

# P2N2222A

## Amplifier Transistors

### NPN Silicon

#### Features

- These are Pb-Free Devices\*

**MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	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	W mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

#### THERMAL CHARACTERISTICS

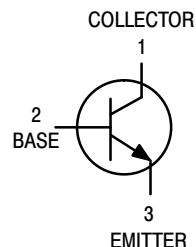
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	$^\circ\text{C}/\text{W}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

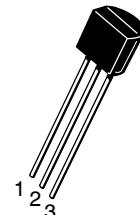


**ON Semiconductor®**

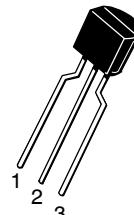
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TO-92  
CASE 29  
STYLE 17

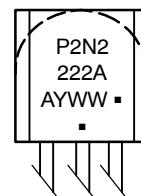


STRAIGHT LEAD  
BULK PACK



BENT LEAD  
TAPE & REEL  
AMMO PACK

#### MARKING DIAGRAM



A = Assembly Location

Y = Year

WW = Work Week

■ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
P2N2222AG	TO-92 (Pb-Free)	5000 Units/Bulk
P2N2222ARL1G	TO-92 (Pb-Free)	2000/Tape & Ammo

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

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# P2N222A

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector – Emitter Breakdown Voltage ( $I_C = 10 \mu\text{Adc}$ , $I_B = 0$ )	$V_{(\text{BR})\text{CEO}}$	40	–	Vdc
Collector – Base Breakdown Voltage ( $I_C = 10 \mu\text{Adc}$ , $I_E = 0$ )	$V_{(\text{BR})\text{CBO}}$	75	–	Vdc
Emitter – Base Breakdown Voltage ( $I_E = 10 \mu\text{Adc}$ , $I_C = 0$ )	$V_{(\text{BR})\text{EBO}}$	6.0	–	Vdc
Collector Cutoff Current ( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB(\text{off})} = 3.0 \text{ Vdc}$ )	$I_{\text{CEX}}$	–	10	nAdc
Collector Cutoff Current ( $V_{CB} = 60 \text{ Vdc}$ , $I_E = 0$ ) ( $V_{CB} = 60 \text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ )	$I_{\text{CBO}}$	– –	0.01 10	$\mu\text{Adc}$
Emitter Cutoff Current ( $V_{EB} = 3.0 \text{ Vdc}$ , $I_C = 0$ )	$I_{\text{EBO}}$	–	10	nAdc
Collector Cutoff Current ( $V_{CE} = 10 \text{ V}$ )	$I_{\text{CEO}}$	–	10	nAdc
Base Cutoff Current ( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB(\text{off})} = 3.0 \text{ Vdc}$ )	$I_{\text{BEX}}$	–	20	nAdc

## ON CHARACTERISTICS

DC Current Gain ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $T_A = -55^\circ\text{C}$ ) ( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) (Note 1) ( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) (Note 1) ( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) (Note 1)	$h_{FE}$	35 50 75 35 100 50 40	– – – – 300 – –	–
Collector – Emitter Saturation Voltage (Note 1) ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{CE(\text{sat})}$	– –	0.3 1.0	Vdc
Base – Emitter Saturation Voltage (Note 1) ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{BE(\text{sat})}$	0.6 –	1.2 2.0	Vdc

## SMALL-SIGNAL CHARACTERISTICS

Current – Gain – Bandwidth Product (Note 2) ( $I_C = 20 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )C	$f_T$	300	–	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{\text{obo}}$	–	8.0	pF
Input Capacitance ( $V_{EB} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{\text{ibo}}$	–	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	kΩ
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	$\mu\text{Mhos}$
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 ( $I_C = 100 \mu\text{Adc}$ , $V_{CE} = 10 \text{ Vdc}$ , $R_S = 1.0 \text{ k}\Omega$ , $f = 1.0 \text{ kHz}$ )	$N_F$	–	4.0	dB

