

# STARPOWER

## SEMICONDUCTOR

## IGBT

# GD720HTA120P6HLT

**1200V/720A 6 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 hybrid and electric vehicle.

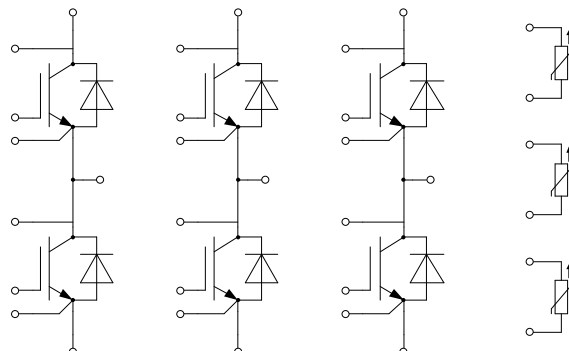
## Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- Low switching losses
- 4 $\mu$ 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 pinfin baseplate using  $Si_3N_4$ AMB technology

## Typical Applications

- Automotive application
- Hybrid and electric vehicle
- Inverter for motor drive

## Equivalent Circuit Schematic



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

| Symbol    | Description                                                                          | Values   | Unit |
|-----------|--------------------------------------------------------------------------------------|----------|------|
| $V_{CES}$ | Collector-Emitter Voltage                                                            | 1200     | V    |
| $V_{GES}$ | Gate-Emitter Voltage                                                                 | $\pm 20$ | V    |
| $I_{CN}$  | Implemented Collector Current                                                        | 720      | A    |
| $I_C$     | Collector Current @ $T_F=65^{\circ}\text{C}$                                         | 600      | A    |
| $I_{CM}$  | Pulsed Collector Current $t_p=1\text{ms}$                                            | 1440     | A    |
| $P_D$     | Maximum Power Dissipation<br>@ $T_F=75^{\circ}\text{C}$ $T_{vj}=175^{\circ}\text{C}$ | 1204     | W    |

**Diode**

| Symbol    | Description                                    | Values | Unit |
|-----------|------------------------------------------------|--------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                | 1200   | V    |
| $I_{FN}$  | Implemented Collector Current                  | 720    | A    |
| $I_F$     | Diode Continuous Forward Current               | 600    | A    |
| $I_{FM}$  | Diode Maximum Forward Current $t_p=1\text{ms}$ | 1440   | A    |

**Module**

| Symbol      | Description                                                                                                                 | Value                       | Unit               |
|-------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------|
| $T_{vjmax}$ | Maximum Junction Temperature                                                                                                | 175                         | $^{\circ}\text{C}$ |
| $T_{vjop}$  | Operating Junction Temperature continuous<br>For 10s within a period of 30s, occurrence<br>maximum 3000 times over lifetime | -40 to +150<br>+150 to +175 | $^{\circ}\text{C}$ |
| $T_{STG}$   | Storage Temperature Range                                                                                                   | -40 to +125                 | $^{\circ}\text{C}$ |
| $V_{ISO}$   | Isolation Voltage RMS, $f=50\text{Hz}$ , $t=1\text{min}$                                                                    | 3000                        | V                  |

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

| Symbol        | Parameter                               | Test Conditions                                                                                                                                          | Min. | Typ. | Max. | Unit          |
|---------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                          |      | 1.50 |      | V             |
|               |                                         | $I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}$                                                                                         |      | 1.80 |      |               |
|               |                                         | $I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=175^{\circ}\text{C}$                                                                                         |      | 1.85 |      |               |
|               |                                         | $I_C=720\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                          |      | 1.60 |      |               |
|               |                                         | $I_C=720\text{A}, V_{GE}=15\text{V}, T_{vj}=175^{\circ}\text{C}$                                                                                         |      | 2.05 |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=15.6\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^{\circ}\text{C}$                                                                                            |      | 6.0  |      | 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                |                                                                                                                                                          |      | 1.67 |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=100\text{kHz}, V_{GE}=0\text{V}$                                                                                                   |      | 48.7 |      | nF            |
| $C_{oes}$     | Output Capacitance                      |                                                                                                                                                          |      | 1.55 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                                                          |      | 0.26 |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{CE}=800\text{V}, I_C=600\text{A}, V_{GE}=-8\dots+15\text{V}$                                                                                         |      | 3.52 |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 208  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                          |      | 65   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                          |      | 505  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                          |      | 104  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                          |      | 77.7 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                          |      | 62.2 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 225  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                          |      | 75   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                          |      | 567  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                          |      | 191  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                          |      | 110  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                          |      | 83.4 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=175^{\circ}\text{C}$ |      | 226  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                                                          |      | 77   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                                                          |      | 583  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                                                          |      | 203  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                                                          |      | 118  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                                                          |      | 85.9 |      | mJ            |
| $I_{SC}$      | SC Data                                 | $t_p \leq 4\mu\text{s}, V_{GE}=15\text{V}, T_{vj}=175^{\circ}\text{C}, V_{CC}=800\text{V}, V_{CEM} \leq 1200\text{V}$                                    |      | 2600 |      | A             |

