

# STARPOWER

## SEMICONDUCTOR

## IGBT

# GD100PIY120C6SNF

**1200V/100A PIM 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.

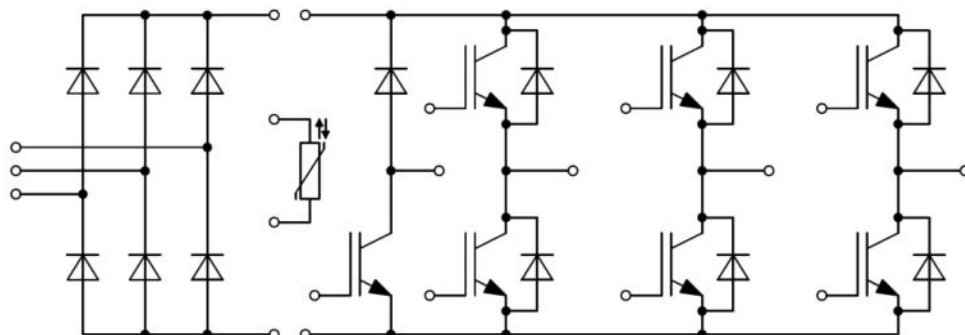
## Features

- 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
- PressFIT contact 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-inverter**

| Symbol    | Description                                                                 | Value      | Unit |
|-----------|-----------------------------------------------------------------------------|------------|------|
| $V_{CES}$ | Collector-Emitter Voltage                                                   | 1200       | V    |
| $V_{GES}$ | Gate-Emitter Voltage                                                        | $\pm 20$   | V    |
| $I_C$     | Collector Current @ $T_C=25^{\circ}\text{C}$<br>@ $T_C=100^{\circ}\text{C}$ | 155<br>100 | A    |
| $I_{CM}$  | Pulsed Collector Current $t_p=1\text{ms}$                                   | 200        | A    |
| $P_D$     | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$                       | 511        | W    |

**Diode-inverter**

| Symbol    | Description                                    | Value | Unit |
|-----------|------------------------------------------------|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                | 1200  | V    |
| $I_F$     | Diode Continuous Forward Current               | 100   | A    |
| $I_{FM}$  | Diode Maximum Forward Current $t_p=1\text{ms}$ | 200   | A    |

**Diode-rectifier**

| Symbol    | Description                                                                                       | Value        | Unit                 |
|-----------|---------------------------------------------------------------------------------------------------|--------------|----------------------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                                                                   | 1600         | V                    |
| $I_O$     | Average Output Current 50Hz/60Hz,sine wave                                                        | 100          | A                    |
| $I_{FSM}$ | Surge Forward Current $t_p=10\text{ms}$ @ $T_j=25^{\circ}\text{C}$<br>@ $T_j=150^{\circ}\text{C}$ | 1150<br>880  | A                    |
| $I^2t$    | $I^2t$ -value, $t_p=10\text{ms}$ @ $T_j=25^{\circ}\text{C}$<br>@ $T_j=150^{\circ}\text{C}$        | 6600<br>3850 | $\text{A}^2\text{s}$ |

**IGBT-brake**

| Symbol    | Description                                                                 | Value     | Unit |
|-----------|-----------------------------------------------------------------------------|-----------|------|
| $V_{CES}$ | Collector-Emitter Voltage                                                   | 1200      | V    |
| $V_{GES}$ | Gate-Emitter Voltage                                                        | $\pm 20$  | V    |
| $I_C$     | Collector Current @ $T_C=25^{\circ}\text{C}$<br>@ $T_C=100^{\circ}\text{C}$ | 125<br>75 | A    |
| $I_{CM}$  | Pulsed Collector Current $t_p=1\text{ms}$                                   | 150       | A    |
| $P_D$     | Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$                       | 432       | W    |

**Diode-brake**

| Symbol    | Description                                    | Value | Unit |
|-----------|------------------------------------------------|-------|------|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage                | 1200  | V    |
| $I_F$     | Diode Continuous Forward Current               | 35    | A    |
| $I_{FM}$  | Diode Maximum Forward Current $t_p=1\text{ms}$ | 70    | A    |

**Module**

| Symbol     | Description                                                                              | Value       | Unit               |
|------------|------------------------------------------------------------------------------------------|-------------|--------------------|
| $T_{jmax}$ | Maximum Junction Temperature(inverter,brake)<br>Maximum Junction Temperature (rectifier) | 175<br>150  | $^{\circ}\text{C}$ |
| $T_{jop}$  | 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, $f=50\text{Hz}$ , $t=1\text{min}$                                 | 2500        | V                  |

**IGBT-inverter 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 | $I_C=100\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$                                                        |      | 1.70  | 2.15 | V             |
|               |                                         | $I_C=100\text{A}, V_{GE}=15\text{V}, T_j=125^{\circ}\text{C}$                                                       |      | 1.95  |      |               |
|               |                                         | $I_C=100\text{A}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}$                                                       |      | 2.00  |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=2.50\text{mA}, V_{CE}=V_{GE}, T_j=25^{\circ}\text{C}$                                                          | 5.2  | 6.0   | 6.8  | V             |
| $I_{CES}$     | Collector Cut-Off Current               | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                          |      |       | 1.0  | mA            |
| $I_{GES}$     | Gate-Emitter Leakage Current            | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                          |      |       | 100  | nA            |
| $R_{Gint}$    | Internal Gate Resistance                |                                                                                                                     |      | 7.5   |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$                                                                |      | 10.35 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                     |      | 0.29  |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\dots+15\text{V}$                                                                                        |      | 0.78  |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=100\text{A}, R_G=1.6\Omega, V_{GE}=\pm 15\text{V}, T_j=25^{\circ}\text{C}$                 |      | 170   |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 32    |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 360   |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 86    |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 5.90  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 6.05  |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=100\text{A}, R_G=1.6\Omega, V_{GE}=\pm 15\text{V}, T_j=125^{\circ}\text{C}$                |      | 180   |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 42    |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 470   |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 165   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 9.10  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 9.35  |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=100\text{A}, R_G=1.6\Omega, V_{GE}=\pm 15\text{V}, T_j=150^{\circ}\text{C}$                |      | 181   |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 43    |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 480   |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 186   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 10.0  |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 10.5  |      | mJ            |
| $I_{SC}$      | SC Data                                 | $t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$ |      | 400   |      | A             |

