IGBT Fourpack Module, 50 A

FEATURES
- Trench gate field stop IGBT
- Square RBSOA
- HEXFRED® low Qrr, low switching energy
- Positive VCE(on) temperature coefficient
- Copper baseplate
- Low stray inductance design
- Designed and qualified for industrial market
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

BENEFITS
- Benchmark efficiency for SMPS appreciation in particular HF welding
- Rugged transient performance
- Low EMI, requires less snubbing
- Direct mounting to heatsink space saving
- PCB solderable terminals
- Low junction to case thermal resistance

<table>
<thead>
<tr>
<th>PRIMARY CHARACTERISTICS</th>
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<tbody>
<tr>
<td>VCES</td>
<td>1200 V</td>
</tr>
<tr>
<td>IC at TC = 66 °C</td>
<td>50 A</td>
</tr>
<tr>
<td>VCE(on) (typical)</td>
<td>2.34 V</td>
</tr>
<tr>
<td>Speed</td>
<td>8 kHz to 30 kHz</td>
</tr>
<tr>
<td>Package</td>
<td>ECONO 2</td>
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<tr>
<td>Circuit configuration</td>
<td>4 pack</td>
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<th>ABSOLUTE MAXIMUM RATINGS</th>
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<tr>
<td>Parameter</td>
<td>SYMBOL</td>
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<tr>
<td>Collector to emitter voltage</td>
<td>VCES</td>
</tr>
<tr>
<td>Continuous collector current</td>
<td>IC</td>
</tr>
<tr>
<td>Pulsed collector current, see fig. C.T.5</td>
<td>ICM</td>
</tr>
<tr>
<td>Clamped inductive load current</td>
<td>IMM</td>
</tr>
<tr>
<td>Diode continuous forward current</td>
<td>IF</td>
</tr>
<tr>
<td>Diode maximum forward current</td>
<td>IMF</td>
</tr>
<tr>
<td>Gate to emitter voltage</td>
<td>VGE</td>
</tr>
<tr>
<td>Maximum power dissipation (IGBT)</td>
<td>PO</td>
</tr>
<tr>
<td>Isolation voltage</td>
<td>VSOL</td>
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### ELECTRICAL SPECIFICATIONS ($T_J = 25 \, ^\circ\text{C}$ unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
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</thead>
<tbody>
<tr>
<td>Collector to emitter breakdown voltage</td>
<td>$B_V(\text{CES})$</td>
<td>$V_{GE} = 0 , V, I_C = 2 , mA$</td>
<td>1200</td>
<td>-</td>
<td>-</td>
<td>V</td>
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<tr>
<td>Collector to emitter voltage</td>
<td>$V_{GE(ON)}$</td>
<td>$I_C = 50 , A, V_{GE} = 15 , V$</td>
<td>-</td>
<td>2.34</td>
<td>2.80</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>$I_C = 50 , A, V_{GE} = 15 , V, T_J = 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>2.66</td>
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<tr>
<td>Gate threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td>$V_{GE} = V_{IC} = 2 , mA (25 , ^\circ\text{C} \text{ to } 125 , ^\circ\text{C})$</td>
<td>4.6</td>
<td>5.9</td>
<td>7.6</td>
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<td>Threshold voltage temperature coefficient</td>
<td>$\Delta V_{GE(th)} / \Delta T_J$</td>
<td>$V_{GE}, I_C = 2 , mA (25 , ^\circ\text{C} \text{ to } 125 , ^\circ\text{C})$</td>
<td>-13</td>
<td>-</td>
<td>-</td>
<td>mV/°C</td>
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<tr>
<td>Zero gate voltage collector current</td>
<td>$I_{CES}$</td>
<td>$V_{GE} = 0 , V, V_{CE} = 1200 , V$</td>
<td>-</td>
<td>1</td>
<td>50</td>
<td>μA</td>
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<tr>
<td>Diode forward voltage drop</td>
<td>$V_{FM}$</td>
<td>$I_F = 50 , A$</td>
<td>-</td>
<td>3.30</td>
<td>4.5</td>
<td>V</td>
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<td>$I_F = 50 , A, T_J = 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>3.60</td>
<td>-</td>
<td></td>
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<tr>
<td>Gate to emitter leakage current</td>
<td>$I_{GES}$</td>
<td>$V_{GE} = \pm 20 , V$</td>
<td>-</td>
<td>-</td>
<td>± 200</td>
<td>nA</td>
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### SWITCHING CHARACTERISTICS ($T_J = 25 \, ^\circ\text{C}$ unless otherwise noted)

