

2N3904RLRA Datasheet

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| | |
|------------------------------|---|
| DiGi Electronics Part Number | 2N3904RLRA-DG |
| Manufacturer | onsemi |
| Manufacturer Product Number | 2N3904RLRA |
| Description | TRANS NPN 40V 0.2A TO92 |
| Detailed Description | Bipolar (BJT) Transistor NPN 40 V 200 mA 300MHz 6 25 mW Through Hole TO-92 (TO-226) |



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Purchase and inquiry

Manufacturer Product Number:

2N3904RLRA

Series:

-

Transistor Type:

NPN

Voltage - Collector Emitter Breakdown (Max):

40 V

Current - Collector Cutoff (Max):

50nA

Power - Max:

625 mW

Operating Temperature:

-55°C ~ 150°C (TJ)

Package / Case:

TO-226-3, TO-92-3 Long Body (Formed Leads)

Base Product Number:

2N3904

Manufacturer:

onsemi

Product Status:

Obsolete

Current - Collector (Ic) (Max):

200 mA

Vce Saturation (Max) @ Ib, Ic:

200mV @ 1mA, 10mA

DC Current Gain (hFE) (Min) @ Ic, Vce:

40 @ 100µA, 1V

Frequency - Transition:

300MHz

Mounting Type:

Through Hole

Supplier Device Package:

TO-92 (TO-226)

Environmental & Export classification

RoHS Status:

RoHS non-compliant

REACH Status:

REACH Unaffected

HTSUS:

8541.21.0075

Moisture Sensitivity Level (MSL):

1 (Unlimited)

ECCN:

EAR99

General Purpose Transistors

NPN Silicon

2N3903, 2N3904

Features

- Pb-Free Packages are Available*

MAXIMUM RATINGS

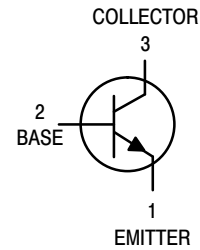
| Rating | Symbol | Value | Unit |
|---|----------------|-------------|----------------------------|
| Collector - Emitter Voltage | V_{CEO} | 40 | Vdc |
| Collector - Base Voltage | V_{CBO} | 60 | Vdc |
| Emitter - Base Voltage | V_{EBO} | 6.0 | Vdc |
| Collector Current - Continuous | I_C | 200 | mAdc |
| 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 (Note 1)

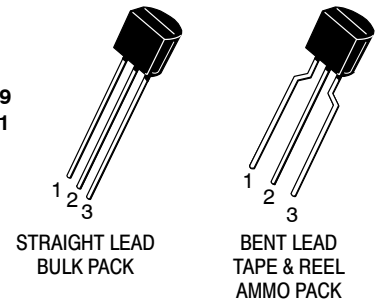
| Characteristic | Symbol | Max | Unit |
|---|-----------------|------|---------------------------|
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 200 | $^\circ\text{C}/\text{W}$ |
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 83.3 | $^\circ\text{C}/\text{W}$ |

Stresses exceeding 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. Indicates Data in addition to JEDEC Requirements.



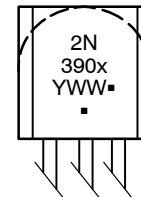
TO-92
CASE 29
STYLE 1



STRAIGHT LEAD
BULK PACK

BENT LEAD
TAPE & REEL
AMMO PACK

MARKING DIAGRAMS



x = 3 or 4

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.

