Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor’s system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.
FGH40N60SMDF_F085
600 V, 40 A Field Stop IGBT

Features

- Maximum Junction Temperature: \( T_J = 175°C \)
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: \( V_{CE(sat)} = 1.7 \text{ V(Typ.)} \) @ \( I_C = 40 \text{ A} \)
- High Input Impedance
- Fast Switching: \( E_{OFF} = 6.25 \text{ uJ/A} \)
- Tightened Parameter Distribution
- RoHS Compliant
- Qualified to Automotive Requirements of AEC-Q101

Applications

- Automotive chargers, Converters, High Voltage Auxiliaries
- Inverters, PFC, UPS

General Description

Using Novel Field Stop IGBT Technology, Fairchild’s new series of Field Stop IGBTs offer the optimum performance for Automotive Chargers, Inverter, and other applications where low conduction and switching losses are essential.

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</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>( \pm 20 )</td>
<td>V</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current @ ( T_C = 25°C )</td>
<td>80</td>
<td>A</td>
</tr>
<tr>
<td>( I_C )</td>
<td>Collector Current @ ( T_C = 100°C )</td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td>( I_{CM(1)} )</td>
<td>Pulsed Collector Current @ ( T_C = 25°C )</td>
<td>120</td>
<td>A</td>
</tr>
<tr>
<td>( P_D )</td>
<td>Maximum Power Dissipation @ ( T_C = 25°C )</td>
<td>349</td>
<td>W</td>
</tr>
<tr>
<td>( P_D )</td>
<td>Maximum Power Dissipation @ ( T_C = 100°C )</td>
<td>174</td>
<td>W</td>
</tr>
<tr>
<td>( T_J )</td>
<td>Operating Junction Temperature</td>
<td>-55 to +175</td>
<td>°C</td>
</tr>
<tr>
<td>( T_{stg} )</td>
<td>Storage Temperature Range</td>
<td>-55 to +175</td>
<td>°C</td>
</tr>
<tr>
<td>( T_L )</td>
<td>Maximum Lead Temp. for soldering Purposes, 1/8” from case for 5 seconds</td>
<td>300</td>
<td>°C</td>
</tr>
</tbody>
</table>

Notes:

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

Thermal Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Typ.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{JC(IGBT)} )</td>
<td>Thermal Resistance, Junction to Case</td>
<td>0.43</td>
<td>°C/W</td>
</tr>
<tr>
<td>( R_{JC(Diode)} )</td>
<td>Thermal Resistance, Junction to Case</td>
<td>1.45</td>
<td>°C/W</td>
</tr>
<tr>
<td>( R_{JJA} )</td>
<td>Thermal Resistance, Junction to Ambient</td>
<td>40</td>
<td>°C/W</td>
</tr>
</tbody>
</table>
### Package Marking and Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Top Mark</th>
<th>Package</th>
<th>Packing Method</th>
<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGH40N60SMDF_F085</td>
<td>FGH40N60SMDF</td>
<td>TO-247</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>30</td>
</tr>
</tbody>
</table>

