

# STARPOWER

## SEMICONDUCTOR

## IGBT

# GD400HFX170C2S

**1700V/400A 2 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.

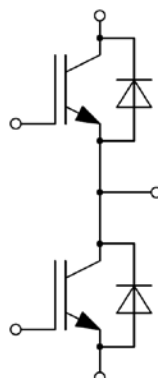
## Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- 10 $\mu$ 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                             | 1700     | V    |
| $V_{GES}$ | Gate-Emitter Voltage                                  | $\pm 20$ | V    |
| $I_C$     | Collector Current @ $T_C=25^{\circ}\text{C}$          | 648      | A    |
|           | @ $T_C=100^{\circ}\text{C}$                           | 400      | A    |
| $I_{CM}$  | Pulsed Collector Current $t_p=1\text{ms}$             | 800      | A    |
| $P_D$     | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$ | 2380     | W    |

**Diode**

| Symbol    | Description                                    | Value | Unit |
|-----------|------------------------------------------------|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                | 1700  | 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 | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$                                                        |      | 1.85 | 2.20 | V             |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=125^{\circ}\text{C}$                                                       |      | 2.25 |      |               |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}$                                                       |      | 2.35 |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=16.0\text{mA}, V_{CE}=V_{GE}, T_j=25^{\circ}\text{C}$                                                          | 5.6  | 6.2  | 6.8  | 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                |                                                                                                                     |      | 1.88 |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$                                                                |      | 48.2 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                     |      | 1.17 |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\text{V}\dots+15\text{V}$                                                                                |      | 3.77 |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=900\text{V}, I_C=400\text{A}, R_G=0.82\Omega, V_{GE}=\pm 15\text{V}, T_j=25^{\circ}\text{C}$                |      | 204  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 38   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 425  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 113  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 97.9 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 84.0 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=900\text{V}, I_C=400\text{A}, R_G=0.82\Omega, V_{GE}=\pm 15\text{V}, T_j=125^{\circ}\text{C}$               |      | 208  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 50   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 528  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 184  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 141  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 132  |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=900\text{V}, I_C=400\text{A}, R_G=0.82\Omega, V_{GE}=\pm 15\text{V}, T_j=150^{\circ}\text{C}$               |      | 216  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 50   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 544  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 204  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 161  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 137  |      | mJ            |
| $I_{SC}$      | SC Data                                 | $t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}, V_{CC}=100\text{V}, V_{CEM} \leq 1700\text{V}$ |      | 1600 |      | 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         | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                               |      | 1.80 | 2.25 | V             |
|           |                               | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$                                                              |      | 1.90 |      |               |
|           |                               | $I_F=400\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$                                                              |      | 1.95 |      |               |
| $Q_r$     | Recovered Charge              | $V_R=900\text{V}, I_F=400\text{A},$<br>$-di/dt=8800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=25^{\circ}\text{C}$  |      | 116  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 666  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 63.8 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=900\text{V}, I_F=400\text{A},$<br>$-di/dt=8800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=125^{\circ}\text{C}$ |      | 187  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 662  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 114  |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=900\text{V}, I_F=400\text{A},$<br>$-di/dt=8800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=150^{\circ}\text{C}$ |      | 209  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 640  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 132  |      | mJ            |

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

| Symbol        | Parameter                                | Min. | Typ.  | Max.  | Unit       |
|---------------|------------------------------------------|------|-------|-------|------------|
| $L_{CE}$      | Stray Inductance                         |      |       | 20    | nH         |
| $R_{CC'+EE'}$ | Module Lead Resistance, Terminal to Chip |      | 0.35  |       | m $\Omega$ |
| $R_{thJC}$    | Junction-to-Case (per IGBT)              |      |       | 0.063 | K/W        |
|               | Junction-to-Case (per Diode)             |      |       | 0.105 |            |
| $R_{thCH}$    | Case-to-Heatsink (per IGBT)              |      | 0.032 |       | K/W        |
|               | Case-to-Heatsink (per Diode)             |      | 0.053 |       |            |
|               | 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          |

