# PIM with Trench Field-Stop IGBT, Emitter Controlled Diode and NTC

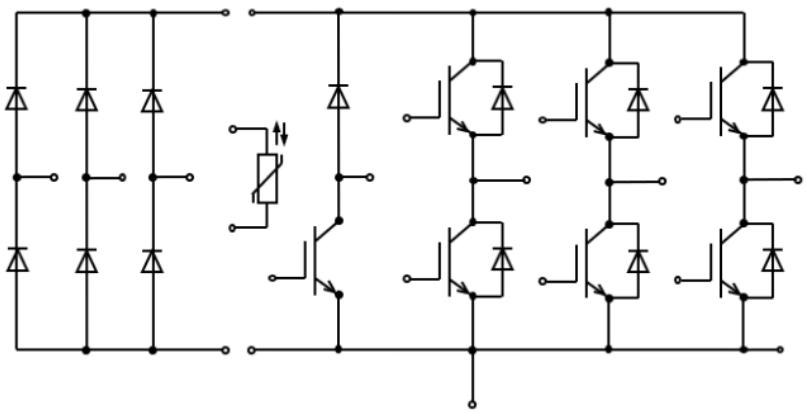
## Features

- $V_{CE}$=1200V $I_C$=50A
- Low $V_{CE(sat)}$ with Positive Temperature Coefficient
- Maximum junction temperature 150℃

## Applications

- The inverter
- Motor control and drives

## Equivalent Circuit Schematic



## IGBT - Inverter

### Maximum Rated Values

| Symbol | Description | Conditions | Values | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | $T_{vj}$=25℃ | 1200 | V |
| $V_{GES}$ | Gate-Emitter Peak Voltage | $T_{vj}$=25℃ | ±20 | V |
| $I_C$ | Continuous DC Collector Current | $T_C$=100℃ | 50 | A |
| $I_{CRM}$ | Repetitive Peak Collector Current | $t_P$=1ms | 100 | A |
| $P_{tot}$ | Total Power Dissipation | $T_C$=25℃, $T_{vj\ max}$=150℃ | 270 | W |

## Characteristic Values

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $V_{GE}$=15V, $I_C$=50A, $T_{vj}$=25℃ | --- | 1.80 | 2.25 | V |
| | | $V_{GE}$=15V, $I_C$=50A, $T_{vj}$=125℃ | --- | 2.05 | 2.7 | V |
| $V_{GE(th)}$ | Gate Threshold Voltage | $V_{GE}$=$V_{CE}$, $I_C$=2mA | 5.0 | 6.0 | 6.5 | V |
| $I_{CES}$ | Collector-Emitter Cut-Off Current | $V_{CE}$=1200V, $V_{GE}$=0V | --- | --- | 4.0 | mA |
| $I_{GES}$ | Gate-Emitter Leakage Current | $V_{GE}$=15V, $V_{CE}$=0V | --- | --- | 450 | nA |
| $t_{d(on)}$ | Turn-on Delay Time | $V_{CC}$=600V<br>$V_{GE}$=±15V<br>$I_C$=50A<br>$R_G$=15Ω<br>Inductive Load<br>$T_{vj}$=25℃ | --- | 76 | --- | ns |
| $t_r$ | Turn-on Rise Time | | --- | 62 | --- | ns |
| $t_{d(off)}$ | Turn-off Delay Time | | --- | 278 | --- | ns |
| $t_f$ | Turn-off Fall Time | | --- | 196 | --- | ns |
| $E_{on}$ | Turn-on Switching Loss | | --- | 5.2 | --- | mJ |
| $E_{off}$ | Turn-off Switching Loss | | --- | 3.1 | --- | mJ |
| $I_{SC}$ | Short Circuit data | $V_{GE}$≤15V, $V_{CC}$=600V<br>$t_P$≤10μs, $T_{vj}$=125°C | --- | 250 | --- | A |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per IGBT | --- | --- | 0.47 | K/W |
| $T_{VJ\ OP}$ | Virtual Junction Temperature | Under Switching | -40 | --- | 125 | ℃ |

