

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD400MJA100F6S

**1000V/400A 3-level 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 3-level-application.

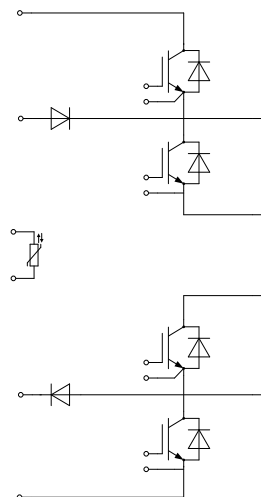
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175 °C
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology

### Typical Applications

- Solar power
- 3-level-application

### Equivalent Circuit Schematic



**Absolute Maximum Ratings**  $T_C=25^{\circ}\text{C}$  unless otherwise noted**T1,T4 IGBT**

| Symbol    | Description                                                | Value                | Unit |
|-----------|------------------------------------------------------------|----------------------|------|
| $V_{CES}$ | Collector-Emitter Voltage                                  | 1000                 | V    |
| $V_{GES}$ | Gate-Emitter Voltage<br>Transient Gate-Emitter Voltage     | $\pm 20$<br>$\pm 30$ | V    |
| $I_{CN}$  | Implemented Collector Current                              | 400                  | A    |
| $I_C$     | Collector Current @ $T_C=100^{\circ}\text{C}$              | 200                  | A    |
| $I_{CRM}$ | Repetitive Peak Collector Current tp limited by $T_{vjop}$ | 800                  | A    |

**T2,T3 IGBT**

| Symbol    | Description                                                | Value                | Unit |
|-----------|------------------------------------------------------------|----------------------|------|
| $V_{CES}$ | Collector-Emitter Voltage                                  | 1000                 | V    |
| $V_{GES}$ | Gate-Emitter Voltage<br>Transient Gate-Emitter Voltage     | $\pm 20$<br>$\pm 30$ | V    |
| $I_{CN}$  | Implemented Collector Current                              | 400                  | A    |
| $I_C$     | Collector Current @ $T_C=100^{\circ}\text{C}$              | 200                  | A    |
| $I_{CRM}$ | Repetitive Peak Collector Current tp limited by $T_{vjop}$ | 800                  | A    |

**D1-D4 Diode**

| Symbol    | Description                                              | Value | Unit |
|-----------|----------------------------------------------------------|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                          | 1000  | V    |
| $I_{FN}$  | Implemented Forward Current                              | 200   | A    |
| $I_F$     | Diode Continuous Forward Current                         | 200   | A    |
| $I_{FRM}$ | Repetitive Peak Forward Current tp limited by $T_{vjop}$ | 400   | A    |

**D5,D6 Diode**

| Symbol    | Description                                              | Value | Unit |
|-----------|----------------------------------------------------------|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                          | 1000  | V    |
| $I_{FN}$  | Implemented Forward Current                              | 100   | A    |
| $I_F$     | Diode Continuous Forward Current                         | 100   | A    |
| $I_{FRM}$ | Repetitive Peak Forward Current tp limited by $T_{vjop}$ | 200   | A    |

**Module**

| Symbol      | Description                                              | Value       | Unit               |
|-------------|----------------------------------------------------------|-------------|--------------------|
| $T_{vjmax}$ | Maximum Junction Temperature                             | 175         | $^{\circ}\text{C}$ |
| $T_{vjop}$  | 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, $f=50\text{Hz}$ , $t=1\text{min}$ | 3200        | V                  |

**T1,T4 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 | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                         |      | 1.50 | 1.95 | V             |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=125^{\circ}\text{C}$                                                                                        |      | 1.75 |      |               |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}$                                                                                        |      | 1.85 |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=8.00\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^{\circ}\text{C}$                                                                                           | 4.0  | 4.7  | 5.4  | V             |
| $I_{CES}$     | Collector Cut-Off Current               | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                           |      |      | 1.0  | mA            |
| $I_{GES}$     | Gate-Emitter Leakage Current            | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                           |      |      | 400  | nA            |
| $R_{Gint}$    | Internal Gate Resistance                |                                                                                                                                                         |      | 1.3  |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=100\text{kHz}, V_{GE}=0\text{V}$                                                                                                  |      | 33.3 |      | nF            |
| $C_{oes}$     | Onput Capacitance                       |                                                                                                                                                         |      | 1.19 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                                                         |      | 0.19 |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\dots+15\text{V}$                                                                                                                            |      | 2.33 |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=7.5\Omega, R_{Goff}=27\Omega, L_S=25\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 143  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 47   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 1393 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 30   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 8.43 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 10.1 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=7.5\Omega, R_{Goff}=27\Omega, L_S=25\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=125^{\circ}\text{C}$ |      | 145  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 50   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 1509 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 38   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 9.17 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 13.6 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=7.5\Omega, R_{Goff}=27\Omega, L_S=25\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 151  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 52   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 1724 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 39   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 9.20 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 15.0 |      | mJ            |

**T2,T3 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 | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                         |      | 1.50 | 1.95 | V             |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=125^{\circ}\text{C}$                                                                                        |      | 1.75 |      |               |
|               |                                         | $I_C=400\text{A}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}$                                                                                        |      | 1.85 |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=8.00\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^{\circ}\text{C}$                                                                                           | 4.0  | 4.7  | 5.4  | V             |
| $I_{CES}$     | Collector Cut-Off Current               | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                           |      |      | 1.0  | mA            |
| $I_{GES}$     | Gate-Emitter Leakage Current            | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                           |      |      | 400  | nA            |
| $R_{Gint}$    | Internal Gate Resistance                |                                                                                                                                                         |      | 1.3  |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=100\text{kHz}, V_{GE}=0\text{V}$                                                                                                  |      | 33.3 |      | nF            |
| $C_{oes}$     | Onput Capacitance                       |                                                                                                                                                         |      | 1.19 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                                                         |      | 0.19 |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\dots+15\text{V}$                                                                                                                            |      | 2.33 |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=2.2\Omega, R_{Goff}=51\Omega, L_S=40\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 397  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 77   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 2023 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 71   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 6.22 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 14.7 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=2.2\Omega, R_{Goff}=51\Omega, L_S=40\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=125^{\circ}\text{C}$ |      | 439  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 80   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 2247 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 58   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 8.74 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 18.2 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=750\text{V}, I_C=200\text{A}, R_{Gon}=2.2\Omega, R_{Goff}=51\Omega, L_S=40\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 452  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                         |      | 82   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                         |      | 2301 |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                         |      | 55   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                         |      | 9.57 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                         |      | 18.7 |      | mJ            |