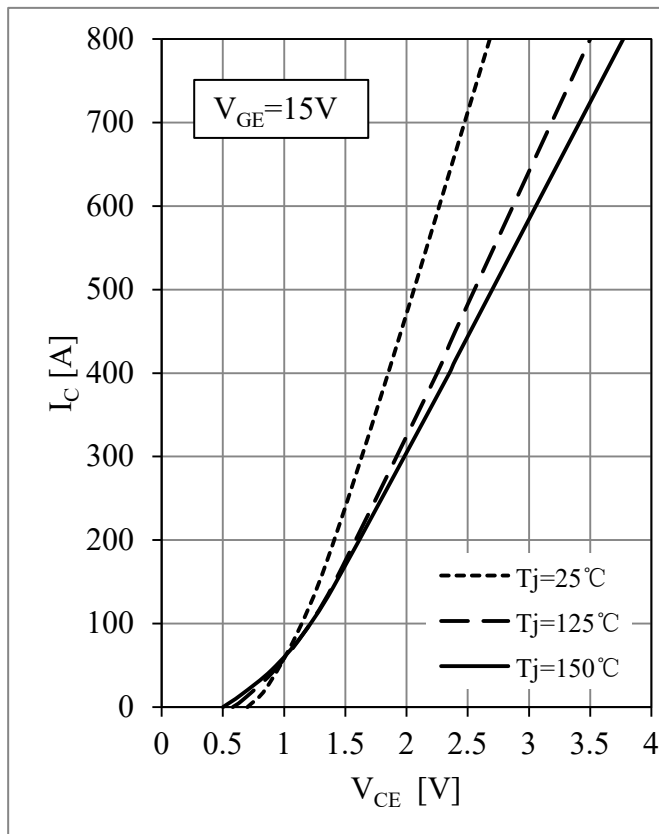


Fig 1. IGBT Output Characteristics

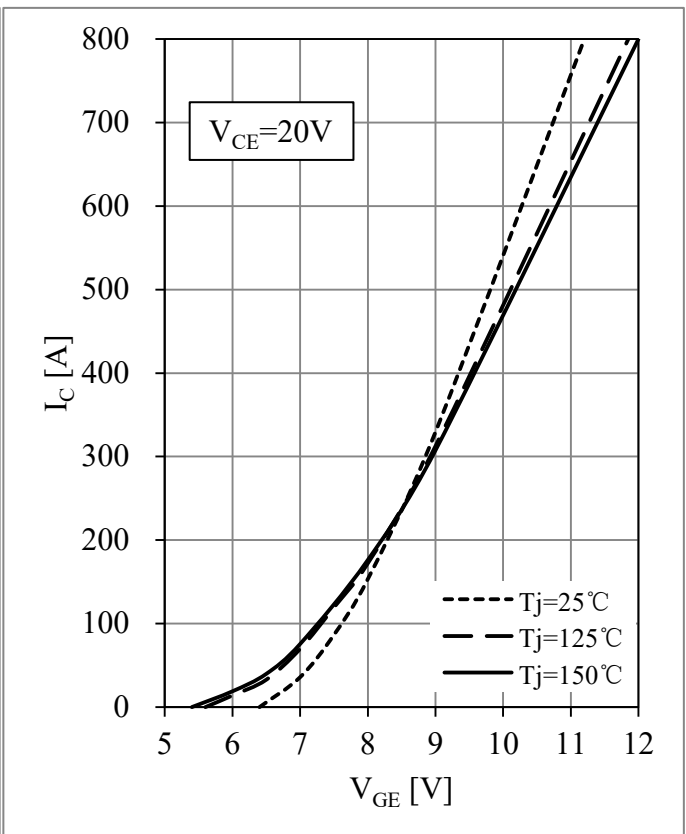
