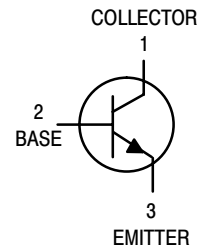
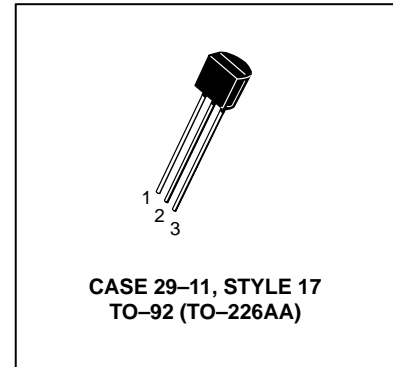


# Amplifier Transistors

## NPN Silicon

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	$V_{CEO}$	40	Vdc
Collector–Base Voltage	$V_{CBO}$	75	Vdc
Emitter–Base Voltage	$V_{EBO}$	6.0	Vdc
Collector Current — Continuous	$I_C$	600	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	625 5.0	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	1.5 12	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$



### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	$^\circ\text{C}/\text{W}$

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
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### OFF CHARACTERISTICS

Collector–Emitter Breakdown Voltage ( $I_C = 10 \text{ mAdc}$ , $I_B = 0$ )	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage ( $I_C = 10 \mu\text{Adc}$ , $I_E = 0$ )	$V_{(BR)CBO}$	75	—	Vdc
Emitter–Base Breakdown Voltage ( $I_E = 10 \mu\text{Adc}$ , $I_C = 0$ )	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB(off)} = 3.0 \text{ Vdc}$ )	$I_{CEX}$	—	10	nAdc
Collector Cutoff Current ( $V_{CB} = 60 \text{ Vdc}$ , $I_E = 0$ ) ( $V_{CB} = 60 \text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ )	$I_{CBO}$	— —	0.01 10	$\mu\text{Adc}$
Emitter Cutoff Current ( $V_{EB} = 3.0 \text{ Vdc}$ , $I_C = 0$ )	$I_{EBO}$	—	10	nAdc
Collector Cutoff Current ( $V_{CE} = 10 \text{ V}$ )	$I_{CEO}$	—	10	nAdc
Base Cutoff Current ( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB(off)} = 3.0 \text{ Vdc}$ )	$I_{BEX}$	—	20	nAdc

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

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS</b>				
DC Current Gain ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $T_A = -55^\circ\text{C}$ ) ( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) <sup>(1)</sup> ( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) <sup>(1)</sup> ( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) <sup>(1)</sup>	$h_{FE}$	35 50 75 35 100 50 40	— — — — 300 — —	—
Collector–Emitter Saturation Voltage <sup>(1)</sup> ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{CE(sat)}$	— —	0.3 1.0	Vdc
Base–Emitter Saturation Voltage <sup>(1)</sup> ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{BE(sat)}$	0.6 —	1.2 2.0	Vdc

**SMALL–SIGNAL CHARACTERISTICS**

Current–Gain — Bandwidth Product <sup>(2)</sup> ( $I_C = 20 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )	$f_T$	300	—	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{obo}$	—	8.0	pF
Input Capacitance ( $V_{EB} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{ibo}$	—	25	pF
Input Impedance ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{ie}$	2.0 0.25	8.0 1.25	$k\Omega$
Voltage Feedback Ratio ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{re}$	— —	8.0 4.0	$\times 10^{-4}$
Small–Signal Current Gain ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{fe}$	50 75	300 375	—
Output Admittance ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	5.0 25	35 200	$\mu\text{hos}$
Collector Base Time Constant ( $I_E = 20 \text{ mAdc}$ , $V_{CB} = 20 \text{ Vdc}$ , $f = 31.8 \text{ MHz}$ )	$r_b'C_c$	—	150	ps
Noise Figure ( $I_C = 100 \mu\text{A}$ , $V_{CE} = 10 \text{ Vdc}$ , $R_S = 1.0 \text{ k}\Omega$ , $f = 1.0 \text{ kHz}$ )	$N_F$	—	4.0	dB

