# **General Purpose Transistors**

# **NPN Silicon**

#### **Features**

• Pb-Free Packages are Available\*

#### **MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage PN2222 PN2222A	V <sub>CEO</sub>	30 40	Vdc
Collector-Base Voltage PN2222 PN2222A	V <sub>CBO</sub>	60 75	Vdc
Emitter-Base Voltage PN2222 PN2222A	V <sub>EBO</sub>	5.0 6.0	Vdc
Collector Current - Continuous	Ic	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

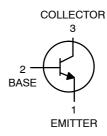
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	83.3	°C/W

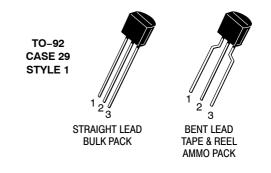
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



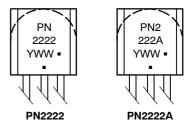
## ON Semiconductor®

http://onsemi.com





#### **MARKING DIAGRAM**



Y = Year WW = Work Week ■ = Pb-Free Package

(Note: Microdot may be in either location)

#### **ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

<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					
Collector – Emitter Breakdown Voltage (I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 0)	PN2222 PN2222A	V <sub>(BR)CEO</sub>	30 40	- -	Vdc
Collector – Base Breakdown Voltage ( $I_C = 10 \mu Adc, I_E = 0$ )	PN2222 PN2222A	V <sub>(BR)CBO</sub>	60 75	- -	Vdc
Emitter – Base Breakdown Voltage ( $I_E = 10 \mu Adc, I_C = 0$ )	PN2222 PN2222A	V <sub>(BR)EBO</sub>	5.0 6.0	_ _	Vdc
Collector Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)	PN2222A	I <sub>CEX</sub>	-	10	nAdc
	PN2222 PN2222A PN2222 PN2222A	Ісво	- - - -	0.01 0.01 10 10	μAdc
Emitter Cutoff Current (V <sub>EB</sub> = 3.0 Vdc, I <sub>C</sub> = 0)	PN2222A	I <sub>EBO</sub>	_	100	nAdc
Base Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB(off)</sub> = 3.0 Vdc)	PN2222A	I <sub>BL</sub>	-	20	nAdc
ON CHARACTERISTICS		•			
DC Current Gain $ \begin{array}{l} (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}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} $	PN2222A only PN2222 PN2222A	h <sub>FE</sub>	35 50 75 35 100 50 30 40	- - - 300 - -	-
Collector – Emitter Saturation Voltage (Note 1) (I <sub>C</sub> = 150 mAdc, I <sub>B</sub> = 15 mAdc) (I <sub>C</sub> = 500 mAdc, I <sub>B</sub> = 50 mAdc)	PN2222 PN2222A PN2222 PN2222A	V <sub>CE(sat)</sub>	- - - -	0.4 0.3 1.6 1.0	Vdc
Base – Emitter Saturation Voltage (Note 1) (I <sub>C</sub> = 150 mAdc, I <sub>B</sub> = 15 mAdc) (I <sub>C</sub> = 500 mAdc, I <sub>B</sub> = 50 mAdc)	PN2222 PN2222A PN2222 PN2222A	V <sub>BE</sub> (sat)	- 0.6 - -	1.3 1.2 2.6 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)	PN2222 PN2222A	f <sub>T</sub>	250 300	_ _	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)	PN2222 PN2222A	C <sub>ibo</sub>	- -	30 25	pF
Input Impedance ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )	PN2222A PN2222A	h <sub>ie</sub>	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio ( $I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) ( $I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)	PN2222A PN2222A	h <sub>re</sub>	_ _	8.0 4.0	X 10 <sup>-4</sup>
$\label{eq:small-Signal Current Gain}                                    $	PN2222A PN2222A	h <sub>fe</sub>	50 75	300 375	_

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

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

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL	CHARACTERISTICS					
Output Admittance ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )		PN2222A PN2222A	h <sub>oe</sub>	5.0 25	35 200	μMhos
Collector Base Tin (I <sub>E</sub> = 20 mAdc,	ne Constant V <sub>CB</sub> = 20 Vdc, f = 31.8 MHz)	PN2222A	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 $\mu$ Adc, f = 1.0 kHz) PN2222A			NF	-	4.0	dB
SWITCHING CHA	RACTERISTICS (PN2222A only)		•	•		
Delay Time	$(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = -0.5 \text{ Vdc},$		t <sub>d</sub>	_	10	ns
Rise Time	I <sub>C</sub> = 150 mAdc, I <sub>B1</sub> = 15 mAdc) (Figure 1)		t <sub>r</sub>	-	25	ns
Storage Time	torage Time $(V_{CC} = 30 \text{ Vdc}, I_C = 150 \text{ mAdc},$		t <sub>s</sub>	-	225	ns
$I_{B1} = I_{B2} = 15 \text{ mAdc} $ (Figure 2)		t <sub>f</sub>	_	60	ns	

#### **ORDERING INFORMATION**

Device	Package	Shipping <sup>†</sup>
PN2222G	TO-92 (Pb-Free)	5000 Units / Bulk
PN2222AG	TO-92 (Pb-Free)	5000 Units / Bulk
PN2222ARLRA	TO-92	2000 / Tape & Reel
PN2222ARLRAG	TO-92 (Pb-Free)	2000 / Tape & Reel
PN2222ARLRM	TO-92	2000 / Tape & Ammo Box
PN2222ARLRMG	TO-92 (Pb-Free)	2000 / Tape & Ammo Box
PN2222ARLRPG	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**

