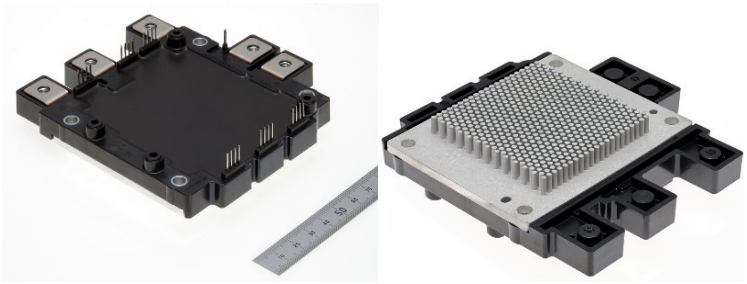
<IGBT Modules>

# CT600CJ1A060-A

**HIGH POWER SWITCHING USE**
**INSULATED TYPE**



| | |
|---|---|
| Collector current $I_C$ | **600** A |
| Collector-emitter voltage $V_{CES}$ | **650** V |

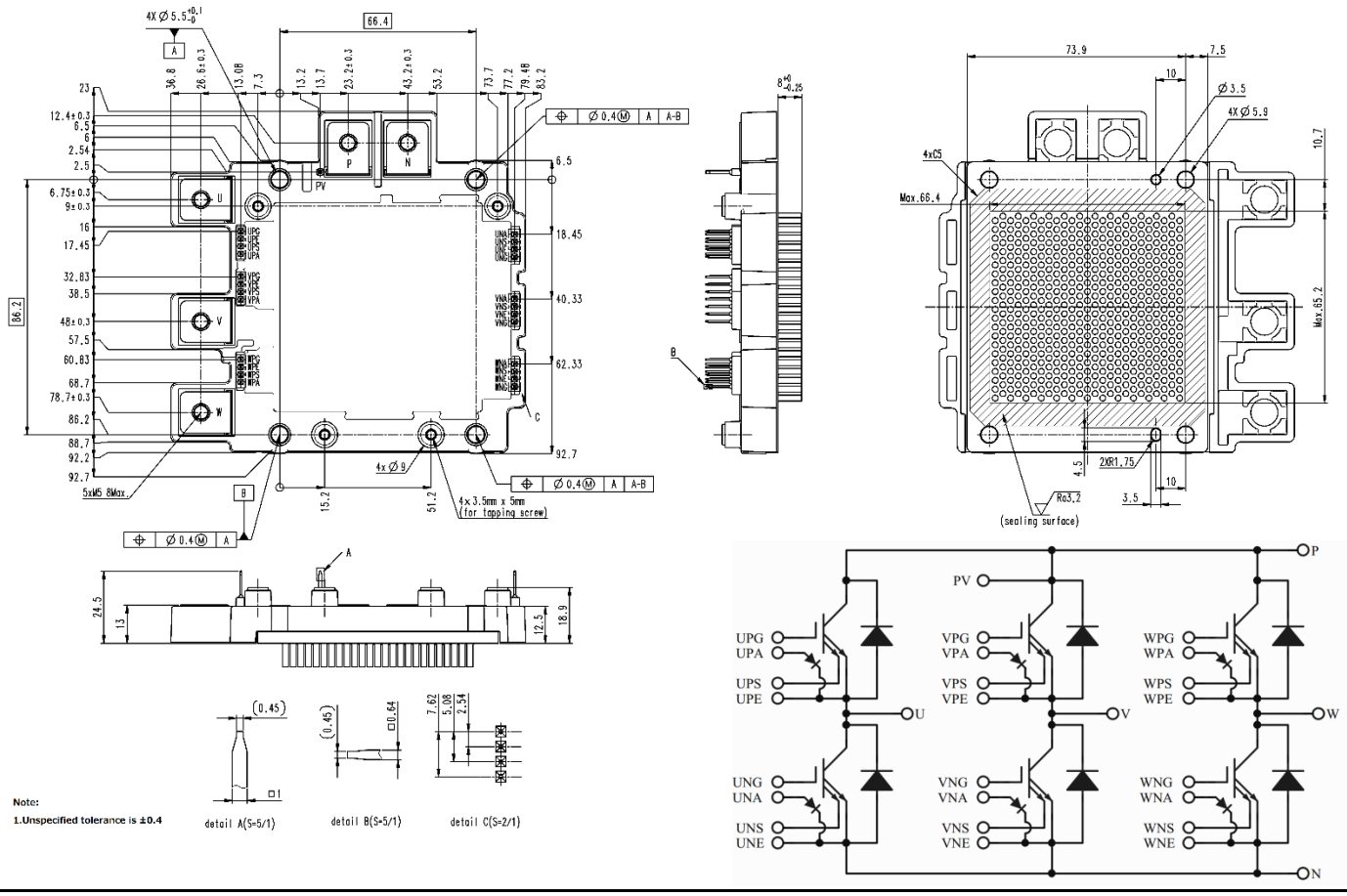
- ●High-Reliability DLB structure*Note
- ●Direct cooling package with cooling fin
- ●Compact, light-weight, high-power-density module
- ●6-Elements package (6-in-1, insulated type)
- ●Low internal impedance package
- ●Low-loss CSTBT™ chip technology*Note
- ●Built-in on-chip temperature sensor
- ●Built-in on-chip current sensor for SC protection
- ●Compliant with RoHS directive 2011/65/EU
- ●High strength material(Al)

