





## 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       | $I_C=3.2\text{mA}$ , $V_{CE}=V_{GE}$                                       | 4.0                       | 4.8  | 6.0       | V     |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C=150\text{A}$ ,<br>$V_{GE}=15\text{V}$                                 | $T_J=25^{\circ}\text{C}$  | 1.35 | 1.70      | V     |
|               |                                      |                                                                            | $T_J=125^{\circ}\text{C}$ | 1.45 |           | V     |
|               |                                      |                                                                            | $T_J=150^{\circ}\text{C}$ | 1.50 |           | 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>$V_{CE}=0\text{V}$ , $T_J=25^{\circ}\text{C}$ |                           |      | $\pm 200$ | nA    |
| $C_{ies}$     | Input Capacitance                    | $V_{CE}=25\text{V}$ , $V_{GE}=0\text{V}$ ,<br>$f=100\text{kHz}$            |                           | 10.4 |           | nF    |
| $C_{oes}$     | Output Capacitance                   |                                                                            |                           | 0.62 |           | nF    |
| $C_{res}$     | Reveres Transfer Capacitance         |                                                                            |                           | 0.22 |           | nF    |

### Switching Characteristics

|              |                        |                                                                                                                               |                    |  |      |  |    |
|--------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------|--|------|--|----|
| $t_{d(on)}$  | Turn-on Delay Time     | $V_{CC}=300V, I_C=150A,$<br>$R_{Gon}=5.1\Omega, V_{GE}=\pm 15V,$<br>Inductive Load                                            | $T_J=25^{\circ}C$  |  | 122  |  | ns |
|              |                        |                                                                                                                               | $T_J=125^{\circ}C$ |  | 124  |  |    |
|              |                        |                                                                                                                               | $T_J=150^{\circ}C$ |  | 126  |  |    |
| $t_r$        | Rise Time              |                                                                                                                               | $T_J=25^{\circ}C$  |  | 110  |  | ns |
|              |                        |                                                                                                                               | $T_J=125^{\circ}C$ |  | 112  |  |    |
|              |                        |                                                                                                                               | $T_J=150^{\circ}C$ |  | 113  |  |    |
| $t_{d(off)}$ | Turn-off Delay Time    | $V_{CC}=300V, I_C=150A,$<br>$R_{Goff}=5.1\Omega, V_{GE}=\pm 15V,$<br>Inductive Load                                           | $T_J=25^{\circ}C$  |  | 252  |  | ns |
|              |                        |                                                                                                                               | $T_J=125^{\circ}C$ |  | 321  |  |    |
|              |                        |                                                                                                                               | $T_J=150^{\circ}C$ |  | 332  |  |    |
| $t_f$        | Fall Time              |                                                                                                                               | $T_J=25^{\circ}C$  |  | 55   |  | ns |
|              |                        |                                                                                                                               | $T_J=125^{\circ}C$ |  | 82   |  |    |
|              |                        |                                                                                                                               | $T_J=150^{\circ}C$ |  | 85   |  |    |
| $E_{on}$     | Turn-on Switching Loss | $V_{CC}=300V, I_C=150A,$<br>$R_{Gon}=5.1\Omega, V_{GE}=\pm 15V,$<br>$di/dt=1078A/us$ ( $T_J=150^{\circ}C$ )<br>Inductive Load | $T_J=25^{\circ}C$  |  | 2.13 |  | mJ |
|              |                        |                                                                                                                               | $T_J=125^{\circ}C$ |  | 3.25 |  |    |
|              |                        |                                                                                                                               | $T_J=150^{\circ}C$ |  | 3.40 |  |    |



|                      |                                                                               |                                                                                                                                                             |                       |  |      |      |      |
|----------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|------|------|------|
| E <sub>off</sub>     | Turn-off Switching Loss                                                       | V <sub>CC</sub> =300V, I <sub>C</sub> =150A,<br>R <sub>Goff</sub> =5.1Ω, V <sub>GE</sub> =±15V,<br>dv/dt=6374V/μs (T <sub>J</sub> =150°C)<br>Inductive Load | T <sub>J</sub> =25°C  |  | 3.37 |      | mJ   |
|                      |                                                                               |                                                                                                                                                             | T <sub>J</sub> =125°C |  | 4.24 |      |      |
|                      |                                                                               |                                                                                                                                                             | T <sub>J</sub> =150°C |  | 4.46 |      |      |
| Q <sub>g</sub>       | Total Gate Charge                                                             | V <sub>GE</sub> =+15V...-15V                                                                                                                                | T <sub>J</sub> =25°C  |  | 1.42 |      | μC   |
| R <sub>g (int)</sub> | Internal Gate Resistor                                                        |                                                                                                                                                             |                       |  | 2    |      | Ω    |
| I <sub>SC</sub>      | V <sub>CC</sub> =360V, tp=10μs, V <sub>GE</sub> =+/-15V, T <sub>J</sub> =25°C |                                                                                                                                                             |                       |  | 770  |      | A    |
| R <sub>θJC</sub>     | IGBT Thermal Resistance: Junction-to-Case                                     |                                                                                                                                                             |                       |  |      | 0.27 | °C/W |