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

| Symbol    | Parameter                     | Test Conditions                                                                                                                               | Min. | Typ. | Max. | Unit          |
|-----------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_F$     | Diode Forward Voltage         | $I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                |      | 1.95 |      | V             |
|           |                               | $I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$                                                                               |      | 1.95 |      |               |
|           |                               | $I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=175^{\circ}\text{C}$                                                                               |      | 1.90 |      |               |
|           |                               | $I_F=720\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$                                                                                |      | 2.05 |      |               |
|           |                               | $I_F=720\text{A}, V_{GE}=0\text{V}, T_{vj}=175^{\circ}\text{C}$                                                                               |      | 2.05 |      |               |
| $Q_r$     | Recovered Charge              | $V_R=800\text{V}, I_F=600\text{A},$<br>$-di/dt=8281\text{A}/\mu\text{s}, L_S=24\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=25^{\circ}\text{C}$  |      | 44.3 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 346  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 16.2 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=800\text{V}, I_F=600\text{A},$<br>$-di/dt=6954\text{A}/\mu\text{s}, L_S=24\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=150^{\circ}\text{C}$ |      | 73.4 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 385  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 27.8 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=800\text{V}, I_F=600\text{A},$<br>$-di/dt=6679\text{A}/\mu\text{s}, L_S=24\text{nH},$<br>$V_{GE}=-8\text{V}, T_{vj}=175^{\circ}\text{C}$ |      | 80.7 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                                               |      | 392  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                                               |      | 30.7 |      | mJ            |

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

| Symbol       | Parameter              | Test Conditions                                        | Min. | Typ. | Max. | Unit             |
|--------------|------------------------|--------------------------------------------------------|------|------|------|------------------|
| $R_{25}$     | Rated Resistance       |                                                        |      | 5.0  |      | $\text{k}\Omega$ |
| $\Delta R/R$ | Deviation of $R_{100}$ | $T_C=100^{\circ}\text{C}, R_{100}=493.3\Omega$         | -5   |      | 5    | %                |
| $P_{25}$     | Power Dissipation      |                                                        |      |      | 20.0 | mW               |
| $B_{25/50}$  | B-value                | $R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$  |      | 3375 |      | K                |
| $B_{25/80}$  | B-value                | $R_2=R_{25}\exp[B_{25/80}(1/T_2-1/(298.15\text{K}))]$  |      | 3411 |      | K                |
| $B_{25/100}$ | B-value                | $R_2=R_{25}\exp[B_{25/100}(1/T_2-1/(298.15\text{K}))]$ |      | 3433 |      | K                |

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

| Symbol        | Parameter                                                                                                                                                   | Min.       | Typ.           | Max.           | Unit       |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|----------------|------------|
| $L_{CE}$      | Stray Inductance                                                                                                                                            |            | 8              |                | nH         |
| $R_{CC'+EE'}$ | Module Lead Resistance, Terminal to Chip                                                                                                                    |            | 0.75           |                | m $\Omega$ |
| p             | Maximum Pressure In Cooling Circuit<br>$T_{baseplate} < 40^{\circ}\text{C}$<br>$T_{baseplate} > 40^{\circ}\text{C}$<br>(relative pressure)                  |            |                | 2.5<br>2.0     | bar        |
| $R_{thJF}$    | Junction-to-Cooling Fluid (per IGBT)<br>Junction-to-Cooling Fluid (per Diode)<br>$\Delta V/\Delta t = 10.0\text{dm}^3/\text{min}, T_F = 75^{\circ}\text{C}$ |            | 0.072<br>0.104 | 0.083<br>0.120 | K/W        |
| M             | Terminal Connection Torque, Screw M5<br>Mounting Torque, Screw M4                                                                                           | 3.6<br>1.8 |                | 4.4<br>2.2     | N.m        |
| G             | Weight of Module                                                                                                                                            |            | 750            |                | g          |