**D1-D4 Diode Characteristics**  $T_C=25^{\circ}\text{C}$  unless otherwise noted

| Symbol | Parameter             | Test Conditions                                                 | Min. | Typ. | Max. | Unit |
|--------|-----------------------|-----------------------------------------------------------------|------|------|------|------|
| $V_F$  | Diode Forward Voltage | $I_F=200\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 1.60 | 2.05 | V    |
|        |                       | $I_F=200\text{A}, V_{GE}=0\text{V}, T_{vj}=125^{\circ}\text{C}$ |      | 1.60 |      |      |
|        |                       | $I_F=200\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 1.55 |      |      |

**D5,D6 Diode Characteristics**  $T_C=25^{\circ}\text{C}$  unless otherwise noted

| Symbol    | Parameter                     | Test Conditions                                                                                                                               | Min. | Typ. | Max. | Unit          |
|-----------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_F$     | Diode Forward Voltage         | $I_F=100\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                |      | 1.40 | 1.85 | V             |
|           |                               | $I_F=100\text{A}, V_{GE}=0\text{V}, T_{vj}=125^{\circ}\text{C}$                                                                               |      | 1.70 |      |               |
|           |                               | $I_F=100\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$                                                                               |      | 1.80 |      |               |
| $Q_r$     | Recovered Charge              | $V_R=750\text{V}, I_F=200\text{A},$<br>$-di/dt=4540\text{A}/\mu\text{s}, L_S=25\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 0.60 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 41   |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 0.07 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=750\text{V}, I_F=200\text{A},$<br>$-di/dt=4010\text{A}/\mu\text{s}, L_S=25\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=125^{\circ}\text{C}$ |      | 0.61 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 42   |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 0.07 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=750\text{V}, I_F=200\text{A},$<br>$-di/dt=3970\text{A}/\mu\text{s}, L_S=25\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 0.63 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 43   |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 0.08 |      | mJ            |

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

| Symbol       | Parameter              | Test Conditions                                       | Min. | Typ. | Max. | Unit       |
|--------------|------------------------|-------------------------------------------------------|------|------|------|------------|
| $R_{25}$     | Rated Resistance       |                                                       |      | 22.0 |      | k $\Omega$ |
| $\Delta R/R$ | Deviation of $R_{100}$ | $T_C=100^{\circ}\text{C}, R_{100}=1486.1\Omega$       | -5   |      | 5    | %          |
| $P_{25}$     | Power Dissipation      |                                                       |      |      | 200  | mW         |
| $B_{25/50}$  | B-value                | $R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$ |      | 4000 |      | K          |

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

| Symbol     | Parameter                          | Min. | Typ.  | Max.  | Unit |
|------------|------------------------------------|------|-------|-------|------|
| $R_{thJC}$ | Junction-to-Case (per T1,T4 IGBT)  |      |       | 0.133 | K/W  |
|            | Junction-to-Case (per T2,T3 IGBT)  |      |       | 0.142 |      |
|            | Junction-to-Case (per D1-D4 Diode) |      |       | 0.298 |      |
|            | Junction-to-Case (per D5,D6 Diode) |      |       | 0.328 |      |
| $R_{thCH}$ | Case-to-Heatsink (per T1,T4 IGBT)  |      | 0.036 |       | K/W  |
|            | Case-to-Heatsink (per T2,T3 IGBT)  |      | 0.045 |       |      |
|            | Case-to-Heatsink (per D1-D4 Diode) |      | 0.072 |       |      |
|            | Case-to-Heatsink (per D5,D6 Diode) |      | 0.065 |       |      |
| M          | Mounting Torque, Screw:M5          | 3.0  |       | 5.0   | N.m  |
| G          | Weight of Module                   |      | 250   |       | g    |