### Diode, Inverter (D1,D2,D3,D4)

**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 | 150 | A |
| I <sub>FM</sub>  | Diode Maximum Forward Current    | tp=1ms                | 300 | A |

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

| Symbol          | Description                   | Conditions                                                                                                                      |                      | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------|------|------|------|------|
| V <sub>FM</sub> | Forward Voltage               | I <sub>F</sub> =150A                                                                                                            | T <sub>J</sub> =25℃  |      | 1.58 |      | V    |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 1.60 |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 1.60 |      |      |
| t <sub>rr</sub> | Reverse Recovery Time         | I <sub>F</sub> =150A,<br>-di <sub>F</sub> /dt=1117A/μs(T <sub>J</sub> =150℃),<br>V <sub>R</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25℃  |      | 228  |      | ns   |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 230  |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 240  |      |      |
| I <sub>rr</sub> | Peak Reverse Recovery Current |                                                                                                                                 | T <sub>J</sub> =25℃  |      | 70   |      | A    |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 78   |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 82   |      |      |



|                  |                                            |                                                                                                                                 |                      |  |       |      |     |
|------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------|--|-------|------|-----|
| Q <sub>rr</sub>  | Reverse Recovery Charge                    | I <sub>F</sub> =150A,<br>-di <sub>F</sub> /dt=1117A/μs(T <sub>J</sub> =150℃),<br>V <sub>R</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25℃  |  | 8.14  |      | μC  |
|                  |                                            |                                                                                                                                 | T <sub>J</sub> =125℃ |  | 10.24 |      |     |
|                  |                                            |                                                                                                                                 | T <sub>J</sub> =150℃ |  | 11.61 |      |     |
| E <sub>rec</sub> | Reverse Recovery Energy                    |                                                                                                                                 | T <sub>J</sub> =25℃  |  | 2.3   |      | mJ  |
|                  |                                            |                                                                                                                                 | T <sub>J</sub> =125℃ |  | 2.9   |      |     |
|                  |                                            |                                                                                                                                 | T <sub>J</sub> =150℃ |  | 3.3   |      |     |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case |                                                                                                                                 |                      |  |       | 0.37 | ℃/W |

### Diode, 3-Level (D5,D6)

#### 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 | 150 | A |
| I <sub>FM</sub>  | Diode Maximum Forward Current    | t <sub>p</sub> =1ms   | 300 | A |

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

| Symbol          | Description                   | Conditions                                                                                                                      |                      | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------|------|------|------|------|
| V <sub>FM</sub> | Forward Voltage               | I <sub>F</sub> =150A                                                                                                            | T <sub>J</sub> =25℃  |      | 1.58 |      | V    |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 1.60 |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 1.60 |      |      |
| t <sub>rr</sub> | Reverse Recovery Time         | I <sub>F</sub> =150A,<br>-di <sub>F</sub> /dt=1117A/μs(T <sub>J</sub> =150℃),<br>V <sub>R</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25℃  |      | 228  |      | ns   |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 230  |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 240  |      |      |
| I <sub>rr</sub> | Peak Reverse Recovery Current |                                                                                                                                 | T <sub>J</sub> =25℃  |      | 70   |      | A    |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =125℃ |      | 78   |      |      |
|                 |                               |                                                                                                                                 | T <sub>J</sub> =150℃ |      | 82   |      |      |



