NPN General - Purpose Amplifier

2N3904

Description

This device is designed as a general−purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

MAXIMUM RATINGS

(Values are at T_A = 25°C unless otherwise noted.) (Note 1, Note 2)

Symbol	Parameter	Value	Unit
V_{CEO}	Collector − Emitter Voltage	40	V
V_{CBO}	Collector − Base Voltage	60	V
V_{EBO}	Emitter − Base Voltage	6.0	V
I_C	Collector Current − Continuous	200	mA
T_J, T_{STG}	Operating and Storage Junction Temperature Range	−55 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. These ratings are based on a maximum junction temperature of 150°C.
2. These are steady−state limits. ON Semiconductor should be consulted on applications involving pulsed orlow−duty cycle operations.

THERMAL CHARACTERISTICS

(Values are at T_A = 25°C unless otherwise noted.)

Symbol	Parameter	Max	Unit
P_D	Total Device Dissipation	625	mW
	Derate Above 25°C	5.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	°C/W

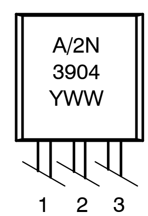
ON Semiconductor®

www.onsemi.com

TO−92 3
CASE 135AN

TO−92 3
LEADFORMED
CASE 135AR

MARKING DIAGRAM



1: Emitter
2: Base
3: Collector

A = Assembly Code
2N3904 = Device Code
YWW = Date Code

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

ELECTRICAL CHARACTERISTICS (Values are at T_A = 25°C unless otherwise noted.)

Symbol	Parametr	Conditions	Min	Max	Unit
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector–Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	40	–	V
$V_{(BR)CBO}$	Collector–Base Breakdown Voltage	I_C = 10 μA, I_E = 0	60	–	V
$V_{(BR)EBO}$	Emitter–Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0	–	V
I_{BL}	Base Cutoff Current	V_{CE} = 30 V, V_{EB} = 3 V	–	50	nA
I_{CEX}	Collector Cut–Off Current	V_{CE} = 30 V, V_{EB} = 3 V	–	50	nA
ON CHARACTERISTICS (Note 3)					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 1.0 V	40	–	–
		I_C = 1.0 mA, V_{CE} = 1.0 V	70	–	
		I_C = 10 mA, V_{CE} = 1.0 V	100	300	
		I_C = 50 mA, V_{CE} = 1.0 V	60	–	
		I_C = 100 mA, V_{CE} = 1.0 V	30	–	
$V_{CE(sat)}$	Collector–Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA	–	0.2	V
		I_C = 50.0 mA, I_B = 5.0 mA	–	0.3	
$V_{BE(sat)}$	Base–Emitter Saturation Voltage	I_C = 10.0 mA, I_B = 1.0 mA	0.65	0.85	V
		I_C = 50.0 mA, I_B = 5.0 mA	–	0.95	
SMALL–SIGNAL CHARACTERISTICS					
f_T	Current–Gain – Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	300	–	MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 100 kHz	–	4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 100 kHz	–	8.0	pF
NF	Noise Figure	I_C = 100 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ, f = 10 Hz to 15.7 kHz	–	5.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = 3.0 V, V_{BE} = 0.5 V, I_C = 10 mA, I_{B1} = 1.0 mA	–	35	ns
t_r	Rise Time		–	35	ns
t_s	Storage Time	V_{CC} = 3.0 V, I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA	–	200	ns
t_f	Fall Time		–	50	ns

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.