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

| Symbol    | Parameter                     | Test Conditions                                                                                                           | Min. | Typ. | Max. | Unit          |
|-----------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_F$     | Diode Forward Voltage         | $I_F=100\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                               |      | 1.85 | 2.30 | V             |
|           |                               | $I_F=100\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$                                                              |      | 1.90 |      |               |
|           |                               | $I_F=100\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$                                                              |      | 1.95 |      |               |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=100\text{A},$<br>$-di/dt=3500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=25^{\circ}\text{C}$  |      | 11.0 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 173  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 4.02 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=100\text{A},$<br>$-di/dt=3500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=125^{\circ}\text{C}$ |      | 19.6 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 184  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 6.86 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=100\text{A},$<br>$-di/dt=3500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=150^{\circ}\text{C}$ |      | 21.9 |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                           |      | 190  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                           |      | 7.84 |      | mJ            |

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

| Symbol | Parameter             | Test Conditions                             | Min. | Typ. | Max. | Unit |
|--------|-----------------------|---------------------------------------------|------|------|------|------|
| $V_F$  | Diode Forward Voltage | $I_F=100\text{A}, T_j=150^{\circ}\text{C}$  |      | 0.95 |      | V    |
| $I_R$  | Reverse Current       | $T_j=150^{\circ}\text{C}, V_R=1600\text{V}$ |      |      | 2.0  | mA   |

**IGBT-brake 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 | $I_C=75\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$                                                         |      | 1.70 | 2.15 | V             |
|               |                                         | $I_C=75\text{A}, V_{GE}=15\text{V}, T_j=125^{\circ}\text{C}$                                                        |      | 1.95 |      |               |
|               |                                         | $I_C=75\text{A}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}$                                                        |      | 2.00 |      |               |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage          | $I_C=1.88\text{mA}, V_{CE}=V_{GE}, T_j=25^{\circ}\text{C}$                                                          | 5.2  | 6.0  | 6.8  | V             |
| $I_{CES}$     | Collector Cut-Off Current               | $V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                          |      |      | 1.0  | mA            |
| $I_{GES}$     | Gate-Emitter Leakage Current            | $V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                          |      |      | 100  | nA            |
| $R_{Gint}$    | Internal Gate Resistance                |                                                                                                                     |      | 5.0  |      | $\Omega$      |
| $C_{ies}$     | Input Capacitance                       | $V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$                                                                |      | 7.76 |      | nF            |
| $C_{res}$     | Reverse Transfer Capacitance            |                                                                                                                     |      | 0.22 |      | nF            |
| $Q_G$         | Gate Charge                             | $V_{GE}=-15\dots+15\text{V}$                                                                                        |      | 0.58 |      | $\mu\text{C}$ |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=75\text{A}, R_G=2.2\Omega, V_{GE}=\pm 15\text{V}, T_j=25^{\circ}\text{C}$                  |      | 170  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 32   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 360  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 86   |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 3.64 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 4.60 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=75\text{A}, R_G=2.2\Omega, V_{GE}=\pm 15\text{V}, T_j=125^{\circ}\text{C}$                 |      | 180  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 42   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 470  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 165  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 7.80 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 7.00 |      | mJ            |
| $t_{d(on)}$   | Turn-On Delay Time                      | $V_{CC}=600\text{V}, I_C=75\text{A}, R_G=2.2\Omega, V_{GE}=\pm 15\text{V}, T_j=150^{\circ}\text{C}$                 |      | 181  |      | ns            |
| $t_r$         | Rise Time                               |                                                                                                                     |      | 43   |      | ns            |
| $t_{d(off)}$  | Turn-Off Delay Time                     |                                                                                                                     |      | 480  |      | ns            |
| $t_f$         | Fall Time                               |                                                                                                                     |      | 186  |      | ns            |
| $E_{on}$      | Turn-On Switching Loss                  |                                                                                                                     |      | 9.10 |      | mJ            |
| $E_{off}$     | Turn-Off Switching Loss                 |                                                                                                                     |      | 7.90 |      | mJ            |
| $I_{SC}$      | SC Data                                 | $t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$ |      | 300  |      | A             |

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

| Symbol    | Parameter                     | Test Conditions                                                                                                          | Min. | Typ. | Max. | Unit          |
|-----------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_F$     | Diode Forward Voltage         | $I_F=35\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$                                                               |      | 1.85 | 2.30 | V             |
|           |                               | $I_F=35\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$                                                              |      | 1.90 |      |               |
|           |                               | $I_F=35\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$                                                              |      | 1.95 |      |               |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=35\text{A},$<br>$-di/dt=2500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=25^{\circ}\text{C}$  |      | 4.5  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                          |      | 93   |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                          |      | 1.47 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=35\text{A},$<br>$-di/dt=2500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=125^{\circ}\text{C}$ |      | 7.8  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                          |      | 98   |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                          |      | 2.65 |      | mJ            |
| $Q_r$     | Recovered Charge              | $V_R=600\text{V}, I_F=35\text{A},$<br>$-di/dt=2500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$<br>$T_j=150^{\circ}\text{C}$ |      | 8.6  |      | $\mu\text{C}$ |
| $I_{RM}$  | Peak Reverse Recovery Current |                                                                                                                          |      | 101  |      | A             |
| $E_{rec}$ | Reverse Recovery Energy       |                                                                                                                          |      | 2.89 |      | mJ            |

