

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD400CUY65C2S

**650V/400A 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 general inverters and UPS.

### Features

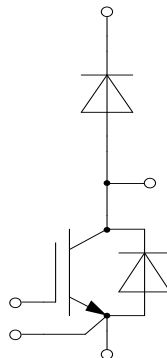
- Low  $V_{CE(sat)}$  Trench IGBT technology
- 6 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175°C
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology



### Typical Applications

- Inverter for motor drive
- AC and DC servo drive amplifier
- Uninterruptible power supply

### Equivalent Circuit Schematic



**Absolute Maximum Ratings**  $T_C=25^{\circ}\text{C}$  unless otherwise noted**IGBT**

| Symbol    | Description   | Value    | Unit |
|-----------|---|----------|------|
| $V_{CES}$ | Collector-Emitter Voltage                             | 650      | V    |
| $V_{GES}$ | Gate-Emitter Voltage                                  | $\pm 20$ | V    |
| $I_C$     | Collector Current @ $T_C=25^{\circ}\text{C}$          | 499      | A    |
|           | @ $T_C=65^{\circ}\text{C}$                            | 400      | A    |
| $I_{CM}$  | Pulsed Collector Current $t_p=1\text{ms}$             | 800      | A    |
| $P_D$     | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$ | 1239     | W    |

**Diode**

| Symbol    | Description                                    | Value | Unit |
|-----------|--|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                | 650   | V    |
| $I_F$     | Diode Continuous Forward Current               | 400   | A    |
| $I_{FM}$  | Diode Maximum Forward Current $t_p=1\text{ms}$ | 800   | A    |

**Module**

| Symbol     | Description  | Value       | Unit               |
|------------|--|-------------|--------------------|
| $T_{jmax}$ | Maximum Junction Temperature                             | 175         | $^{\circ}\text{C}$ |
| $T_{jop}$  | Operating Junction Temperature                           | -40 to +150 | $^{\circ}\text{C}$ |
| $T_{STG}$  | Storage Temperature Range                                | -40 to +125 | $^{\circ}\text{C}$ |
| $V_{ISO}$  | Isolation Voltage RMS, $f=50\text{Hz}$ , $t=1\text{min}$ | 4000        | V                  |

**IGBT Characteristics**  $T_c=25^\circ\text{C}$  unless otherwise noted

| Symbol        | Parameter                               | Test Conditions  | Min.  | Typ. | Max. | Unit          |    |
|---------------|---|--|---|------|------|---------------|----|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$   |   | 1.45 | 1.90 | V             |    |
|               |   | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$  |   | 1.60 |      |               |    |
|               |   | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$  |   | 1.70 |      |               |    |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=6.40\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$   | 5.1   | 5.8  | 6.5  | V             |    |
| $I_{CES}$     | Collector Cut-Off Current               | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$   |   |      | 5.0  | mA            |    |
| $I_{GES}$     | Gate-Emitter Leakage Current            | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$   |   |      | 400  | nA            |    |
| $R_{Gint}$    | Internal Gate Resistance                |  |   | 1.0  |      | $\Omega$      |    |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$   |   | 23.4 |      | nF            |    |
| $C_{res}$     | Reverse Transfer Capacitance            |  |   |      | 0.68 |               | nF |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\text{V}\dots+15\text{V}$   |   | 3.87 |      | $\mu\text{C}$ |    |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$  |   | 88   |      | ns            |    |
| $t_r$         | Rise Time                               |  |   | 40   |      | ns            |    |
| $t_{d(off)}$  | Turn-Off Delay Time                     |  |   | 294  |      | ns            |    |
| $t_f$         | Fall Time                               |  |   | 43   |      | ns            |    |
| $E_{on}$      | Turn-On Switching Loss                  |  |   | 1.32 |      | mJ            |    |
| $E_{off}$     | Turn-Off Switching Loss                 |  |   | 12.5 |      | mJ            |    |
| $t_{d(on)}$   | Turn-On Delay Time                      |  | $V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$              |      | 96   |               | ns |
| $t_r$         | Rise Time                               |  |   |      | 48   |               | ns |
| $t_{d(off)}$  | Turn-Off Delay Time                     |  |   | 312  |      | ns            |    |
| $t_f$         | Fall Time                               |  |   | 60   |      | ns            |    |
| $E_{on}$      | Turn-On Switching Loss                  |  |   | 1.92 |      | mJ            |    |
| $E_{off}$     | Turn-Off Switching Loss                 |  |   | 13.5 |      | mJ            |    |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=300\text{V}, I_C=400\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$ |   |      | 104  |               | ns |
| $t_r$         | Rise Time                               |  |   |      | 48   |               | ns |
| $t_{d(off)}$  | Turn-Off Delay Time                     |  |   | 318  |      | ns            |    |
| $t_f$         | Fall Time                               |  |   | 60   |      | ns            |    |
| $E_{on}$      | Turn-On Switching Loss                  |  |   | 2.04 |      | mJ            |    |
| $E_{off}$     | Turn-Off Switching Loss                 |  |   | 14.0 |      | mJ            |    |
| $I_{SC}$      | SC Data                                 |  | $t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$ |      | 2000 |               | A  |

