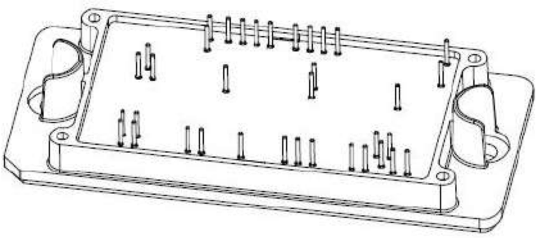
# HCG450FL065K1F1

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Features

- Neutral Point Clamped Three−Level Inverter Module
- Low Inductive Layout
- Solderable Pins



## Benefits

- Higher System Efficiency
- Reduced Cooling Requirements
- Low Conduction Losses Over Temperature

## Applications

- Solar Inverters
- Uninterruptable Power Supplies Systems

**HCG450FL065K1F1**
650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Table 1 Absolute Maximum Ratings (Ta = 25 °C)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| **OUTER IGBT (Q1, Q4)** | | | |
| Collector−emitter voltage | $V_{CES}$ | 650 | V |
| Gate−emitter voltage | $V_{GE}$ | ±20 | V |
| Continuous collector current @ $T_C$ = 80°C, $T_j$ = 175°C | $I_C$ | 270 | A |
| Pulsed collector current @ $T_j$ = 175°C | $I_{CP}$ | 810 | A |
| Junction temperature | $T_j$ | -40 to +175 | ℃ |
| **INNER IGBT (Q2, Q3)** | | | |
| Collector−emitter voltage | $V_{CES}$ | 650 | V |
| Gate−emitter voltage | $V_{GE}$ | ±20 | V |
| Continuous collector current @ $T_C$ = 80°C, $T_j$ = 175°C | $I_C$ | 270 | A |
| Pulsed collector current @ $T_j$ = 175°C | $I_{CP}$ | 810 | A |
| Junction temperature | $T_j$ | -40 to +175 | ℃ |
| **DIODE(D1,D2,D3,D4)** | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | 650 | V |
| Continuous forward current @ $T_C$ = 80°C, $T_j$ = 175°C | $I_F$ | 188 | A |
| Repetitive peak forward current @ $T_j$ = 175°C | $I_{FRM}$ | 563 | A |
| $I^2t$-value@ $V_R$ = 0 V, Tp = 10 ms, $T_{vj}$ = 150°C | $I^2t$ | 1800 | $A^2s$ |
| Junction temperature | $T_j$ | -40 to +175 | ℃ |
| **DIODE(D5,D6)** | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | 650 | V |
| Continuous forward current @ $T_C$ = 80°C, $T_j$ = 175°C | $I_F$ | 230 | A |
| Repetitive peak forward current @ $T_j$ = 175°C | $I_{FRM}$ | 690 | A |
| $I^2t$-value@ $V_R$ = 0 V, Tp = 10 ms, $T_{vj}$ = 150°C | $I^2t$ | 9800 | $A^2s$ |
| Junction temperature | $T_j$ | -40 to +175 | ℃ |
| **INSULATION PROPERTIES** | | | |
| Isolation test voltage, t = 1 s, 50 Hz | $V_{ISO}$ | 4000 | $V_{RMS}$ |
| **RECOMMENDED TEMPERATURE** | | | |
| Storage temperature | $T_{stg}$ | -40 to +125 | ℃ |
| Operating temperature | $T_{op}$ | -40 to +150 | ℃ |

