Insulated Gate Bipolar Transistor
(Ultrafast IGBT), 90 A

FEATURES
• NPT Gen 5 IGBT technology
• Square RBSOA
• Positive $V_{CE(on)}$ temperature coefficient
• Fully isolated package
• Speed 8 kHz to 60 kHz
• Very low internal inductance ($\leq 5$ nH typical)
• Industry standard outline
• UL approved file E78996
• Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

BENEFITS
• Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
• Easy to assemble and parallel
• Direct mounting on heatsink
• Plug-in compatible with other SOT-227 packages
• Low EMI, requires less snubbing

PRIMARY CHARACTERISTICS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>MAX.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector to emitter voltage</td>
<td>$V_{CES}$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_C = 90 , ^\circ C$</td>
<td>149</td>
<td>A</td>
</tr>
<tr>
<td>Continuous collector current</td>
<td>$I_C$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>90</td>
<td>A</td>
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<tr>
<td></td>
<td></td>
<td>$T_C = 90 , ^\circ C$</td>
<td>200</td>
<td>A</td>
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<tr>
<td>Pulsed collector current</td>
<td>$I_{CM}$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Clamped inductive load current</td>
<td>$I_{LM}$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Gate to emitter voltage</td>
<td>$V_{GE}$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>$\pm 20$</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$T_C = 90 , ^\circ C$</td>
<td>862</td>
<td>W</td>
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<tr>
<td>Power dissipation, IGBT</td>
<td>$P_D$</td>
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<tr>
<td></td>
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<td>$T_C = 90 , ^\circ C$</td>
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ABSOLUTE MAXIMUM RATINGS

<table>
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<tr>
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<td>Collector to emitter voltage</td>
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<td>V</td>
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<tr>
<td>Continuous collector current</td>
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<tr>
<td>Pulsed collector current</td>
<td>$I_{CM}$</td>
<td>$T_C = 25 , ^\circ C$</td>
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<td>A</td>
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<tr>
<td>Clamped inductive load current</td>
<td>$I_{LM}$</td>
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<td>A</td>
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<tr>
<td>Gate to emitter voltage</td>
<td>$V_{GE}$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>$\pm 20$</td>
<td>V</td>
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<tr>
<td>Power dissipation, IGBT</td>
<td>$P_D$</td>
<td>$T_C = 25 , ^\circ C$</td>
<td>862</td>
<td>W</td>
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<tr>
<td>Isolation voltage</td>
<td>$V_{BOL}$</td>
<td>Any terminal to case, $t = 1 , \text{min}$</td>
<td>2500</td>
<td>V</td>
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## ELECTRICAL SPECIFICATIONS (T\textsubscript{J} = 25 °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>
</tr>
</thead>
<tbody>
<tr>
<td>Collector to emitter breakdown voltage</td>
<td>V\textsubscript{BR(CES)}</td>
<td>V\textsubscript{GE} = 0 V, I\textsubscript{C} = 250 μA</td>
<td>1200</td>
<td>-</td>
<td>-</td>
<td>V</td>
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<tr>
<td>Collector to emitter voltage</td>
<td>V\textsubscript{CE(on)}</td>
<td>V\textsubscript{GE} = 15 V, I\textsubscript{C} = 75 A</td>
<td>-</td>
<td>3.3</td>
<td>3.8</td>
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<tr>
<td>Gate threshold voltage</td>
<td>V\textsubscript{GE(th)}</td>
<td>V\textsubscript{CE} = V\textsubscript{GE}, I\textsubscript{C} = 250 μA</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient of threshold voltage</td>
<td>V\textsubscript{GE(th)/AT\textsubscript{J}}</td>
<td>V\textsubscript{GE} = V\textsubscript{GE}, I\textsubscript{C} = 1 mA (25 °C to 125 °C)</td>
<td>-</td>
<td>-12</td>
<td>-</td>
<td>mV/°C</td>
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<tr>
<td>Collector to emitter leakage current</td>
<td>I\textsubscript{CES}</td>
<td>V\textsubscript{GE} = 0 V, V\textsubscript{CE} = 1200 V</td>
<td>-</td>
<td>7</td>
<td>250</td>
<td>μA</td>
</tr>
<tr>
<td>Gate to emitter leakage current</td>
<td>I\textsubscript{GES}</td>
<td>V\textsubscript{GE} = ± 20 V</td>
<td>-</td>
<td>-</td>
<td>± 250</td>
<td>nA</td>
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</table>

