FGH40N60UFD
600V, 40A Field Stop IGBT

Features
• High current capability
• Low saturation voltage: $V_{CE(sat)} = 1.8V$ @ $I_C = 40A$
• High input impedance
• Fast switching
• RoHS compliant

Applications
• Induction Heating, UPS, SMPS, PFC

General Description
Using Novel Field Stop IGBT Technology, Fairchild’s new series of Field Stop IGBTs offer the optimum performance for Induction Heating, UPS, SMPS and PFC applications where low conduction and switching losses are essential.

Absolute Maximum Ratings

<table>
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<tr>
<th>Symbol</th>
<th>Description</th>
<th>Ratings</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>$V_{CES}$</td>
<td>Collector to Emitter Voltage</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GES}$</td>
<td>Gate to Emitter Voltage</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Collector Current @ $T_C = 25^\circ C$</td>
<td>80</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CM (1)}$</td>
<td>Pulsed Collector Current @ $T_C = 100^\circ C$</td>
<td>120</td>
<td>A</td>
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<tr>
<td>$I_F$</td>
<td>Diode Continuous Forward Current @ $T_C = 25^\circ C$</td>
<td>40</td>
<td>A</td>
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<tr>
<td>$I_{FM}$</td>
<td>Diode Maximum Forward Current</td>
<td>80</td>
<td>A</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Maximum Power Dissipation @ $T_C = 25^\circ C$</td>
<td>290</td>
<td>W</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Operating Junction Temperature</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature Range</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_L$</td>
<td>Maximum Lead Temp. for soldering</td>
<td>300</td>
<td>°C</td>
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</table>

Notes:
1: Repetitive rating: Pulse width limited by max. junction temperature

Thermal Characteristics

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<tr>
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<th>Parameter</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>$R_{JUC(IGBT)}$</td>
<td>Thermal Resistance, Junction to Case</td>
<td>-</td>
<td>0.43</td>
<td>°C/W</td>
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<tr>
<td>$R_{JUC(Diode)}$</td>
<td>Thermal Resistance, Junction to Case</td>
<td>-</td>
<td>1.45</td>
<td>°C/W</td>
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<tr>
<td>$R_{JUA}$</td>
<td>Thermal Resistance, Junction to Ambient</td>
<td>-</td>
<td>40</td>
<td>°C/W</td>
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### Package Marking and Ordering Information

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<th>Device</th>
<th>Package</th>
<th>Packaging Type</th>
<th>Qty per Tube</th>
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<td>FGH40N60UFDTU</td>
<td>TO-247</td>
<td>Tube</td>
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### Electrical Characteristics of the IGBT \( T_J = 25^\circ C \) unless otherwise noted

