

2N4401

General Purpose Transistors

NPN Silicon

Features

- Pb-Free Packages are Available*

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------|----------------|----------------------------|
| Collector – Emitter Voltage | V_{CEO} | 40 | Vdc |
| Collector – Base Voltage | V_{CBO} | 60 | 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°C | P_D | 625 5.0 | mW mW/ $^\circ\text{C}$ |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°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 | $^\circ\text{C}/\text{W}$ |

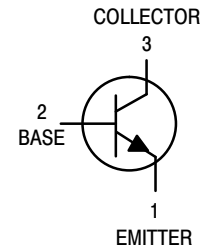
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

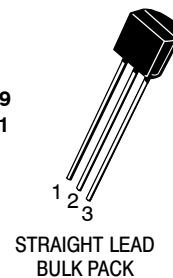


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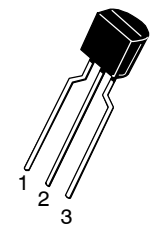
<http://onsemi.com>



TO-92
CASE 29
STYLE 1

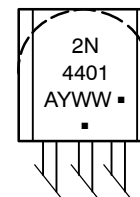


STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK

MARKING DIAGRAM



2N4401 = Device Code
A = Assembly Location
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 2 of this data sheet.

2N4401

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector–Emitter Breakdown Voltage (Note 1) (I _C = 1.0 mAdc, I _B = 0) | V _{(BR)CEO} | 40 | – | Vdc |
| Collector–Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V _{(BR)CBO} | 60 | – | Vdc |
| Emitter–Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V _{(BR)EBO} | 6.0 | – | Vdc |
| Base Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc) | I _{BEV} | – | 0.1 | μAdc |
| Collector Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc) | I _{CEX} | – | 0.1 | μAdc |

ON CHARACTERISTICS (Note 1)

| | | | | |
|--|----------------------|-----------------------------|-------------------------|-----|
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) | h _{FE} | 20 40 80 100 40 | – – – 300 – | – |
| Collector–Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | V _{CE(sat)} | – – | 0.4 0.75 | Vdc |
| Base–Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | V _{BE(sat)} | 0.75 – | 0.95 1.2 | Vdc |

SMALL-SIGNAL CHARACTERISTICS

| | | | | |
|---|-----------------|-----|-----|--------------------|
| Current–Gain – Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | f _T | 250 | – | MHz |
| Collector–Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | – | 6.5 | pF |
| Emitter–Base Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{eb} | – | 30 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.0 | 15 | k Ω |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 8.0 | X 10 ⁻⁴ |
| Small–Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 40 | 500 | – |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{oe} | 1.0 | 30 | μmhos |

SWITCHING CHARACTERISTICS

| | | | | | |
|--------------|--|----------------|---|-----|----|
| Delay Time | (V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | t _d | – | 15 | ns |
| Rise Time | | t _r | – | 20 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) | t _s | – | 225 | ns |
| Fall Time | | t _f | – | 30 | ns |

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|-------------|--------------------|------------------------|
| 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 |