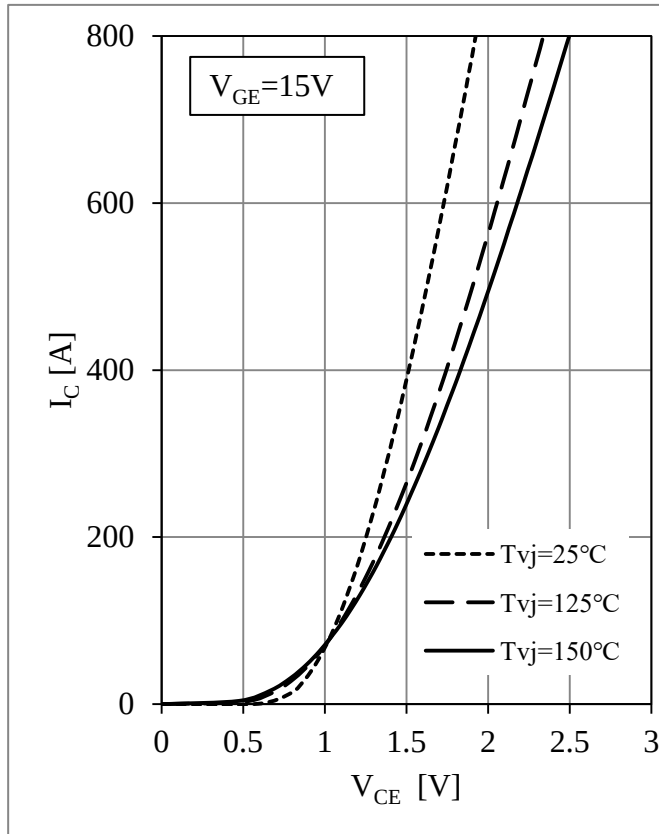


Fig 1. T1,T4 IGBT Output Characteristics

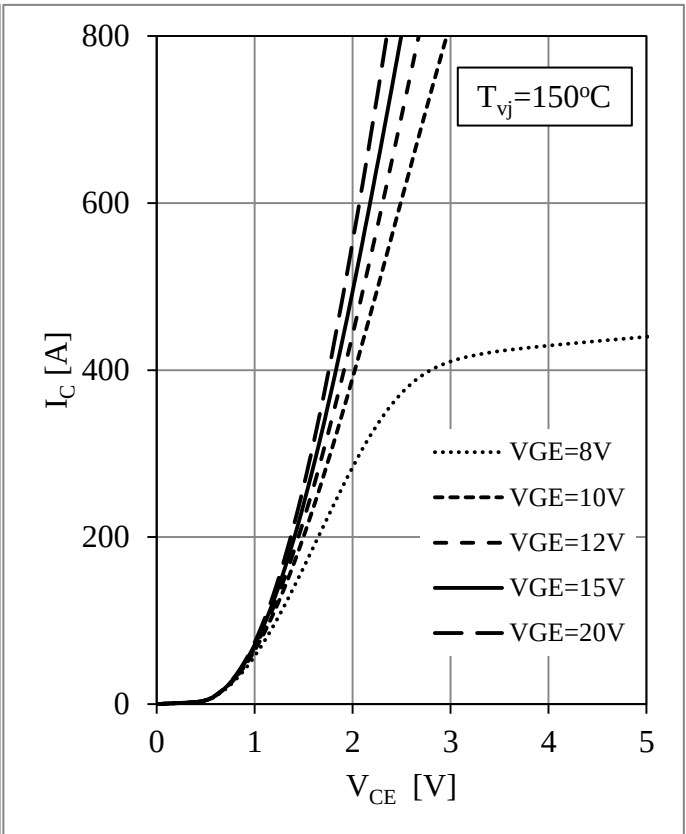


Fig 2. T1,T4 IGBT Output Characteristics

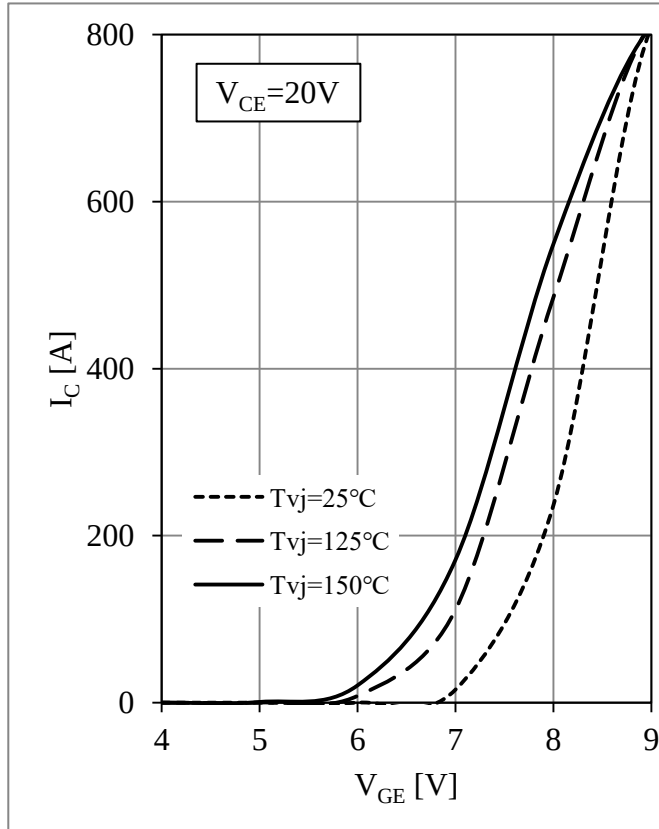
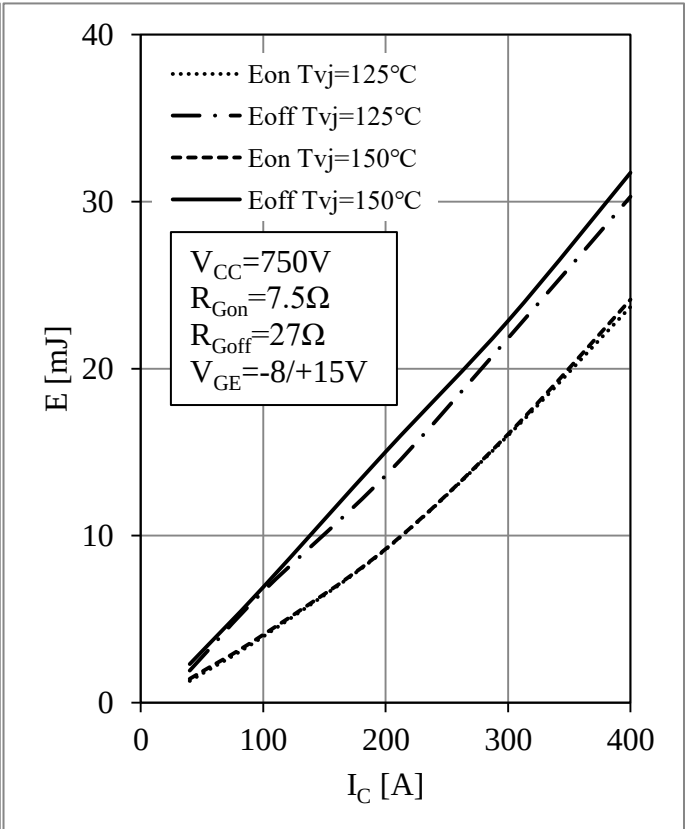