**SWITCHING CHARACTERISTICS**

Delay Time	$(V_{CC} = 30 \text{ Vdc}$ , $V_{BE(off)} = -2.0 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = 15 \text{ mAdc}$ ) (Figure 1)	$t_d$	—	10	ns
Rise Time		$t_r$	—	25	ns
Storage Time	$(V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = I_{B2} = 15 \text{ mAdc}$ ) (Figure 2)	$t_s$	—	225	ns
Fall Time		$t_f$	—	60	ns

- Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .
- $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

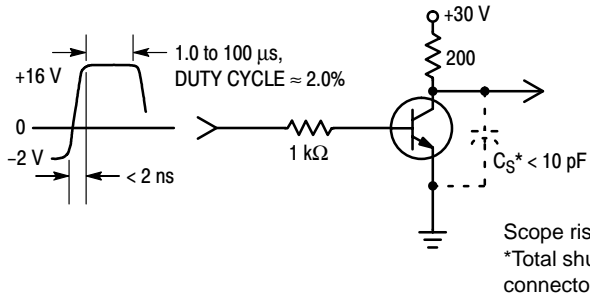


Figure 1. Turn-On Time

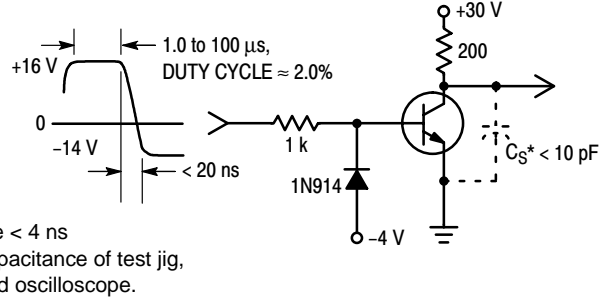


Figure 2. Turn-Off Time

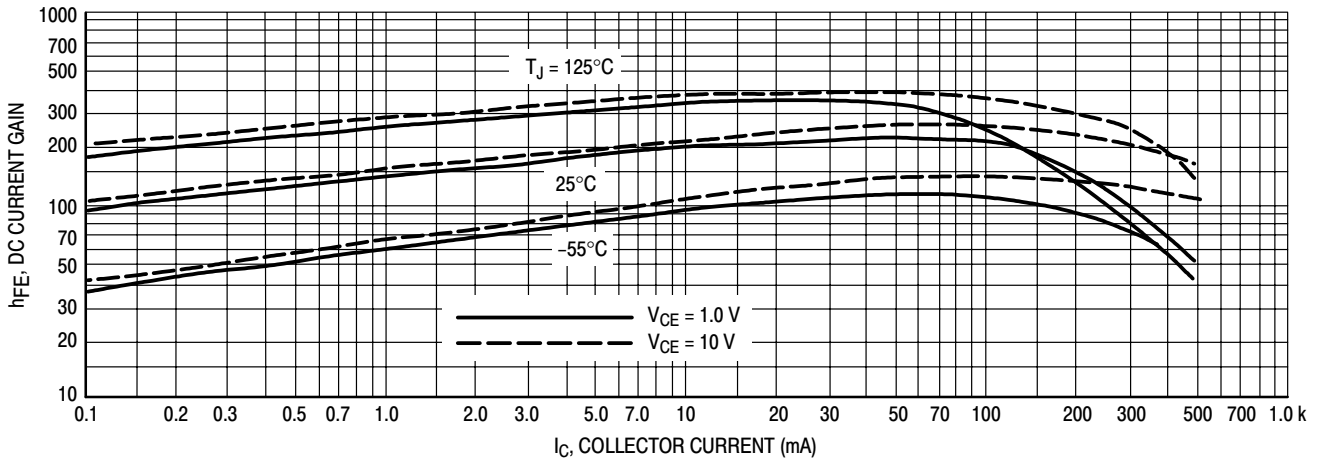


Figure 3. DC Current Gain

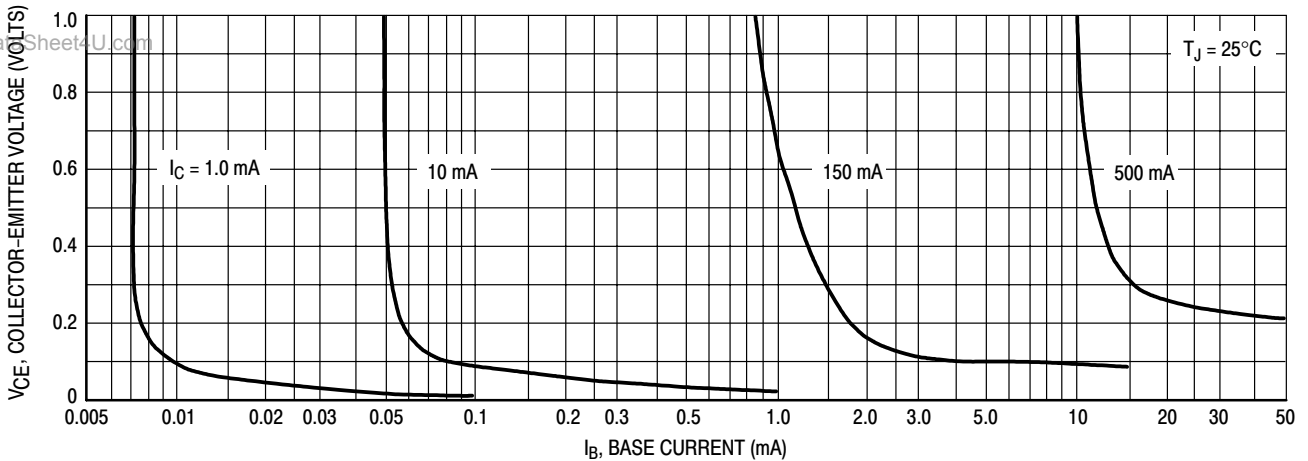


Figure 4. Collector Saturation Region

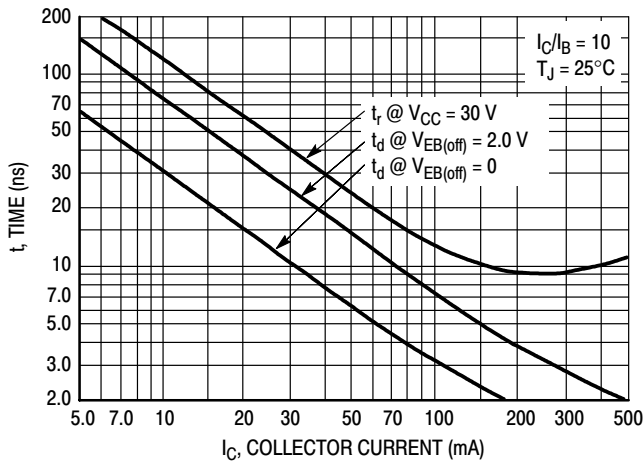