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

| Symbol                         | Parameter                                                                                                                                                                                                                                           | Min. | Typ.                                               | Max.                                      | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------------------------------------|-------------------------------------------|------|
| $L_{CE}$                       | Stray Inductance                                                                                                                                                                                                                                    |      | 40                                                 |                                           | nH   |
| $R_{CC'+EE'}$<br>$R_{AA'+CC'}$ | Module Lead Resistance, Terminal to Chip                                                                                                                                                                                                            |      | 4.00<br>3.00                                       |                                           | mΩ   |
| $R_{thJC}$                     | Junction-to-Case (per IGBT-inverter)<br>Junction-to-Case (per Diode-inverter)<br>Junction-to-Case (per Diode-rectifier)<br>Junction-to-Case (per IGBT-brake-chopper)<br>Junction-to-Case (per Diode-brake-chopper)                                  |      |                                                    | 0.293<br>0.505<br>0.571<br>0.347<br>1.068 | K/W  |
| $R_{thCH}$                     | Case-to-Heatsink (per IGBT-inverter)<br>Case-to-Heatsink (per Diode-inverter)<br>Case-to-Heatsink (per Diode-rectifier)<br>Case-to-Heatsink (per IGBT-brake-chopper)<br>Case-to-Heatsink (per Diode-brake-chopper)<br>Case-to-Heatsink (per Module) |      | 0.123<br>0.212<br>0.240<br>0.146<br>0.449<br>0.009 |                                           | K/W  |
| M                              | Mounting Torque, Screw:M5                                                                                                                                                                                                                           | 3.0  |                                                    | 6.0                                       | N.m  |
| G                              | Weight of Module                                                                                                                                                                                                                                    |      | 300                                                |                                           | g    |

