



# GK30PI60B3H

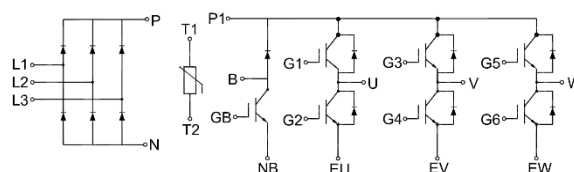
## IGBT Module

Preliminary Data

### Features:

- Trench & Field Stop IGBT
- Short Circuit Rated  $>10\mu\text{s}$
- Low Saturation Voltage
- Low Switching Loss
- 100% RBSOA Tested( $2\times I_c$ )
- Low Stray Inductance
- Lead Free, Compliant with RoHS Requirement

### Circuit Diagram



### Applications:

- Industrial Inverters
- Servo Applications

### IGBT, Inverter Maximum Rated Values

|           |                                    |                                                        |          |   |
|-----------|------------------------------------|--------------------------------------------------------|----------|---|
| $V_{CES}$ | Collector-Emitter Blocking Voltage |                                                        | 600      | V |
| $V_{GES}$ | Gate-Emitter Voltage               |                                                        | $\pm 20$ | V |
| $I_c$     | Continuous Collector Current       | $T_c=100^\circ\text{C}$                                | 30       | A |
|           |                                    | $T_c=25^\circ\text{C}$                                 | 60       | A |
| $I_{CM}$  | Repetitive Peak Collector Current  | $t_p=1\text{ms}$                                       | 60       | A |
| $P_D$     | Maximum Power Dissipation per IGBT | $T_c=25^\circ\text{C}$<br>$T_{Jmax}=175^\circ\text{C}$ | 170      | W |



## Electrical Characteristics of IGBT

### Static Characteristics

| Symbol        | Description                          | Conditions                                                    | Min.              | Typ. | Max.      | Units |
|---------------|--------------------------------------|---------------------------------------------------------------|-------------------|------|-----------|-------|
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage       | $I_C=0.25mA$ , $V_{CE}=V_{GE}$ , $T_J=25^\circ C$             | 4.0               | 5.6  | 7.0       | V     |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C=30A$ ,<br>$V_{GE}=15V$                                   | $T_J=25^\circ C$  | 1.40 |           | V     |
|               |                                      |                                                               | $T_J=125^\circ C$ | 1.55 |           | V     |
| $I_{CES}$     | Collector-Emitter Leakage Current    | $V_{GE}=0V$ ,<br>$V_{CE}=V_{CES}$ , $T_J=25^\circ C$          |                   |      | 1         | mA    |
| $I_{GES}$     | Gate-Emitter Leakage Current         | $V_{GE}=\pm 20V$ ,<br>$V_{CE}=0V$ , $T_J=25^\circ C$          |                   |      | $\pm 200$ | nA    |
| $C_{ies}$     | Input Capacitance                    | $V_{CE}=30V$ , $V_{GE}=0V$ ,<br>$f=100kHz$ , $T_J=25^\circ C$ |                   | 2.99 |           | nF    |
| $C_{oes}$     | Output Capacitance                   |                                                               |                   | 0.13 |           | nF    |
| $C_{res}$     | Reverse Transfer Capacitance         |                                                               |                   | 0.02 |           | nF    |

### Switching Characteristics

|                     |                                                                             |                                                                                                                                                          |                      |  |      |      |     |
|---------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--|------|------|-----|
| t <sub>d(on)</sub>  | Turn-on Delay Time                                                          | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Gon</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                        | T <sub>J</sub> =25℃  |  | 152  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 183  |      |     |
| t <sub>r</sub>      | Rise Time                                                                   |                                                                                                                                                          | T <sub>J</sub> =25℃  |  | 62   |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 66   |      |     |
| t <sub>d(off)</sub> | Turn-off Delay Time                                                         | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Goff</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                       | T <sub>J</sub> =25℃  |  | 173  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 188  |      |     |
| t <sub>f</sub>      | Fall Time                                                                   |                                                                                                                                                          | T <sub>J</sub> =25℃  |  | 147  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 156  |      |     |
| E <sub>on</sub>     | Turn-on Switching Loss                                                      | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Gon</sub> =30Ω, V <sub>GE</sub> =±15V,<br>di/dt=362A/μs (T <sub>J</sub> =125℃)<br>Inductive Load   | T <sub>J</sub> =25℃  |  | 0.91 |      | mJ  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 1.04 |      |     |
| E <sub>off</sub>    | Turn-off Switching Loss                                                     | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Goff</sub> =30Ω, V <sub>GE</sub> =±15V,<br>du/dt=2705V/μs (T <sub>J</sub> =125℃)<br>Inductive Load | T <sub>J</sub> =25℃  |  | 0.26 |      | mJ  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 0.31 |      |     |
| Q <sub>g</sub>      | Total Gate Charge                                                           | V <sub>GE</sub> =+15V...-15V                                                                                                                             | T <sub>J</sub> =25℃  |  | 150  |      | nC  |
| R <sub>G(int)</sub> | Internal Gate Resistor                                                      | T <sub>J</sub> =25℃                                                                                                                                      |                      |  | 0    |      | Ω   |
| I <sub>SC</sub>     | V <sub>CC</sub> =300V, V <sub>GE</sub> =±15V, tp=10μs, T <sub>J</sub> =150℃ |                                                                                                                                                          |                      |  | 190  |      | A   |
| R <sub>θJC</sub>    | IGBT Thermal Resistance: Junction-to-Case(per IGBT)                         |                                                                                                                                                          |                      |  |      | 0.87 | ℃/W |