Figure 5. Turn-On Time

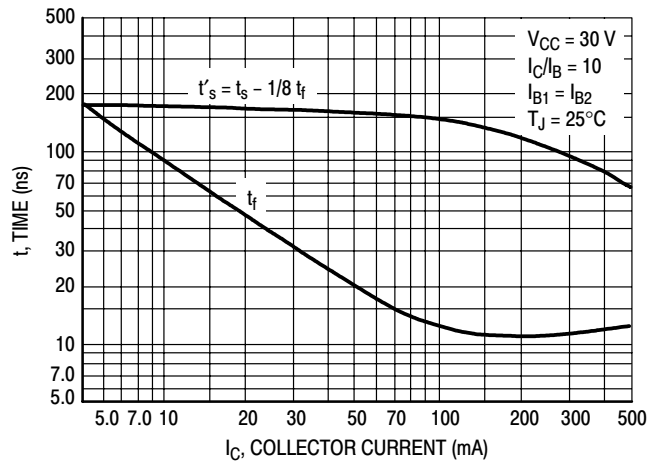


Figure 6. Turn-Off Time

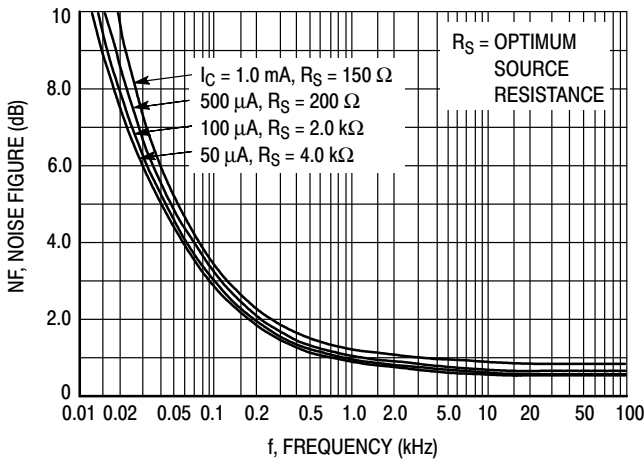


Figure 7. Frequency Effects

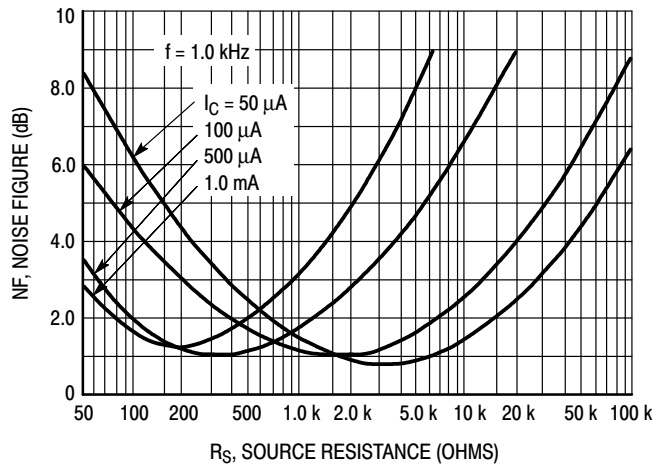


Figure 8. Source Resistance Effects

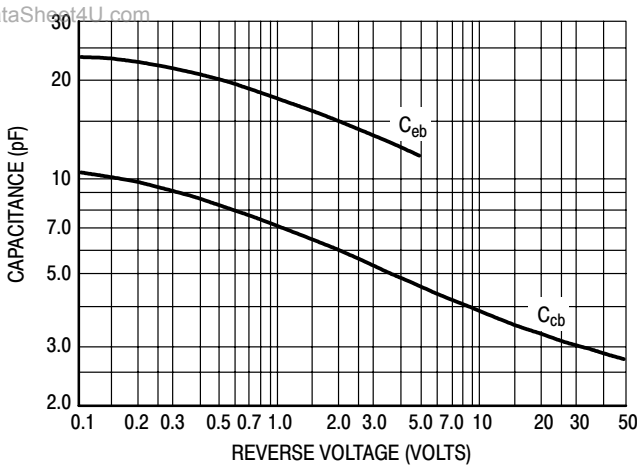


Figure 9. Capacitances

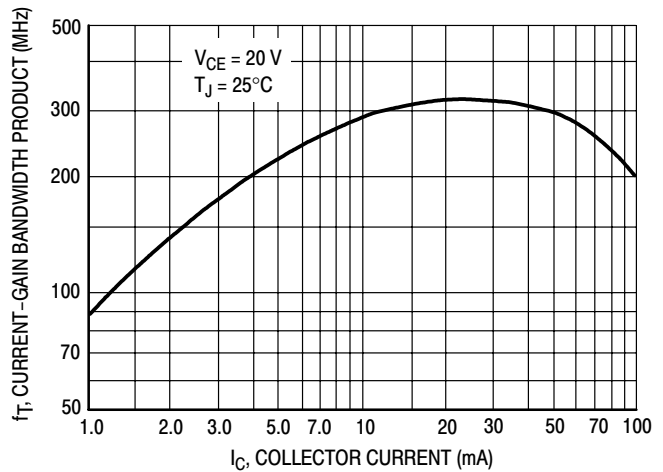


Figure 10. Current-Gain Bandwidth Product

