STARPOWER SEMICONDUCTOR

GD450CUY120P1S

1200V/450A chopper in one-package

General Description

STARPOWER IGBT Power Module provides ultra low conduction loss as well as short circuit ruggedness. They are designed for the applications such as electric vehicle and solar power.

Features

- Low V_{CE(sat)} Trench IGBT technology
- 10μs short circuit capability
- V_{CE(sat)} with positive temperature coefficient
- Maximum junction temperature 175°C
- Low inductance case
- Isolated copper baseplate using DBC technology
- High power and thermal cycling capability

Typical Applications

- High Power Converter
- Solar Power
- Hybrid and Electric Vehicle

Equivalent Circuit Schematic
## Absolute Maximum Ratings \( T_C=25^\circ C \) unless otherwise noted

### IGBT

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CES} )</td>
<td>Collector-Emitter Voltage</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>( V_{GES} )</td>
<td>Gate-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>761</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>( @ T_C=100^\circ C )</td>
<td>450</td>
<td>A</td>
</tr>
<tr>
<td>( I_{CM} )</td>
<td>Pulsed Collector Current ( t_p=1\text{ms} )</td>
<td>900</td>
<td>A</td>
</tr>
<tr>
<td>( P_D )</td>
<td>Maximum Power Dissipation ( @ T_J=175^\circ C )</td>
<td>2.6</td>
<td>kW</td>
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### Diode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>( V_{RRM} )</td>
<td>Repetitive Peak Reverse Voltage</td>
<td>1200</td>
<td>V</td>
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<tr>
<td>( I_F )</td>
<td>Diode Continuous Forward Current</td>
<td>450</td>
<td>A</td>
</tr>
<tr>
<td>( I_{FM} )</td>
<td>Diode Maximum Forward Current ( t_p=1\text{ms} )</td>
<td>900</td>
<td>A</td>
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### Module

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>( T_{jmax} )</td>
<td>Maximum Junction Temperature</td>
<td>175</td>
<td>°C</td>
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<tr>
<td>( T_{jop} )</td>
<td>Operating Junction Temperature</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>( T_{STG} )</td>
<td>Storage Temperature Range</td>
<td>-40 to +125</td>
<td>°C</td>
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<tr>
<td>( V_{ISO} )</td>
<td>Isolation Voltage RMS,( f=50\text{Hz},t=1\text{min} )</td>
<td>2500</td>
<td>V</td>
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## IGBT Characteristics