**HCG450FL065K1F1**
650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Table 2 Characteristics Values

<table>
<tr><th>Parameter</th><th>Symbol</th><th colspan="2">Conditions</th><th>Min.</th><th>Typ.</th><th>Max.</th><th>Unit</th></tr>
<tr><td colspan="8">IGBT (Q1,Q4)</td></tr>
<tr><td rowspan="2">Collector−emitter saturation voltage</td><td rowspan="2">$V_{CE(sat)}$</td><td>$V_{GE}$ = 15 V, $I_C$ = 450 A</td><td>$T_j$ = 25℃</td><td>-</td><td>1.6</td><td>2.2</td><td rowspan="2">V</td></tr>
<tr><td>$V_{GE}$ = 15 V, $I_C$ = 450 A</td><td>$T_j$ = 150℃</td><td>-</td><td>1.85</td><td>-</td></tr>
<tr><td>Gate−emitter threshold voltage</td><td>$V_{GE(TH)}$</td><td>$V_{GE}$ = $V_{CE}$, $I_C$ = 4 mA</td><td>$T_j$ = 25℃</td><td>3.2</td><td>3.8</td><td>4.4</td><td>V</td></tr>
<tr><td>Total gate charge</td><td>$Q_g$</td><td>$V_{GE}$ = ±15 V, $V_{CE}$ = 480 V</td><td>$T_j$ = 25℃</td><td>-</td><td>1.6</td><td>-</td><td>μC</td></tr>
<tr><td>Gate-source leakage current</td><td>$I_{GES}$</td><td>$V_{GE}$ = 20 V, $V_{CE}$ = 0 V</td><td>$T_j$ = 25℃</td><td>-</td><td>-</td><td>100</td><td>nA</td></tr>
<tr><td>Collector−emitter voltage</td><td>$V_{(BR)CES}$</td><td>$V_{GE}$ = 0 V</td><td>$T_j$ = 25℃</td><td>650</td><td>-</td><td>-</td><td>V</td></tr>
<tr><td>Collector−emitter cutoff current</td><td>$I_{CES}$</td><td>$V_{CE}$ = 650 V, $V_{GE}$ = 0 V</td><td>$T_j$ = 25°C</td><td>-</td><td>-</td><td>100</td><td>μA</td></tr>
<tr><td>Input capacitance</td><td>$C_{iss}$</td><td rowspan="3">$V_{GE}$ = 0 V, $V_{CE}$ = 20 V, f = 10 KHz</td><td>$T_j$ = 25℃</td><td>-</td><td>24</td><td>-</td><td rowspan="3">nF</td></tr>
<tr><td>Output capacitance</td><td>$C_{oss}$</td><td>$T_j$ = 25℃</td><td>-</td><td>1.9</td><td>-</td></tr>
<tr><td>Reverse transfer capacitance</td><td>$C_{rss}$</td><td>$T_j$ = 25℃</td><td>-</td><td>0.14</td><td>-</td></tr>
<tr><td rowspan="2">Turn-on delay time (inductive load)</td><td rowspan="2">$t_{d\ on}$</td><td rowspan="8">$V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 9.4 Ω, $R_{Goff}$ = 15.7 Ω</td><td>$T_j$ = 25℃</td><td>-</td><td>75</td><td>-</td><td rowspan="8">ns</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>58</td><td>-</td></tr>
<tr><td rowspan="2">Rise time (inductive load)</td><td rowspan="2">$t_r$</td><td>$T_j$ = 25℃</td><td>-</td><td>33</td><td>-</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>38</td><td>-</td></tr>
<tr><td rowspan="2">Turn-off delay time (inductive load)</td><td rowspan="2">$t_{d\ off}$</td><td>$T_j$ = 25℃</td><td>-</td><td>757</td><td>-</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>804</td><td>-</td></tr>
<tr><td rowspan="2">Fall time (inductive load)</td><td rowspan="2">$t_f$</td><td>$T_j$ = 25℃</td><td>-</td><td>44</td><td>-</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>54</td><td>-</td></tr>
<tr><td rowspan="2">Turn - on switching loss</td><td rowspan="2">$E_{on}$</td><td rowspan="4">$V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 9.4 Ω, $R_{Goff}$ = 15.7 Ω,</td><td>$T_j$ = 25℃</td><td>-</td><td>4.7</td><td>-</td><td rowspan="4">mJ</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>6.8</td><td>-</td></tr>
<tr><td rowspan="2">Turn - off switching loss</td><td rowspan="2">$E_{off}$</td><td>$T_j$ = 25℃</td><td>-</td><td>2.6</td><td>-</td></tr>
<tr><td>$T_j$ = 150℃</td><td>-</td><td>3.3</td><td>-</td></tr>
<tr><td colspan="8">IGBT (Q2,Q3)</td></tr>
<tr><td rowspan="2">Collector−emitter saturation voltage</td><td rowspan="2">$V_{CE(sat)}$</td><td>$V_{GE}$ = 15 V, $I_C$ = 450 A</td><td>$T_j$ = 25℃</td><td>-</td><td>1.6</td><td>2.2</td><td rowspan="2">V</td></tr>
<tr><td>$V_{GE}$ = 15 V, $I_C$ = 450 A</td><td>$T_j$ = 150℃</td><td>-</td><td>1.85</td><td>-</td></tr>
</table>

