FJPF2145
ESBC™ Rated NPN Power Transistor

ESBC Features (FDC655 MOSFET)

<table>
<thead>
<tr>
<th>V_{CS(ON)}</th>
<th>I_C</th>
<th>Equiv. R_{CS(ON)}^{(1)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21 V</td>
<td>2 A</td>
<td>0.105 Ω</td>
</tr>
</tbody>
</table>

- Low Equivalent On Resistance
- Very Fast Switch: 150 kHz
- Wide RBSOA: Up to 1100 V
- Avalanche Rated
- Low Driving Capacitance, no Miller Capacitance
- Low Switching Losses
- Reliable HV Switch: No False Triggering due to High dv/dt Transients

Applications

- High-Voltage, High-Speed Power Switches
- Emitter-Switched Bipolar/MOSFET Cascode (ESBC™)
- Smart Meters, Smart Breakers, SMPS, HV Industrial Power Supplies
- Motor Drivers and Ignition Drivers

Description

The FJPF2145 is a low-cost, high-performance power switch designed to provide the best performance when used in an ESBC™ configuration in applications such as: power supplies, motor drivers, smart grid, or ignition switches. The power switch is designed to operate up to 1100 volts and up to 5 amps, while providing exceptionally low on-resistance and very low switching losses.

The ESBC™ switch can be driven using off-the-shelf power supply controllers or drivers. The ESBC™ MOSFET is a low-voltage, low-cost, surface-mount device that combines low-input capacitance and fast switching. The ESBC™ configuration further minimizes the required driving power because it does not have Miller capacitance.

The FJPF2145 provides exceptional reliability and a large operating range due to its square reverse-bias-safe-operating-area (RBSOA) and rugged design. The device is avalanche rated and has no parasitic transistors, so is not prone to static dv/dt failures.

The power switch is manufactured using a dedicated high-voltage bipolar process and is packaged in a high-voltage TO-220F package.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Marking</th>
<th>Package</th>
<th>Packing Method</th>
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<tbody>
<tr>
<td>FJPF2145TU</td>
<td>J2145</td>
<td>TO-220F</td>
<td>TUBE</td>
</tr>
</tbody>
</table>

Notes:
1. Figure of Merit.
2. Other Fairchild MOSFETs can be used in this ESBC application.
Absolute Maximum Ratings

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 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_{CBO}</td>
<td>Collector-Base Voltage</td>
<td>1100</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>Collector-Emitter Voltage</td>
<td>800</td>
<td>V</td>
</tr>
<tr>
<td>V_{EBO}</td>
<td>Emitter-Base Voltage</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>Collector Current (DC)</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>I_B</td>
<td>Base Current</td>
<td>1.5</td>
<td>A</td>
</tr>
<tr>
<td>P_C</td>
<td>Collector Dissipation (T_C = 25°C)</td>
<td>40</td>
<td>W</td>
</tr>
<tr>
<td>T_J</td>
<td>Operating and Junction Temperature Range</td>
<td>-55 to +125 °C</td>
<td></td>
</tr>
<tr>
<td>T_{STG}</td>
<td>Storage Temperature Range</td>
<td>-55 to +150 °C</td>
<td></td>
</tr>
<tr>
<td>EAR(4)</td>
<td>Avalanche Energy (T_J = 25°C, 1.2 mH)</td>
<td>15</td>
<td>mJ</td>
</tr>
</tbody>
</table>

Notes:
3. Pulse test is pulse width ≤ 5 ms, duty cycle ≤ 10%.
4. Lab characterization data only for reference.

Thermal Characteristics

Values are at TA = 25°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{jc}</td>
<td>Thermal Resistance, Junction to Case</td>
<td>3.125</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{ja}</td>
<td>Thermal Resistance, Junction to Ambient</td>
<td>70.44</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