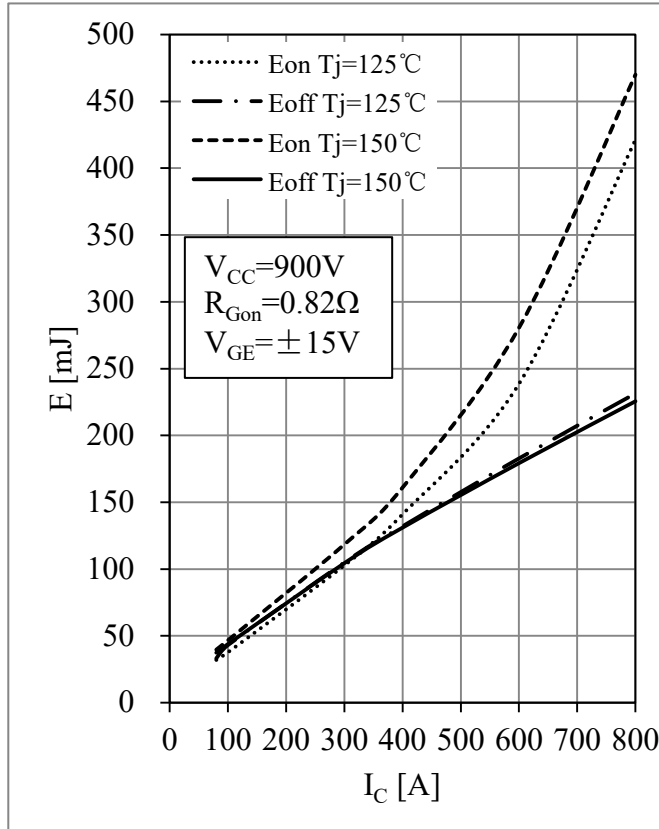
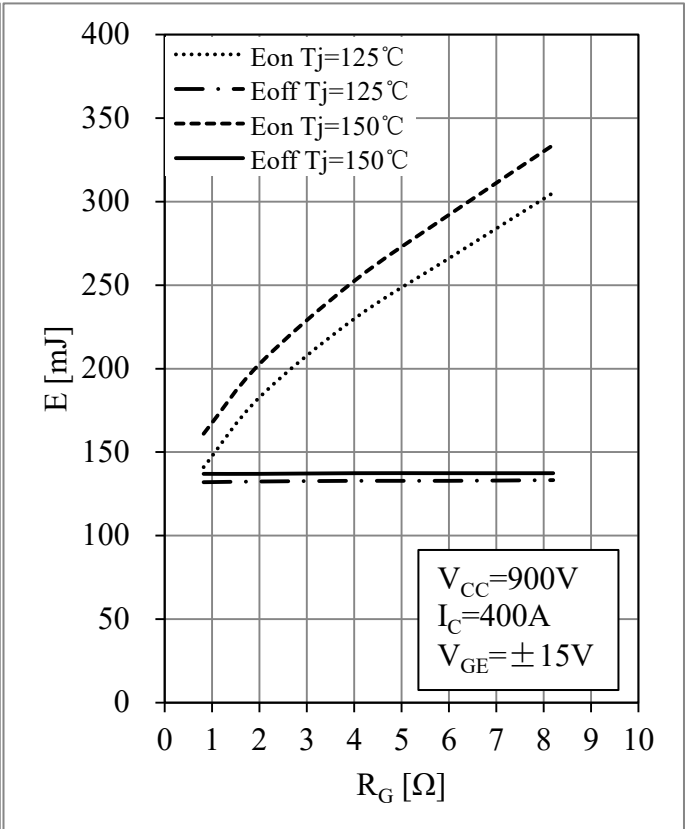


