



# 2N3904

## SMALL SIGNAL NPN TRANSISTOR

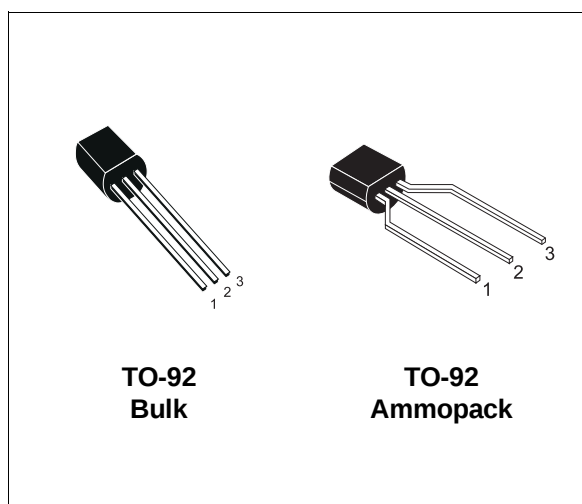
### PRELIMINARY DATA

| Ordering Code | Marking | Package / Shipment |
|---------------|---------|--------------------|
| 2N3904        | 2N3904  | TO-92 / Bulk       |
| 2N3904-AP     | 2N3904  | TO-92 / Ammopack   |

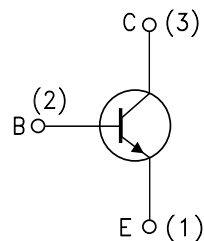
- SILICON EPITAXIAL PLANAR NPN TRANSISTOR
- TO-92 PACKAGE SUITABLE FOR THROUGH-HOLE PCB ASSEMBLY
- THE PNP COMPLEMENTARY TYPE IS 2N3906

### APPLICATIONS

- WELL SUITABLE FOR TV AND HOME APPLIANCE EQUIPMENT
- SMALL LOAD SWITCH TRANSISTOR WITH HIGH GAIN AND LOW SATURATION VOLTAGE



### INTERNAL SCHEMATIC DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

| Symbol    | Parameter                                               | Value      | Unit               |
|-----------|---------------------------------------------------------|------------|--------------------|
| $V_{CBO}$ | Collector-Base Voltage ( $I_E = 0$ )                    | 60         | V                  |
| $V_{CEO}$ | Collector-Emitter Voltage ( $I_B = 0$ )                 | 40         | V                  |
| $V_{EBO}$ | Emitter-Base Voltage ( $I_C = 0$ )                      | 6          | V                  |
| $I_C$     | Collector Current                                       | 200        | mA                 |
| $P_{tot}$ | Total Dissipation at $T_C = 25\text{ }^{\circ}\text{C}$ | 625        | mW                 |
| $T_{stg}$ | Storage Temperature                                     | -65 to 150 | $^{\circ}\text{C}$ |
| $T_j$     | Max. Operating Junction Temperature                     | 150        | $^{\circ}\text{C}$ |

## THERMAL DATA

|                         |                                     |     |      |      |
|-------------------------|-------------------------------------|-----|------|------|
| R <sub>thj-amb</sub> •  | Thermal Resistance Junction-Ambient | Max | 200  | °C/W |
| R <sub>thj-case</sub> • | Thermal Resistance Junction-Case    | Max | 83.3 | °C/W |

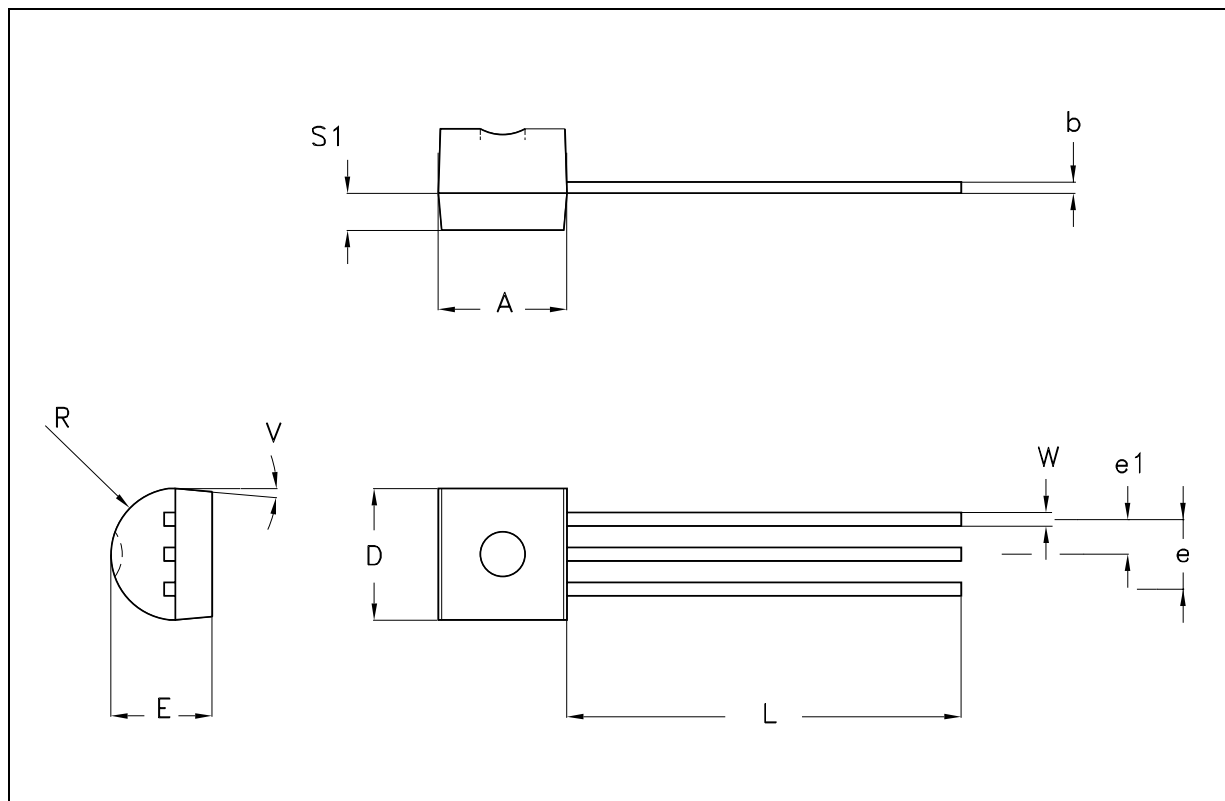
ELECTRICAL CHARACTERISTICS (T<sub>case</sub> = 25 °C unless otherwise specified)

| Symbol                 | Parameter                                                | Test Conditions                                                                                                                                                                                                                                                      | Min.                        | Typ. | Max.         | Unit   |
|------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|--------------|--------|
| I <sub>CEX</sub>       | Collector Cut-off Current (V <sub>BE</sub> = -3 V)       | V <sub>CE</sub> = 30 V                                                                                                                                                                                                                                               |                             |      | 50           | nA     |
| I <sub>BEX</sub>       | Base Cut-off Current (V <sub>BE</sub> = -3 V)            | V <sub>CE</sub> = 30 V                                                                                                                                                                                                                                               |                             |      | 50           | nA     |
| V <sub>(BR)CEO</sub> * | Collector-Emitter Breakdown Voltage (I <sub>B</sub> = 0) | I <sub>C</sub> = 1 mA                                                                                                                                                                                                                                                | 40                          |      |              | V      |
| V <sub>(BR)CBO</sub>   | Collector-Base Breakdown Voltage (I <sub>E</sub> = 0)    | I <sub>C</sub> = 10 μA                                                                                                                                                                                                                                               | 60                          |      |              | V      |
| V <sub>(BR)EBO</sub>   | Emitter-Base Breakdown Voltage (I <sub>C</sub> = 0)      | I <sub>E</sub> = 10 μA                                                                                                                                                                                                                                               | 6                           |      |              | V      |
| V <sub>CE(sat)</sub> * | Collector-Emitter Saturation Voltage                     | I <sub>C</sub> = 10 mA    I <sub>B</sub> = 1 mA<br>I <sub>C</sub> = 50 mA    I <sub>B</sub> = 5 mA                                                                                                                                                                   |                             |      | 0.2<br>0.2   | V<br>V |
| V <sub>BE(sat)</sub> * | Base-Emitter Saturation Voltage                          | I <sub>C</sub> = 10 mA    I <sub>B</sub> = 1 mA<br>I <sub>C</sub> = 50 mA    I <sub>B</sub> = 5 mA                                                                                                                                                                   | 0.65                        |      | 0.85<br>0.95 | V<br>V |
| h <sub>FE</sub> *      | DC Current Gain                                          | I <sub>C</sub> = 0.1 mA    V <sub>CE</sub> = 1 V<br>I <sub>C</sub> = 1 mA       V <sub>CE</sub> = 1 V<br>I <sub>C</sub> = 10 mA      V <sub>CE</sub> = 1 V<br>I <sub>C</sub> = 50 mA      V <sub>CE</sub> = 1 V<br>I <sub>C</sub> = 100 mA     V <sub>CE</sub> = 1 V | 60<br>80<br>100<br>60<br>30 |      | 300          |        |
| f <sub>T</sub>         | Transition Frequency                                     | I <sub>C</sub> = 10 mA    V <sub>CE</sub> = 20 V    f = 100 MHz                                                                                                                                                                                                      | 250                         | 270  |              | MHz    |
| C <sub>CBO</sub>       | Collector-Base Capacitance                               | I <sub>E</sub> = 0    V <sub>CB</sub> = 10 V    f = 1 MHz                                                                                                                                                                                                            |                             | 4    |              | pF     |
| C <sub>EBO</sub>       | Emitter-Base Capacitance                                 | I <sub>C</sub> = 0    V <sub>EB</sub> = 0.5 V    f = 1 MHz                                                                                                                                                                                                           |                             | 18   |              | pF     |
| NF                     | Noise Figure                                             | V <sub>CE</sub> = 5 V    I <sub>C</sub> = 0.1 mA    f = 10 Hz<br>to 15.7 KHz    R <sub>G</sub> = 1 KΩ                                                                                                                                                                |                             | 5    |              | dB     |
| t <sub>d</sub>         | Delay Time                                               | I <sub>C</sub> = 10 mA    I <sub>B</sub> = 1 mA                                                                                                                                                                                                                      |                             |      | 35           | ns     |
| t <sub>r</sub>         | Rise Time                                                | V <sub>CC</sub> = 30 V                                                                                                                                                                                                                                               |                             |      | 35           | ns     |
| t <sub>s</sub>         | Storage Time                                             | I <sub>C</sub> = 10 mA    I <sub>B1</sub> = -I <sub>B2</sub> = 1 mA                                                                                                                                                                                                  |                             |      | 200          | ns     |
| t <sub>f</sub>         | Fall Time                                                | V <sub>CC</sub> = 30 V                                                                                                                                                                                                                                               |                             |      | 50           | ns     |

\* Pulsed: Pulse duration = 300 μs, duty cycle ≤ 2 %

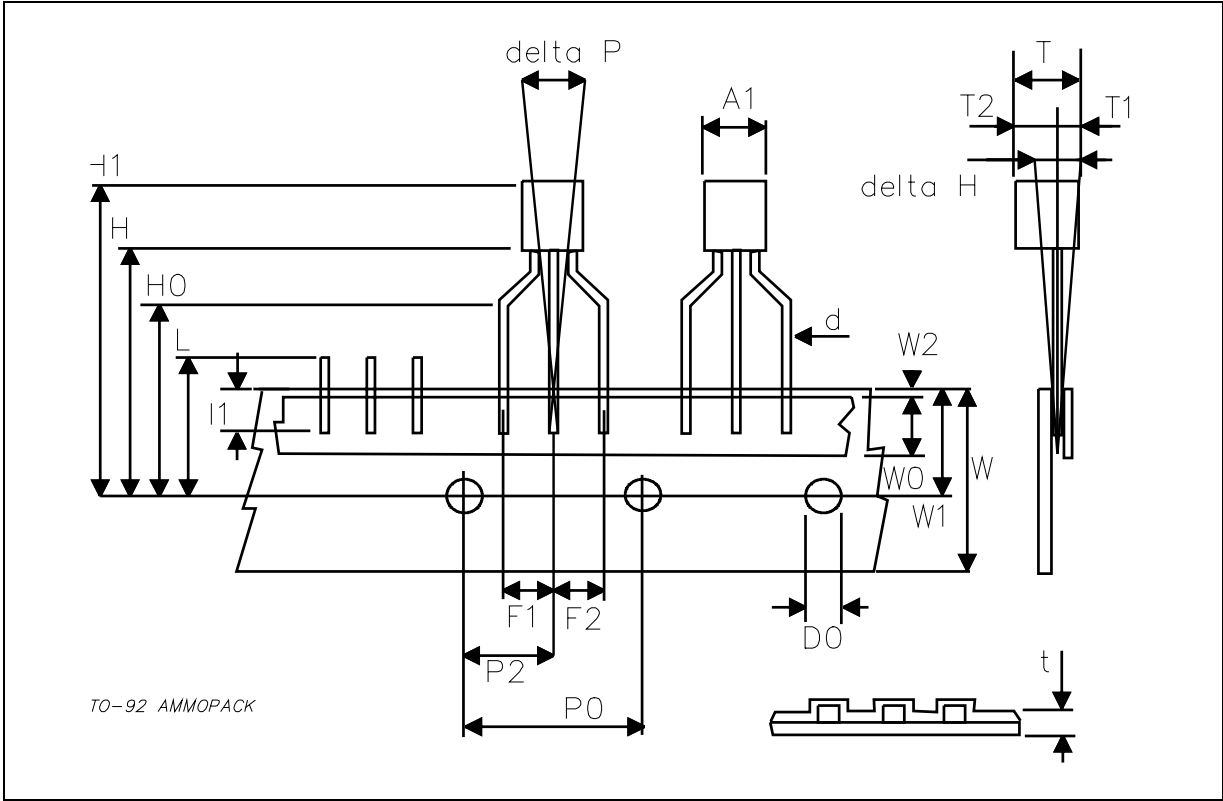
## TO-92 MECHANICAL DATA

| DIM. | mm       |      |          | inch     |      |          |
|------|----------|------|----------|----------|------|----------|
|      | MIN.     | TYP. | MAX.     | MIN.     | TYP. | MAX.     |
| A    | 4.32     |      | 4.95     | 0.170    |      | 0.195    |
| b    | 0.36     |      | 0.51     | 0.014    |      | 0.020    |
| D    | 4.45     |      | 4.95     | 0.175    |      | 0.194    |
| E    | 3.30     |      | 3.94     | 0.130    |      | 0.155    |
| e    | 2.41     |      | 2.67     | 0.095    |      | 0.105    |
| e1   | 1.14     |      | 1.40     | 0.045    |      | 0.055    |
| L    | 12.70    |      | 15.49    | 0.500    |      | 0.609    |
| R    | 2.16     |      | 2.41     | 0.085    |      | 0.094    |
| S1   | 1.14     |      | 1.52     | 0.045    |      | 0.059    |
| W    | 0.41     |      | 0.56     | 0.016    |      | 0.022    |
| V    | 4 degree |      | 6 degree | 4 degree |      | 6 degree |



TO-92 AMMOPACK SHIPMENT (Suffix"-AP") MECHANICAL DATA

| DIM.    | mm    |       |       | inch   |       |       |
|---------|-------|-------|-------|--------|-------|-------|
|         | MIN.  | TYP.  | MAX.  | MIN.   | TYP.  | MAX.  |
| A1      |       |       | 4.80  |        |       | 0.189 |
| T       |       |       | 3.80  |        |       | 0.150 |
| T1      |       |       | 1.60  |        |       | 0.063 |
| T2      |       |       | 2.30  |        |       | 0.091 |
| d       |       |       | 0.48  |        |       | 0.019 |
| P0      | 12.50 | 12.70 | 12.90 | 0.492  | 0.500 | 0.508 |
| P2      | 5.65  | 6.35  | 7.05  | 0.222  | 0.250 | 0.278 |
| F1,F2   | 2.44  | 2.54  | 2.94  | 0.096  | 0.100 | 0.116 |
| delta H | -2.00 |       | 2.00  | -0.079 |       | 0.079 |
| W       | 17.50 | 18.00 | 19.00 | 0.689  | 0.709 | 0.748 |
| W0      | 5.70  | 6.00  | 6.30  | 0.224  | 0.236 | 0.248 |
| W1      | 8.50  | 9.00  | 9.25  | 0.335  | 0.354 | 0.364 |
| W2      |       |       | 0.50  |        |       | 0.020 |
| H       | 18.50 |       | 20.50 | 0.728  |       | 0.807 |
| H0      | 15.50 | 16.00 | 16.50 | 0.610  | 0.630 | 0.650 |
| H1      |       |       | 25.00 |        |       | 0.984 |
| D0      | 3.80  | 4.00  | 4.20  | 0.150  | 0.157 | 0.165 |
| t       |       |       | 0.90  |        |       | 0.035 |
| L       |       |       | 11.00 |        |       | 0.433 |
| I1      | 3.00  |       |       | 0.118  |       |       |
| delta P | -1.00 |       | 1.00  | -0.039 |       | 0.039 |



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