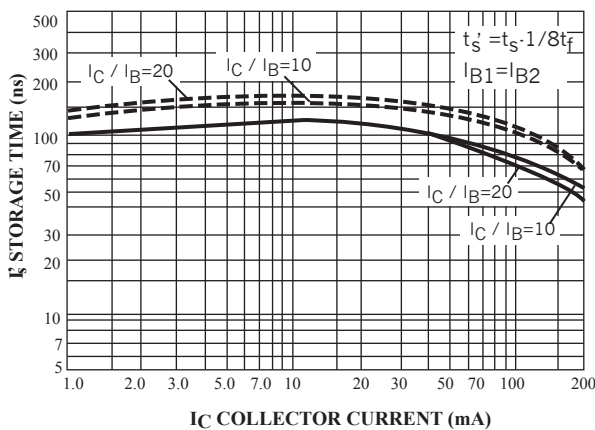


Figure 7. Storage Time

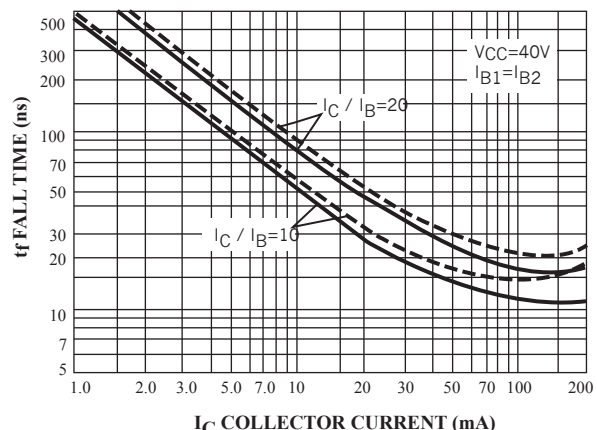


Figure 8. Fall Time

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

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

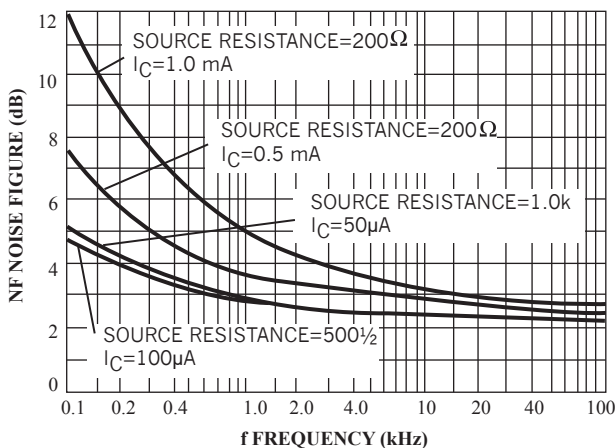


Figure 9.

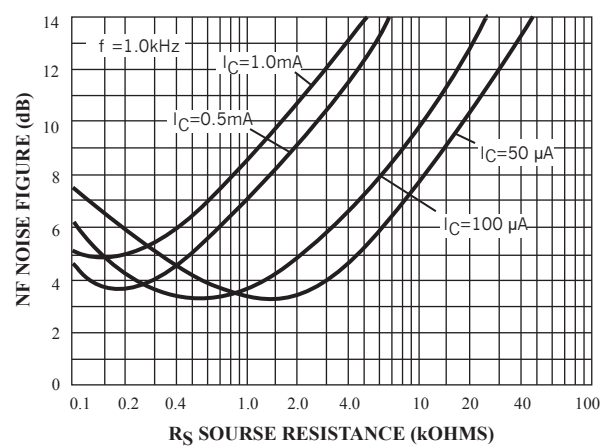
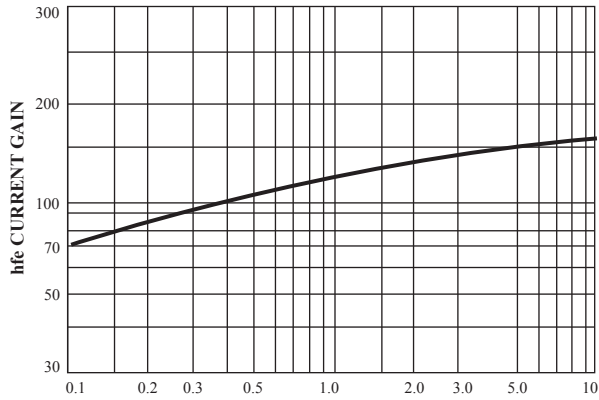
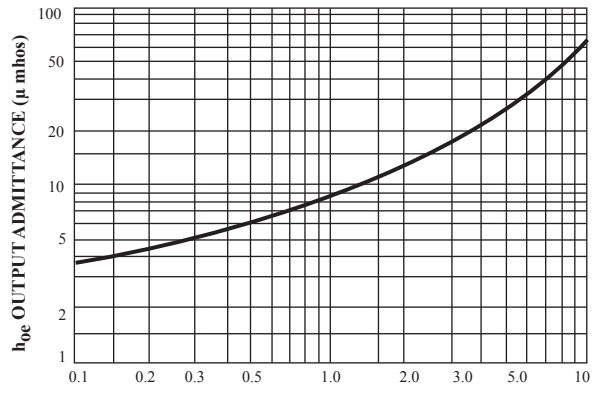


