

Switching Transistor

PNP Silicon

- This device is available in Pb-free package(s). Specifications herein apply to both standard and Pb-free devices. Please see our website at www.onsemi.com for specific Pb-free orderable part numbers, or contact your local ON Semiconductor sales office or representative.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	-25	Vdc
Collector–Emitter Voltage	V_{CES}	-25	Vdc
Collector–Base Voltage	V_{CBO}	-25	Vdc
Emitter–Base Voltage	V_{EBO}	-4.0	Vdc
Collector Current — Continuous	I_C	-500	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	625 5.0	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°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	$R_{\theta JA}^{(1)}$	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)

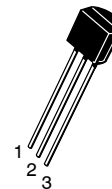
Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

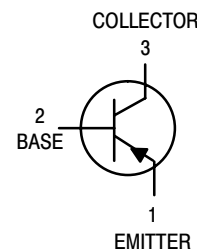
Collector–Emitter Breakdown Voltage ($I_C = -100 \mu\text{Adc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	-25	—	Vdc
Collector–Emitter Sustaining Voltage ⁽²⁾ ($I_C = -10 \text{mAdc}$, $I_B = 0$)	$V_{CEO(sus)}$	-25	—	Vdc
Collector–Base Breakdown Voltage ($I_C = -100 \mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	-25	—	Vdc
Emitter–Base Breakdown Voltage ($I_E = -100 \mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	-4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = -15 \text{Vdc}$, $V_{BE} = 0$) ($V_{CE} = -15 \text{Vdc}$, $V_{BE} = 0$, $T_A = -65^\circ\text{C}$)	I_{CES}	—	-0.035 -2.0	μAdc
Emitter Cutoff Current ($V_{EB} = -3.0 \text{V}$, $I_C = 0$)	I_{EBO}	—	-35	nA
Base Current ($V_{CE} = -15 \text{Vdc}$, $V_{BE} = 0$)	I_B	—	-0.035	μAdc

- $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
- Pulse Test: Pulse Width $\leq 300 \mu\text{s}$; Duty Cycle $\leq 2.0\%$.

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CASE 29-11, STYLE 1
TO-92 (TO-226AA)



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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS⁽²⁾				
DC Current Gain ($I_C = -1.0\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$) ($I_C = -10\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$) ($I_C = -50\text{ mAdc}$, $V_{CE} = -1.0\text{ Vdc}$) ($I_C = -300\text{ mAdc}$, $V_{CE} = -2.0\text{ Vdc}$)	h_{FE}	80 100 100 20	— — — —	—
Collector – Emitter Saturation Voltage ($I_C = -50\text{ mAdc}$, $I_B = -2.5\text{ mAdc}$) ($I_C = -300\text{ mAdc}$, $I_B = -30\text{ mAdc}$)	$V_{CE(sat)}$	— —	-0.25 -1.0	Vdc
Base – Emitter Saturation Voltage ($I_C = -50\text{ mAdc}$, $I_B = -2.5\text{ mAdc}$) ($I_C = -300\text{ mAdc}$, $I_B = -30\text{ mAdc}$)	$V_{BE(sat)}$	— -0.80	-1.1 -2.0	Vdc

SMALL-SIGNAL CHARACTERISTICS

Current – Gain — Bandwidth Product ($V_{CE} = -3.0\text{ Vdc}$, $I_C = -50\text{ mAdc}$, $f = 100\text{ MHz}$)	f_T	150	—	MHz
Output Capacitance ($V_{CB} = -10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{obo}	—	10	pF
Input Capacitance ($V_{EB} = -0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$)	C_{ibo}	—	25	pF
Input Impedance ($I_C = -10\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{ie}	—	2000	$k\Omega$
Voltage Feedback Ratio ($I_C = -10\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{re}	—	15	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = -10\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	100	—	—
Output Admittance ($I_C = -10\text{ mAdc}$, $V_{CE} = -10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{oe}	—	1.2	mmhos