**Diode Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

| Symbol    | Parameter                     | Test Conditions   | Min. | Typ. | Max. | Unit          |
|-----------|-------------------------------|---|------|------|------|---------------|
| $V_F$     | Diode Forward Voltage         | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$   |      | 1.55 | 2.00 | V             |
|           |                               | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$  |      | 1.50 |      |               |
|           |                               | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$  |      | 1.45 |      |               |
| $Q_r$     | Recovered Charge              |   |      | 16.5 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current | $V_R=300\text{V}, I_F=400\text{A},$<br>$-di/dt=7700\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=25^\circ\text{C}$  |      | 297  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |   |      | 3.96 |      | mJ            |
| $Q_r$     | Recovered Charge              |   |      | 31.9 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current | $V_R=300\text{V}, I_F=400\text{A},$<br>$-di/dt=7700\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=125^\circ\text{C}$ |      | 363  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |   |      | 8.14 |      | mJ            |
| $Q_r$     | Recovered Charge              |   |      | 35.2 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current | $V_R=300\text{V}, I_F=400\text{A},$<br>$-di/dt=7700\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=150^\circ\text{C}$ |      | 385  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |   |      | 9.13 |      | mJ            |

**Module Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

| Symbol        | Parameter                                | Min. | Typ.  | Max.  | Unit       |
|---------------|--|------|-------|-------|------------|
| $L_{CE}$      | Stray Inductance                         |      | 15    |       | nH         |
| $R_{CC'+EE'}$ | Module Lead Resistance, Terminal to Chip |      | 0.25  |       | m $\Omega$ |
| $R_{thJC}$    | Junction-to-Case (per IGBT)              |      |       | 0.121 | K/W        |
|               | Junction-to-Case (per Diode)             |      |       | 0.222 |            |
| $R_{thCH}$    | Case-to-Heatsink (per IGBT)              |      | 0.021 |       | K/W        |
|               | Case-to-Heatsink (per Diode)             |      | 0.038 |       |            |
|               | Case-to-Heatsink (per Module)            |      | 0.010 |       |            |
| M             | Terminal Connection Torque, Screw M6     | 2.5  |       | 5.0   | N.m        |
|               | Mounting Torque, Screw M6                | 3.0  |       | 5.0   |            |
| G             | Weight of Module                         |      | 300   |       | g          |

