# RSPP5012FW2

## FPM2 PIM

## 1200V 50A, IGBT Module

### Electrical Features

- Trench Field Stop IGBT
- Very low $V_{CE(sat)}$
- Extremely low switching losses

### Mechanical Features

- Very Low Thermal Resistance with DBC Substrate
- High power density
- Compact design
- Isolation Rating of 2500 Vrms/1 min

### Typical Applications

- Auxiliary inverters
- Air-conditioner
- Motor drives

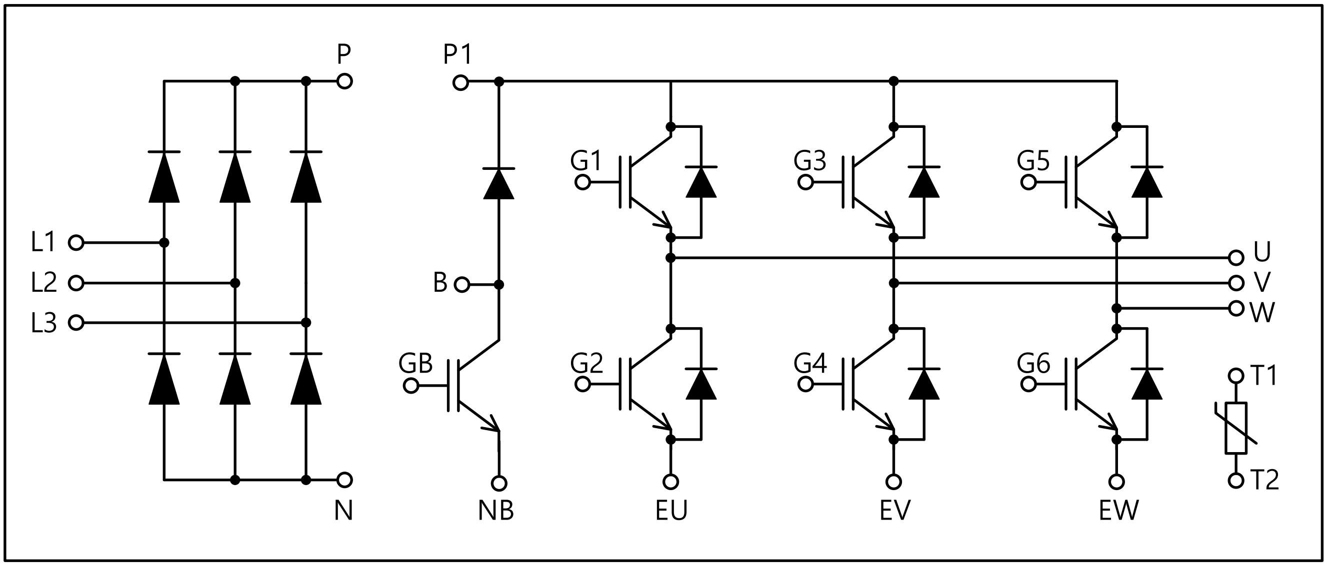


Figure 1. Internal Circuit

## ABSOLUTE MAXIMUM RATINGS ($T_j$ = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Rating | Unit |
|---|---|---|---|---|
| **IGBT, INVERTER** | | | | |
| $V_{CES}$ | Collector-Emitter Voltage | | 1200 | V |
| $V_{GES}$ | Gate-Emitter Voltage | | ±20 | V |
| $I_C$ | DC Collector Current | $T_C$=100°C, $T_j$≤175°C | 50 | A |
| $I_{CRM}$ | Repetitive Peak Collector Current | Under 1ms Pulse Width | 100 | A |
| **Diode, INVERTER** | | | | |
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | | 1200 | V |
| $I_F$ | DC Forward Current | | 50 | A |
| $I_{FRM}$ | Repetitive Peak Forward Current | Under 1ms Pulse Width | 100 | A |
| $I^2t$ | $I^2t$ Value | $t_p$=10ms, $T_j$=150°C | 200 | $A^2s$ |
| **IGBT, Brake-Chopper** | | | | |
| $V_{CES}$ | Collector-Emitter Voltage | | 1200 | V |
| $V_{GES}$ | Gate-Emitter Voltage | | ±20 | V |
| $I_C$ | DC Collector Current | $T_C$=100°C, $T_j$≤175°C | 35 | A |
| $I_{CRM}$ | Repetitive Peak Collector Current | Under 1ms Pulse Width | 70 | A |
| **Diode, Brake-Chopper** | | | | |
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | | 1200 | V |
| $I_F$ | DC Forward Current | | 25 | A |
| $I_{FRM}$ | Repetitive Peak Forward Current | Under 1ms Pulse Width | 50 | A |
| $I^2t$ | $I^2t$ Value | $V_R$=0V, $t_p$=10ms, $T_j$=150°C | 112 | $A^2s$ |
| **Diode, Rectifier** | | | | |
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | | 1600 | V |
| $I_{FRMSM}$ | Maximum RMS Forward Current per Chip | $T_C$=90°C | 50 | A |
| $I_{RMSM}$ | Maximum RMS Forward Current at Rectifier Output | $T_C$=90°C | 50 | A |
| $I_{FSM}$ | Surge Forward Current | $t_p$=10ms, $T_j$=150°C | 410 | A |
| $I^2t$ | $I^2t$ Value | $t_p$=10ms, $T_j$=150°C | 840 | $A^2s$ |