*Note DLB: Direct-Lead-Bonding (Wire-bond-Less power contacts); CSTBT™: Carrier Stored Trench Gate Bipolar Transistor

## APPLICATION

EV/HEV and High Reliability Inverter

**PACKAGE OUTLINES & CIRCUIT DIAGRAM** Unit : mm



**ABSOLUTE MAXIMUM RATINGS** ($T_{vj}$ = 25°C, unless otherwise noted)

| Symbol | Item | Conditions | Ratings | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage | -40°C ≤ $T_{vj}$ ≤ 150 °C, $V_{GE}$ = 0V | 650 | V |
| $V_{GES}$ | Gate-emitter voltage | $V_{GE}$ = 0V | ±20 | V |
| $I_C$ | Collector current | $T_W$ = 25°C | 600 | A |
| $I_{CRM}$ | Peak collector current | $T_W$ = 25°C, Repetitive, pulse(Note 1) | 1200 | A |
| $I_E$ | Emitter current | $T_W$ = 25°C | 600 | A |
| $I_{ERM}$ | Peak emitter current | $T_W$ = 25°C, Repetitive, pulse(Note 1) | 1200 | A |
| $P_{tot}$ | Maximum collector dissipation | $T_W$ = 25°C, $T_{vj}$ =175°C | 708 | W |
| $T_{vj}$ | Junction temperature | Repetition | -40 ~ +150 | °C |
| | | Non-repetition, Accumulated time 10hour | +150 ~ +175 | °C |
| $T_{stg}$ | Storage temperature | — | -40 ~ +125 | °C |
| $V_{isol}$ | Isolation voltage | Main terminals to base plate, AC 1 minute, 60Hz | 2500 | Vrms |

**MECHANICAL RATINGS**

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| — | Tightening torque strength | Main terminal screw : M5 | Torque coefficient =0.32 | 2.8 | 3.2 | 6.0 | Nm |
| | | Mounting screw : M5 | | 2.8 | 3.2 | 6.0 | Nm |
| — | Weight | Typical value | | — | 340 | — | g |