Fig 2. IGBT Transfer Characteristics

Fig 3. IGBT Switching Loss vs.  $I_C$ Fig 4. IGBT Switching Loss vs.  $R_G$

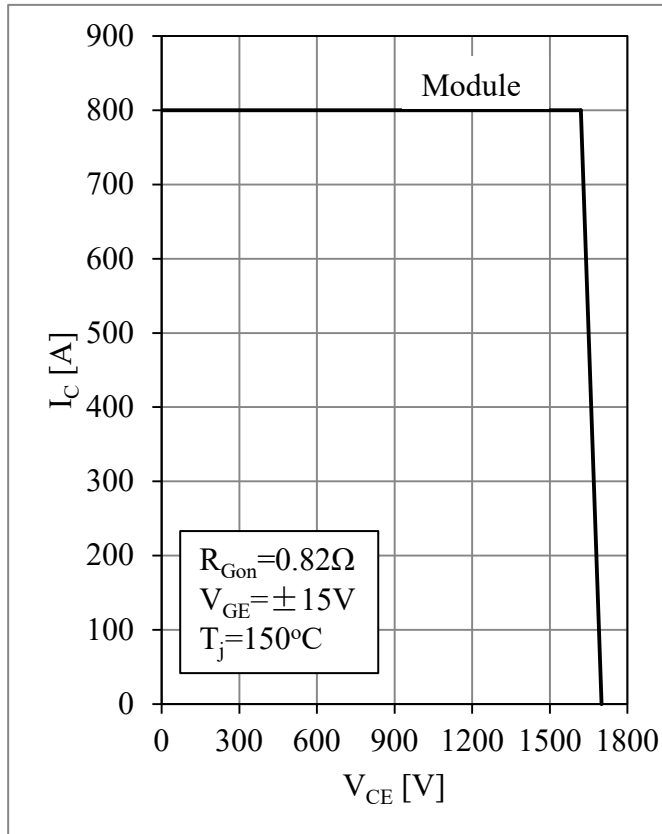


Fig 5. RBSOA