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

2.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

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

Characteristic	Symbol	Min	Max	Unit
<b>SWITCHING CHARACTERISTICS</b>				
Delay Time ( $V_{CC} = 30 \text{ Vdc}$ , $V_{BE(\text{off})} = -2.0 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = 15 \text{ mAdc}$ ) (Figure 1)	$t_d$	—	10	ns
Rise Time ( $V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = I_{B2} = 15 \text{ mAdc}$ ) (Figure 2)	$t_r$	—	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 ( $V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = I_{B2} = 15 \text{ mAdc}$ ) (Figure 2)	$t_f$	—	60	ns

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

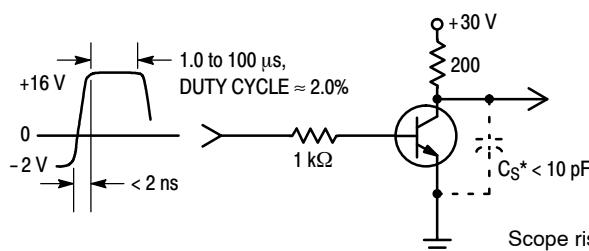


Figure 1. Turn-On Time

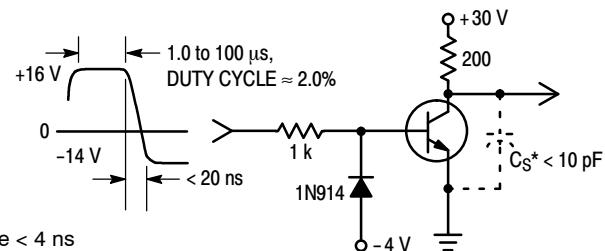


Figure 2. Turn-Off Time

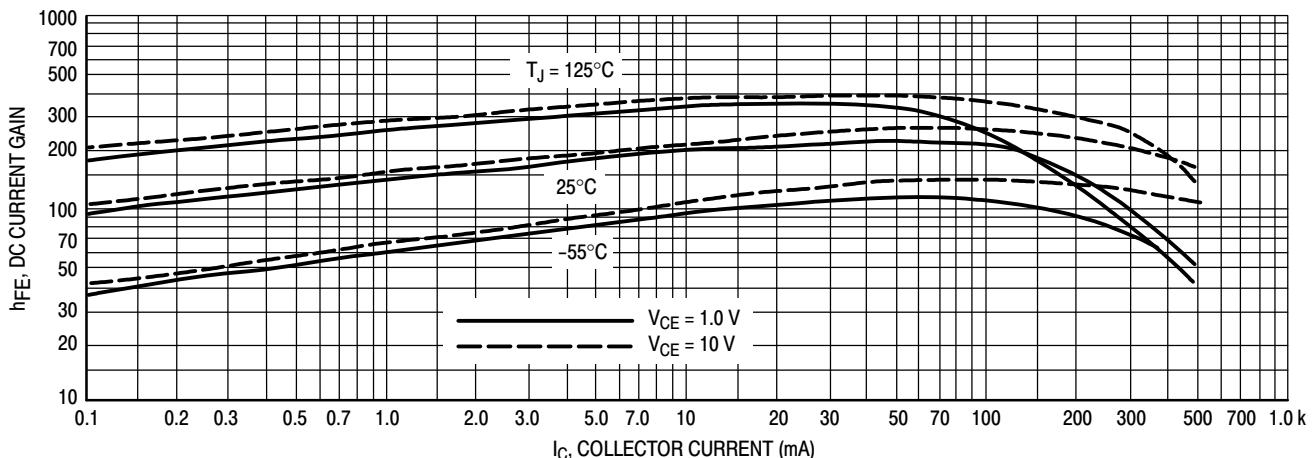