Figure 10.

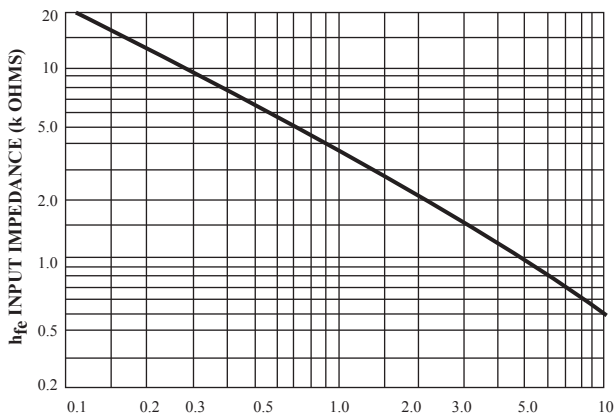
### h PARAMETERS ( $V_{CE}=10\text{ Vdc}$ , $m\ f=1.0\text{ kHz}$ , $T_A=25^\circ\text{C}$ )



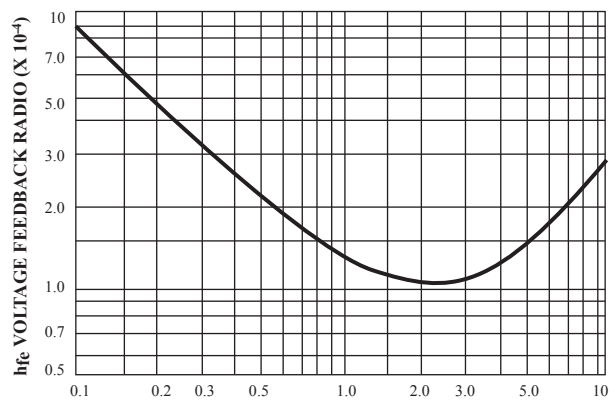
**Figure 11. Current Gain**



**Figure 12. Output Admittance**

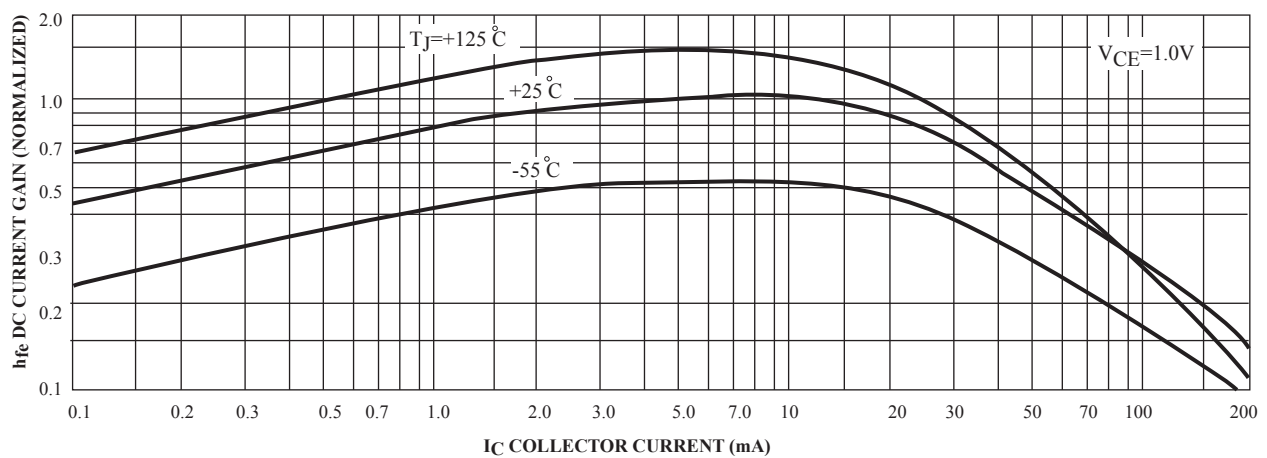