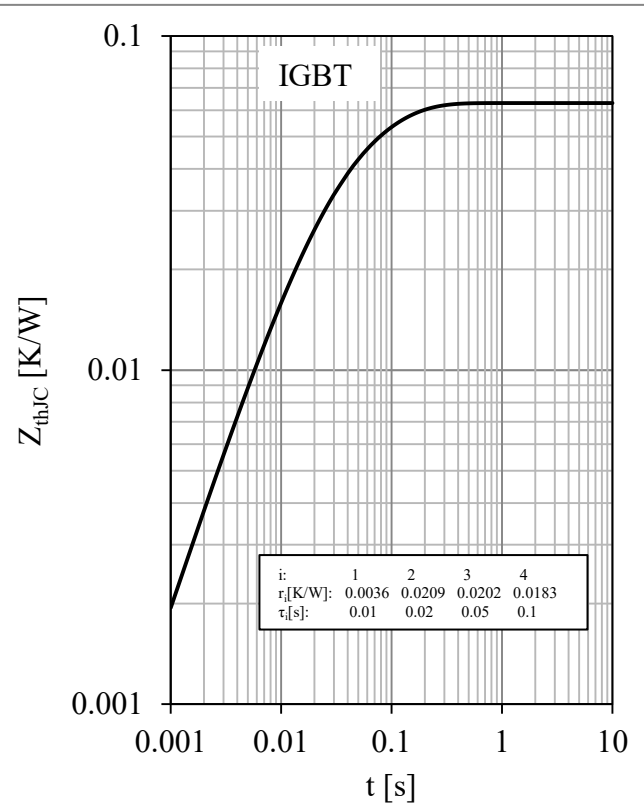


Fig 6. IGBT Transient Thermal Impedance

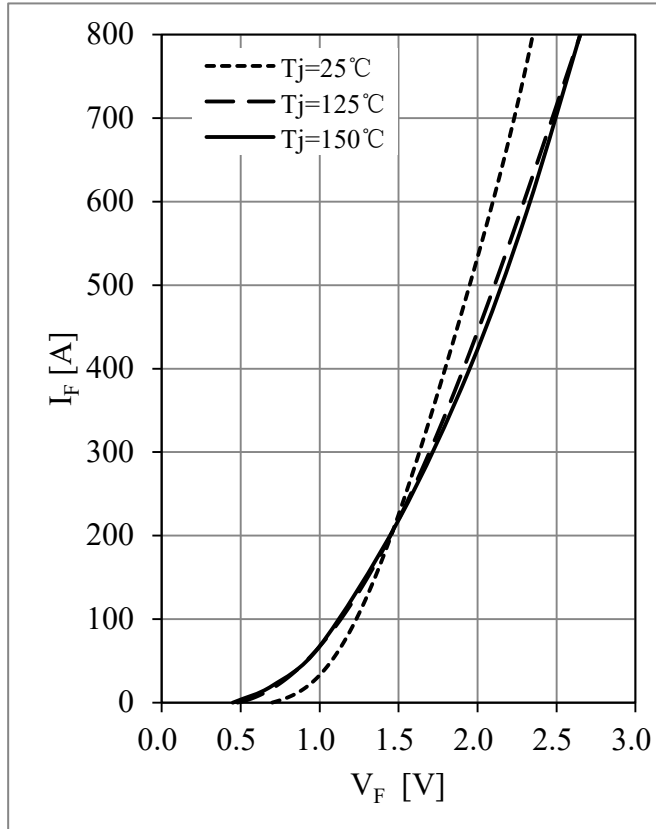
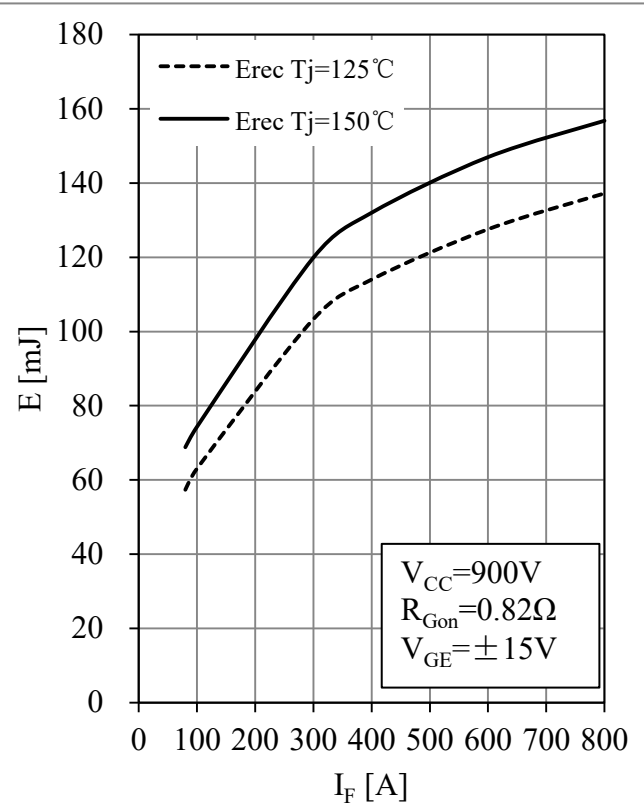