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<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
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</thead>
<tbody>
<tr>
<td>Total gate charge (turn-on)</td>
<td>$Q_G$</td>
<td>$I_C = 50 , A$</td>
<td>-</td>
<td>154</td>
<td>-</td>
<td>nC</td>
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<td>Gate to emitter charge (turn-on)</td>
<td>$Q_{GE}$</td>
<td>$V_{CC} = 960 , V$</td>
<td>-</td>
<td>17</td>
<td>-</td>
<td></td>
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<tr>
<td>Gate to collector charge (turn-on)</td>
<td>$Q_{GC}$</td>
<td>$V_{GE} = 15 , V$</td>
<td>-</td>
<td>79</td>
<td>-</td>
<td></td>
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<tr>
<td>Turn-on switching loss</td>
<td>$E_{\text{on}}$</td>
<td>$I_C = 50 , A, V_{CC} = 600 , V$</td>
<td>-</td>
<td>1.17</td>
<td>-</td>
<td>mJ</td>
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<tr>
<td>Turn-off switching loss</td>
<td>$E_{\text{off}}$</td>
<td>$V_{GE} = 15 , V, R_0 \geq 4.7 , \Omega, L = 500 , \mu\text{H}$</td>
<td>-</td>
<td>1.50</td>
<td>-</td>
<td></td>
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<tr>
<td>Total switching loss</td>
<td>$E_{\text{tot}}$</td>
<td>$T_J \geq 25 , ^\circ\text{C}$</td>
<td>-</td>
<td>2.67</td>
<td>-</td>
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<tr>
<td>Turn-on delay time</td>
<td>$t_{d(on)}$</td>
<td>$I_C = 50 , A, V_{CC} = 600 , V$</td>
<td>-</td>
<td>1.58</td>
<td>-</td>
<td></td>
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<tr>
<td>Turn-off delay time</td>
<td>$t_{d(off)}$</td>
<td>$V_{GE} = 15 , V, R_0 \geq 4.7 , \Omega, L = 500 , \mu\text{H}$</td>
<td>-</td>
<td>2.52</td>
<td>-</td>
<td></td>
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<tr>
<td>Rise time</td>
<td>$t_r$</td>
<td>$I_C = 50 , A, V_{CC} = 600 , V$</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{f}$</td>
<td>$T_J \geq 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>96</td>
<td>-</td>
<td></td>
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<tr>
<td>Reverse bias safe operating area</td>
<td>RBSOA</td>
<td>$T_J \geq 150 , ^\circ\text{C}, I_C \geq 150 , A, V_{CC} \geq 800 , V, V_P \geq 1200 , V, R_0 \geq 4.7 , \Omega, V_{GE} \geq 16 , V \text{ to } 0 , V$</td>
<td>Fullsquare</td>
<td>5</td>
<td>-</td>
<td>μs</td>
</tr>
<tr>
<td>Short circuit safe operating area</td>
<td>SCSOA</td>
<td>$T_J \geq 150 , ^\circ\text{C}, V_{CC} \geq 600 , V, V_P \geq 1200 , V, R_0 \geq 10 , \Omega, V_{GE} \geq 15 , V \text{ to } 0 , V$</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>μs</td>
</tr>
<tr>
<td>Diode peak reverse recovery current</td>
<td>$I_{rr}$</td>
<td>$T_J \geq 25 , ^\circ\text{C}$</td>
<td>-</td>
<td>1.3</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_J \geq 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>2.0</td>
<td>-</td>
<td></td>
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<tr>
<td>Diode reverse recovery time</td>
<td>$t_{rr}$</td>
<td>$T_J \geq 25 , ^\circ\text{C}$</td>
<td>-</td>
<td>0.453</td>
<td>-</td>
<td>μs</td>
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<tr>
<td></td>
<td></td>
<td>$T_J \geq 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>0.74</td>
<td>-</td>
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<tr>
<td>Total reverse recovery charge</td>
<td>$Q_{rr}$</td>
<td>$T_J \geq 25 , ^\circ\text{C}$</td>
<td>-</td>
<td>0.12</td>
<td>-</td>
<td>μC</td>
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<td></td>
<td></td>
<td>$T_J \geq 125 , ^\circ\text{C}$</td>
<td>-</td>
<td>0.4</td>
<td>-</td>
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</tbody>
</table>

