



# GT450HF65T9H

## IGBT Module

Preliminary Data

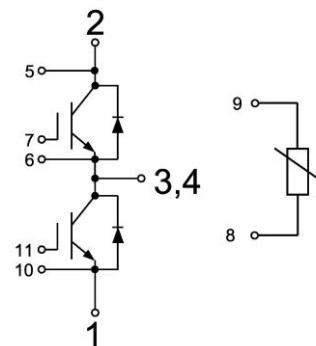
### Features:

- Trench & Field Stop IGBT
- Short Circuit Rated  $>6\mu\text{s}$
- Low Switching Loss
- 100% RBSOA Tested( $2\times I_c$ )
- Low Stray Inductance
- Lead Free, Compliant with RoHS Requirement

### Applications:

- Commercial Agriculture Vehicles
- Motor Drives
- Solar Applications
- UPS Systems

### Circuit Diagram



### IGBT, Inverter

**Maximum Rated Values** ( $T_c=25^\circ\text{C}$  unless otherwise specified)

|           |                                    |                                                          |          |   |
|-----------|------------------------------------|----------------------------------------------------------|----------|---|
| $V_{CES}$ | Collector-Emitter Blocking Voltage |                                                          | 650      | V |
| $V_{GES}$ | Gate-Emitter Voltage               |                                                          | $\pm 20$ | V |
| $I_c$     | Continuous Collector Current       | $T_c=100^\circ\text{C}$                                  | 450      | A |
|           |                                    | $T_c=25^\circ\text{C}$                                   | 550      | A |
| $I_{CM}$  | Peak Collector Current Repetitive  | $t_p=1\text{ms}$                                         | 900      | A |
| $P_D$     | Maximum Power Dissipation (IGBT)   | $T_c=25^\circ\text{C}$ ,<br>$T_{Jmax}=175^\circ\text{C}$ | 1699     | W |



## Electrical Characteristics of IGBT ( $T_C=25^{\circ}\text{C}$ unless otherwise specified)

### Static Characteristics

| Symbol        | Description                          | Conditions                                                                 | Min.                      | Typ.  | Max.      | Units |
|---------------|--------------------------------------|----------------------------------------------------------------------------|---------------------------|-------|-----------|-------|
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage       | $I_C=7.2\text{mA}$ , $V_{CE}=V_{GE}$                                       | 4.3                       | 4.6   | 5.3       | V     |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C=600\text{A}$ ,<br>$V_{GE}=15\text{V}$                                 | $T_J=25^{\circ}\text{C}$  | 1.55  | 1.90      | V     |
|               |                                      |                                                                            | $T_J=125^{\circ}\text{C}$ | 1.80  |           | V     |
|               |                                      |                                                                            | $T_J=150^{\circ}\text{C}$ | 1.85  |           | V     |
| $I_{CES}$     | Collector-Emitter Leakage Current    | $V_{GE}=0\text{V}$ ,<br>$V_{CE}=V_{CES}$ , $T_J=25^{\circ}\text{C}$        |                           |       | 1         | mA    |
| $I_{GES}$     | Gate-Emitter Leakage Current         | $V_{GE}=\pm 20\text{V}$ ,<br>$V_{CE}=0\text{V}$ , $T_J=25^{\circ}\text{C}$ |                           |       | $\pm 600$ | nA    |
| $C_{ies}$     | Input Capacitance                    | $V_{CE}=25\text{V}$ , $V_{GE}=0\text{V}$ ,<br>$f=100\text{kHz}$            |                           | 32.54 |           | nF    |
| $C_{oes}$     | Output Capacitance                   |                                                                            |                           | 2.10  |           | nF    |
| $C_{res}$     | Reverse Transfer Capacitance         |                                                                            |                           | 0.59  |           | nF    |