TC = 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>
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<tbody>
<tr>
<td>V&lt;sub&gt;CE(sat)&lt;/sub&gt;</td>
<td>Collector to Emitter Saturation Voltage</td>
<td>( I_C=450A, V_{GE}=15V, T_J=25°C )</td>
<td>1.70</td>
<td>2.05</td>
<td></td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>( I_C=450A, V_{GE}=15V, T_J=125°C )</td>
<td>1.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_C=450A, V_{GE}=15V, T_J=150°C )</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;GE(th)&lt;/sub&gt;</td>
<td>Gate-Emitter Threshold Voltage</td>
<td>( I_C=1.3mA, V_{CE}=V_{GE}, T_J=25°C )</td>
<td>5.2</td>
<td>6.0</td>
<td>6.8</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;CES&lt;/sub&gt;</td>
<td>Collector Cut-Off Current</td>
<td>( V_{CE}=V_{CES}, V_{GE}=0V, T_J=25°C )</td>
<td>1.0</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>I&lt;sub&gt;GES&lt;/sub&gt;</td>
<td>Gate-Emitter Leakage Current</td>
<td>( V_{GE}=V_{GES}, V_{CE}=0V, T_J=25°C )</td>
<td>400</td>
<td></td>
<td></td>
<td>nA</td>
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<tr>
<td>R&lt;sub&gt;Gint&lt;/sub&gt;</td>
<td>Internal Gate Resistance</td>
<td></td>
<td>2.4</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>t&lt;sub&gt;d(on)&lt;/sub&gt;</td>
<td>Turn-On Delay Time</td>
<td>( V_{CC}=600V, I_C=450A, R_{Gon}=2.5Ω )</td>
<td>235</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>t&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Rise Time</td>
<td>( R_{Goff}=3.1Ω, V_{GE}=±15V, T_J=25°C )</td>
<td>96</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>t&lt;sub&gt;d(off)&lt;/sub&gt;</td>
<td>Turn-Off Delay Time</td>
<td>( V_{GC}=600V, I_C=450A, R_{Gon}=2.5Ω )</td>
<td>618</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>Fall Time</td>
<td>( R_{Goff}=3.1Ω, V_{GE}=±15V, T_J=25°C )</td>
<td>93</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>E&lt;sub&gt;on&lt;/sub&gt;</td>
<td>Turn-On Switching Loss</td>
<td>( V_{CC}=600V, I_C=450A, T_J=125°C )</td>
<td>44.9</td>
<td></td>
<td></td>
<td>mJ</td>
</tr>
<tr>
<td>E&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Turn-Off Switching Loss</td>
<td>( V_{GC}=600V, I_C=450A, T_J=150°C )</td>
<td>41.2</td>
<td></td>
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<td>mJ</td>
</tr>
<tr>
<td>I&lt;sub&gt;ISC SC Data&lt;/sub&gt;</td>
<td></td>
<td>( t_P≤10μs, V_{GE}=15V, T_J=150°C, V_{CC}=800V, V_{CEM}\leq1200V )</td>
<td>1800</td>
<td></td>
<td></td>
<td>A</td>
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**Diode Characteristics**  \( T_C=25^\circ C \) unless otherwise noted

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>( V_F )</td>
<td>Diode Forward Voltage</td>
<td>( I_F=450,A, V_{GE}=0,V, T_J=25^\circ C )</td>
<td>1.65</td>
<td>2.10</td>
<td></td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>( I_F=450,A, V_{GE}=0,V, T_J=125^\circ C )</td>
<td>1.65</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_F=450,A, V_{GE}=0,V, T_J=150^\circ C )</td>
<td>1.65</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
<td>( Q_r )</td>
<td>Recovered Charge</td>
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<td></td>
<td></td>
<td>38</td>
<td>( \mu C )</td>
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<tr>
<td>( I_{RM} )</td>
<td>Peak Reverse Recovery Current</td>
<td>( V_{CC}=600,V, I_F=450,A, )</td>
<td>228</td>
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<td></td>
<td>A</td>
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<tr>
<td></td>
<td></td>
<td>(-\text{di}/\text{dt}=3800,A/\mu s, V_{GE}=-15,V, )</td>
<td></td>
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<td></td>
<td></td>
<td>( T_J=25^\circ C )</td>
<td>18.1</td>
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<td>mJ</td>
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<tr>
<td>( Q_r )</td>
<td>Recovered Charge</td>
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<td>76</td>
<td>( \mu C )</td>
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<td>( I_{RM} )</td>
<td>Peak Reverse Recovery Current</td>
<td>( V_{CC}=600,V, I_F=450,A, )</td>
<td>290</td>
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<td>(-\text{di}/\text{dt}=3800,A/\mu s, V_{GE}=-15,V, )</td>
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<tr>
<td></td>
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<td>( T_J=125^\circ C )</td>
<td>31.4</td>
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<td>mJ</td>
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<tr>
<td>( Q_r )</td>
<td>Recovered Charge</td>
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<td>86</td>
<td>( \mu C )</td>
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<tr>
<td>( I_{RM} )</td>
<td>Peak Reverse Recovery Current</td>
<td>( V_{CC}=600,V, I_F=450,A, )</td>
<td>318</td>
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<td>A</td>
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<td>(-\text{di}/\text{dt}=3800,A/\mu s, V_{GE}=-15,V, )</td>
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<tr>
<td></td>
<td></td>
<td>( T_J=150^\circ C )</td>
<td>34.2</td>
<td></td>
<td></td>
<td>mJ</td>
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**NTC Characteristics**  \( T_C=25^\circ C \) unless otherwise noted