# Diode - Inverter

## Maximum Rated Values

| Symbol | Description | Conditions | Values | Unit |
|---|---|---|---|---|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | $T_{vj}$=25℃ | 1200 | V |
| $I_F$ | Continuous DC Forward Current | | 50 | A |
| $I_{FRM}$ | Repetitive Peak Collector Current | $t_P$=1ms | 100 | A |
| $I^2t$ | $I^2t$ Value | $t_P$=10ms, $V_R$=0V, $T_j$=125℃ | 550 | $A^2s$ |

### Characteristic Values

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_F$ | Forward Voltage | $I_F$=50A, $V_{GE}$=0V, $T_{vj}$=25℃ | --- | 1.90 | 2.2 | V |
| | | $I_F$=50A, $V_{GE}$=0V, $T_{vj}$=125℃ | --- | 1.80 | 2.1 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_F$=50A, -di/dt=3000A/us $V_R$=600V, $T_{vj}$=25℃ | --- | 43 | --- | ns |
| $Q_r$ | Recovered Charge | | --- | 2.1 | --- | uC |
| $E_{rec}$ | Reverse Recovery Energy | | --- | 0.43 | --- | mJ |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | --- | --- | 0.85 | K/W |
| $T_{VJ\ OP}$ | Virtual Junction Temperature | Under Switching | -40 | --- | 125 | ℃ |

## Diode - Rectifier

### Maximum Rated Values

| Symbol | Description | Conditions | Values | Unit |
|---|---|---|---|---|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | $T_{vj}$=25℃ | 1800 | V |
| $I_{FRMSM}$ | Maximum RMS forward current Per chip | $T_{vj}$=80℃ | 70 | A |
| $I_{FSM}$ | Surge Forward Current | $t_P$=10ms, $T_j$=25℃ | 500 | A |
| $I^2t$ | $I^2t$ Value | $t_P$=10ms, $T_j$=25℃ | 1100 | $A^2s$ |

### Characteristic Values

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_F$ | Forward Voltage | $I_F$=50A, $T_{vj}$=150℃ | --- | 1.25 | --- | V |
| $I_R$ | Recovery Current | $V_R$=1800V, $T_{vj}$=150℃ | --- | 1.2 | --- | mA |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | --- | 0.65 | --- | K/W |
| $T_{VJ\ OP}$ | Virtual Junction Temperature | Under Switching | -40 | --- | 150 | ℃ |

# IGBT – Brake

## Maximum Rated Values

| Symbol | Description | Conditions | Values | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | $T_{vj}$=25℃ | 1200 | V |
| $V_{GES}$ | Gate-Emitter Peak Voltage | $T_{vj}$=25℃ | ±20 | V |
| $I_C$ | Continuous DC Collector Current | $T_C$=100℃ | 35 | A |
| $I_{CRM}$ | Repetitive Peak Collector Current | $t_P$=1ms | 70 | A |
| $P_{tot}$ | Total Power Dissipation | $T_C$=25℃, $T_{vj\ max}$=150℃ | 166.7 | W |

## Characteristic Values

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $V_{GE}$=15V, $I_C$=35A, $T_{vj}$=25℃ | --- | 2.15 | 2.5 | V |
| | | $V_{GE}$=15V, $I_C$=35A, $T_{vj}$=150℃ | --- | 2.13 | 2.4 | V |
| $V_{GE(th)}$ | Gate Threshold Voltage | $V_{GE}$=$V_{CE}$, $I_C$=5.0mA | 5.0 | 5.8 | 6.5 | V |
| $I_{CES}$ | Collector-Emitter Cut-Off Current | $V_{CE}$=1200V, $V_{GE}$=0V | --- | --- | 1.2 | mA |
| $I_{GES}$ | Gate-Emitter Leakage Current | $V_{GE}$=15V, $V_{CE}$=0V | --- | --- | 410 | nA |
| $t_{d(on)}$ | Turn-on Delay Time | $V_{CC}$=600V<br>$V_{GE}$=±15V<br>$I_C$=35A<br>$R_G$=15Ω<br>Inductive Load<br>$T_{vj}$=25℃ | --- | 170 | --- | ns |
| $t_r$ | Turn-on Rise Time | | --- | 160 | --- | ns |
| $t_{d(off)}$ | Turn-off Delay Time | | --- | 310 | --- | ns |
| $t_f$ | Turn-off Fall Time | | --- | 100 | --- | ns |
| $E_{on}$ | Turn-on Switching Loss | | --- | 4.6 | --- | mJ |
| $E_{off}$ | Turn-off Switching Loss | | --- | 2.2 | --- | mJ |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per IGBT | --- | --- | 0.75 | K/W |
| $T_{VJ\ OP}$ | Virtual Junction Temperature | Under Switching | -40 | --- | 150 | ℃ |

