

## 2N4401

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

#### ON CHARACTERISTICS (Note 1)

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

#### SMALL–SIGNAL CHARACTERISTICS

Current–Gain – Bandwidth Product	( $I_C = 20\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 100\text{ MHz}$ )	$f_T$	250	–	MHz
Collector–Base Capacitance	( $V_{CB} = 5.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	$C_{cb}$	–	6.5	pF
Emitter–Base Capacitance	( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )	$C_{eb}$	–	30	pF
Input Impedance	( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	$h_{ie}$	1.0	15	k $\Omega$
Voltage Feedback Ratio	( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	$h_{re}$	0.1	8.0	$\times 10^{-4}$
Small–Signal Current Gain	( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	$h_{fe}$	40	500	–
Output Admittance	( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	$h_{oe}$	1.0	30	$\mu\text{mhos}$

#### SWITCHING CHARACTERISTICS

Delay Time	( $V_{CC} = 30\text{ Vdc}$ , $V_{BE} = 2.0\text{ Vdc}$ , $I_C = 150\text{ mA}$ , $I_{B1} = 15\text{ mA}$ )	$t_d$	–	15	ns
Rise Time		$t_r$	–	20	ns
Storage Time	( $V_{CC} = 30\text{ Vdc}$ , $I_C = 150\text{ mA}$ , $I_{B1} = I_{B2} = 15\text{ mA}$ )	$t_s$	–	225	ns
Fall Time		$t_f$	–	30	ns

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

#### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
2N4401	TO–92	5000 Units / Bulk
2N4401G	TO–92 (Pb–Free)	5000 Units / Bulk
2N4401RLRA	TO–92	2000 / Tape & Reel
2N4401RLRAG	TO–92 (Pb–Free)	2000 / Tape & Reel
2N4401RLRMG	TO–92 (Pb–Free)	2000 / Tape & Ammo Box
2N4401RLRP	TO–92	2000 / Tape & Ammo Box
2N4401RLRPG	TO–92 (Pb–Free)	2000 / Tape & Ammo Box