## ELECTRICAL CHARACTERISTICS (Tj = 25°C unless otherwise specified.)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **IGBT, INVERTER** | | | | | | | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C$=50A, $V_{GE}$=15V | $T_j$=25°C | − | 1.50 | 1.8 | V |
| | | | $T_j$=125°C | | 1.72 | | |
| | | | $T_j$=175°C | | 1.86 | | |
| $V_{GEth}$ | Gate Threshold Voltage | $I_C$=250uA, $V_{CE}$=$V_{GE}$ | | 5.0 | 5.8 | 6.6 | V |
| $I_{CES}$ | Collector-Emitter Cut-off Current | $V_{CE}$=1200V, $V_{GE}$=0V | | | | 2.0 | uA |
| $I_{GES}$ | Gate Leakage Current | $V_{CE}$=0V, $V_{GE}$=20V | | | | 100 | nA |
| $Q_G$ | Total Gate Charge | $V_{GE}$=±15V, $V_{CE}$=600V | | | 0.178 | | uC |
| $R_{Gint}$ | Internal Gate Resistance | | | | 0 | | Ω |
| $C_{ies}$ | Input Capacitance | $V_{CE}$=30V, $V_{GE}$=0V, f=1.0MHz | | | 5980 | | pF |
| $C_{oes}$ | Output Capacitance | | | | 115 | | |
| $C_{res}$ | Reverse Transfer Capacitance | | | | 25 | | |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|

**IGBT, INVERTER** (Continued)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $t_{don}$ | Turn-on Delay Time | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 61 | | ns |
| | | | $T_j$=125℃ | | 62 | | |
| | | | $T_j$=175℃ | | 64 | | |
| $t_r$ | Rise Time | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 24 | | ns |
| | | | $T_j$=125℃ | | 27 | | |
| | | | $T_j$=175℃ | | 29 | | |
| $t_{doff}$ | Turn-off Delay Time | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 220 | | ns |
| | | | $T_j$=125℃ | | 269 | | |
| | | | $T_j$=175℃ | | 297 | | |
| $t_f$ | Fall Time | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 98 | | ns |
| | | | $T_j$=125℃ | | 176 | | |
| | | | $T_j$=175℃ | | 234 | | |
| $E_{on}$ | Turn-on Energy Loss per Pulse | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 2.01 | | mJ |
| | | | $T_j$=125℃ | | 2.52 | | |
| | | | $T_j$=175℃ | | 2.92 | | |
| $E_{off}$ | Turn-off Energy Loss per Pulse | $V_{CE}$=600V, IC=50A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5Ω, $R_{G\_OFF}$=5Ω | $T_j$=25℃ | | 3.09 | | mJ |
| | | | $T_j$=125℃ | | 4.57 | | |
| | | | $T_j$=175℃ | | 5.57 | | |
| $I_{SC}$ | Short-circuit Current | $V_{CC}$=600V, $V_{GE}$≤15V, $V_{CEmax}$≤1200V, $T_j$=150℃<br>$t_p$≤10us | | | 141 | | A |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per IGBT | | | 0.9 | | ℃/W |
| $T_{jop}$ | Temperature under Switching Conditions | | | -40 | | 175 | ℃ |

**Diode, INVERTER**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $V_F$ | Forward Voltage | $I_F$=50A, $V_{GE}$=0V | $T_j$=25℃ | | 1.85 | 2.1 | V |
| | | | $T_j$=125℃ | | 2.00 | | |
| | | | $T_j$=175℃ | | 1.96 | | |
| $I_{RM}$ | Peak Reverse Recovery Current | $V_R$=600V, $I_F$=50A,<br>$V_{GE}$=0V, $R_G$=5Ω | $T_j$=25℃ | | 53.1 | | A |
| | | | $T_j$=125℃ | | 53.3 | | |
| | | | $T_j$=175℃ | | 55.6 | | |
| $t_{rr}$ | Reverse Recovery Time | $V_R$=600V, $I_F$=50A,<br>$V_{GE}$=0V, $R_G$=5Ω | $T_j$=25℃ | | 255 | | ns |
| | | | $T_j$=125℃ | | 286 | | |
| | | | $T_j$=175℃ | | 377 | | |
| $Q_r$ | Recovered Charge | $V_R$=600V, $I_F$=50A,<br>$V_{GE}$=0V, $R_G$=5Ω | $T_j$=25℃ | | 3.04 | | uC |
| | | | $T_j$=125℃ | | 4.26 | | |
| | | | $T_j$=175℃ | | 5.78 | | |
| $E_{rec}$ | Reverse Recovery Energy | $V_R$=600V, $I_F$=50A,<br>$V_{GE}$=0V, $R_G$=5Ω | $T_j$=25℃ | | 0.63 | | mJ |
| | | | $T_j$=125℃ | | 0.80 | | |
| | | | $T_j$=175℃ | | 0.97 | | |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | | | 1.2 | | ℃/W |
| $T_{jop}$ | Temperature under Switching Conditions | | | -40 | | 175 | ℃ |

**ELECTRICAL CHARACTERISTICS** (Tj = 25°C unless otherwise specified.) (continued)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **IGBT, Brake-Chopper** | | | | | | | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C$=35A, $V_{GE}$=15V | $T_j$=25°C | – | 1.55 | 1.85 | V |
| | | | $T_j$=125°C | | 1.76 | | |
| | | | $T_j$=175°C | | 1.86 | | |
| $V_{GEth}$ | Gate Threshold Voltage | $I_C$=250uA, $V_{CE}$=$V_{GE}$ | | 5.0 | 5.8 | 6.6 | V |
| $I_{CES}$ | Collector-Emitter Cut-off Current | VCE=1200V, VGE=0V | | | | 2.0 | uA |
| $I_{GES}$ | Gate Leakage Current | $V_{CE}$=0V, $V_{GE}$=20V | | | | 100 | nA |
| $Q_G$ | Total Gate Charge | $V_{GE}$=±15V, $V_{CE}$=600V | | | 0.115 | | uC |
| $R_{Gint}$ | Internal Gate Resistance | | | | 0 | | Ω |
| $C_{ies}$ | Input Capacitance | $V_{CE}$=30V, $V_{GE}$=0V, f=1.0MHz | | | 3730 | | pF |
| $C_{oes}$ | Output Capacitance | | | | 107 | | |
| $C_{res}$ | Reverse Transfer Capacitance | | | | 15 | | |
| $t_{don}$ | Turn-on Delay Time | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 107 | | ns |
| | | | $T_j$=125℃ | | 107 | | |
| | | | $T_j$=175℃ | | 109 | | |
| $t_r$ | Rise Time | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 91 | | ns |
| | | | $T_j$=125℃ | | 94 | | |
| | | | $T_j$=175℃ | | 96 | | |
| $t_{doff}$ | Turn-off Delay Time | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 233 | | ns |
| | | | $T_j$=125℃ | | 276 | | |
| | | | $T_j$=175℃ | | 295 | | |
| $t_f$ | Fall Time | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 138 | | ns |
| | | | $T_j$=125℃ | | 242 | | |
| | | | $T_j$=175℃ | | 306 | | |
| $E_{on}$ | Turn-on Energy Loss per Pulse | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 3.58 | | mJ |
| | | | $T_j$=125℃ | | 4.24 | | |
| | | | $T_j$=175℃ | | 4.78 | | |
| $E_{off}$ | Turn-off Energy Loss per Pulse | $V_{CE}$=600V, $I_C$=35A,<br>$V_{GE}$=0/15V,<br>$R_{G\_ON}$=5.5Ω, $R_{G\_OFF}$=5.5Ω | $T_j$=25℃ | | 2.36 | | mJ |
| | | | $T_j$=125℃ | | 3.41 | | |
| | | | $T_j$=175℃ | | 3.99 | | |
| $I_{SC}$ | Short-circuit Current | $V_{CC}$=600V, $V_{GE}$≤15V, $V_{CEmax}$≤1200V, $T_j$=150℃<br>$t_p$≤9us | | | 123 | | A |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per IGBT | | | 1.0 | | ℃/W |
| $T_{jop}$ | Temperature under Switching Conditions | | | -40 | | 175 | ℃ |