## Diode, Inverter Maximum Rated Values

|           |                                  |                           |     |   |
|-----------|----------------------------------|---------------------------|-----|---|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage  | $T_J=25^{\circ}\text{C}$  | 600 | V |
| $I_F$     | Diode Continuous Forward Current | $T_C=100^{\circ}\text{C}$ | 30  | A |
| $I_{FM}$  | Diode Maximum Forward Current    | $t_p=1\text{ms}$          | 60  | A |

## Electrical Characteristics of Diode

| Symbol           | Description                                           | Conditions                                                                                                        |                      | Min. | Typ. | Max. | Units |  |
|------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------|------|------|------|-------|--|
| V <sub>FM</sub>  | Forward Voltage                                       | I <sub>F</sub> =30A                                                                                               | T <sub>J</sub> =25℃  |      | 1.95 |      | V     |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 2.10 |      |       |  |
| t <sub>rr</sub>  | Reverse Recovery Time                                 | I <sub>F</sub> =30A,<br>-diF/dt=463A/μs(T <sub>J</sub> =125℃),<br>V <sub>rr</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25℃  |      | 125  |      | ns    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 139  |      |       |  |
| I <sub>rr</sub>  | Peak Reverse Recovery Current                         |                                                                                                                   | T <sub>J</sub> =25℃  |      | 11.3 |      | A     |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 11.9 |      |       |  |
| Q <sub>rr</sub>  | Reverse Recovery Charge                               |                                                                                                                   | T <sub>J</sub> =25℃  |      | 0.81 |      | μC    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 0.93 |      |       |  |
| E <sub>rec</sub> | Reverse Recovery Energy                               |                                                                                                                   | T <sub>J</sub> =25℃  |      | 0.07 |      | mJ    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 0.08 |      |       |  |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case(per Diode) |                                                                                                                   |                      |      |      | 1.56 | ℃/W   |  |

## IGBT, Brake-Chopper Maximum Rated Values

|           |                                    |                                                            |          |   |
|-----------|------------------------------------|------------------------------------------------------------|----------|---|
| $V_{CES}$ | Collector-Emitter Blocking Voltage |                                                            | 600      | V |
| $V_{GES}$ | Gate-Emitter Voltage               |                                                            | $\pm 20$ | V |
| $I_C$     | Continuous Collector Current       | $T_C=100^{\circ}\text{C}$                                  | 30       | A |
|           |                                    | $T_C=25^{\circ}\text{C}$                                   | 60       | A |
| $I_{CM}$  | Repetitive Peak Collector Current  | $t_p=1\text{ms}$                                           | 60       | A |
| $P_D$     | Maximum Power Dissipation per IGBT | $T_C=25^{\circ}\text{C}$<br>$T_{Jmax}=175^{\circ}\text{C}$ | 170      | W |



## Electrical Characteristics of IGBT

### Static Characteristics

| Symbol        | Description                          | Conditions                                                    | Min.              | Typ. | Max.      | Units |
|---------------|--------------------------------------|---------------------------------------------------------------|-------------------|------|-----------|-------|
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage       | $I_C=0.25mA$ , $V_{CE}=V_{GE}$ , $T_J=25^\circ C$             | 4.0               | 5.6  | 7.0       | V     |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C=30A$ ,<br>$V_{GE}=15V$                                   | $T_J=25^\circ C$  | 1.40 |           | V     |
|               |                                      |                                                               | $T_J=125^\circ C$ | 1.55 |           | V     |
| $I_{CES}$     | Collector-Emitter Leakage Current    | $V_{GE}=0V$ ,<br>$V_{CE}=V_{CES}$ , $T_J=25^\circ C$          |                   |      | 1         | mA    |
| $I_{GES}$     | Gate-Emitter Leakage Current         | $V_{GE}=\pm 20V$ ,<br>$V_{CE}=0V$ , $T_J=25^\circ C$          |                   |      | $\pm 200$ | nA    |
| $C_{ies}$     | Input Capacitance                    | $V_{CE}=30V$ , $V_{GE}=0V$ ,<br>$f=100kHz$ , $T_J=25^\circ C$ |                   | 2.99 |           | nF    |
| $C_{oes}$     | Output Capacitance                   |                                                               |                   | 0.13 |           | nF    |
| $C_{res}$     | Reverse Transfer Capacitance         |                                                               |                   | 0.02 |           | nF    |