**ELECTRICAL CHARACTERISTICS** ($T_{vj}$ = 25°C, unless otherwise noted)

| Symbol | Item | Conditions | | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min. | Typ. | Max. | |
| $I_{CES}$ | Collector cut-off current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | | | — | — | 1 | mA |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $I_C$ = 60mA, $V_{CE}$ = 10V | | | 5.5 | 6.5 | 7.5 | V |
| $I_{GES}$ | Gate leakage current | $V_{GE}$ = $V_{GES}$ | | | — | — | 15 | µA |
| $V_{CEsat}$ | Collector-emitter saturation voltage | $I_C$ = 600A, $V_{GE}$ = 15V | $T_{vj}$ = 25°C | Main terminal | — | 1.50 | 1.80 | V |
| | | | | Chip | — | 1.25 | — | V |
| | | | $T_{vj}$=125°C | Main terminal | — | 1.60 | 1.90 | V |
| | | | | Chip | — | 1.25 | — | V |
| $V_{EC}$ | Emitter-collector voltage | $I_E$ = 600A, $V_{GE}$ = 0V, $T_{vj}$ = 25°C | | Main terminal | — | 1.70 | 2.00 | V |
| | | | | Chip | — | 1.60 | — | V |
| $C_{ies}$ | Input capacitance | $V_{CE}$ = 10V, $V_{GE}$ = 0V, $T_{vj}$ = 25°C | | | — | 49 | — | nF |
| $C_{oes}$ | Output capacitance | | | | — | 6.8 | — | nF |
| $C_{res}$ | Reverse transfer capacitance | | | | — | 0.9 | — | nF |
| $V_F$ | On-chip temperature-sense diode voltage | $I_F$ = 200µA | | | 2.65 | 2.75 | 2.85 | V |
| | | $I_F$ = 200µA, $T_{vj}$ = 125°C | | | 1.98 | 2.08 | 2.18 | V |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 350V, $I_C$ = $I_E$ = 600A, $V_{GE}$ = 15V, $T_{vj}$ = 125°C, $R_{G(on)}$ = 3.9Ω (d$I_C$/dt≒4.5kA/µs), $R_{G(off)}$ = 4.7Ω (d$I_C$/dt≒4.0kA/µs), Ls=15nH, Inductive load switching operation. Note) see switching measurement circuit on page6 | | | — | 0.21 | — | µs |
| $t_r$ | Turn-on rise time | | | | — | 0.13 | — | µs |
| $E_{on}$ | Turn-on loss | | | | — | 21.5 | — | mJ/p |
| $t_{d(off)}$ | Turn-off delay time | | | | — | 0.95 | — | µs |
| $t_f$ | Turn-off fall time | | | | — | 0.25 | — | µs |
| $E_{off}$ | Turn-off loss | | | | — | 43.7 | — | mJ/p |
| $t_{rr}$ | Reverse-recovery time | | | | — | 0.23 | — | µs |
| $Q_{rr}$ | Reverse-recovery charge | | | | — | 34 | — | µC |
| $E_{rr}$ | Reverse-recovery loss | | | | — | 14.5 | — | mJ/p |

**THERMAL RESISTANCES**

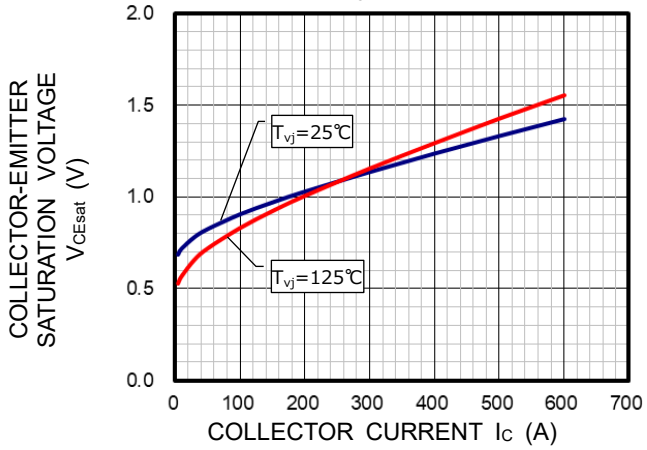
| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $R_{th(j-w)Q}$ | Junction-water thermal resistance | IGBT part (1/6 module) | 50% LLC : Flow rate:10L/min | — | 0.180 | 0.212 | K/W |
| $R_{th(j-w)D}$ | | FWD part (1/6 module) | | — | 0.205 | 0.242 | K/W |

Note1 : Pulse width and repetition rate should be such that the device junction temperature ($T_{Vj}$) dose not exceed maximum ratings.

## PERFORMANCE CURVES

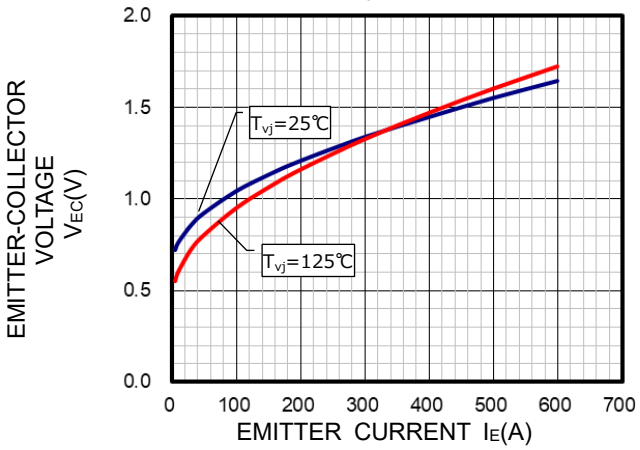
### COLLECTOR-EMITTER SATURATION CHARACTERISTICS (Representative Example:Main terminal)