**ELECTRICAL CHARACTERISTICS** (Tj = 25°C unless otherwise specified.) (continued)

**Diode, Brake-Chopper**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_F$ | Forward Voltage | $I_F$=25A, $V_{GE}$=0V | $T_j$=25℃ | | 1.80 | 2.1 | V |
| | | | $T_j$=125℃ | | 1.96 | | |
| | | | $T_j$=175℃ | | 1.91 | | |
| $I_{RM}$ | Peak Reverse Recovery Current | $V_R$=600V, $I_F$=25A, $V_{GE}$=0V, $R_G$=5.5Ω | $T_j$=25℃ | | 12.32 | | A |
| | | | $T_j$=125℃ | | 14.1 | | |
| | | | $T_j$=175℃ | | 15.7 | | |
| $t_{rr}$ | Reverse Recovery Time | $V_R$=600V, $I_F$=25A, $V_{GE}$=0V, $R_G$=5.5Ω | $T_j$=25℃ | | 202 | | ns |
| | | | $T_j$=125℃ | | 290 | | |
| | | | $T_j$=175℃ | | 385 | | |
| $Q_r$ | Recovered Charge | $V_R$=600V, $I_F$=25A, $V_{GE}$=0V, $R_G$=5.5Ω | $T_j$=25℃ | | 1.338 | | uC |
| | | | $T_j$=125℃ | | 2.202 | | |
| | | | $T_j$=175℃ | | 3.04 | | |
| $E_{rec}$ | Reverse Recovery Energy | $V_R$=600V, $I_F$=25A, $V_{GE}$=0V, $R_G$=5.5Ω | $T_j$=25℃ | | 0.369 | | mJ |
| | | | $T_j$=125℃ | | 0.533 | | |
| | | | $T_j$=175℃ | | 0.659 | | |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | | | 2.0 | | ℃/W |
| $T_{jop}$ | Temperature under Switching Conditions | | | -40 | | 175 | ℃ |

**Diode, Rectifier**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_F$ | Forward Voltage | $I_F$=50A, $T_j$=150℃ | | 1.18 | | V |
| $I_r$ | Reverse Current | $V_R$=1600V, $T_j$=150℃ | | 1 | | mA |
| $R_{thJC}$ | Thermal Resistance, Junction to Case | Per Diode | | 1.1 | | ℃/W |
| $T_{jop}$ | Temperature under Switching Conditions | | -40 | | 150 | ℃ |

**NTC-Thermistor**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{25}$ | Rated Resistance | $T_{NTC}$=25°C | 4.85 | 5 | 5.15 | kΩ |
| ΔR/R | Deviation of R100 | $T_C$=100°C, $R_{100}$=490Ω | -5 | | 5 | % |
| $P_{25}$ | Power Dissipation | $T_{NTC}$=25°C | | | 60 | mW |
| $B_{25/50}$ | B-constant | $R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15K))]$ | | 3375 | | K |
| $B_{25/80}$ | B-constant | $R_2=R_{25}\exp[B_{25/80}(1/T_2-1/(298.15K))]$ | | 3425 | | K |
| $B_{25/100}$ | B-constant | $R_2=R_{25}\exp[B_{25/100}(1/T_2-1/(298.15K))]$ | | 3443 | | K |

### Package

| Symbol | Parameter | Conditions | Rating | Unit |
|---|---|---|---|---|
| $V_{ISO}$ | Isolation Test Voltage | RMS, f=50Hz, t=1min | 2500 | V |
| $d_{creep}$ | Creepage Distance | Terminal to Heatsink | 11.5 | mm |
| | | Terminal to Terminal | 6.3 | mm |
| $d_{clear}$ | Clearance | Terminal to Heatsink | 10.0 | mm |
| | | Terminal to Terminal | 5.0 | mm |
| CTI | Comparative Tracking Index | | >200 | - |