### Switching Characteristics

|                     |                                                                             |                                                                                                                                                          |                      |  |      |      |     |
|---------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--|------|------|-----|
| t <sub>d(on)</sub>  | Turn-on Delay Time                                                          | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Gon</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                        | T <sub>J</sub> =25℃  |  | 152  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 183  |      |     |
| t <sub>r</sub>      | Rise Time                                                                   | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Gon</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                        | T <sub>J</sub> =25℃  |  | 62   |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 66   |      |     |
| t <sub>d(off)</sub> | Turn-off Delay Time                                                         | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Goff</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                       | T <sub>J</sub> =25℃  |  | 173  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 188  |      |     |
| t <sub>f</sub>      | Fall Time                                                                   | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Goff</sub> =30Ω,<br>V <sub>GE</sub> =±15V,<br>Inductive Load                                       | T <sub>J</sub> =25℃  |  | 147  |      | ns  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 156  |      |     |
| E <sub>on</sub>     | Turn-on Switching Loss                                                      | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Gon</sub> =30Ω, V <sub>GE</sub> =±15V,<br>di/dt=362A/μs (T <sub>J</sub> =125℃)<br>Inductive Load   | T <sub>J</sub> =25℃  |  | 0.91 |      | mJ  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 1.04 |      |     |
| E <sub>off</sub>    | Turn-off Switching Loss                                                     | V <sub>CC</sub> =300V, I <sub>C</sub> =30A,<br>R <sub>Goff</sub> =30Ω, V <sub>GE</sub> =±15V,<br>du/dt=2705V/μs (T <sub>J</sub> =125℃)<br>Inductive Load | T <sub>J</sub> =25℃  |  | 0.26 |      | mJ  |
|                     |                                                                             |                                                                                                                                                          | T <sub>J</sub> =125℃ |  | 0.31 |      |     |
| Q <sub>g</sub>      | Total Gate Charge                                                           | V <sub>GE</sub> =+15V...-15V                                                                                                                             | T <sub>J</sub> =25℃  |  | 150  |      | nC  |
| R <sub>G(int)</sub> | Internal Gate Resistor                                                      | T <sub>J</sub> =25℃                                                                                                                                      |                      |  | 0    |      | Ω   |
| I <sub>SC</sub>     | V <sub>CC</sub> =300V, V <sub>GE</sub> =±15V, tp=10μs, T <sub>J</sub> =150℃ |                                                                                                                                                          |                      |  | 190  |      | A   |
| R <sub>θJC</sub>    | IGBT Thermal Resistance: Junction-to-Case(per IGBT)                         |                                                                                                                                                          |                      |  |      | 0.87 | ℃/W |



## Diode, Brake-Chopper Maximum Rated Values

|                  |                                  |                       |     |   |
|------------------|----------------------------------|-----------------------|-----|---|
| V <sub>RRM</sub> | Repetitive Peak Reverse Voltage  | T <sub>J</sub> =25°C  | 600 | V |
| I <sub>F</sub>   | Diode Continuous Forward Current | T <sub>C</sub> =100°C | 30  | A |
| I <sub>FM</sub>  | Diode Maximum Forward Current    | t <sub>p</sub> =1ms   | 60  | A |

## Electrical Characteristics of Diode

| Symbol           | Description                                           | Conditions                                                                                                        |                      | Min. | Typ. | Max. | Units |  |
|------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------|------|------|------|-------|--|
| V <sub>FM</sub>  | Forward Voltage                                       | I <sub>F</sub> =30A                                                                                               | T <sub>J</sub> =25℃  |      | 1.95 |      | V     |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 2.10 |      |       |  |
| t <sub>rr</sub>  | Reverse Recovery Time                                 | I <sub>F</sub> =30A,<br>-diF/dt=463A/μs(T <sub>J</sub> =125℃),<br>V <sub>rr</sub> =300V,<br>V <sub>GE</sub> =-15V | T <sub>J</sub> =25℃  |      | 125  |      | ns    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 139  |      |       |  |
| I <sub>rr</sub>  | Peak Reverse Recovery Current                         |                                                                                                                   | T <sub>J</sub> =25℃  |      | 11.3 |      | A     |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 11.9 |      |       |  |
| Q <sub>rr</sub>  | Reverse Recovery Charge                               |                                                                                                                   | T <sub>J</sub> =25℃  |      | 0.81 |      | μC    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 0.93 |      |       |  |
| E <sub>rec</sub> | Reverse Recovery Energy                               |                                                                                                                   | T <sub>J</sub> =25℃  |      | 0.07 |      | mJ    |  |
|                  |                                                       |                                                                                                                   | T <sub>J</sub> =125℃ |      | 0.08 |      |       |  |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case(per Diode) |                                                                                                                   |                      |      |      | 1.56 | ℃/W   |  |

## Diode, Rectifier 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  | 1800 | V                |
| I <sub>FRMSM</sub> | Maximum RMS Forward Current per Chip    | T <sub>J</sub> =80°C  | 20   | A                |
| I <sub>RMSM</sub>  | Maximum RMS Current At Rectifier Output | T <sub>J</sub> =80°C  | 30   | A                |
| I <sub>FSM</sub>   | Surge Current @t <sub>p</sub> =10ms     | T <sub>J</sub> =25°C  | 300  | A                |
|                    |                                         | T <sub>J</sub> =150°C | 245  |                  |
| I <sup>2</sup> t   | I <sup>2</sup> t - value                | T <sub>J</sub> =25°C  | 450  | A <sup>2</sup> s |
|                    |                                         | T <sub>J</sub> =150°C | 300  |                  |