$V_{GE}$=15V



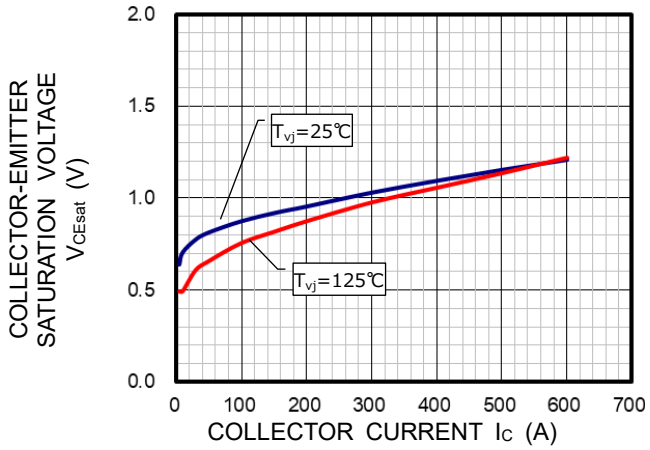

### FREE-WHEEL DIODE FORWARD CHARACTERISTICS (Representative Example:Main terminal)

$V_{GE}$=0V



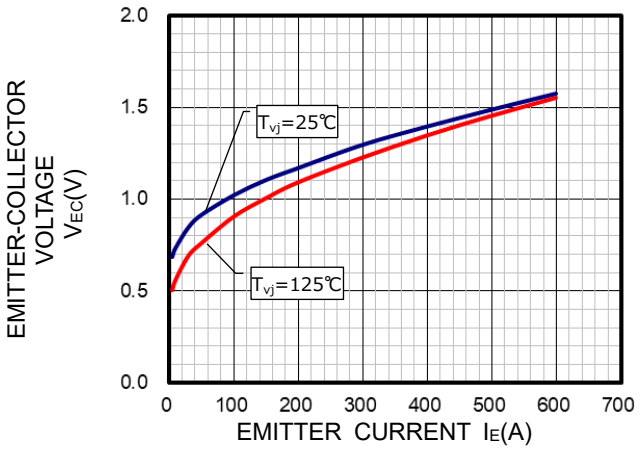

### COLLECTOR-EMITTER SATURATION CHARACTERISTICS (Representative Example:Chip)

$V_{GE}$=15V



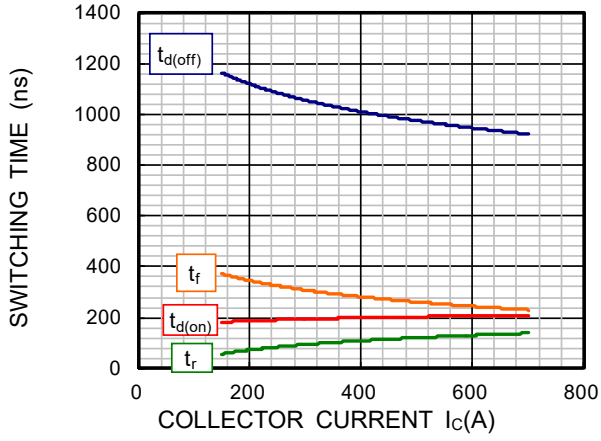

### FREE-WHEEL DIODE FORWARD CHARACTERISTICS (Representative Example:Chip)

$V_{GE}$=0V



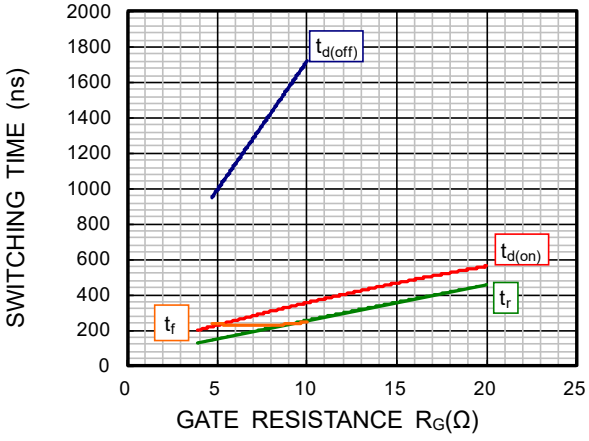

### SWITCHING CHARACTERISTICS (Representative Example)

$V_{CC}$=350V, $V_{GE}$=15V, $R_{G(on)}$=3.9Ω, $R_{G(off)}$=4.7Ω,
$T_{vj}$=125°C, Ls=15nH, Inductive load