[†]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

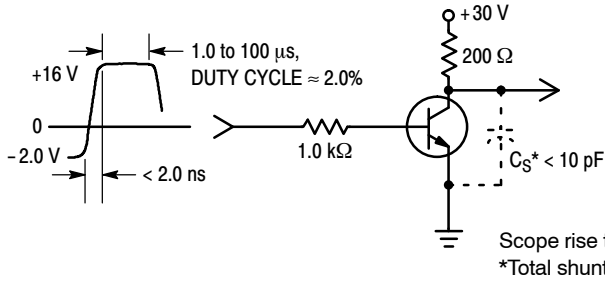


Figure 1. Turn-On Time

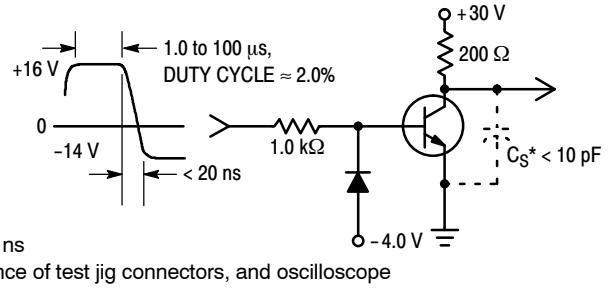


Figure 2. Turn-Off Time

TRANSIENT CHARACTERISTICS

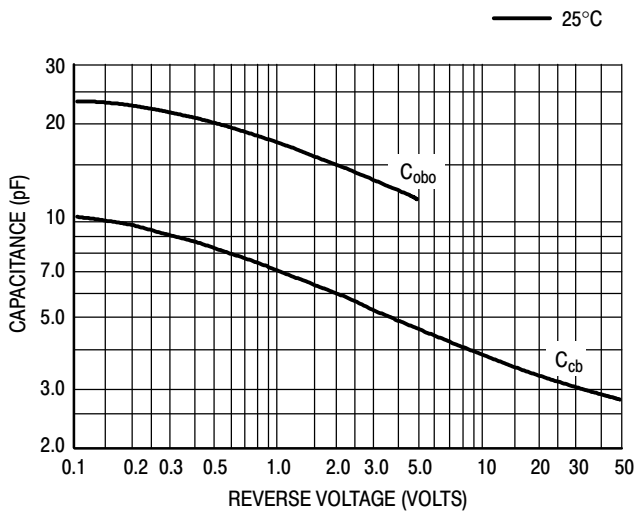


Figure 3. Capacitances

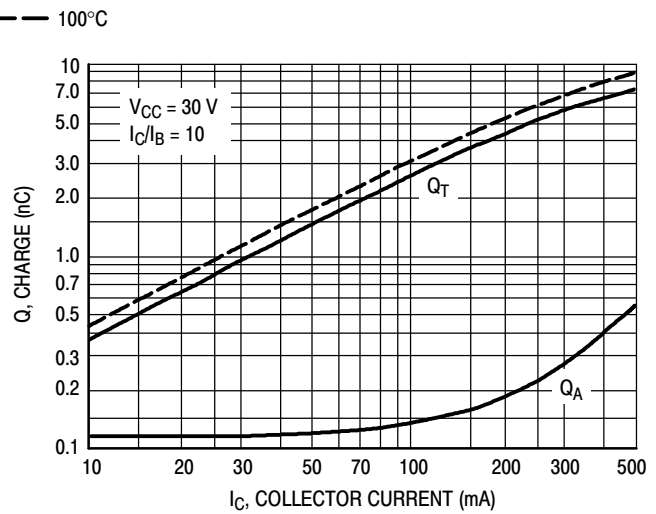


Figure 4. Charge Data

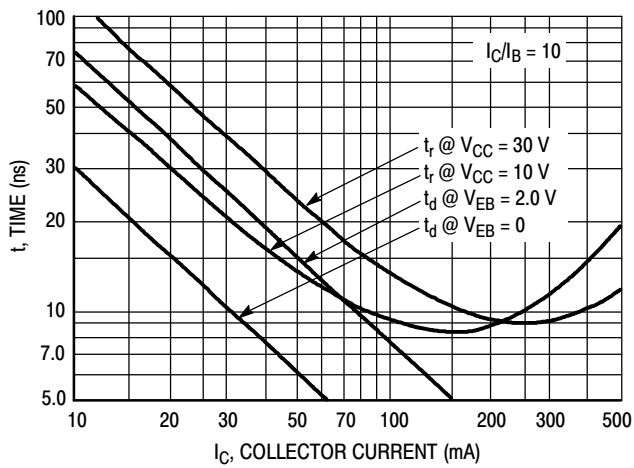


Figure 5. Turn-On Time

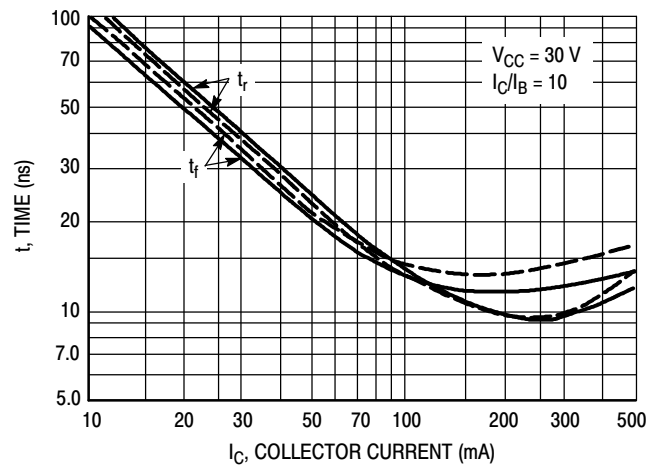