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

| Symbol           | Description                                | Conditions            |                       | Min. | Typ. | Max. | Units |
|------------------|--------------------------------------------|-----------------------|-----------------------|------|------|------|-------|
| V <sub>F</sub>   | Forward Voltage                            | I <sub>F</sub> =10A   | T <sub>J</sub> =25°C  |      | 1.05 |      | V     |
|                  |                                            |                       | T <sub>J</sub> =150°C |      | 1.00 |      |       |
| I <sub>R</sub>   | Reverse Current                            | V <sub>R</sub> =1600V | T <sub>J</sub> =25°C  |      |      | 1    | mA    |
| R <sub>θJC</sub> | Diode Thermal Resistance: Junction-to-Case |                       |                       |      |      | 0.94 | °C/W  |

## Internal NTC-Thermistor Characteristics

| Symbol              | Conditions                                           | 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)          | 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) |                 |      |      | 0.08 | °C/W  |
| T                | Mounting Screw:M4                                  |                 | 1.5  |      | 1.8  | N·m   |
| G                | Weight                                             |                 |      | 23   |      | g     |

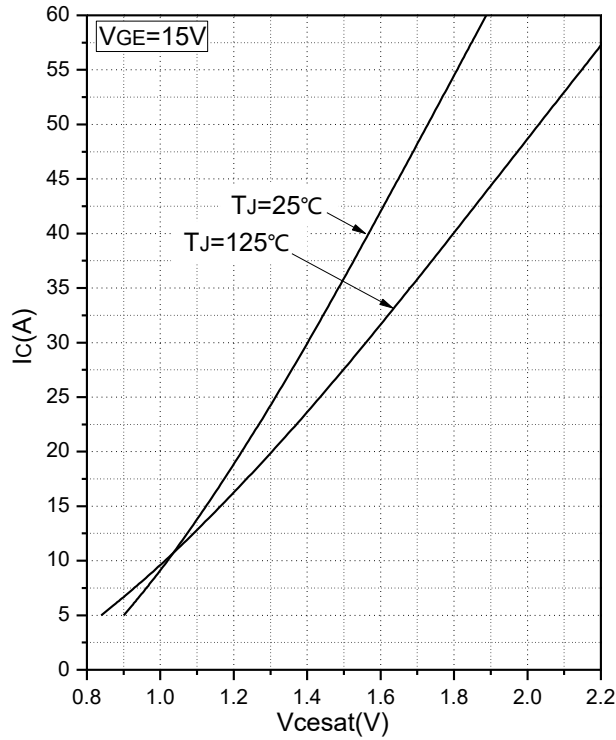


Fig.1 Typical Saturation Voltage Characteristics(Inverter)

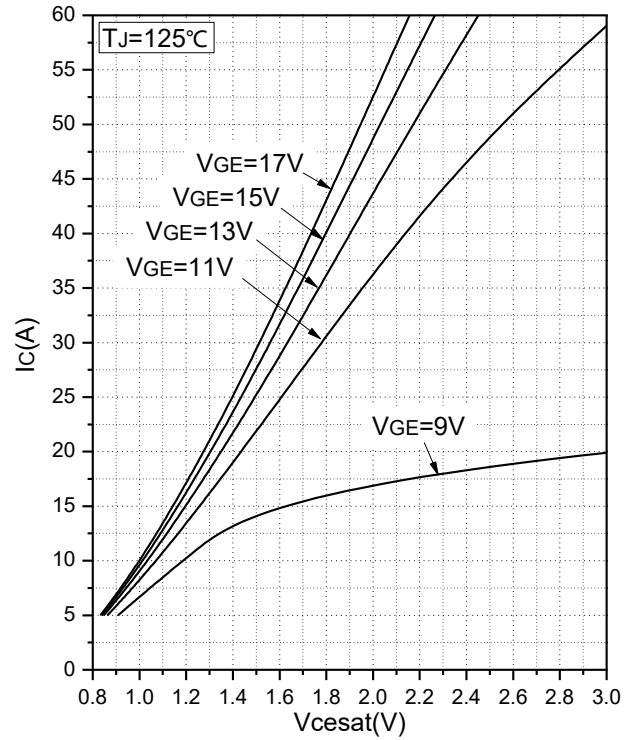


Fig.2 Typical Output Characteristics(Inverter)