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

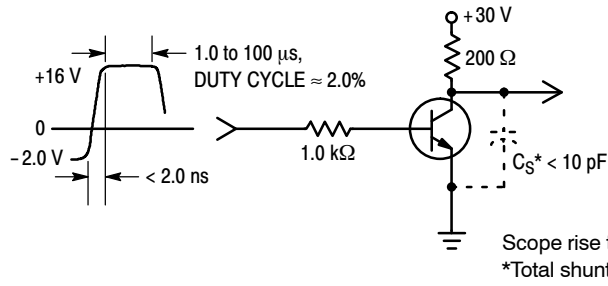


Figure 1. Turn-On Time

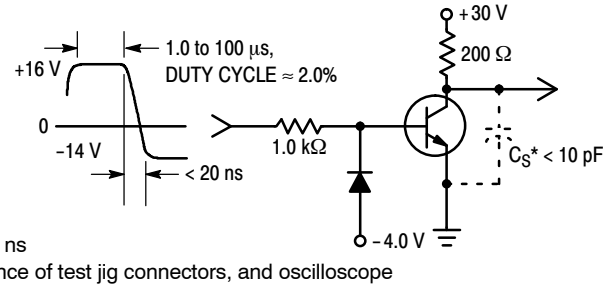


Figure 2. Turn-Off Time

## TRANSIENT CHARACTERISTICS

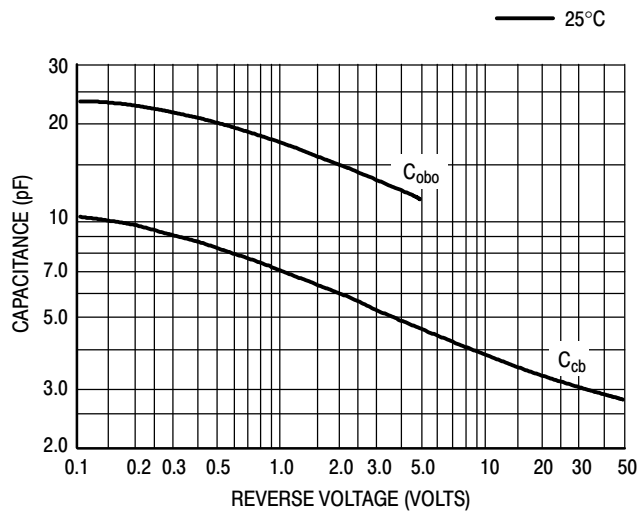


Figure 3. Capacitances

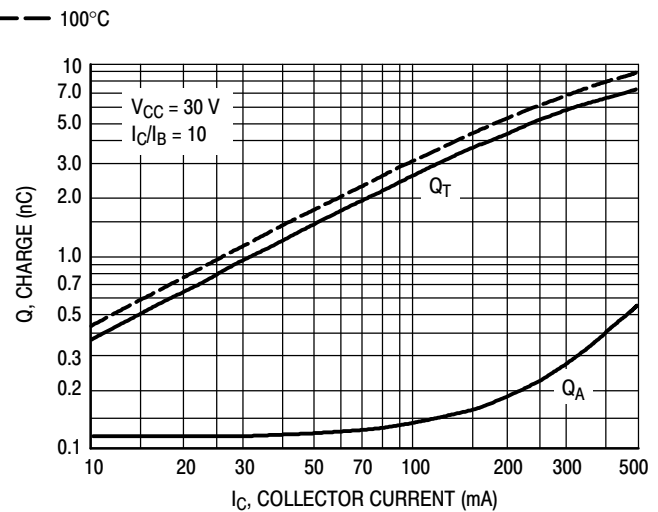