## Diode - Brake

### Maximum Rated Values

| Symbol | Description | Conditions | Values | Unit |
|---|---|---|---|---|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | $T_{vj}$=25℃ | 1200 | V |
| $I_F$ | Continuous DC Forward Current | | 35 | A |
| $I_{FRM}$ | Repetitive Peak Collector Current | $t_P$=1ms | 70 | A |

### Characteristic Values

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_F$ | Forward Voltage | $I_F$=35A, $V_{GE}$=0V, $T_{vj}$=25℃ | --- | 1.95 | 2.3 | V |
| | | $I_F$=35A, $V_{GE}$=0V, $T_{vj}$=125℃ | --- | 1.9 | 2.2 | V |
| $t_{rr}$ | Peak Reverse Recovery Current | $I_F$=35A, -di/dt=100A/us<br>$V_R$=600V, $T_{vj}$=25℃ | --- | 140 | --- | ns |
| $Q_r$ | Recovered Charge | | --- | 1.1 | --- | uC |
| $E_{rec}$ | Reverse Recovery Energy | | --- | 6.7 | --- | mJ |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | --- | --- | 1.03 | K/W |
| $T_{VJ\ OP}$ | Virtual Junction Temperature | Under Switching | -40 | --- | 150 | ℃ |

## NTC-Thermistor

### Characteristic Values

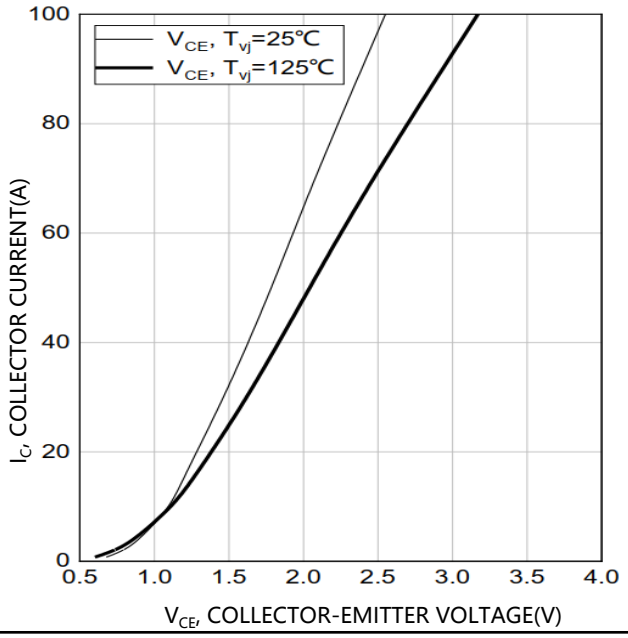
| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $R_{25}$ | Rated Resistance | $T_C$=25℃ | --- | 5 | --- | KΩ |
| $B_{25/50}$ | B Value | $R_2 = R_{25} \exp [B_{25/50}(1/T_2 – 1/(298\ K))]$ | --- | 3380 | --- | K |

## Module

| Symbol | Description | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{ISOL}$ | Isolation Test Voltage | RMS, f=50Hz, t=1min | 2500 | --- | --- | V |
| $T_{stg}$ | Storage Temperature | | -40 | --- | 125 | ℃ |
| F | Mounting Fource per Clamp | | 3 | --- | 6 | Nm |
| G | Weight | | --- | 300 | --- | g |