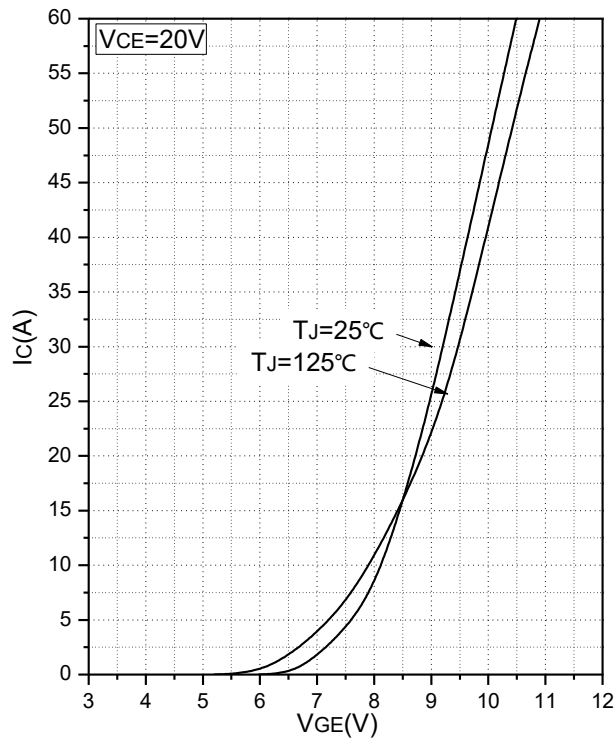


Fig.3 Transfer Characteristics(Inverter)

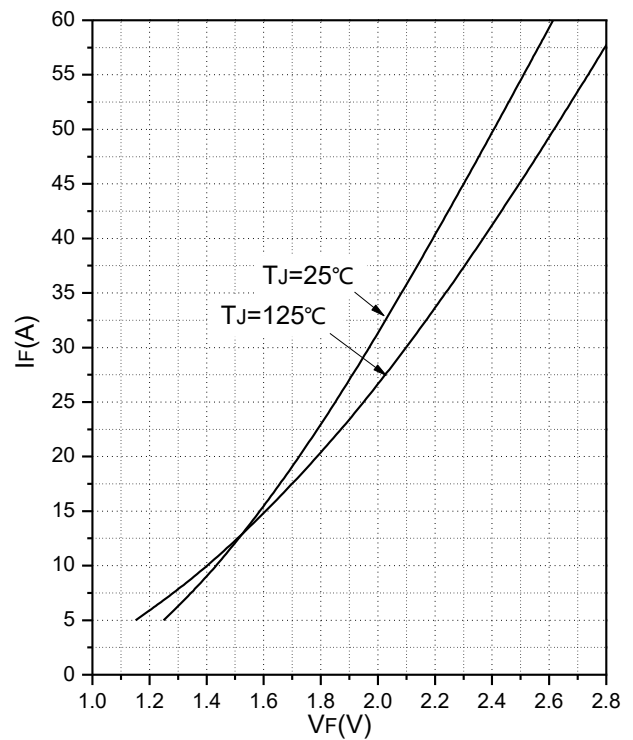


Fig.4 Forward Characteristics of Diode(Inverter)

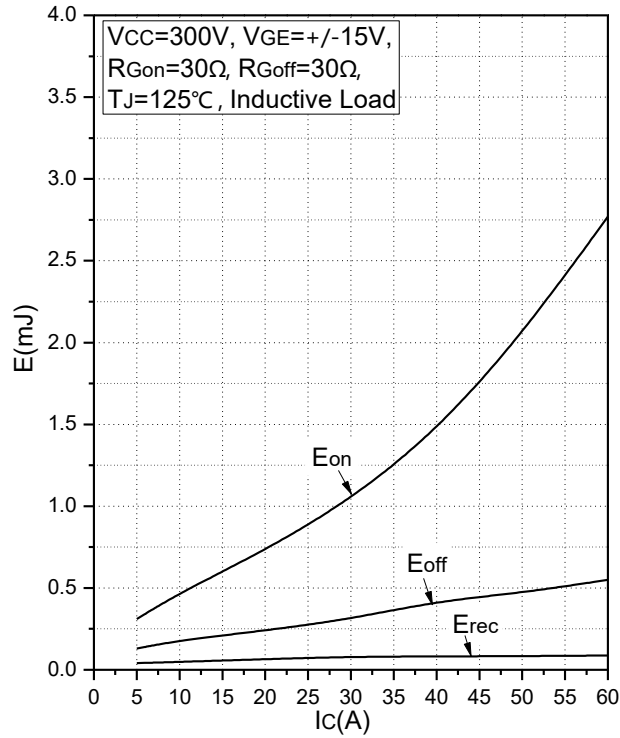


Fig.5 Typical Switching Loss vs. Collector Current(Inverter)