### Switching Characteristics

| Switching Characteristics |                        |                                                                                                                                 |                    |  |     |  |    |
|---------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------------|--|-----|--|----|
| $t_{d(on)}$               | Turn-on Delay Time     | $V_{CC}=300V, I_C=450A,$<br>$R_{Gon}=10\Omega, V_{GE}=\pm 15V,$<br>Inductive Load                                               | $T_J=25^{\circ}C$  |  | 897 |  | ns |
|                           |                        |                                                                                                                                 | $T_J=125^{\circ}C$ |  | 909 |  |    |
|                           |                        |                                                                                                                                 | $T_J=150^{\circ}C$ |  | 929 |  |    |
| $t_r$                     | Rise Time              |                                                                                                                                 | $T_J=25^{\circ}C$  |  | 328 |  | ns |
|                           |                        |                                                                                                                                 | $T_J=125^{\circ}C$ |  | 357 |  |    |
|                           |                        |                                                                                                                                 | $T_J=150^{\circ}C$ |  | 358 |  |    |
| $t_{d(off)}$              | Turn-off Delay Time    | $V_{CC}=300V, I_C=450A,$<br>$R_{Goff}=10\Omega, V_{GE}=\pm 15V,$<br>Inductive Load                                              | $T_J=25^{\circ}C$  |  | 846 |  | ns |
|                           |                        |                                                                                                                                 | $T_J=125^{\circ}C$ |  | 852 |  |    |
|                           |                        |                                                                                                                                 | $T_J=150^{\circ}C$ |  | 858 |  |    |
| $t_f$                     | Fall Time              |                                                                                                                                 | $T_J=25^{\circ}C$  |  | 154 |  | ns |
|                           |                        |                                                                                                                                 | $T_J=125^{\circ}C$ |  | 165 |  |    |
|                           |                        |                                                                                                                                 | $T_J=150^{\circ}C$ |  | 168 |  |    |
| $E_{on}$                  | Turn-on Switching Loss | $V_{CC}=300V, I_C=450A,$<br>$R_{Gon}=10\Omega, V_{GE}=\pm 15V,$<br>$di/dt=1072A/\mu s$ ( $T_J=150^{\circ}C$ )<br>Inductive Load | $T_J=25^{\circ}C$  |  | 15  |  | mJ |
|                           |                        |                                                                                                                                 | $T_J=125^{\circ}C$ |  | 19  |  |    |
|                           |                        |                                                                                                                                 | $T_J=150^{\circ}C$ |  | 21  |  |    |



|                     |                                                                     |                                                                                                                                                            |                       |  |      |       |      |
|---------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|------|-------|------|
| E <sub>off</sub>    | Turn-off Switching Loss                                             | V <sub>CC</sub> =300V, I <sub>C</sub> =450A,<br>R <sub>Goff</sub> =10Ω, V <sub>GE</sub> =±15V,<br>du/dt=1187V/μs (T <sub>J</sub> =150°C)<br>Inductive Load | T <sub>J</sub> =25°C  |  | 28   |       | mJ   |
|                     |                                                                     |                                                                                                                                                            | T <sub>J</sub> =125°C |  | 31   |       |      |
|                     |                                                                     |                                                                                                                                                            | T <sub>J</sub> =150°C |  | 34   |       |      |
| Q <sub>g</sub>      | Total Gate Charge                                                   | V <sub>GE</sub> =+15V...-15V                                                                                                                               | T <sub>J</sub> =25°C  |  | 2.21 |       | uC   |
| R <sub>G(int)</sub> | Internal Gate Resistance                                            |                                                                                                                                                            | T <sub>J</sub> =25°C  |  | 0.67 |       | Ω    |
| SCSOA               | V <sub>CC</sub> =300V, V <sub>GE</sub> =±15V, T <sub>J</sub> =150°C |                                                                                                                                                            |                       |  | 6    |       | μs   |
| R <sub>θJC</sub>    | IGBT Thermal Resistance: Junction-to-Case (per IGBT)                |                                                                                                                                                            |                       |  |      | 0.088 | °C/W |

## Diode, Inverter

### Maximum Rated Values (T<sub>C</sub>=25°C unless otherwise specified)

|                  |                                  |                       |     |   |
|------------------|----------------------------------|-----------------------|-----|---|
| V <sub>RRM</sub> | Repetitive Peak Reverse Voltage  | T <sub>J</sub> =25°C  | 650 | V |
| I <sub>F</sub>   | Diode Continuous Forward Current | T <sub>C</sub> =100°C | 450 | A |
| I <sub>FM</sub>  | Peak Diode Current Repetitive    | tp=1ms                | 900 | A |