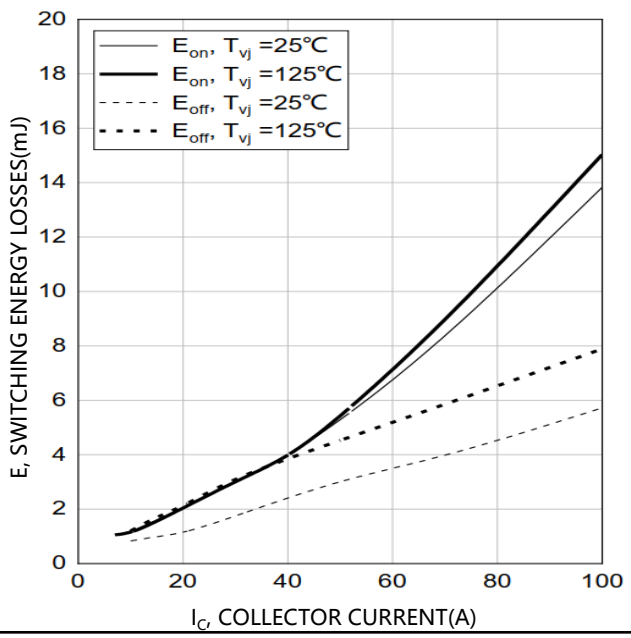
# Typical Characteristics

**Fig. 1**



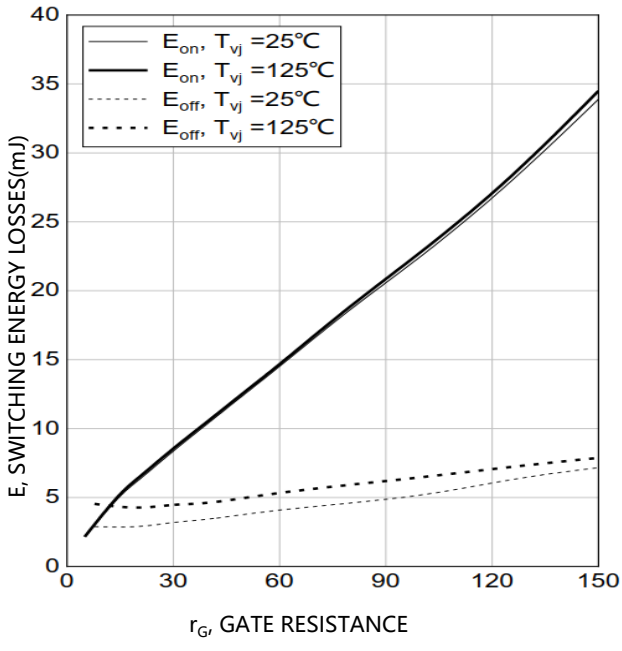

Transfer characteristic IGBT-Inverter (typical)
$I_C=f(V_{GE})$ at $V_{CE}$=15V

**Fig. 2**



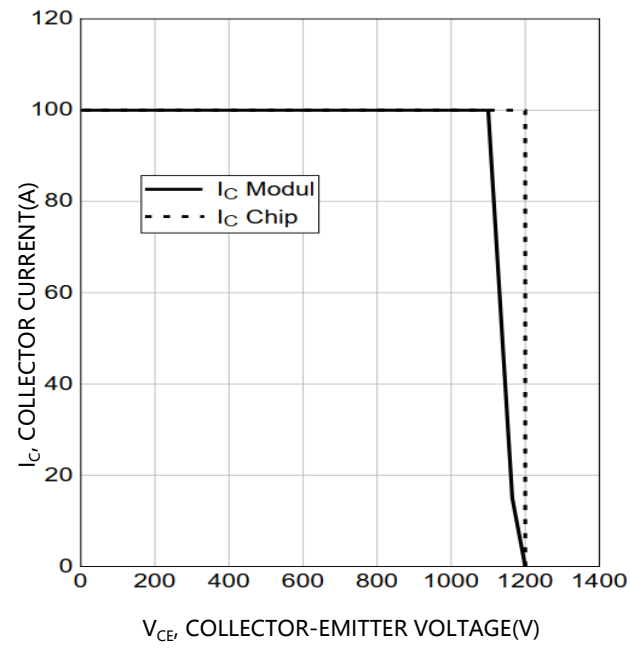

Switching losses IGBT-Inverter (typical)
$E_{on}=f(I_C)$, $E_{off}=f(I_C)$ at $V_{GE}=\pm15V$ , $R_G$=15Ω and $V_{CE}$=600V