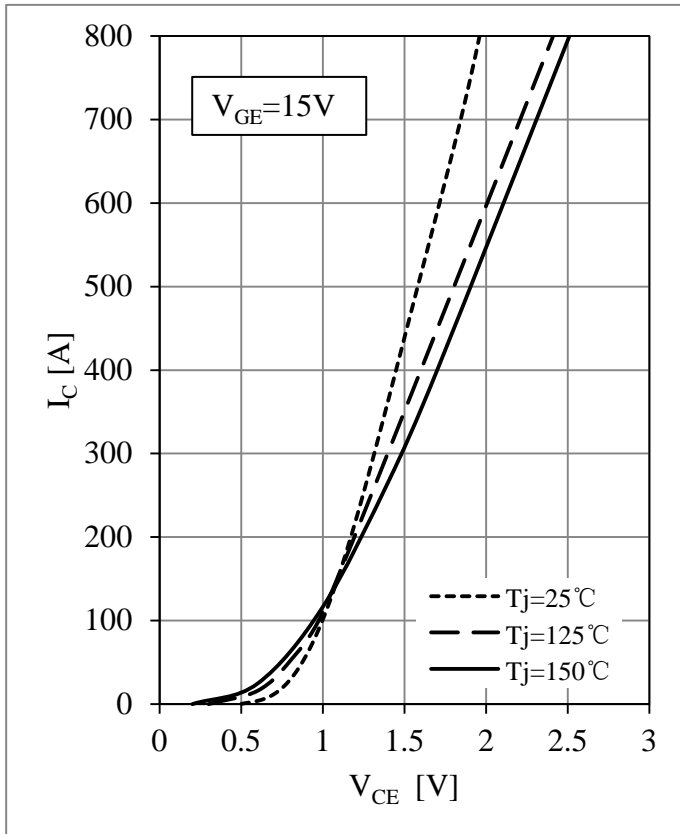


Fig 1. IGBT Output Characteristics

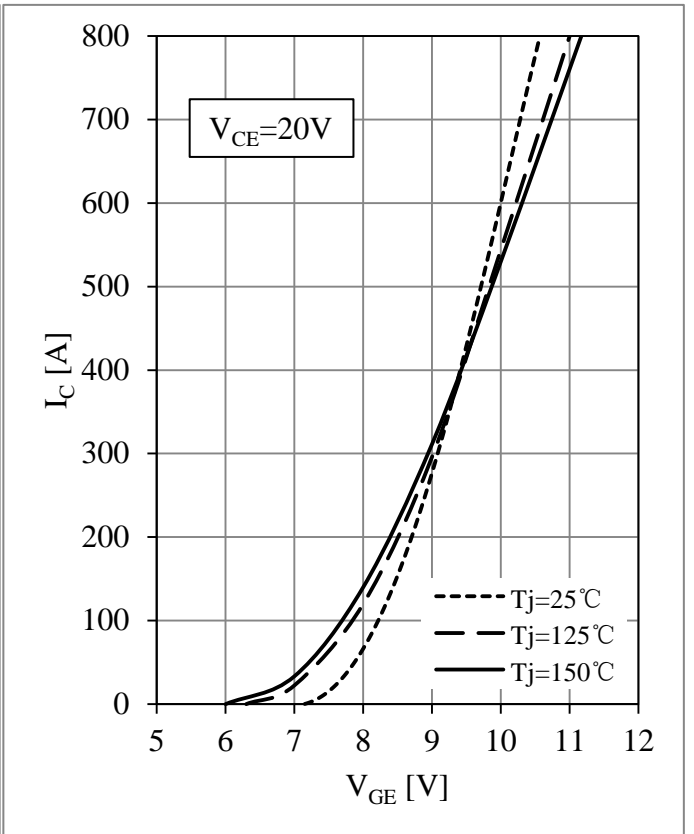


Fig 2. IGBT Transfer Characteristics