# HCG450FL065K1F1

## 650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Gate−emitter threshold voltage | $V_{GE(TH)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 4 mA | $T_j$ = 25℃ | 3.2 | 3.8 | 4.4 | V |
| Total gate charge | $Q_g$ | $V_{GE}$ = ±15 V, $V_{CE}$ = 480 V | $T_j$ = 25℃ | - | 1.6 | - | μC |
| Gate-source leakage current | $I_{GES}$ | $V_{GE}$ = 20 V, $V_{CE}$ = 0 V | $T_j$ = 25℃ | - | - | 100 | nA |
| Collector−emitter voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0 V | $T_j$ = 25℃ | 650 | - | - | V |
| Collector−emitter cutoff current | $I_{CES}$ | $V_{CE}$ = 650 V, $V_{GE}$ = 0 V | $T_j$ = 25℃ | - | - | 100 | μA |
| Input capacitance | $C_{iss}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 20 V, f = 10 KHz | $T_j$ = 25℃ | - | 24 | - | nF |
| Output capacitance | $C_{oss}$ | | $T_j$ = 25℃ | - | 1.9 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | $T_j$ = 25℃ | - | 0.14 | - | |
| Turn-on delay time (inductive load) | $t_{d\ on}$ | $V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 4.3 Ω, $R_{Goff}$ = 32 Ω | $T_j$ = 25℃ | - | 35 | - | ns |
| | | | $T_j$ = 150°C | - | 26 | - | |
| Rise time (inductive load) | $t_r$ | | $T_j$ = 25℃ | - | 25 | - | |
| | | | $T_j$ = 150℃ | - | 30 | - | |
| Turn-off delay time (inductive load) | $t_{d\ off}$ | | $T_j$ = 25℃ | - | 1100 | - | |
| | | | $T_j$ = 150℃ | - | 1300 | - | |
| Fall time (inductive load) | $t_f$ | | $T_j$ = 25℃ | - | 27 | - | |
| | | | $T_j$ = 150℃ | - | 33 | - | |
| Turn - on switching loss | $E_{on}$ | $V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 4.3 Ω, $R_{Goff}$ = 32 Ω | $T_j$ = 25℃ | - | 1.62 | - | mJ |
| | | | $T_j$ = 150℃ | - | 2.56 | - | |
| Turn - off switching loss | $E_{off}$ | | $T_j$ = 25℃ | - | 5.62 | - | |
| | | | $T_j$ = 150℃ | - | 6.63 | - | |

**NEUTRAL POINT DIODE (D5, D6)**

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Diode forward voltage | $V_F$ | $I_F$ = 450 A | $T_j$ = 25℃ | - | 1.65 | 2.05 | V |
| | | $I_F$ = 450 A | $T_j$ = 150℃ | - | 1.75 | - | |
| Reverse recovery time | $T_{RR}$ | $V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 9.4 Ω, $R_{Goff}$ = 15.7 Ω | $T_j$ = 25℃ | - | 173 | - | ns |
| | | | $T_j$ = 150℃ | - | 215 | - | |
| Reverse recovery charge | $Q_{RR}$ | | $T_j$ = 25℃ | - | 8.68 | - | μC |
| | | | $T_j$ = 150℃ | - | 20.4 | - | |
| Peak reverse recovery current | $I_{RRM}$ | | $T_j$ = 25℃ | - | 120 | - | A |
| | | | $T_j$ = 150℃ | - | 184 | - | |
| Reverse recovery energy | $E_{RR}$ | | $T_j$ = 25℃ | - | 2.02 | - | mJ |
| | | | $T_j$ = 150℃ | - | 4.02 | - | |

**HCG450FL065K1F1**

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **INVERSE DIODE (D1,D2,D3,D4)** | | | | | | | |
| Diode forward voltage | $V_F$ | $I_F$ = 100 A | $T_j$ = 25℃ | - | 1.23 | 1.65 | V |
| | | $I_F$ = 100 A | $T_j$ = 150℃ | - | 1.18 | - | |
| | | $I_F$ = 200 A | $T_j$ = 25℃ | | 1.58 | - | |
| | | $I_F$ = 200 A | $T_j$ = 150℃ | | 1.64 | | |
| Reverse recovery time | $T_{RR}$ | $V_{GE}$ = -7 V / +15 V, $V_{CE}$ = 400 V, $I_C$ = 150 A, $R_{Gon}$ = 4.3 Ω, $R_{Goff}$ = 32 Ω | $T_j$ = 25℃ | - | 342 | - | ns |
| | | | $T_j$ = 150℃ | - | 432 | - | |
| Reverse recovery charge | $Q_{RR}$ | | $T_j$ = 25℃ | - | 2.58 | - | μC |
| | | | $T_j$ = 150℃ | - | 3.99 | - | |
| Peak reverse recovery current | $I_{RRM}$ | | $T_j$ = 25℃ | - | 43.3 | - | A |
| | | | $T_j$ = 150℃ | - | 48.1 | - | |
| Reverse recovery energy | $E_{RR}$ | | $T_j$ = 25℃ | - | 2.52 | - | mJ |
| | | | $T_j$ = 150℃ | - | 4.02 | - | |

**HCG450FL065K1F1**

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Table 3 Thermal Resistance

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Thermal resistance – chip–to–heatsink (D1,D2,D3,D4) | $R_{thJH}$ | Thermal grease ,λ = 2.8 W/mK | - | 0.41 | - | ℃ /W |
| Thermal resistance – chip–to–case (D1,D2,D3,D4) | $R_{thJC}$ | | - | 0.32 | - | ℃ /W |
| Thermal resistance – chip–to–heatsink (Q2,Q3) | $R_{thJH}$ | Thermal grease ,λ = 2.8 W/mK | - | 0.28 | - | ℃ /W |
| Thermal resistance – chip–to–case (Q2,Q3) | $R_{thJC}$ | | - | 0.18 | - | ℃ /W |
| Thermal resistance – chip–to–heatsink (D5, D6) | $R_{thJH}$ | Thermal grease ,λ = 2.8 W/mK | - | 0.29 | - | ℃ /W |
| Thermal resistance – chip–to–case (D5, D6) | $R_{thJC}$ | | - | 0.19 | - | ℃ /W |
| Thermal resistance – chip–to–heatsink(Q1, Q4) | $R_{thJH}$ | Thermal grease ,λ = 2.8 W/mK | - | 0.24 | - | °C /W |
| Thermal resistance – chip–to–case (Q1, Q4) | $R_{thJC}$ | | - | 0.16 | - | ℃ /W |