**Fig. 3**




Switching losses IGBT-Inverter (typical)
Eon=f(RG), Eoff=f(RG) at VGE=±15V, Ic=50A and VCE=600V

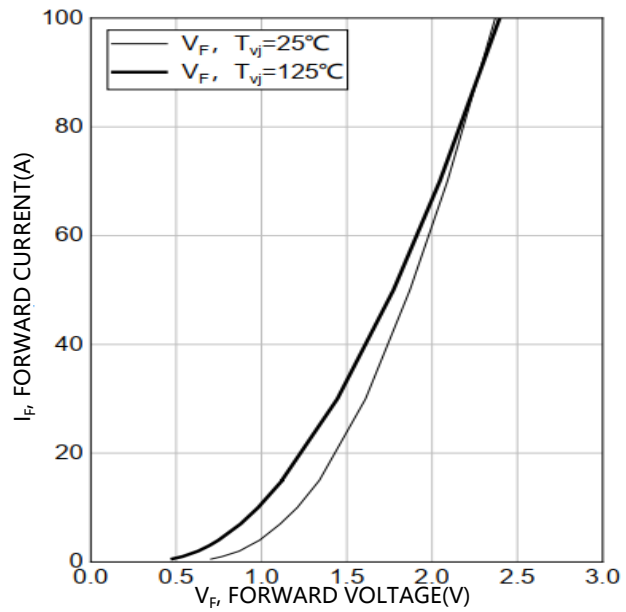
**Fig. 4**




Reverse Bias Safe Operating Area IGBT-Inverter (RBSOA), Ic=f(VCE) at VGE=±15V, RGoff=15Ω Tvj=150℃