Electrical Characteristics

Values are at TA = 25°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV_{CBO}</td>
<td>Collector-Base Breakdown Voltage</td>
<td>I_C = 1 mA, I_E = 0</td>
<td>1100</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>BV_{CEO}</td>
<td>Collector-Emitter Breakdown Voltage</td>
<td>I_C = 5 mA, I_B = 0</td>
<td>800</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>BV_{EBO}</td>
<td>Emitter-Base Breakdown Voltage</td>
<td>I_E = 1 mA, I_C = 0</td>
<td>7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>I_{CBO}</td>
<td>Collector Cut-off Current</td>
<td>V_CB = 800 V, I_E = 0</td>
<td>10</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>Emitter Cut-off Current</td>
<td>V_CB = 5 V, I_C = 0</td>
<td>10</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h_{FE1}</td>
<td>DC Current Gain</td>
<td>V_CE = 5 V, I_C = 0.2 A</td>
<td>20</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h_{FE2}</td>
<td></td>
<td>V_CE = 5 V, I_C = 1 A</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>V_{CE(sat)}</td>
<td>Collector-Emitter Saturation Voltage</td>
<td>I_C = 0.25 A, I_B = 0.05 A</td>
<td>0.051</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 0.5 A, I_B = 0.167 A</td>
<td>0.055</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 1 A, I_B = 0.33 A</td>
<td>0.085</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 1.5 A, I_B = 0.3 A</td>
<td>0.159</td>
<td>2.000</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_{BE(sat)}</td>
<td>Base-Emitter Saturation Voltage</td>
<td>I_C = 500 mA, I_B = 50 mA</td>
<td>0.756</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>I_C = 1.5 A, I_B = 0.3 A</td>
<td>0.840</td>
<td>1.500</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_C = 2 A, I_B = 0.4 A</td>
<td>0.863</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>C_{IB}</td>
<td>Input Capacitance</td>
<td>V_{EB} = 5 V, I_C = 0, f = 1 MHz</td>
<td>1.618</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>C_{DB}</td>
<td>Output Capacitance</td>
<td>V_CB = 200 V, I_E = 0, f = 1 MHz</td>
<td>11.39</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>f_T</td>
<td>Current Gain Bandwidth Product</td>
<td>V_CE = 10 V, I_C = 0.2 A</td>
<td>15</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
</tbody>
</table>

Note:
5. Pulse test is pulse width ≤ 5 ms, duty cycle ≤ 10%.
ESBC-Configured Electrical Characteristics\(^{(6)}\)

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(f_T)</td>
<td>Current Gain Bandwidth Product</td>
<td>(I_C = 0.1\ A, V_{CE} = 10\ V)</td>
<td>28.40</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{tf})</td>
<td>Inductive Current Fall Time</td>
<td></td>
<td>95</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_s)</td>
<td>Inductive Storage Time</td>
<td>(V_{CC} = 100\ V, V_{GS} = 10\ V, R_G = 4.7\ \Omega)</td>
<td>0.13</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{tf})</td>
<td>Inductive Voltage Fall Time</td>
<td>(V_{Clamp} = 500\ V, I_C = 0.5\ A, I_B = 0.05\ A, h_{FE} = 10, L_C = 166\ \mu H, SRF = 684\ kHz)</td>
<td>135</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{tr})</td>
<td>Inductive Voltage Rise Time</td>
<td></td>
<td>80</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_c)</td>
<td>Inductive Crossover Time</td>
<td></td>
<td>115</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{tf})</td>
<td>Inductive Current Fall Time</td>
<td></td>
<td>50</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_s)</td>
<td>Inductive Storage Time</td>
<td>(V_{CC} = 100\ V, V_{GS} = 10\ V, R_G = 47\ \Omega)</td>
<td>0.34</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{tf})</td>
<td>Inductive Voltage Fall Time</td>
<td>(V_{Clamp} = 500\ V, I_C = 1\ A, I_B = 0.2\ A, h_{FE} = 5, L_C = 166\ \mu H, SRF = 684\ kHz)</td>
<td>150</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{tr})</td>
<td>Inductive Voltage Rise Time</td>
<td></td>
<td>60</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_c)</td>
<td>Inductive Crossover Time</td>
<td></td>
<td>95</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{CSW})</td>
<td>Maximum Collector-Source Voltage at Turn-off without Snubber</td>
<td>(h_{FE} = 5, I_C = 2\ A)</td>
<td>1100</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(I_{GS(OS)})</td>
<td>Gate-Source Leakage Current</td>
<td>(V_{GS} = \pm 20\ V)</td>
<td>1</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{CS(ON)})</td>
<td>Collector-Source On Voltage</td>
<td>(V_{GS} = 10\ V, I_C = 2\ A, I_B = 0.67\ A, h_{FE} = 3)</td>
<td>0.209</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{GS} = 10\ V, I_C = 1\ A, I_B = 0.33\ A, h_{FE} = 3)</td>
<td>0.114</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{GS} = 10\ V, I_C = 0.5\ A, I_B = 0.17\ A, h_{FE} = 3)</td>
<td>0.068</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{GS} = 10\ V, I_C = 0.3\ A, I_B = 0.06\ A, h_{FE} = 5)</td>
<td>0.062</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{GS(th)})</td>
<td>Gate Threshold Voltage</td>
<td>(V_{BS} = V_{GS}, I_B = 250\ \mu A)</td>
<td>1.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C_{iss})</td>
<td>Input Capacitance ((V_{GS} = V_{CB} = 0))</td>
<td>(V_{CS} = 25\ V, f = 1\ MHz)</td>
<td>470</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Q_{GS(tot)})</td>
<td>Gate-Source Charge (V_{CB} = 0)</td>
<td>(V_{GS} = 10\ V, I_C = 6.3\ A, V_{CS} = 25\ V)</td>
<td>9</td>
<td>nC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R_{DS(ON)})</td>
<td>Static Drain-to-Source On Resistance</td>
<td>(V_{GS} = 10\ V, I_D = 6.3\ A)</td>
<td>21</td>
<td>m\Omega</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{GS} = 4.5\ V, I_D = 5.5\ A)</td>
<td>26</td>
<td>m\Omega</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{GS} = 10\ V, I_D = 6.3\ A, T_J = 125^\circ C)</td>
<td>30</td>
<td>m\Omega</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