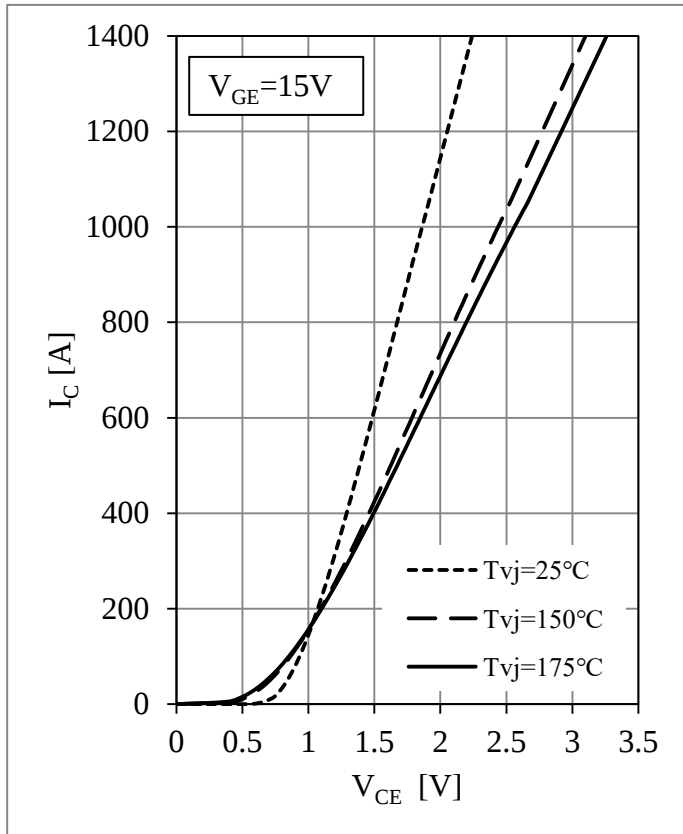


Fig 1. IGBT Output Characteristics

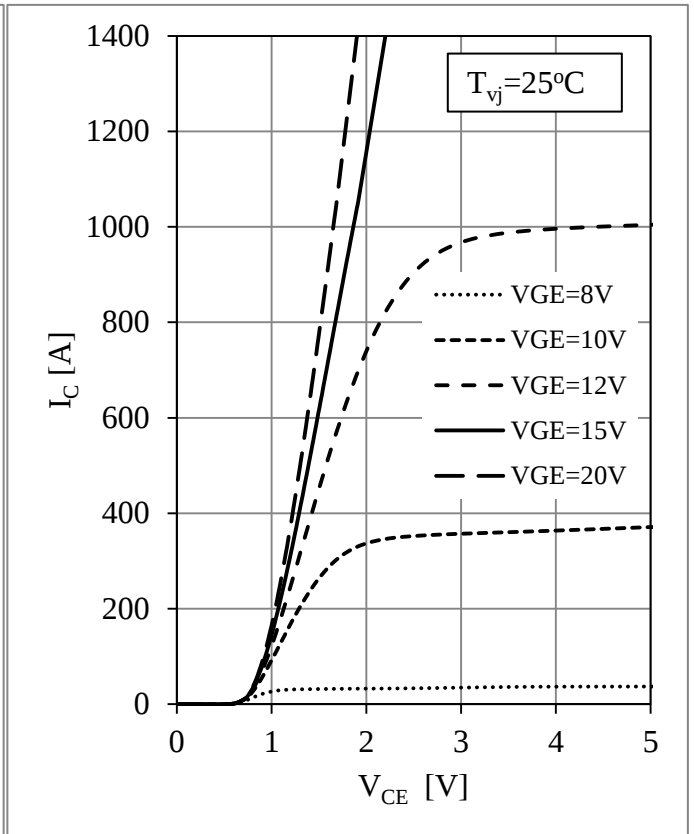


Fig 2. IGBT Output Characteristics

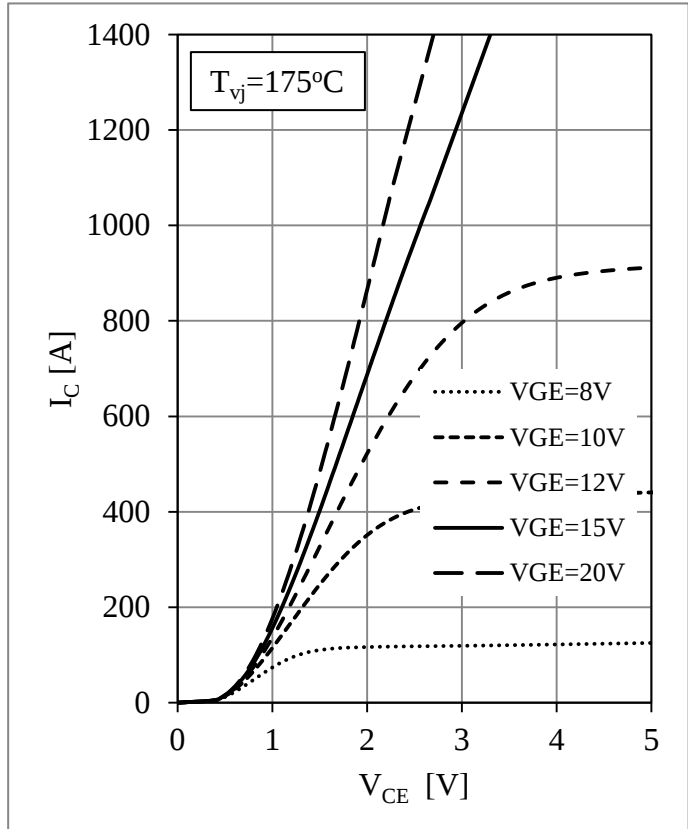


Fig 3. IGBT Output Characteristics

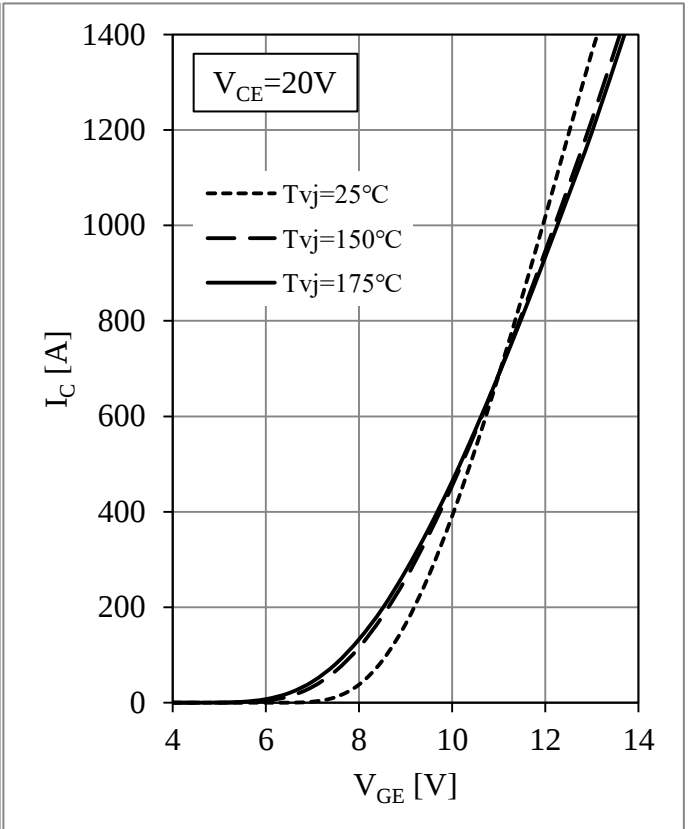


