

TO-92 Plastic-Encapsulate Transistors

2N4401052

NPN Silicon

Features

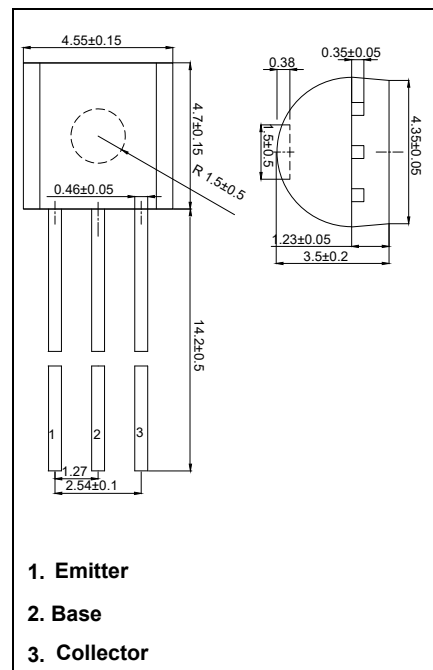
- Pb-Free Packages are Available

MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_{CEO}	Collector – Emitter Voltage	40	Vdc
V_{CBO}	Collector – Base Voltage	60	Vdc
V_{EBO}	Emitter – Base Voltage	6.0	Vdc
I_C	Collector Current – Continuous	600	mAdc
P_D	Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	625 5.0	mW mW/ $^\circ\text{C}$
P_D	Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	1.5 12	W mW/ $^\circ\text{C}$
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to $+150$	$^\circ\text{C}$

THERMAL CHARACTERISTICS

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



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

Symbol	Characteristic	Min	Max	Unit
--------	----------------	-----	-----	------

OFF CHARACTERISTICS

$V_{(BR)CEO}$	Collector–Emitter Breakdown Voltage (Note 1)	($I_C = 1.0$ mAdc, $I_B = 0$)	40	–	Vdc
$V_{(BR)CBO}$	Collector–Base Breakdown Voltage	($I_C = 0.1$ mAdc, $I_E = 0$)	60	–	Vdc
$V_{(BR)EBO}$	Emitter–Base Breakdown Voltage	($I_E = 0.1$ mAdc, $I_C = 0$)	6.0	–	Vdc
I_{BEV}	Base Cutoff Current	($V_{CE} = 35$ Vdc, $V_{EB} = 0.4$ Vdc)	–	0.1	μAdc
I_{CEX}	Collector Cutoff Current	($V_{CE} = 35$ Vdc, $V_{EB} = 0.4$ Vdc)	–	0.1	μAdc

ON CHARACTERISTICS (Note 1)

h_{FE}	DC Current Gain	($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 2.0$ Vdc)	20 40 80 100 40	– – – 300 –	–
$V_{CE(sat)}$	Collector–Emitter Saturation Voltage	($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	– –	0.4 0.75	Vdc
$V_{BE(sat)}$	Base–Emitter Saturation Voltage	($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	0.75 –	0.95 1.2	Vdc

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

Symbol	Characteristic	Min	Max	Unit
--------	----------------	-----	-----	------

SMALL-SIGNAL CHARACTERISTICS

f _T	Current-Gain – Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz)	250	–	MHz
C _{cb}	Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	–	6.5	pF
C _{eb}	Emitter-Base Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	–	30	pF
h _{ie}	Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	1.0	15	k Ω
h _{re}	Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	0.1	8.0	X 10 ⁻⁴
h _{fe}	Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	40	500	–
h _{oe}	Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)	1.0	30	μmhos

SWITCHING CHARACTERISTICS

t _d	Delay Time	(V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc)	–	15	ns
t _r	Rise Time		–	20	ns
t _s	Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc)	–	225	ns
t _f	Fall Time		–	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