TYPICAL PERFORMANCE CHARACTERISTICS

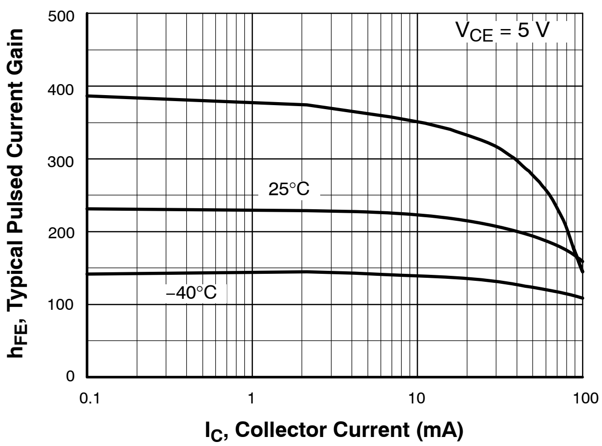


Figure 1. Typical Pulsed Current Gain vs. Collector Current

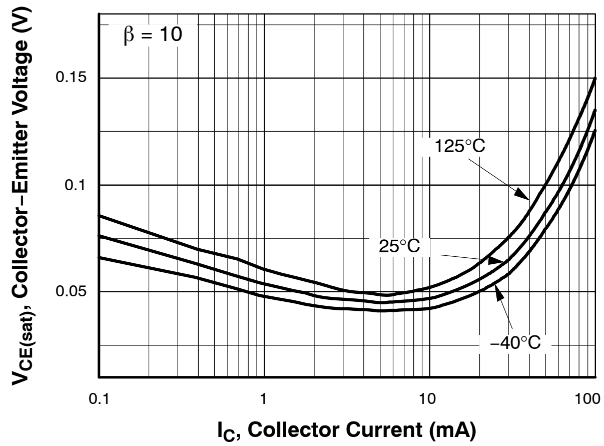


Figure 2. Collector−Emitter Saturation Voltage vs. Collector Current

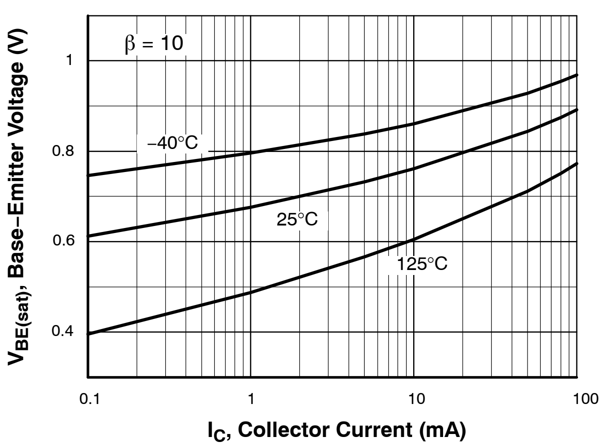


Figure 3. Base−Emitter Saturation Voltage vs. Collector Current

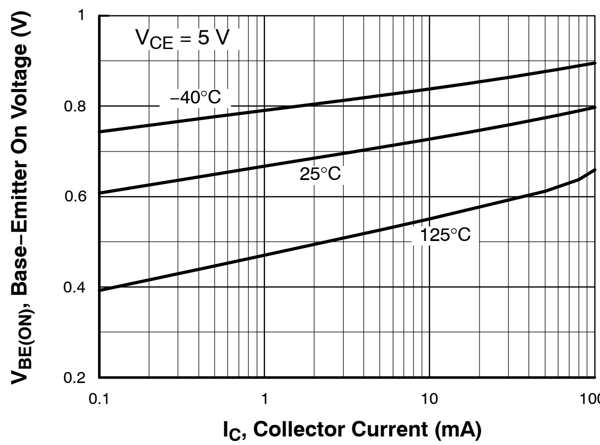