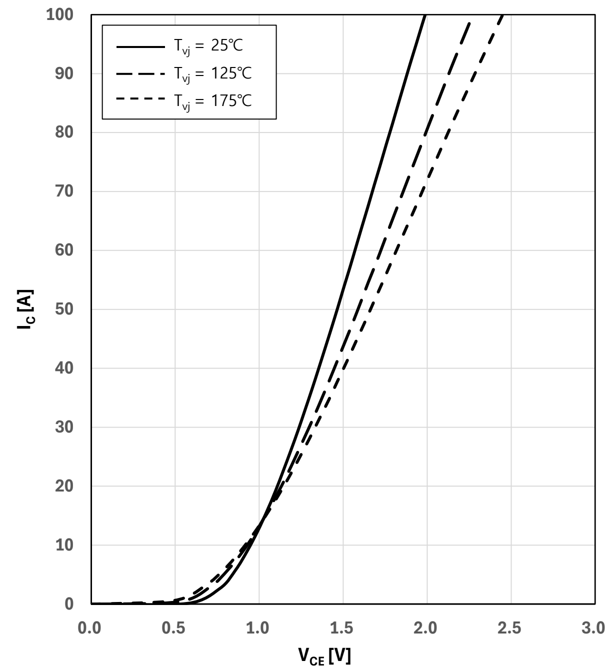
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $T_{stg}$ | Storage Temperature | | -40 | | 125 | ℃ |
| G | Weight | | | 43 | | g |
| F | Mounting Force per Clamp | | 20 | | 50 | N |

## CHARACTERISTICS DIAGRAMS

### Output characteristic (typical), IGBT, Inverter

$I_C=f(V_{CE})$

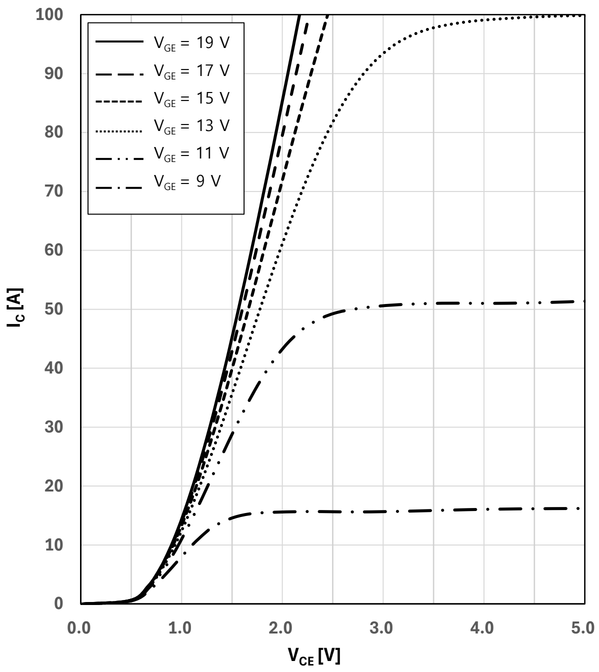
$V_{GE}=15V$



### Output characteristic (typical), IGBT, Inverter

$I_C=f(V_{CE})$

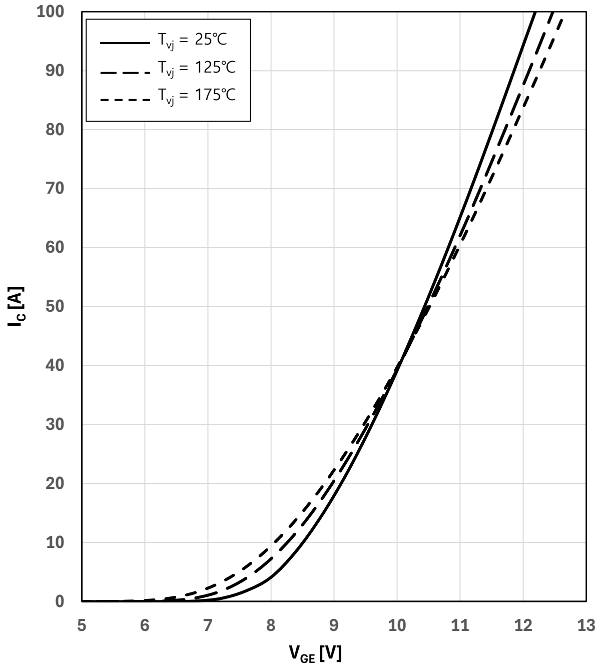
$T_j=175°C$



### Transfer characteristic (typical), IGBT, Inverter

$I_C=f(V_{GE})$

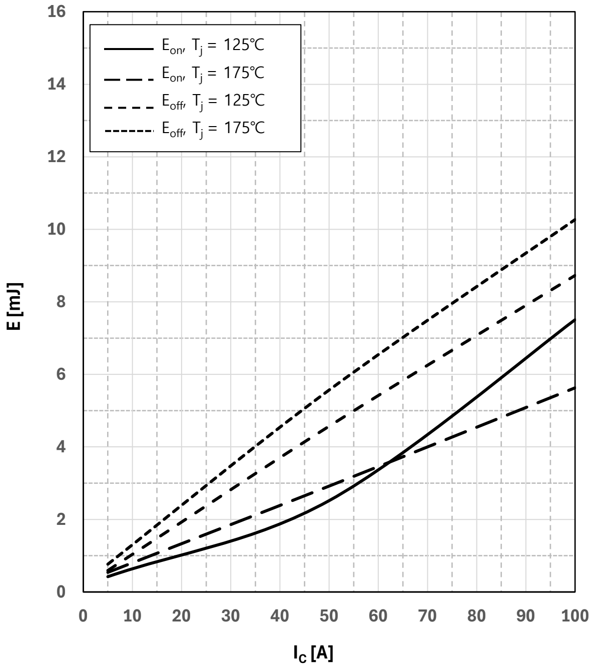
$V_{CE}=20V$



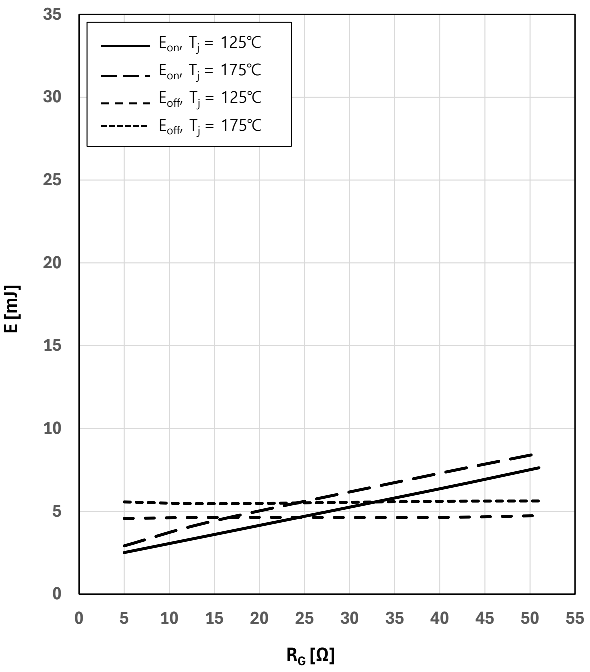
### Switching losses (typical), IGBT, Inverter