|                  |                                            |                                                                                                                                  |                       |  |       |      |      |
|------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|-------|------|------|
| Q <sub>rr</sub>  | Reverse Recovery Charge                    | I <sub>F</sub> =150A,<br>-di <sub>F</sub> /dt=1117A/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  |  | 8.14  |      | μC   |
|                  |                                            |                                                                                                                                  | T <sub>J</sub> =125°C |  | 10.24 |      |      |
|                  |                                            |                                                                                                                                  | T <sub>J</sub> =150°C |  | 11.61 |      |      |
| E <sub>rec</sub> | Reverse Recovery Energy                    |                                                                                                                                  | T <sub>J</sub> =25°C  |  | 2.3   |      | mJ   |
|                  |                                            |                                                                                                                                  | T <sub>J</sub> =125°C |  | 2.9   |      |      |
|                  |                                            |                                                                                                                                  | T <sub>J</sub> =150°C |  | 3.3   |      |      |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case |                                                                                                                                  |                       |  |       | 0.37 | °C/W |

## Internal NTC- Thermistor Characteristic

| 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, 30s | 4500                           |      |      | V     |
| Internal Isolation |                                              |                  | Al <sub>2</sub> O <sub>3</sub> |      |      |       |
| d <sub>creep</sub> | Creepage Distance: Terminal to Heatsink      |                  |                                | 11.5 |      | mm    |
|                    | Creepage Distance: Terminal to Terminal      |                  |                                | 6.3  |      | mm    |
| d <sub>clear</sub> | Clearance: Terminal to Heatsink              |                  |                                | 10.0 |      | mm    |
|                    | Clearance: Terminal to Terminal              |                  |                                | 5.0  |      | mm    |
| L <sub>SCE</sub>   | Stray Inductance Module                      |                  |                                | 15   |      | nH    |
| 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 | ℃   |
| CTI              | Comparative Tracking Index                         | 200 |    |      |     |
| R <sub>ecs</sub> | Case-to-Sink Thermally (Conductive Grease Applied) |     |    | 0.05 | ℃/W |
| T                | Mounting Screw:M4                                  | 1.8 |    | 2.0  | N·m |
| G                | Weight                                             |     | 40 |      | g   |

## Ordering Information Table

Device code

|   |   |     |    |    |    |   |
|---|---|-----|----|----|----|---|
| G | T | 150 | TL | 65 | B9 | H |
| ① | ② | ③   | ④  | ⑤  | ⑥  | ⑦ |

- ① - IGBT Module
- ② - Trench & Field Stop IGBT
- ③ - Rated Current (150=150A)
- ④ - Circuit Configuration: TL (Three Level)
- ⑤ - Rated Voltage (65=650V)
- ⑥ - Package Type
- ⑦ - Test Level (Pass the Important Reliability Test-Industrial Grade)