**Figure 13. Input Impedance**



**Figure 14. Voltage Feedback Ratio**

### TYPICAL STATIC CHARACTERISTICS



**Figure 15. DC Current Gain**

## (NPN)

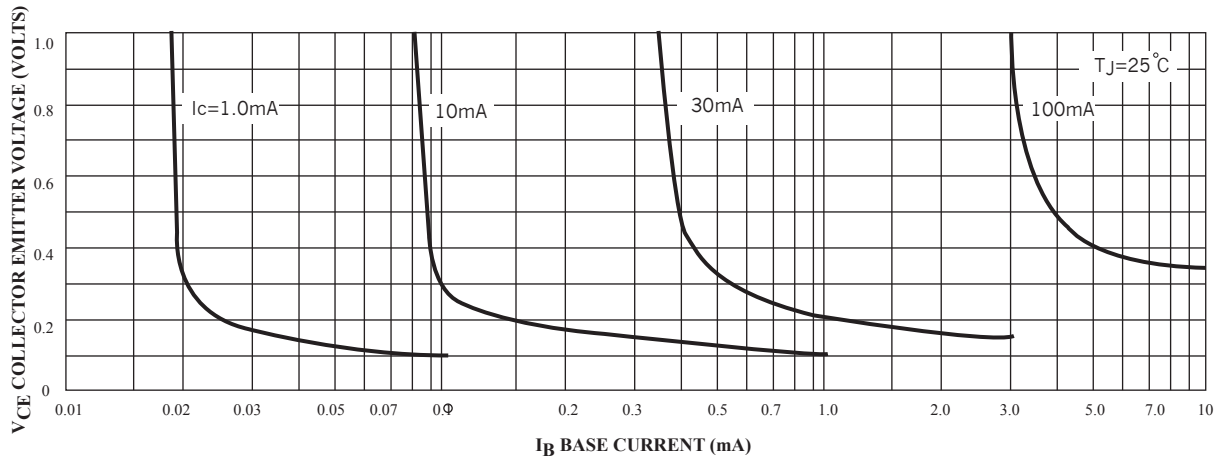


Figure 16. Collector Saturation Region

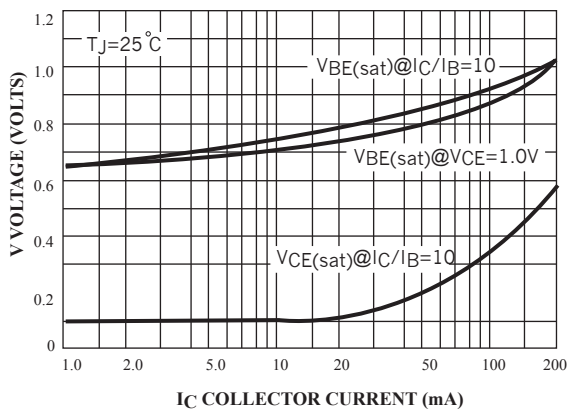


Figure 17. "ON" Voltage

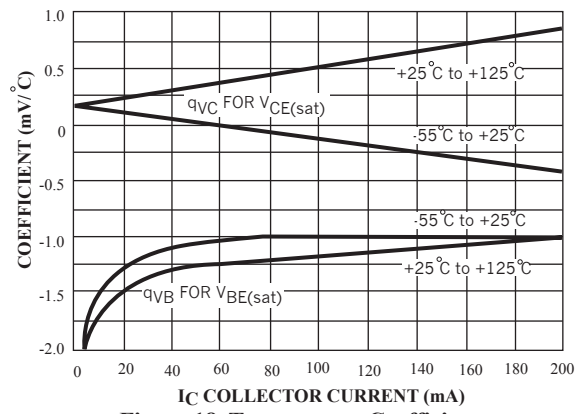
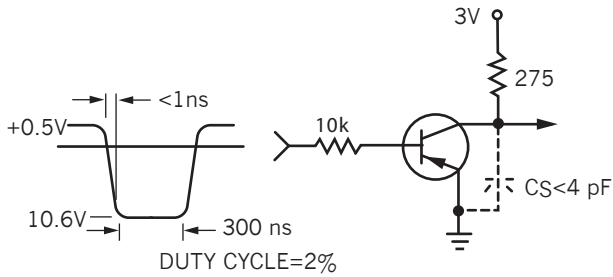