<table>
<thead>
<tr>
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<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>( R_{25} )</td>
<td>Rated Resistance</td>
<td>( T_C=100^\circ C, R_{100}=493.3,\Omega )</td>
<td>5.0</td>
<td></td>
<td>5</td>
<td>%</td>
</tr>
<tr>
<td>( \Delta R/R )</td>
<td>Deviation of ( R_{100} )</td>
<td>( T_C=25^\circ C )</td>
<td>-5</td>
<td></td>
<td>5</td>
<td>%</td>
</tr>
<tr>
<td>( P_{25} )</td>
<td>Power Dissipation</td>
<td>( R_2=0.3\times(1/T_2-1/(298.15K)) )</td>
<td></td>
<td>20.0</td>
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<td>mW</td>
</tr>
<tr>
<td>( B_{25/50} )</td>
<td>B-value</td>
<td>( R_2=0.3\times(1/T_2-1/(298.15K)) )</td>
<td>3375</td>
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<td>K</td>
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<tr>
<td>( B_{25/80} )</td>
<td>B-value</td>
<td>( R_2=0.3\times(1/T_2-1/(298.15K)) )</td>
<td>3411</td>
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<td></td>
<td>K</td>
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<tr>
<td>( B_{25/100} )</td>
<td>B-value</td>
<td>( R_2=0.3\times(1/T_2-1/(298.15K)) )</td>
<td>3433</td>
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<td>K</td>
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**Module Characteristics** $T_c=25^\circ$C unless otherwise noted

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<th>Symbol</th>
<th>Parameter</th>
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<th>Typ.</th>
<th>Max.</th>
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<tbody>
<tr>
<td>$L_{CE}$</td>
<td>Stray Inductance</td>
<td>18</td>
<td></td>
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<td>nH</td>
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<td>$R_{CC'+EE'}$</td>
<td>Module Lead Resistance, Terminal to Chip</td>
<td>0.30</td>
<td></td>
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<td>mΩ</td>
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<tr>
<td>$R_{thJC}$</td>
<td>Junction-to-Case (per IGBT)</td>
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<td></td>
<td>57.2</td>
<td>K/kW</td>
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<td></td>
<td>Junction-to-Case (per Diode)</td>
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<td>101.9</td>
<td>K/kW</td>
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<td>$R_{thCH}$</td>
<td>Case-to-Heatsink (per IGBT)</td>
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<td>9.6</td>
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<td>K/kW</td>
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<td>Case-to-Heatsink (per Diode)</td>
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<td>17.0</td>
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<td>K/kW</td>
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<tr>
<td></td>
<td>Case-to-Heatsink (per Module)</td>
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<td>4.5</td>
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<td>K/kW</td>
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<tr>
<td>$M$</td>
<td>Terminal Connection Torque, Screw M4</td>
<td>1.8</td>
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<td>2.1</td>
<td>N.m</td>
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<td></td>
<td>Terminal Connection Torque, Screw M8</td>
<td>8.0</td>
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<td>10</td>
<td>N.m</td>
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<td>Mounting Torque, Screw M5</td>
<td>3.0</td>
<td></td>
<td>6.0</td>
<td>N.m</td>
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<tr>
<td>$G$</td>
<td>Weight of Module</td>
<td>825</td>
<td></td>
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<td>g</td>
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Fig 1. IGBT Output Characteristics

Fig 2. IGBT Transfer Characteristics

Fig 3. IGBT Switching Loss vs. IC

Fig 4. IGBT Switching Loss vs. RG

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Fig 5. RBSOA

Fig 6. IGBT Transient Thermal Impedance

Fig 7. Diode Forward Characteristics

Fig 8. Diode Switching Loss vs. $I_F$
Fig 9. Diode Switching Loss vs. $R_G$

Fig 10. Diode Transient Thermal Impedance

Fig 11. NTC Temperature Characteristic

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Circuit Schematic

Package Dimensions
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