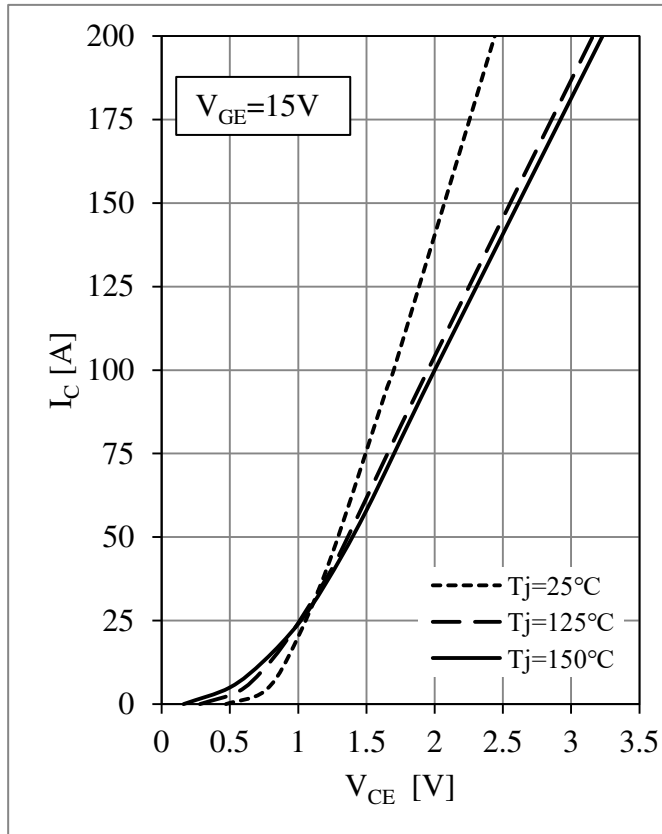


Fig 1. IGBT-inverter Output Characteristics

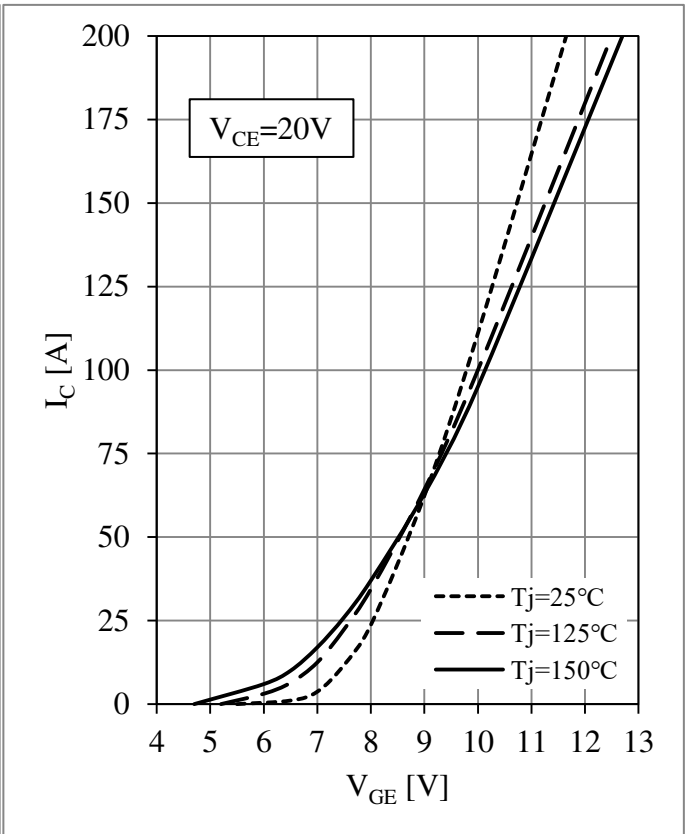
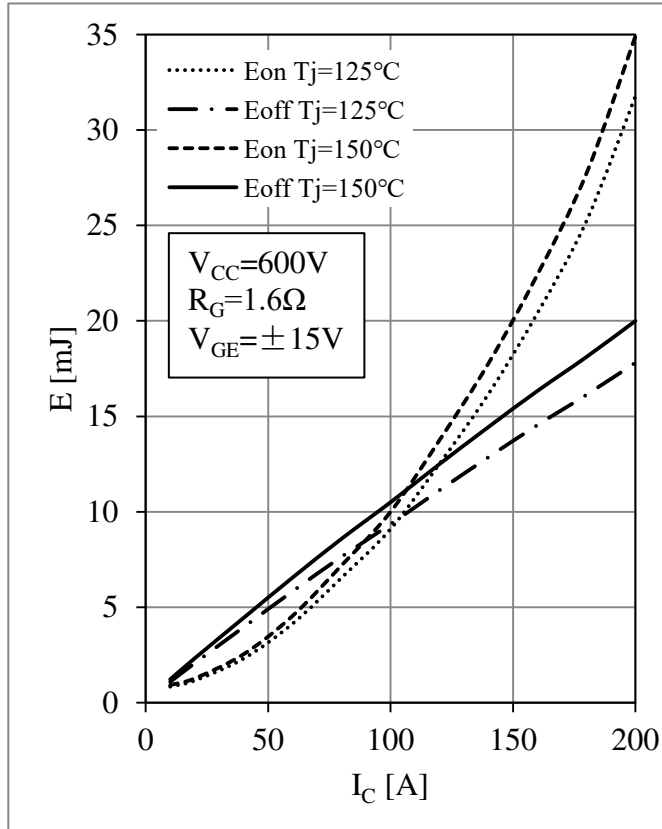
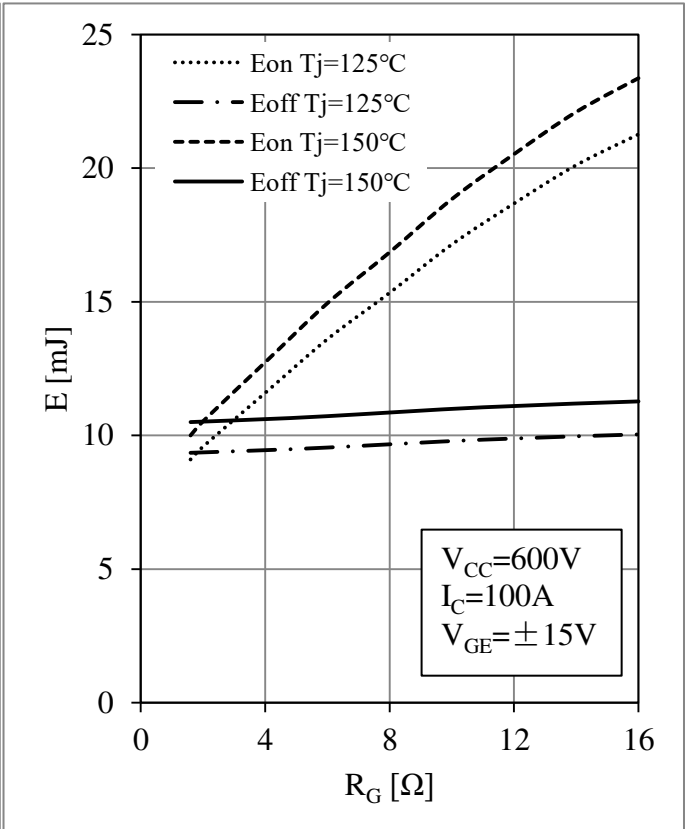