## Table 4 NTC-Thermistor

| Parameter | Symbol | Min | Typ. | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| Rated resistance | $R_{25}$ | - | 22 | - | kΩ | $T_C$ = 25°C |
| Deviation of R100 | ΔR/R | -5 | - | 5 | % | $T_C$ = 100°C, $R_{100}$ = 1486 Ω |
| Power dissipation | P25 | - | - | 20 | mW | TNTC = 25°C |
| B-value | $B_{25/50}$ | - | 3950 | - | K | B (25/50), tolerance ±3% |
| B-value | $B_{25/100}$ | - | 3998 | - | K | B (25/100), tolerance ±3% |

**HCG450FL065K1F1**
650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Table 5 Module

| Parameter | Symbol | Min | Typ. | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| Stray Inductance | $L_{CE}$ | - | 17 | - | nH | |
| Mounting Torque Screw:M5 | M | 3.0 | - | 5.0 | N.m | |
| Creepage distance | $d_{Creep}$ | | 12.7 | | mm | terminal to heatsink |
| Clearance | $d_{Clear}$ | | 12.7 | | mm | terminal to heatsink |
| CTI | | | ≥600 | | | |
| RTI | | | 130 | | ℃ | |
| Flatness of base plate | | | | 0.3 | mm | |
| Weight | | | 176.5 | | g | |

# HCG450FL065K1F1

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Typical Characteristics

### IGBT Q1, Q2, Q3, Q4 and DIODE D1, D2, D3, D4

Fig.1 Typical output characteristics IGBT
Tvj = 25℃

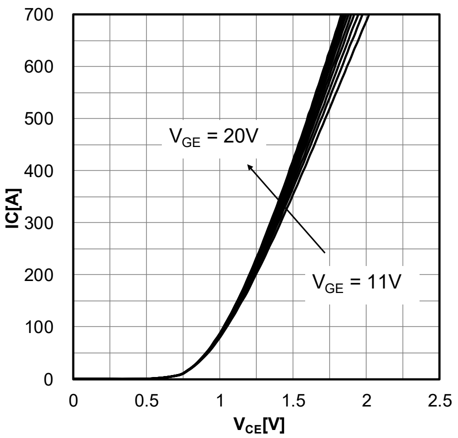



Fig.2 Typical output characteristics IGBT
Tvj = 150℃

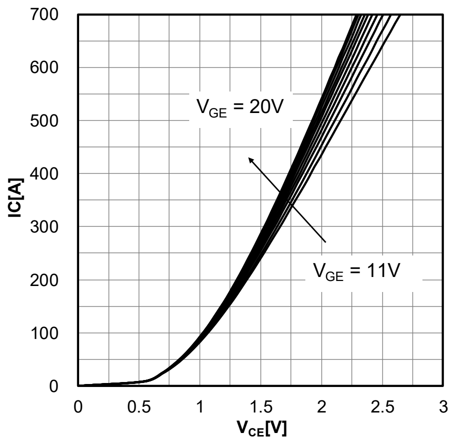



Fig.3 Body diode characteristics

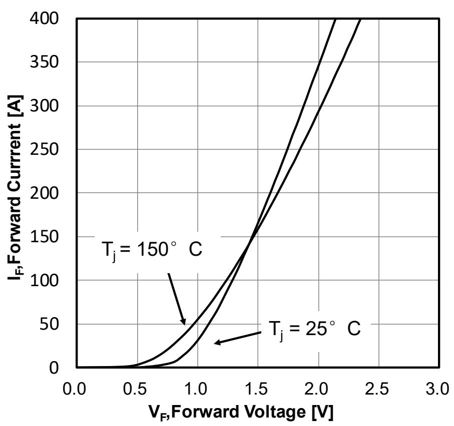



Fig.4 Transient thermal impedance(Q1, Q4)

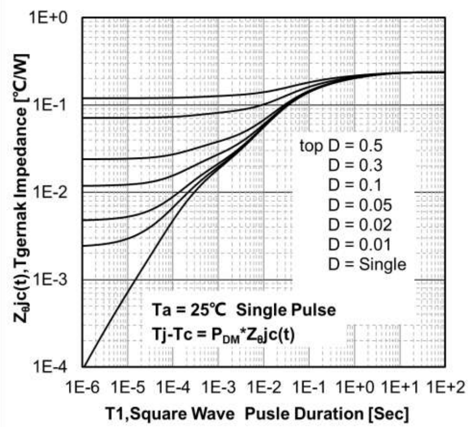



Fig.4 Transient thermal impedance (Q2, Q3)

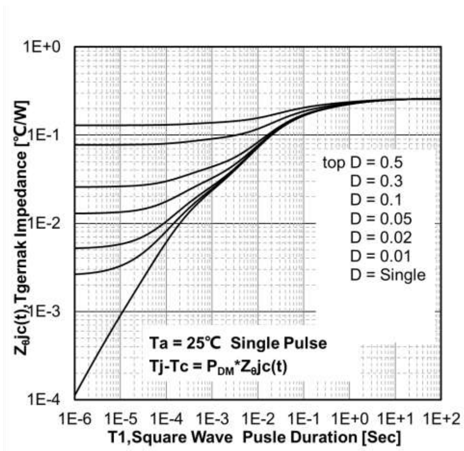
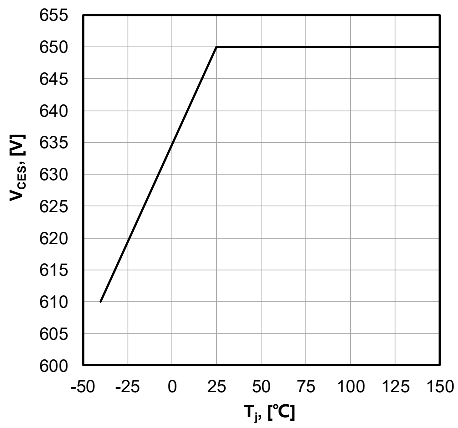



Fig.6 Maximum allowed collector-emitter voltage
(Q1, Q2, Q3, Q4)



# HCG450FL065K1F1

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Typical Characteristics

**DIODE D5, D6**

Fig.7 Diode forward characteristics

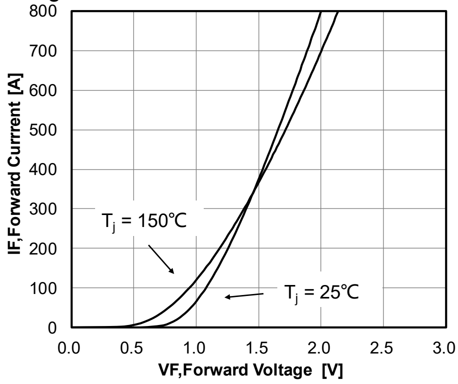



Fig.8 Transient thermal impedance (D5, D6)

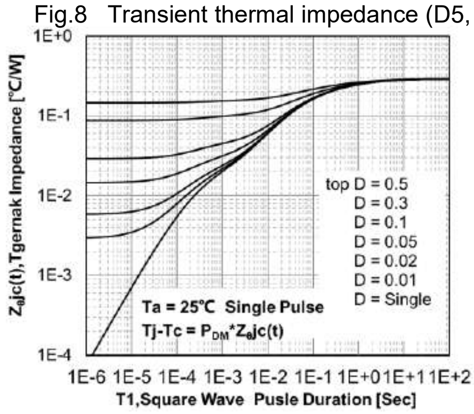



Fig.9 Maximum allowed collector-emitter voltage (D5, D6)

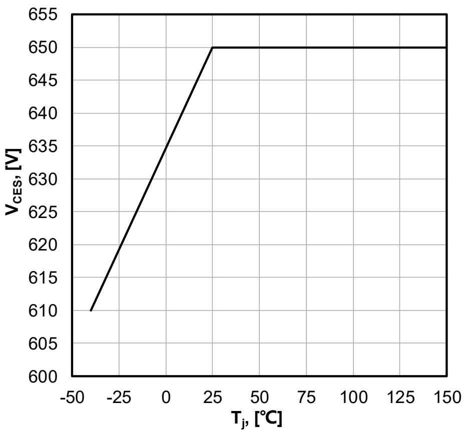
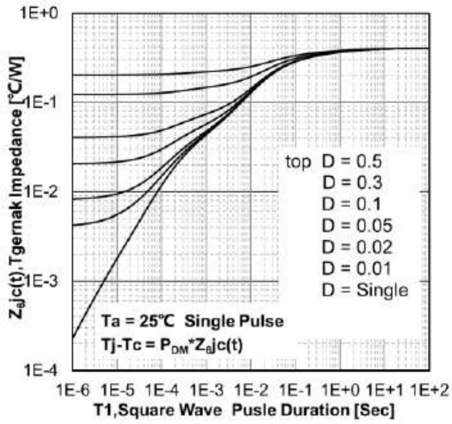



Fig.10 Transient thermal impedance (D1, D2, D3, D4)



## HCG450FL065K1F1

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

# Typical Characteristics

### IGBT Q1, Q4 and DIODE D5, D6

Fig.11 Switching losses IGBT,Inverter (typical)
$E_{on}$ = f ($I_C$), $E_{off}$ = f ($I_C$),
$V_{GE}$ = +15 V / -7 V, $R_{Gon}$ = 9.4 Ω, $R_{Goff}$ = 16.7 Ω,
$V_{CE}$ = 400 V

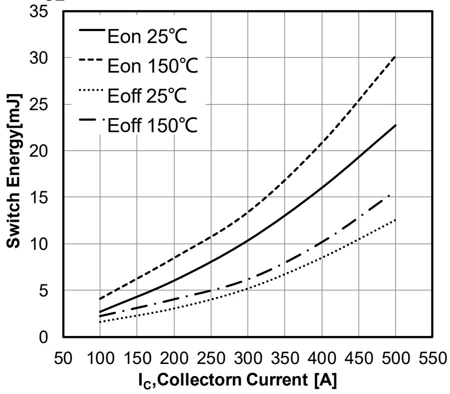
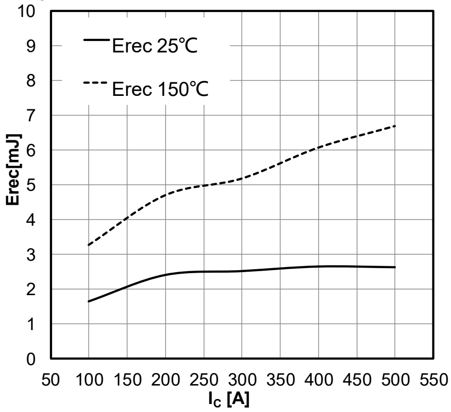



Fig.12 Switching losses IGBT,Inverter (typical)
$E_{rec}$ = f ($I_C$),
$V_{GE}$ = +15 V / -7 V, $R_{Gon}$ = 9.4 Ω, $R_{Goff}$ = 16.7 Ω,
$V_{CE}$ = 400 V




### IGBT Q2, Q3 and DIODE D1, D4

Fig.13 Switching losses IGBT,Inverter (typical)
$E_{on}$ = f ($I_C$), $E_{off}$ = f ($I_C$),
$V_{GE}$ = +15 V / -7 V, $R_{Gon}$ = 4.3 Ω, $R_{Goff}$ = 32 Ω,
$V_{CE}$ = 400 V

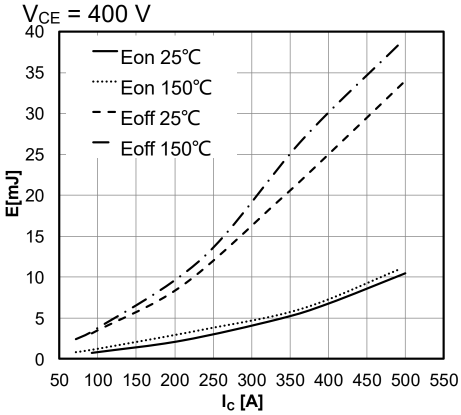



Fig.14 Switching losses IGBT, Inverter (typical)
$E_{rec}$ = f ($I_C$),
$V_{GE}$ = +15 V / -7 V, $R_{Gon}$ = 4.3 Ω, $R_{Goff}$ = 32 Ω,
$V_{CE}$ = 400 V

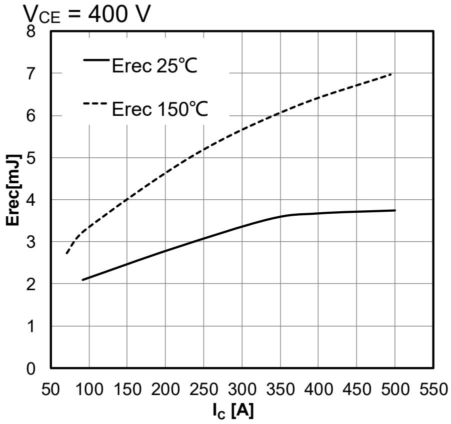



Fig.15 NTC-Thermistor-temperature characteristic (typical)

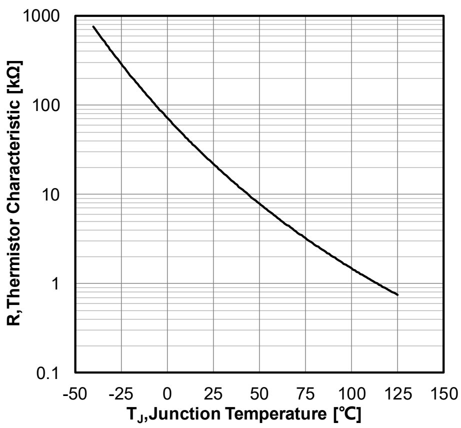
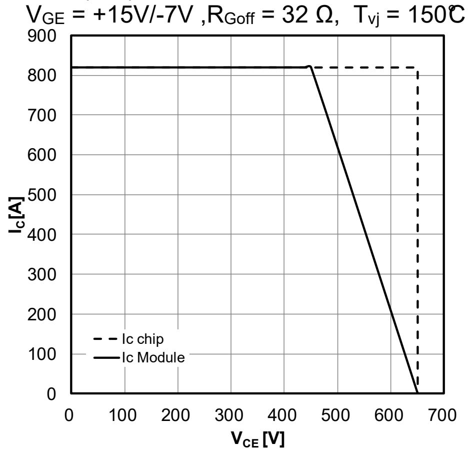


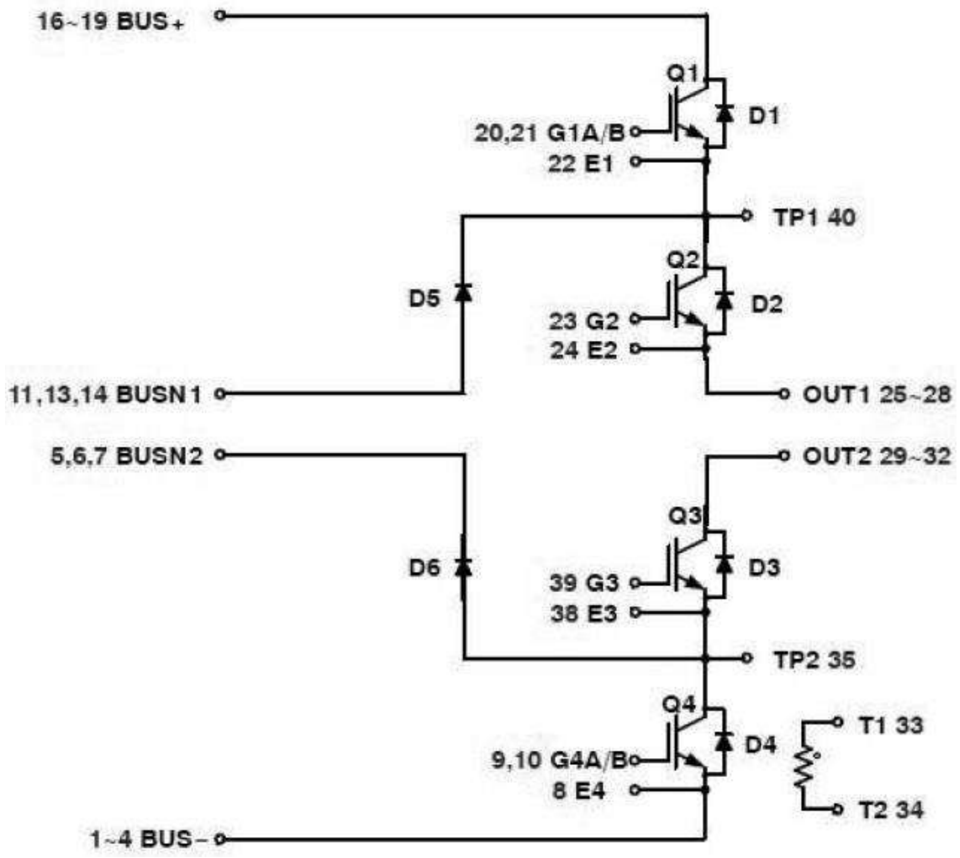

Fig.16 Reverse bias safe operating area IGBT,Inverter(RBSOA)
$I_c$ = f ($V_{CE}$),
$V_{GE}$ = +15V/-7V ,$R_{Goff}$ = 32 Ω, $T_{vj}$ = 150℃