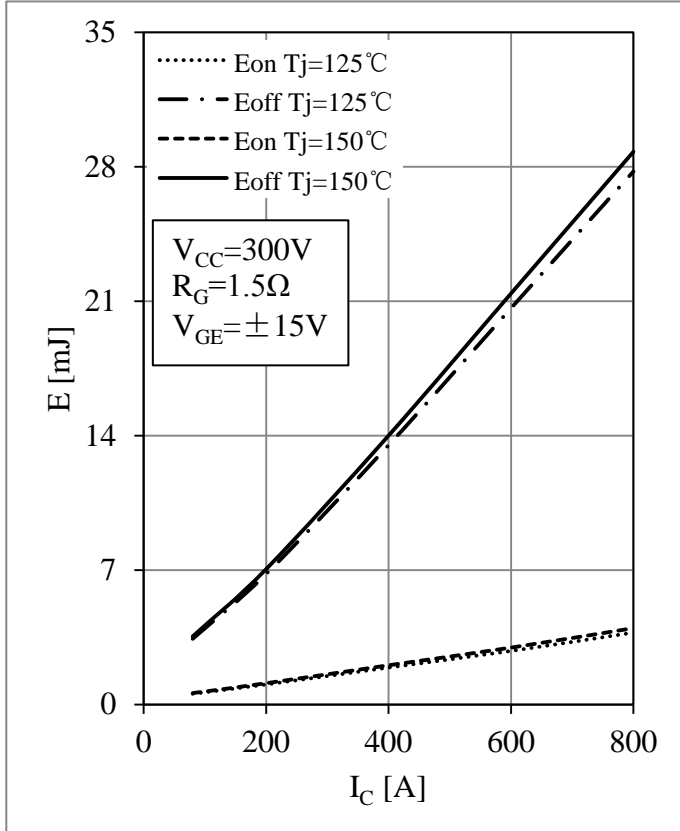


Fig 3. IGBT Switching Loss vs.  $I_c$

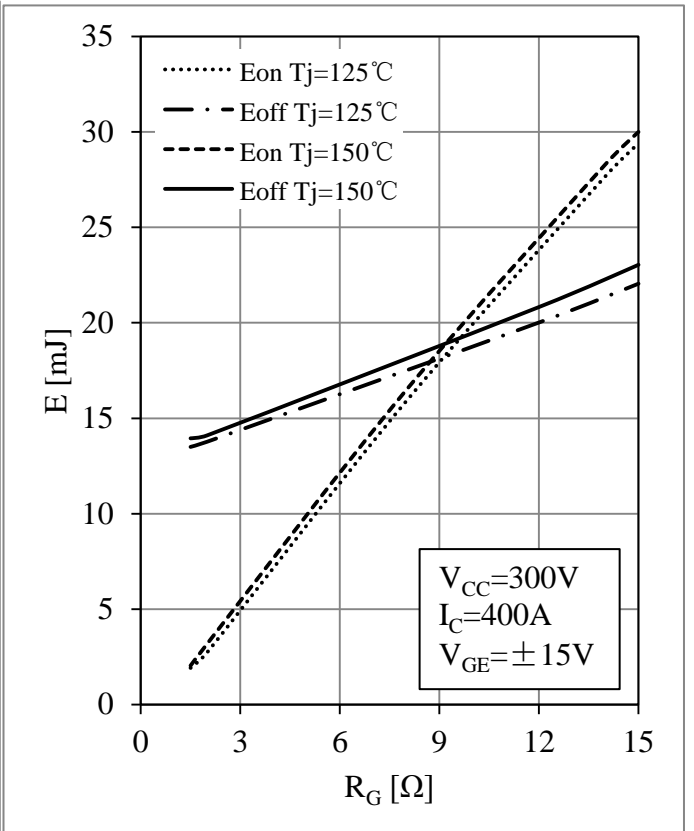


Fig 4. IGBT Switching Loss vs.  $R_G$