Fig 7. Diode Forward Characteristics

Fig 8. Diode Switching Loss vs.  $I_F$

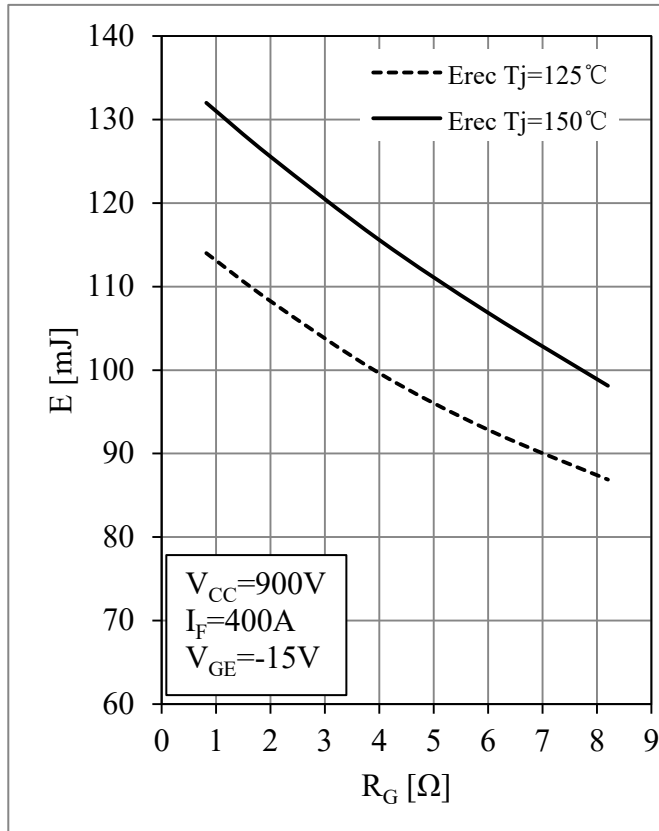
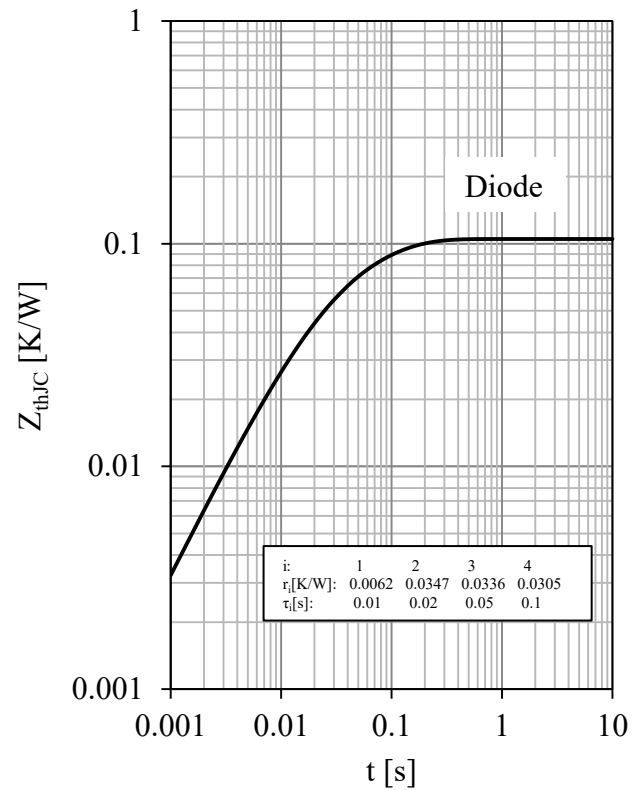
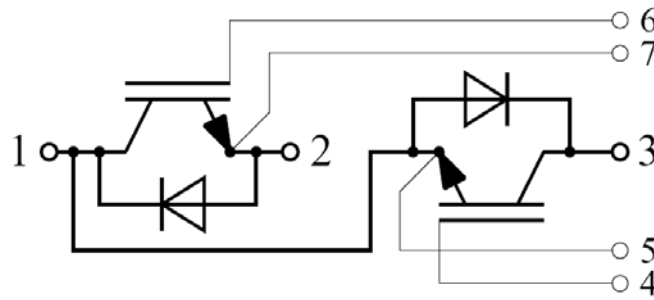
Fig 9. Diode Switching Loss vs.  $R_G$ 