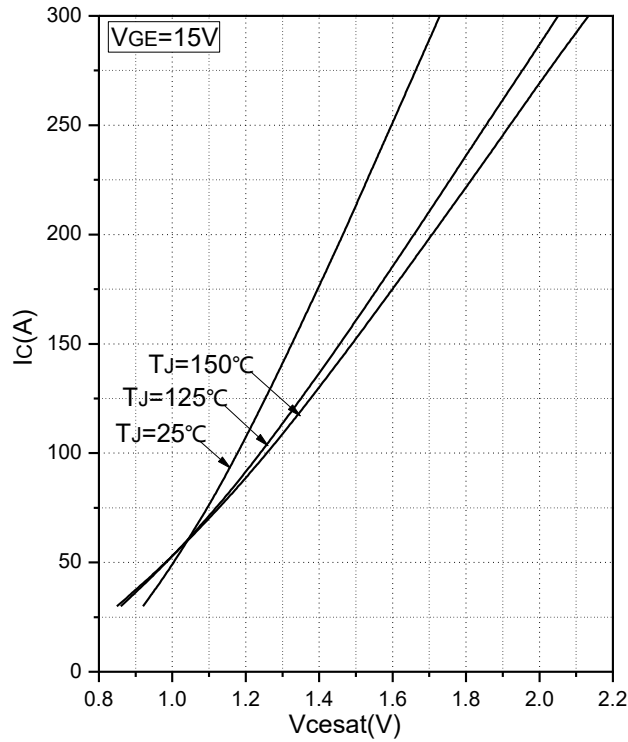


Fig.1 Typical Saturation Voltage Characteristics

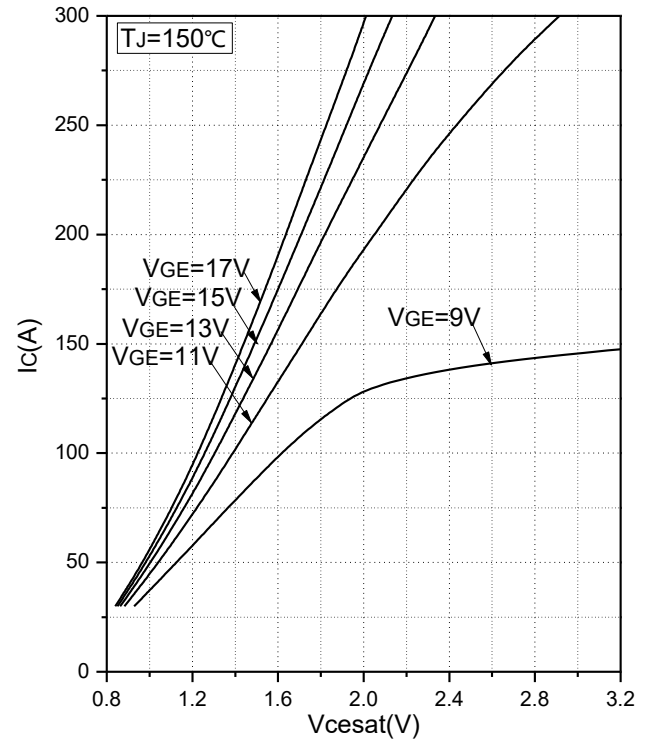


Fig.2 Typical Output Characteristics

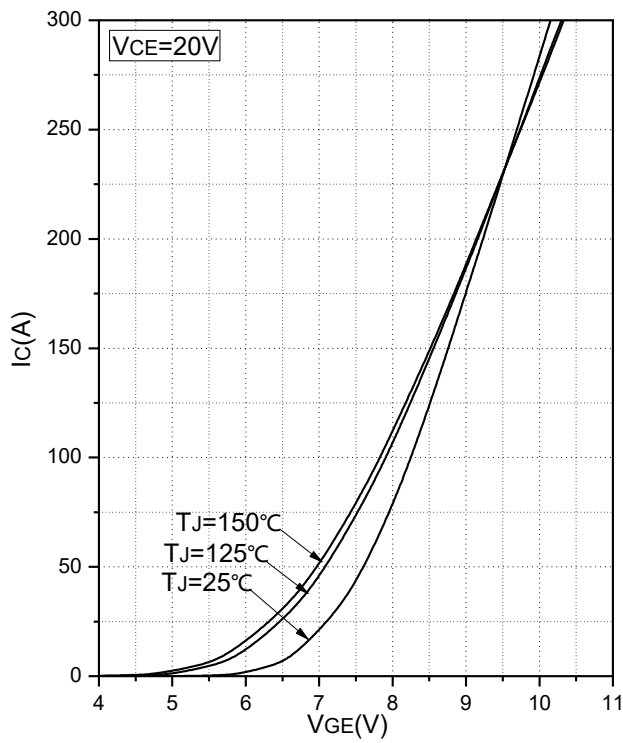