Fig 4. IGBT Transfer Characteristics

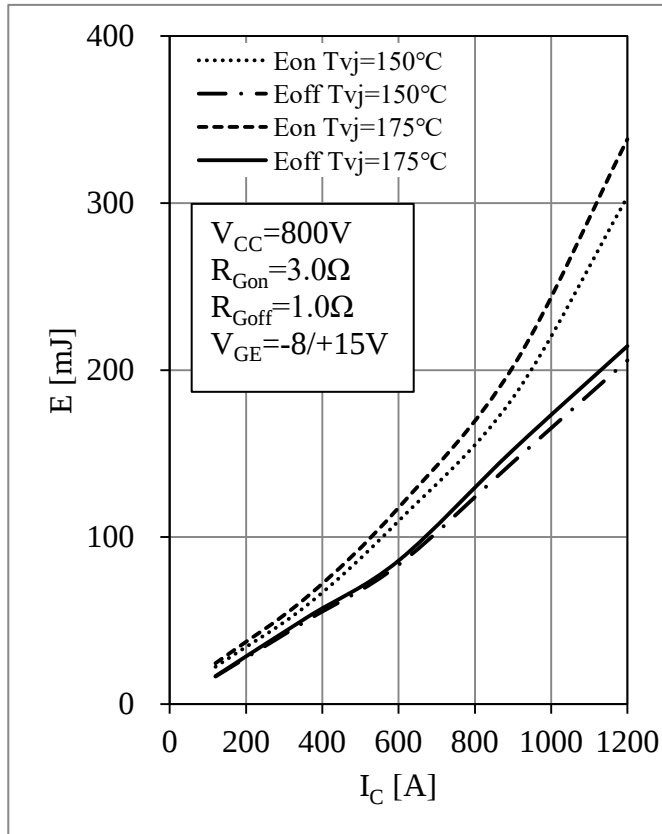
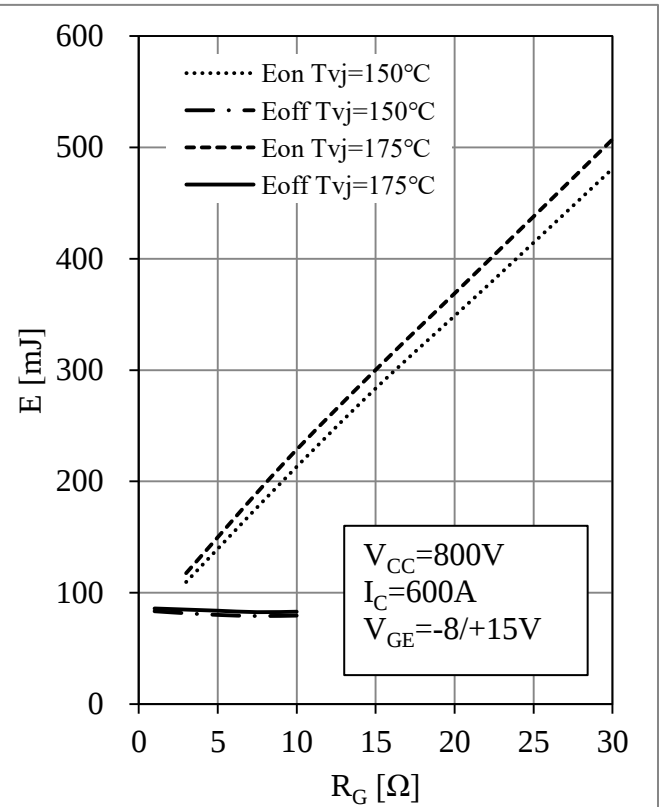
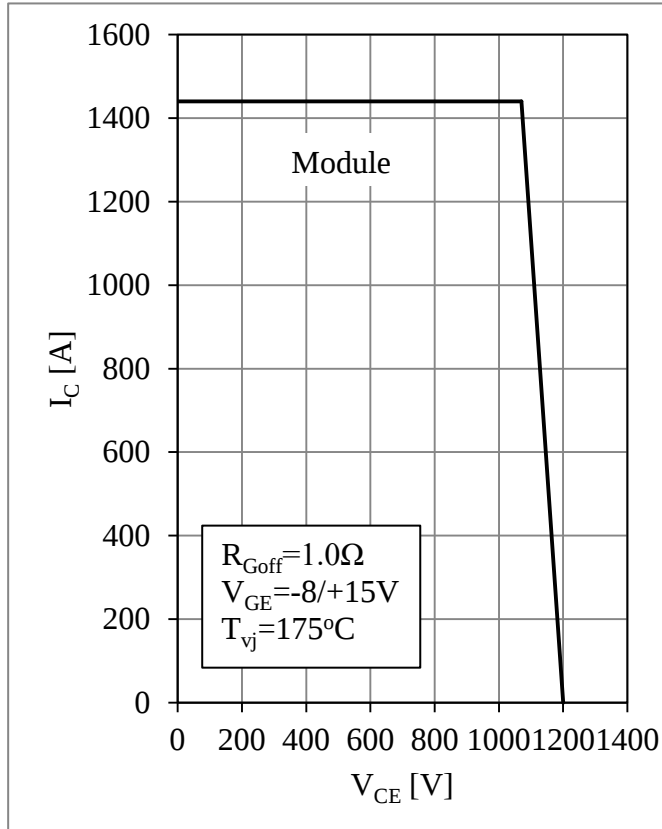
Fig 5. IGBT Switching Loss vs.  $I_C$ Fig 6. IGBT Switching Loss vs.  $R_G$ 