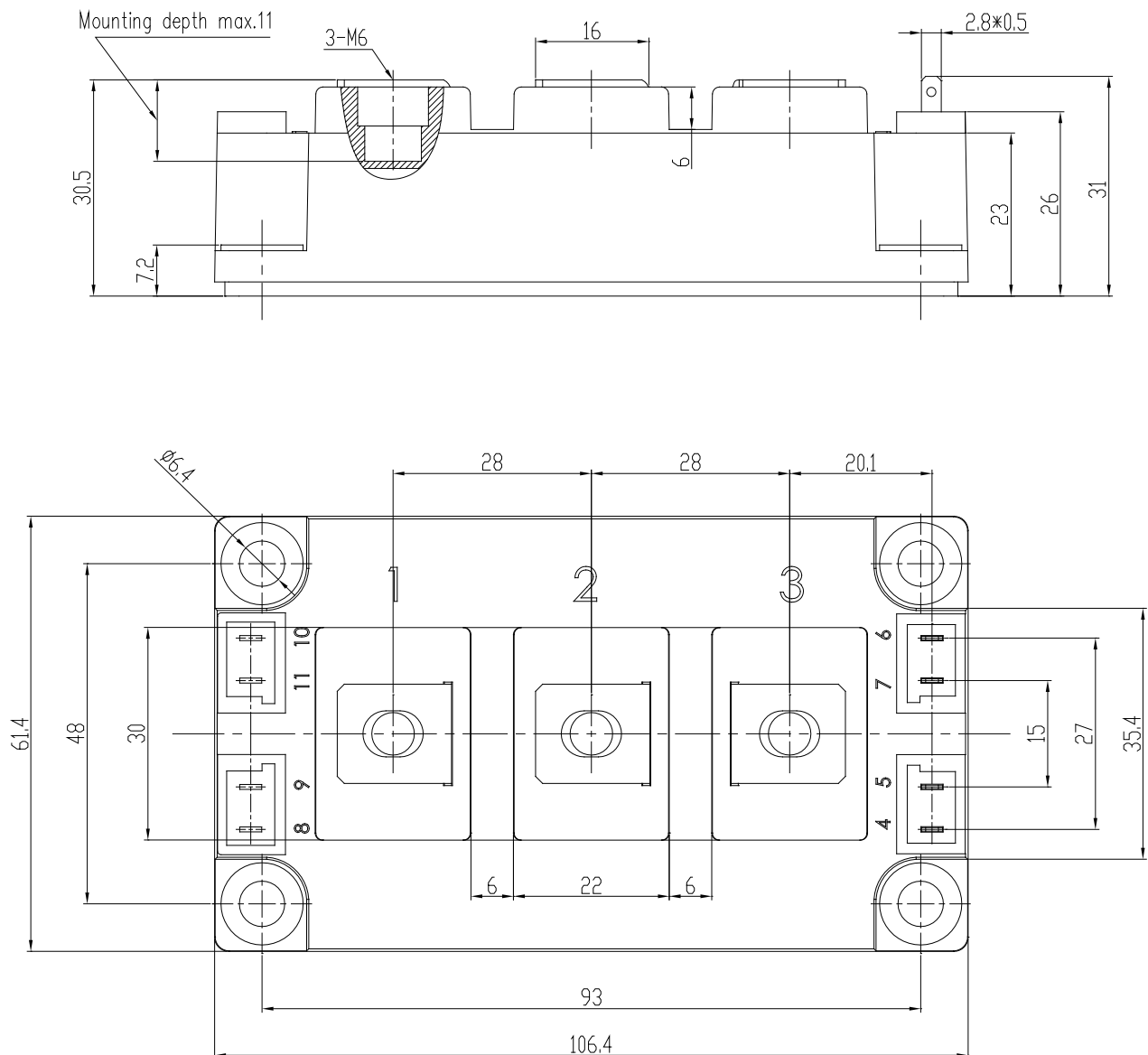
Fig 10. Diode Transient Thermal Impedance

## Circuit Schematic



## Package Dimensions

Dimensions in Millimeters



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