Figure 6. Rise and Fall Times

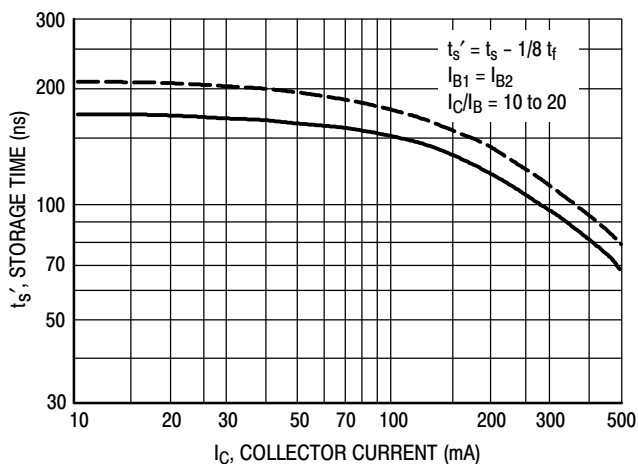


Figure 7. Storage Time

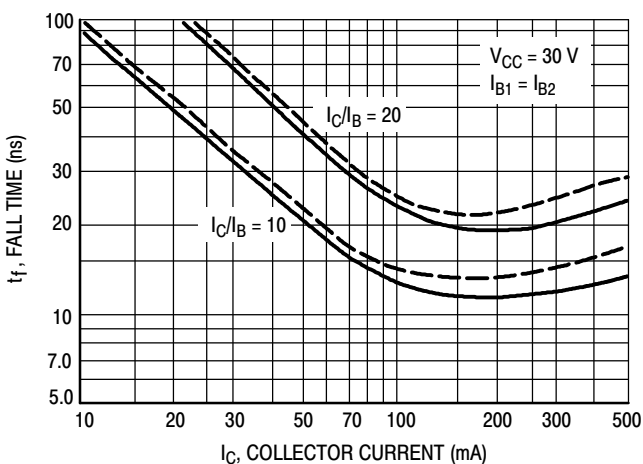


Figure 8. Fall Time

SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE

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

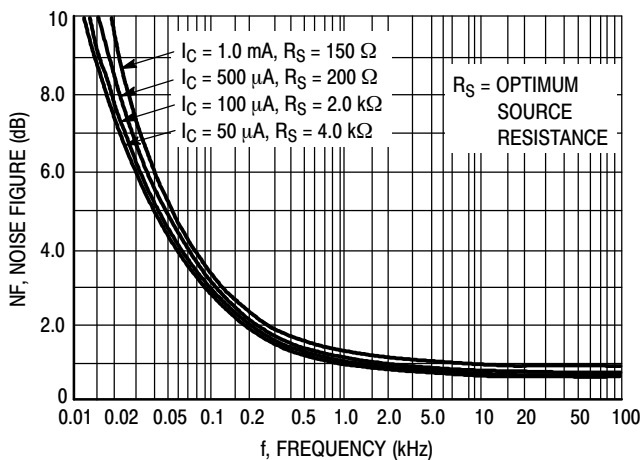


Figure 9. Frequency Effects

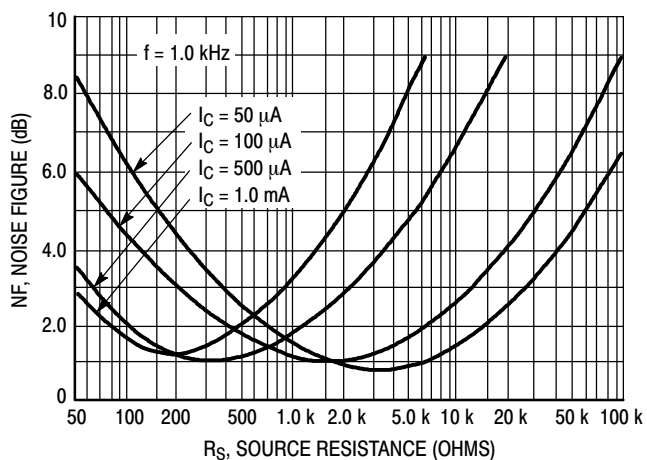


Figure 10. Source Resistance Effects

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.