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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tr>
<td>( B_{V_{CES}} )</td>
<td>Collector to Emitter Breakdown Voltage</td>
<td>( V_{GE} = 0V, I_C = 250\mu A )</td>
<td>600</td>
<td>-</td>
<td>-</td>
<td>V</td>
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<tr>
<td>( \Delta B_{V_{CES}} )</td>
<td>Temperature Coefficient of Breakdown Voltage</td>
<td>( V_{GE} = 0V, I_C = 250\mu A )</td>
<td>-</td>
<td>0.6</td>
<td>-</td>
<td>V/°C</td>
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<td>( I_{CES} )</td>
<td>Collector Cut-Off Current</td>
<td>( V_{CE} = V_{CES}, V_{GE} = 0V )</td>
<td>-</td>
<td>-</td>
<td>250</td>
<td>μA</td>
</tr>
<tr>
<td>( I_{GES} )</td>
<td>G-E Leakage Current</td>
<td>( V_{GE} = V_{GES}, V_{CE} = 0V )</td>
<td>-</td>
<td>-</td>
<td>±400</td>
<td>nA</td>
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<table>
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<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tr>
<td>( V_{GE(th)} )</td>
<td>G-E Threshold Voltage</td>
<td>( I_C = 250\mu A, V_{GE} = V_{GE} )</td>
<td>4.0</td>
<td>5.0</td>
<td>6.5</td>
<td>V</td>
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<tr>
<td>( V_{CE(sat)} )</td>
<td>Collector to Emitter Saturation Voltage</td>
<td>( I_C = 20A, V_{GE} = 15V )</td>
<td>-</td>
<td>1.8</td>
<td>2.4</td>
<td>V</td>
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<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tr>
<td>( C_{ges} )</td>
<td>Input Capacitance</td>
<td>( V_{CE} = 30V, V_{GE} = 0V, f = 1MHz )</td>
<td>-</td>
<td>2110</td>
<td>-</td>
<td>pF</td>
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<tr>
<td>( C_{ces} )</td>
<td>Output Capacitance</td>
<td>( V_{CE} = 30V, V_{GE} = 0V, f = 1MHz )</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>pF</td>
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<tr>
<td>( C_{res} )</td>
<td>Reverse Transfer Capacitance</td>
<td>( V_{CE} = 30V, V_{GE} = 0V, f = 1MHz )</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>pF</td>
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### Switching Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tbody>
<tr>
<td>( t_{on} )</td>
<td>Turn-On Delay Time</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>24</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( tr )</td>
<td>Rise Time</td>
<td>( T_J = 25^\circ C )</td>
<td>-</td>
<td>44</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( td'(off) )</td>
<td>Turn-Off Delay Time</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>112</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( tf )</td>
<td>Fall Time</td>
<td>( T_J = 25^\circ C )</td>
<td>-</td>
<td>30</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td>( E_{on} )</td>
<td>Turn-On Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>1.19</td>
<td>-</td>
<td>mJ</td>
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<tr>
<td>( E_{off} )</td>
<td>Turn-Off Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>0.46</td>
<td>-</td>
<td>mJ</td>
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<tr>
<td>( E_{ts} )</td>
<td>Total Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>1.65</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>( t_{on} )</td>
<td>Turn-On Delay Time</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>24</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( tr )</td>
<td>Rise Time</td>
<td>( T_J = 125^\circ C )</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( td'(off) )</td>
<td>Turn-Off Delay Time</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>120</td>
<td>-</td>
<td>ns</td>
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<tr>
<td>( tf )</td>
<td>Fall Time</td>
<td>( T_J = 125^\circ C )</td>
<td>-</td>
<td>40</td>
<td>-</td>
<td>ns</td>
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<tr>
<td>( E_{on} )</td>
<td>Turn-On Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
<td>mJ</td>
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<td>( E_{off} )</td>
<td>Turn-Off Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>0.69</td>
<td>-</td>
<td>mJ</td>
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<tr>
<td>( E_{ts} )</td>
<td>Total Switching Loss</td>
<td>( V_{CC} = 400V, I_C = 40A, R_C = 10\Omega, V_{GE} = 15V, )</td>
<td>-</td>
<td>1.89</td>
<td>-</td>
<td>mJ</td>
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<tr>
<td>( Q_g )</td>
<td>Total Gate Charge</td>
<td>( V_{CE} = 400V, I_C = 40A, V_{GE} = 15V )</td>
<td>-</td>
<td>120</td>
<td>-</td>
<td>nC</td>
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<tr>
<td>( Q_{ge} )</td>
<td>Gate to Emitter Charge</td>
<td>( V_{CE} = 400V, I_C = 40A, V_{GE} = 15V )</td>
<td>-</td>
<td>14</td>
<td>-</td>
<td>nC</td>
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<tr>
<td>( Q_{gc} )</td>
<td>Gate to Collector Charge</td>
<td>( V_{CE} = 400V, I_C = 40A, V_{GE} = 15V )</td>
<td>-</td>
<td>58</td>
<td>-</td>
<td>nC</td>
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Electrical Characteristics of the Diode  \( T_C = 25^\circ C \) unless otherwise noted

