NPN General Purpose Amplifier

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA.

Absolute Maximum Ratings*  
TA = 25°C unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CEO}</td>
<td>Collector-Emitter Voltage</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{CBO}</td>
<td>Collector-Base Voltage</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-Base Voltage</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current - Continuous</td>
<td>600</td>
<td>mA</td>
</tr>
<tr>
<td>T_J, T_{stg}</td>
<td>Operating and Storage Junction Temperature Range</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics  
TA = 25°C unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_D</td>
<td>Total Device Dissipation</td>
<td>625</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>Derate above 25°C</td>
<td>5.0</td>
<td>mW/°C</td>
</tr>
<tr>
<td>R_{JUC}</td>
<td>Thermal Resistance, Junction to Case</td>
<td>83.3</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{JUA}</td>
<td>Thermal Resistance, Junction to Ambient</td>
<td>200</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06,“
NPN General Purpose Amplifier

Electrical Characteristics

Symbol | Parameter | Test Conditions | Min | Max | Units
--- | --- | --- | --- | --- | ---

**OFF CHARACTERISTICS**

- \( V_{\text{BRCEO}} \) Collector-Emitter Breakdown Voltage
- \( V_{\text{BRCEO}} \) Collector-Base Breakdown Voltage
- \( V_{\text{BRCEO}} \) Emitter-Base Breakdown Voltage
- \( I_{\text{L}} \) Base Cutoff Current
- \( I_{\text{CCE}} \) Collector Cutoff Current

**ON CHARACTERISTICS**

- \( h_{\text{FE}} \) DC Current Gain
- \( V_{\text{CESat}} \) Collector-Emitter Saturation Voltage
- \( V_{\text{BESat}} \) Base-Emitter Saturation Voltage

**SMALL SIGNAL CHARACTERISTICS**

- \( f_{\text{T}} \) Current Gain - Bandwidth Product
- \( C_{\text{cb}} \) Collector-Base Capacitance
- \( C_{\text{eb}} \) Emitter-Base Capacitance
- \( h_{\text{ie}} \) Input Impedance
- \( h_{\text{re}} \) Voltage Feedback Ratio
- \( h_{\text{ie}} \) Small-Signal Current Gain
- \( h_{\text{re}} \) Output Admittance

**SWITCHING CHARACTERISTICS**

- \( t_{\text{d}} \) Delay Time
- \( t_{\text{r}} \) Rise Time
- \( t_{\text{s}} \) Storage Time
- \( t_{\text{f}} \) Fall Time

---

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%
### Typical Characteristics

**Typical Pulsed Current Gain vs Collector Current**

<table>
<thead>
<tr>
<th>$h_{fe}$ - TYPICAL PULSED CURRENT GAIN</th>
<th>$I_c$ - COLLECTOR CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>0.3</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>300</td>
</tr>
</tbody>
</table>

- $T = 25 \, ^\circ C$
- $T = 125 \, ^\circ C$
- $T = -40 \, ^\circ C$

**Collector-Emitter Saturation Voltage vs Collector Current**

<table>
<thead>
<tr>
<th>$V_{CE}$ - COLLECTOR-EMITTER VOLTAGE (V)</th>
<th>$I_c$ - COLLECTOR CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>0.3</td>
<td>30</td>
</tr>
<tr>
<td>0.4</td>
<td>100</td>
</tr>
<tr>
<td>0.5</td>
<td>300</td>
</tr>
</tbody>
</table>

- $\beta = 10$
- $V_{CE} = 5V$

**Base-Emitter Saturation Voltage vs Collector Current**

<table>
<thead>
<tr>
<th>$V_{BE}$ - BASE-EMITTER VOLTAGE (V)</th>
<th>$I_c$ - COLLECTOR CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>0.3</td>
<td>30</td>
</tr>
<tr>
<td>0.4</td>
<td>100</td>
</tr>
<tr>
<td>0.5</td>
<td>300</td>
</tr>
</tbody>
</table>

- $\beta = 10$
- $V_{BE} = 5V$

**Base-Emitter ON Voltage vs Collector Current**

<table>
<thead>
<tr>
<th>$V_{BE(ON)}$ - BASE-EMITTER ON VOLTAGE (V)</th>
<th>$I_c$ - COLLECTOR CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>0.3</td>
<td>30</td>
</tr>
<tr>
<td>0.4</td>
<td>100</td>
</tr>
<tr>
<td>0.5</td>
<td>300</td>
</tr>
</tbody>
</table>