Fig 3. T1,T4 IGBT Transfer Characteristics

Fig 4. T1,T4 IGBT Switching Loss vs.  $I_C$

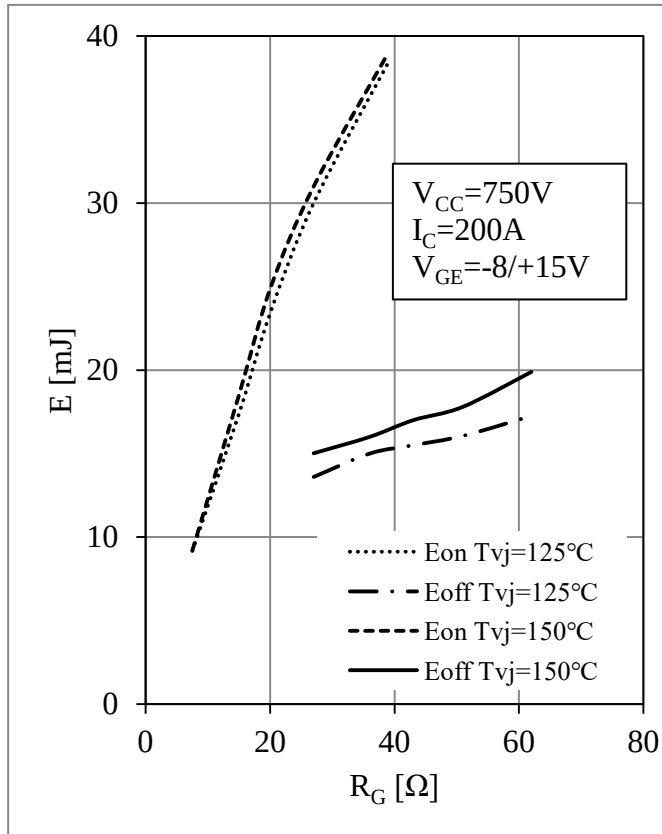
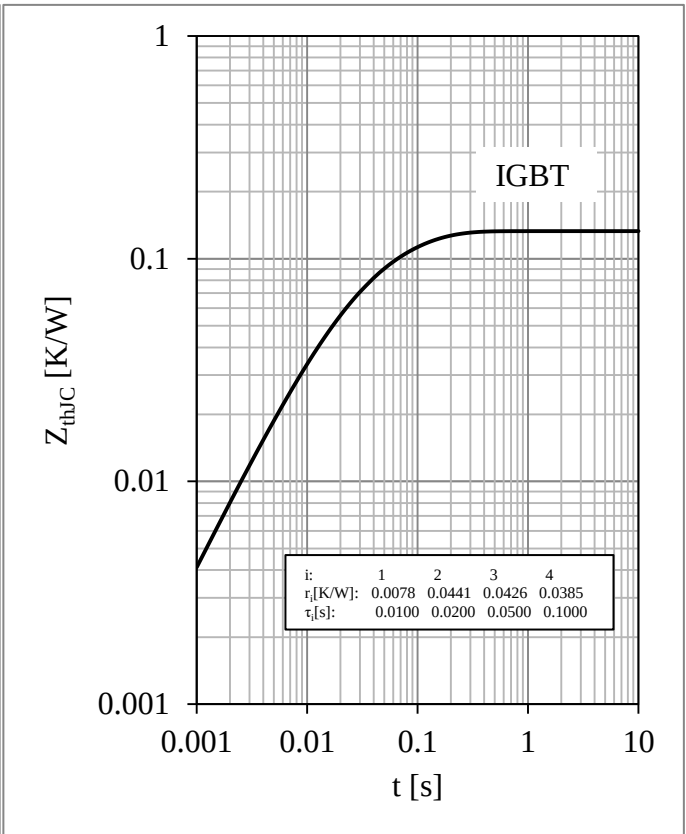
Fig 5. T1, T4 IGBT Switching Loss vs.  $R_G$ 