Figure 4. Charge Data

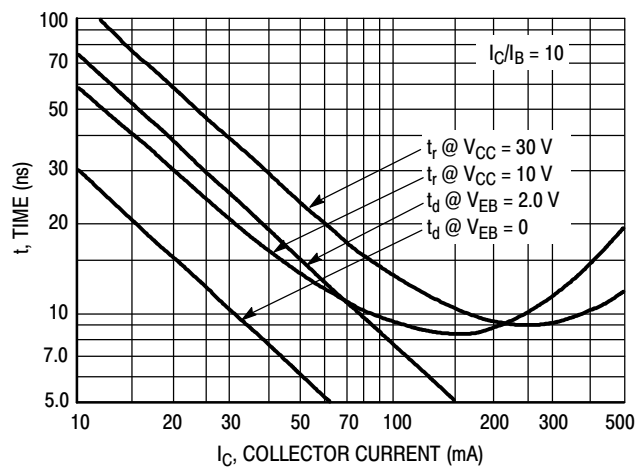


Figure 5. Turn-On Time

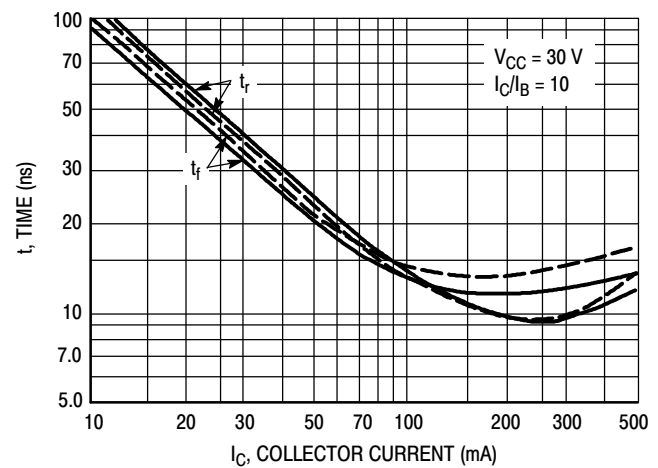
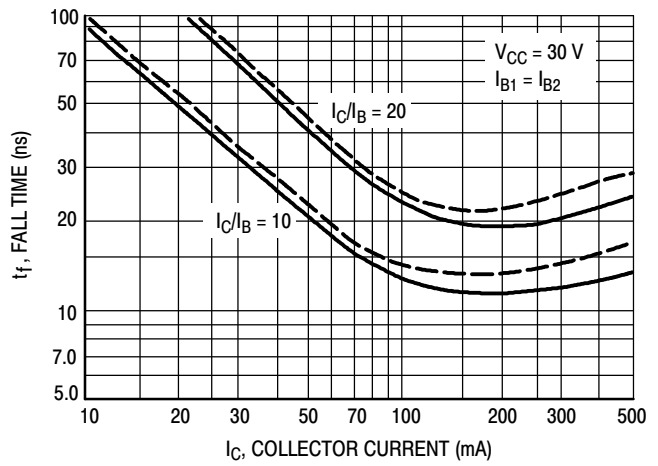
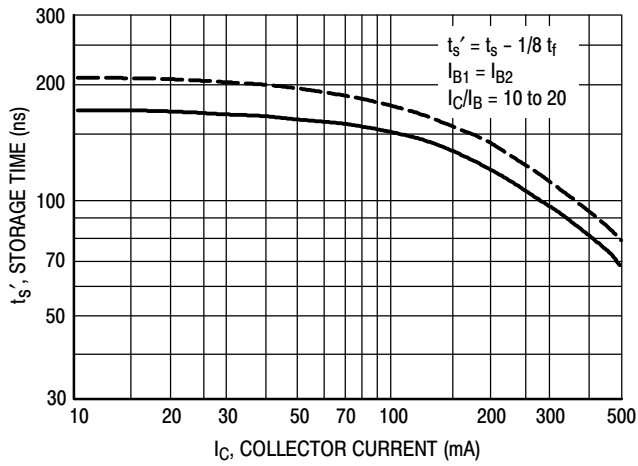
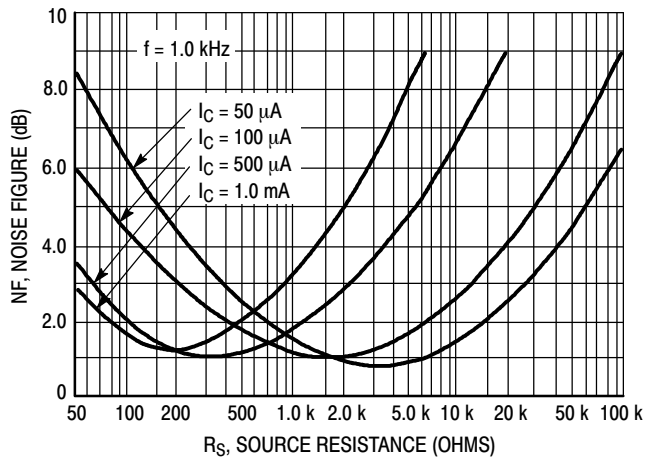
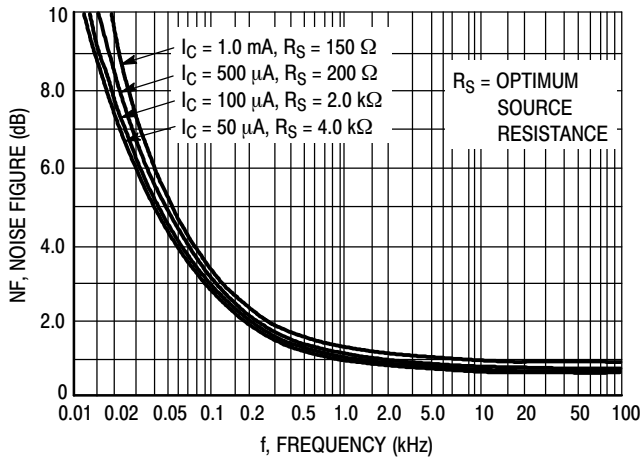