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

2N3903, 2N3904**ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector – Emitter Breakdown Voltage (Note 2) ($I_C = 1.0\text{ mAdc}$, $I_B = 0$) | $V_{(BR)CEO}$ | 40 | – | Vdc |
| Collector – Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{Adc}$, $I_E = 0$) | $V_{(BR)CBO}$ | 60 | – | Vdc |
| Emitter – Base Breakdown Voltage ($I_E = 10\text{ }\mu\text{Adc}$, $I_C = 0$) | $V_{(BR)EBO}$ | 6.0 | – | Vdc |
| Base Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$) | I_{BL} | – | 50 | nAdc |
| Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$) | I_{CEX} | – | 50 | nAdc |

ON CHARACTERISTICS

| | | | | | |
|---|--------|---------------|------|------|-----|
| DC Current Gain (Note 2) ($I_C = 0.1\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$) | 2N3903 | h_{FE} | 20 | – | – |
| | 2N3904 | | 40 | – | – |
| ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$) | 2N3903 | | 35 | – | – |
| | 2N3904 | | 70 | – | – |
| ($I_C = 10\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$) | 2N3903 | | 50 | 150 | – |
| | 2N3904 | | 100 | 300 | – |
| ($I_C = 50\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$) | 2N3903 | | 30 | – | – |
| | 2N3904 | | 60 | – | – |
| ($I_C = 100\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$) | 2N3903 | | 15 | – | – |
| | 2N3904 | | 30 | – | – |
| Collector – Emitter Saturation Voltage (Note 2) ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$) ($I_C = 50\text{ mAdc}$, $I_B = 5.0\text{ mAdc}$) | | $V_{CE(sat)}$ | – | 0.2 | Vdc |
| | | | – | 0.3 | |
| Base – Emitter Saturation Voltage (Note 2) ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$) ($I_C = 50\text{ mAdc}$, $I_B = 5.0\text{ mAdc}$) | | $V_{BE(sat)}$ | 0.65 | 0.85 | Vdc |
| | | | – | 0.95 | |

SMALL-SIGNAL CHARACTERISTICS

| | | | | | |
|--|------------------|-----------|------------|------------|------------------|
| Current – Gain – Bandwidth Product ($I_C = 10\text{ mAdc}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$) | 2N3903 2N3904 | f_T | 250 300 | – – | MHz |
| Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) | | C_{obo} | – | 4.0 | pF |
| Input Capacitance ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$) | | C_{ibo} | – | 8.0 | pF |
| Input Impedance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) | 2N3903 2N3904 | h_{ie} | 1.0 1.0 | 8.0 10 | k Ω |
| Voltage Feedback Ratio ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) | 2N3903 2N3904 | h_{re} | 0.1 0.5 | 5.0 8.0 | $\times 10^{-4}$ |
| Small-Signal Current Gain ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) | 2N3903 2N3904 | h_{fe} | 50 100 | 200 400 | – |
| Output Admittance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) | | h_{oe} | 1.0 | 40 | μmhos |
| Noise Figure ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) | 2N3903 2N3904 | NF | – – | 6.0 5.0 | dB |

SWITCHING CHARACTERISTICS

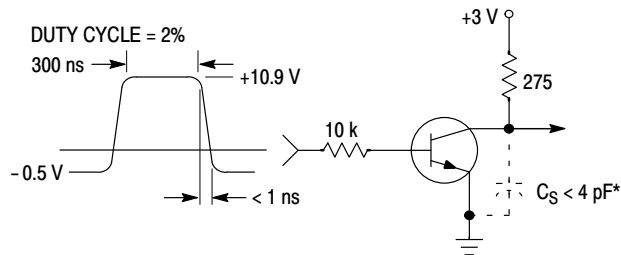
| | | | | | | |
|--------------|---|------------------|-------|---|------------|----|
| Delay Time | $(V_{CC} = 3.0\text{ Vdc}$, $V_{BE} = 0.5\text{ Vdc}$, $I_C = 10\text{ mAdc}$, $I_{B1} = 1.0\text{ mAdc}$) | | t_d | – | 35 | ns |
| Rise Time | | | t_r | – | 35 | ns |
| Storage Time | $(V_{CC} = 3.0\text{ Vdc}$, $I_C = 10\text{ mAdc}$, $I_{B1} = I_{B2} = 1.0\text{ mAdc}$) | 2N3903 2N3904 | t_s | – | 175 200 | ns |
| Fall Time | | | t_f | – | 50 | ns |

2. Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$; Duty Cycle $\leq 2\%$.