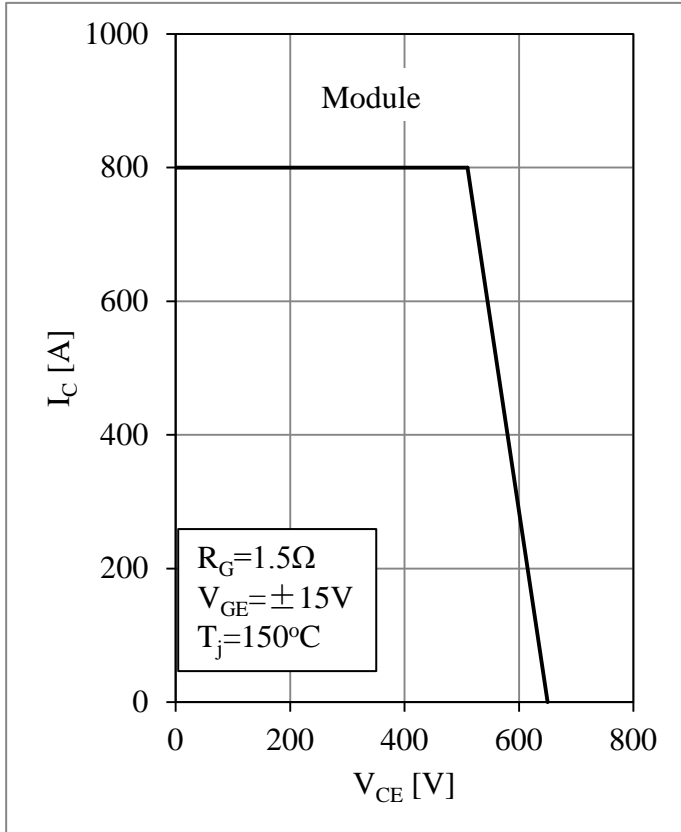


Fig 5. RBSOA

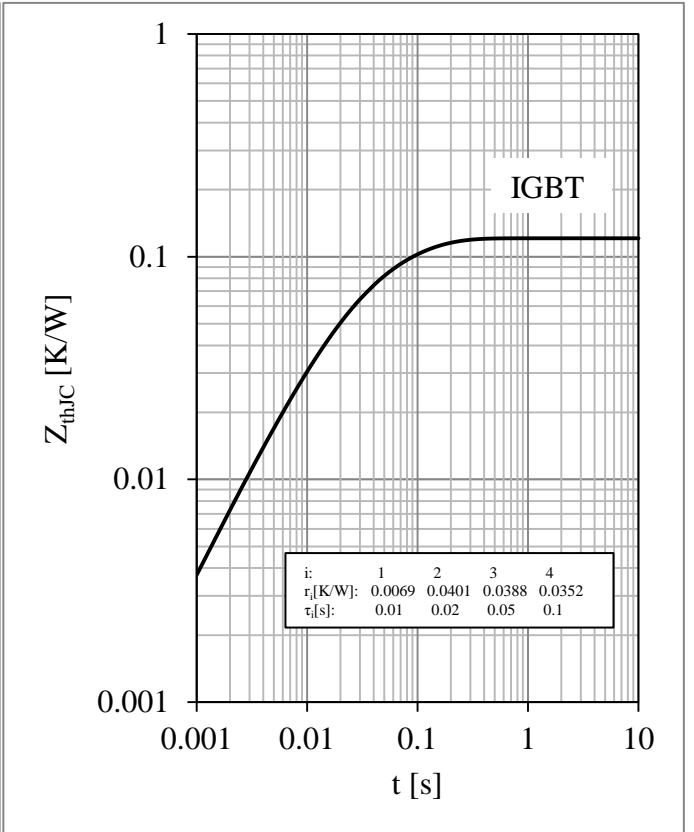


Fig 6. IGBT Transient Thermal Impedance