Figure 6. Rise and Fall Times



### SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

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



## 2N4401

### 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.

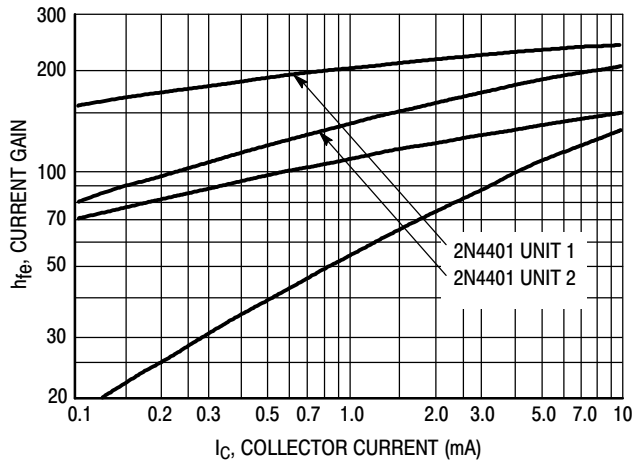


Figure 11. Current Gain

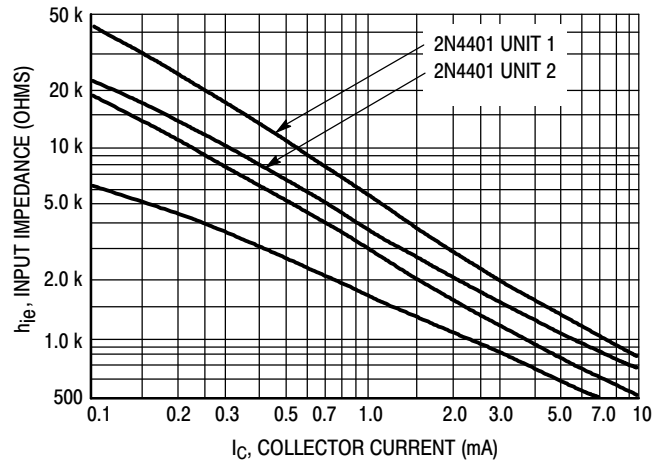


Figure 12. Input Impedance

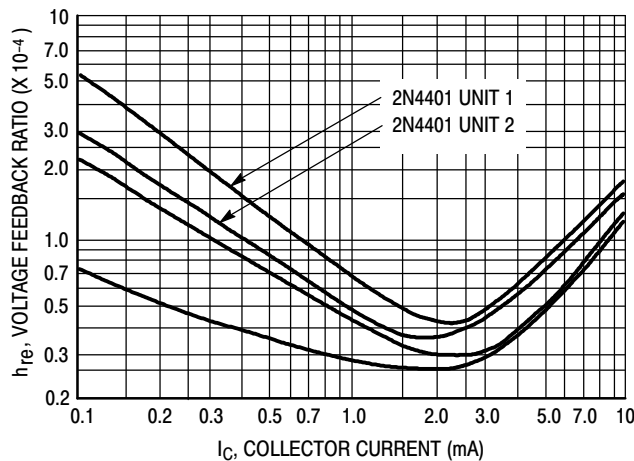