Fig 2. IGBT-inverter Transfer Characteristics

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

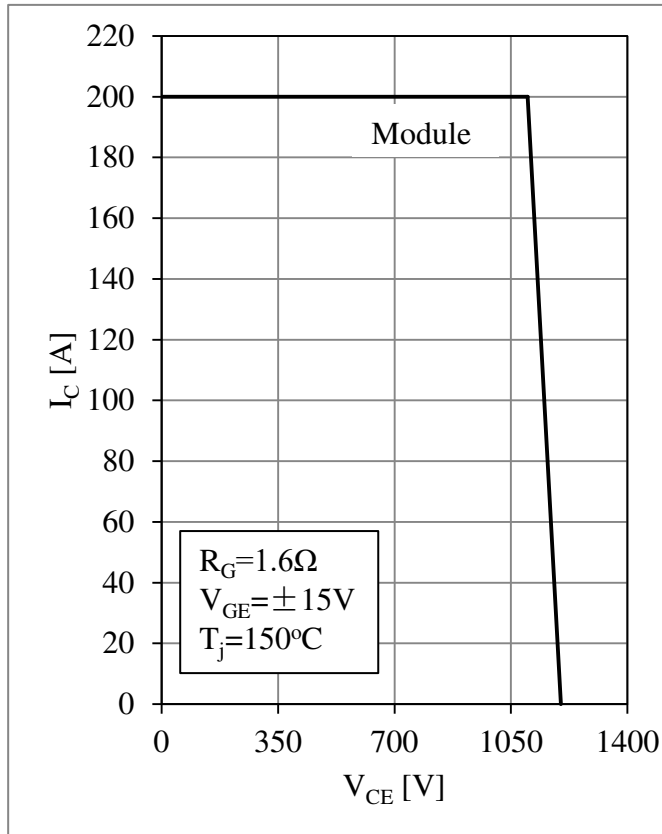


Fig 5. IGBT-inverter RBSOA

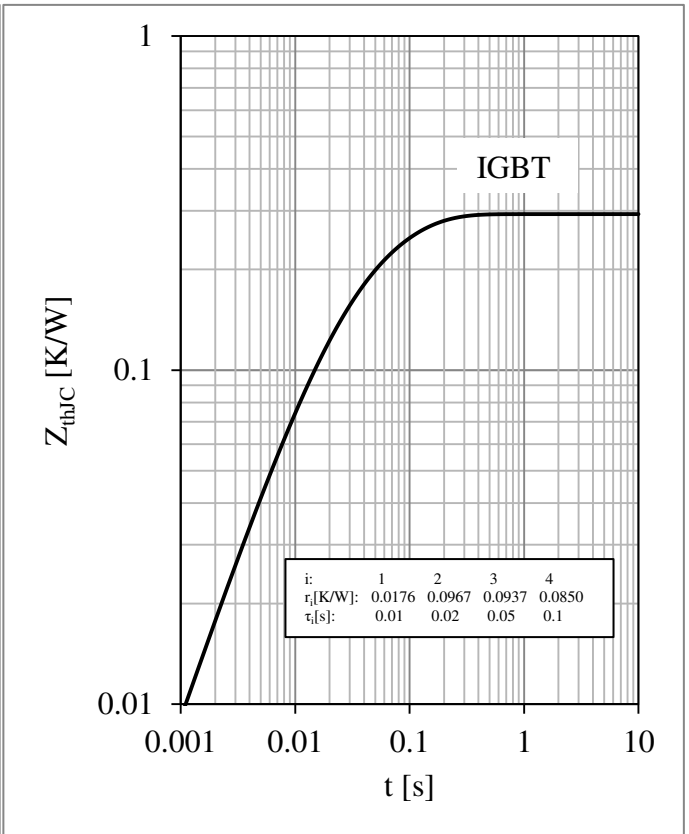


Fig 6. IGBT-inverter Transient Thermal Impedance