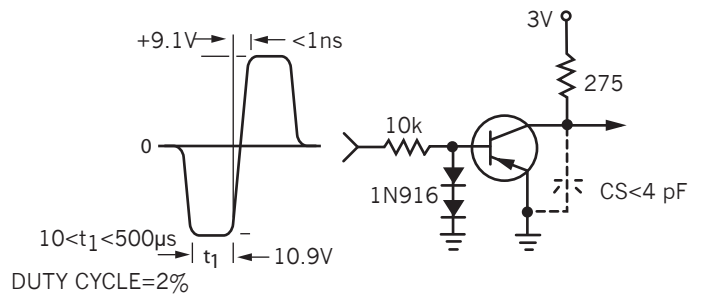


Figure 18. Temperature Coefficients

**(PNP)**



**Figure 19. Delay and Rise Time Equivalent Test Circuit**

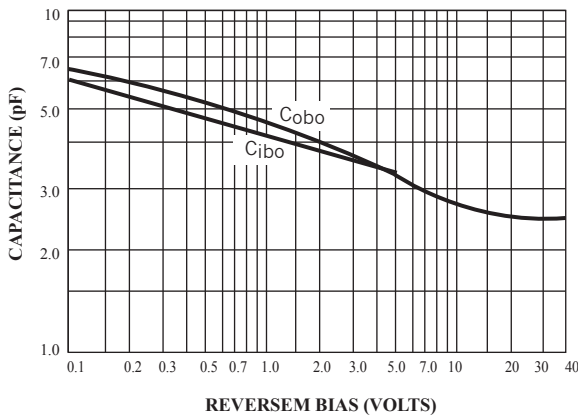


**Figure 20 . Storage and Fall Time Equivalent Test Circuit**

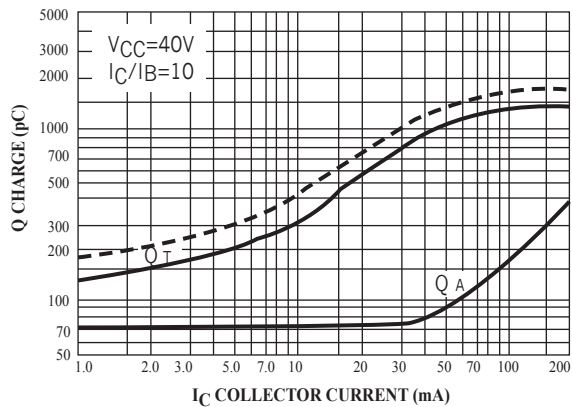
\*Total shunt capacitance of test jig and connectors

**TYPICAL TRANSIENT CHARACTERISTICS**

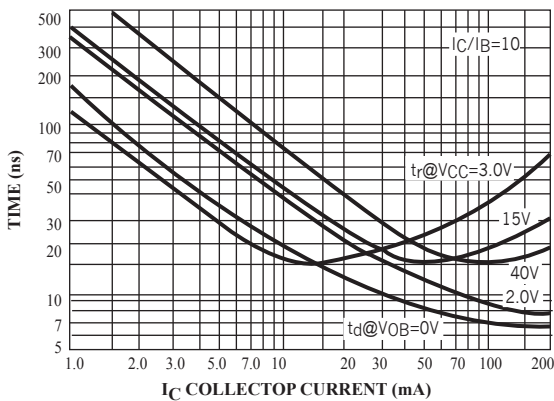
————  $T_J=25^\circ\text{C}$     - - - - -  $T_J=125^\circ\text{C}$



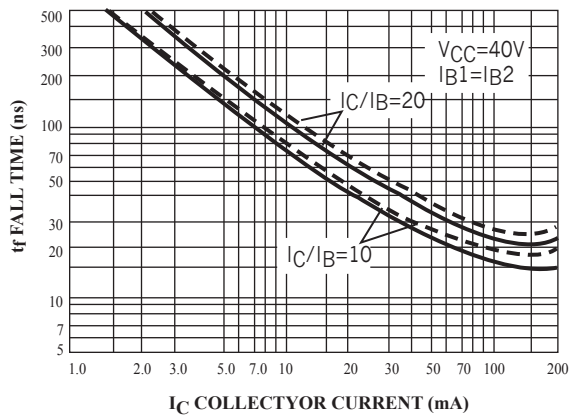
**Figure 21. Capacitance**



**Figure 22. Charge Data**



**Figure 23. Turn-On Time**



**Figure 24. Fall Time**



**(PNP)**

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

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

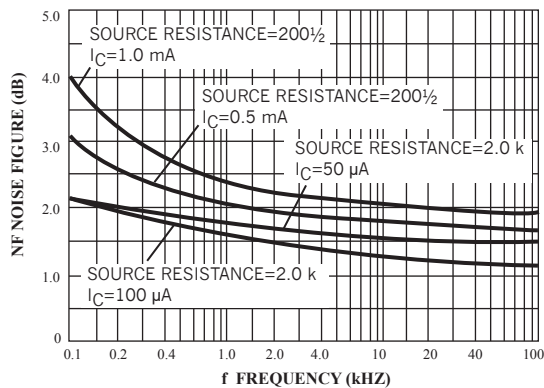


Figure 25.

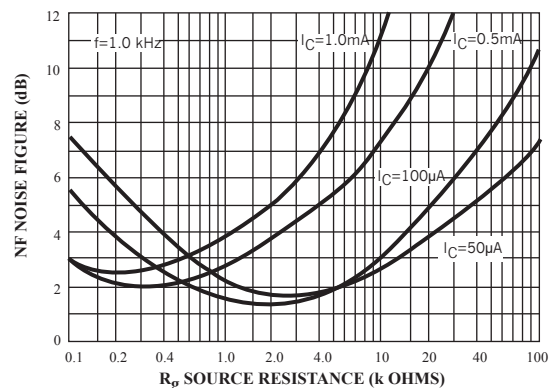


Figure 26.