**Note**

(1) Energy losses include "tail" and diode reverse recovery

### INTERNAL NTC - THERMISTOR SPECIFICATIONS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>TYP.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance</td>
<td>$R_{25}$</td>
<td>$T_C = 25 , ^\circ\text{C}$</td>
<td>5000</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td>$R_{100}$</td>
<td>$T_C = 100 , ^\circ\text{C}$</td>
<td>493 ± 5</td>
<td>%</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{25/50}$</td>
<td>$R_0 = R_{25} \exp \left[ (B_{25/50} / 298.15) \left( 1 / T_2 - 1 / T_1 \right) \right]$</td>
<td>3375 ± 5</td>
<td>%</td>
</tr>
<tr>
<td>Maximum operating temperature</td>
<td>220</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissipation constant</td>
<td>2</td>
<td>mW/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal time constant</td>
<td>8</td>
<td>s</td>
<td></td>
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</tbody>
</table>

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## THERMAL AND MECHANICAL SPECIFICATIONS

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<th>PARAMETER</th>
<th>SYMBOL</th>
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<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
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</thead>
<tbody>
<tr>
<td>Junction and storage temperature range</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;, T&lt;sub&gt;Stg&lt;/sub&gt;</td>
<td>-40, -</td>
<td>150</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to case IGBT</td>
<td>R&lt;sub&gt;TJC&lt;/sub&gt;</td>
<td>- , -</td>
<td>0.54</td>
<td>°C/W</td>
<td></td>
<td></td>
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<tr>
<td>Junction to case DIODE</td>
<td>R&lt;sub&gt;TJC&lt;/sub&gt;</td>
<td>- , -</td>
<td>1</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case to sink per module</td>
<td>R&lt;sub&gt;TJC3b&lt;/sub&gt;</td>
<td>-</td>
<td>0.05</td>
<td>°C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting torque (M5)</td>
<td></td>
<td>2.7 , 3.3</td>
<td>3.3</td>
<td>Nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>-</td>
<td>170</td>
<td>g</td>
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</tbody>
</table>

![Trench IGBT Output Characteristics, V<sub>GE</sub> = 15 V](image1)

![Maximum Trench IGBT Continuous Collector Current vs. Case Temperature](image2)

![Trench IGBT Output Characteristics, T<sub>j</sub> = 125 °C](image3)

![Trench IGBT Transfer Characteristics](image4)
Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

Fig. 7 - Typical Trench IGBT Energy Loss vs. IC (with Antiparallel Diode)

Fig. 8 - Typical Trench IGBT Switching Time vs. IC (with Antiparallel Diode)

Fig. 9 - Typical Trench IGBT Energy Loss vs. Rg (with Antiparallel Diode)

Fig. 10 - Typical Trench IGBT Switching Time vs. Rg (with Antiparallel Diode)
Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

Fig. 12 - Typical Diode Forward Characteristics

Fig. 13 - Typical Diode Reverse Recovery Time vs. dI/dt

Fig. 14 - Typical Diode Reverse Recovery Current vs. dI/dt

Fig. 15 - Typical Diode Reverse Recovery Charge vs. dI/dt

Fig. 16 - Trench IGBT Reverse BIAS SOA
\[ T_J = 150 \, ^\circ\text{C}, I_C = 150 \, \text{A}, R_\text{th} = 4.7 \, \Omega, V_{GE} = +15 \, \text{V} / 0 \, \text{V}, V_{CC} = 800 \, \text{V}, V_P = 1200 \, \text{V} \]
Fig. 17 - Trench IGBT Safe Operating Area

Fig. 18 - Maximum Trench IGBT Thermal Impedance $Z_{thJC}$ Characteristics

Fig. 19 - Maximum Diode Thermal Impedance $Z_{thJC}$ Characteristics
Fig. 20 - Gate Charge Circuit (Turn-Off)

Fig. 21 - RBSOA Circuit

Fig. 22 - S.C. SOA Circuit

Fig. 23 - Switching Loss Circuit

Fig. 24 - Resistive Load Circuit
ORDERING INFORMATION TABLE

<table>
<thead>
<tr>
<th>Device code</th>
<th>VS-</th>
<th>G</th>
<th>T</th>
<th>50</th>
<th>Y</th>
<th>F</th>
<th>120</th>
<th>N</th>
<th>T</th>
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</tr>
</tbody>
</table>

1 - Vishay Semiconductors product
2 - Insulated gate bipolar transistor (IGBT)
3 - T = Trench gate field stop IGBT
4 - Current rating (50 = 50 A)
5 - Circuit configuration (Y = 4 pack)
6 - Package indicator (F = ECONO 2)
7 - Voltage rating (120 = 1200 V)
8 - Speed/type (N = ultrafast with reduced diode, speed 8 kHz to 60 kHz)
9 - NTC Thermistor

CIRCUIT CONFIGURATION

![Circuit Diagram 1](QB1 QB2 QB3 QB4)

![Circuit Diagram 2](QB1 QB2 QB3 QB4)
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