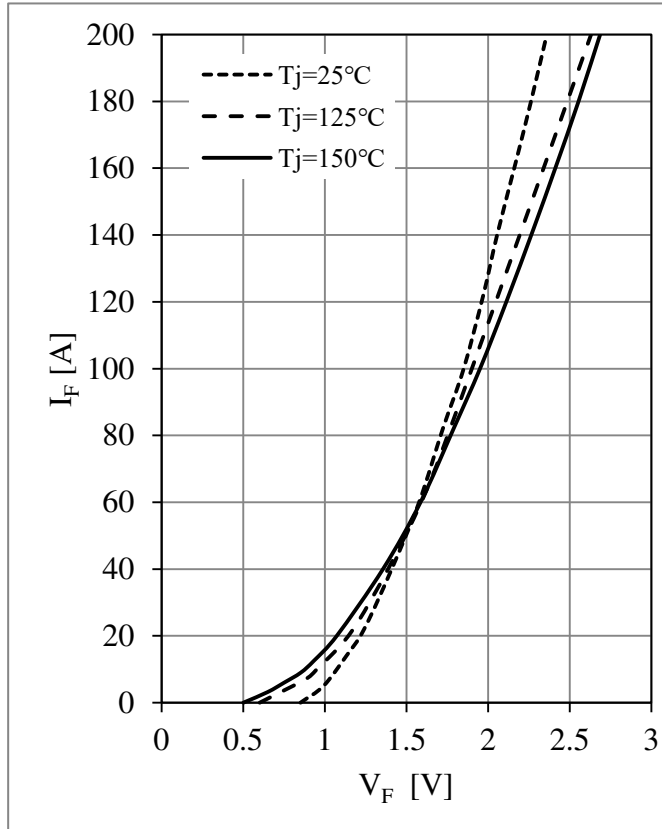
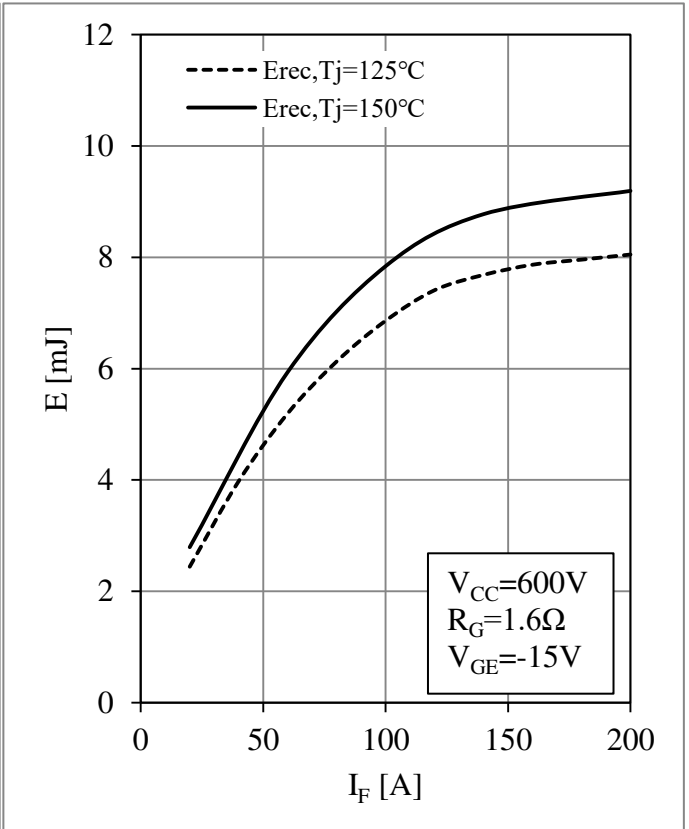
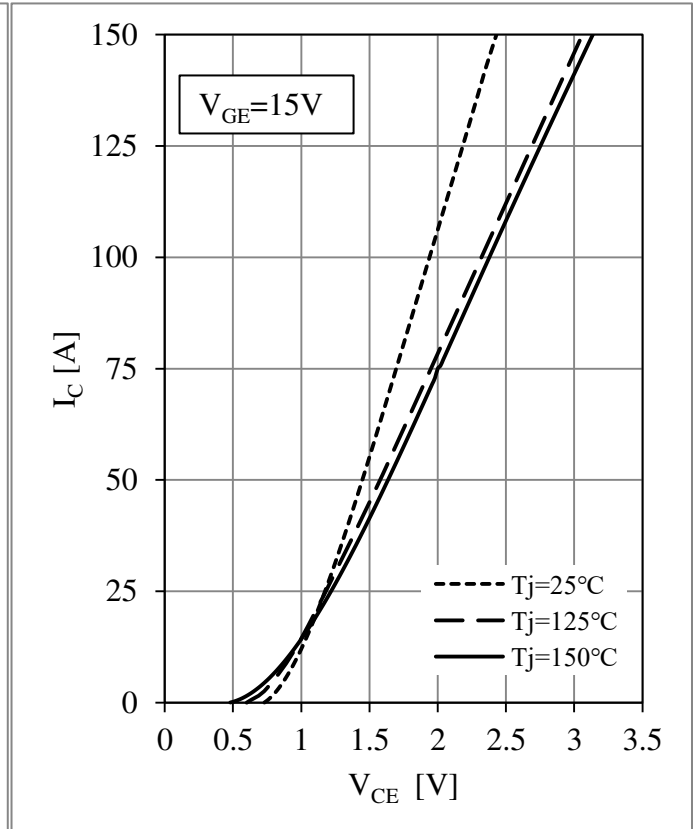
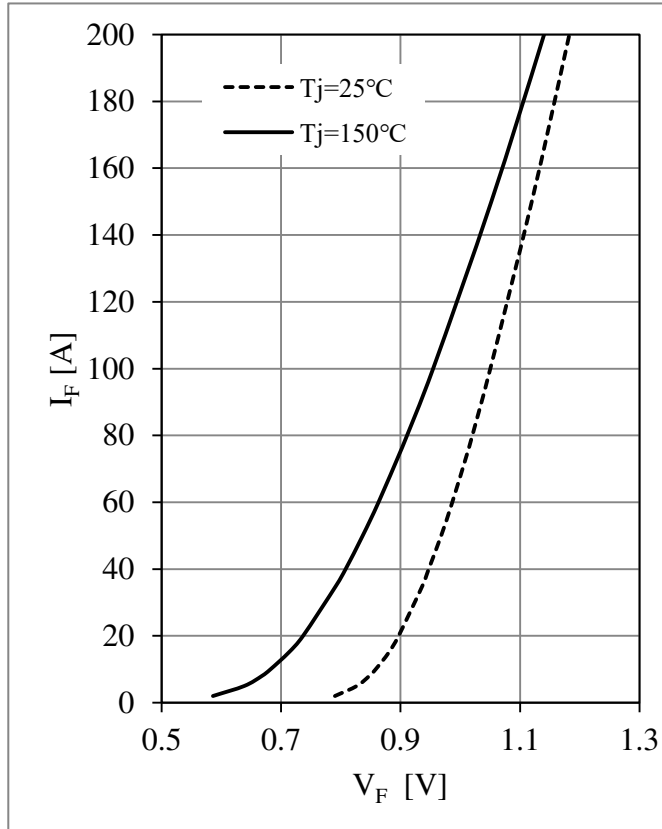
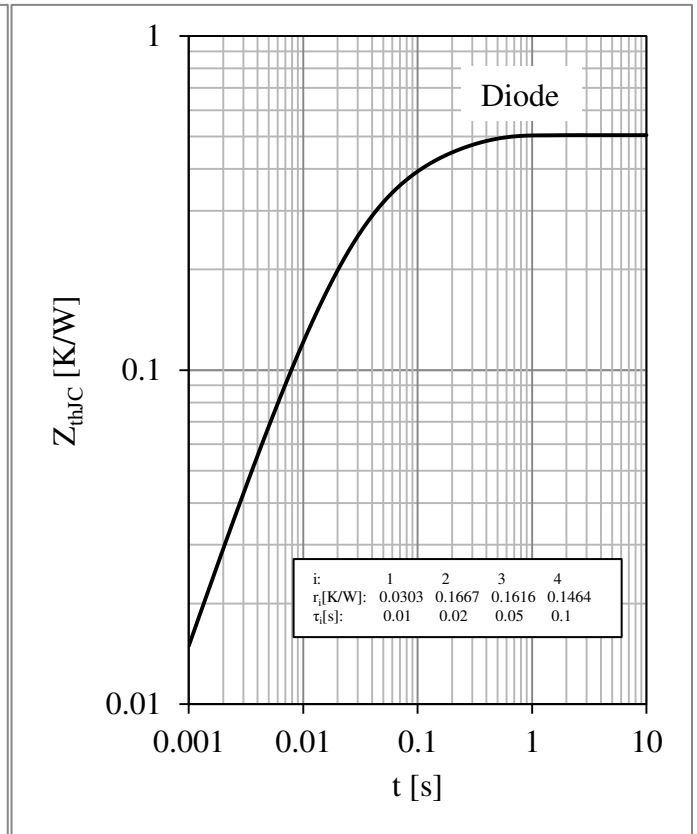
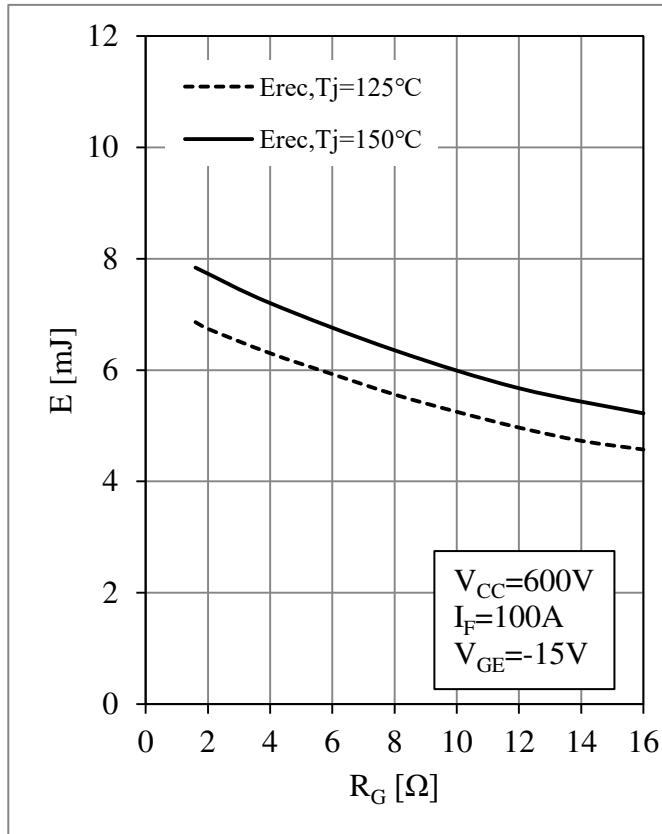