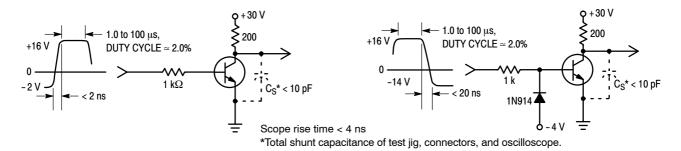


Figure 1. Turn-On Time

Figure 2. Turn-Off Time

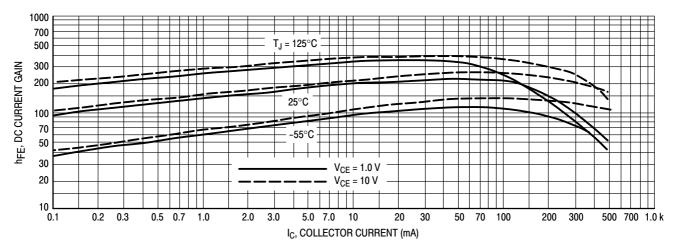


Figure 3. DC Current Gain

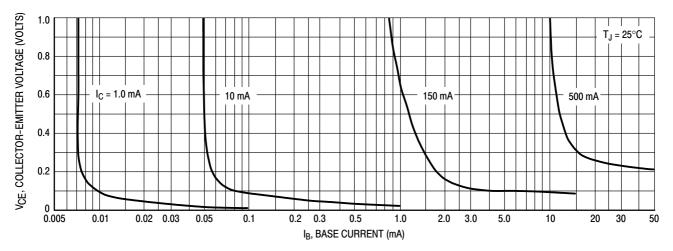


Figure 4. Collector Saturation Region

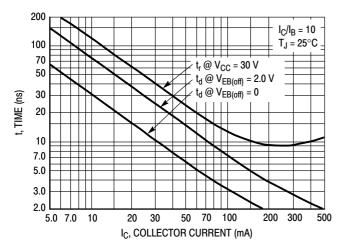


Figure 5. Turn - On Time

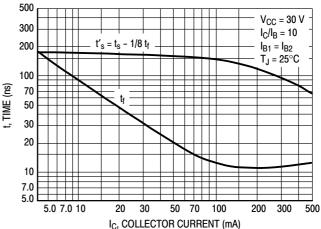
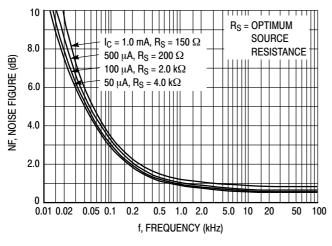


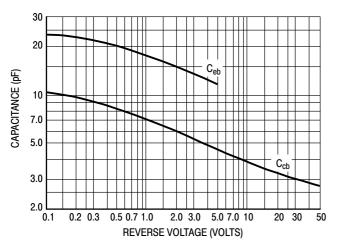
Figure 6. Turn - Off Time



.0 kHz 8.0  $I_C = 50 \mu A$ NF, NOISE FIGURE (dB) 100 μΑ 500 μA 6.0 1.0 mA 4.0 2.0 50 100 200 1.0 k 2.0 k 5.0 k 10 k 20 k 50 k 100 k R<sub>S</sub>, SOURCE RESISTANCE (OHMS)

Figure 7. Frequency Effects

Figure 8. Source Resistance Effects



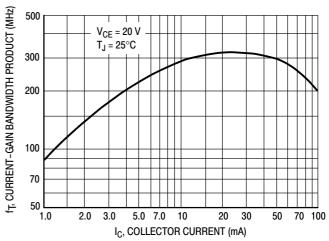
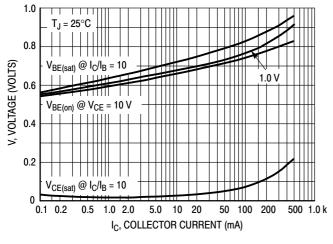


Figure 9. Capacitances

Figure 10. Current-Gain Bandwidth Product



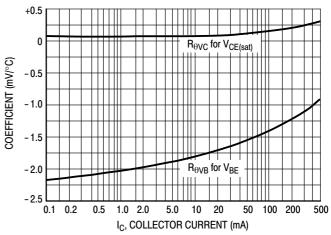
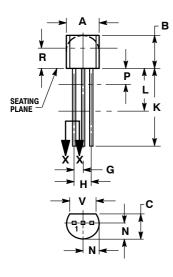


Figure 11. "On" Voltages

Figure 12. Temperature Coefficients

#### PACKAGE DIMENSIONS

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



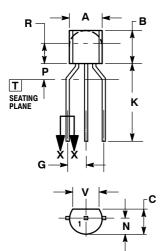
STRAIGHT LEAD **BULK PACK** 



#### NOTES:

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

	INCHES		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
Р		0.100		2.54
R	0.115		2.93	
٧	0.135		3.43	



**BENT LEAD** TAPE & REEL AMMO PACK



#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: MILLIMETERS.
  CONTOUR OF PACKAGE BEYOND
- DIMENSION R IS UNCONTROLLED
- LEAD DIMENSION IS UNCONTROLLED IN PAND 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		

STYLE 1:

PIN 1 FMITTER

BASE

COLLECTOR

ON Semiconductor and un are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice on semiconductor and war engineer trademarks of semiconductor components industries, Ite (SciLLC) solitate services are injective to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

#### **PUBLICATION ORDERING INFORMATION**

#### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor P.O. Box 5163, Denver, Colorado 80217 USA

Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free USA/Canada

Europe, Middle East and Africa Technical Support: Phone: 421 33 790 2910

Japan Customer Focus Center Phone: 81-3-5773-3850

ON Semiconductor Website: www.onsemi.com

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative