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# 2N2710/FTSO2710 T-35-13

## NPN Small Signal High Speed Low Power Saturating Switch Transistor

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

**PACKAGE**

| | |
|---|---|
| 2N2710 | TO-18 |
| FTSO2710 | TO-236AA/AB |

**Temperatures**

| | |
|---|---|
| Storage Temperature | -65° C to 200° C |
| Operating Junction Temperature | 200° C |

**Power Dissipation** (Notes 2 & 3)

| | 2N | FTSO |
|---|---|---|
| Total Dissipation at | | |
| 25° C Ambient Temperature | 0.5 W | 0.350 W* |
| 25° C Case Temperature | 1.2 W | |

**Voltages & Currents**

| | | |
|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage (Note 4) | 20 V |
| $V_{CES}$ | Collector to Emitter Voltage | 30 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V |
| $I_C$ | Collector Current | 500 mA |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| $BV_{CEO}$ | Collector to Emitter Breakdown Voltage | 20 | | V | $I_C = 10$ mA, $I_B = 0$ |
| $BV_{CES}$ | Collector to Emitter Breakdown Voltage | 30 | | V | $I_C = 10$ μA, $I_B = 0$ |
| $BV_{CBO}$ | Collector to Base Breakdown Voltage | 40 | | V | $I_C = 10$ μA, $I_E = 0$ |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | 5.0 | | V | $I_E = 10$ μA, $I_C = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | μA | $V_{EB} = 3.0$ V, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current<br>(150° C) | | 30<br>30 | nA<br>μA | $V_{CB} = 20$ V, $I_E = 0$<br>$V_{CB} = 20$ V, $T_A = 150$° C |
| $h_{FE}$ | DC Current Gain (Note 5) | 40<br>40 | | | $I_C = 10$ mA, $V_{CE} = 1.0$ V<br>$I_C = 50$ mA, $V_{CE} = 1.0$ V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | | 0.25<br>0.40 | V<br>V | $I_C = 10$ mA, $I_B = 1.0$ mA<br>$I_C = 50$ mA, $I_B = 5.0$ mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage | | 0.90<br>1.30 | V<br>V | $I_C = 10$ mA, $I_B = 1.0$ mA<br>$I_C = 50$ mA, $I_B = 5.0$ mA |

**NOTES:**

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 146° C/W (derating factor of 6.8 mW/° C); junction-to-ambient thermal resistance of 350° C/W (derating factor 2.8 mW/° C); (TO-236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length ≤ 300 μs; duty cycle ≤ 2%, and ≤ 1.2 ms pulse duration.
6. For product family characteristic curves, refer to Curve Set T162

* Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

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# 2N2904/5/6/7 PN2904/5/6/7 FTSO2904/5/6/7

T-37-17

## PNP Small Signal General Purpose Amplifiers & Switches

- **$V_{CEO}$ ... -40 V (Min)**
- **$h_{FE}$ ... 40-120 (2N/PN/FTSO2904/6), 100-300 (2N/PN/FTSO2905/7)**
- **$t_{on}$ ... 45 ns (Max) @ 150 mA, $t_{off}$ ... 100 ns (Max) @ 150 mA**
- **Complements ... 2N/PN/FTSO2218 Series, 2N/PN/FTSO2218A Series**

**PACKAGE**

| | |
|---|---|
| 2N2904 | TO-39 |
| 2N2905 | TO-39 |
| 2N2906 | TO-18 |
| 2N2907 | TO-18 |
| PN2904 | TO-92 |
| PN2905 | TO-92 |
| PN2906 | TO-92 |
| PN2907 | TO-92 |
| FTSO2904 | TO-236AA/AB |
| FTSO2905 | TO-236AA/AB |
| FTSO2906 | TO-236AA/AB |
| FTSO2907 | TO-236AA/AB |

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

| **Temperatures** | **2N** | **PN/FTSO** |
|---|---|---|
| Storage Temperature | -65° C to 200° C | -55° C to 150° C |
| Operating Junction Temperature | 175° C | 150° C |

**Power Dissipation** (Notes 2 & 3)

| Total Dissipation at | **2N2904/5** | **2N2906/7** |
|---|---|---|
| 25° C Ambient Temperature | 0.6 W | 0.4 W |
| 25° C Case Temperature | 3.0 W | 1.8 W |

| Total Dissipation at | **PN** | **FTSO** |
|---|---|---|
| 25° C Ambient Temperature | 0.625 W | 0.350 W* |
| 25° C Case Temperature | 1.0 W | |

| **Voltages & Currents** | | **2N/PN2904** |
|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage (Note 4) | −40 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V |
| $I_C$ | Collector Current | 600 mA |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | 2N/PN2904/6 MIN | MAX | | TEST CONDITIONS |
|---|---|---|---|---|---|
| $h_{FE}$ | DC Current Gain (Note 5) | 40 | 120 | | $I_C$ = 150 mA, $V_{CE}$ = −10 V |
| | | 20 | | | $I_C$ = 500 mA, $V_{CE}$ = −10 V |
| | | 35 | | | $I_C$ = 10 mA, $V_{CE}$ = −10 V |
| | | 25 | | | $I_C$ = 1.0 mA, $V_{CE}$ = −10 V |
| | | 20 | | | $I_C$ = 0.1 mA, $V_{CE}$ = −10 V |

**NOTES:**

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 58 3° C/W (derating factor of 17.2 mW/° C); junction-to-ambient thermal resistance of 292° C/W (derating factor of 3 42 mW/° C) for 2N2904 and 2N2905; junction-to-case thermal resistance of 97.3° C/W (derating factor of 10.3 mW/° C); junction-to-ambient thermal resistance of 437° C/W (derating factor of 2.28 mW/° C) for the 2N2906 and 2N2907. These ratings give a maximum junction resistance of 150° C and junction-to-case thermal resistance of 125° C/W (derating factor of 8.0 mW/° C); junction-to-ambient thermal resistance of 200° C/W (derating factor of 5.0 mW/° C) for PN2904, PN2905, PN2906, and PN2907; (TO236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs; duty cycle = 1%
6. For product family characteristic curves, refer to Curve Set T212.

* Package mounted on 99.5% alumina 8mm x 8mm x 0.6mm.

**2N2904/5/6/7**
**PN2904/5/6/7**
**FTSO2904/5/6/7**

T-35-17

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | 2N/PN2905/7 MIN | MAX | | TEST CONDITIONS |
|---|---|---|---|---|---|
| $h_{FE}$ | DC Current Gain (Note 5) | 100<br>30<br>75<br>50<br>35 | 300 | | $I_C$ = 150 mA, $V_{CE}$ = −10 V<br>$I_C$ = 500 mA, $V_{CE}$ = −10 V<br>$I_C$ = 10 mA, $V_{CE}$ = −10 V<br>$I_C$ = 1.0 mA, $V_{CE}$ = −10 V<br>$I_C$ = 0.1 mA, $V_{CE}$ = −10 V |
| SYMBOL | CHARACTERISTIC | MIN | MAX | UNITS | TEST CONDITIONS |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | −5.0 | | V | $I_C$ = 0, $I_E$ = 10 μA |
| $BV_{CBO}$ | Collector to Base Breakdown Voltage | −60 | | V | $I_C$ = 10 μA, $I_E$ = 0 |
| $I_{CEX}$ | Collector Reverse Current | | 50 | nA | $V_{CE}$ = −30 V, $V_{EB}$ = −0.5 V |
| $I_{CBO}$ | Collector Cutoff Current | | 20<br>20 | nA<br>μA | $V_{CB}$ = −50 V, $I_E$ = 0<br>$V_{CB}$ = −50 V, $I_E$ = 0, $T_A$ = 150° C |
| $I_B$ | Base Current | | 50 | nA | $V_{CE}$ = −30 V, $V_{EB}$ = −0.5 V |
| $V_{CEO(sus)}$ | Collector to Emitter Sustaining Voltage (Notes 4 & 5) | −60 | | V | $I_C$ = 10 mA (pulsed), $I_B$ = 0 |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage (Note 5) | | −0.4<br>−1.6 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage (Note 5) | | −1.3<br>−2.6 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA |
| $C_{ob}$ | Output Capacitance | | 8.0 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 100 kHz |
| $C_{ib}$ | Emitter Transition Capacitance | | 30 | pF | $V_{EB}$ = −2.0 V, $I_C$ = 0, f = 100 kHz |
| $h_{fe}$ | High Frequency Current Gain | 2.0 | | | $I_C$ = 50 mA, $V_{CE}$ = −20 V, f = 100 MHz |
| $t_d$ | Turn On Delay Time (test circuit no. 224) | | 10 | ns | $I_C$ = 150 mA, $V_{CC}$ = −30 V, $I_{B1}$ = 15 mA |
| $t_r$ | Rise Time (test circuit no. 224) | | 40 | ns | $I_C$ = 150 mA, $V_{CC}$ = −30 V, $I_{B1}$ = $I_{B2}$ = 15 mA |
| $t_s$ | Storage Time (test circuit no. 225) | | 80 | ns | $I_C$ = 150 mA, $V_{CC}$ = −6.0 V, $I_{B1}$ = 15 mA |
| $t_f$ | Fall Time (test circuit no. 225) | | 30 | ns | $I_C$ = 150 mA, $V_{CC}$ = −6.0 V, $I_{B1}$ = $I_{B2}$ = 15 mA |

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# 2N2904A/5A/6A/7A
# PN2904A/5A/6A/7A
# FTSO2904A/5A/6A/7A

T-35-17

## PNP Small Signal General Purpose Amplifiers & Switches

- $P_D$ ... 625 mW @ $T_A$ = 25° C (PN Series)
- $V_{CEO}$ ... -60 V (Min)
- $h_{FE}$ ... 40-120 (2N/PN/FTSO2904A/6A), 100-300 (2N/PN/FTSO2905A/7A)
- $t_{on}$ ... 45 ns (Max) @ 150 mA, $t_{off}$ ... 100 ns (Max) @ 150 mA
- Complements ... 2N/PN/FTSO2218 Series, 2N/PN/FTSO2218A Series

**PACKAGE**

| | |
|---|---|
| 2N2904A | TO-39 |
| 2N2905A | TO-39 |
| 2N2906A | TO-18 |
| 2N2907A | TO-18 |
| PN2904A | TO-92 |
| PN2905A | TO-92 |
| PN2906A | TO-92 |
| PN2907A | TO-92 |
| FTSO2904A | TO-236AA/AB |
| FTSO2905A | TO-236AA/AB |
| FTSO2906A | TO-236AA/AB |
| FTSO2907A | TO-236AA/AB |

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

| **Temperatures** | **2N** | **PN/FTSO** |
|---|---|---|
| Storage Temperature | -65° C to 200° C | -55° C to 150° C |
| Operating Junction Temperature | 175° C | 150° C |

**Power Dissipation** (Notes 2 & 3)

| Total Dissipation at | **2N2904/5A** | **2N2906/7A** |
|---|---|---|
| 25° C Ambient Temperature | 0.6 W | 0.4 W |
| 25° C Case Temperature | 3.0 W | 1.8 W |

| Total Dissipation at | **PN** | **FTSO** |
|---|---|---|
| 25° C Ambient Temperature | 0.625 W | 0.350 W* |
| 25° C Case Temperature | 1.0 W | |

| **Voltages & Currents** | | **2N/PN** |
|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage (Note 4) | −40 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V |
| $I_C$ | Collector Current | 600 mA |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | 2904A/2906A MIN | 2904A/2906A MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| $h_{FE}$ | DC Current Gain (Note 5) | 40 | 120 | | $I_C$ = 150 mA, $V_{CE}$ = −10 V |
| | | 40 | | | $I_C$ = 500 mA, $V_{CE}$ = −10 V |
| | | 40 | | | $I_C$ = 10 mA, $V_{CE}$ = −10 V |
| | | 40 | | | $I_C$ = 1.0 mA, $V_{CE}$ = −10 V |
| | | 40 | | | $I_C$ = 0.1 mA, $V_{CE}$ = −10 V |

**NOTES:**
1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 58.3° C/W (derating factor of 17.2 mW/° C); junction-to-ambient thermal resistance of 292° C/W (derating factor of 3.42 mW/° C) for 2N2904A and 2N2905A; junction-to-case thermal resistance of 97.3° C/W (derating factor of 10.3 mW/° C); junction-to-ambient thermal resistance of 437° C/W (derating factor of 2.28 mW/° C) for the 2N2906A and 2N2907A. These ratings give a maximum junction resistance of 150° C and junction-to-case thermal resistance of 125° C/W (derating factor of 8.0 mW/° C); junction-to-ambient thermal resistance of 200° C/W (derating factor of 5.0 mW/° C) for PN2904A, PN2905A, PN2906A, and PN2907A; (TO-236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs; duty cycle = 1%.
6. For product family characteristic curves, refer to Curve Set T212.

* Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

# 2N2904A/5A/6A/7A
# PN2904A/5A/6A/7A
# FTSO2904A/5A/6A/7A

T-35-17

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | 2905A/2907A MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| $h_{FE}$ | DC Current Gain (Note 5) | 100<br>50<br>100<br>100<br>75 | 300 | | $I_C$ = 150 mA, $V_{CE}$ = −10 V<br>$I_C$ = 500 mA, $V_{CE}$ = −10 V<br>$I_C$ = 10 mA, $V_{CE}$ = −10 V<br>$I_C$ = 1.0 mA, $V_{CE}$ = −10 V<br>$I_C$ = 0.1 mA, $V_{CE}$ = −10 V |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | −5.0 | | V | $I_C$ = 0, $I_E$ = 10 μA |
| $BV_{CBO}$ | Collector to Base Breakdown Voltage | −60 | | V | $I_C$ = 10 μA, $I_E$ = 0 |
| $I_{CEX}$ | Collector Reverse Current | | 50 | nA | $V_{CE}$ = −30 V, $V_{EB}$ = −0.5 V |
| $I_{CBO}$ | Collector Cutoff Current | | 10<br>10 | nA<br>μA | $V_{CB}$ = −50 V, $I_E$ = 0<br>$V_{CB}$ = −50 V, $I_E$ = 0, $T_A$ = 150° C |
| $I_B$ | Base Current | | 50 | nA | $V_{CE}$ = −0 V, $V_{EB}$ = −0.5 V |
| $V_{CEO(sus)}$ | Collector to Emitter Sustaining Voltage (Notes 4 & 5) | −40 | | V | $I_C$ = 10 mA (pulsed), $I_B$ = 0 |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage (Note 5) | | −0.4<br>−1.6 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage (Note 5) | | −1.3<br>−2.6 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA |
| $C_{ob}$ | Output Capacitance | | 8.0 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 100 kHz |
| $C_{ib}$ | Emitter Transition Capacitance | | 30 | pF | $V_{EB}$ = −2.0 V, $I_C$ = 0, f = 100 kHz |
| $h_{fe}$ | High Frequency Current Gain | 2.0 | | | $I_C$ = 50 mA, $V_{CE}$ = −20 V, f = 100 MHz |
| $t_d$ | Turn On Delay Time (test circuit no. 224) | | 10 | ns | $I_C$ = 150 mA, $V_{CC}$ = −30 V, $I_{B1}$ = 15 mA |
| $t_r$ | Rise Time (test circuit no. 224) | | 40 | ns | $I_C$ = 150 mA, $V_{CC}$ = −30 V, $I_{B1}$ = $I_{B2}$ = 15 mA |
| $t_s$ | Storage Time (test circuit no. 225) | | 80 | ns | $I_C$ = 150 mA, $V_{CC}$ = −6.0 V, $I_{B1}$ = 15 mA |
| $t_f$ | Fall Time (test circuit no. 225) | | 30 | ns | $I_C$ = 150 mA, $V_{CC}$ = −6.0 V, $I_{B1}$ = $I_{B2}$ = 15 mA |
| $t_{on}$ | Turn On Time (test circuit no. 224) | | 45 | ns | $I_C$ = 150 mA, $V_{CC}$ = −3.0 V, $I_{B1}$ = 15 mA |
| $t_{off}$ | Turn Off Time (test circuit no. 225) | | 100 | ns | $I_C$ = 150 mA, $V_{CC}$ = −6.0 V, $I_{B1}$ = $I_{B2}$ = 15 mA |

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# 2N3019/2N3020

T-29-23

## NPN Small Signal General Purpose Amplifiers

- $V_{CEO}$ ... **80 V (Min)**
- $V_{CE(sat)}$ ... **0.5 V (Max) @ 500 mA**
- $h_{FE}$ ... **100-300 @ 150 mA (2N3019), 50 (Min) @ 100 μA & 500 mA (2N3019)**
- **Complements ... 2N4031, 2N4033**

**PACKAGE**

| | |
|---|---|
| 2N3019 | TO-5 |
| 2N3020 | TO-5 |

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

**Temperatures**

| | |
|---|---|
| Storage Temperature | -65° to 200° C |
| Operating Junction Temperature | 200° C |

**Power Dissipation** (Notes 2 & 3)

| | |
|---|---|
| Total Dissipation at | |
| 25° C Ambient Temperature | 0.8 W |
| 25° C Case Temperature | 5.0 W |

**Voltages & Currents**

| | | |
|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 80 V |
| $V_{CB}$ | Collector to Base Voltage | 140 V |
| $V_{EB}$ | Emitter to Base Voltage | 7.0 V |
| $I_C$ | Collector Current | 1.0 A |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 5)

| SYMBOL | CHARACTERISTIC | 3019 MIN | 3019 MAX | 3020 MIN | 3020 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| $BV_{CEO}$ | Collector to Emitter Breakdown Voltage (Note 4) | 80 | | 80 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $BV_{CBO}$ | Collector to Base Breakdown Voltage | 140 | | 140 | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | 7.0 | | 7.0 | | V | $I_E$ = 100 μA, $I_C$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 10 | | 10 | nA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| $I_{CBO}$ | Collector Cutoff Current | | 10<br>10 | | 10<br>10 | nA<br>μA | $V_{CB}$ = 90 V, $I_E$ = 0<br>$V_{CB}$ = 90 V, $I_E$ = 0, $T_A$ = 150° C |
| $h_{FE}$ | DC Current Gain (Note 4) | 50<br>90<br>100<br>40<br><br>50<br>15 | <br><br>300<br><br><br><br> | 30<br>40<br>40<br><br><br>30<br>15 | 100<br>120<br>120<br><br><br>100<br> | | $I_C$ = 0.1 mA, $V_{CE}$ = 10 V<br>$I_C$ = 10 mA, $V_{CE}$ = 10 V<br>$I_C$ = 150 mA, $V_{CE}$ = 10 V<br>$I_C$ = 150 mA, $V_{CE}$ = 10 V, $T_A$ = −55° C<br>$I_C$ = 500 mA, $V_{CE}$ = 10 V<br>$I_C$ = 1.0 A, $V_{CE}$ = 10 V |

**NOTES:**

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 35° C/W (derating factor of 28.6 mW/° C); junction-to-ambient thermal resistance of 217° C/W (derating factor of 4.6 mW/° C).
4. Pulse conditions: length ≤ 300 μs; duty cycle ≤ 1%.
5. For product family characteristic curves, refer to Curve Set T149.

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 5)

| SYMBOL | CHARACTERISTIC | 3019 MIN | 3019 MAX | 3020 MIN | 3020 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage (Note 4) | | 0.2<br>0.5 | | 0.2<br>0.5 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 500 mA, $I_B$ = 50 mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage (Note 4) | | 1.1 | | 1.1 | V | $I_C$ = 150 mA, $I_B$ = 15 mA |
| $C_{ob}$ | Output Capacitance | | 12 | | 12 | pF | $V_{CB}$ = 10 V, $I_E$ = 0, f = 1.0 MHz |
| $C_{ib}$ | Input Capacitance | | 60 | | 60 | pF | $V_{EB}$ = 0.5 V, $I_C$ = 0, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 80 | 400 | 30 | 200 | | $I_C$ = 1.0 mA, $V_{CE}$ = 5.0 V, f = 1.0 kHz |
| $h_{fe}$ | Current Gain Bandwidth Product | 5.0 | | 5.0 | | | $I_C$ = 50 mA, $V_{CE}$ = 10 V, f = 20 MHz |
| $r_b'C_c$ | Collector Base Time Constant | | 400 | | 400 | ps | $I_C$ = 10 mA, $V_{CE}$ = 10 V, f = 4.0 MHz |
| NF | Noise Figure | | 4.0 | | | dB | $I_C$ = 100 μA, $V_{CE}$ = 10 V, f = 1.0 kHz, $R_S$ = 10 kΩ |

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# 2N3053

T-29-21

## NPN Small Signal General Purpose Amplifier

- $V_{CEO}$ ... **40 V (Min)**
- $h_{FE}$ ... **50-250 @ 150 mA**
- $f_T$ ... **100 MHz (Min) @ 50 mA**

**PACKAGE**

| | |
|---|---|
| 2N3053 | TO-39 |

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

**Temperatures**

| | |
|---|---|
| Storage Temperature | -65° C to 200° C |
| Operating Junction Temperature | 175° C |

**Power Dissipation** (Notes 2 & 3)

| | |
|---|---|
| Total Dissipation at 25° C Case Temperature | 5.0 W |
| Linear Derating Factor | 28.6 mW/° C |

**Voltages & Currents**

| | | |
|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V |
| $I_C$ | Collector Current (Continuous) | 700 mA |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 5)

| SYMBOL | CHARACTERISTIC | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| $BV_{ECO}$ | Collector to Emitter Breakdown Voltage | 40 | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| $BV_{CER}$ | Collector to Emitter Breakdown Voltage | 50 | | V | $I_C$ = 100 μA, $R_{BE}$ = 10Ω |
| $BV_{CBO}$ | Collector to Base Breakdown Voltage | 60 | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | 5.0 | | V | $I_C$ = 0, $I_E$ = 100 μA |
| $I_{CEX}$ | Collector Cutoff Current | | 0.25 | μA | $V_{CE}$ = 30 V, $V_{EB(OFF)}$ = 1.5 V |
| $I_{EBO}$ | Emitter to Base Cutoff Current | | 0.25 | μA | $V_{EB}$ = 4.0 V, $I_C$ = 0 |
| $h_{FE}$ | DC Pulse Current Gain (Note 4) | 25<br>50 | <br>250 | | $I_C$ = 150 mA, $V_{CE}$ = 2.5 V<br>$I_C$ = 150 mA, $V_{CE}$ = 10 V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage (Note 4) | | 1.4 | V | $I_C$ = 150 mA, $I_B$ = 1.5 mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage (Note 4) | | 1.7 | V | $I_C$ = 150 mA, $I_B$ = 15 mA |
| $V_{BE(ON)}$ | Base to Emitter "On" Voltage | | 1.7 | V | $I_C$ = 150 mA, $V_{CE}$ = 2.5 V |
| $C_{ob}$ | Output Capacitance | | 15 | pF | $V_{CB}$ = 10 V, $I_E$ = 0, f = 140 kHz |
| $C_{ib}$ | Input Capacitance | | 80 | pF | $V_{EB}$ = 0.5 V, $I_C$ = 0, f = 140 kHz |
| $h_{fe}$ | Current Gain Bandwidth Product | 5.0 | | | $I_C$ = 50 mA, $V_{CE}$ = 10 V, f = 20 MHz |

**NOTES:**

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 35° C/W (derating factor of 28.6 mW/° C).
4. Pulse conditions: length = 300 μs; duty cycle = 2%.
5. For product family characteristic curves, refer to Curve Set T149.

FAIRCHILD
A Schlumberger Company

# 2N3107/2N3108 2N3109

T-29-21

## NPN Small Signal General Purpose Amplifiers & Saturated Switches

- **$V_{CEO}$ ... 40 V (Min) (2N3109), 60 V (Min) (2N3107/8)**
- **$V_{CE(sat)}$ ... 1.0 V (Max) @ 1.0 A**
- **$h_{FE}$ ... 100-300 @ 150 mA (2N3107/9), 40 (Min) @ 500 mA (2N3107/9, 40 (Min) @ 500 mA (2N3107/9)**
- **$t_{on}$ ... 200 ns (Max) @ 150 mA**
- **$t_{off}$ ... 600 ns (Max) (2N3108), 1.0 μs (Max) (2N3107/9) @ 150 mA**
- **NF ... 7.0 dB (Max) @ 1.0 kHz**

**PACKAGE**

| | |
|---|---|
| 2N3107 | TO-39 |
| 2N3108 | TO-39 |
| 2N3109 | TO-39 |

3

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

**Temperatures**

| | |
|---|---|
| Storage Temperature | -65° C to 200° C |
| Operating Junction Temperature | 200° C |

**Power Dissipation** (Notes 2 & 3)

| | |
|---|---|
| Total Dissipation at | |
| 25° C Ambient Temperature | 0.8 W |
| 25° C Case Temperature | 5.0 W |

| **Voltages & Currents** | **3107/8** | **3109** |
|---|---|---|
| $V_{CEO}$ Collector to Emitter Voltage (Note 4) | 60 V | 40 V |
| $V_{CBO}$ Collector to Base Voltage | 100 V | 80 V |
| $V_{EBO}$ Emitter to Base Voltage | 7.0 V | 7.0 V |