$E=f(I_C)$

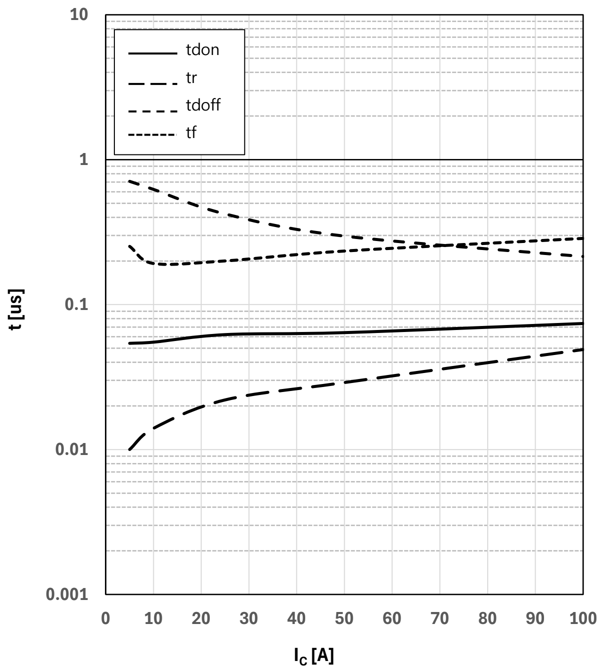
$R_{Goff}=5\Omega$, $R_{Gon}=5\Omega$, $V_{CE}=600V$, $V_{GE}=\pm15V$



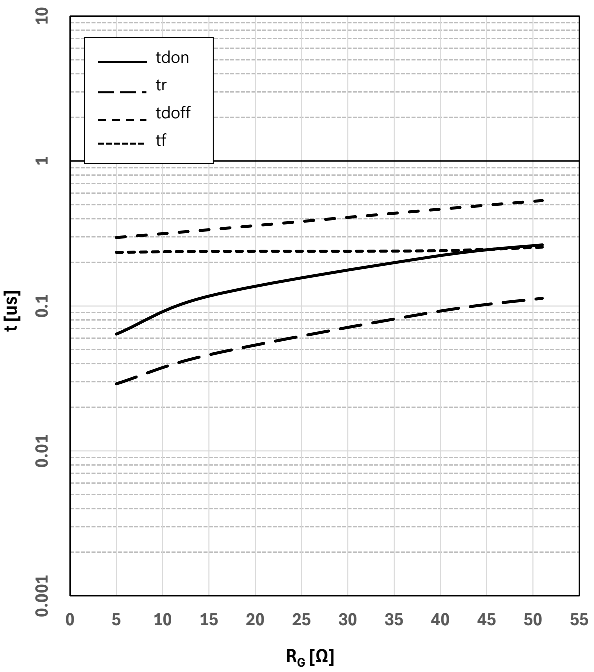
**Switching losses (typical), IGBT, Inverter**
E=f($R_G$)
$I_C$=50A, $V_{CE}$=600V, $V_{GE}$=±15V



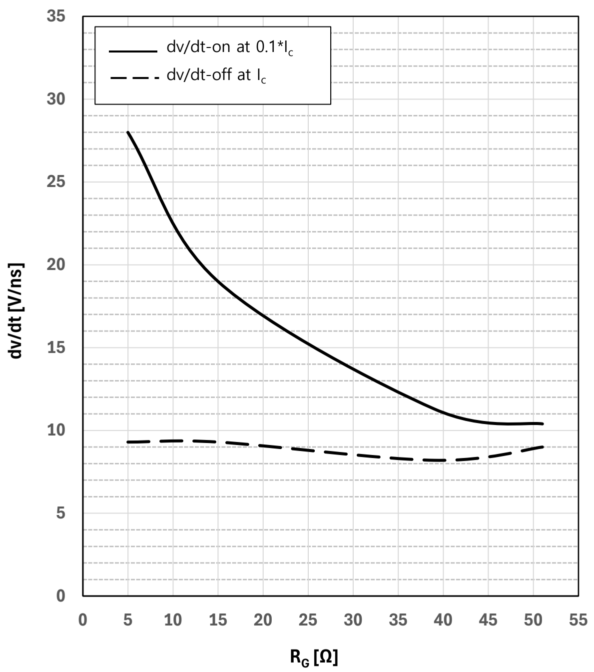
**Switching times (typical), IGBT, Inverter**
t=f($I_C$)
$R_{Goff}$=5Ω, $R_{Gon}$=5Ω, $V_{CE}$=600V, $V_{GE}$=±15V, $T_j$=175°C



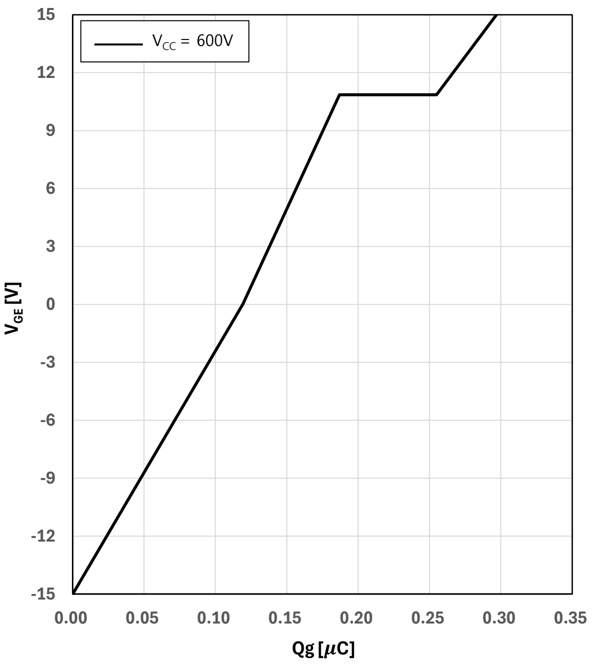
**Switching times (typical), IGBT, Inverter**
t=f($R_G$)
$I_C$=50A, $V_{CE}$=600V, $V_{GE}$=±15V, $T_j$=175°C