Fig 7. RBSOA

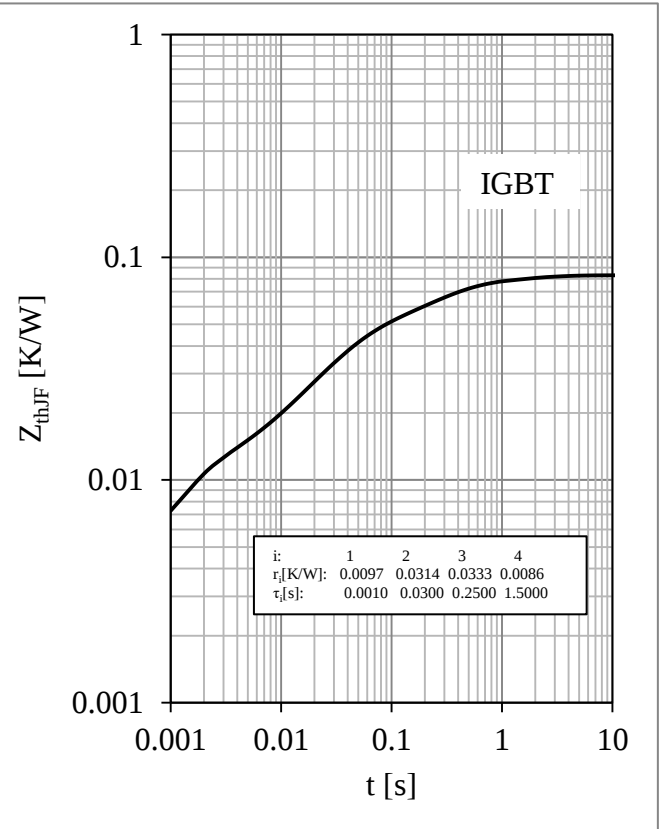


Fig 8. IGBT Transient Thermal Impedance

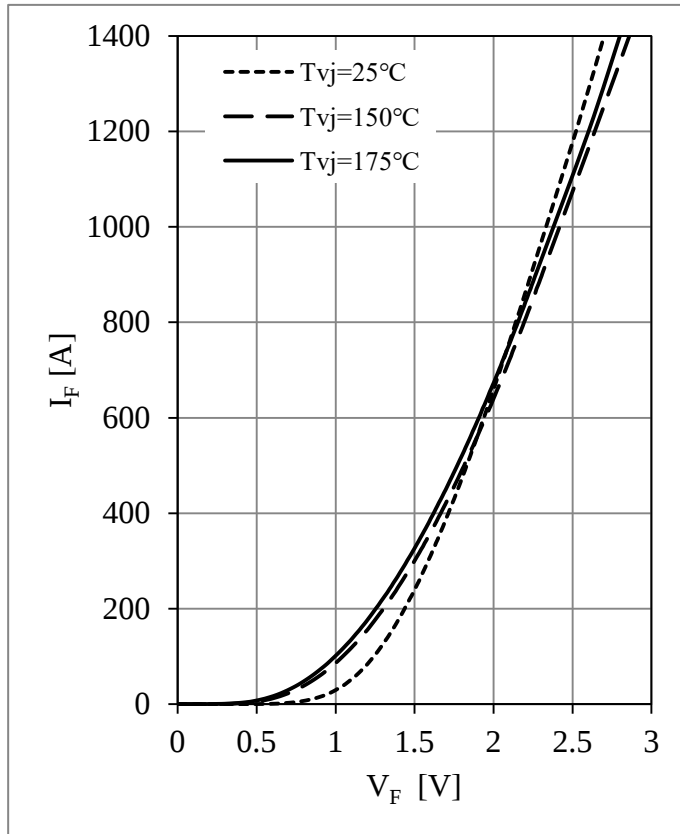


Fig 9. Diode Forward Characteristics