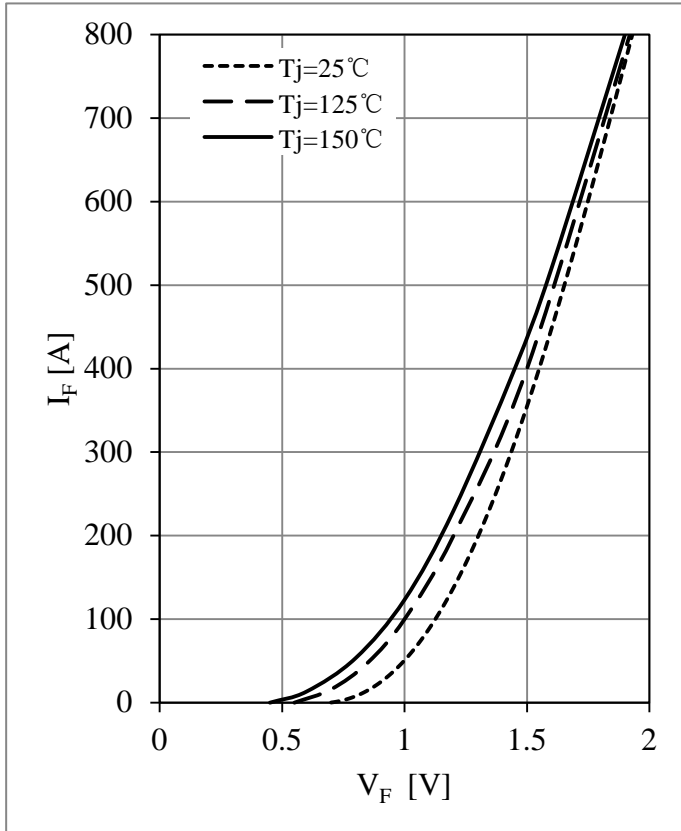


Fig 7. Diode Forward Characteristics

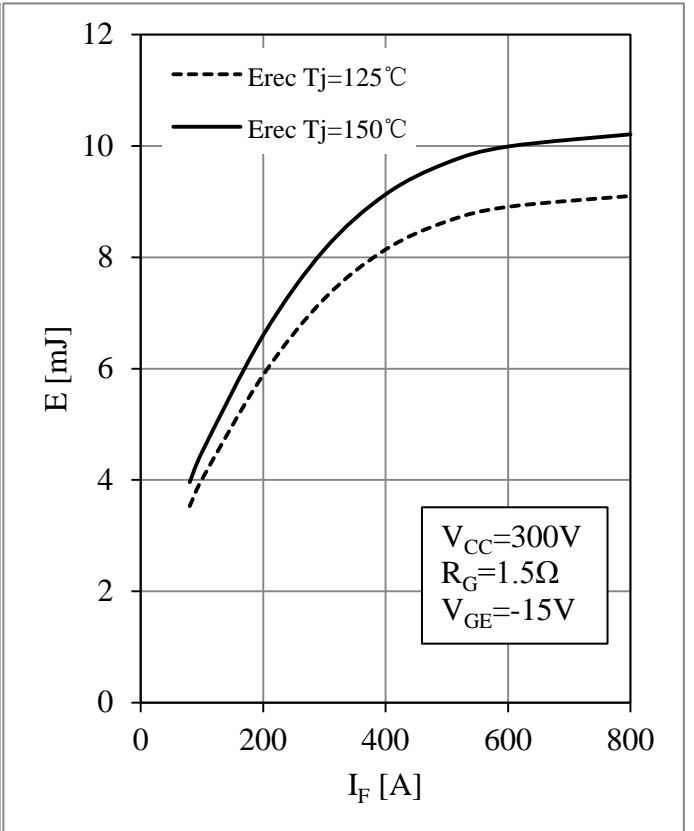


Fig 8. Diode Switching Loss vs.  $I_F$