SWITCHING CHARACTERISTICS

Delay Time	$(V_{CC} = -10\text{ Vdc}$, $I_C = -300\text{ mAdc}$, $I_{B1} = -30\text{ mAdc}$)	t_d	—	20	ns
Rise Time		t_r	—	70	ns
Storage Time	$(V_{CC} = -10\text{ Vdc}$, $I_C = -300\text{ mAdc}$, $I_{B1} = -30\text{ mAdc}$, $I_{B2} = -30\text{ mAdc}$)	t_s	—	140	ns
Fall Time		t_f	—	70	ns
Turn-On Time	$(I_C = -300\text{ mAdc}$, $I_{B1} = -30\text{ mAdc}$)	t_{on}	—	75	ns
Turn-Off Time	$(I_C = -300\text{ mAdc}$, $I_{B1} = -30\text{ mAdc}$, $I_{B2} = 30\text{ mAdc}$)	t_{off}	—	170	ns

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

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SWITCHING TIME EQUIVALENT TEST CIRCUIT

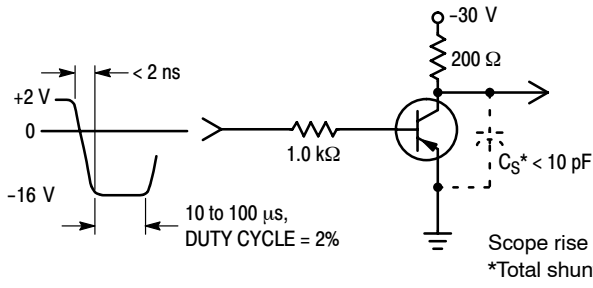


Figure 1. Turn-On Time

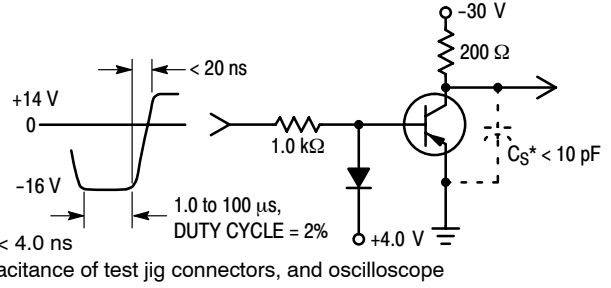


Figure 2. Turn-Off Time

TRANSIENT CHARACTERISTICS

— 25°C - - - 100°C

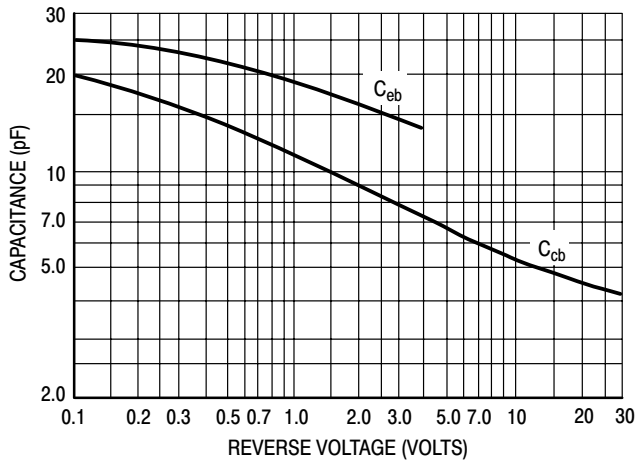


Figure 3. Capacitances

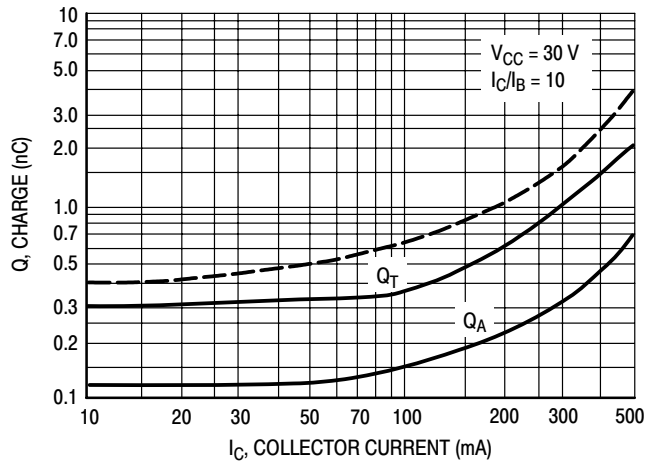


Figure 4. Charge Data

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TRANSIENT CHARACTERISTICS (Continued)

— 25°C - - - 100°C

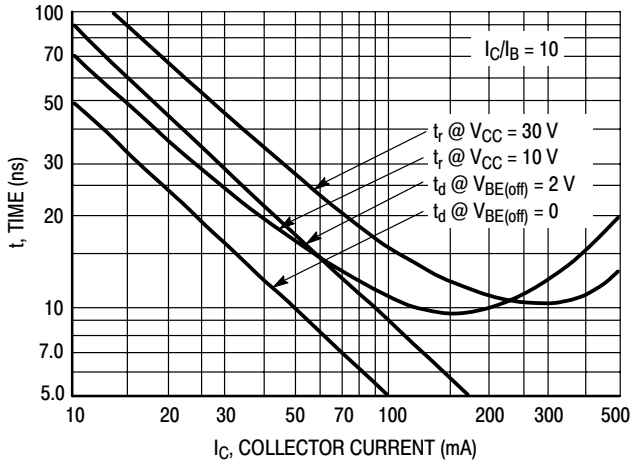


Figure 5. Turn-On Time

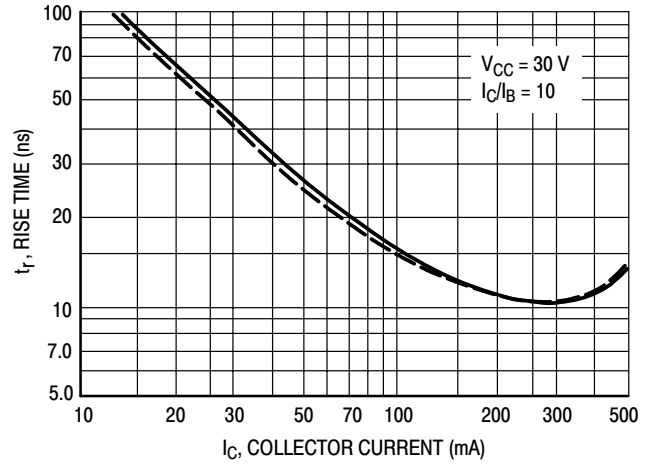


Figure 6. Rise Time

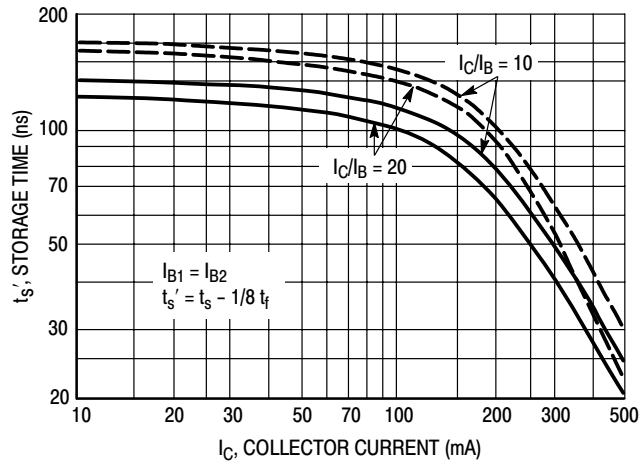


Figure 7. Storage Time

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SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

$V_{CE} = -10 \text{ Vdc}$, $T_A = 25^\circ\text{C}$

Bandwidth = 1.0 Hz

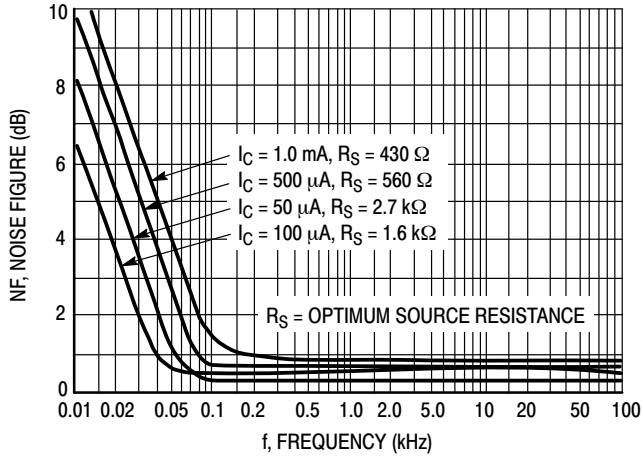


Figure 8. Frequency Effects

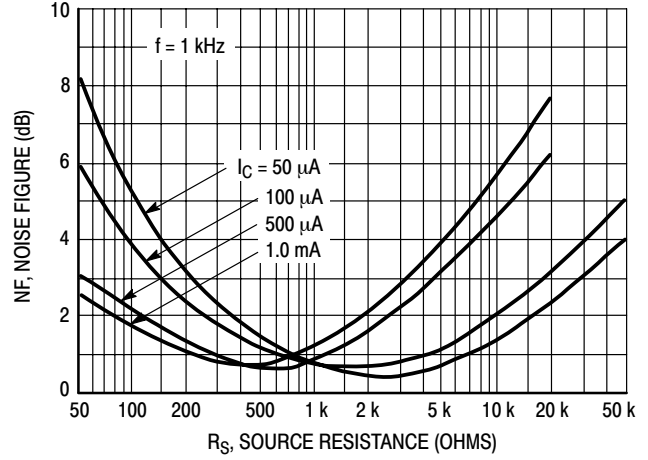


Figure 9. Source Resistance Effects

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h PARAMETERS

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

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were

selected from the 2N4402 line, and the same units were used to develop the correspondingly-numbered curves on each graph.