Figure 3. DC Current Gain

# P2N2222A

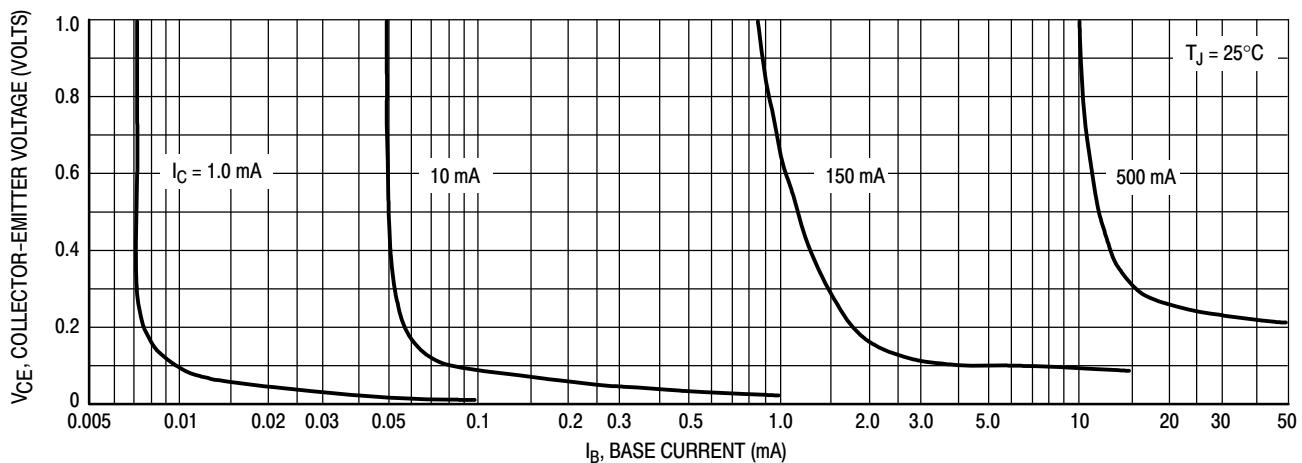


Figure 4. Collector Saturation Region

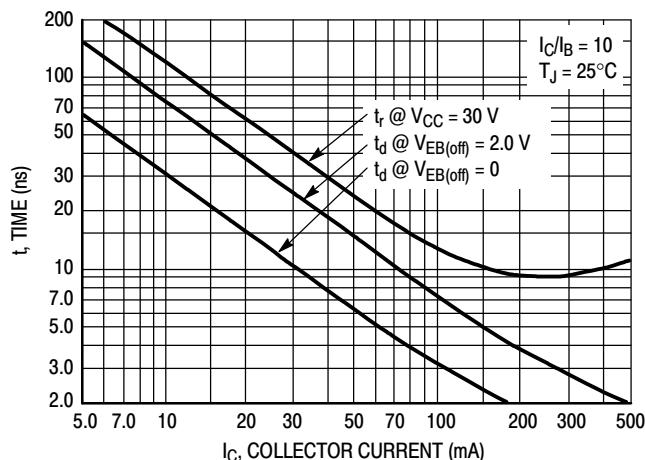


Figure 5. Turn-On Time

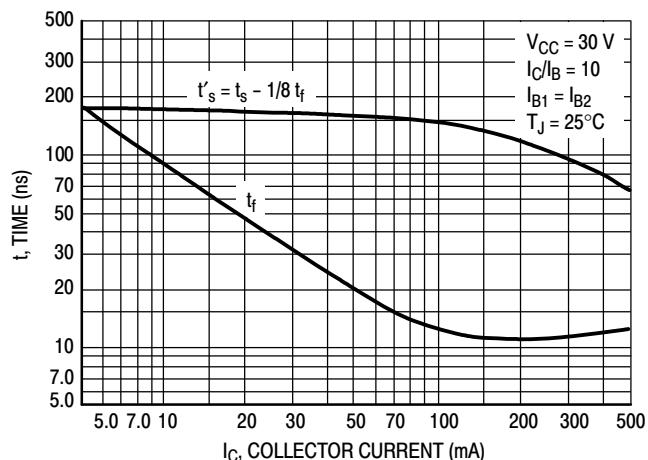


Figure 6. Turn-Off Time

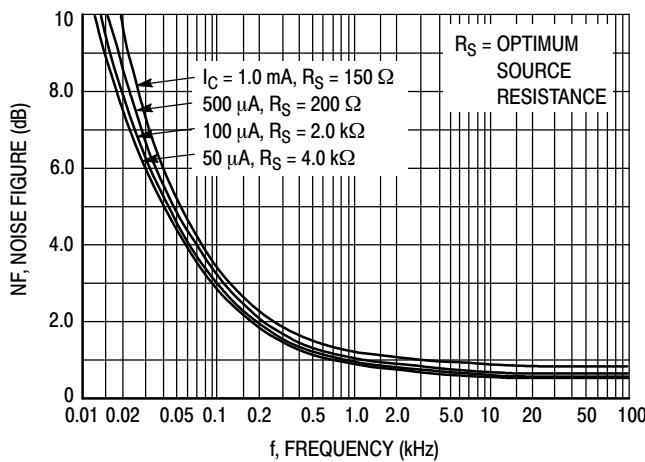


Figure 7. Frequency Effects

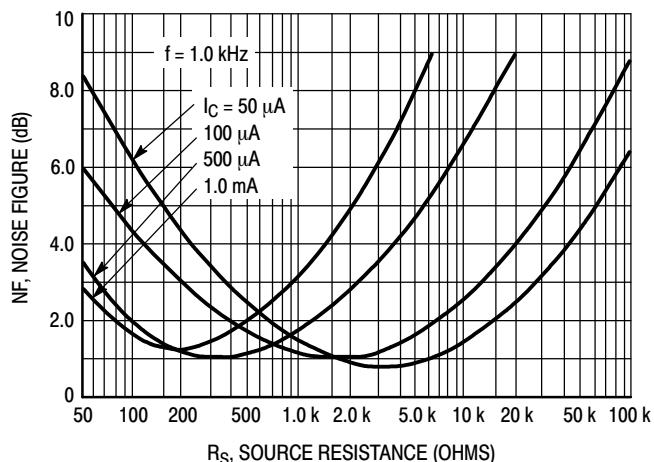
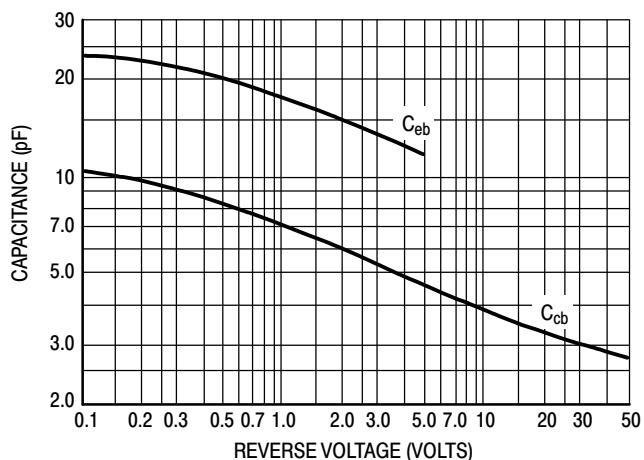
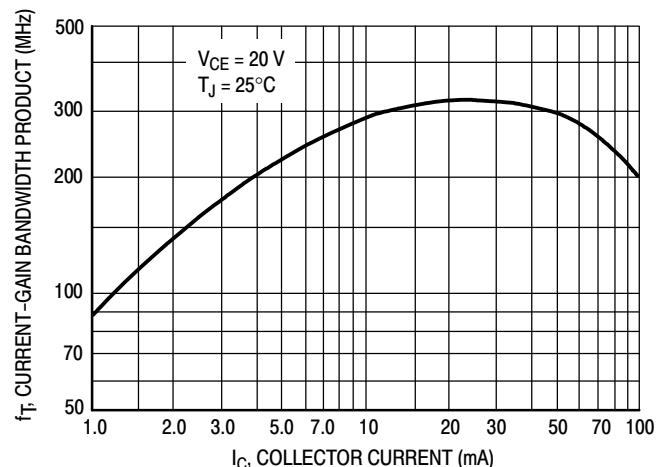