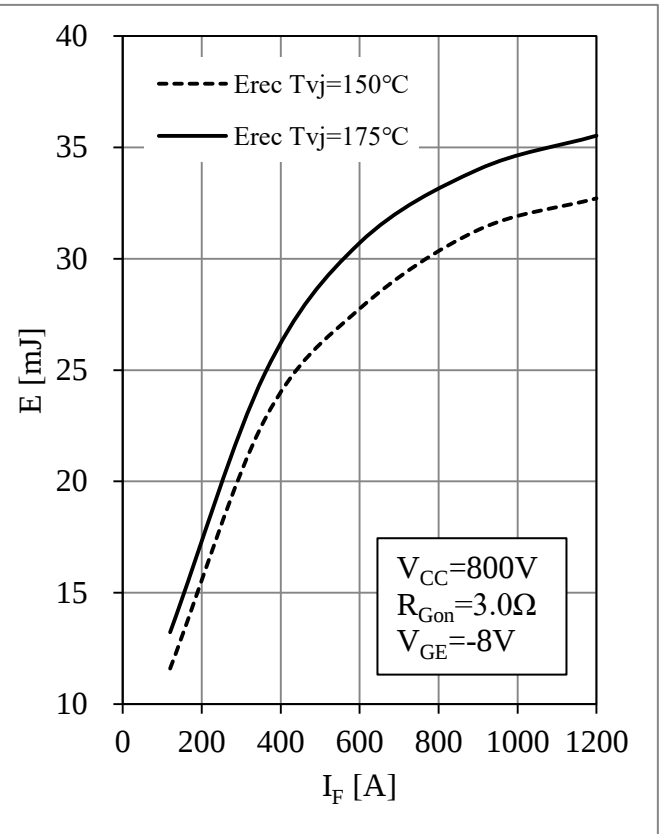
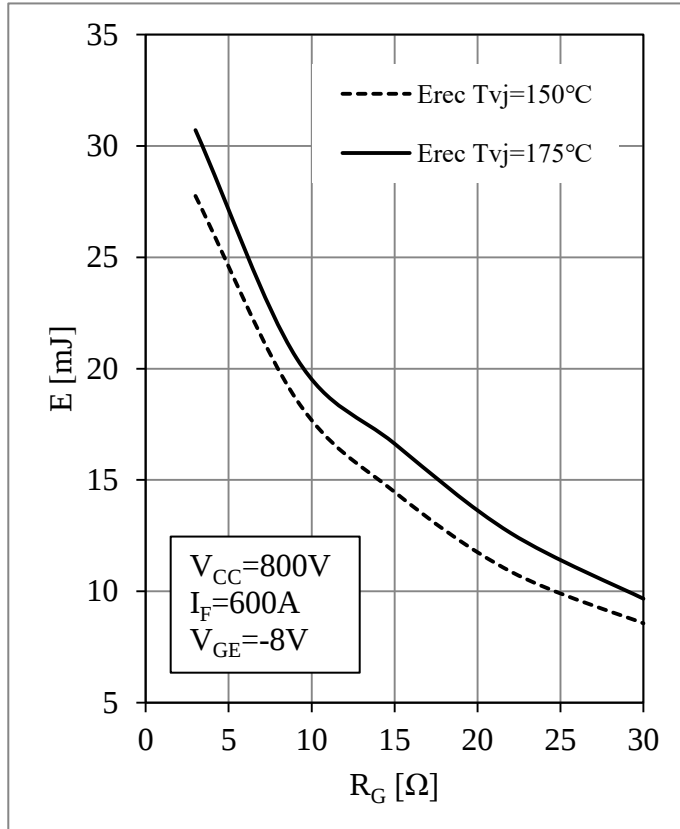
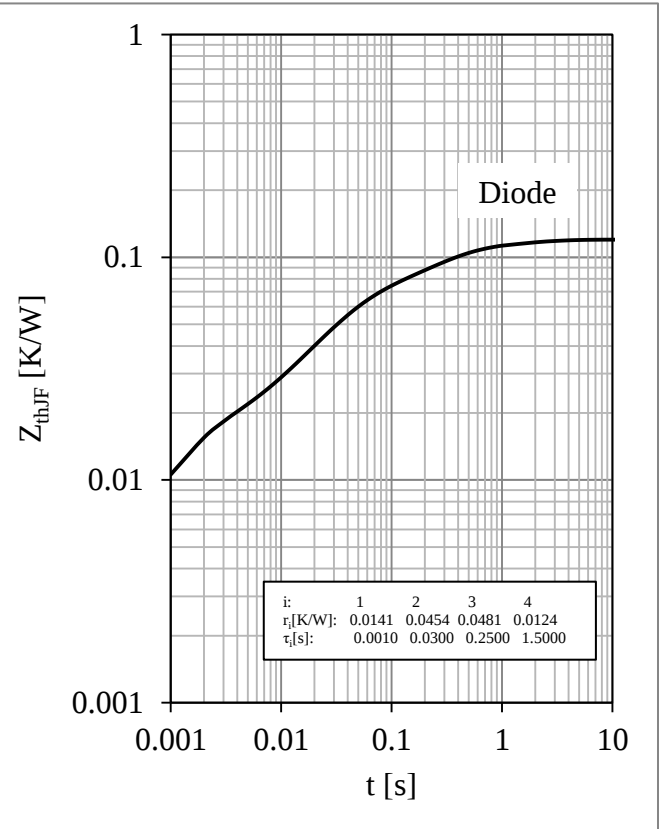
Fig 10. Diode Switching Loss vs.  $I_F$ Fig 11. Diode Switching Loss vs.  $R_G$ 