### Electrical Characteristics of the IGBT \(T_C = 25°C\) unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Off Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(BV_{CES})</td>
<td>Collector to Emitter Breakdown Voltage</td>
<td>(V_{GE} = 0\ V, I_C = 250\ \mu A)</td>
<td>600</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(\Delta BV_{CES}) / (\Delta T_J)</td>
<td>Temperature Coefficient of Breakdown Voltage</td>
<td>(V_{GE} = 0\ V, I_C = 250\ \mu A)</td>
<td></td>
<td>0.6</td>
<td></td>
<td>V/°C</td>
</tr>
<tr>
<td>(I_{CES})</td>
<td>Collector Cut-Off Current</td>
<td>(V_{CE} = V_{CES}, V_{GE} = 0\ V)</td>
<td></td>
<td></td>
<td>250</td>
<td>\mu A</td>
</tr>
<tr>
<td>(I_{GES})</td>
<td>G-E Leakage Current</td>
<td>(V_{GE} = V_{GES}, V_{CE} = 0\ V)</td>
<td></td>
<td></td>
<td>±400</td>
<td>nA</td>
</tr>
<tr>
<td><strong>On Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{GE(th)})</td>
<td>G-E Threshold Voltage</td>
<td>(I_C = 250\ \mu A, V_{CE} = V_{GE})</td>
<td>3.5</td>
<td>4.8</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>(V_{CE(sat)})</td>
<td>Collector to Emitter Saturation Voltage</td>
<td>(I_C = 40\ A, V_{GE} = 15\ V)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(I_{CES})</td>
<td>Collector Cut-Off Current</td>
<td>(I_C = 40\ A, V_{GE} = 15\ V, T_C = 150°C)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td><strong>Dynamic Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C_{ies})</td>
<td>Input Capacitance</td>
<td>(V_{CE} = 30\ V, V_{GE} = 0\ V, f = 1\ MHz)</td>
<td>-</td>
<td>1840</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>(C_{oes})</td>
<td>Output Capacitance</td>
<td>(V_{CE} = 30\ V, V_{GE} = 0\ V, f = 1\ MHz)</td>
<td>-</td>
<td>180</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>(C_{res})</td>
<td>Reverse Transfer Capacitance</td>
<td>(V_{CE} = 30\ V, V_{GE} = 0\ V, f = 1\ MHz)</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>pF</td>
</tr>
</tbody>
</table>

### Switching Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(t_{d(on)})</td>
<td>Turn-On Delay Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{r})</td>
<td>Rise Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{d(off)})</td>
<td>Turn-Off Delay Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>110</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{f})</td>
<td>Fall Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>11</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
<td>(E_{on})</td>
<td>Turn-On Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>1.3</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(E_{off})</td>
<td>Turn-Off Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>0.25</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(E_{bs})</td>
<td>Total Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 25°C)</td>
<td>-</td>
<td>1.55</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(t_{d(on)})</td>
<td>Turn-On Delay Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{r})</td>
<td>Rise Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>32</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{d(off)})</td>
<td>Turn-Off Delay Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>112</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{f})</td>
<td>Fall Time</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>11</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
<td>(E_{on})</td>
<td>Turn-On Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>2.05</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(E_{off})</td>
<td>Turn-Off Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>0.48</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(E_{bs})</td>
<td>Total Switching Loss</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, R_G = 6\ \Omega, V_{GE} = 15\ V, Inductive Load, T_C = 125°C)</td>
<td>-</td>
<td>2.53</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>(Q_{g})</td>
<td>Total Gate Charge</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, V_{GE} = 15\ V)</td>
<td>-</td>
<td>122</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>(Q_{ge})</td>
<td>Gate to Emitter Charge</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, V_{GE} = 15\ V)</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>(Q_{gc})</td>
<td>Gate to Collector Charge</td>
<td>(V_{CC} = 400\ V, I_C = 40\ A, V_{GE} = 15\ V)</td>
<td>-</td>
<td>59</td>
<td>-</td>
<td>nC</td>
</tr>
</tbody>
</table>
### Electrical Characteristics of the Diode

$T_C = 25^\circ C$ unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{FM}$</td>
<td>Diode Forward Voltage</td>
<td>$I_F = 20$ A</td>
<td>$T_C = 25^\circ C$</td>
<td>-</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_C = 150^\circ C$</td>
<td>-</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Diode Reverse Recovery Time</td>
<td>$I_F = 20$ A, $di_F/dt = 200$ A/μs</td>
<td>$T_C = 25^\circ C$</td>
<td>-</td>
<td>57</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_C = 125^\circ C$</td>
<td>-</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Diode Reverse Recovery Charge</td>
<td>$I_F = 20$ A, $di_F/dt = 200$ A/μs</td>
<td>$T_C = 25^\circ C$</td>
<td>-</td>
<td>164</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_C = 125^\circ C$</td>
<td>-</td>
<td>718</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Typical Performance Characteristics

Figure 1. Typical Output Characteristics

![Typical Output Characteristics](image1.png)