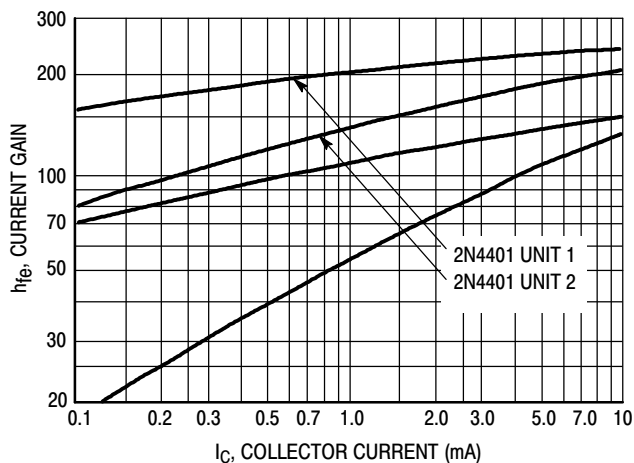


Figure 11. Current Gain

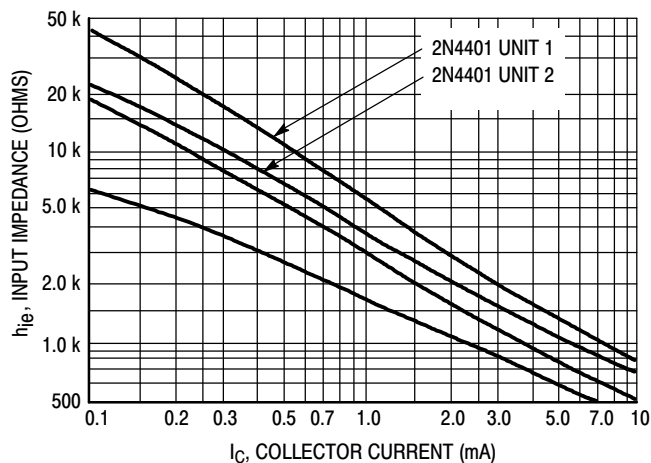


Figure 12. Input Impedance

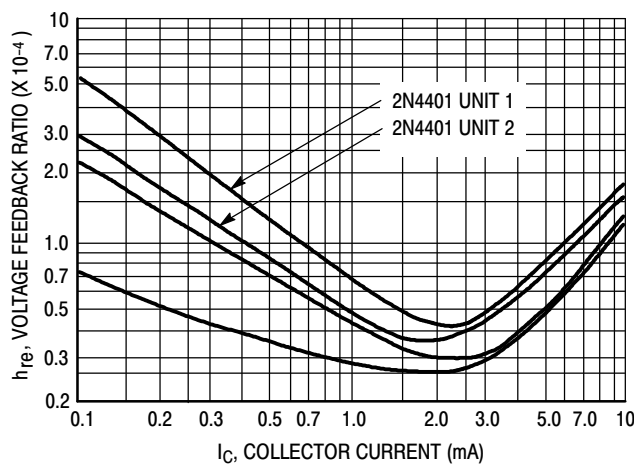


Figure 13. Voltage Feedback Ratio

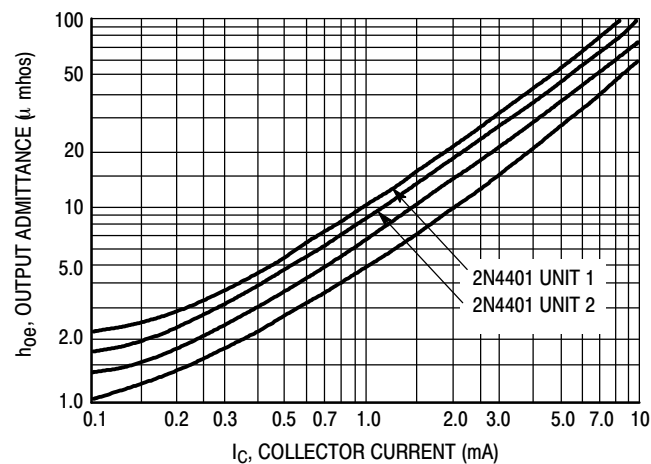


Figure 14. Output Admittance