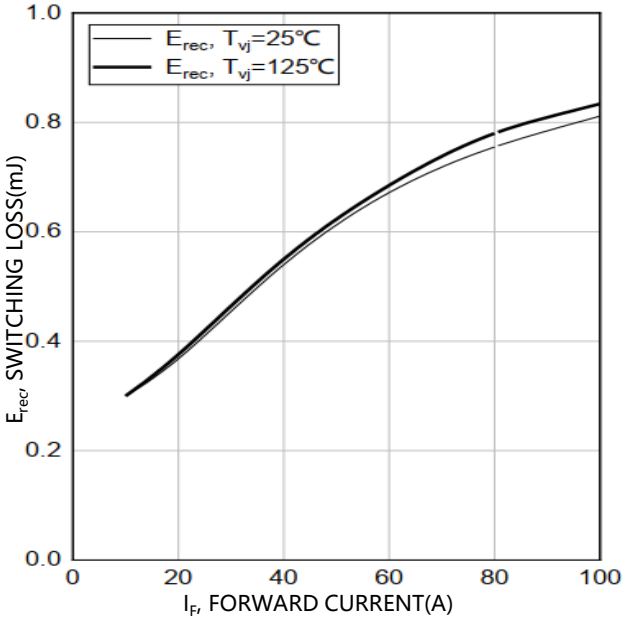
## Typical Characteristics

**Fig. 5**



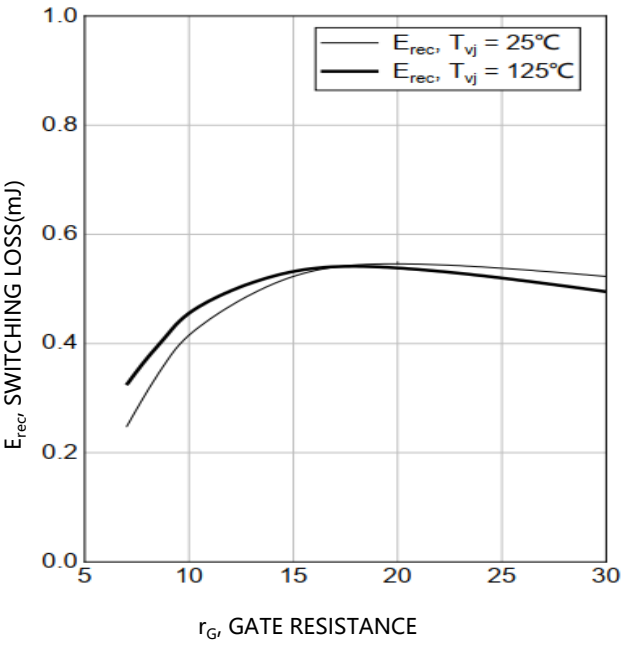

Forward characteristic of Diode-Inverter (typical)
$I_F=f(V_F)$ at $V_{GE}=\pm 15V$

**Fig. 6**



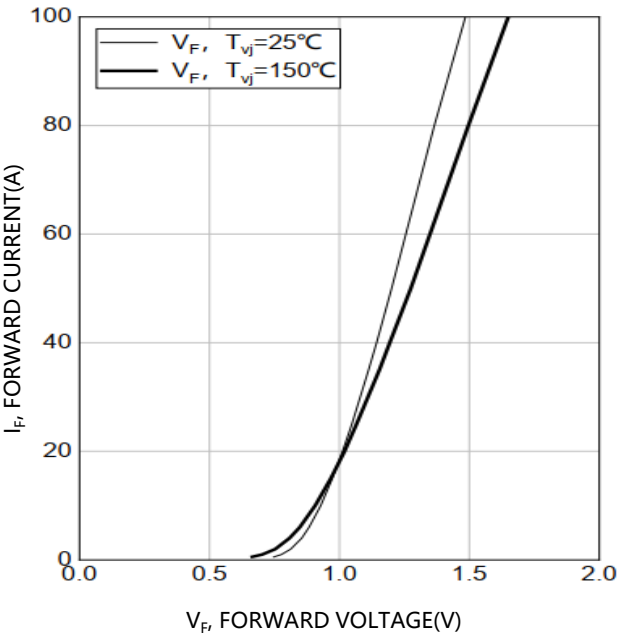

Switching losses Diode-Inverter (typical)
$E_{rec}=f(I_F)$ at $R_G=15\Omega$ and $V_{CE}=600V$

**Fig. 7**




Switching Losses Diode-Inverter (typical)
$E_{rec}=f(R_G)$ at $I_F=50A$ and $V_{CE}=600V$