Figure 4. Base−Emitter On Voltage vs. Collector Current

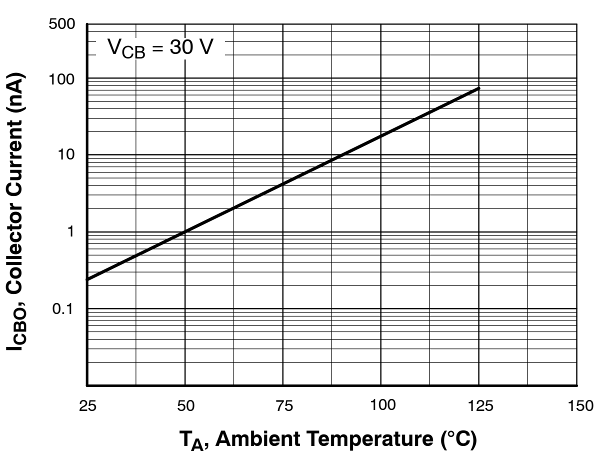


Figure 5. Collector Cut−Off Current vs. Ambient Temperature

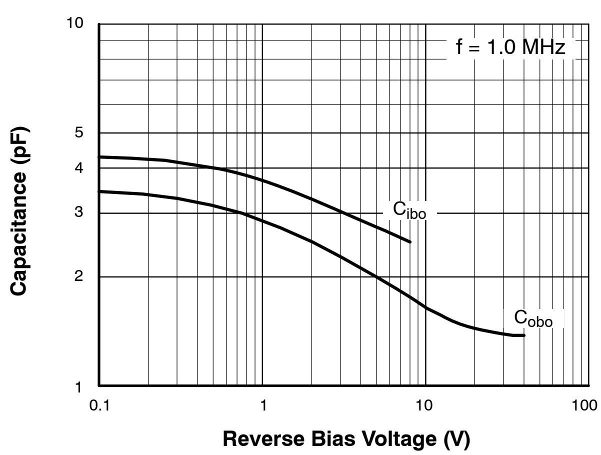


Figure 6. Capacitance vs. Reverse Bias Voltage

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

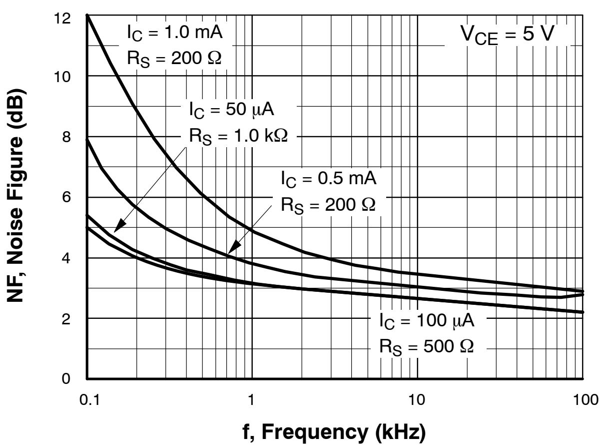


Figure 7. Noise Figure vs. Frequency