### Electrical Characteristics of Diode (T<sub>C</sub>=25°C unless otherwise specified)

| Symbol          | Description                   | Conditions                                                                                                          |                       | Min. | Typ. | Max. | Units |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------|------|------|------|-------|
| V <sub>FM</sub> | Forward Voltage               | I <sub>F</sub> =450A                                                                                                | T <sub>J</sub> =25°C  |      | 1.65 |      | V     |
|                 |                               |                                                                                                                     | T <sub>J</sub> =125°C |      | 1.75 |      |       |
|                 |                               |                                                                                                                     | T <sub>J</sub> =150°C |      | 1.75 |      |       |
| t <sub>rr</sub> | Reverse Recovery Time         | I <sub>F</sub> =450A,<br>-diF/dt=1372A/μs(T <sub>J</sub> =150°C),<br>V <sub>R</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25°C  |      | 180  |      | ns    |
|                 |                               |                                                                                                                     | T <sub>J</sub> =125°C |      | 196  |      |       |
|                 |                               |                                                                                                                     | T <sub>J</sub> =150°C |      | 228  |      |       |
| I <sub>rr</sub> | Peak Reverse Recovery Current |                                                                                                                     | T <sub>J</sub> =25°C  |      | 100  |      | A     |
|                 |                               |                                                                                                                     | T <sub>J</sub> =125°C |      | 131  |      |       |
|                 |                               |                                                                                                                     | T <sub>J</sub> =150°C |      | 144  |      |       |
| Q <sub>rr</sub> | Reverse Recovery Charge       |                                                                                                                     | T <sub>J</sub> =25°C  |      | 8.5  |      | μC    |
|                 |                               |                                                                                                                     | T <sub>J</sub> =125°C |      | 14.1 |      |       |
|                 |                               |                                                                                                                     | T <sub>J</sub> =150°C |      | 16.7 |      |       |



|                  |                                                        |                                                                                                                     |                       |  |      |       |      |
|------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------|--|------|-------|------|
| E <sub>rec</sub> | Reverse Recovery Energy                                | I <sub>F</sub> =450A,<br>-diF/dt=1372A/μs(T <sub>J</sub> =150°C),<br>V <sub>R</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25°C  |  | 0.85 |       | mJ   |
|                  |                                                        |                                                                                                                     | T <sub>J</sub> =125°C |  | 2.11 |       |      |
|                  |                                                        |                                                                                                                     | T <sub>J</sub> =150°C |  | 2.68 |       |      |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case (per Diode) |                                                                                                                     |                       |  |      | 0.119 | °C/W |

## Internal NTC-Thermistor Characteristics

| Symbol              | Description                                      | Min. | Typ. | Max. | Units |
|---------------------|--------------------------------------------------|------|------|------|-------|
| R <sub>25</sub>     | T <sub>C</sub> =25°C                             |      | 5    |      | kΩ    |
| ΔR/R                | T <sub>C</sub> =100°C, R <sub>100</sub> =465Ω    | -5   |      | 5    | %     |
| P <sub>25</sub>     | T <sub>C</sub> =25°C                             |      |      | 10   | mW    |
| B <sub>25/50</sub>  | $R_2=R_{25} \exp[B_{25/50}(1/T_2-1/(298.15K))]$  |      | 3380 |      | K     |
| B <sub>25/80</sub>  | $R_2=R_{25} \exp[B_{25/80}(1/T_2-1/(298.15K))]$  |      | 3440 |      | K     |
| B <sub>25/100</sub> | $R_2=R_{25} \exp[B_{25/100}(1/T_2-1/(298.15K))]$ |      | 3545 |      | K     |

## Module

| Symbol           | Description                                        |                      | Min. | Typ. | Max. | Units |
|------------------|----------------------------------------------------|----------------------|------|------|------|-------|
| V <sub>iso</sub> | Isolation Voltage (All Terminals Shorted)          | RMS, f=50Hz, 1minute | 2500 |      |      | V     |
| T <sub>J</sub>   | Maximum Junction Temperature                       |                      |      |      | 175  | °C    |
| T <sub>JOP</sub> | Maximum Operating Junction Temperature Range       |                      | -40  |      | +150 | °C    |
| T <sub>stg</sub> | Storage Temperature                                |                      | -40  |      | +125 | °C    |
| CTI              | Comparative Tracking Index                         |                      | 200  |      |      |       |
| R <sub>θCS</sub> | Case-to-Sink Thermally (Conductive Grease Applied) |                      |      |      | 0.03 | °C/W  |
| M                | Power Terminals Screw:M6                           |                      | 4.0  |      | 5.0  | N·m   |
| M                | Mounting Screw:M5                                  |                      | 3.0  |      | 6.0  | N·m   |
| G                | Weight                                             |                      |      | 330  |      | g     |