Fig 7. Diode-inverter Forward Characteristics

Fig 8. Diode-inverter Switching Loss vs.  $I_F$



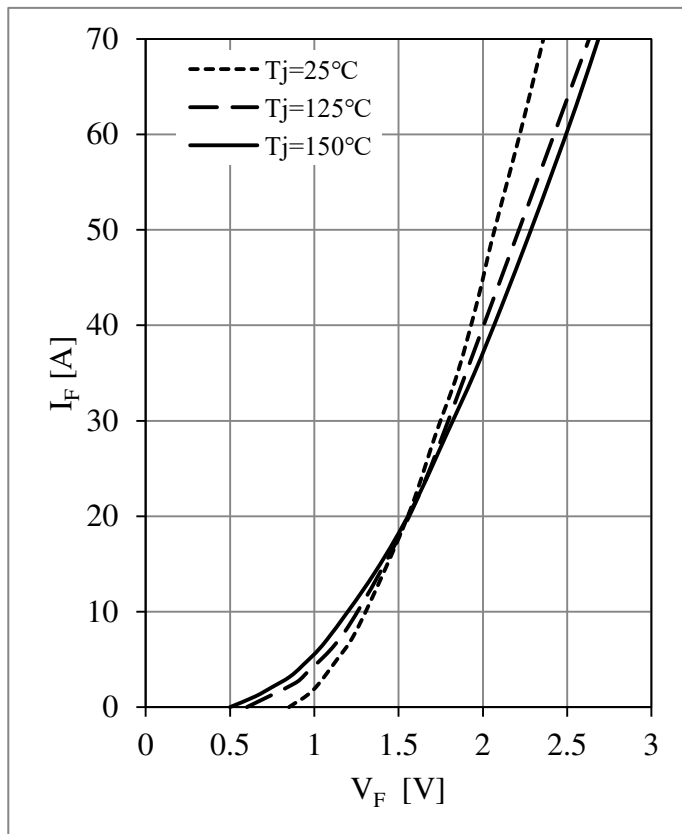


Fig 13. Diode-brake-chopper Forward Characteristics

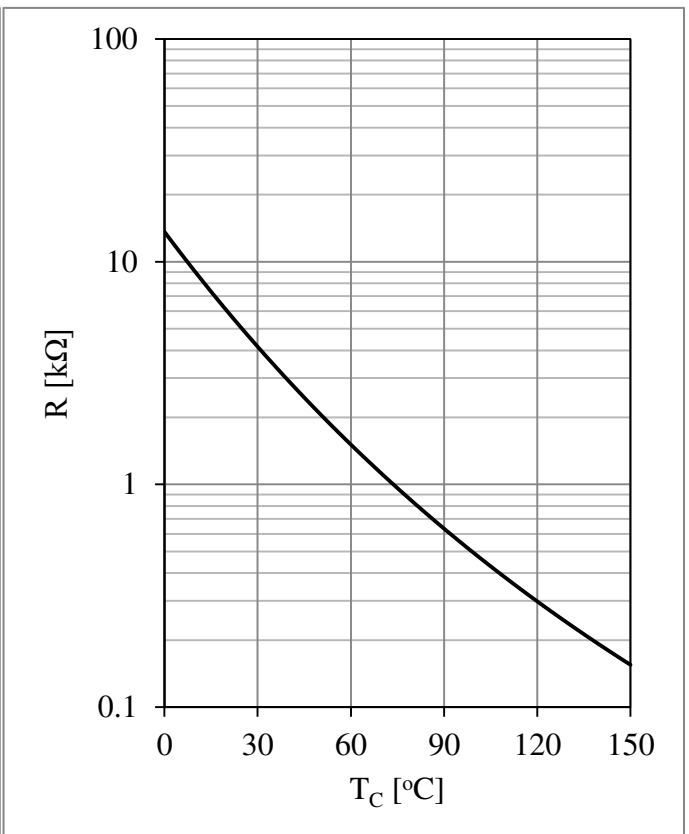
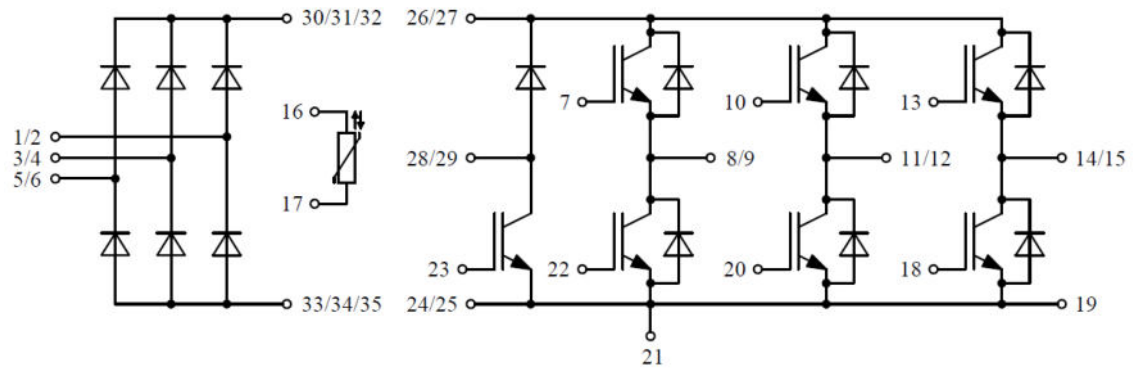