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 7)

| SYMBOL | CHARACTERISTIC | 3107/9 MIN | 3107/9 MAX | 3108 MIN | 3108 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| $BV_{CBO}$ | Collector to Base Breakdown Voltage (2N3107 only) | 100 | | | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| | (2N3108 only) | | | 100 | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| | (2N3109 only) | 80 | | | | V | $I_C$ = 100 μA, $I_E$ = 0 |
| $BV_{EBO}$ | Emitter to Base Breakdown Voltage | 7.0 | | 7.0 | | V | $I_E$ = 100 μA, $I_C$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 10 | | 10 | nA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| $I_{CBO}$ | Collector Cutoff Current | | 10 | | 10 | μA | $V_{CB}$ = 60 V, $I_E$ = 0, $T_A$ = 150° C |
| $I_{CES}$ | Collector Reverse Current | | 10 | | 10 | nA | $V_{CE}$ = 60 V, $V_{EB}$ = 0 |

**NOTES:**

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 35° C/W (derating factor of 28.6 mW/° C); junction-to-ambient thermal resistance of 218° C/W (derating factor of 4 5 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest
5. Pulse conditions: length = 300 μs; duty cycle = 1%.
6. Saturation voltage measured with 1/4" lead length.
7. For product family characteristic curves, refer to Curve Set T149.

## 2N3107/2N3108/2N3109

T-29-21

**ELECTRICAL CHARACTERISTICS** (25° C Ambient Temperature unless otherwise noted) (Note 6)

| SYMBOL | CHARACTERISTIC | 3107/9 MIN | 3107/9 MAX | 3108 MIN | 3108 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| $h_{FE}$ | DC Pulse Current Gain (Note 5) | 100<br>40<br>35<br>30 | 300 | 40<br>25<br>20<br>15 | 120 | | $I_C$ = 150 mA, $V_{CE}$ = 1.0 V<br>$I_C$ = 500 mA, $V_{CE}$ = 10 V<br>$I_C$ = 0.1 mA, $V_{CE}$ = 10 V<br>$I_C$ = 150 mA, $V_{CE}$ = 10 V, $T_A$ = −55° C |
| $V_{CEO(sus)}$ | Collector to Emitter Sustaining Voltage (Notes 4 & 5) (2N3107)<br>(2N3108)<br>(2N3109) | 60<br><br>40 | | 60 | | V<br>V<br>V | $I_C$ = 30 mA, $I_B$ = 0<br>$I_C$ = 30 mA, $I_B$ = 0<br>$I_C$ = 30 mA, $I_B$ = 0 |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage (Note 5)<br>(Notes 5 & 6) | | 0.25<br>1.0 | | 0.25<br>1.0 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 1.0 A, $I_B$ = 100 mA |
| $V_{BE(sat)}$ | Base to Emitter Saturation Voltage (Note 5)<br>(Notes 5 & 6) | | 1.1<br>2.0 | | 1.1<br>2.0 | V<br>V | $I_C$ = 150 mA, $I_B$ = 15 mA<br>$I_C$ = 1.0 A, $I_B$ = 100 mA |
| $C_{ob}$ | Open Circuit Output Capacitance<br>(2N3107)<br>(2N3108)<br>(2N3109) | | 20<br><br>25 | | <br>20<br> | pF<br>pF<br>pF | $V_{CB}$ = 10 V, $I_E$ = 0, f = 140 kHz<br>$V_{CB}$ = 10 V, $I_E$ = 0, f = 140 kHz<br>$V_{CB}$ = 10 V, $I_E$ = 0, f = 140 kHz |
| $C_{ib}$ | Open Circuit Input Capacitance | | 80 | | 80 | pF | $V_{EB}$ = 0.5 V, $I_E$ = 0, f = 140 kHz |
| $t_{on}$ | Turn On Time<br>(test circuit no. 288) | | 200 | | 200 | ns | $I_C \approx$ 150 mA, $I_{B1} \approx$ 7.5 mA, $I_{B2} \approx$ 7.5 mA |
| $t_{off}$ | Turn Off Time<br>(test circuit no. 289) | | 1000 | | 600 | ns | $I_C \approx$ 150 mA, $I_{B1} \approx$ 7.5 mA, $I_{B2} \approx$ 7.5 mA |