Fig 12. Diode Transient Thermal Impedance

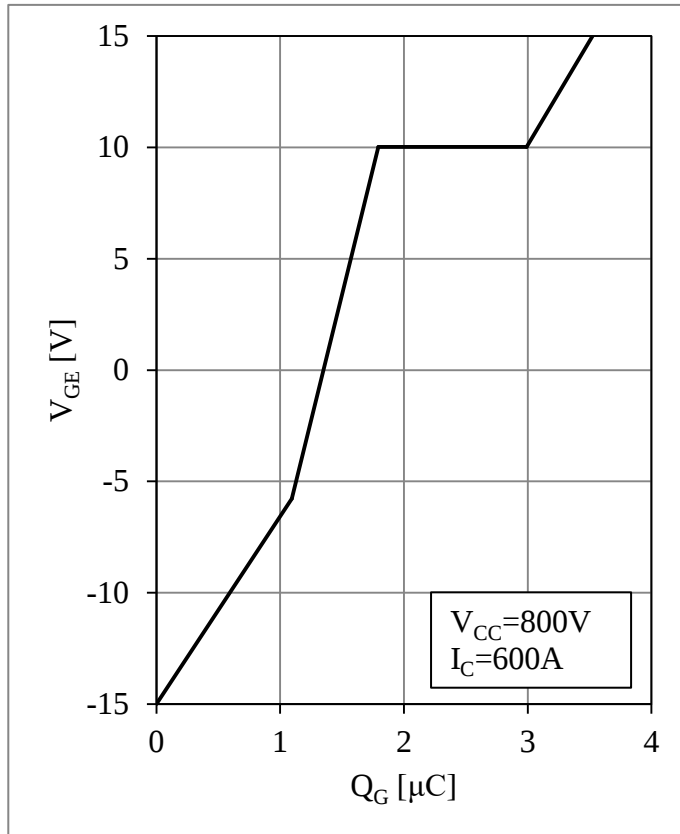


Fig 13. IGBT Gate Charge Characteristic

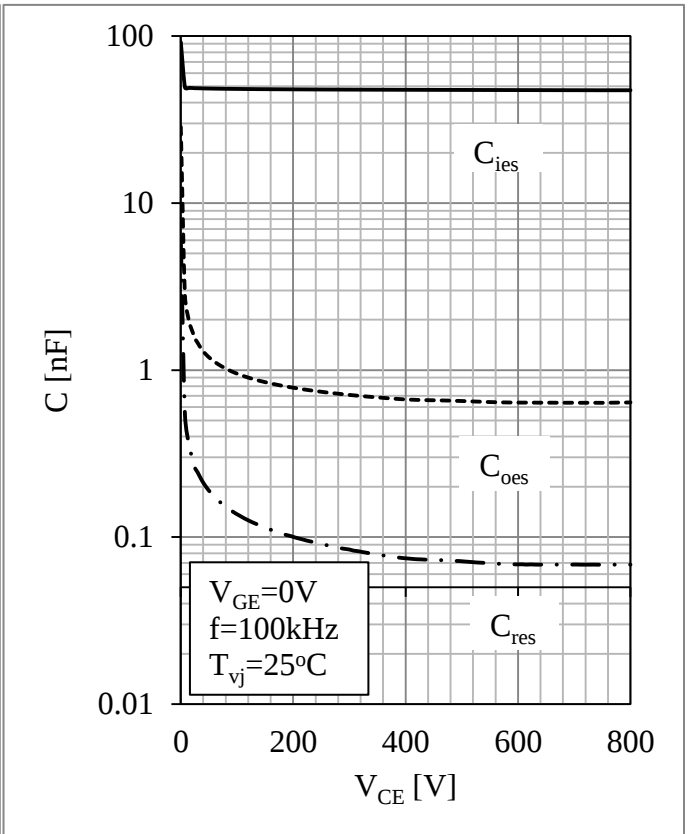


Fig 14. IGBT Capacity Characteristic

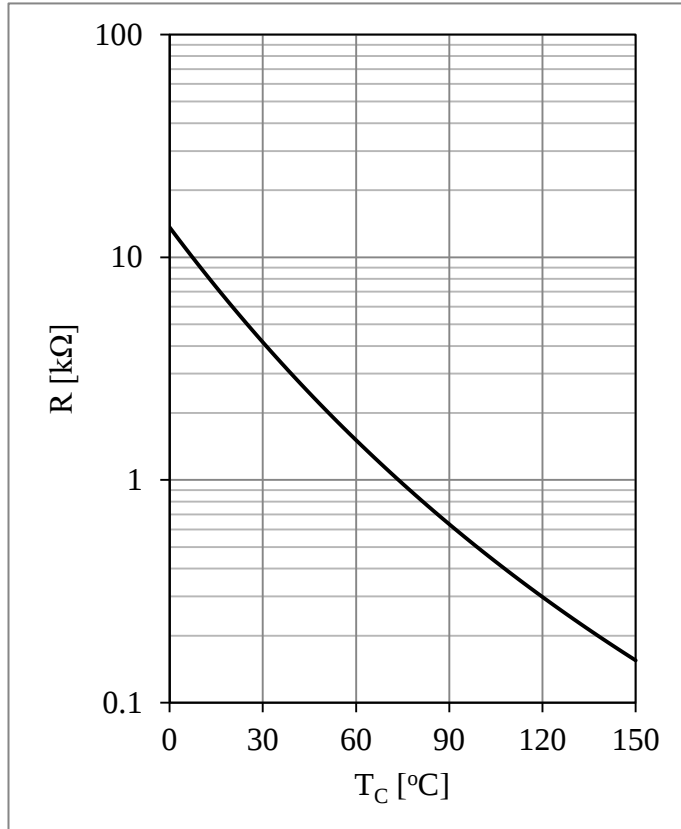
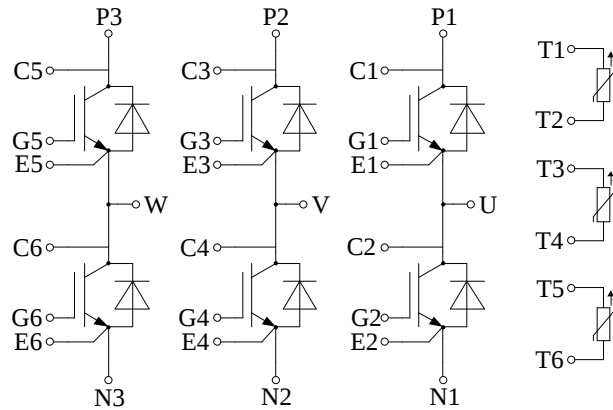