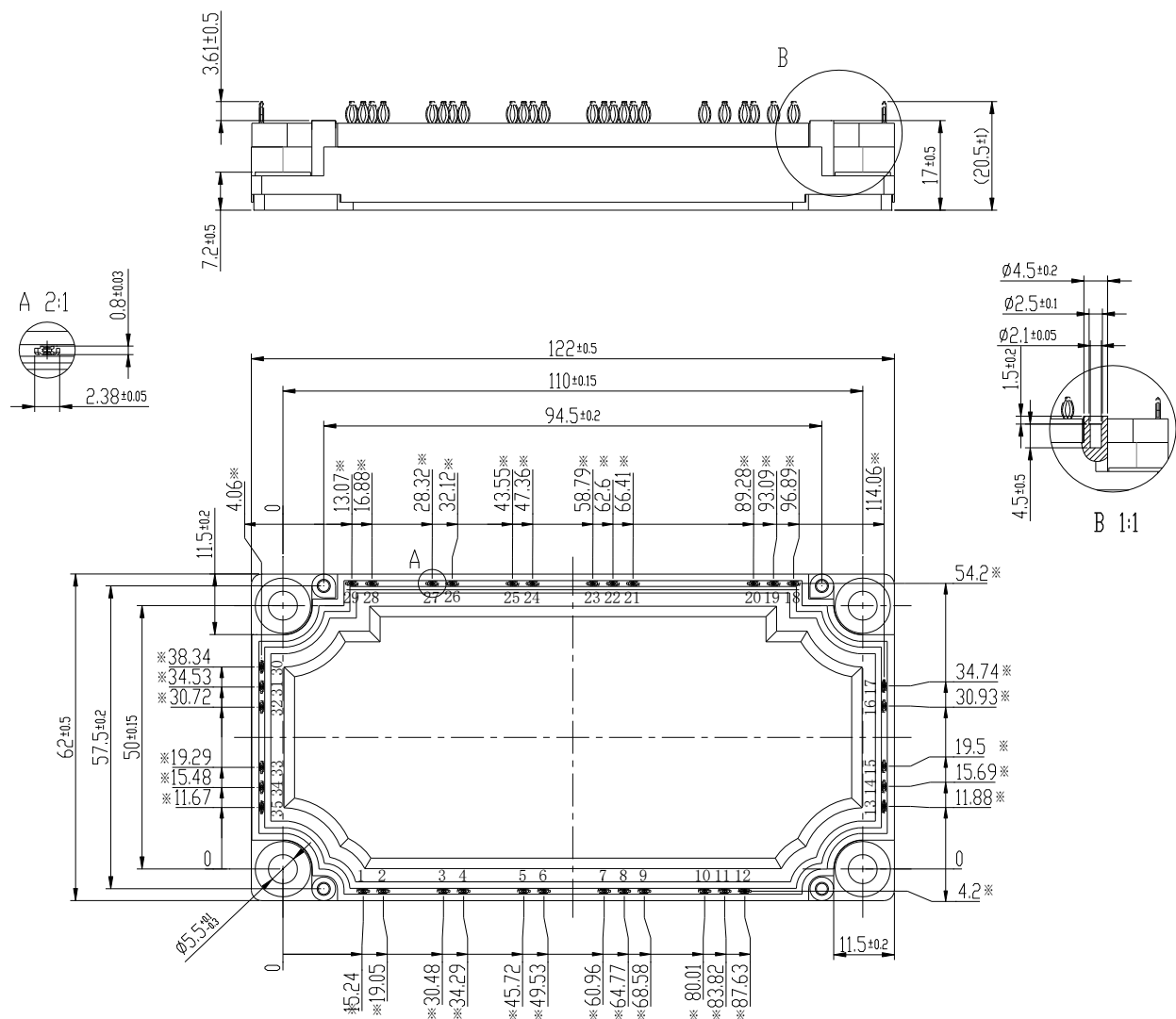
Fig 14. NTC Temperature Characteristic

## Circuit Schematic



## Package Dimensions

Dimensions in Millimeters



\*all dimensions with a tolerance of  $\pm 0.4$

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