- $V_{CE} = 5V$

**Collector-Cutoff Current vs Ambient Temperature**

<table>
<thead>
<tr>
<th>$I_{cc}$ - COLLECTOR CURRENT (nA)</th>
<th>$T_A$ - AMBIENT TEMPERATURE (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>500</td>
<td>150</td>
</tr>
</tbody>
</table>

- $V_{CB} = 40V$

**Emitter Transition and Output Capacitance vs Reverse Bias Voltage**

<table>
<thead>
<tr>
<th>$C_{ob}$ - CAPACITANCE (pF)</th>
<th>REVERSE BIAS VOLTAGE (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

- $f = 1 \, MHz$
Typical Characteristics (continued)

**Turn On and Turn Off Times vs Collector Current**

![Graph showing turn on and turn off times vs collector current]

**Switching Times vs Collector Current**

![Graph showing switching times vs collector current]

**Power Dissipation vs Ambient Temperature**

![Graph showing power dissipation vs ambient temperature]

NPN General Purpose Amplifier

(continued)

2N4401 / MMBT4401
Typical Common Emitter Characteristics \( (f = 1.0 \text{kHz}) \)

NPN General Purpose Amplifier

(continued)

Common Emitter Characteristics

- \( V_{CE} = 10 \text{ V} \)
- \( T_A = 25^\circ \text{C} \)

Common Emitter Characteristics

- \( V_{CE} = 10 \text{ V} \)
- \( I_C = 10 \text{ mA} \)

Common Emitter Characteristics

- \( I_C = 10 \text{ mA} \)
- \( T_A = 25^\circ \text{C} \)

Common Emitter Characteristics

- \( V_{CE} = 10 \text{ V} \)
- \( I_C = 10 \text{ mA} \)
NPN General Purpose Amplifier
(continued)

Test Circuits

FIGURE 1: Saturated Turn-On Switching Time

FIGURE 2: Saturated Turn-Off Switching Time
TO-92 Tape and Reel Data

TO-92 Packaging
Configuration: Figure 1.0

TO-92 TAMMO PACKING INFORMATION

<table>
<thead>
<tr>
<th>Packing Style</th>
<th>Quantity</th>
<th>EOL code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reel A</td>
<td>2,000</td>
<td>D8Z</td>
</tr>
<tr>
<td>Reel E</td>
<td>2,000</td>
<td>D7Z</td>
</tr>
<tr>
<td>Ammo M</td>
<td>2,000</td>
<td>D7Z</td>
</tr>
<tr>
<td>Ammo P</td>
<td>2,000</td>
<td>D7Z</td>
</tr>
</tbody>
</table>

Unit weight:
- Reel weight with components = 1.04 kg
- Ammo weight with components = 1.02 kg
Max quantity per intermediate box = 10,000 units

(TO-92) BULK PACKING INFORMATION

<table>
<thead>
<tr>
<th>EOL CODE</th>
<th>DESCRIPTION</th>
<th>LEADCLIP / DIMENSION</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>J18Z</td>
<td>TO-18 OPTION STD</td>
<td>NO LEAD CLIP</td>
<td>2.0 K / BOX</td>
</tr>
<tr>
<td>J5Z</td>
<td>TO-5 OPTION STD</td>
<td>NO LEAD CLIP</td>
<td>1.5 K / BOX</td>
</tr>
<tr>
<td>NO EOL</td>
<td>TO-92 STANDARD</td>
<td>NO LEAD CLIP</td>
<td>2.0 K / BOX</td>
</tr>
<tr>
<td>L3Z</td>
<td>TO-92 STANDARD</td>
<td>NO LEAD CLIP</td>
<td>2.0 K / BOX</td>
</tr>
</tbody>
</table>

BULK OPTION
See Bulk Packing Information table

©2001 Fairchild Semiconductor Corporation
TO-92 Reeling Style
Configuration: Figure 2.0

- Machine Option “A” (H)
- Style “A”, D26Z, D70Z (s/h)
- FIRST WIRE OFF IS EMITTER
- ADHESIVE TAPE IS ON THE TOP SIDE
- FLAT OF TRANSISTOR IS ON BOTTOM
- ORDER STYLE D75Z (P)