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<th>Symbol</th>
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<th>Typ.</th>
<th>Max</th>
<th>Units</th>
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<tr>
<td>( V_{FM} )</td>
<td>Diode Forward Voltage</td>
<td>( I_F = 20A )</td>
<td>( T_C = 25^\circ C )</td>
<td>-</td>
<td>1.95</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( T_C = 125^\circ C )</td>
<td>-</td>
<td>1.85</td>
<td>-</td>
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<tr>
<td>( t_{rr} )</td>
<td>Diode Reverse Recovery Time</td>
<td>( I_{ES} = 20A, \frac{dI_{ES}}{dt} = 200A/\mu s )</td>
<td>( T_C = 25^\circ C )</td>
<td>-</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( T_C = 125^\circ C )</td>
<td>-</td>
<td>140</td>
<td>-</td>
</tr>
<tr>
<td>( Q_{rr} )</td>
<td>Diode Reverse Recovery Charge</td>
<td>( I_{ES} = 20A, \frac{dI_{ES}}{dt} = 200A/\mu s )</td>
<td>( T_C = 25^\circ C )</td>
<td>-</td>
<td>75</td>
<td>-</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>( T_C = 125^\circ C )</td>
<td>-</td>
<td>375</td>
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</table>
Typical Performance Characteristics

Figure 1. Typical Output Characteristics

Figure 2. Typical Output Characteristics

Figure 3. Typical Saturation Voltage Characteristics

Figure 4. Transfer Characteristics

Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

Figure 6. Saturation Voltage vs. V_{GE}
Typical Performance Characteristics

Figure 7. Saturation Voltage vs. $V_{GE}$

Figure 8. Saturation Voltage vs. $V_{GE}$

Figure 9. Capacitance Characteristics

Figure 10. Gate charge Characteristics

Figure 11. SOA Characteristics

Figure 12. Turn-on Characteristics vs. Gate Resistance
Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Gate Resistance

Common Emitter
V_{CE} = 400V, V_{GE} = 15V
I_{C} = 40A
T_{C} = 25°C ...
T_{C} = 125°C ...

Figure 14. Turn-on Characteristics vs. Collector Current

Common Emitter
V_{CE} = 400V, V_{GE} = 15V
I_{C} = 40A
T_{C} = 25°C ...
T_{C} = 125°C ...

Figure 15. Turn-off Characteristics vs. Collector Current

Common Emitter
V_{GE} = 15V, R_{G} = 10Ω
T_{C} = 25°C ...
T_{C} = 125°C ...

Figure 16. Switching Loss vs. Gate Resistance

Common Emitter
V_{CE} = 400V, V_{GE} = 15V
I_{C} = 40A
T_{C} = 25°C ...
T_{C} = 125°C ...

Figure 17. Switching Loss vs. Collector Current

Common Emitter
V_{GE} = 15V, R_{G} = 10Ω
T_{C} = 25°C ...
T_{C} = 125°C ...

Figure 18. Turn-off Switching SOA Characteristics

Common Emitter
V_{GE} = 15V, T_{C} = 125°C
Typical Performance Characteristics

Figure 19. Forward Characteristics

Figure 20. Typical Reverse Current vs. Reverse Voltage

Figure 21. Stored Charge

Figure 22. Reverse Recovery Time

Figure 23. Transient Thermal Impedance of IGBT

Forward Voltage, $V_f$ [V]

Forward Current, $I_f$ [A]

Reverse Voltage, $V_r$ [V]

Reverse Current, $I_r$ [mA]

Forward Current, $I_F$ [A]

Reverse Recovery Time, $t_r$ [µs]

Rectangular Pulse Duration [sec]

Peak $T_J = P_{DM} \times Z_{THJC} + T_C$

Thermal Response $Z_{THJC}$

Duty Factor, $D = t_1/t_2$

Single pulse

Duty Factor, $D = t_1/t_2$

Peak $T_J = P_{DM} \times Z_{THJC} + T_C$
TO-247AB (FKS PKG CODE 001)

Dimensions in Millimeters
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- Current Transfer Logic™
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PRODUCT STATUS DEFINITIONS

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<thead>
<tr>
<th>Definition of Terms</th>
<th>Product Status</th>
<th>Definition</th>
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<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>
<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>
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<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>
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<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>
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