## Ordering Information Table

|             |   |   |     |    |    |    |   |
|-------------|---|---|-----|----|----|----|---|
| Device code | G | T | 450 | HF | 65 | T9 | H |
|             | ① | ② | ③   | ④  | ⑤  | ⑥  | ⑦ |

- ① - IGBT Module
- ② - Field Stop Trench Gate IGBT
- ③ - Rated Current (450=450A)
- ④ - Circuit Configuration (Half Bridge)
- ⑤ - Rated Voltage (65=650V)
- ⑥ - Package Type
- ⑦ - Test Level (Pass the Important Reliability Test-Industrial Grade)

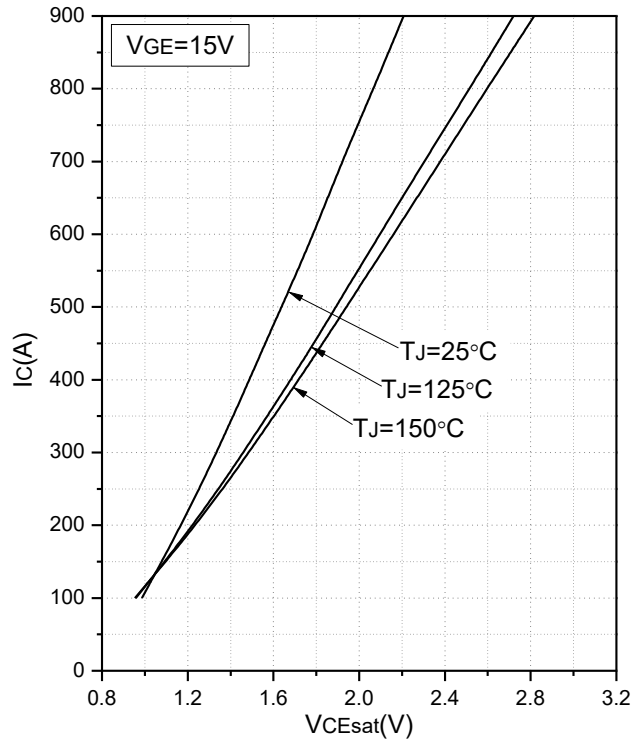


Fig.1 Typical Saturation Voltage Characteristics

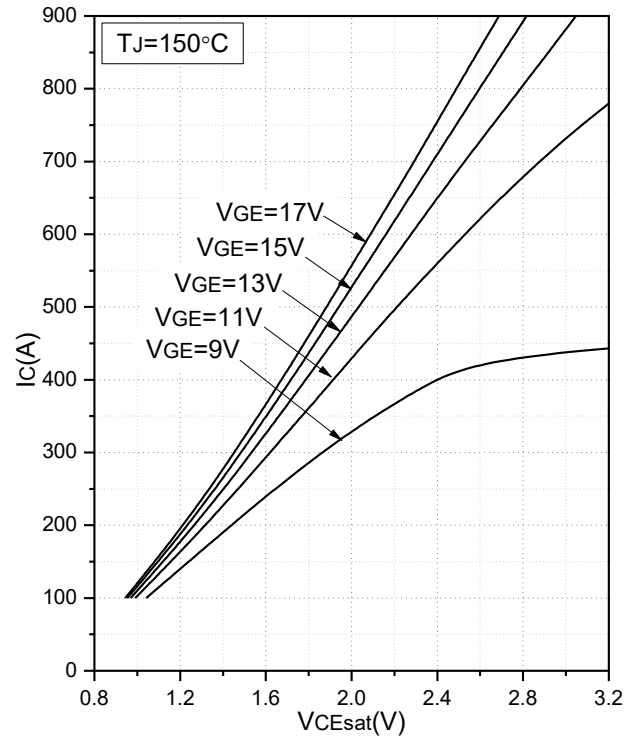


Fig.2 Typical Output Characteristics

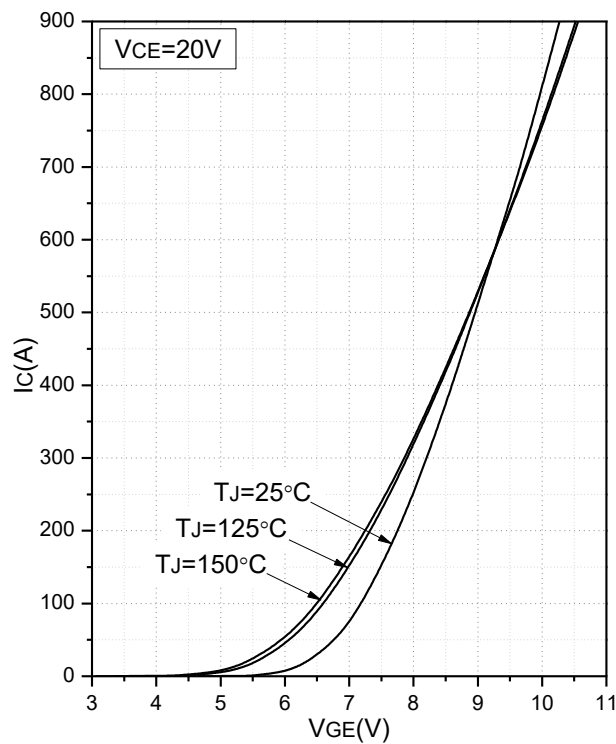