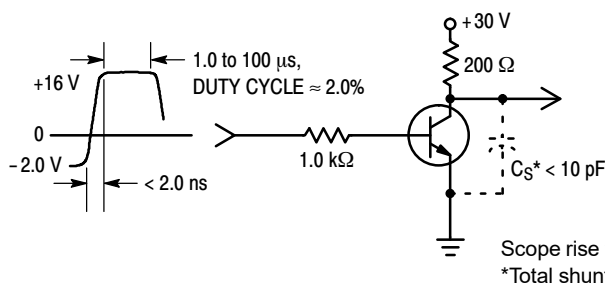


Figure 1. Turn-On Time

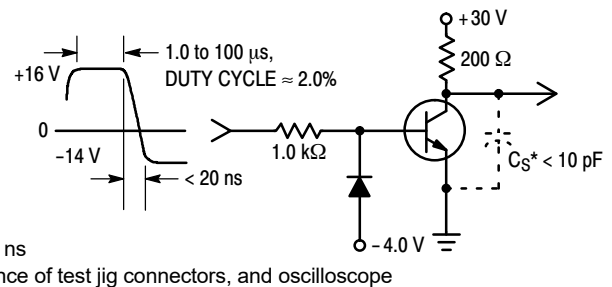


Figure 2. Turn-Off Time

TRANSIENT CHARACTERISTICS

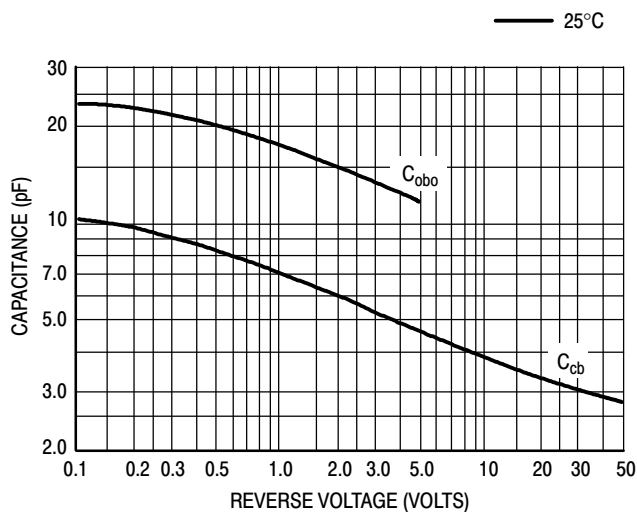


Figure 3. Capacitances

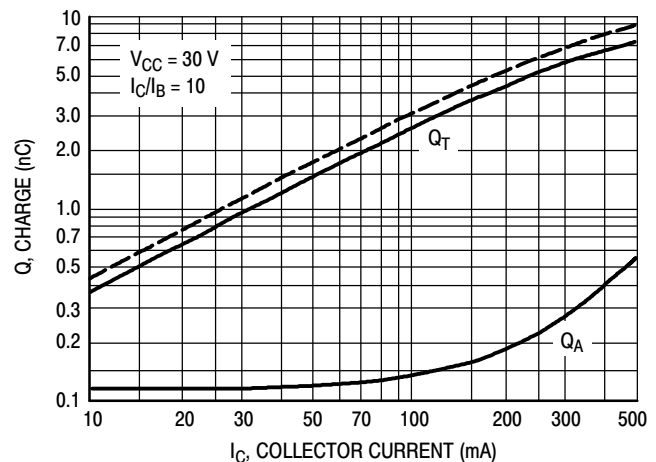


Figure 4. Charge Data

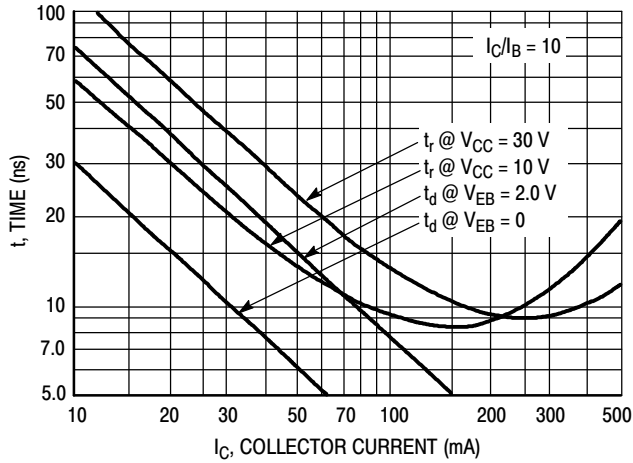


Figure 5. Turn-On Time

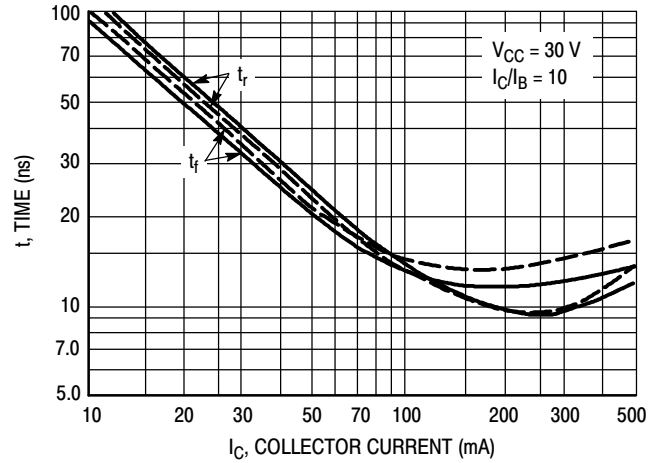


Figure 6. Rise and Fall Times

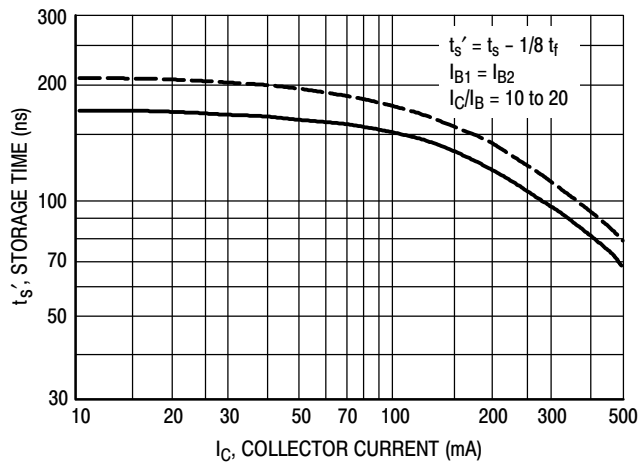