2N3903, 2N3904**ORDERING INFORMATION**

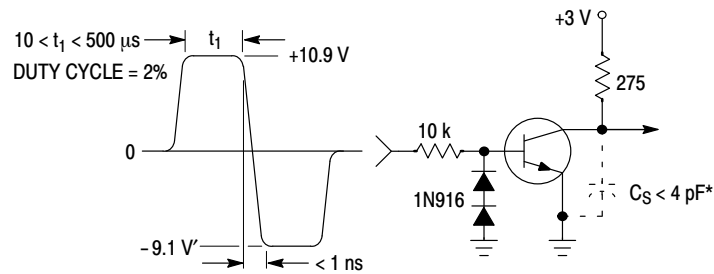
| Device | Package | Shipping† |
|-------------|--------------------|--------------------|
| 2N3903RLRM | TO-92 | 2000 / Ammo Pack |
| 2N3904 | TO-92 | 5000 Units / Bulk |
| 2N3904G | TO-92 (Pb-Free) | 5000 Units / Bulk |
| 2N3904RLRA | TO-92 | 2000 / Tape & Reel |
| 2N3904RLRAG | TO-92 (Pb-Free) | 2000 / Tape & Reel |
| 2N3904RLRM | TO-92 | 2000 / Ammo Pack |
| 2N3904RLRMG | TO-92 (Pb-Free) | 2000 / Ammo Pack |
| 2N3904RLRP | TO-92 | 2000 / Ammo Pack |
| 2N3904RLRPG | TO-92 (Pb-Free) | 2000 / Ammo Pack |
| 2N3904RL1G | TO-92 (Pb-Free) | 2000 / Tape & Reel |
| 2N3904ZL1 | TO-92 | 2000 / Ammo Pack |
| 2N3904ZL1G | TO-92 (Pb-Free) | 2000 / Ammo Pack |

†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.



* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit



* Total shunt capacitance of test jig and connectors

Figure 2. Storage and Fall Time Equivalent Test Circuit

2N3903, 2N3904

TYPICAL TRANSIENT CHARACTERISTICS

— $T_J = 25^\circ\text{C}$
 - - - $T_J = 125^\circ\text{C}$

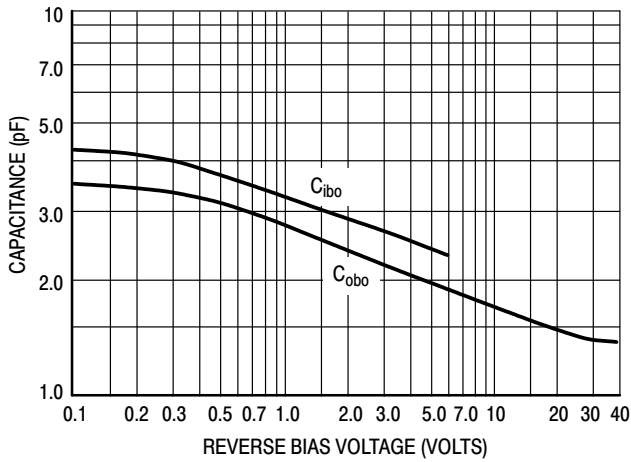


Figure 3. Capacitance

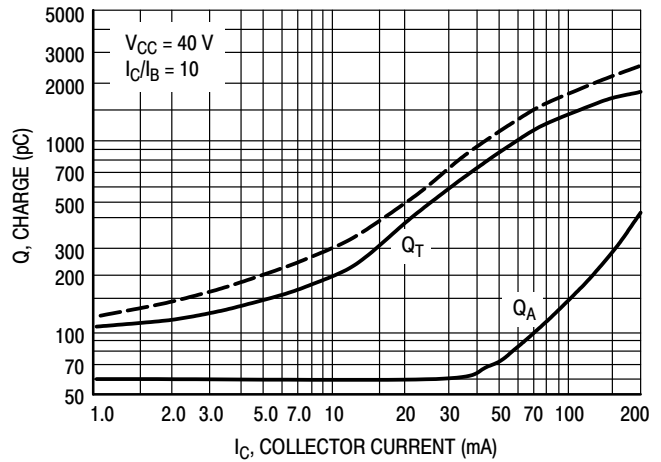


Figure 4. Charge Data

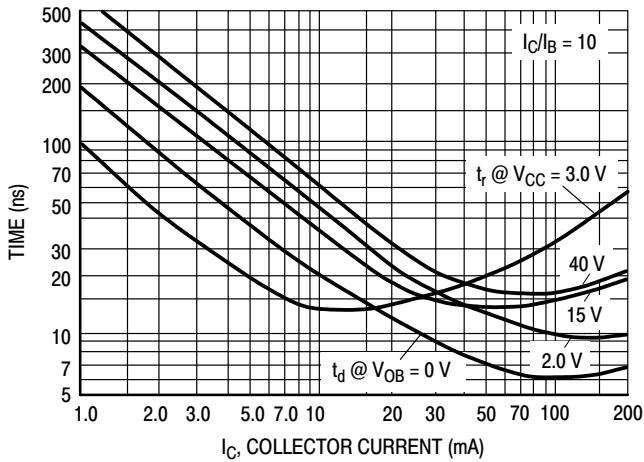


Figure 5. Turn-On Time

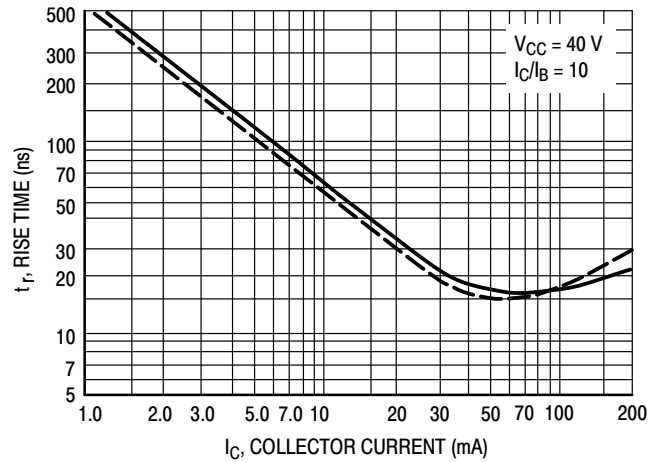