Fig.3 Transfer Characteristic

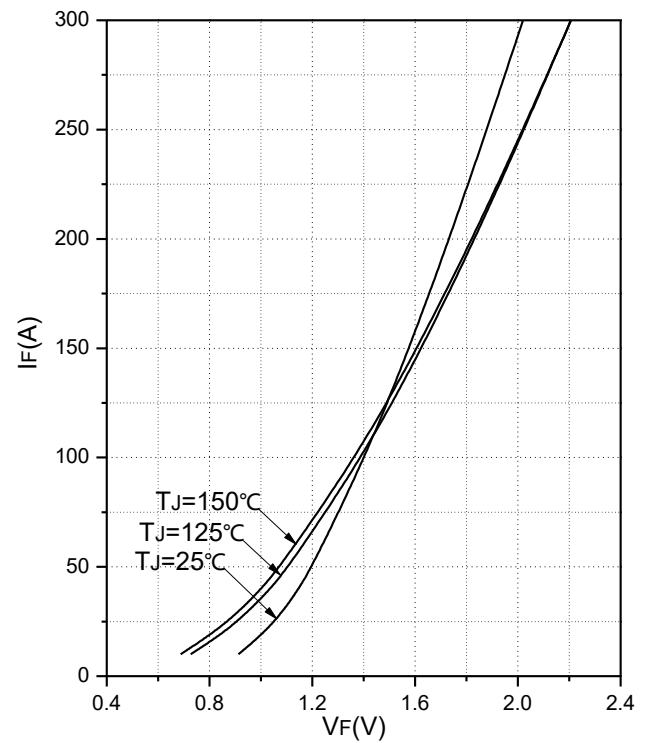
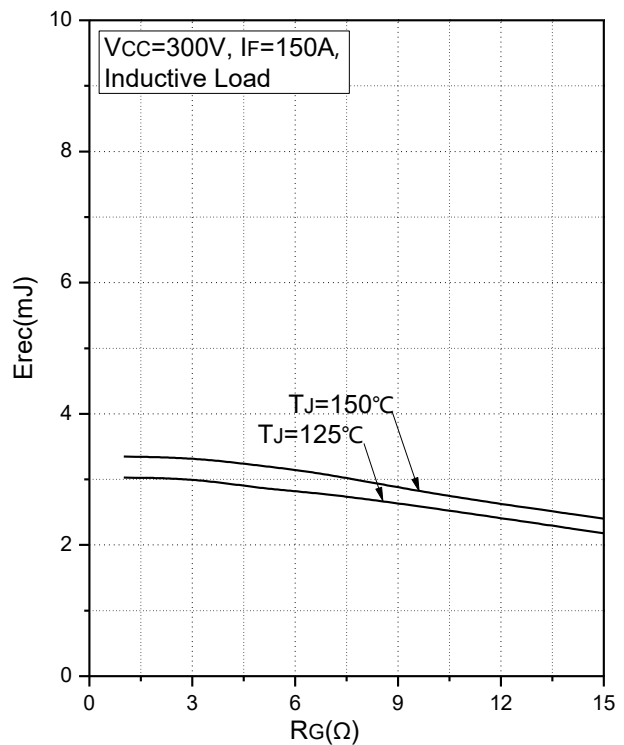
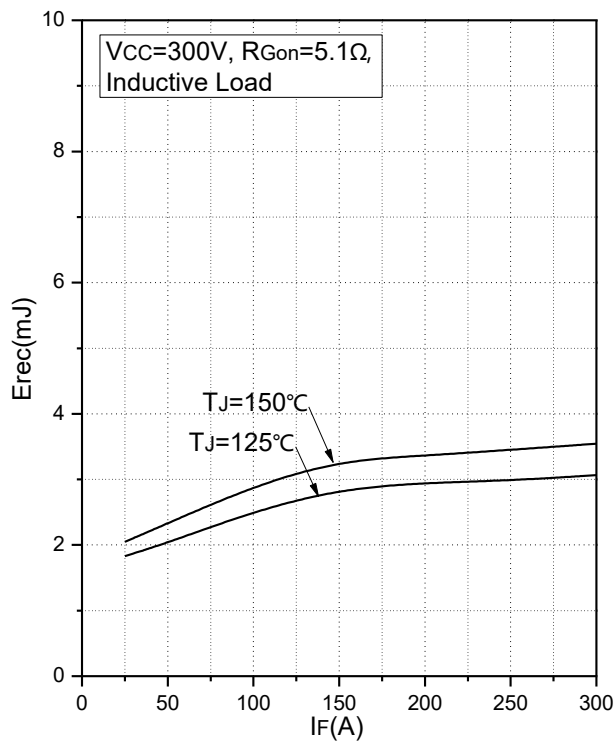
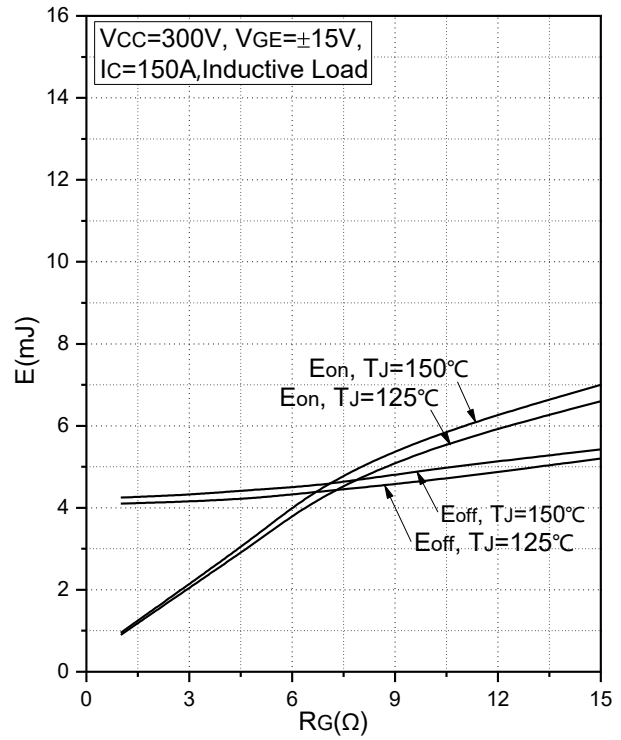
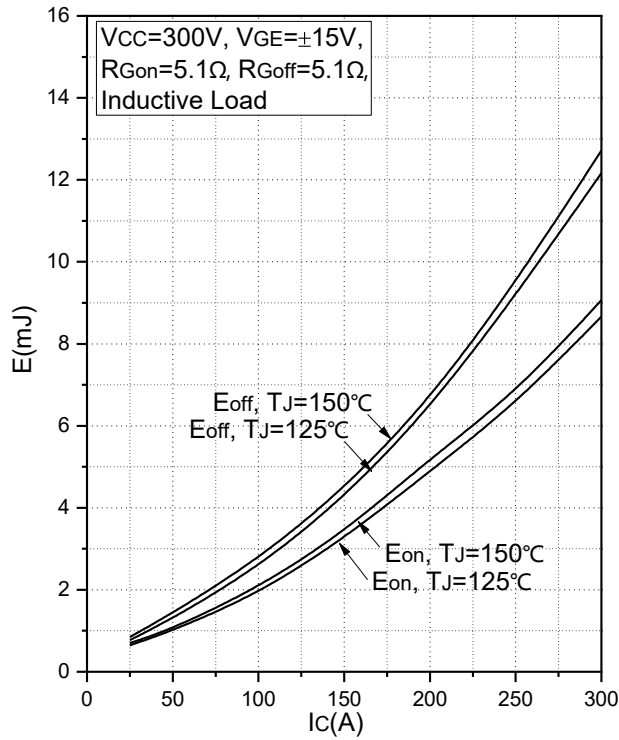