Figure 7. Storage Time

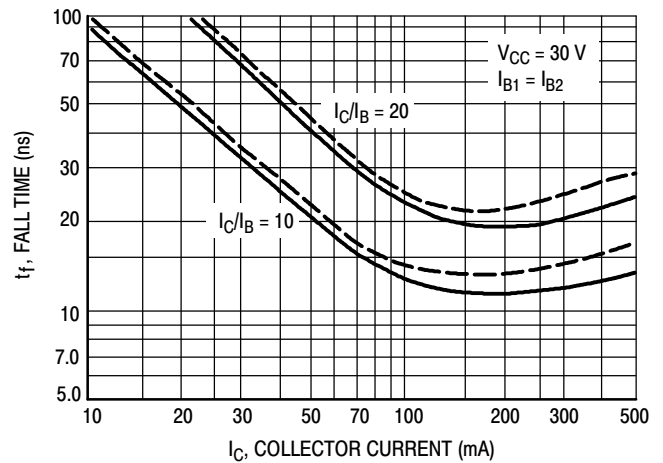


Figure 8. Fall Time

SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

$V_{CE} = 10 \text{ Vdc}$, $T_A = 25^\circ\text{C}$; Bandwidth = 1.0 Hz

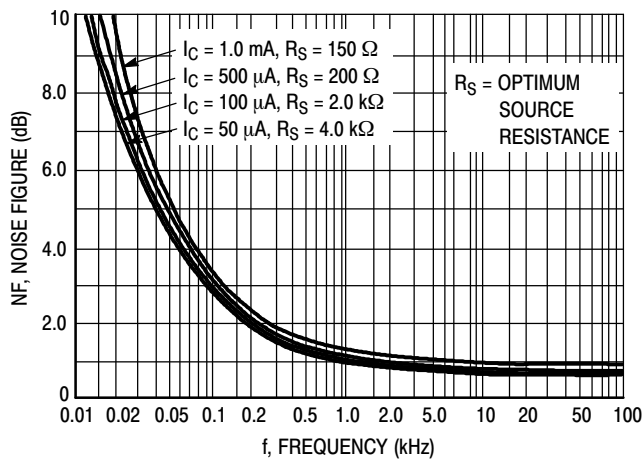


Figure 9. Frequency Effects

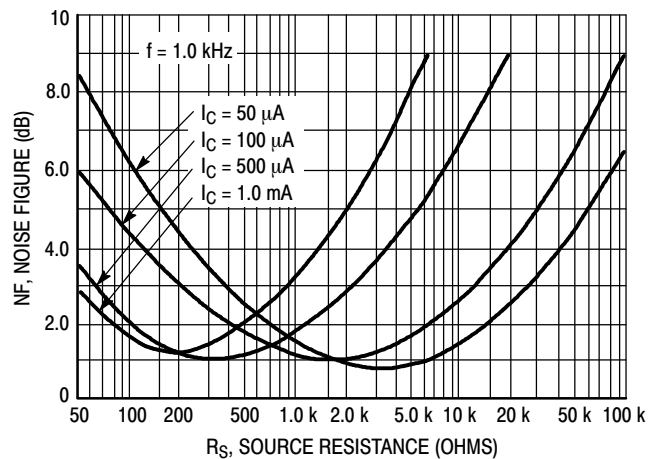


Figure 10. Source Resistance Effects

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 2N4401 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