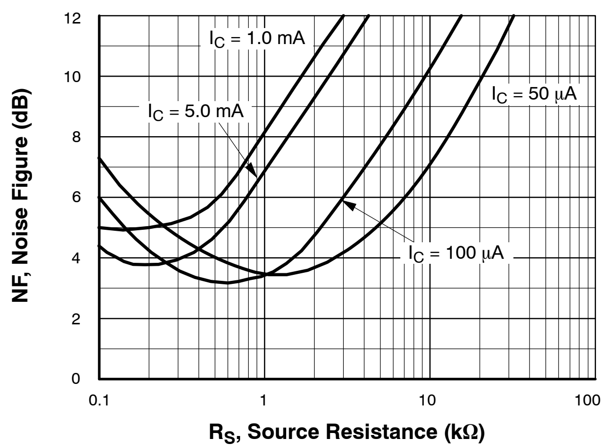


Figure 8. Noise Figure vs. Source Resistance

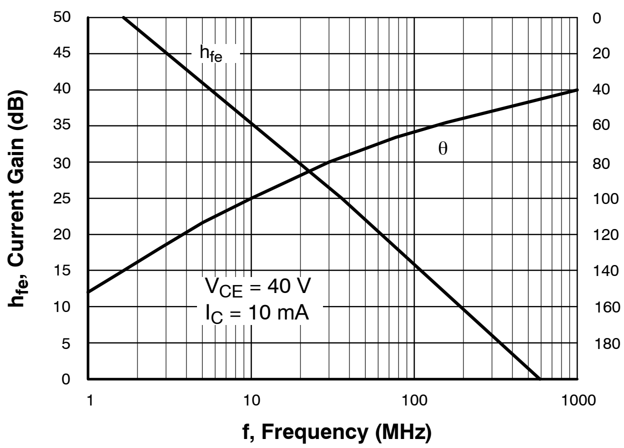


Figure 9. Current Gain and Phase Angle vs. Frequency

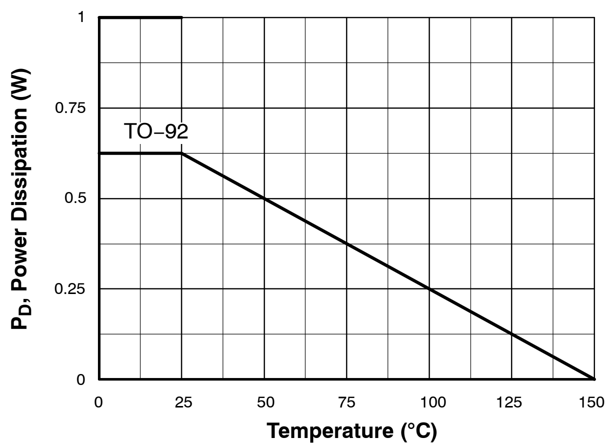


Figure 10. Power Dissipation vs. Ambient Temperature

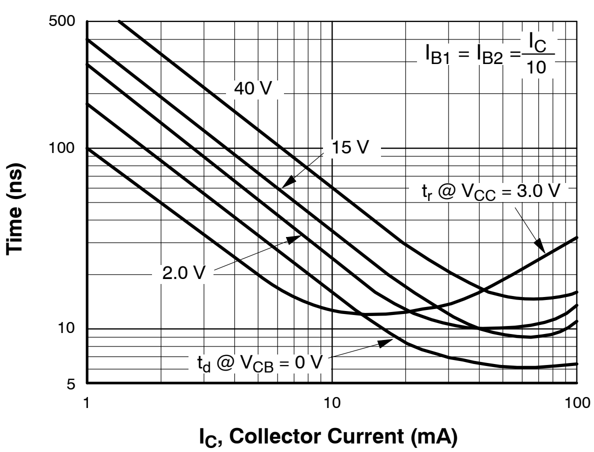


Figure 11. Turn−On Time vs. Collector Current

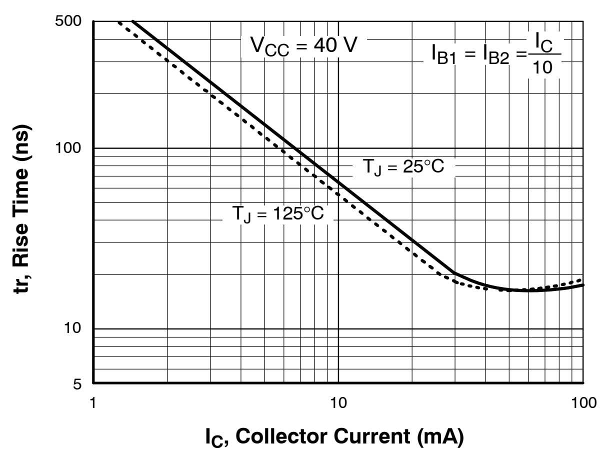