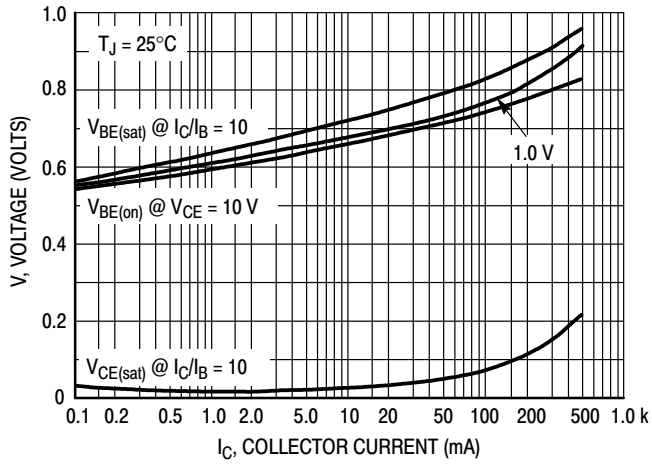


Figure 11. "On" Voltages

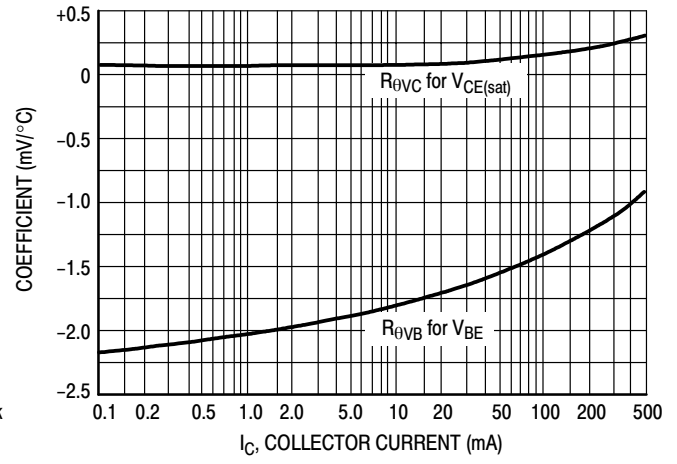
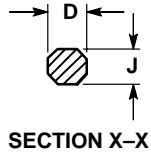
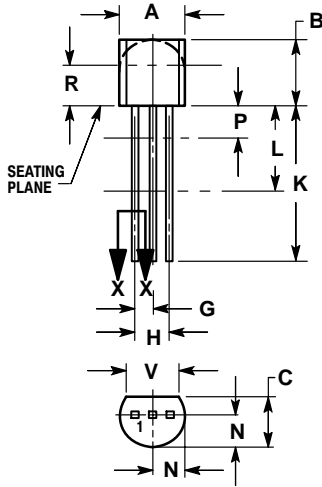


Figure 12. Temperature Coefficients

PACKAGE DIMENSIONS

TO-92 (TO-226)  
CASE 29-11  
ISSUE AL



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---

STYLE 17:

- PIN 1. COLLECTOR
2. BASE
3. EMITTER