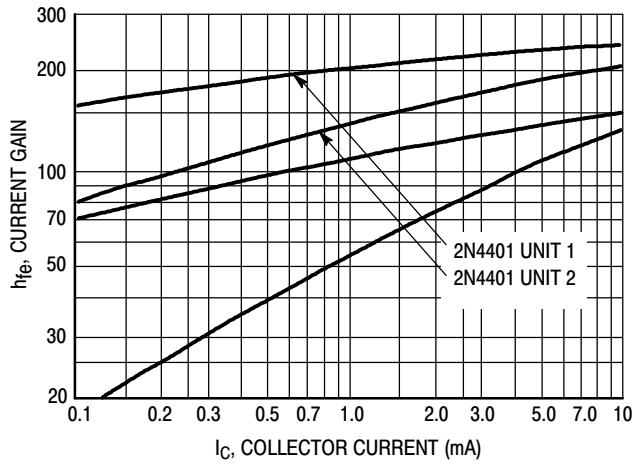


Figure 11. Current Gain

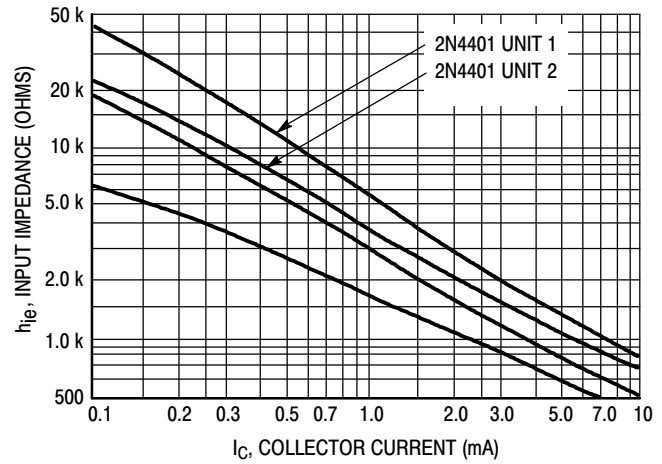


Figure 12. Input Impedance

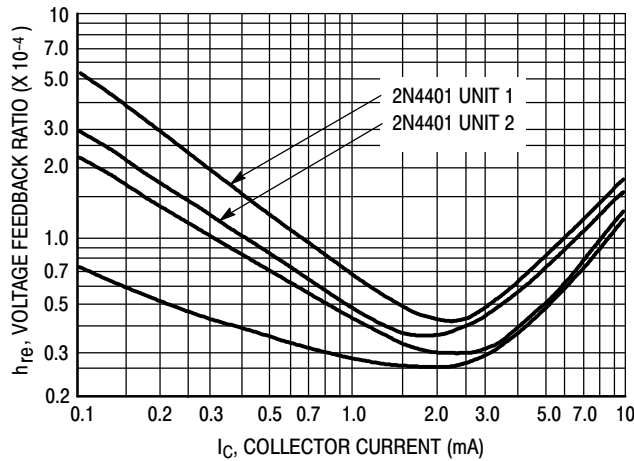


Figure 13. Voltage Feedback Ratio

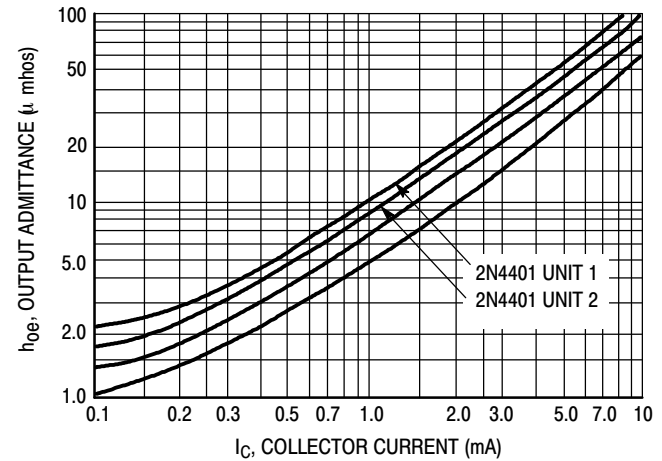


Figure 14. Output Admittance

STATIC CHARACTERISTICS

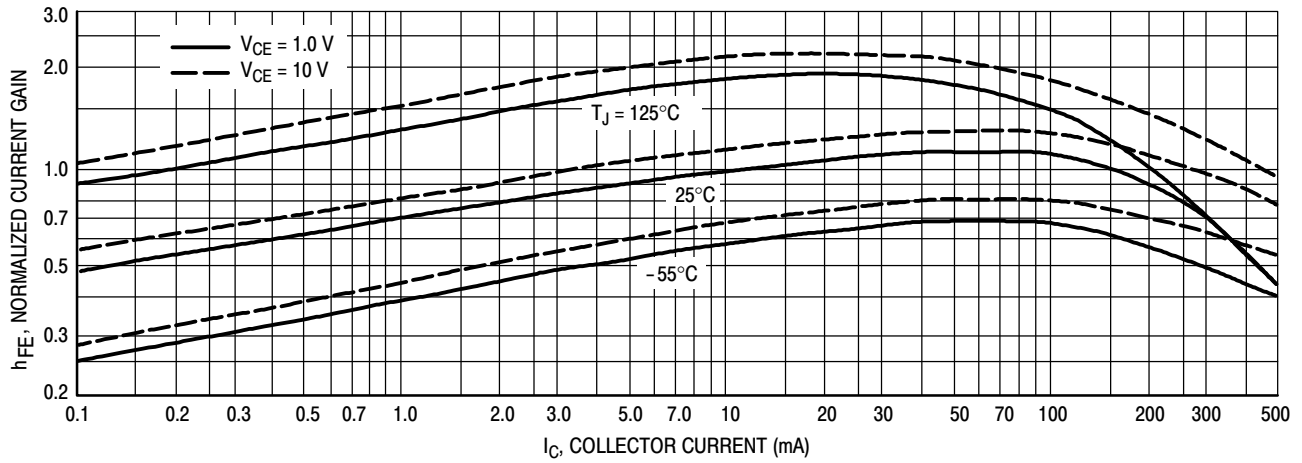


Figure 15. DC Current Gain

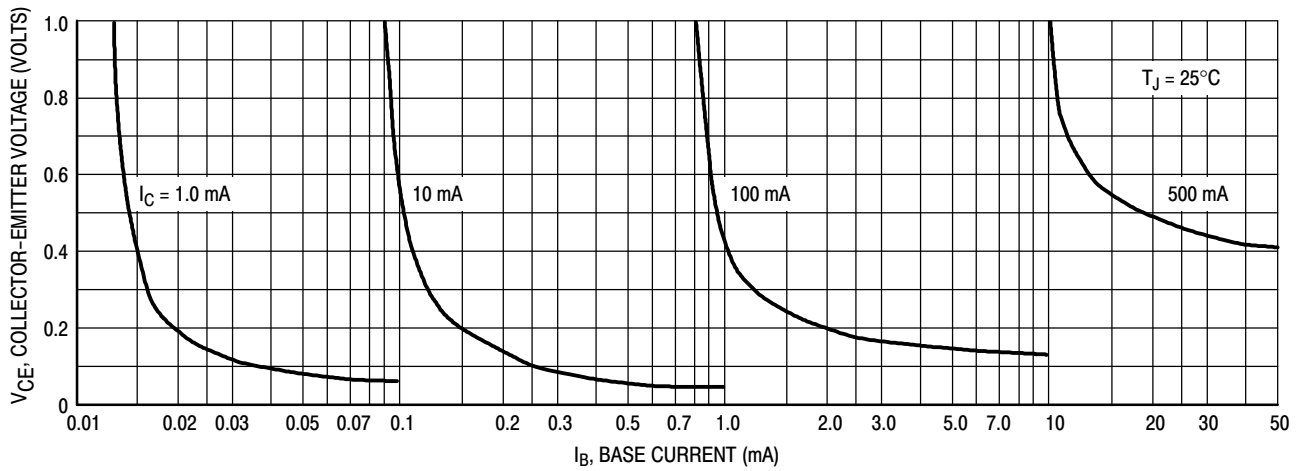