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

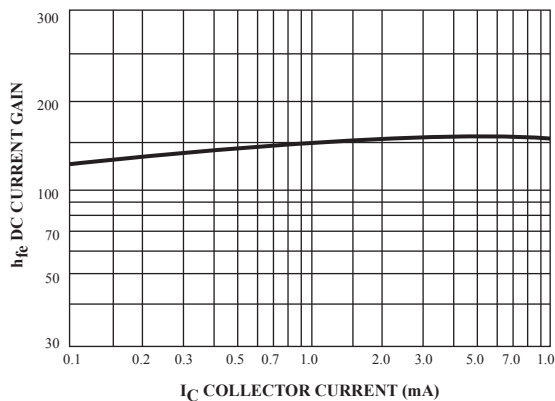


Figure 27. Current Gain

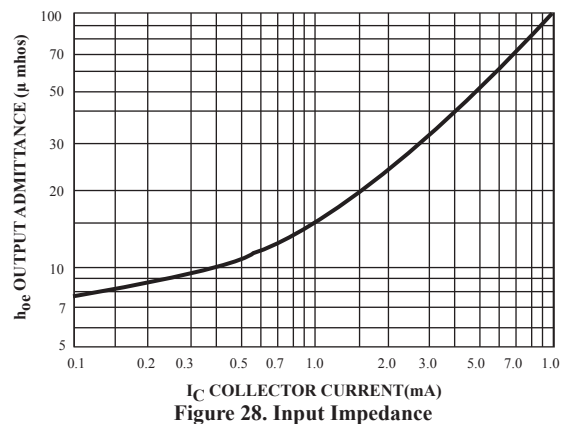


Figure 28. Input Impedance

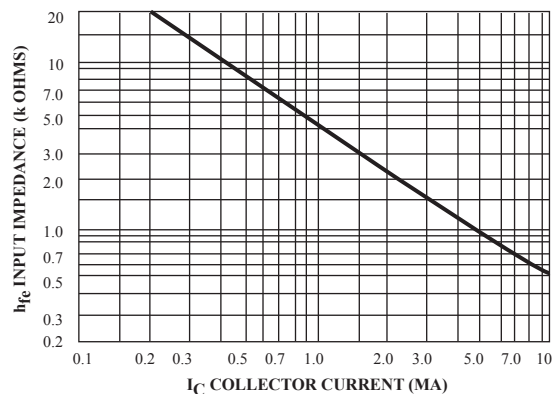


Figure 29. Input Impedance

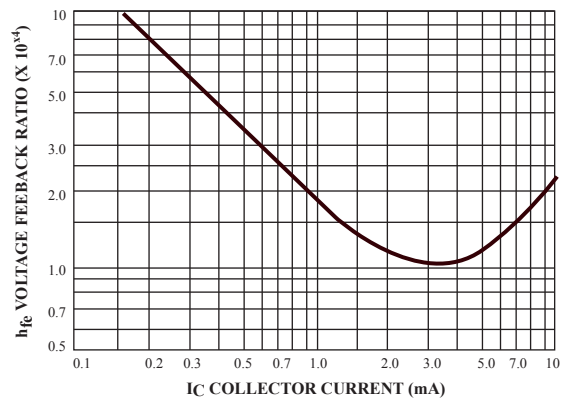
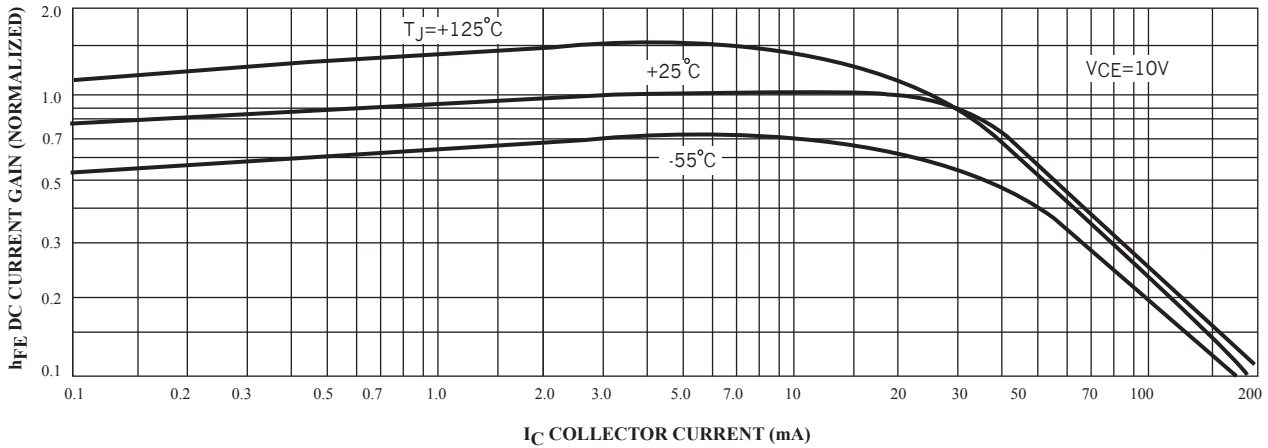