Figure 12. Rise Time vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

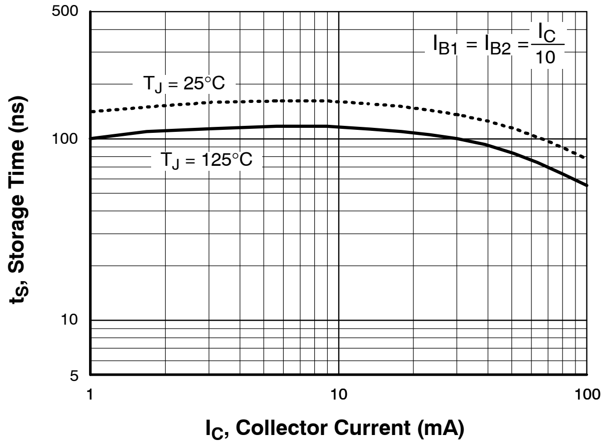


Figure 13. Storage Time vs. Collector Current

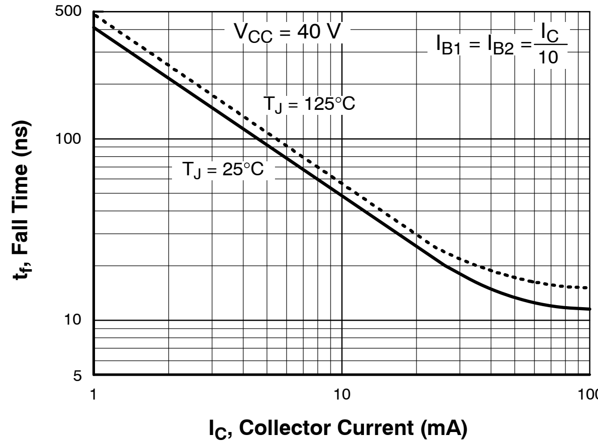


Figure 14. Fall Time vs. Collector Current

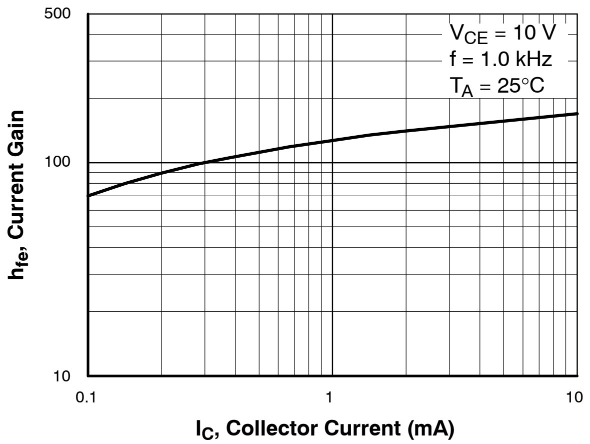


Figure 15. Current Gain

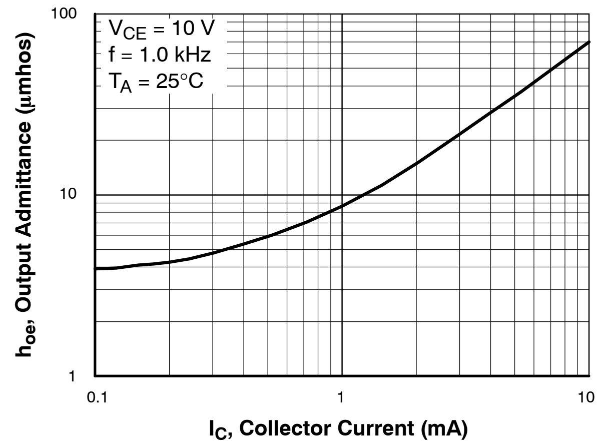