Figure 16. Collector Saturation Region

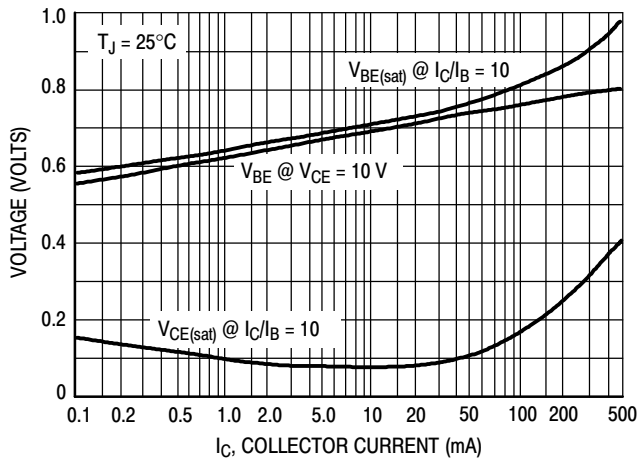


Figure 17. "On" Voltages

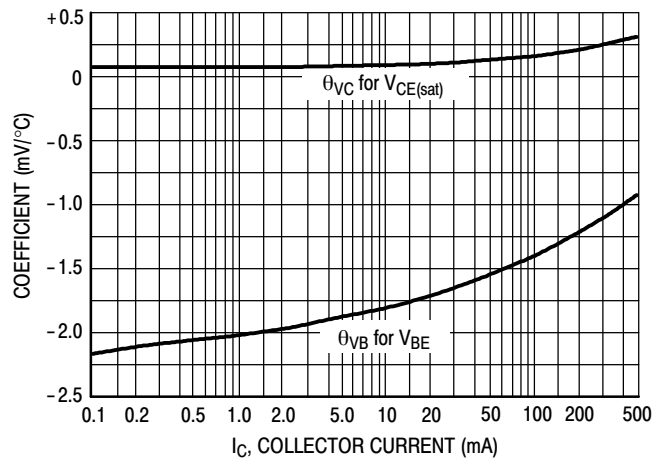


Figure 18. Temperature Coefficients