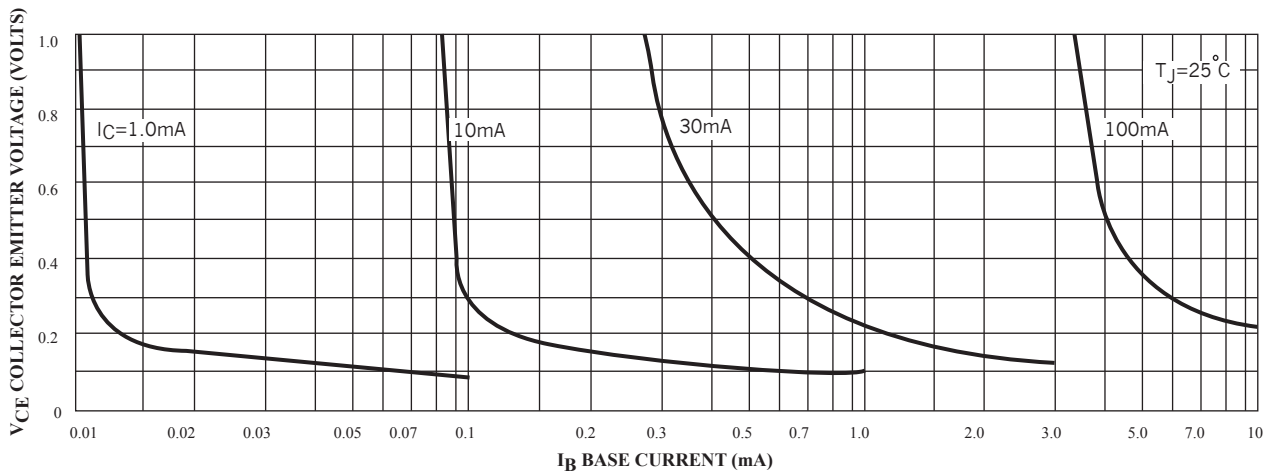
Figure 30. Voltage Feedback Ratio

**(PNP)**

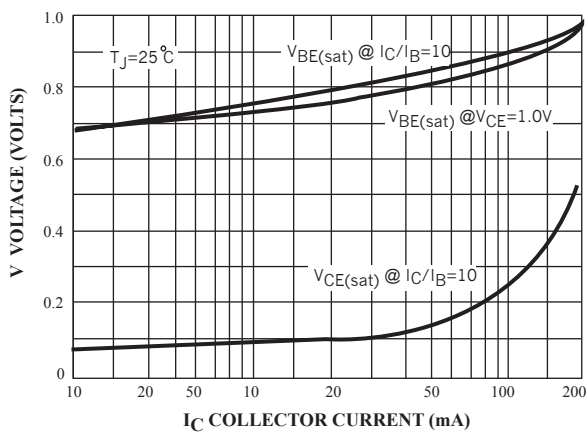
**TYPICAL STATIC CHARACTERISTICS**



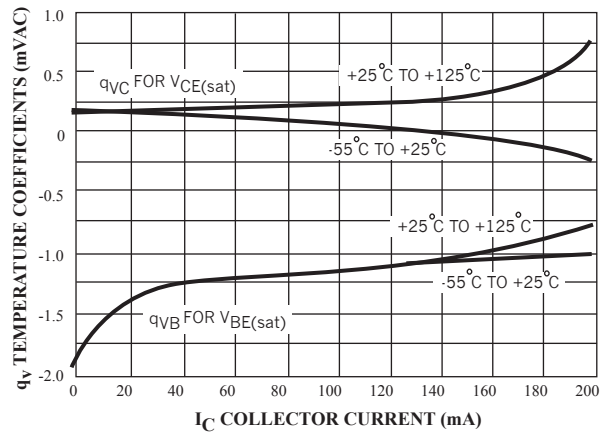
**Figurer 31. DC Current Gain**



**Figure 32. Collector Saturation Region**



**Figure 33. "ON" Voltages**



**Figure 34. Temperature Coefficients**

## SOT-363 Package Outline Dimensions

Unit:mm