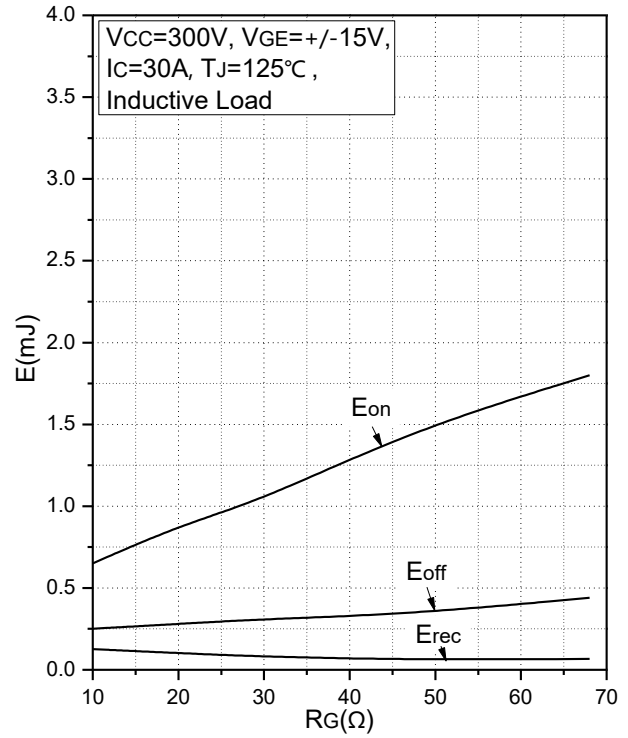


Fig.6 Typical Switching Loss vs. Gate Resistance(Inverter)

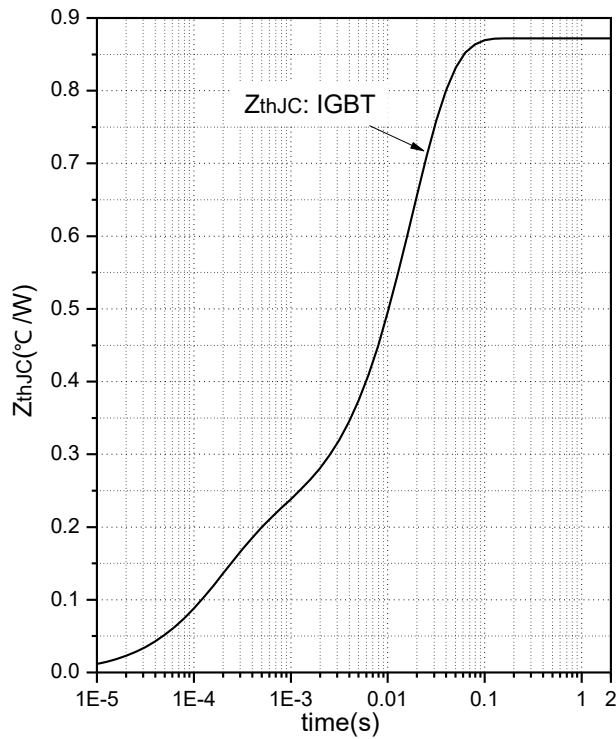


Fig.7 Transient Thermal Impedance IGBT(Inverter)