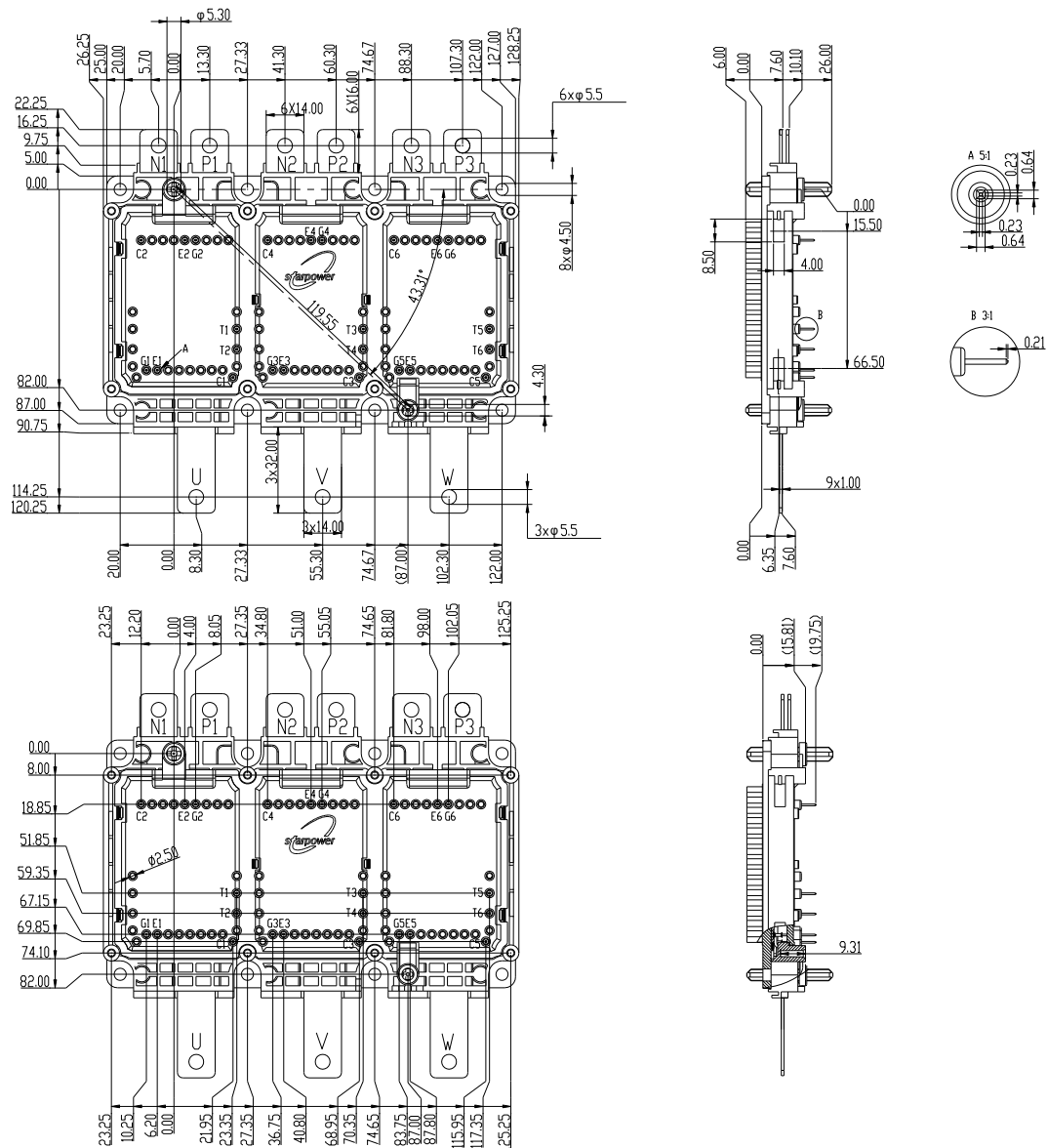
Fig 15. NTC Temperature Characteristic

## Circuit Schematic



## Package Dimensions

Dimensions in Millimeters



## Terms and Conditions of Usage

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