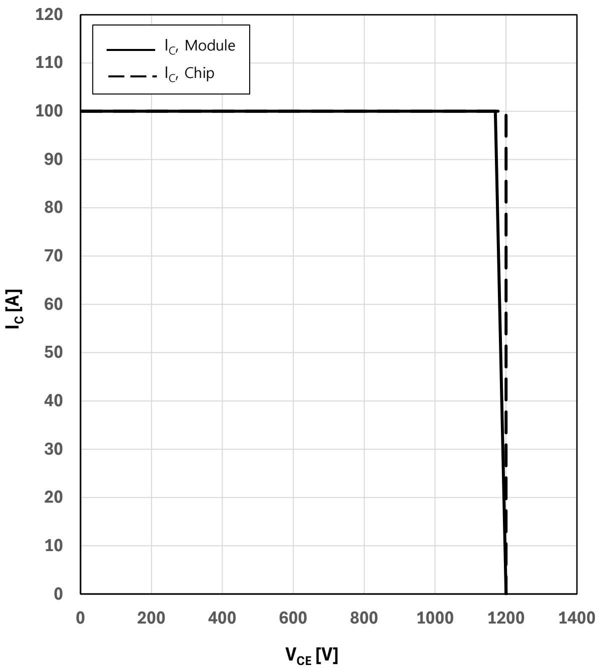


**dv/dt (typical), IGBT, Inverter**
dv/dt=f($R_G$)
$I_C$=50A, $V_{CE}$=600V, $V_{GE}$=±15V, $T_j$=25°C

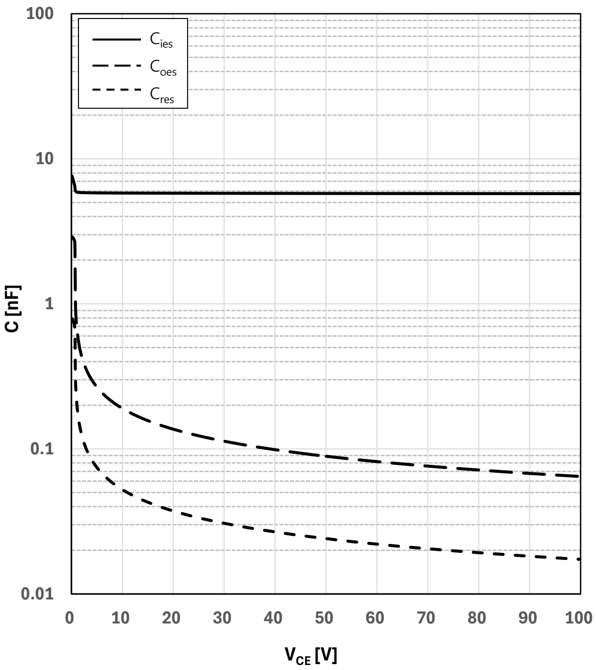


| **Gate charge characteristic (typical), IGBT, Inverter**<br>$V_{GE}$=f($Q_G$)<br>$T_j$=25°C, $I_C$=50A | **Reverse bias safe operating area (RBSOA), IGBT, Inverter**<br>$I_C$=f($V_{CE}$)<br>$R_{Goff}$=5Ω, $V_{GE}$=±15V, $T_j$=175°C |
|---|---|