Fig.4 Forward Characteristics of Diode



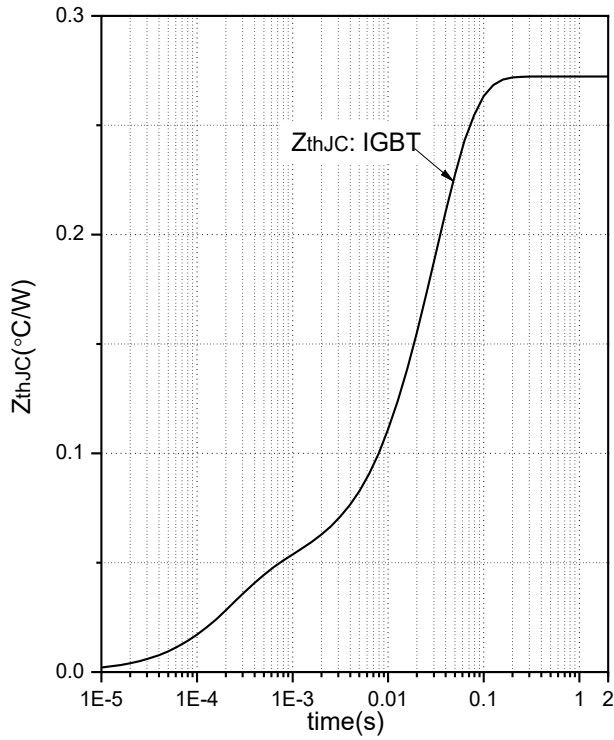


Fig.9 Transient Thermal Impedance (IGBT)