Figure 16. Output Admittance

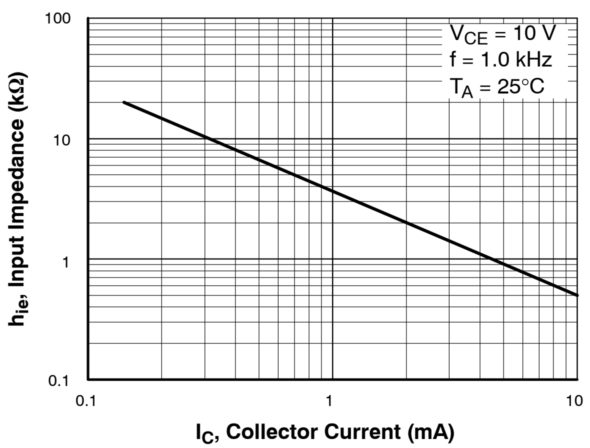


Figure 17. Input Impedance

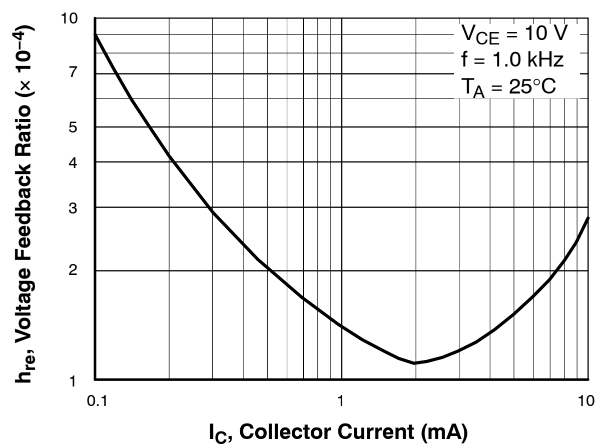


Figure 18. Voltage Feedback Ratio

TEST CIRCUITS

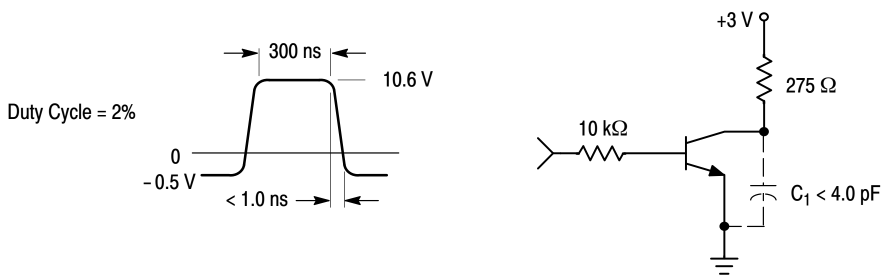


Figure 19. Delay and Rise Time Equivalent Test Circuit

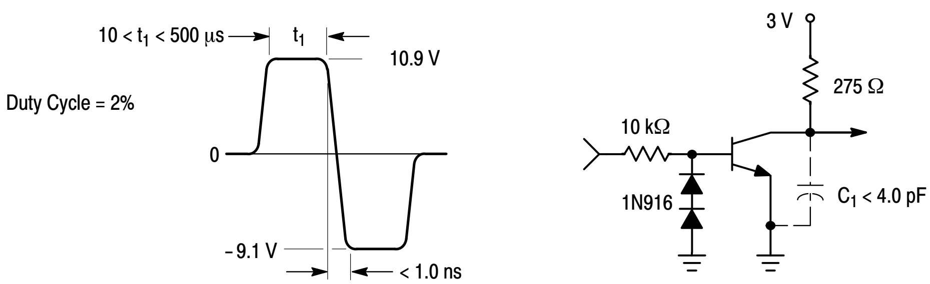


Figure 20. Storage and Fall Time Equivalent Test Circuit