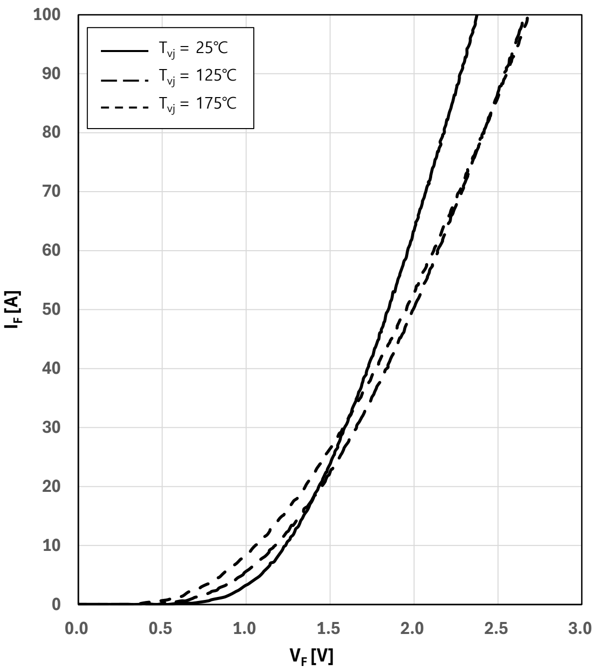


**Capacity characteristic (typical), IGBT, Inverter**
C=f($V_{CE}$)
f=100kHz, $T_j$=25°C, $V_{GE}$=0V



**Forward characteristic (typical), Diode, Inverter**

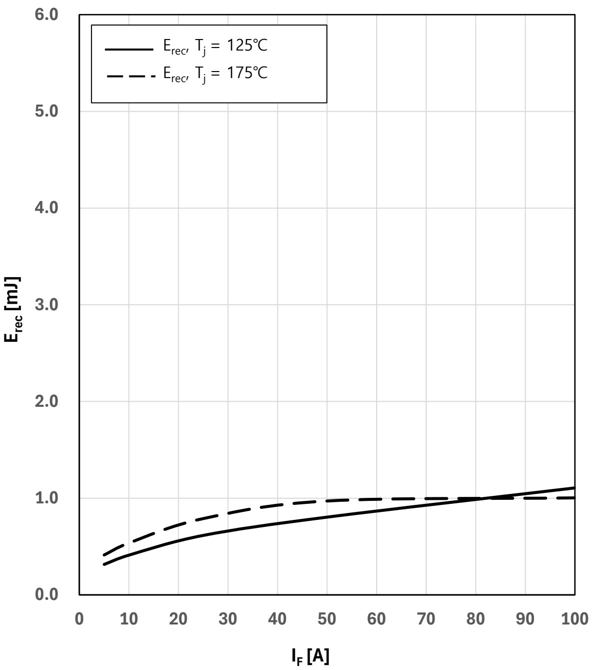
$I_F=f(V_F)$



**Switching losses (typical), Diode, Inverter**

$E_{rec}=f(I_F)$

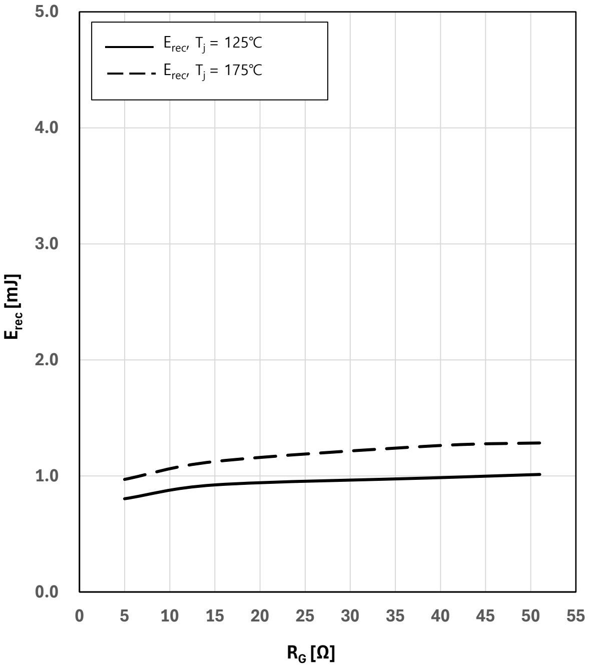
$R_{Gon}$=5Ω, $V_{CE}$=600V



**Switching losses (typical), Diode, Inverter**

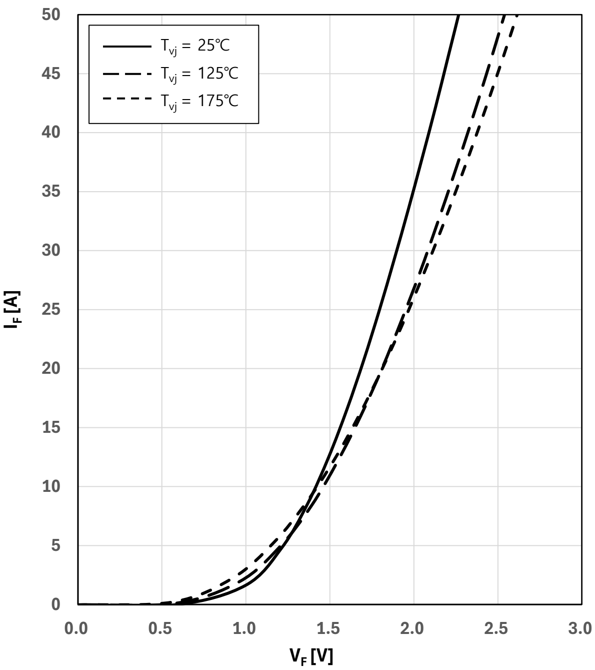
$E_{rec}=f(R_G)$

$V_{CE}$=600V, $I_F$=50A



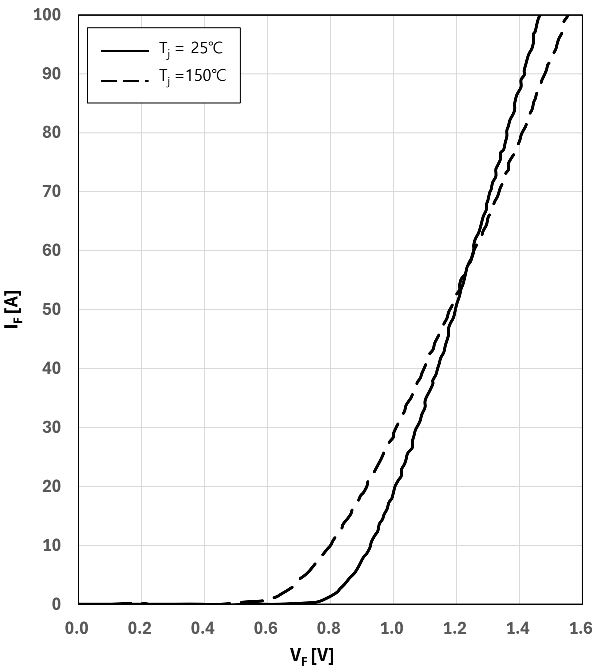
**Forward characteristic (typical), Diode, Brake-Chopper**