Figure 13. Voltage Feedback Ratio

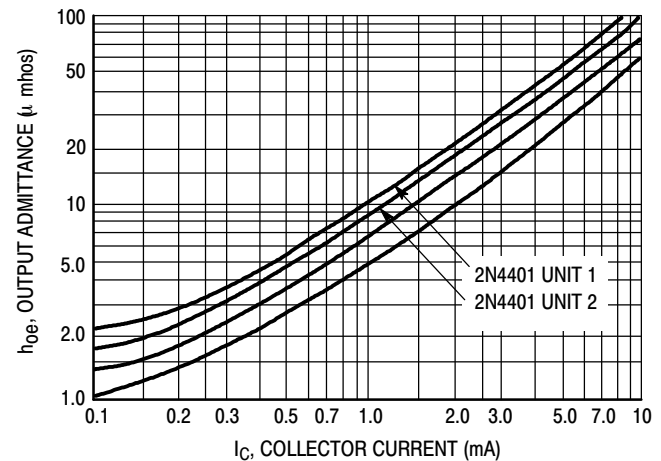


Figure 14. Output Admittance

STATIC CHARACTERISTICS

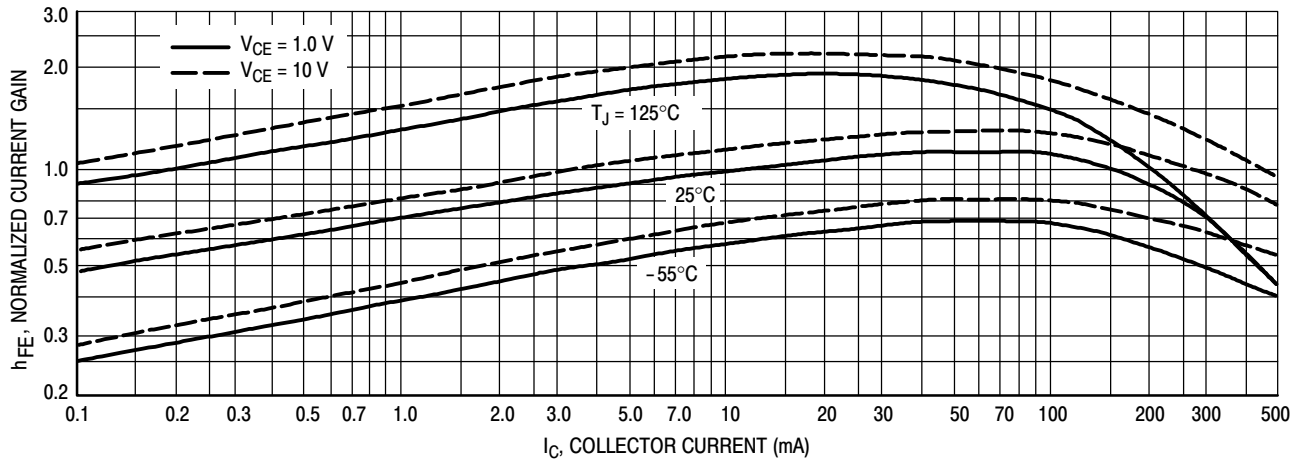


Figure 15. DC Current Gain

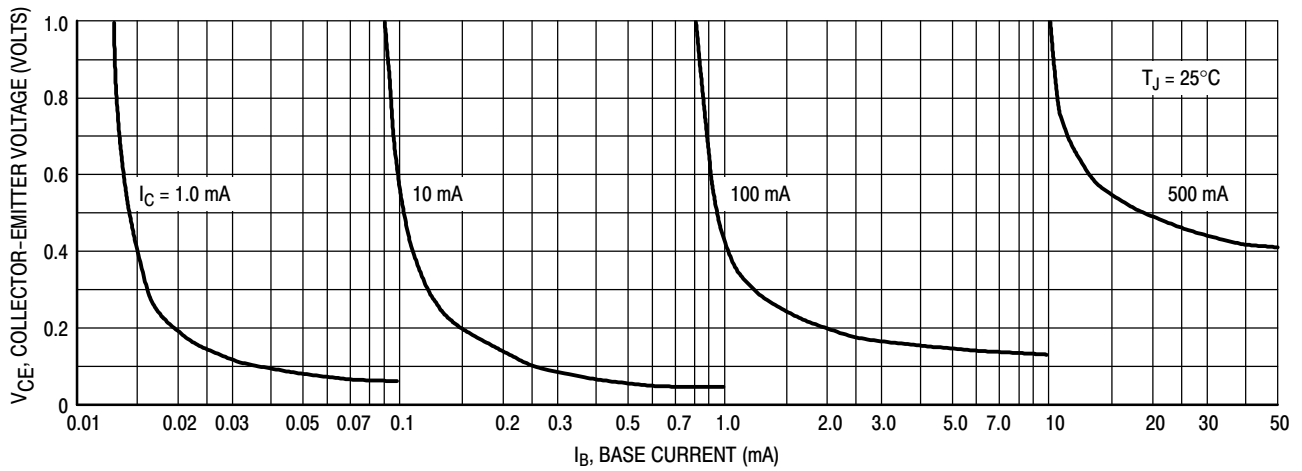


Figure 16. Collector Saturation Region

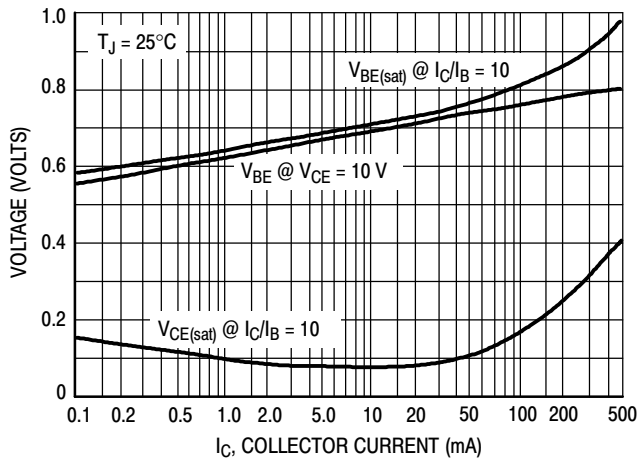


Figure 17. "On" Voltages

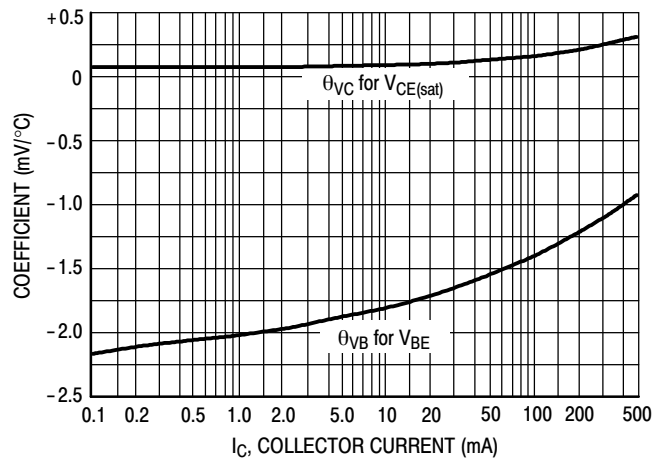


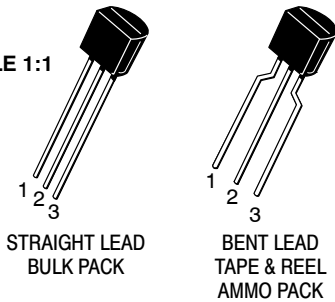
Figure 18. Temperature Coefficients

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®

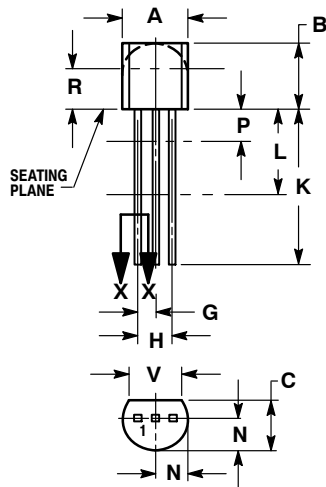
ON

SCALE 1:1

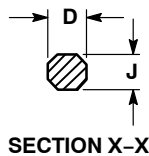


TO-92 (TO-226)  
CASE 29-11  
ISSUE AM

DATE 09 MAR 2007



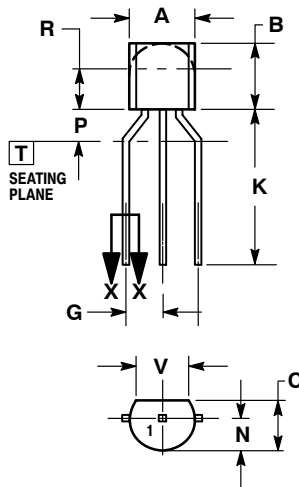
STRAIGHT LEAD  
BULK PACK



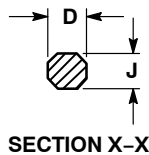
NOTES:

