## **Amplifier Transistors**

### **NPN Silicon**

#### **Features**

• These are Pb-Free Devices\*

#### MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Value	Unit
Collector - Emitter Voltage	V <sub>CEO</sub>	40	Vdc
Collector - Base Voltage	V <sub>CBO</sub>	75	Vdc
Emitter – Base Voltage	V <sub>EBO</sub>	6.0	Vdc
Collector Current – Continuous	I <sub>C</sub>	600	mAdc
Total Device Dissipation @ T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub>	625 5.0	mW mW/°C
Total Device Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C

#### THERMAL CHARACTERISTICS

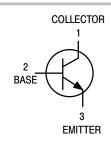
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

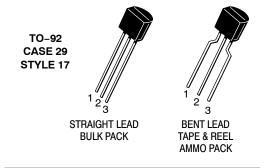
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



#### ON Semiconductor®

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#### **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.

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

### **ELECTRICAL CHARACTERISTICS** (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS	<b>-</b>			
Collector – Emitter Breakdown Voltage $(I_C = 10 \text{ mAdc}, I_B = 0)$	V <sub>(BR)</sub> CEO	40	-	Vdc
Collector – Base Breakdown Voltage $(I_C = 10 \mu Adc, I_E = 0)$	V <sub>(BR)CBO</sub>	75	_	Vdc
Emitter – Base Breakdown Voltage $(I_E = 10 \mu Adc, I_C = 0)$	V <sub>(BR)EBO</sub>	6.0	-	Vdc
Collector Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)	I <sub>CEX</sub>	_	10	nAdc
Collector Cutoff Current (V <sub>CB</sub> = 60 Vdc, I <sub>E</sub> = 0) (V <sub>CB</sub> = 60 Vdc, I <sub>E</sub> = 0, T <sub>A</sub> = 150°C)	I <sub>CBO</sub>	- -	0.01 10	μAdc
Emitter Cutoff Current (V <sub>EB</sub> = 3.0 Vdc, I <sub>C</sub> = 0)	I <sub>EBO</sub>	_	10	nAdc
Collector Cutoff Current (V <sub>CE</sub> = 10 V)	I <sub>CEO</sub>	_	10	nAdc
Base Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)	I <sub>BEX</sub>	-	20	nAdc
ON CHARACTERISTICS	•	•	1	•
$\begin{array}{l} \text{DC Current Gain} \\ (I_C = 0.1 \text{ mAdc, } V_{CE} = 10 \text{ Vdc)} \\ (I_C = 1.0 \text{ mAdc, } V_{CE} = 10 \text{ Vdc)} \\ (I_C = 10 \text{ mAdc, } V_{CE} = 10 \text{ Vdc)} \\ (I_C = 10 \text{ mAdc, } V_{CE} = 10 \text{ Vdc, } T_A = -55^{\circ}\text{C)} \\ (I_C = 150 \text{ mAdc, } V_{CE} = 10 \text{ Vdc, } (\text{Note 1}) \\ (I_C = 150 \text{ mAdc, } V_{CE} = 1.0 \text{ Vdc)} \text{ (Note 1)} \\ (I_C = 500 \text{ mAdc, } V_{CE} = 10 \text{ Vdc)} \text{ (Note 1)} \\ \end{array}$	h <sub>FE</sub>	35 50 75 35 100 50 40	- - - 300 -	-
Collector – Emitter Saturation Voltage (Note 1) $ \begin{pmatrix} I_{C} = 150 \text{ mAdc, } I_{B} = 15 \text{ mAdc} \\ I_{C} = 500 \text{ mAdc, } I_{B} = 50 \text{ mAdc} \end{pmatrix} $	V <sub>CE(sat)</sub>	_ _	0.3 1.0	Vdc
Base – Emitter Saturation Voltage (Note 1) ( $I_C$ = 150 mAdc, $I_B$ = 15 mAdc) ( $I_C$ = 500 mAdc, $I_B$ = 50 mAdc)	V <sub>BE(sat)</sub>	0.6 -	1.2 2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current – Gain – Bandwidth Product (Note 2) (I <sub>C</sub> = 20 mAdc, V <sub>CE</sub> = 20 Vdc, f = 100 MHz)C	f <sub>T</sub>	300	-	MHz
Output Capacitance (V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)	C <sub>obo</sub>	_	8.0	pF
Input Capacitance (V <sub>EB</sub> = 0.5 Vdc, I <sub>C</sub> = 0, f = 1.0 MHz)	C <sub>ibo</sub>	-	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 <sub>ie</sub>	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 <sub>re</sub>	- -	8.0 4.0	X 10 <sup>-4</sup>
Small-Signal Current Gain ( $I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) ( $I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)	h <sub>fe</sub>	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 <sub>oe</sub>	5.0 25	35 200	μMhos
Collector Base Time Constant (I <sub>E</sub> = 20 mAdc, V <sub>CB</sub> = 20 Vdc, f = 31.8 MHz)	rb′C <sub>c</sub>	-	150	ps
Noise Figure (I <sub>C</sub> = 100 $\mu$ Adc, V <sub>CE</sub> = 10 Vdc, R <sub>S</sub> = 1.0 k $\Omega$ , f = 1.0 kHz)	N <sub>F</sub>	_	4.0	dB