Fig 6. T1, T4 IGBT Transient Thermal Impedance

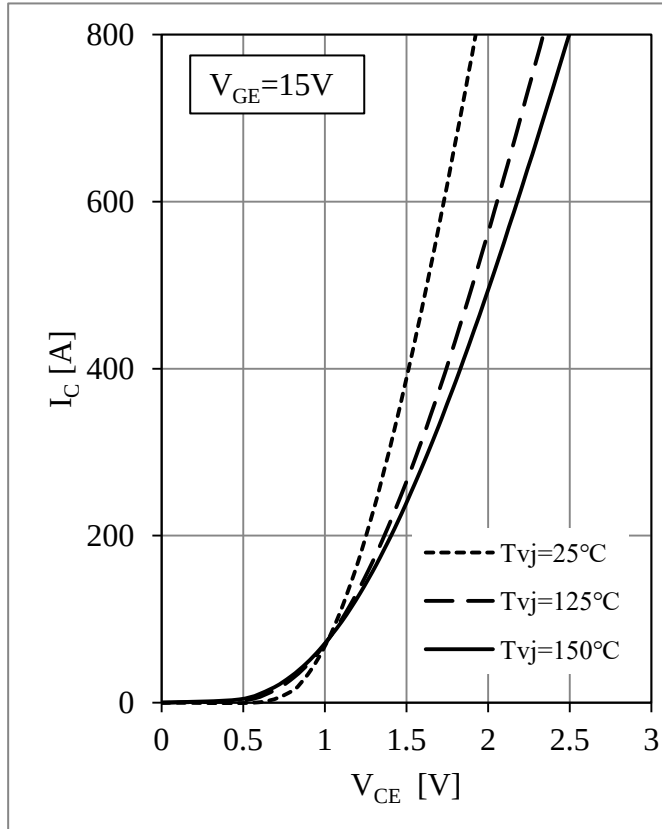


Fig 7. T2, T3 IGBT Output Characteristics

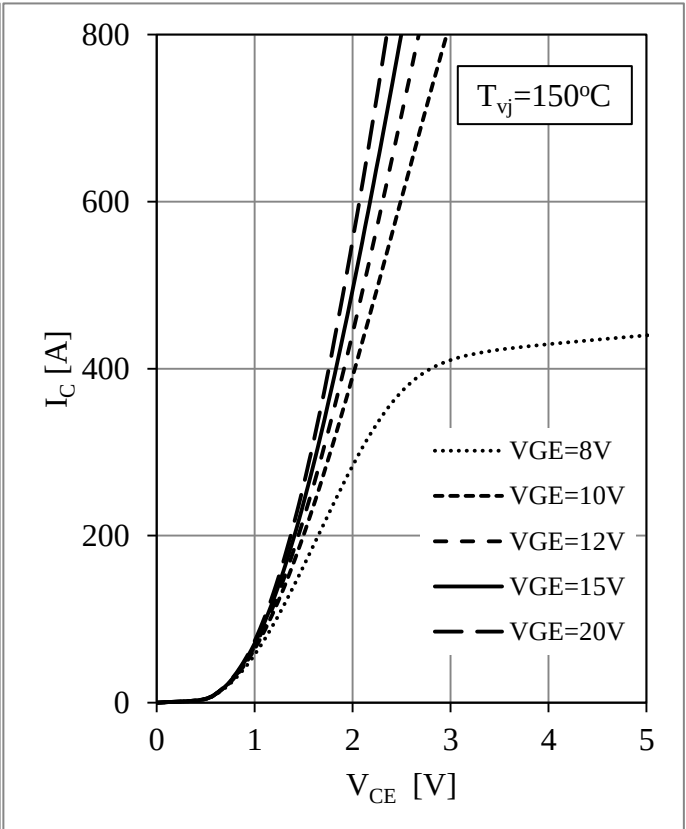


Fig 8. T2, T3 IGBT Output Characteristics



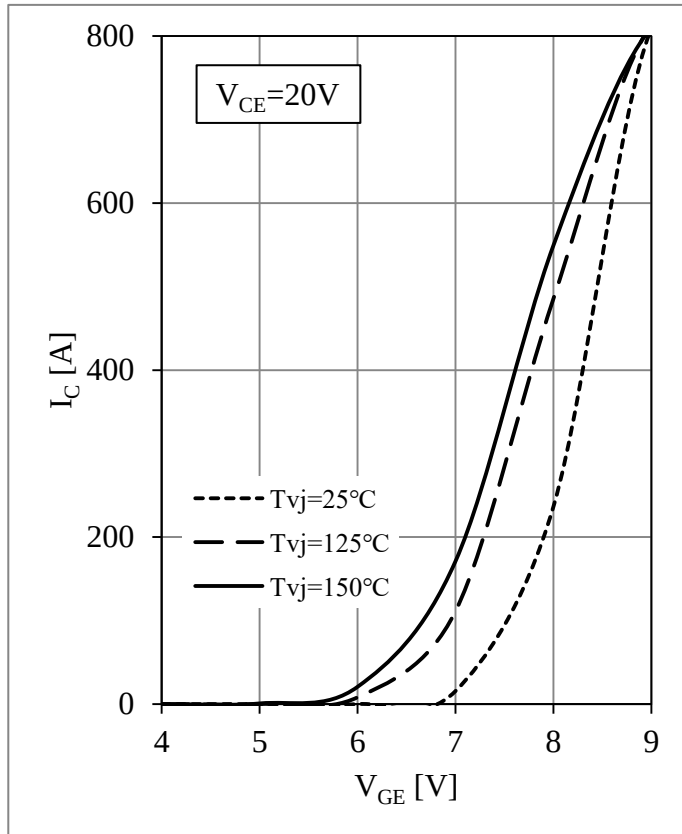


Fig 9. T2,T3 IGBT Transfer Characteristics

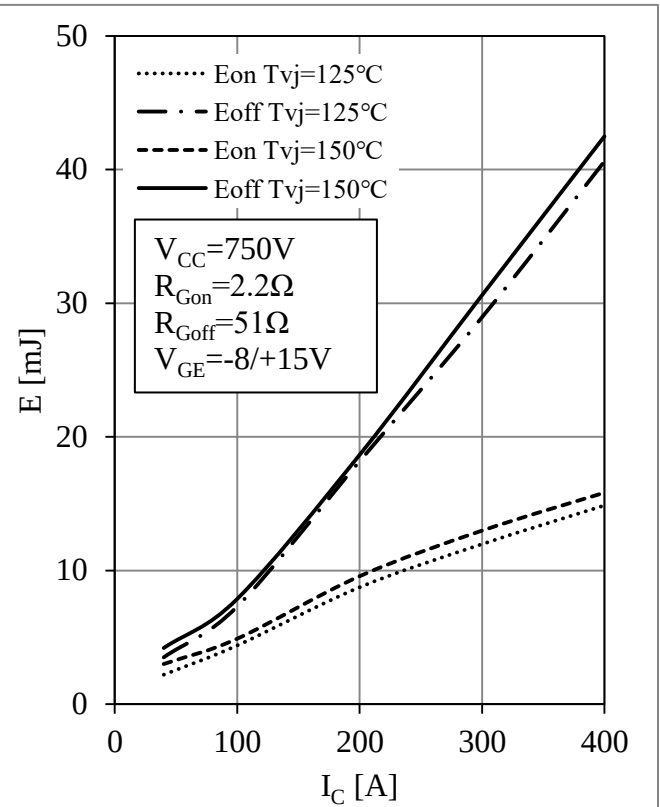
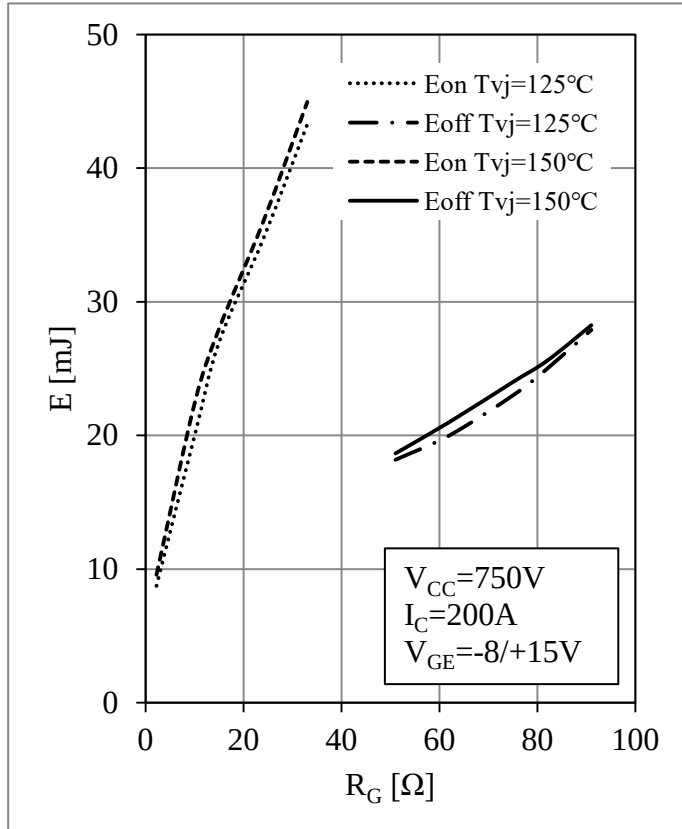
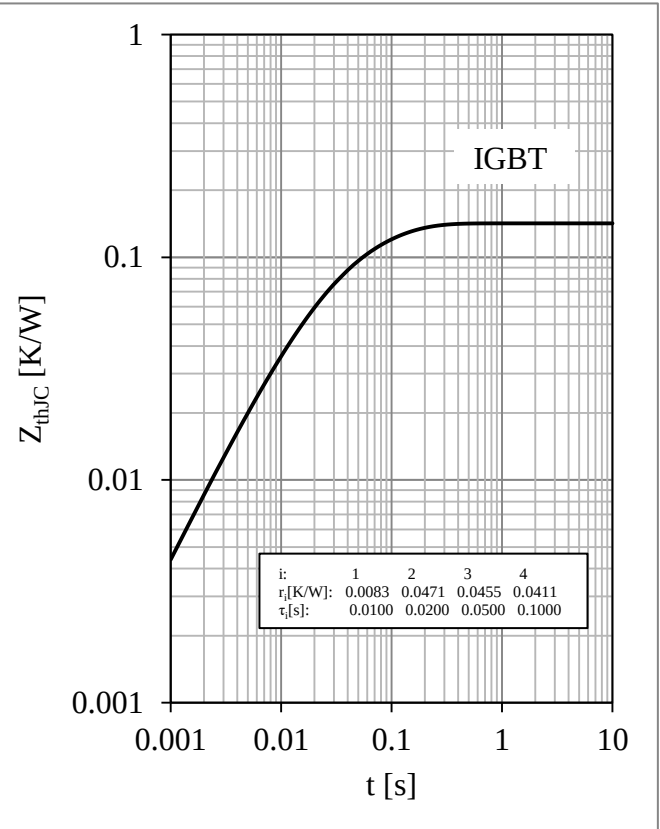
Fig 10. T2,T3 IGBT Switching Loss vs.  $I_C$ Fig 11. T2,T3 IGBT Switching Loss vs.  $R_G$ 

