2N4401 / MMBT4401
NPN General-Purpose Amplifier

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

Ordering Information

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<th>Marking</th>
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<th>Packing Method</th>
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<td>2N4401BU</td>
<td>2N4401</td>
<td>TO-92 3L</td>
<td>Bulk</td>
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<td>2N4401TF</td>
<td>2N4401</td>
<td>TO-92 3L</td>
<td>Tape and Reel</td>
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<td>2N4401TFR</td>
<td>2N4401</td>
<td>TO-92 3L</td>
<td>Tape and Reel</td>
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<td>2N4401</td>
<td>TO-92 3L</td>
<td>Ammo</td>
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<td>2N4401TAR</td>
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<td>TO-92 3L</td>
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<tr>
<td>MMBT4401</td>
<td>2X</td>
<td>SOT-23 3L</td>
<td>Tape and Reel</td>
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Absolute Maximum Ratings\(^{(1),(2)}\)

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at \(T_A = 25\,^\circ C\) unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</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>
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</table>

Notes:
1. These ratings are based on a maximum junction temperature of 150°\(C\).
2. These are steady-state limits. Fairchild Semiconductor should be consulted on applications involving pulsed or low-duty cycle operations.

Thermal Characteristics

Values are at \(T_A = 25\,^\circ C\) unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>(2N4401)</th>
<th>(MMBT4401)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P_D)</td>
<td>Total Device Dissipation</td>
<td>625</td>
<td>350</td>
<td>mW</td>
</tr>
<tr>
<td>Derate Above 25°C</td>
<td>5.0</td>
<td>2.8</td>
<td>mW/°C</td>
<td></td>
</tr>
<tr>
<td>(R_{JUC})</td>
<td>Thermal Resistance, Junction to Case</td>
<td>83.3</td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>(R_{JUA})</td>
<td>Thermal Resistance, Junction to Ambient</td>
<td>200</td>
<td>357</td>
<td>°C/W</td>
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</tbody>
</table>

Notes:
3. PCB size: FR-4, 76 mm x 114 mm x 1.57 mm (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size.
4. Device mounted on FR-4 PCB 1.6 inch x 1.6 inch x 0.06 inch.
### Electrical Characteristics