- Machine Option “E” (J)
- Style “E”, D27Z, D71Z (s/h)
- FIRST WIRE OFF IS COLLECTOR
- ADHESIVE TAPE IS ON THE TOP SIDE
- FLAT OF TRANSISTOR IS ON TOP

TO-92 Radial Ammo Packaging
Configuration: Figure 3.0

- ORDER STYLE D74Z (M)
- FIRST WIRE OFF IS EMITTER (ON PKG. 92)
- ADHESIVE TAPE IS ON BOTTOM SIDE
- FLAT OF TRANSISTOR IS ON BOTTOM

- ORDER STYLE D75Z (P)
- FIRST WIRE OFF IS COLLECTOR (ON PKG. 92)
- ADHESIVE TAPE IS ON BOTTOM SIDE
- FLAT OF TRANSISTOR IS ON TOP
### TO-92 Tape and Reel Data, continued

#### TO-92 Tape and Reel Taping

**Dimension Configuration:** Figure 4.0

![Diagram of TO-92 Tape and Reel Taping](image)

**ITEM DESCRIPTION** | SYMBOL | DIMENSION
--- | --- | ---
Base of Package to Lead Bend | b | 0.036 (max)
Component Height | H6 | 0.935 (+/- 0.025)
Lead Clinch Height | H0 | 0.630 (+/- 0.020)
Component Base Height | H1 | 0.748 (+/- 0.020)
Component Alignment ( side(side) | Pd | 0.040 (max)
Component Alignment ( front/back) | H2 | 0.031 (max)
Component Pitch | P | 0.050 (+/- 0.020)
Feed Hole Pitch | PO | 0.050 (+/- 0.008)
Hole Center to First Lead | P1 | 0.130 (+0.009, -0.010)
Hole Center to Component Center | P2 | 0.247 (+/- 0.007)
Lead Spread | F1:F2 | 0.124 (+/- 0.010)
Lead Thickness | d | 0.018 (+0.002, -0.003)
Cut Lead Length | L | 0.429 (max)
Taped Lead Length | L1 | 0.206 (+0.051, -0.052)
Taped Lead Thickness | I | 0.032 (+/- 0.006)
Carrier Tape Thickness | I1 | 0.031 (+/- 0.006)
Carrier Tape Width | W | 0.798 (+0.020, -0.013)
Hold - down Tape Width | W0 | 0.236 (+/- 0.012)
Hold - down Tape position | W1 | 0.035 (max)
Feed Hole Position | W2 | 0.300 (+/- 0.020)
Spool Hole Diameter | DO | 0.157 (+0.008, -0.007)
Lead Spring Out | S | 0.024 (max)

Note: All dimensions are in inches.

#### TO-92 Reel

**Configuration:** Figure 5.0

![Diagram of TO-92 Reel Configuration](image)

**ITEM DESCRIPTION** | SYMBOL | MINIMUM | MAXIMUM
--- | --- | --- | ---
Reel Diameter | D1 | 13.975 | 14.025
 Arbor Hole Diameter (Standard) | D2 | 1.160 | 1.200
 Arbor Hole Diameter (Small Hole) | D2 | 0.650 | 0.700
Core Diameter | D3 | 3.100 | 3.300
Hub Recess Inner Diameter | D4 | 2.700 | 3.100
Hub Recess Depth | W1 | 0.370 | 0.570
Flange to Flange Inner Width | W2 | 1.020 | 1.050
Hub to Hub Center Width | W3 | 2.030 | 2.070

Note: All dimensions are inches

July 1999, Rev. A
TO-92 Package Dimensions

TO-92 (FS PKG Code 92, 94, 96)

Scale 1:1 on letter size paper
Dimensions shown below are in:
inches [millimeters]

Part Weight per unit (gram): 0.1977

©2000 Fairchild Semiconductor International
SOT-23 Tape and Reel Data

SOT-23 Packaging
Configuration: Figure 10

SOT-23 Package Information

<table>
<thead>
<tr>
<th>Packaging Option</th>
<th>Standard</th>
<th>Customized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape Color</td>
<td>3P</td>
<td>3P</td>
</tr>
<tr>
<td>Qty per Reel/Tub</td>
<td>3000</td>
<td>10,000</td>
</tr>
<tr>
<td>Unit Orientation</td>
<td>3P</td>
<td>3P</td>
</tr>
<tr>
<td>Box Dimensions (mm)</td>
<td>187x107x183</td>
<td>343x343x64</td>
</tr>
<tr>
<td>Max qty per Box</td>
<td>24,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Weight per unit (gm)</td>
<td>0.0082</td>
<td>0.0082</td>
</tr>
<tr>
<td>Weight per Reel (kg)</td>
<td>0.1775</td>
<td>0.4886</td>
</tr>
</tbody>
</table>