Figure 8. Source Resistance Effects

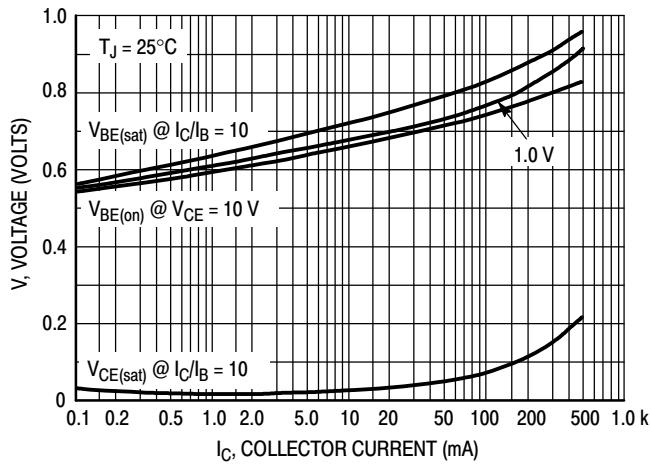
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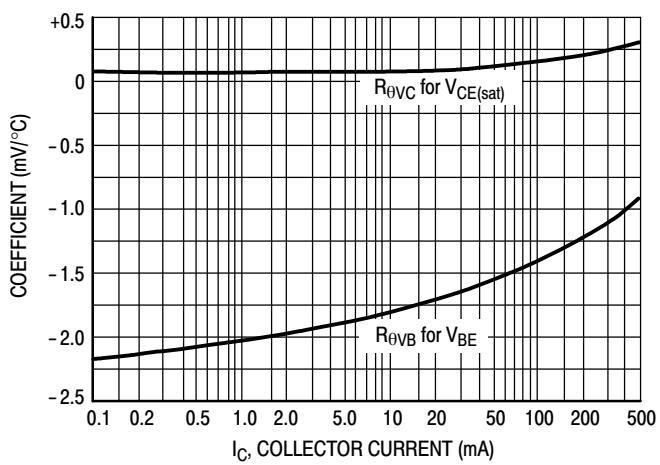
**Figure 9. Capacitances**



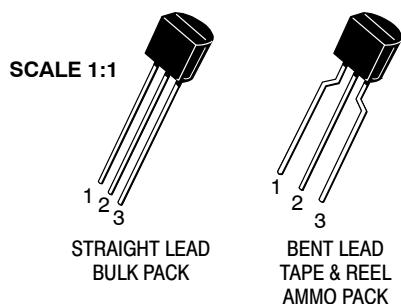
**Figure 10. Current-Gain Bandwidth Product**



**Figure 11. "On" Voltages**

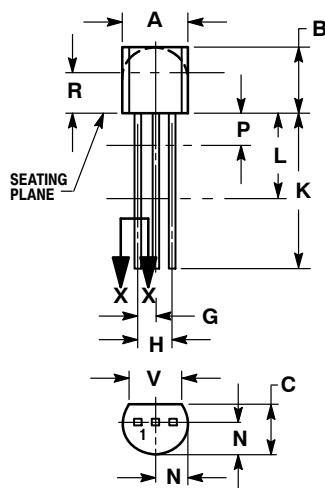


**Figure 12. Temperature Coefficients**

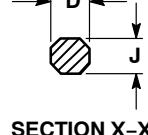


**TO-92 (TO-226)**  
CASE 29-11  
ISSUE AM

DATE 09 MAR 2007

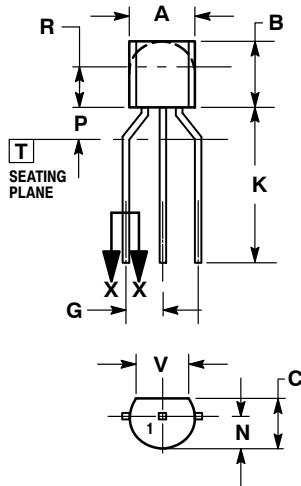


STRAIGHT LEAD  
BULK PACK

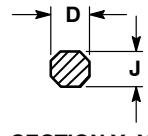


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
  4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

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 <sub>CC</sub> 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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