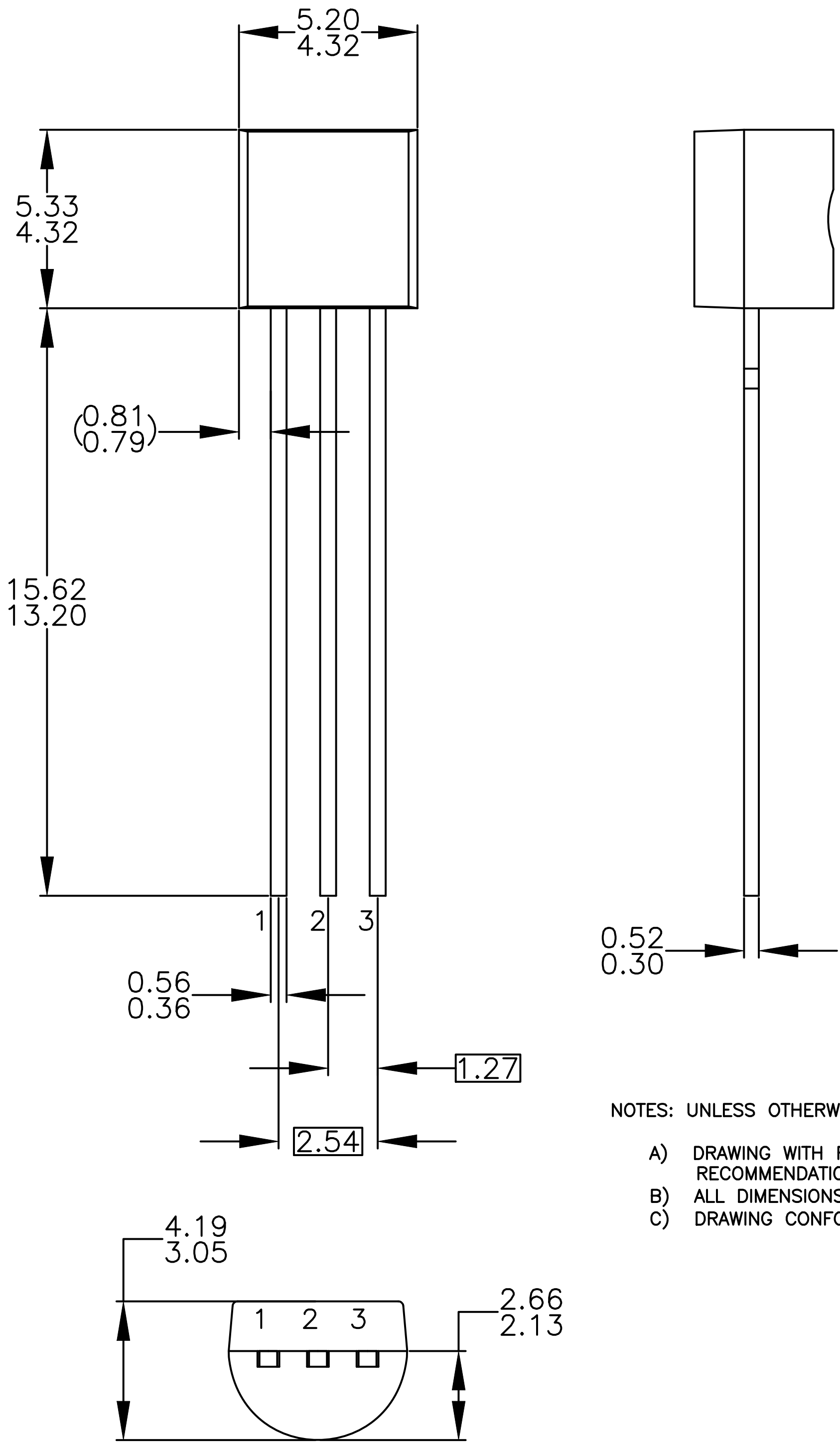
ORDERING INFORMATION

Device	Package	Shipping†
2N3904BU	TO−92−3 LF (Pb−Free)	10000 Units / Bulk Bag
2N3904TA	TO−92−3 LF (Pb−Free)	2000 Units / Fan−Fold
2N3904TAR	TO−92−3 LF (Pb−Free)	2000 Units / Fan−Fold
2N3904TF	TO−92−3 LF (Pb−Free)	2000 Units / Tape & Reel
2N3904TFR	TO−92−3 LF (Pb−Free)	2000 Units / Tape & Reel

†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.