Fig 12. T2,T3 IGBT Transient Thermal Impedance

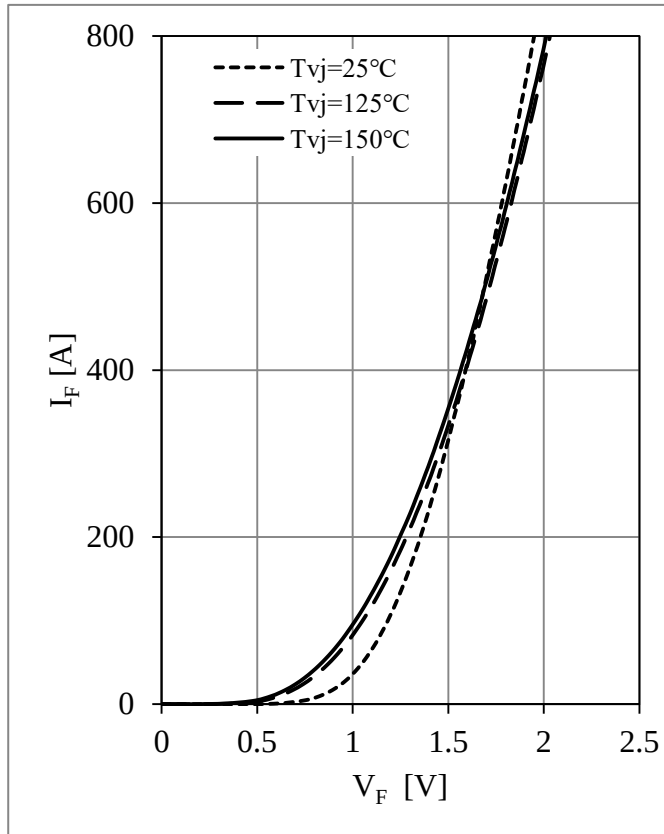


Fig 13. D1-D4 Diode Forward Characteristics

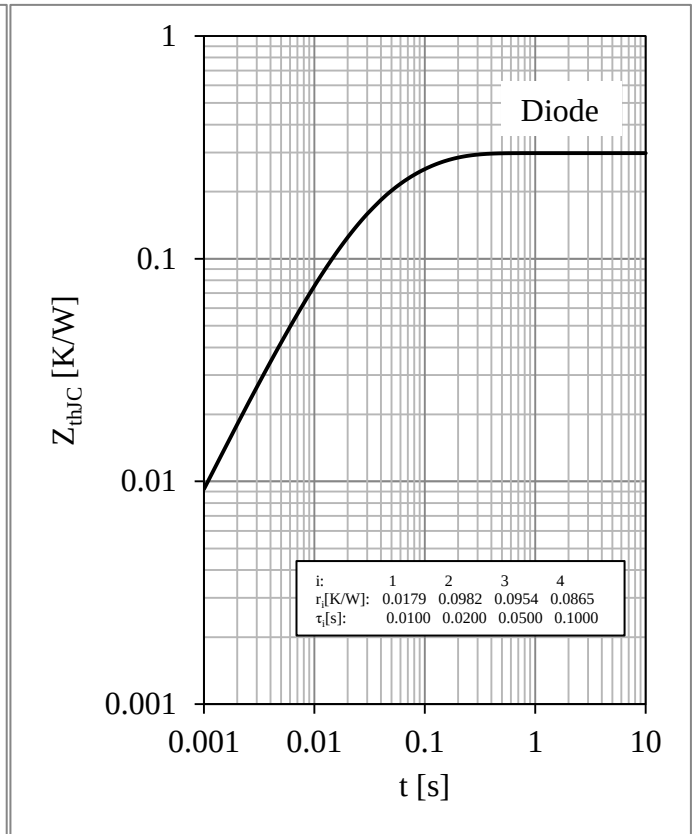


Fig 14. D1-D4 Diode Transient Thermal Impedance