## SWITCHING CHARACTERISTICS (T\textsubscript{J} = 25 °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>
</tr>
</thead>
<tbody>
<tr>
<td>Total gate charge (turn-on)</td>
<td>Q\textsubscript{g}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>690</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>Gate to emitter charge (turn-on)</td>
<td>Q\textsubscript{ge}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>65</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Gate to collector charge (turn-on)</td>
<td>Q\textsubscript{gc}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>250</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Turn-on switching loss</td>
<td>E\textsubscript{on}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>Turn-off switching loss</td>
<td>E\textsubscript{off}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>2.1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total switching loss</td>
<td>E\textsubscript{tot}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>3.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>t\textsubscript{d(on)}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>250</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Rise time</td>
<td>t\textsubscript{r}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>38</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>t\textsubscript{d(off)}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>280</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Fall time</td>
<td>t\textsubscript{f}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>90</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Turn-on switching loss</td>
<td>E\textsubscript{on}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>1.7</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>Turn-off switching loss</td>
<td>E\textsubscript{off}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>4.08</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total switching loss</td>
<td>E\textsubscript{tot}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>5.78</td>
<td>-</td>
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</tr>
<tr>
<td>Turn-on delay time</td>
<td>t\textsubscript{d(on)}</td>
<td>I\textsubscript{C} = 75 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>245</td>
<td>-</td>
<td></td>
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<tr>
<td>Rise time</td>
<td>t\textsubscript{r}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>48</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>t\textsubscript{d(off)}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>280</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Fall time</td>
<td>t\textsubscript{f}</td>
<td>I\textsubscript{C} = 50 A, V\textsubscript{CC} = 600 V, V\textsubscript{GE} = 15 V</td>
<td>-</td>
<td>140</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Reverse bias safe operating area</td>
<td>R\textsubscript{BSOA}</td>
<td>T\textsubscript{J} = 150 °C, I\textsubscript{C} = 200 A, R\textsubscript{g} = 22 Ω, V\textsubscript{GE} = 15 V to 0 V, V\textsubscript{CC} = 900 V, V\textsubscript{p} = 1200 V, L = 500 μH</td>
<td>Fullsquare</td>
<td></td>
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</tr>
</tbody>
</table>

## THERMAL AND MECHANICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction and storage temperature range</td>
<td>T\textsubscript{J}, T\textsubscript{Stg}</td>
<td>-40</td>
<td>-</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal resistance junction to case</td>
<td>R\textsubscript{mJC}</td>
<td>-</td>
<td>-</td>
<td>0.145</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal resistance case to heatsink</td>
<td>R\textsubscript{mCS}</td>
<td>Flat, greased surface</td>
<td>-</td>
<td>0.05</td>
<td>-</td>
</tr>
<tr>
<td>Weight</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>g</td>
<td></td>
</tr>
<tr>
<td>Mounting torque</td>
<td>Torque to terminal</td>
<td>-</td>
<td>-</td>
<td>1.1 (9.7)</td>
<td>Nm (lbf.in)</td>
</tr>
<tr>
<td>Case style</td>
<td>SOT-227</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>
Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

Fig. 3 - Typical IGBT Transfer Characteristics

Fig. 4 - Typical IGBT Zero Gate Voltage Collector Current

Fig. 5 - Typical IGBT Threshold Voltage

Fig. 6 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE} = 15$ V
Fig. 7 - Typical IGBT Energy Losses vs. \( I_C \)
\( T_J = 125 \, ^\circ C, \, L = 500 \, \mu H, \, V_{CC} = 600 \, V, \) 
\( R_g = 5 \, \Omega, \, V_{GE} = 15 \, V, \) Diode used HFA16PB120

Fig. 9 - Typical IGBT Energy Loss vs. \( R_g \) 
\( T_J = 125 \, ^\circ C, \, I_C = 75 \, A, \, L = 500 \, \mu H, \) 
\( V_{CC} = 600 \, V, \, V_{GE} = 15 \, V, \) Diode used HFA16PB120

Fig. 8 - Typical IGBT Switching Time vs. \( I_C \)  
\( T_J = 125 \, ^\circ C, \, L = 500 \, \mu H, \, V_{CC} = 600 \, V, \) 
\( R_g = 5 \, \Omega, \, V_{GE} = 15 \, V, \) Diode used HFA16PB120

Fig. 10 - Typical IGBT Switching Time vs. \( R_g \)  
\( T_J = 125 \, ^\circ C, \, L = 500 \, \mu H, \, V_{CC} = 600 \, V, \) 
\( R_g = 5 \, \Omega, \, V_{GE} = 15 \, V \)

Fig. 11 - Maximum Thermal Impedance \( Z_{thJC} \) Characteristics (IGBT)

Notes:
1. Duty factor \( D = t_1/t_2 \)
2. Peak \( T_J = P_{DM} \times Z_{thJC} + T_C \)
Fig. 12 - IGBT Reverse Bias SOA, TJ = 150 °C, VGE = 15 V

Fig. 13a - Clamped Inductive Load Test Circuit

* Driver same type as D.U.T.; VC = 80 % of V_{ce(max)}
* Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain Id

Fig. 13b - Pulsed Collector Current Test Circuit

Fig. 14a - Switching Loss Test Circuit
Fig. 14b - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

<table>
<thead>
<tr>
<th>Device code</th>
<th>VS-</th>
<th>G</th>
<th>B</th>
<th>90</th>
<th>S</th>
<th>A</th>
<th>120</th>
<th>U</th>
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1 - Vishay Semiconductors product
2 - Insulated gate bipolar transistor (IGBT)
3 - B = IGBT Gen 5
4 - Current rating (90 = 90 A)
5 - Circuit configuration (S = single switch no diode)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (120 = 1200 V)
8 - Speed/type (U = ultrafast IGBT)

CIRCUIT CONFIGURATION

<table>
<thead>
<tr>
<th>CIRCUIT Configuration Code</th>
<th>CIRCUIT Drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single switch no diode</td>
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</tr>
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</table>

CIRCUIT CONFIGURATION CODE:

- S: Single switch no diode

LINKS TO RELATED DOCUMENTS

- Packaging information: [www.vishay.com/doc?95425](www.vishay.com/doc?95425)
SOT-227 Generation 2

DIMENSIONS in millimeters (inches)

Note
• Controlling dimension: millimeter
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