TO−92 3 4.825x4.76
CASE 135AN
ISSUE O

DATE 31 JUL 2016



NOTES: UNLESS OTHERWISE SPECIFIED

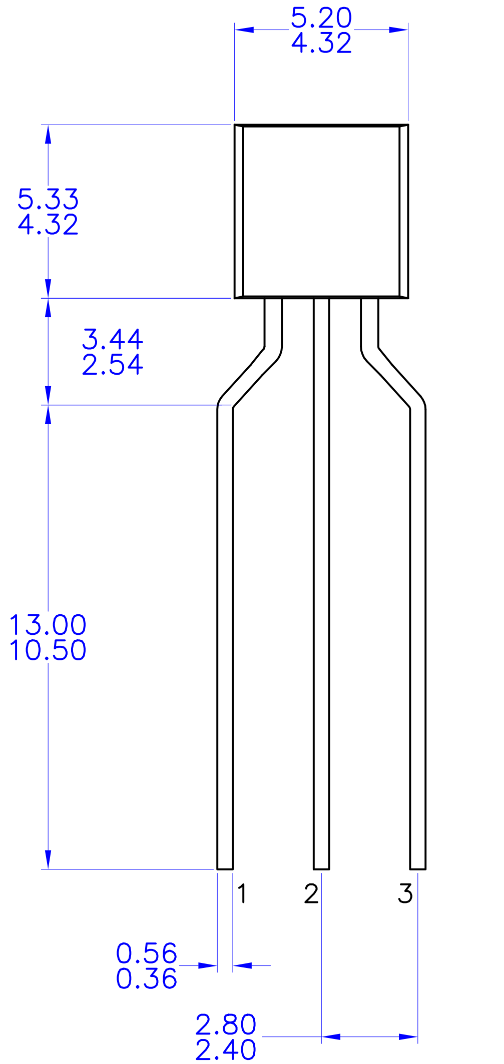
A) DRAWING WITH REFERENCE TO JEDEC TO−92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M−2009.

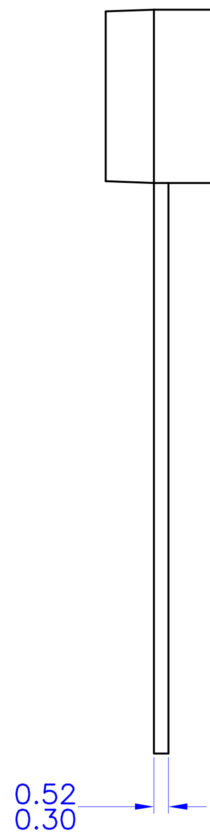
DOCUMENT NUMBER:	**98AON13880G**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.
DESCRIPTION:	**TO−92 3 4.825X4.76**	**PAGE 1 OF 1**

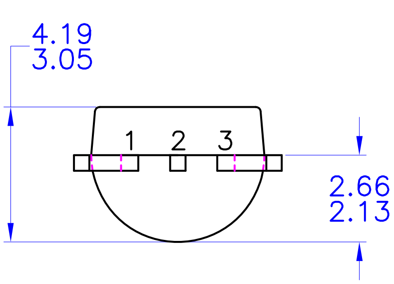
ON Semiconductor®

TO−92 3 4.83x4.76 LEADFORMED
CASE 135AR
ISSUE O

DATE 30 SEP 2016







NOTES: UNLESS OTHERWISE SPECIFIED

A) DRAWING WITH REFERENCE TO JEDEC TO-92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M-1994

DOCUMENT NUMBER:	**98AON13879G**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.
DESCRIPTION:	**TO−92 3 4.83X4.76 LEADFORMED**	**PAGE 1 OF 1**

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT
North American Technical Support:
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

◊