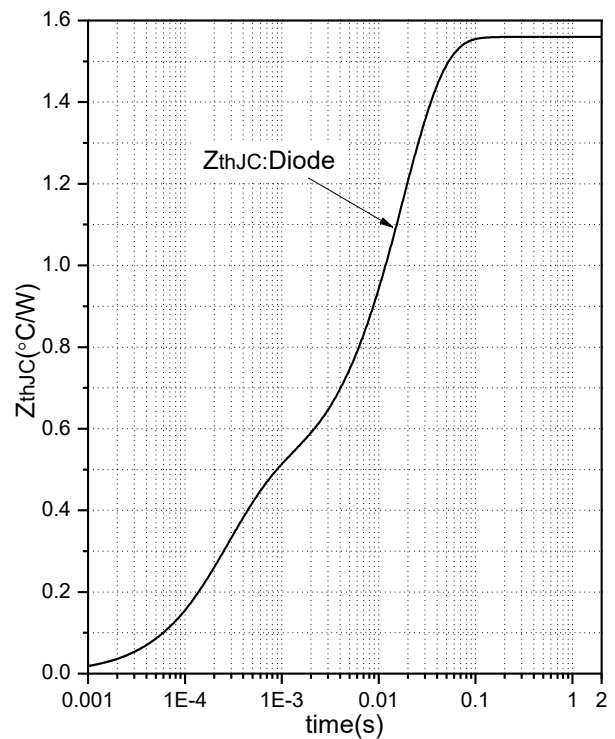
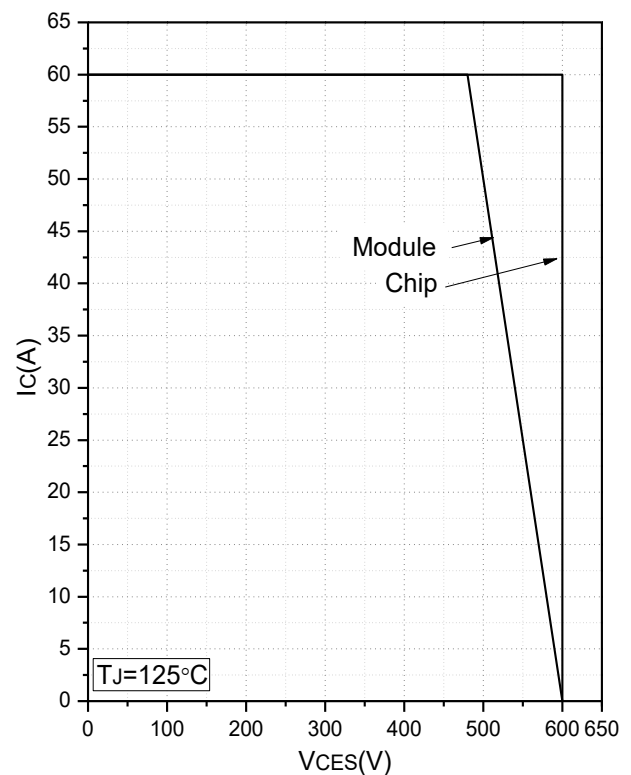
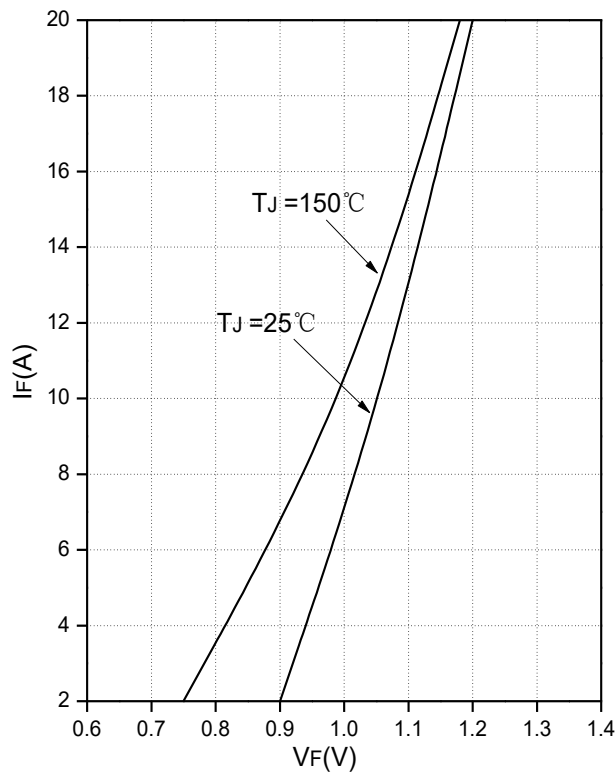
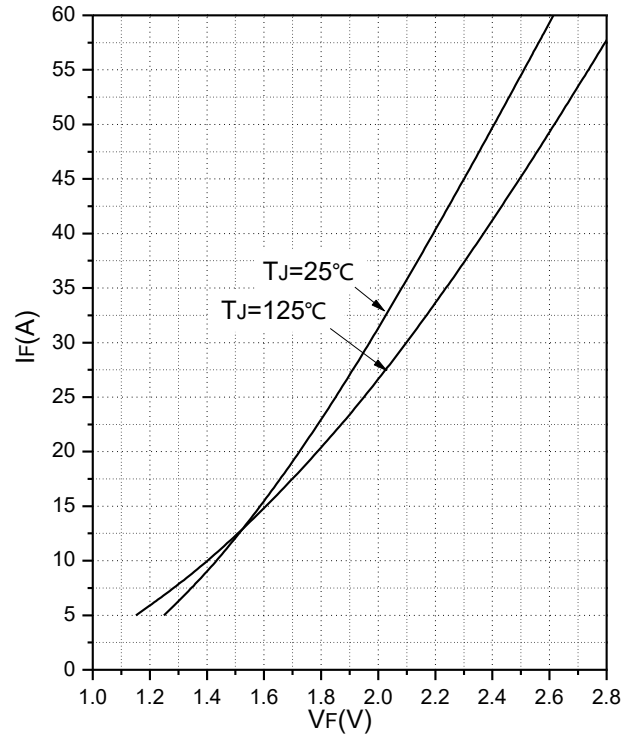
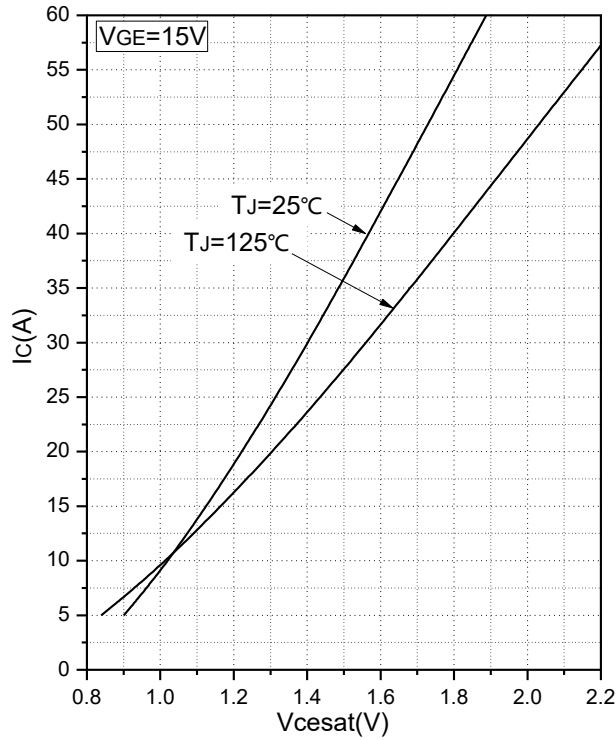