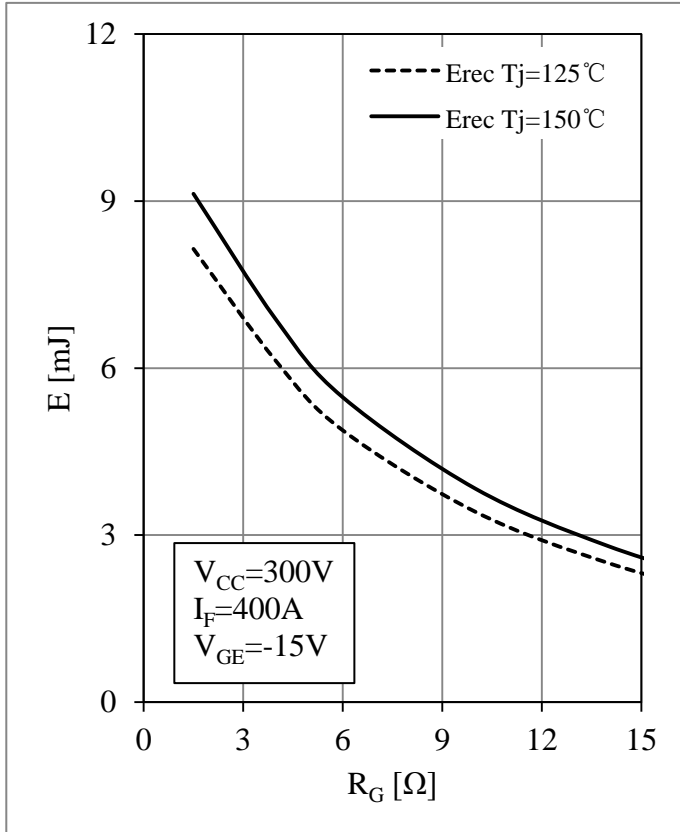


Fig 9. Diode Switching Loss vs.  $R_G$

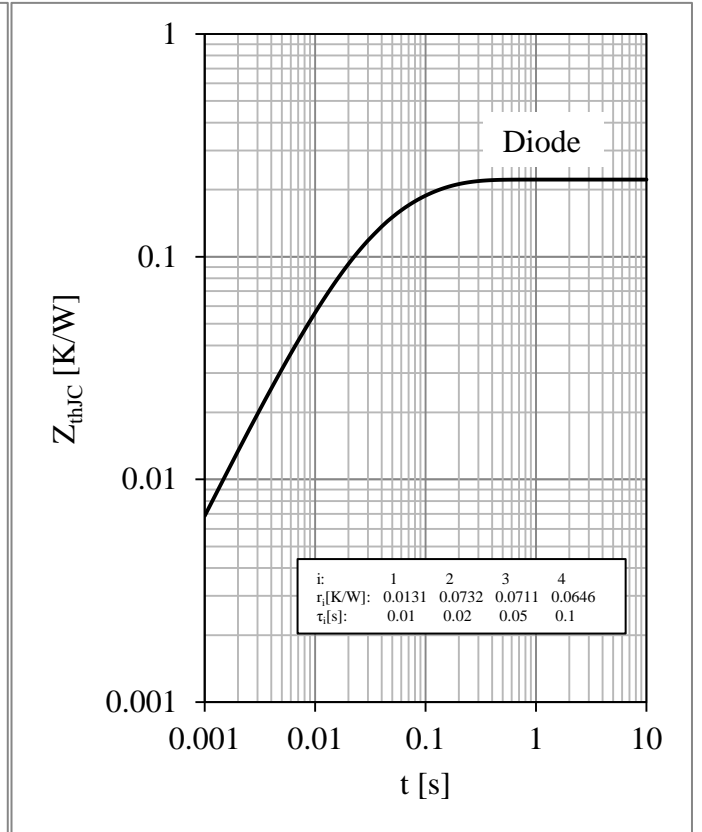
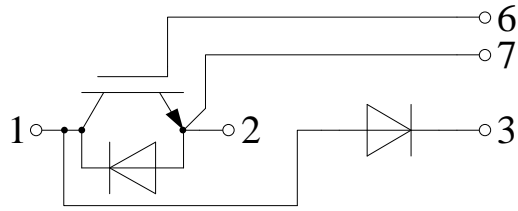