$I_F=f(V_F)$



**Forward characteristic (typical), Diode, Rectifier**

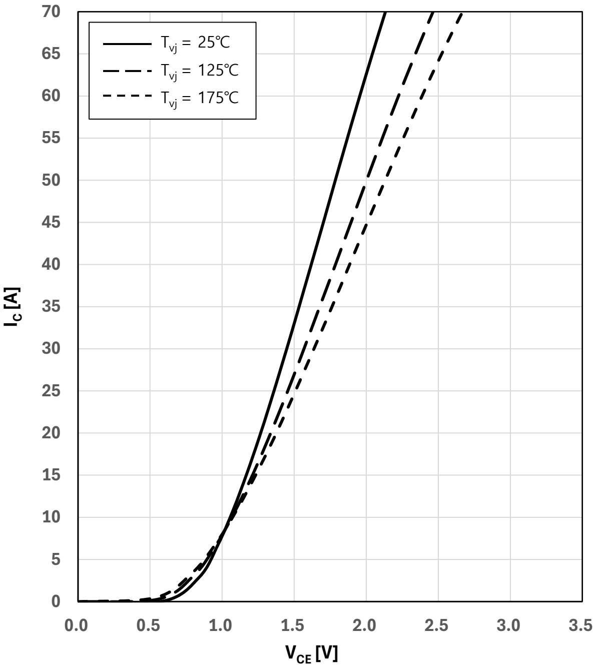
$I_F=f(V_F)$



**Output characteristic (typical), IGBT, Brake-Chopper**

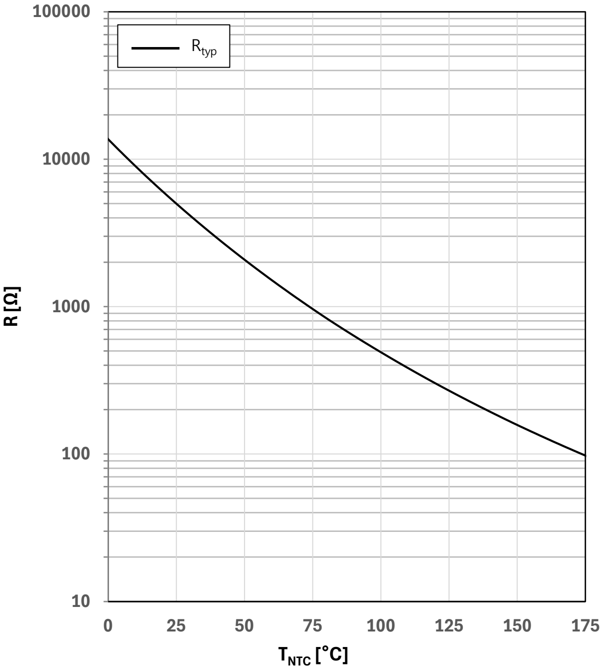
$I_C=f(V_{CE})$

$V_{GE}=15V$

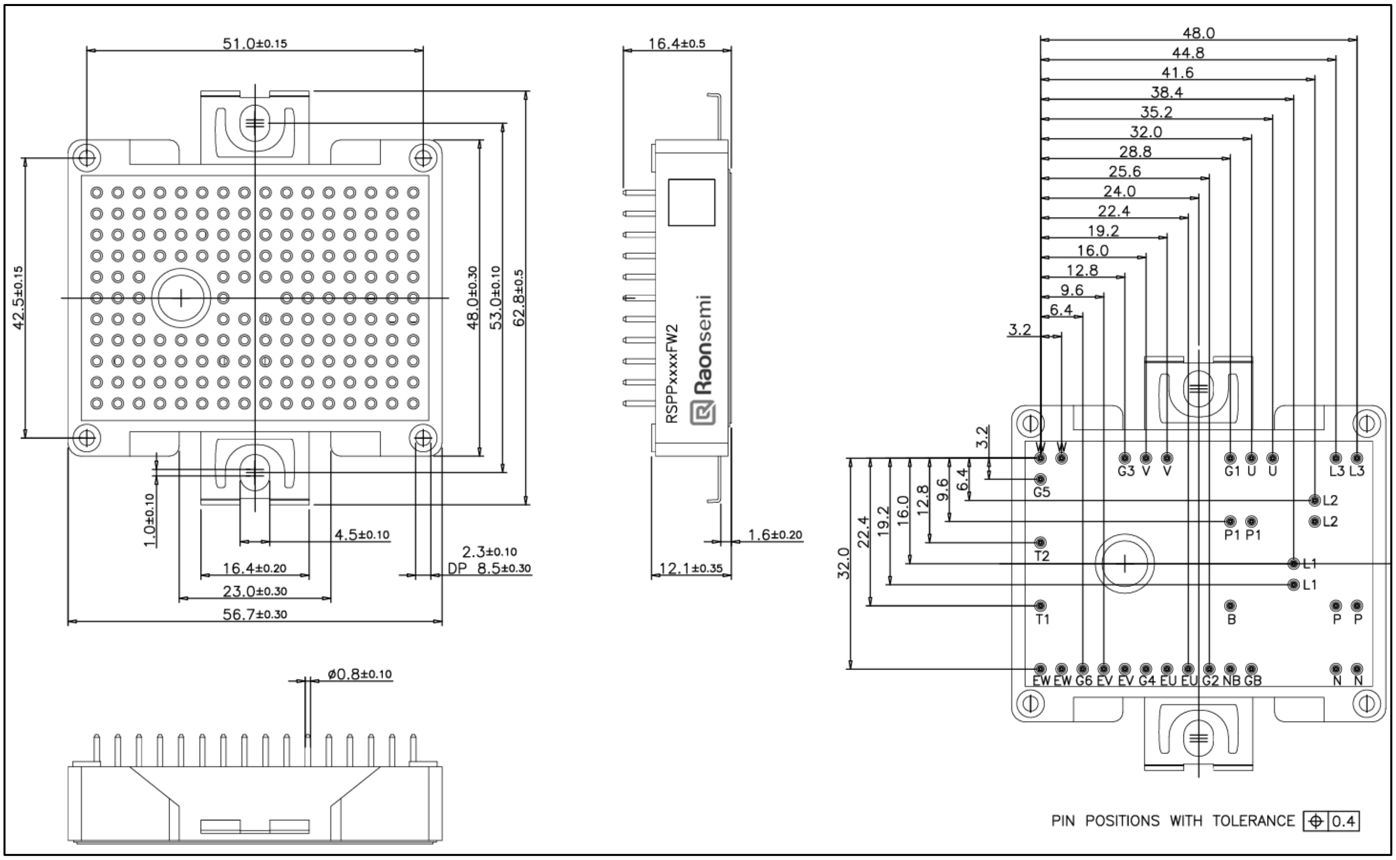


**Temperature characteristic (typical), NTC-Thermistor**

$R=f(T_{NTC})$



## PACKAGE DIMENSIONS



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