Fig.8 Transient Thermal Impedance Diode(Inverter)



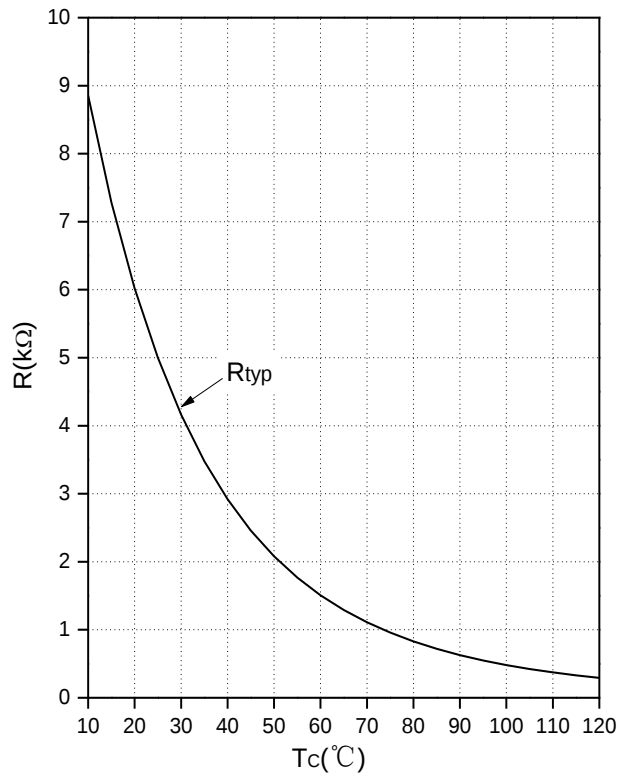
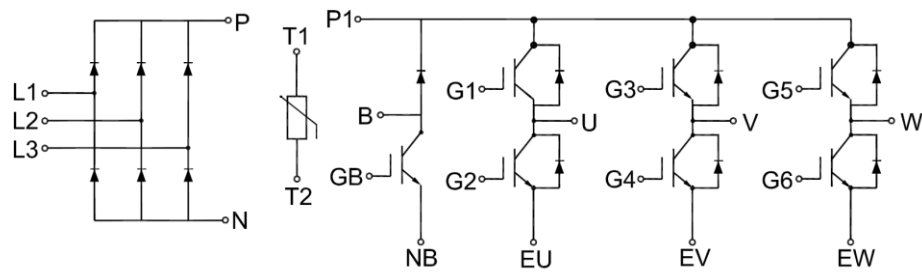


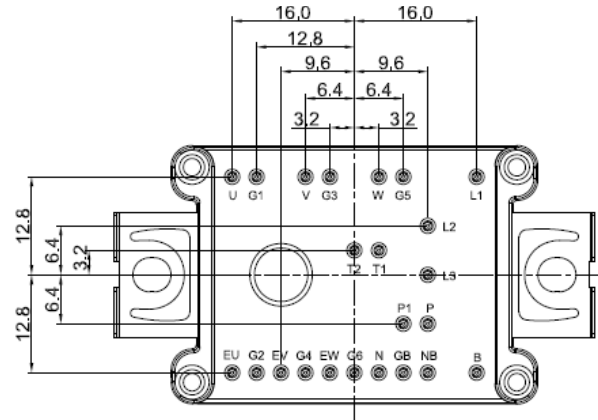
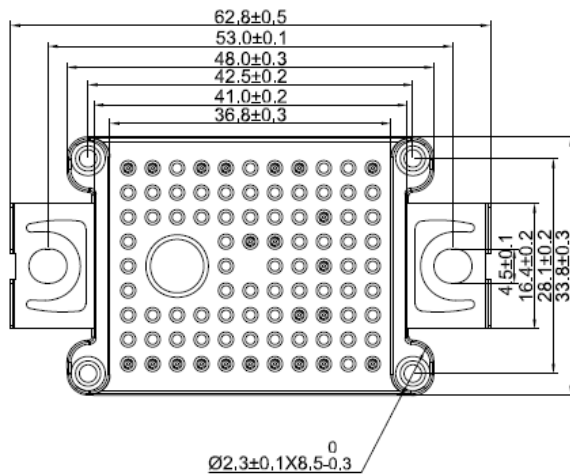
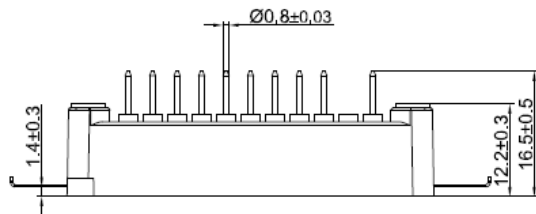
Fig.13 NTC Temperature Characteristics



## Internal Circuit



## Package Outline – Without Fixing Sticks (Unit: mm):





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

## **Announcement**

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The datasheet with “REV.” + “Arabic numerals” is based on engineering data for initial reference purpose only.

The released datasheet would be issued with “REV.” + “alphabet characters”.