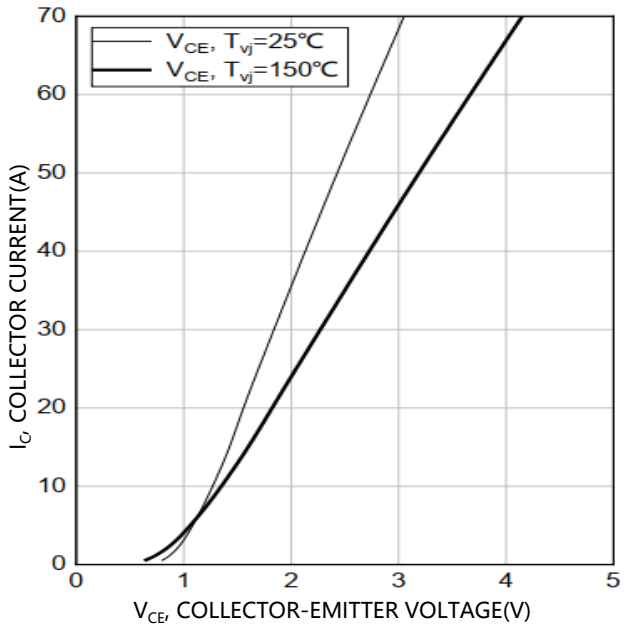
**Fig. 8**




Forward Characteristic of Diode-Rectifier (typical)
$I_F=f(V_F)$

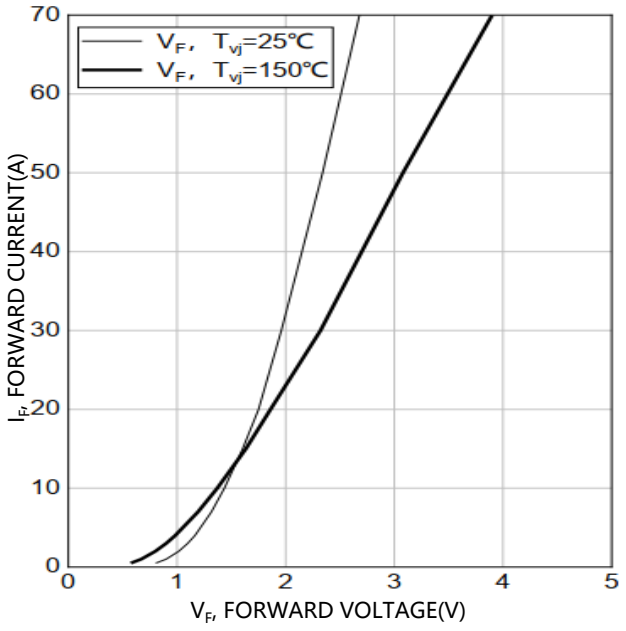
## Typical Characteristics

**Fig. 9**



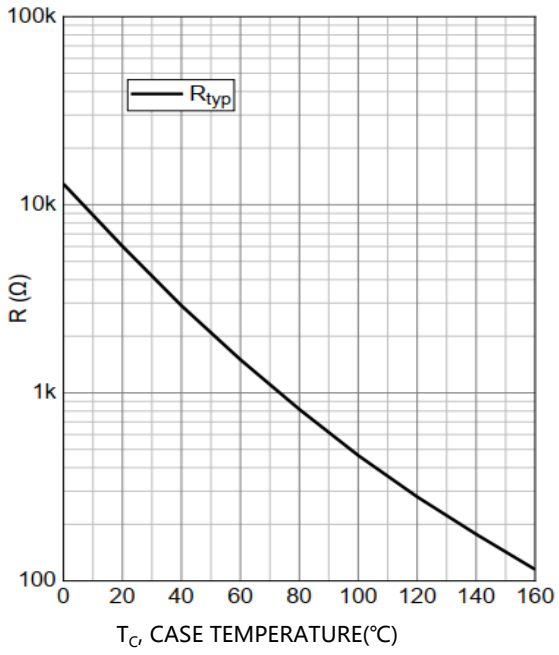

Output Characteristic IGBT-Brake (typical)
$I_C=f(V_{CE})$ at VGE=15V

**Fig. 10**



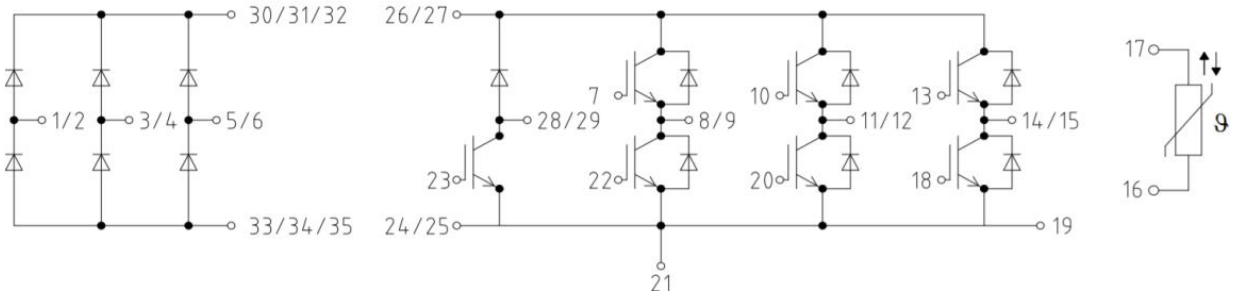

Forward characteristic of Diode-Brake (typical)
$I_F=f(V_F)$

**Fig. 11**




NTC-Thermistor-Temperature Characteristic (typical), R=f(T)

## Circuit Diagram




## Package Outlines (mm)