Figure 2. Typical Output Characteristics

![Typical Output Characteristics](image2.png)

Figure 3. Typical Saturation Voltage Characteristics

![Typical Saturation Voltage Characteristics](image3.png)

Figure 4. Transfer Characteristics

![Transfer Characteristics](image4.png)

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

![Saturation Voltage vs. Case Temperature](image5.png)

Figure 6. Saturation Voltage vs. $V_{GE}$

![Saturation Voltage vs. $V_{GE}$](image6.png)
Typical Performance Characteristics

Figure 7. Saturation Voltage vs. VGE

Figure 8. Saturation Voltage vs. VGE

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

Figure 14. Turn-on Characteristics vs. Collector Current

Figure 15. Turn-off Characteristics vs. Collector Current

Figure 16. Switching Loss vs. Gate Resistance

Figure 17. Switching Loss vs. Collector Current

Figure 18. Turn off Switching SOA Characteristics
Typical Performance Characteristics

Figure 19. Forward Characteristics

Figure 20. Reverse Current

Figure 21. Stored Charge

Figure 22. Reverse Recovery Time

Figure 23. Transient Thermal Impedance of IGBT
Figure 24. TO-247 3L - TO-247, MOLDED, 3 LEAD, JEDEC VARIATION AB

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild’s worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor’s online packaging area for the most recent package drawings:

http://www.fairchildsemi.com/package/packageDetails.html?id=PN_TO247-003
TRADEMARKS
The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

- AccuPower™
- AttitudeEngine™
- Avinda®
- AX-CAP™
- BitsiCTM
- Build It Now™
- CorePLUS™
- CorePOWER™
- CROSSVOLT™
- CTL™
- Current Transfer Logic™
- DEUXPEED™
- Dual Cool™
- EcoSPARK®
- EfficientMax™
- ESBC™
- FPS™
- F-PFS™
- FFRET™
- Global Power Resource™
- GreenBridge™
- Green FPS™
- Green FPS™ e-Series™
- Gmax™
- GTO™
- IntelliMAX™
- ISOPLANAR™
- Marking Small Speakers Sound Louder and Better™
- MegaBuck™
- MICROCOUPLER™
- MicroFET®
- Micro Pak™
- MillerDrive™
- MotionMax™
- MotionGrid™
- MTO™
- MXT™
- MVN™
- miWSaver®
- OptoHET™
- OPTOLOGIC®
- OPTOPLANAR®
- Power Supply, WebDesigner™
- PowerTrench®
- PowerXS™
- Programmable Active Droop™
- OFET™
- QS™
- Quiet Series™
- RapidConfigure™
- Saving our world, 1mW/W/kW at a time™
- SignalWise™
- SmartMax™
- SMART START™
- Solutions for Your Success™
- SPM™
- STEALTH™
- SuperFET®
- SuperSOT™-3
- SuperSOT™-6
- SuperSOT™-8
- SupreMOS®
- SyncFET™
- Sync-Lock™
- Sync-Lock™
- TinyBoost®
- Tiny Buck®
- TinyCalc™
- TinyLogic®
- TINYOPTO™
- TinyPower™
- TinyPWM™
- TinyWire™
- TransiT™
- TriFault Detect™
- TRUECURRENT™
- μSerDes™
- UHC®
- Ultra FRFET™
- UniFET™
- VCX™
- VisualMax™
- VoltagePlus™
- XS™
- Xsens™
- 仙童™

*Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER
FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. TO OBTAIN THE LATEST MOST UP-TO-DATE Datasheet AND PRODUCT INFORMATION, VISIT OUR WEBSITE AT HTTP://WWW.FAIRCHILDSEMI.COM. 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. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

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 here in:
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, and (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 a significant injury of the user.
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.

ANTI-COUNTERFEITING POLICY
Fairchild Semiconductor Corporation’s Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.Fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Counterfeiting parts experience many problems such as loss of brand reputation, substandard performance, failed application, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild’s quality standards for handing and storage and provide access to Fairchild’s full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address and warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

<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>