Values are at $T_A = 25^\circ C$ unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$V_{(BR)CEO}$</td>
<td>Collector-Emitter Breakdown Voltage</td>
<td>$I_C = 1.0\ mA, I_B = 0$</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)CBO}$</td>
<td>Collector-Base Breakdown Voltage</td>
<td>$I_C = 0.1\ mA, I_E = 0$</td>
<td>60</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)EBO}$</td>
<td>Emitter-Base Breakdown Voltage</td>
<td>$I_E = 0.1\ mA, I_C = 0$</td>
<td>6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{BL}$</td>
<td>Base Cut-Off Current</td>
<td>$V_{CE} = 35\ V, V_{EB} = 0.4\ V$</td>
<td>0.1</td>
<td></td>
<td>$\mu A$</td>
</tr>
<tr>
<td>$I_{CEX}$</td>
<td>Collector Cut-Off Current</td>
<td>$V_{CE} = 35\ V, V_{EB} = 0.4\ V$</td>
<td>0.1</td>
<td></td>
<td>$\mu A$</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC Current Gain</td>
<td>$I_C = 0.1\ mA, V_{CE} = 1.0\ V$</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 1.0\ mA, V_{CE} = 1.0\ V$</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 10\ mA, V_{CE} = 1.0\ V$</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 150\ mA, V_{CE} = 1.0\ V$</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500\ mA, V_{CE} = 2.0\ V$</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE(sat)}$</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>$I_C = 150\ mA, I_B = 15\ mA$</td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500\ mA, I_B = 50\ mA$</td>
<td>0.75</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE(sat)}$</td>
<td>Base-Emitter Saturation Voltage</td>
<td>$I_C = 150\ mA, I_B = 15\ mA$</td>
<td>0.75</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C = 500\ mA, I_B = 50\ mA$</td>
<td>1.20</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$f_T$</td>
<td>Current Gain - Bandwidth Product</td>
<td>$I_C = 20\ mA, V_{CE} = 10\ V, f = 100\ MHz$</td>
<td>250</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{cb}$</td>
<td>Collector-Base Capacitance</td>
<td>$V_{CB} = 5.0\ V, I_E = 0$, $f = 140\ kHz$</td>
<td>6.5</td>
<td></td>
<td>pF</td>
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<tr>
<td>$C_{eb}$</td>
<td>Emitter-Base Capacitance</td>
<td>$V_{BE} = 0.5\ V, I_C = 0$, $f = 140\ kHz$</td>
<td>30</td>
<td></td>
<td>pF</td>
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<tr>
<td>$h_{ie}$</td>
<td>Input Impedance</td>
<td>$I_C = 1.0\ mA, V_{CE} = 10\ V, f = 1.0\ kHz$</td>
<td>1.0</td>
<td>15.0</td>
<td>k$\Omega$</td>
</tr>
<tr>
<td>$h_{re}$</td>
<td>Voltage Feedback Ratio</td>
<td>$I_C = 1.0\ mA, V_{CE} = 10\ V, f = 1.0\ kHz$</td>
<td>0.1</td>
<td>8.0</td>
<td>x$10^{-4}$</td>
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<tr>
<td>$h_{fe}$</td>
<td>Small-Signal Current Gain</td>
<td>$I_C = 1.0\ mA, V_{CE} = 10\ V, f = 1.0\ kHz$</td>
<td>40</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>$h_{oe}$</td>
<td>Output Admittance</td>
<td>$I_C = 1.0\ mA, V_{CE} = 10\ V, f = 1.0\ kHz$</td>
<td>1.0</td>
<td>30</td>
<td>$\mu$hmhos</td>
</tr>
<tr>
<td>$t_d$</td>
<td>Delay Time</td>
<td>$V_{CC} = 30\ V, V_{EB} = 2\ V$, $I_C = 150\ mA, I_{B1} = 15\ mA$</td>
<td>15</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_r$</td>
<td>Rise Time</td>
<td>$V_{CC} = 30\ V, I_C = 150\ mA, I_{B1} = I_{B2} = 15\ mA$</td>
<td>20</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_s$</td>
<td>Storage Time</td>
<td>$V_{CC} = 30\ V, I_C = 150\ mA, I_{B1} = I_{B2} = 15\ mA$</td>
<td>225</td>
<td></td>
<td>ns</td>
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<tr>
<td>$t_f$</td>
<td>Fall Time</td>
<td>$V_{CC} = 30\ V, I_C = 150\ mA, I_{B1} = I_{B2} = 15\ mA$</td>
<td>30</td>
<td></td>
<td>ns</td>
</tr>
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</table>

**Note:**

5. Pulse test: pulse width $\leq 300\ \mu s$, duty cycle $\leq 2.0\%$. 

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Typical Performance Characteristics

Figure 3. Typical Pulsed Current Gain vs. Collector Current

Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

Figure 5. Base-Emitter Saturation Voltage vs. Collector Current

Figure 6. Base-Emitter On Voltage vs. Collector Current

Figure 7. Collector Cut-Off Current vs. Ambient Temperature

Figure 8. Emitter Transition and Output Capacitance vs. Reverse Bias Voltage
Typical Performance Characteristics (Continued)

Figure 9. Turn-On and Turn-Off Times vs. Collector Current

Figure 10. Switching Times vs. Collector Current

Figure 11. Power Dissipation vs. Ambient Temperature

Figure 12. Common Emitter Characteristics

Figure 13. Common Emitter Characteristics

Figure 14. Common Emitter Characteristics
Figure 15. 3-Lead, TO-92, JEDEC TO-92 Compliant Straight Lead Configuration, Bulk Type
Figure 16. 3-Lead, TO-92, Molded, 0.2 In Line Spacing Lead Form, Ammo, Tape and Reel Type

NOTES: UNLESS OTHERWISE SPECIFIED
A. DRAWING CONFORMS TO JEDC MS-013, VARIATION AC.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5M-2009.
D. DRAWING FILENAME: MKT-ZA03REV3.
E. FAIRCHILD SEMICONDUCTOR.
Figure 17. 3-LEAD, SOT23, JEDEC TO-236, LOW PROFILE

Notes: Unless otherwise specified
A) Reference JEDEC registration TO-236, Variation AB, issue H.
B) All dimensions are in millimeters.
C) Dimensions are inclusive of burrs, mold flash and tie bar extrusions.
E) Drawing file name: MA03DREV10
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<th>Datasheet Identification</th>
<th>Product Status</th>
<th>Definition</th>
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<td>Advance Information</td>
<td>Formative / In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
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<tr>
<td>Preliminary</td>
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*Rev. 172*