Fig.3 Transfer Characteristics

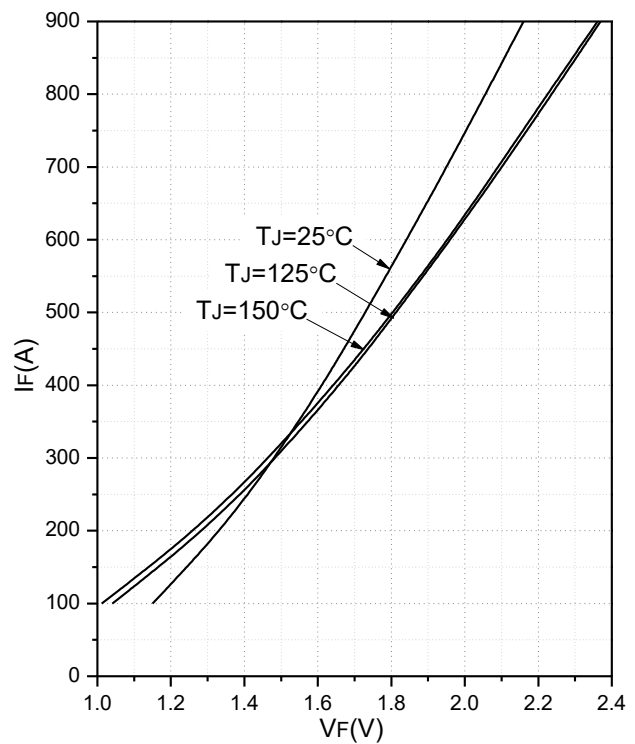


Fig.4 Forward Characteristics of Diode

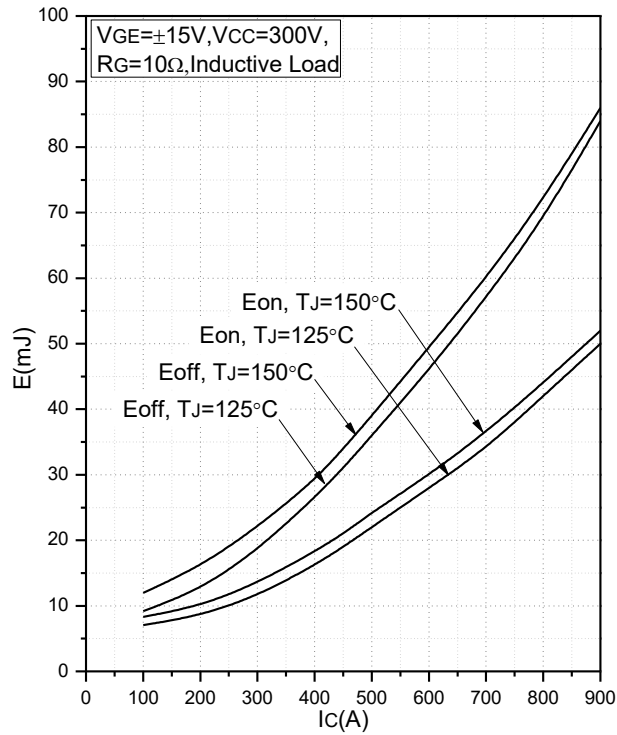


Fig.5 Typical Switching Loss vs. Collector Current

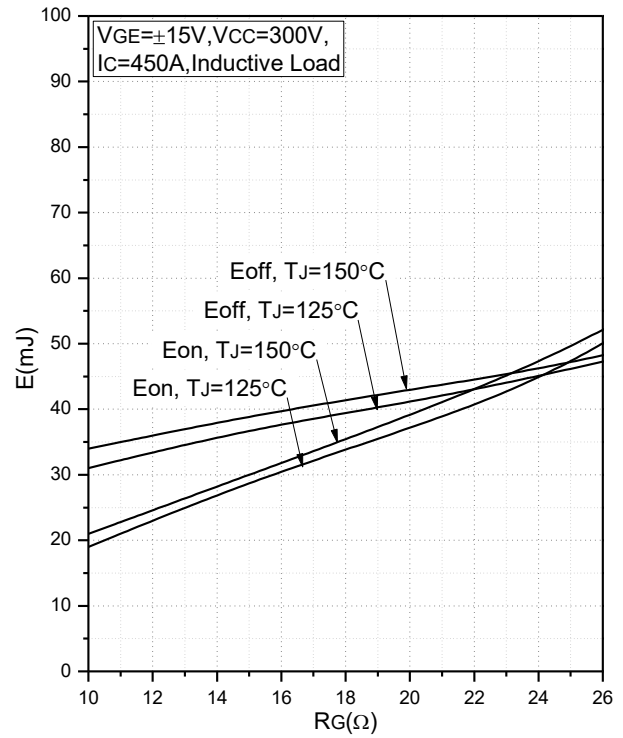


Fig.6 Typical Switching Loss vs. Gate Resistance