Figure 6. Rise Time

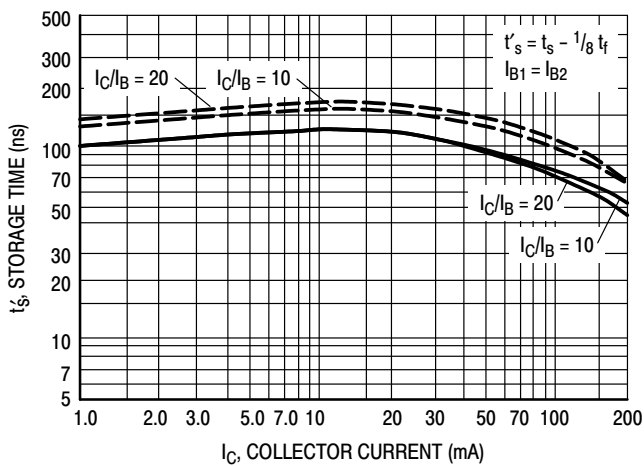


Figure 7. Storage Time

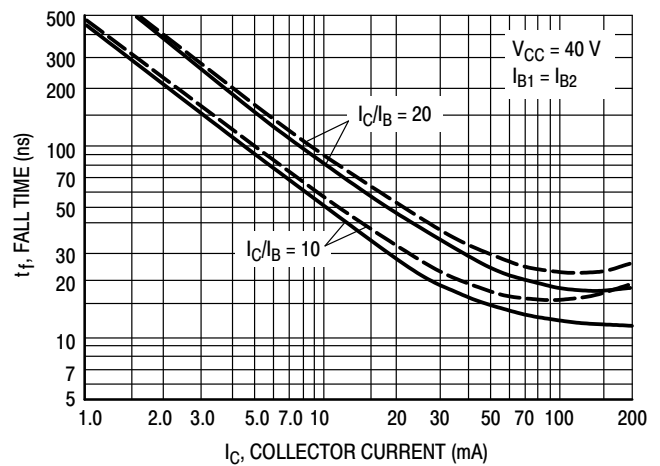


Figure 8. Fall Time

2N3903, 2N3904

**TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS**

($V_{CE} = 5.0 \text{ Vdc}$, $T_A = 25^\circ\text{C}$, Bandwidth = 1.0 Hz)

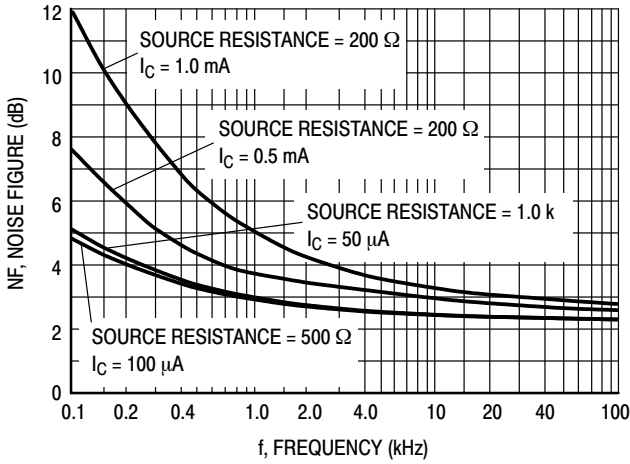


Figure 9.

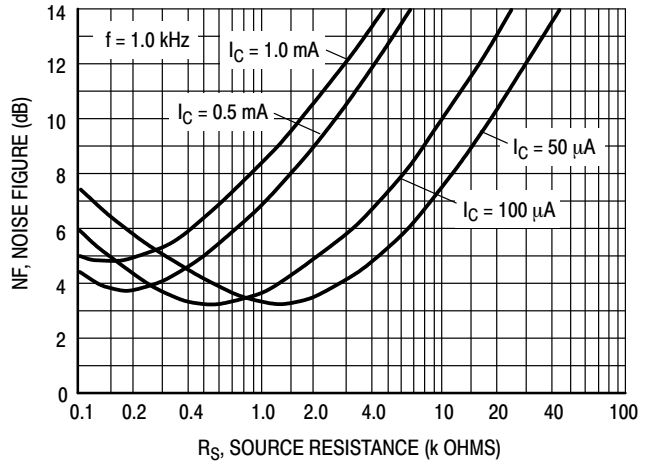


Figure 10.

h PARAMETERS

($V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$, $T_A = 25^\circ\text{C}$)