6. A typical FDC655 MOSFET was used for the specifications above. Values could vary if other Fairchild MOSFETs are used.
Typical Performance Characteristics

Figure 4. Static Characteristics

Figure 5. DC Current Gain

Figure 6. Collector-Emitter Saturation Voltage
   \( h_{FE} = 3 \)

Figure 7. Collector-Emitter Saturation Voltage
   \( h_{FE} = 5 \)

Figure 8. Collector-Emitter Saturation Voltage
   \( h_{FE} = 10 \)

Figure 9. Collector-Emitter Saturation Voltage
   \( h_{FE} = 20 \)
Figure 10. Typical Collector Saturation Voltage

Figure 11. Capacitance

Figure 12. Inductive Load Collector Current Fall - Time (t_f)

Figure 13. Inductive Load Collector Current Storage - Time (t_stg)

Figure 14. Inductive Load Collector Voltage Fall - Time (t_f)

Figure 15. Inductive Load Collector Voltage Rise - Time (t_r)
Typical Performance Characteristics (Continued)

Figure 16. Inductive Load Collector Current / Voltage Crossover (t_c)

Figure 17. BJT RBSOA

Figure 18. ESBC RBSOA

Figure 19. Crossover FBSOA

Figure 20. Power Derating
Test Circuits

Figure 21. Test Circuit For Inductive Load and Reverse Bias Safe Operating

Figure 22. Energy Rating Test Circuit

Figure 23. \( f_T \) Measurement

Figure 24. FBSOA
Test Circuits (Continued)

Functional Test Waveforms

Figure 25. Simplified Saturated Switch Driver Circuit

Figure 26. Crossover Time Measurement

Figure 27. Saturated Switching Waveform
Functional Test Waveforms (Continued)

Figure 28. Storage Time - Common Emitter Base
Turn Off (Ib2) to IC Fall - time

Figure 29. Storage Time - ESBC FET Gate (off) to IC
Fall - time
Very Wide Input Voltage Range Supply

100–1000V DC

100Watts Quasi Resonant 125kHz

24V@3.3A

1000μF 35V

220V ± 2%

12–14Volts

12Vz

2.5A limit

* Make short as possible

Figure 30. 30 W; Secondary-Side Regulation: 3 Capacitor Input; Quasi Resonant

Driving ESBC Switches

Figure 31. VCC Derived

Figure 32. Vbias Supply Derived

Figure 33. Proportional Drive
Physical Dimensions

Figure 34. TO-220, MOLDED, 3-LEAD, FULL PACK EIAJ SC91, STRAIGHT LEAD

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http://www.fairchildsemi.com/dwg/TO/TO220M03.pdf
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- CorePOWER™
- CROSSVOLT™
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- DEUXPEED®
- Dual Cool™
- EcoSPARK®
- EfficientMax™
- ESBC™
- FACT®
- FACT Quiet Series™
- FACT™
- FAST®
- FastCore™
- FETBench
- FPS™
- F-PFSS™
- FRFET®
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- OFET™
- QS™
- Quiet Series™
- RapidConfigure™
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- SmartMax™
- SMART START™
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- SPM™
- STEALTH™
- SuperFET®
- SuperSOT™-3
- SuperSOT™-6
- SuperSOT™-8
- SupreMOS®
- SyncFET™
- Sync-Lock™
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- TinyBuck™
- TinyCalc™
- TinyLogic™
- TINYOPTO™
- TinyPower™
- TinyPWM™
- TinyWire™
- TranSiC™
- Trifault Detect™
- TRUECURRENT™
- µSerDes™
- UHC™
- Ultra FRFET™
- UniFET™
- VX™
- VisualMax™
- VoltagePlus™
- XS™

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2. A critical component in 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.

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**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 / In Design</td>
<td>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>Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.</td>
</tr>
<tr>
<td>No Identification Needed</td>
<td>Full Production</td>
<td>Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.</td>
</tr>
<tr>
<td>Obsolete</td>
<td>Not In Production</td>
<td>Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.</td>
</tr>
</tbody>
</table>

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