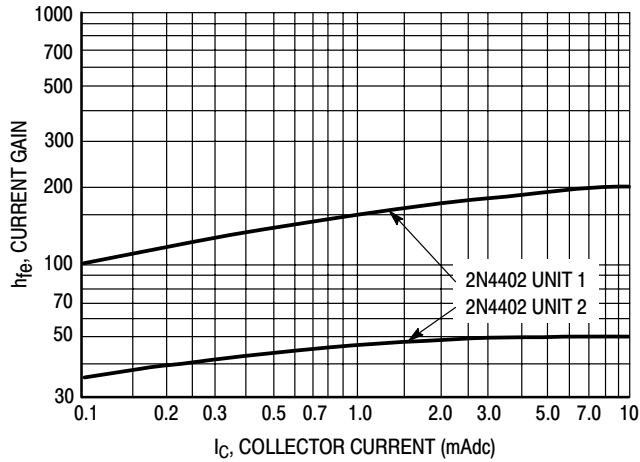


Figure 10. Current Gain

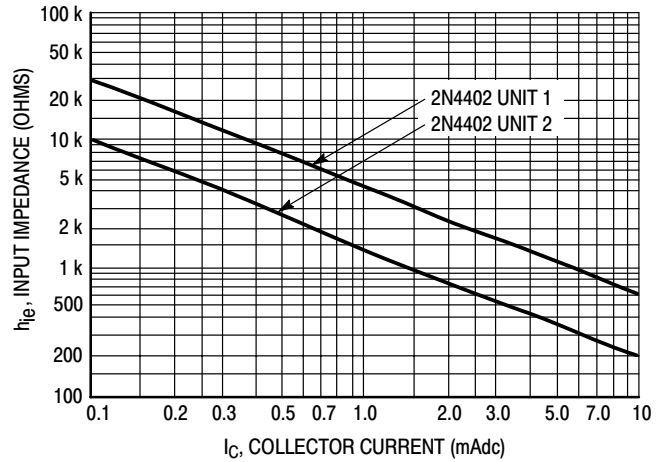


Figure 11. Input Impedance

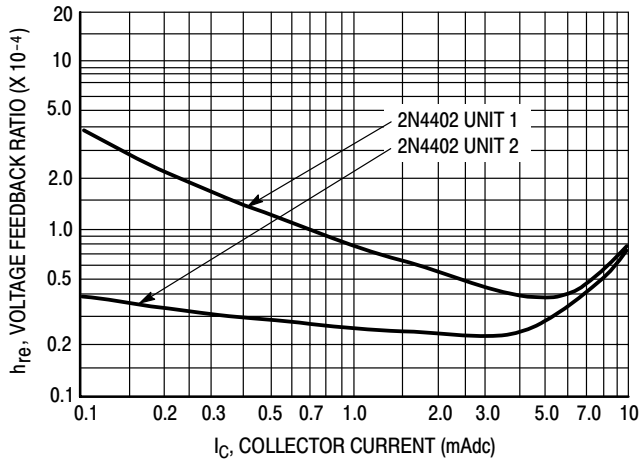


Figure 12. Voltage Feedback Ratio

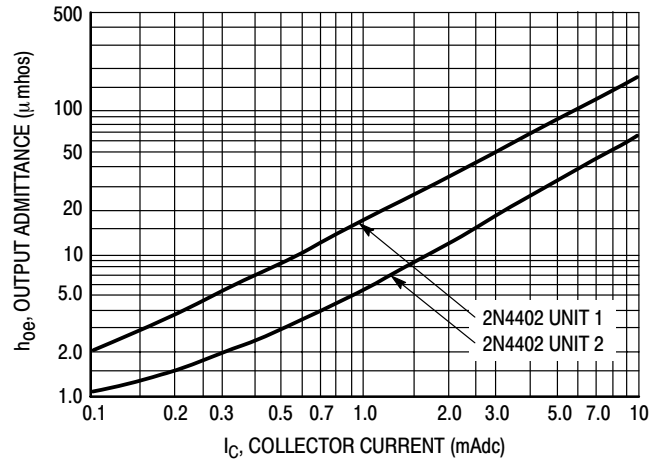


Figure 13. Output Admittance

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STATIC CHARACTERISTICS

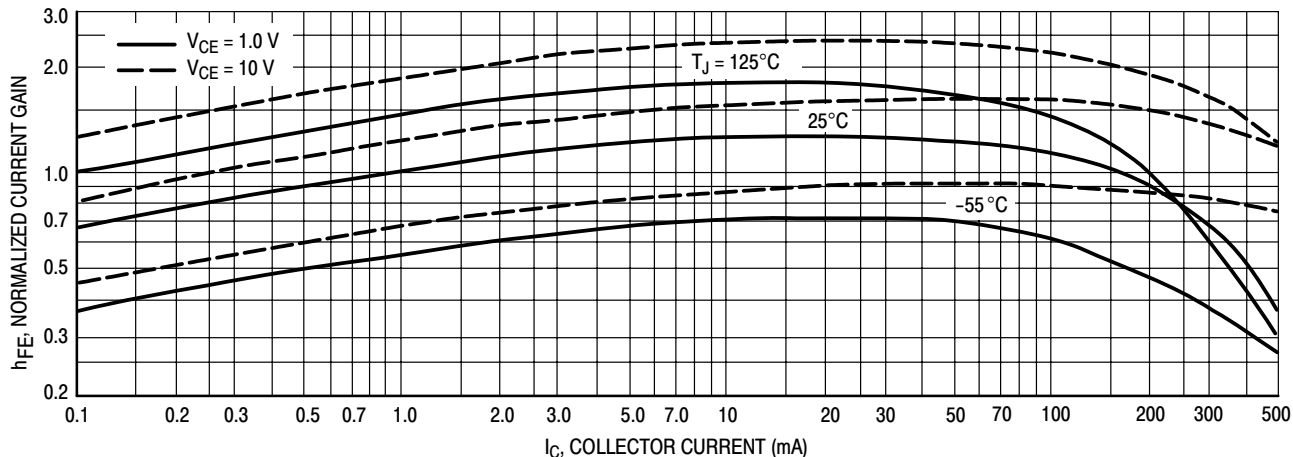


Figure 14. DC Current Gain

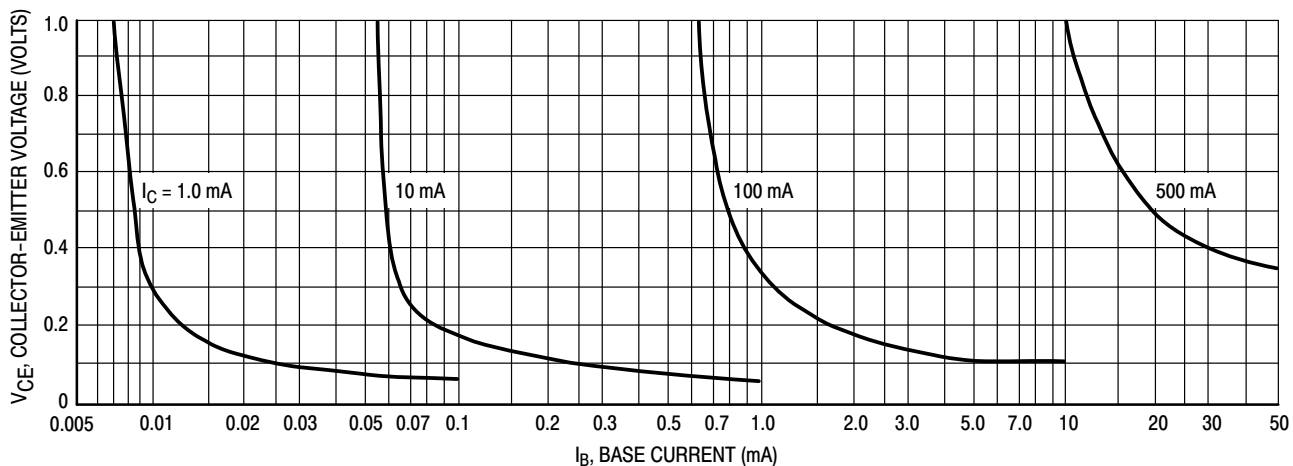


Figure 15. Collector Saturation Region

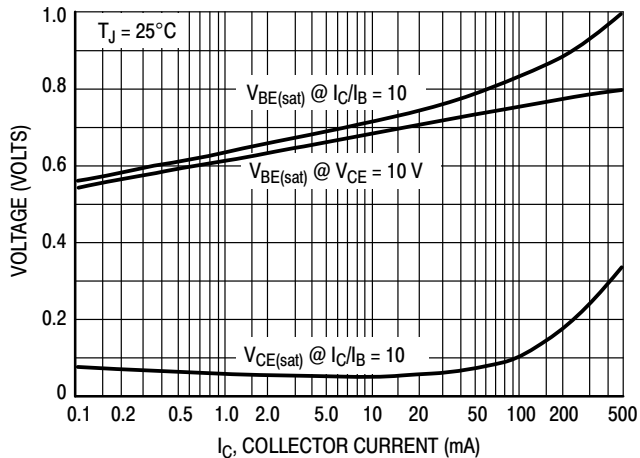


Figure 16. "On" Voltages

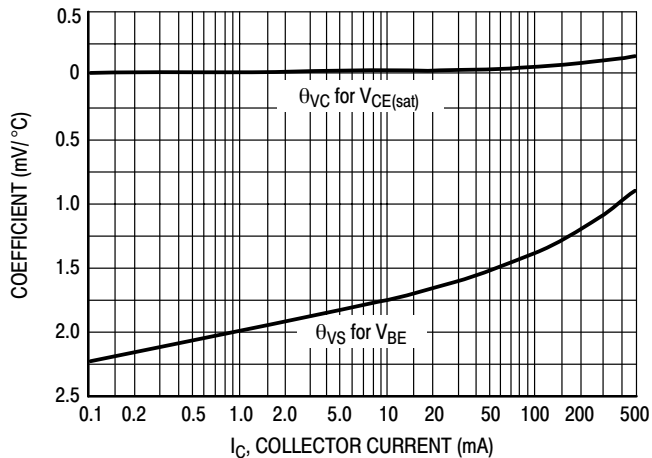
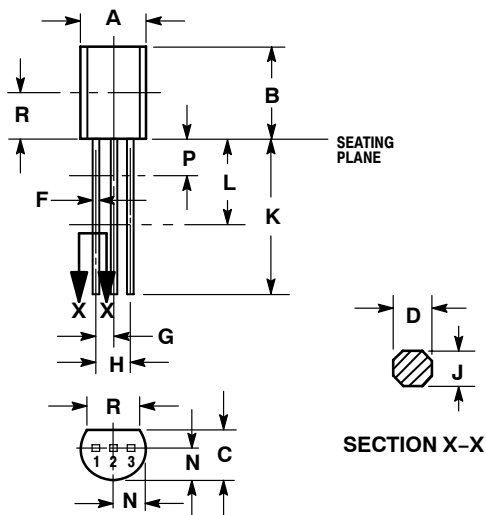


Figure 17. Temperature Coefficients

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PACKAGE DIMENSIONS

CASE 029-11 (TO-226AA) ISSUE AD



SECTION X-X

- STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. COLLECTOR

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSIONS D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.44	5.21
B	0.290	0.310	7.37	7.87
C	0.125	0.165	3.18	4.19
D	0.018	0.021	0.457	0.533
F	0.016	0.019	0.407	0.482
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.018	0.024	0.46	0.61
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	0.135	---	3.43	---

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