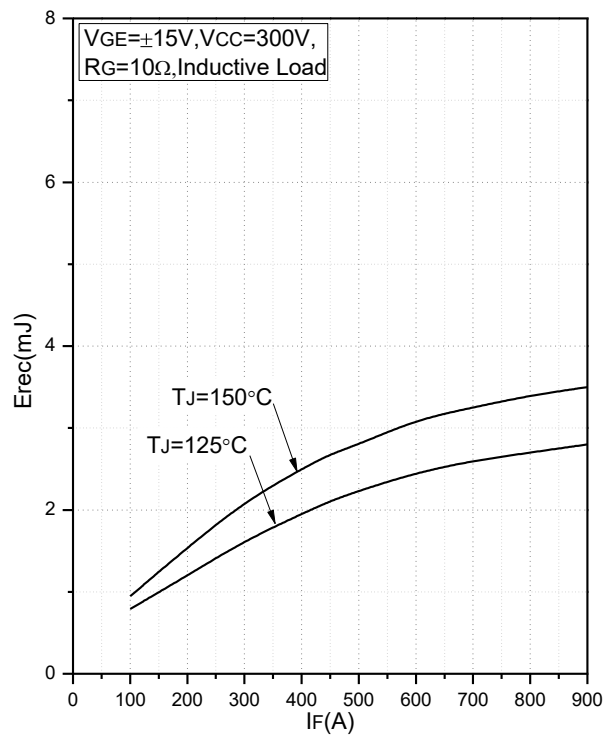


Fig.7 Typical Switching Loss vs. Forward Current

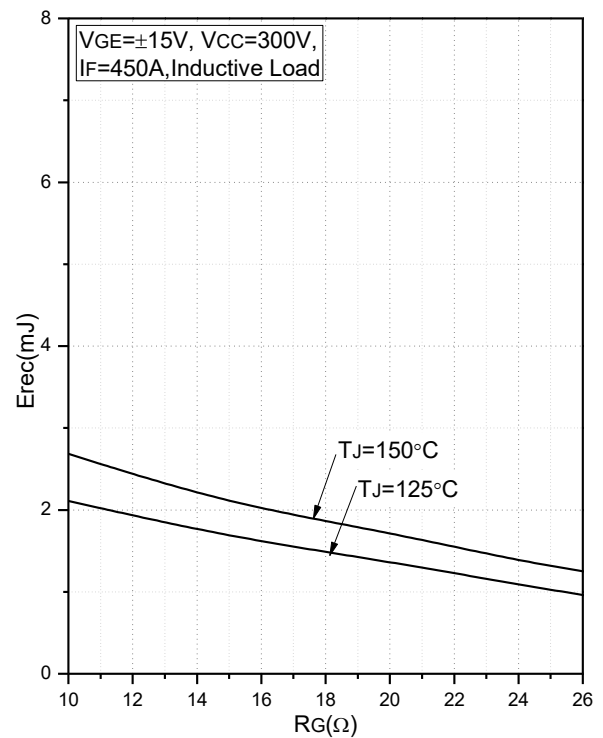


Fig.8 Typical Switching Loss vs. Gate Resistance

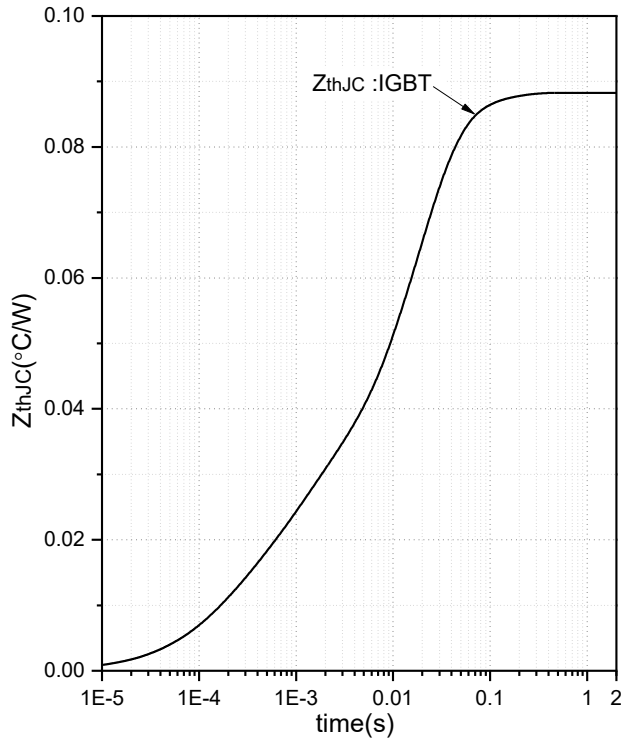


Fig.9 Transient Thermal Impedance (IGBT)

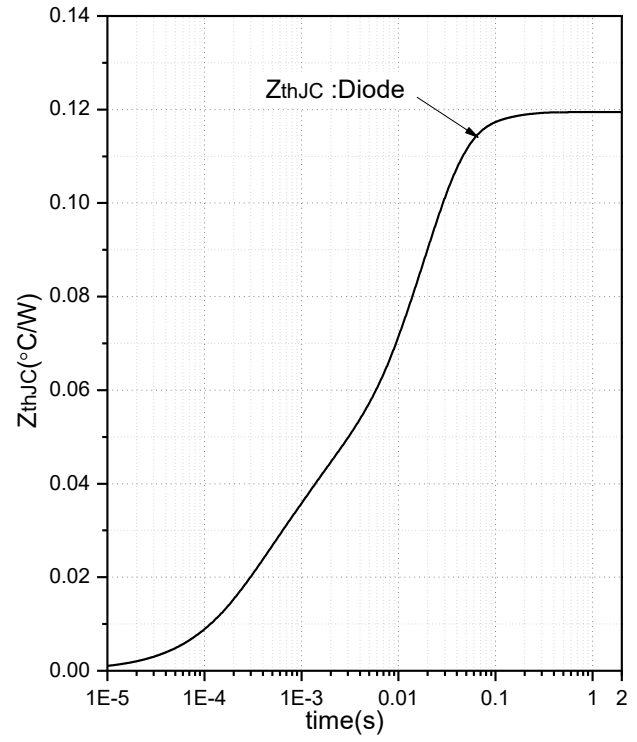


Fig.10 Transient Thermal Impedance (Diode)