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	---



BENT LEAD  
TAPE & REEL  
AMMO PACK



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS	
	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLES ON PAGE 2

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**TO-92 (TO-226)**  
**CASE 29-11**  
**ISSUE AM**

DATE 09 MAR 2007

<b>STYLE 1:</b> PIN 1. EMITTER 2. BASE 3. COLLECTOR	<b>STYLE 2:</b> PIN 1. BASE 2. EMITTER 3. COLLECTOR	<b>STYLE 3:</b> PIN 1. ANODE 2. ANODE 3. CATHODE	<b>STYLE 4:</b> PIN 1. CATHODE 2. CATHODE 3. ANODE	<b>STYLE 5:</b> PIN 1. DRAIN 2. SOURCE 3. GATE
<b>STYLE 6:</b> PIN 1. GATE 2. SOURCE & SUBSTRATE 3. DRAIN	<b>STYLE 7:</b> PIN 1. SOURCE 2. DRAIN 3. GATE	<b>STYLE 8:</b> PIN 1. DRAIN 2. GATE 3. SOURCE & SUBSTRATE	<b>STYLE 9:</b> PIN 1. BASE 1 2. EMITTER 3. BASE 2	<b>STYLE 10:</b> PIN 1. CATHODE 2. GATE 3. ANODE
<b>STYLE 11:</b> PIN 1. ANODE 2. CATHODE & ANODE 3. CATHODE	<b>STYLE 12:</b> PIN 1. MAIN TERMINAL 1 2. GATE 3. MAIN TERMINAL 2	<b>STYLE 13:</b> PIN 1. ANODE 1 2. GATE 3. CATHODE 2	<b>STYLE 14:</b> PIN 1. EMITTER 2. COLLECTOR 3. BASE	<b>STYLE 15:</b> PIN 1. ANODE 1 2. CATHODE 3. ANODE 2
<b>STYLE 16:</b> PIN 1. ANODE 2. GATE 3. CATHODE	<b>STYLE 17:</b> PIN 1. COLLECTOR 2. BASE 3. EMITTER	<b>STYLE 18:</b> PIN 1. ANODE 2. CATHODE 3. NOT CONNECTED	<b>STYLE 19:</b> PIN 1. GATE 2. ANODE 3. CATHODE	<b>STYLE 20:</b> PIN 1. NOT CONNECTED 2. CATHODE 3. ANODE
<b>STYLE 21:</b> PIN 1. COLLECTOR 2. EMITTER 3. BASE	<b>STYLE 22:</b> PIN 1. SOURCE 2. GATE 3. DRAIN	<b>STYLE 23:</b> PIN 1. GATE 2. SOURCE 3. DRAIN	<b>STYLE 24:</b> PIN 1. EMITTER 2. COLLECTOR/ANODE 3. CATHODE	<b>STYLE 25:</b> PIN 1. MT 1 2. GATE 3. MT 2
<b>STYLE 26:</b> PIN 1. $V_{CC}$ 2. GROUND 2 3. OUTPUT	<b>STYLE 27:</b> PIN 1. MT 2. SUBSTRATE 3. MT	<b>STYLE 28:</b> PIN 1. CATHODE 2. ANODE 3. GATE	<b>STYLE 29:</b> PIN 1. NOT CONNECTED 2. ANODE 3. CATHODE	<b>STYLE 30:</b> PIN 1. DRAIN 2. GATE 3. SOURCE
<b>STYLE 31:</b> PIN 1. GATE 2. DRAIN 3. SOURCE	<b>STYLE 32:</b> PIN 1. BASE 2. COLLECTOR 3. EMITTER	<b>STYLE 33:</b> PIN 1. RETURN 2. INPUT 3. OUTPUT	<b>STYLE 34:</b> PIN 1. INPUT 2. GROUND 3. LOGIC	<b>STYLE 35:</b> PIN 1. GATE 2. COLLECTOR 3. EMITTER

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