**HCG450FL065K1F1**

650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

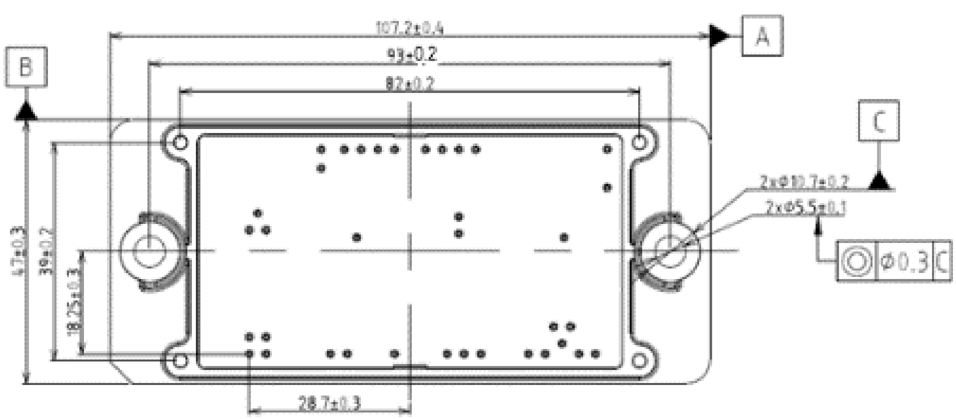
## Circuit Diagram

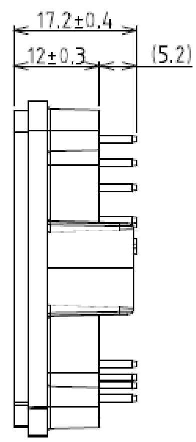


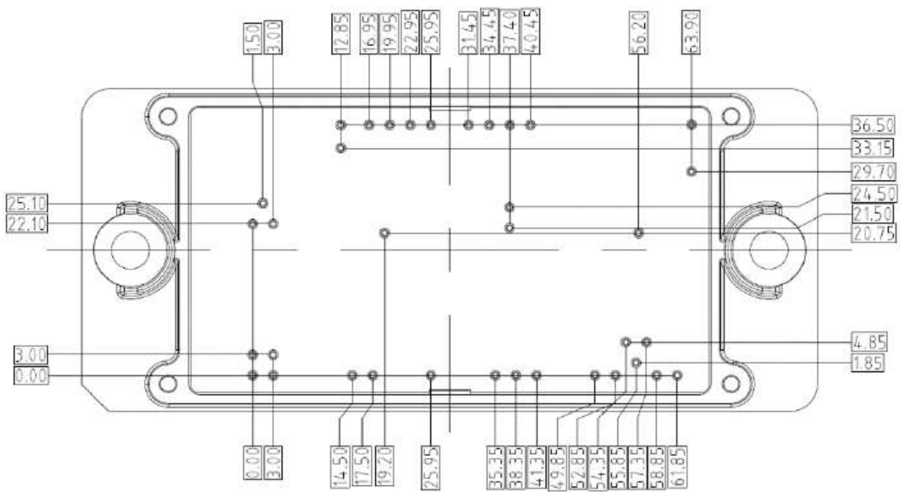
**HCG450FL065K1F1**

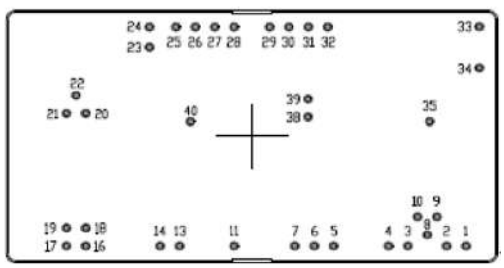
650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

## Package Outlines



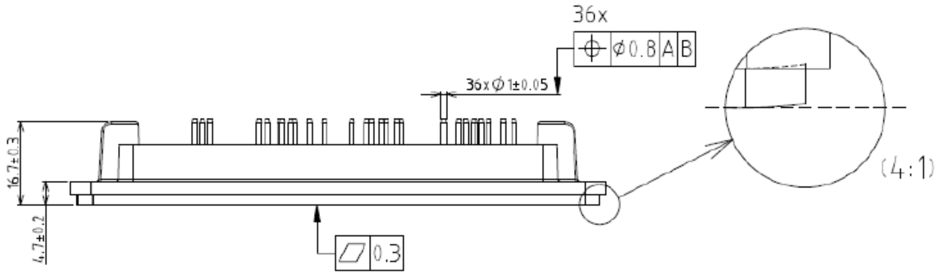



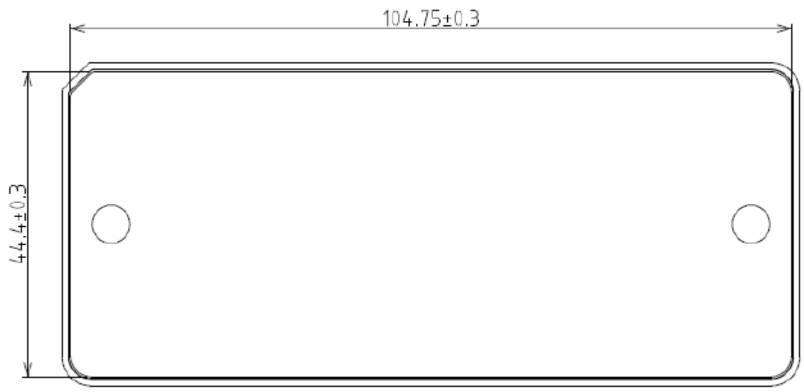



**HCG450FL065K1F1**
650V / 450A C2 (size similar to Flow 2 with Cu Baseplate)

**Package Outlines (continued)**



## Revision History

| Document Version | Description of Changes |
|---|---|
| RevX.0.1 | Released |
| | |
| | |

Zhejiang HIITIO New Energy Co., Ltd
ADD : NO.1125 Zhixing Road,Qiaonan District, Xiaoshan Economic and Technological Development Zone,Hangzhou,Zhejiang
TEL :400-667-9977

IMPORTANT NOTICE:

This product data sheet describes the characteristics of this product for which a warranty is granted. Any such warranty is granted exclusively under the terms and conditions of the supply agreement. There will be no guarantee or of any kind for the product and its characteristics.

The data contained in this document is exclusively intended for technically trained staff. You and your technical departments will have to evaluate the product's suitability for the intended application and the completeness of the product data concerning such application.

Due to technical requirements, our product may contain dangerous substances. For information on the types in question, please contact the sales staff responsible for you.

Changes to this product data sheet are reserved.

Please contact the sales staff (sales@hiitio.com) for further information on the product, technology, delivery terms, conditions and prices.