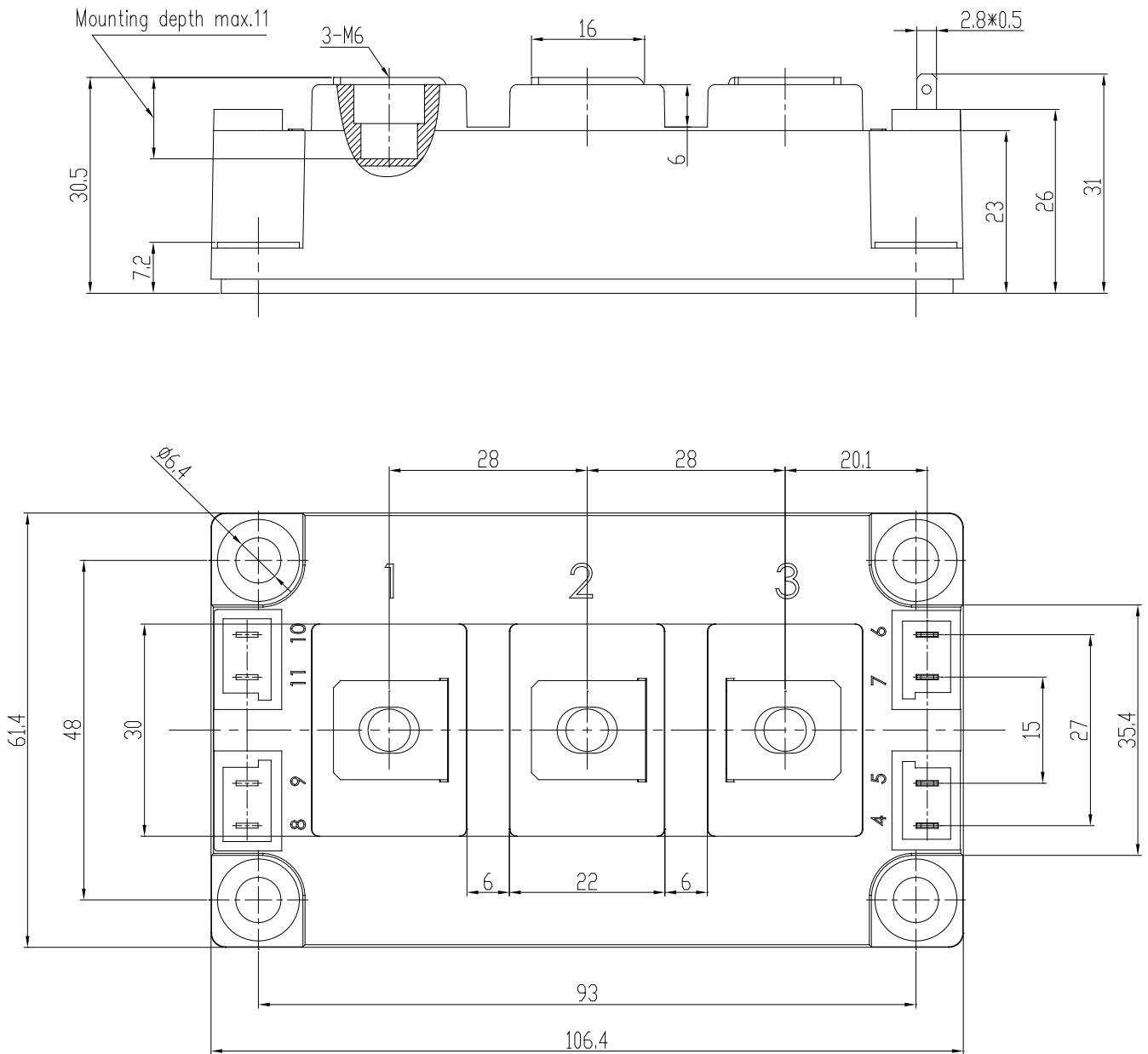
Fig 10. Diode Transient Thermal Impedance

### Circuit Schematic



### Package Dimensions

Dimensions in Millimeters





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