2N4401

STATIC CHARACTERISTICS

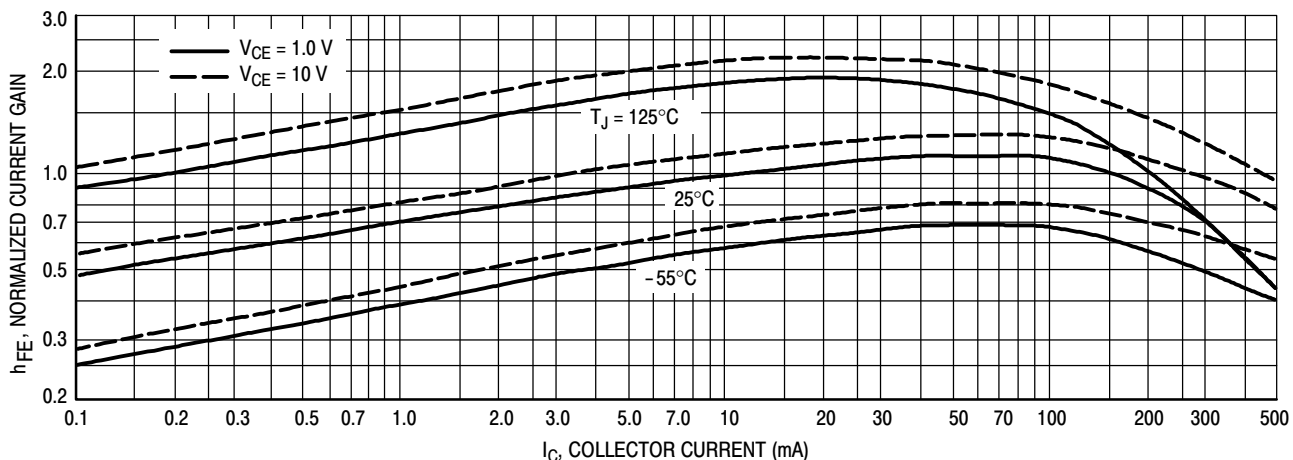


Figure 15. DC Current Gain

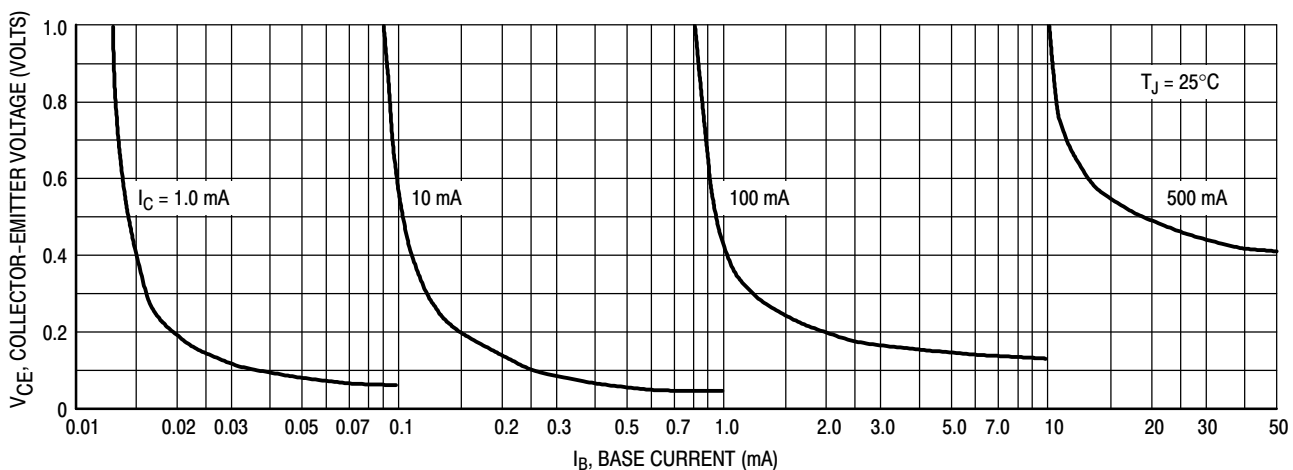


Figure 16. Collector Saturation Region

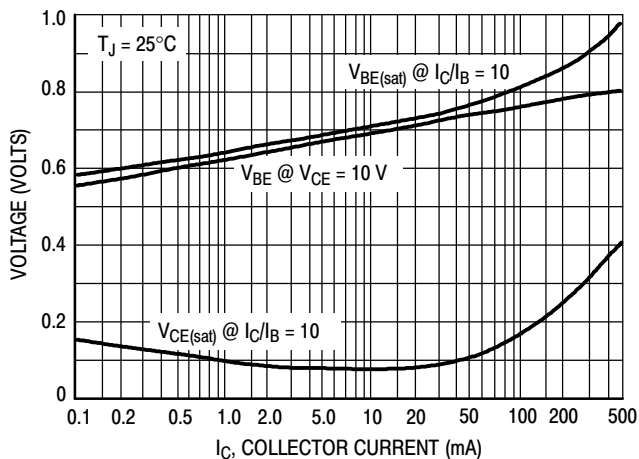


Figure 17. "On" Voltages

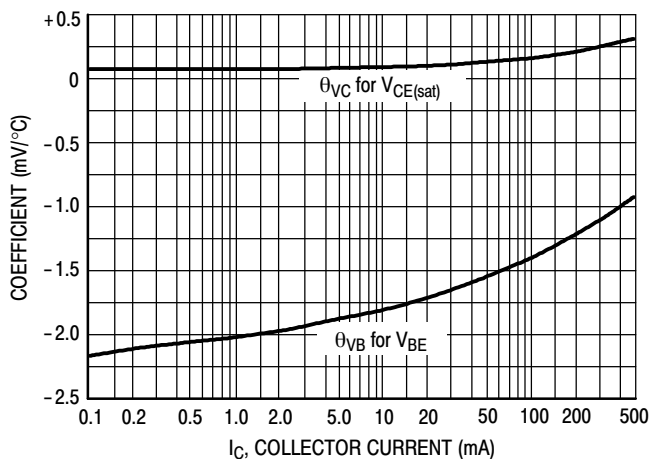


Figure 18. Temperature Coefficients

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



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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| DESCRIPTION: | TO-92 (TO-226) | PAGE 1 OF 3 |