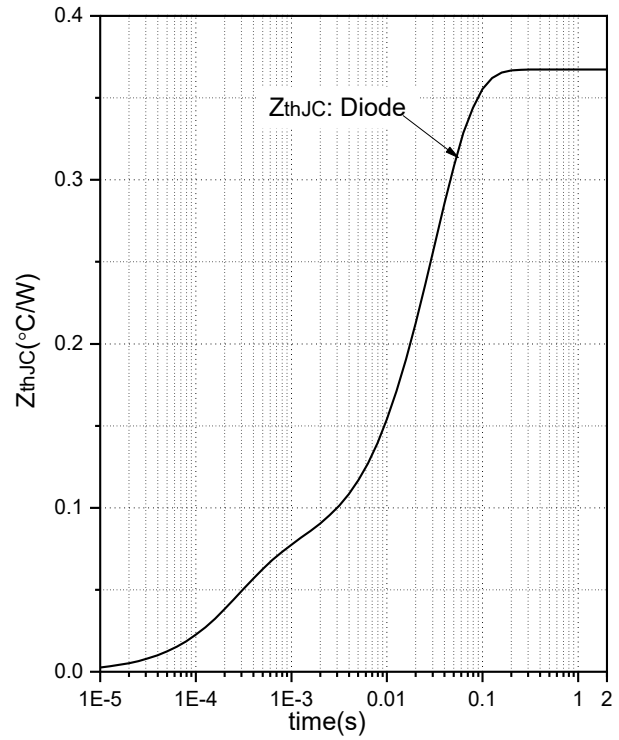


Fig.10 Transient Thermal Impedance (Diode)

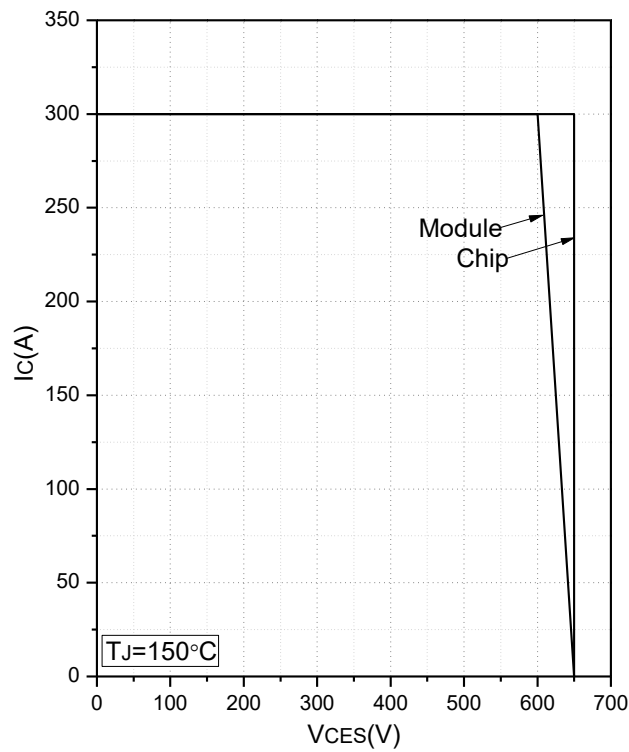


Fig.11 Reverse Bias Safe Operation Area (RBSOA)

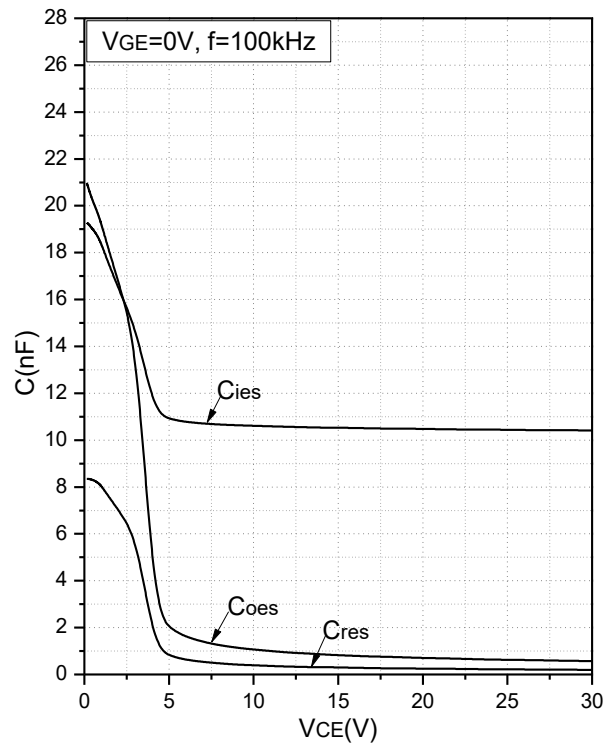


Fig.12 Capacitance Characteristics





| Revision | Notes                             |
|----------|-----------------------------------|
| 01       | Initial Release                   |
| 02       | Update Electrical Characteristics |
|          |                                   |

## Announcement

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