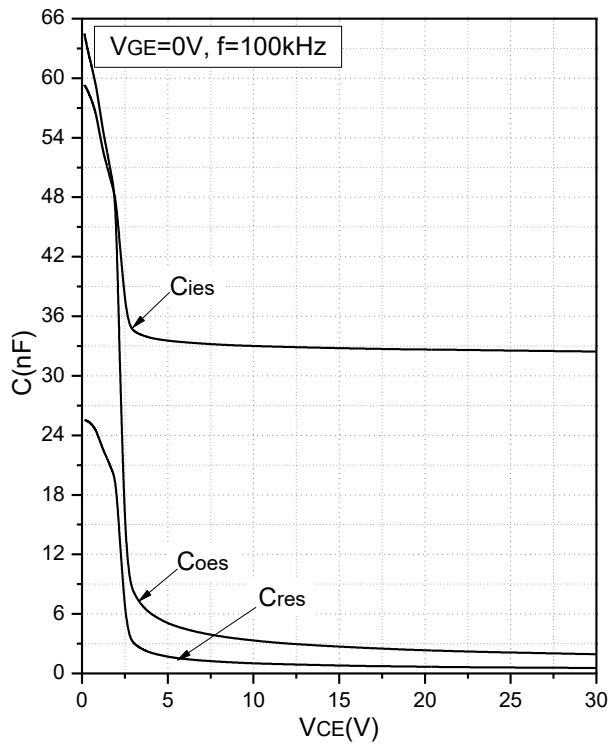


Fig.11 Capacitance Characteristics

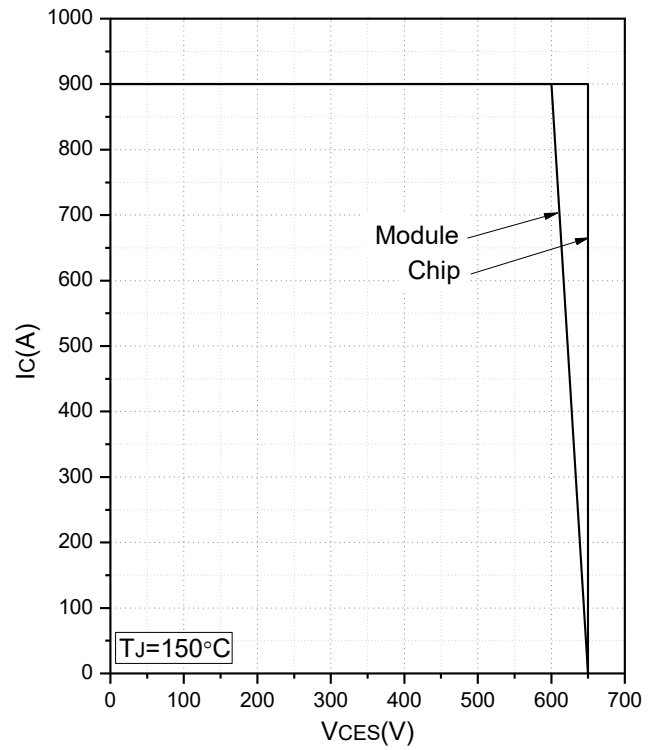


Fig.12 Reverse Bias Safe Operation Area (RBSOA)

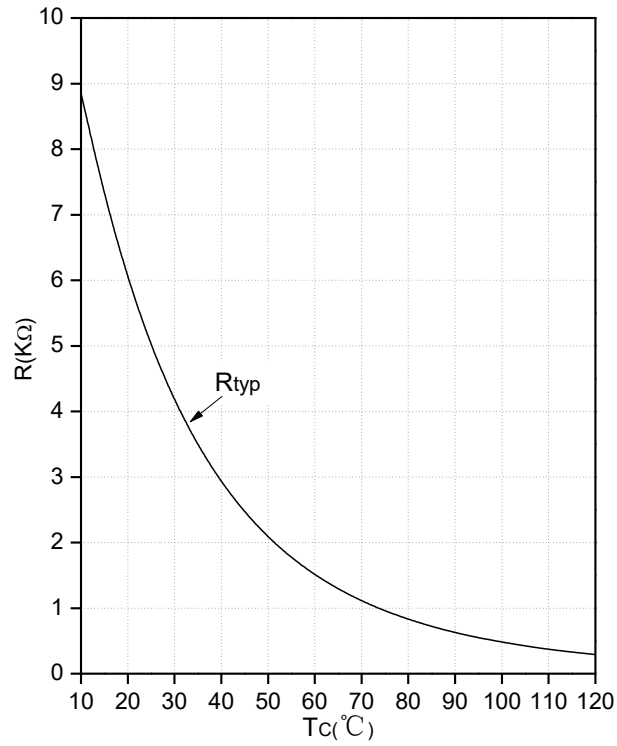


Fig.13 NTC Temperature Characteristics





| Revision | Notes           |
|----------|-----------------|
| 01       | Initial Release |
|          |                 |

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