Note/Comments

Packaging Description:
SOT-23 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in natural primary component of polycarbonate film, adhesive layer, sealant, and anti-static sprayed agent). These sealed parts in standard option are shipped with 3,000 units per 7” or 177cm diameter reel. The reels are dark blue in color and made of polycarbonate plastic anti-static coated. Other option comes in 10,000 units per 13” or 330cm diameter reel. This and some other options are described in the Packaging Information table. These full reels are individually labeled and placed inside a standard intermediate made of recyclable corrugated brown paper with a Fairchild logo printing. One pizza box contains eight reels maximum. These intermediate boxes are placed inside a labeled shipping box which comes in different sizes depending on the number of parts shipped.

SOT-23 Unit Orientation

343mm x 342mm x 64mm
Intermediate box for L87Z Option

187mm x 107mm x 183mm
Intermediate Box for Standard Option

©2000 Fairchild Semiconductor International
September 1999, Rev. C
SOT-23 Tape and Reel Data, continued

SOT-23 Embossed Carrier Tape
Configuration: Figure 3.0

User Direction of Feed

Dimensions are in millimeter

<table>
<thead>
<tr>
<th>Pkg type</th>
<th>A0</th>
<th>B0</th>
<th>W</th>
<th>D0</th>
<th>D1</th>
<th>E1</th>
<th>E2</th>
<th>F</th>
<th>P1</th>
<th>P0</th>
<th>K0</th>
<th>T</th>
<th>Wc</th>
<th>Tc</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT-23 (8mm)</td>
<td>3.15</td>
<td>2.77</td>
<td>2.0</td>
<td>1.55</td>
<td>1.26</td>
<td>1.75</td>
<td>6.25</td>
<td>3.50</td>
<td>4.0</td>
<td>4.0</td>
<td>1.35</td>
<td>0.238</td>
<td>2.2</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Notes: A0, B0, and K0 dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).

SOT-23 Reel Configuration: Figure 4.0

Dimensions are in inches and millimeters

<table>
<thead>
<tr>
<th>Tape Size</th>
<th>Reel</th>
<th>Dim A</th>
<th>Dim B</th>
<th>Dim C</th>
<th>Dim D</th>
<th>Dim N</th>
<th>Dim W1</th>
<th>Dim W2</th>
<th>Dim W3 (LSL-USL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8mm</td>
<td>7&quot;</td>
<td>0.059</td>
<td>0.059</td>
<td>0.059</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
</tr>
<tr>
<td>8mm</td>
<td>13&quot;</td>
<td>0.059</td>
<td>0.059</td>
<td>0.059</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
<td>0.030</td>
</tr>
</tbody>
</table>

September 1999, Rev. C
SOT-23 (FS PKG Code 49)

Dimensions shown below are in:

- **inches [millimeters]**

Part Weight per unit (gram): 0.0082

**Note:** Unless otherwise specified:
1. Standard lead finish: 150 microinches / 3.81 micrometers
   minimum tin / lead (solder) on alloy 42
2. Reference JEDEC registration TO-236, variation A3, issue C, dated Jul 1993
TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACE®
Bottomless™
CoolFET™
CROSSVOLT™
DOMETM
E®CMOS™
EnSigna™
FACT™
FACT Quiet Series™
FAST®
PowerTrench®
QFET™
QS™
QT Optoelectronics™
Quiet Series™
SILENT SWITCHER®
SMART START™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SyncFET™
TinyLogic™
UHC™
VCX™

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD’S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

<table>
<thead>
<tr>
<th>Datasheet Identification</th>
<th>Product Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance Information</td>
<td>Formative or In Design</td>
<td>This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
</tr>
<tr>
<td>Preliminary</td>
<td>First Production</td>
<td>This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.</td>
</tr>
<tr>
<td>No Identification Needed</td>
<td>Full Production</td>
<td>This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.</td>
</tr>
<tr>
<td>Obsolete</td>
<td>Not In Production</td>
<td>This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.</td>
</tr>
</tbody>
</table>
This datasheet has been download from:

www.datasheetcatalog.com

Datasheets for electronics components.