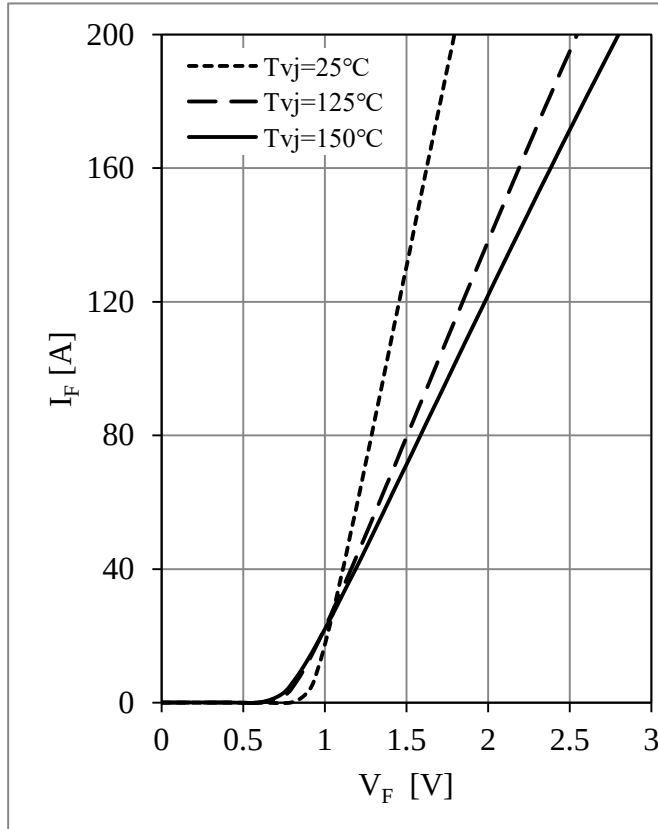
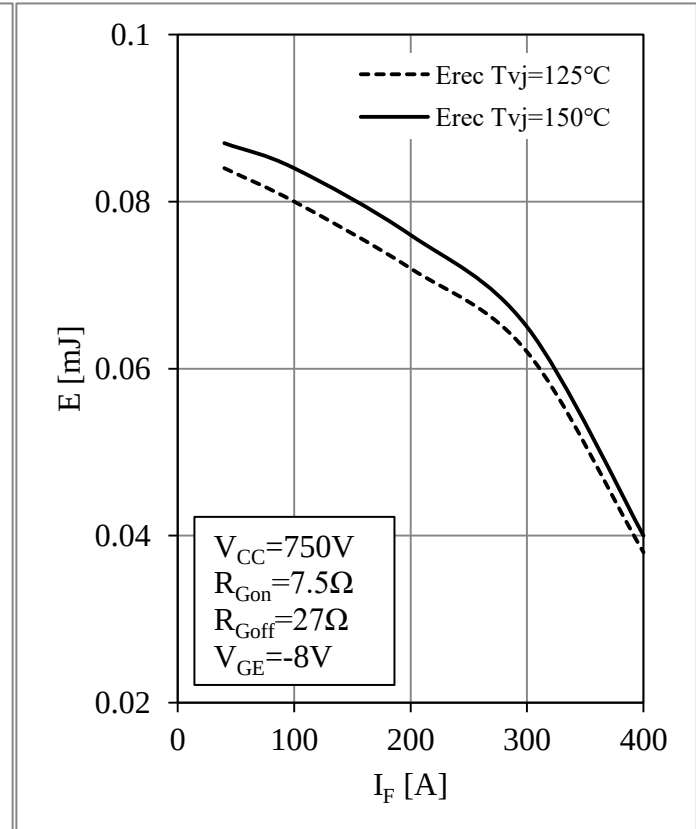
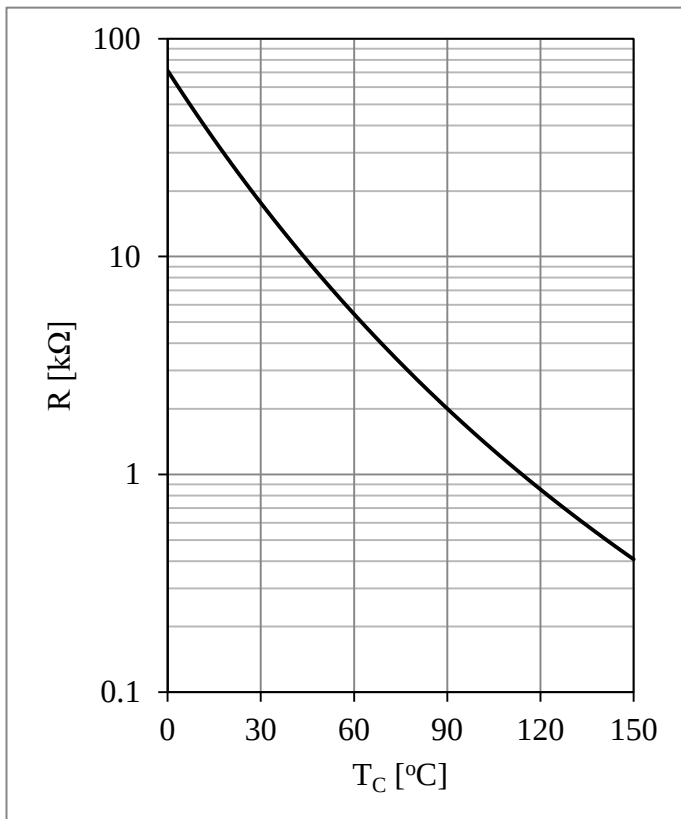
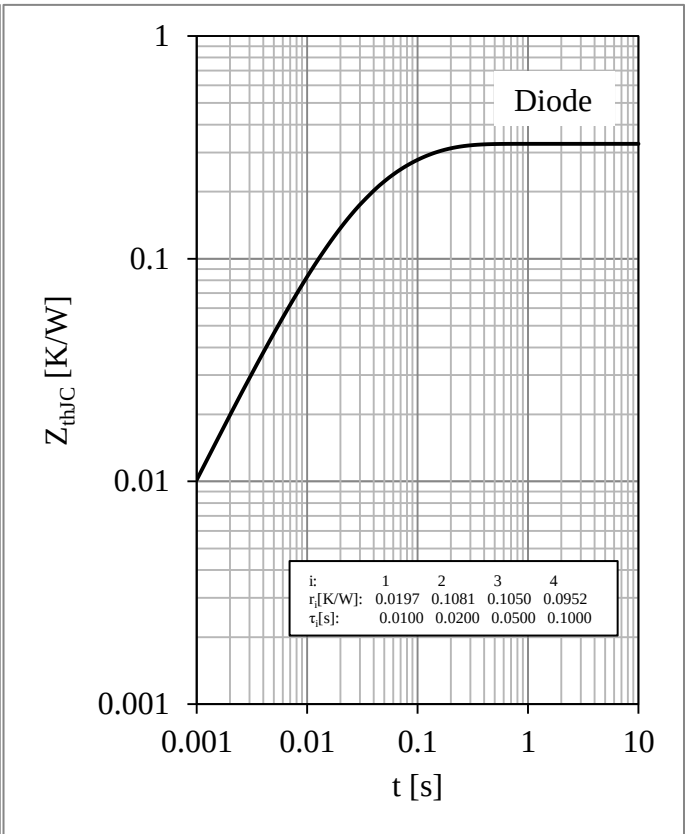
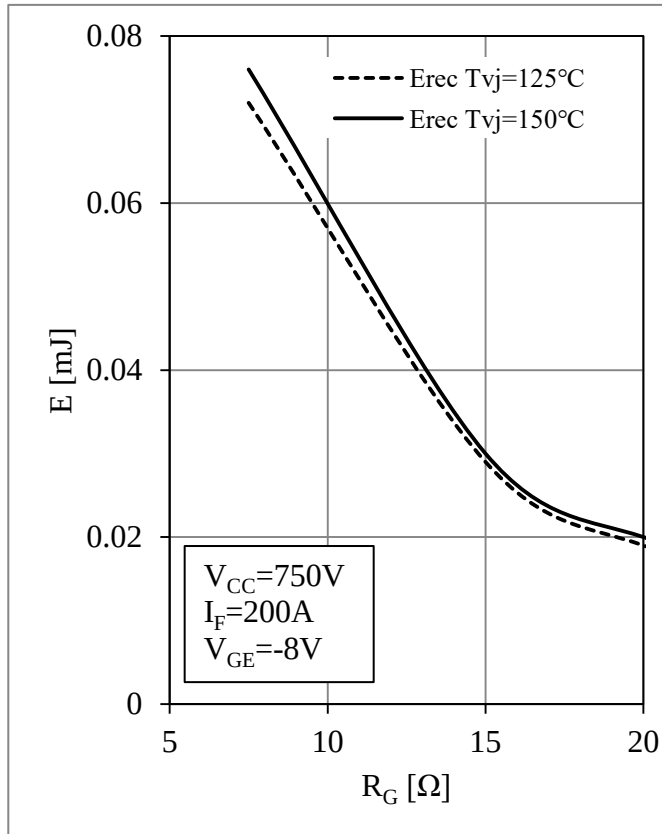
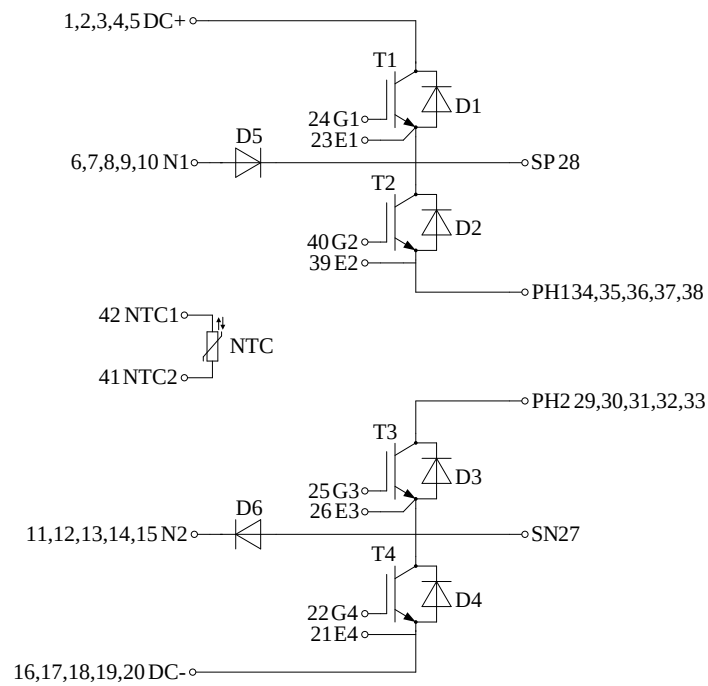