<sup>1.</sup> Pulse Test: Pulse Width  $\leq 300~\mu s$ , Duty Cycle  $\leq 2.0\%$ . 2.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

#### **ELECTRICAL CHARACTERISTICS** (T<sub>A</sub> = 25°C unless otherwise noted) (Continued)

	Characteristic			Max	Unit		
SWITCHING CHARAC	SWITCHING CHARACTERISTICS						
Delay Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -2.0 \text{ Vdc},$	t <sub>d</sub>	-	10	ns		
Rise Time	$I_C$ = 150 mAdc, $I_{B1}$ = 15 mAdc) (Figure 1)	t <sub>r</sub>	-	25	ns		
Storage Time	(V <sub>CC</sub> = 30 Vdc, I <sub>C</sub> = 150 mAdc,	t <sub>s</sub>	-	225	ns		
Fall Time	I <sub>B1</sub> = I <sub>B2</sub> = 15 mAdc) (Figure 2)	t <sub>f</sub>	-	60	ns		

#### **SWITCHING TIME EQUIVALENT TEST CIRCUITS**

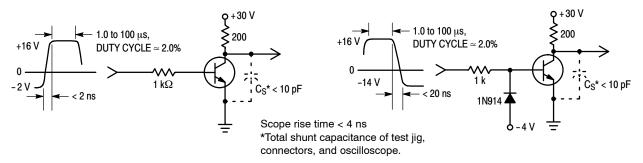


Figure 1. Turn-On Time

Figure 2. Turn-Off Time

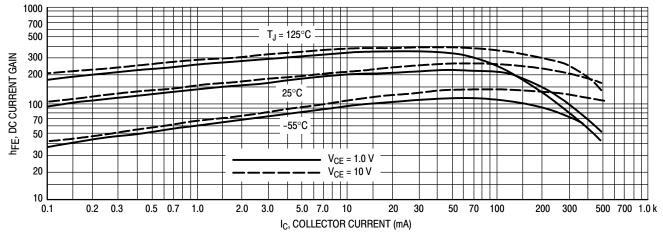


Figure 3. DC Current Gain

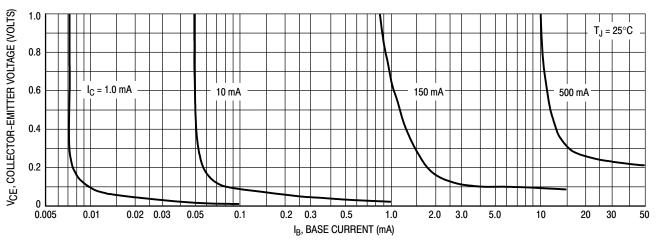


Figure 4. Collector Saturation Region

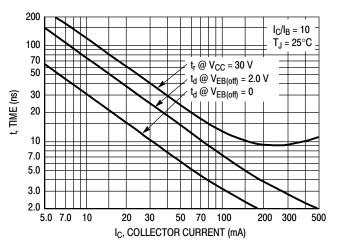


Figure 5. Turn-On Time

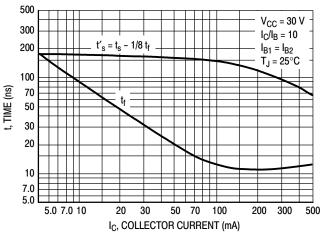


Figure 6. Turn – Off Time

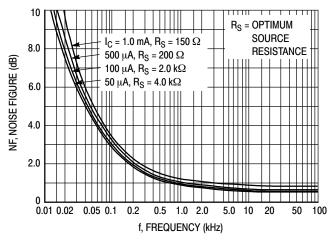


Figure 7. Frequency Effects

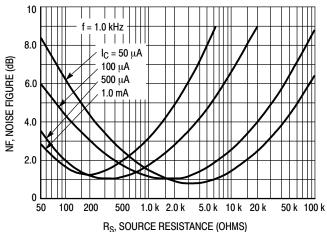


Figure 8. Source Resistance Effects

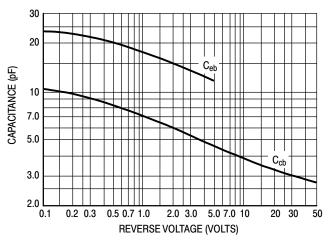
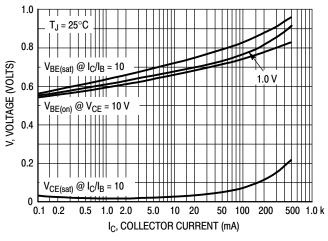


Figure 9. Capacitances

Figure 10. Current-Gain Bandwidth Product



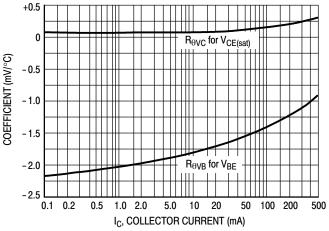
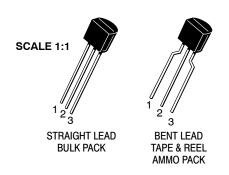


Figure 11. "On" Voltages

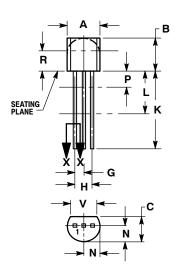
Figure 12. Temperature Coefficients





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

**DATE 09 MAR 2007** 

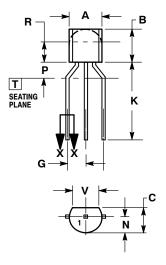


STRAIGHT LEAD **BULK PACK** 