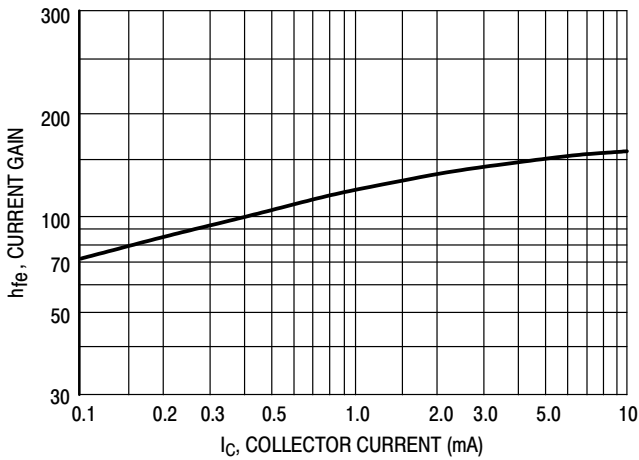


Figure 11. Current Gain

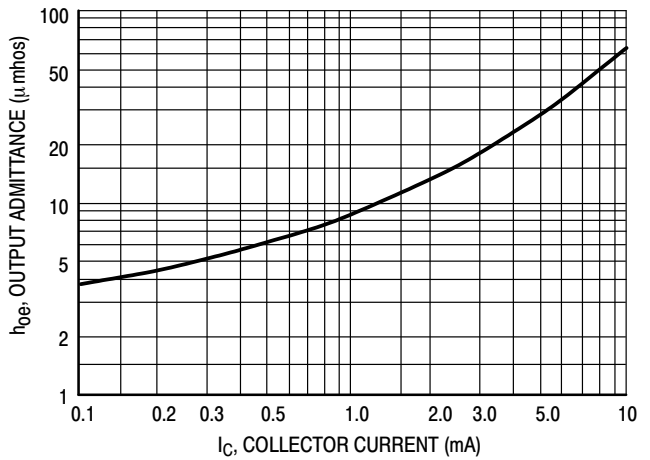


Figure 12. Output Admittance

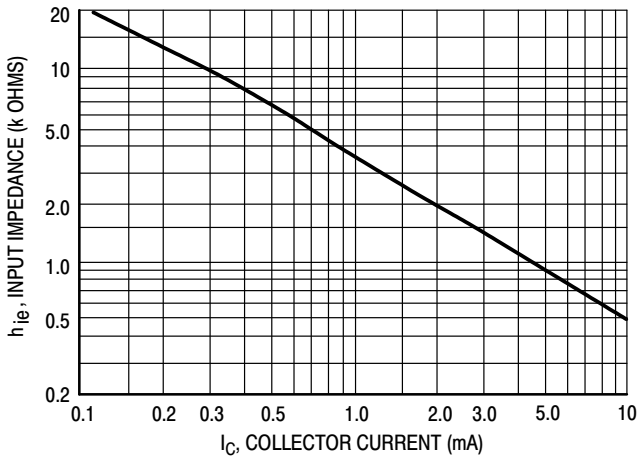


Figure 13. Input Impedance

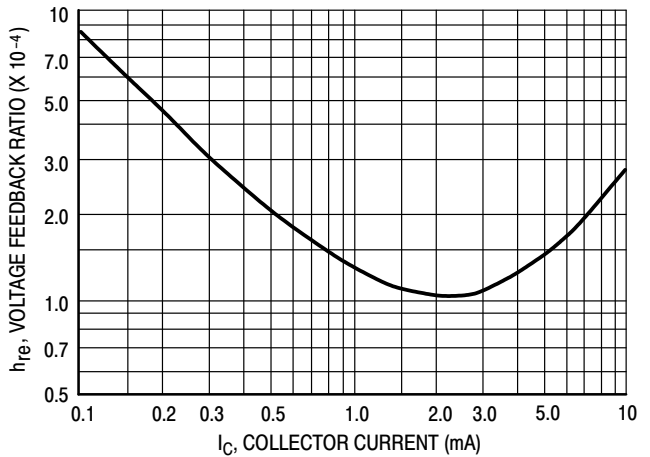


Figure 14. Voltage Feedback Ratio

2N3903, 2N3904

TYPICAL STATIC CHARACTERISTICS

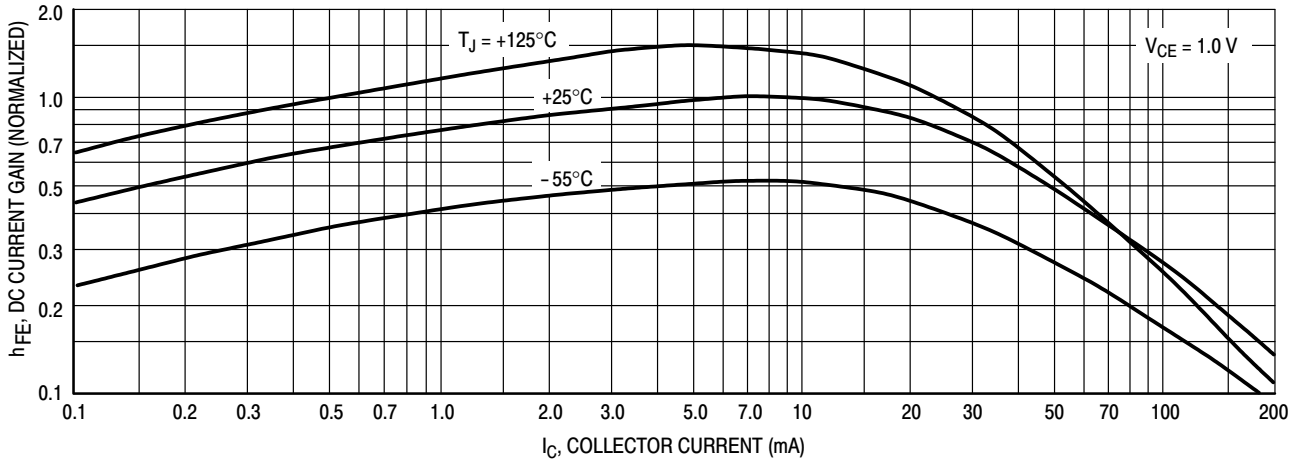


Figure 15. DC Current Gain