Fig 15. D5,D6 Diode Forward Characteristics

Fig 16. D5,D6 Diode Switching Loss vs.  $I_F$

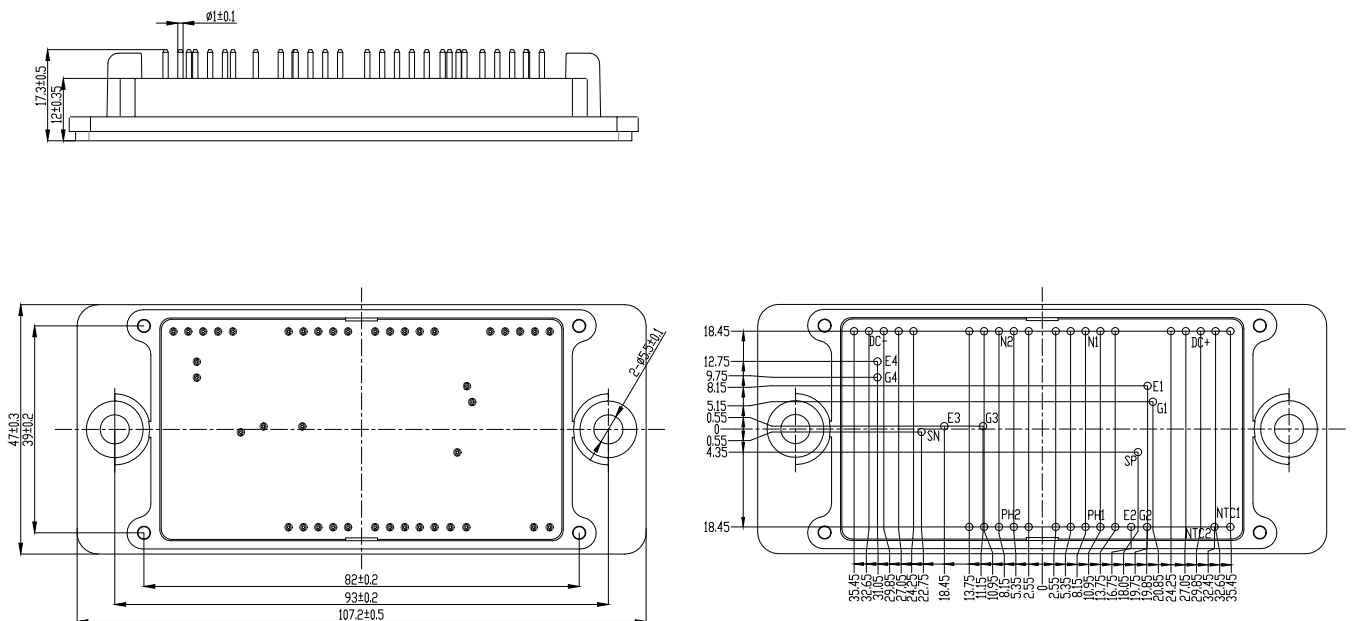


## Circuit Schematic



## Package Dimensions

Dimensions in Millimeters



## Terms and Conditions of Usage

The data contained in this product datasheet is exclusively intended for technically trained staff. you and your technical departments will have to evaluate the suitability of the product for the intended application and the completeness of the product data with respect to such application.

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

Should you require product information in excess of the data given in this product data sheet or which concerns the specific application of our product, please contact the sales office, which is responsible for you (see [www.powersemi.cc](http://www.powersemi.cc)), For those that are specifically interested we may provide application notes.

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

Should you intend to use the Product in aviation applications, in health or live endangering or life support applications, please notify.

If and to the extent necessary, please forward equivalent notices to your customers.  
Changes of this product data sheet are reserved.