- 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.

	INC	HES	MILLIN	IETERS
DIM	MIN	MAX	MIN	MAX
Α	0.175	0.205	4.45	5.20
В	0.170	0.210	4.32	5.33
С	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
Н	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	
٧	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.

	MILLIMETERS				
DIM	MIN	MAX			
Α	4.45	5.20			
В	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				
٧	3.43				

#### **STYLES ON PAGE 2**

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# **TO-92 (TO-226)** CASE 29-11

# ISSUE AM

#### DATE 09 MAR 2007

STYLE 1: PIN 1. 2. 3.	EMITTER BASE COLLECTOR	STYLE 2: PIN 1. 2. 3.	BASE EMITTER COLLECTOR	STYLE 3: PIN 1. 2. 3.	ANODE ANODE CATHODE	STYLE 4: PIN 1. 2. 3.	CATHODE CATHODE ANODE	STYLE 5: PIN 1. 2. 3.	DRAIN SOURCE GATE
STYLE 6: PIN 1. 2. 3.	GATE SOURCE & SUBSTRATE DRAIN	STYLE 7: PIN 1. 2. 3.	SOURCE DRAIN GATE	STYLE 8: PIN 1. 2. 3.	DRAIN GATE SOURCE & SUBSTRATE	STYLE 9: PIN 1. 2. 3.	BASE 1 EMITTER BASE 2	STYLE 10: PIN 1. 2. 3.	CATHODE GATE
STYLE 11: PIN 1. 2. 3.	ANODE CATHODE & ANODE CATHODE	STYLE 12: PIN 1. 2. 3.	MAIN TERMINAL 1 GATE MAIN TERMINAL 2	STYLE 13: PIN 1. 2. 3.	ANODE 1 GATE CATHODE 2	STYLE 14: PIN 1. 2. 3.	EMITTER COLLECTOR BASE	PIN 1. 2.	
2.	ANODE GATE CATHODE	2.	BASE	2.	ANODE CATHODE NOT CONNECTED	2.	ANODE	2.	NOT CONNECTED
PIN 1. 2.	COLLECTOR	PIN 1. 2.	SOURCE GATE DRAIN	STYLE 23: PIN 1. 2. 3.	GATE SOURCE DRAIN	STYLE 24: PIN 1. 2. 3.	EMITTER COLLECTOR/ANODE CATHODE		MT 1 GATE
		2.	MT SUBSTRATE MT	2.		PIN 1. 2.	ANODE	STYLE 30: PIN 1. 2. 3.	DRAIN GATE
	GATE	PIN 1. 2.	BASE COLLECTOR EMITTER	STYLE 33: PIN 1. 2. 3.	RETURN	2.			

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<b>DOCUMENT</b>	NUMBER:
08 V S B 42022	R

PAGE 3 OF 3

ISSUE	REVISION	DATE
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