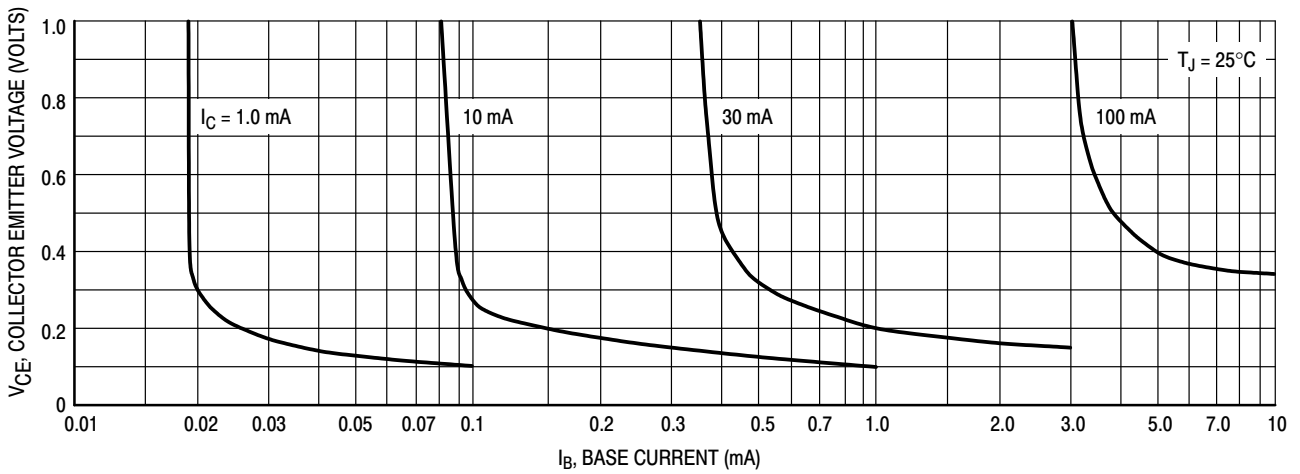


Figure 16. Collector Saturation Region

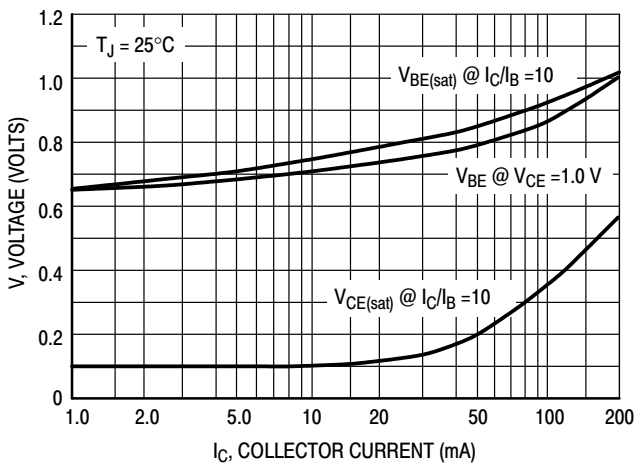


Figure 17. "ON" Voltages

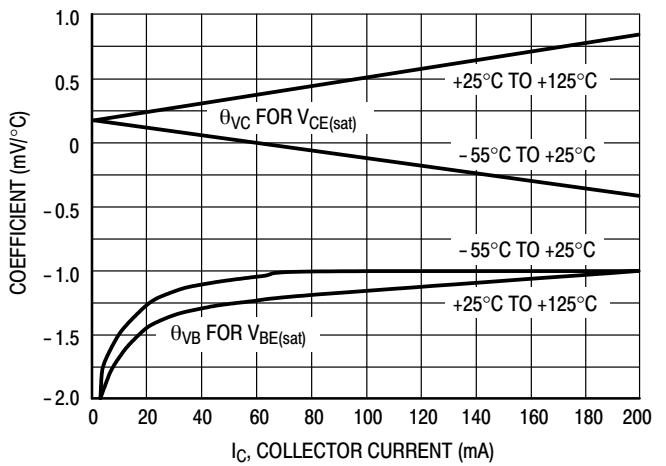
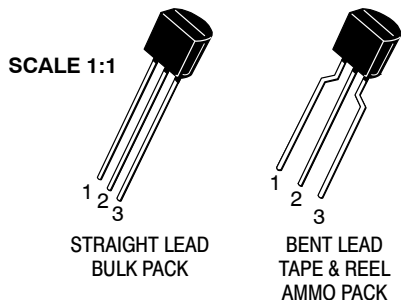


Figure 18. Temperature Coefficients

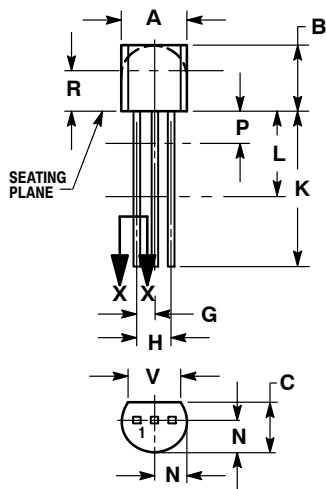


**MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS**

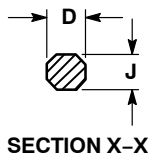


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CASE 29-11
ISSUE AM

DATE 09 MAR 2007

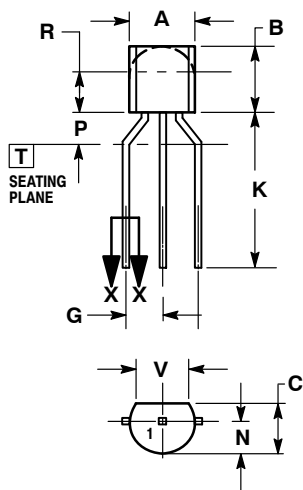


STRAIGHT LEAD
BULK PACK

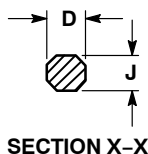


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
 4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

| | | |
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