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

DATE 09 MAR 2007

STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. COLLECTOR

STYLE 2:
 PIN 1. BASE
 2. EMITTER
 3. COLLECTOR

STYLE 3:
 PIN 1. ANODE
 2. ANODE
 3. CATHODE

STYLE 4:
 PIN 1. CATHODE
 2. CATHODE
 3. ANODE

STYLE 5:
 PIN 1. DRAIN
 2. SOURCE
 3. GATE

STYLE 6:
 PIN 1. GATE
 2. SOURCE & SUBSTRATE
 3. DRAIN

STYLE 7:
 PIN 1. SOURCE
 2. DRAIN
 3. GATE

STYLE 8:
 PIN 1. DRAIN
 2. GATE
 3. SOURCE & SUBSTRATE

STYLE 9:
 PIN 1. BASE 1
 2. EMITTER
 3. BASE 2

STYLE 10:
 PIN 1. CATHODE
 2. GATE
 3. ANODE

STYLE 11:
 PIN 1. ANODE
 2. CATHODE & ANODE
 3. CATHODE

STYLE 12:
 PIN 1. MAIN TERMINAL 1
 2. GATE
 3. MAIN TERMINAL 2

STYLE 13:
 PIN 1. ANODE 1
 2. GATE
 3. CATHODE 2

STYLE 14:
 PIN 1. EMITTER
 2. COLLECTOR
 3. BASE

STYLE 15:
 PIN 1. ANODE 1
 2. CATHODE
 3. ANODE 2

STYLE 16:
 PIN 1. ANODE
 2. GATE
 3. CATHODE

STYLE 17:
 PIN 1. COLLECTOR
 2. BASE
 3. EMITTER

STYLE 18:
 PIN 1. ANODE
 2. CATHODE
 3. NOT CONNECTED

STYLE 19:
 PIN 1. GATE
 2. ANODE
 3. CATHODE

STYLE 20:
 PIN 1. NOT CONNECTED
 2. CATHODE
 3. ANODE

STYLE 21:
 PIN 1. COLLECTOR
 2. EMITTER
 3. BASE

STYLE 22:
 PIN 1. SOURCE
 2. GATE
 3. DRAIN

STYLE 23:
 PIN 1. GATE
 2. SOURCE
 3. DRAIN

STYLE 24:
 PIN 1. EMITTER
 2. COLLECTOR/ANODE
 3. CATHODE

STYLE 25:
 PIN 1. MT 1
 2. GATE
 3. MT 2

STYLE 26:
 PIN 1. V_{CC}
 2. GROUND 2
 3. OUTPUT

STYLE 27:
 PIN 1. MT
 2. SUBSTRATE
 3. MT

STYLE 28:
 PIN 1. CATHODE
 2. ANODE
 3. GATE

STYLE 29:
 PIN 1. NOT CONNECTED
 2. ANODE
 3. CATHODE

STYLE 30:
 PIN 1. DRAIN
 2. GATE
 3. SOURCE

STYLE 31:
 PIN 1. GATE
 2. DRAIN
 3. SOURCE

STYLE 32:
 PIN 1. BASE
 2. COLLECTOR
 3. EMITTER

STYLE 33:
 PIN 1. RETURN
 2. INPUT
 3. OUTPUT

STYLE 34:
 PIN 1. INPUT
 2. GROUND
 3. LOGIC

STYLE 35:
 PIN 1. GATE
 2. COLLECTOR
 3. EMITTER

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| NEW STANDARD: | | |
| DESCRIPTION: | TO-92 (TO-226) | PAGE 2 OF 3 |

ON Semiconductor®



DOCUMENT NUMBER:
98ASB42022B

PAGE 3 OF 3

| ISSUE | REVISION | DATE |
|-------|---|-------------|
| AM | ADDED BENT-LEAD TAPE & REEL VERSION. REQ. BY J. SUPINA. | 09 MAR 2007 |
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