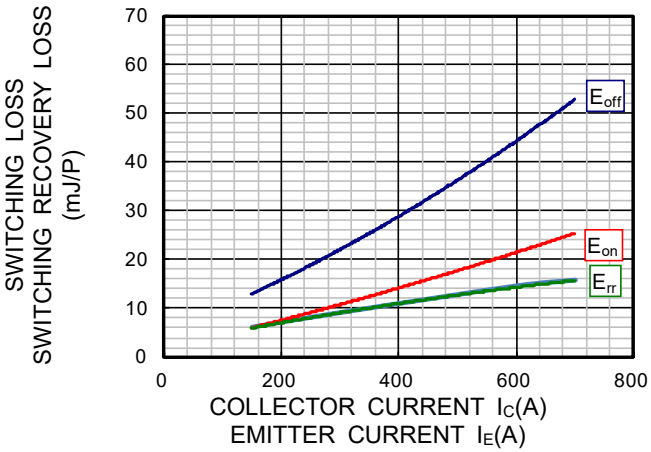



### SWITCHING CHARACTERISTICS (Representative Example)

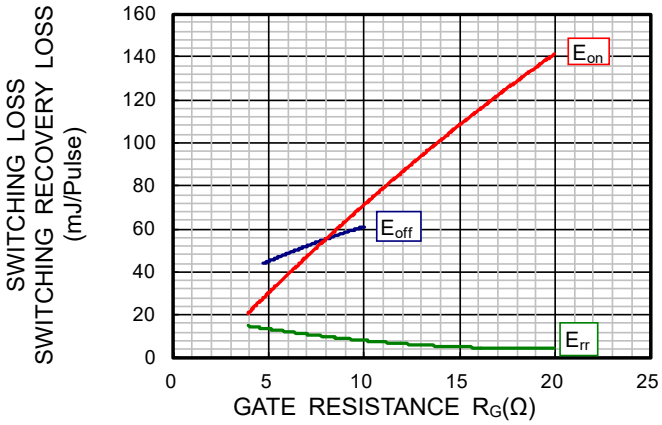
$V_{CC}$=350V, $I_C$=600A, $V_{GE}$=15V,
$T_{vj}$=125°C, Ls=15nH, Inductive load



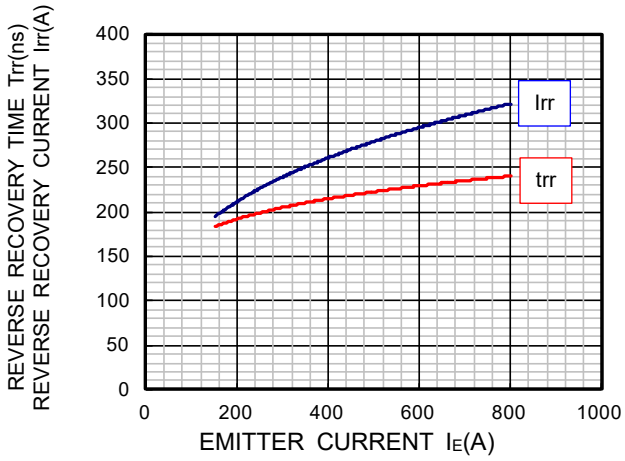
**SWITCHING CHARACTERISTICS**
**(Representative Example)**
$V_{CC}$=350V, $V_{GE}$=15V, $R_{G(on)}$=3.9Ω, $R_{G(off)}$=4.7Ω,
$T_{vj}$=125°C, Ls=15nH, Inductive load




**SWITCHING CHARACTERISTICS**
**(Representative Example)**
$V_{CC}$=350V, $I_C$=$I_E$=600A, $V_{GE}$=15V,
$T_{vj}$=125°C, Ls=15nH, Inductive load

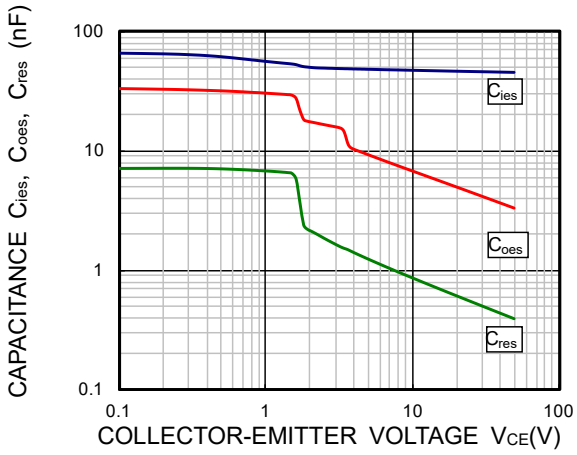



**FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS**
**(Representative Example)**
$V_{CC}$=350V, $V_{GE}$=15V, $R_{G(on)}$=3.9Ω
$T_{vj}$=125°C, Ls=15nH, Inductive load

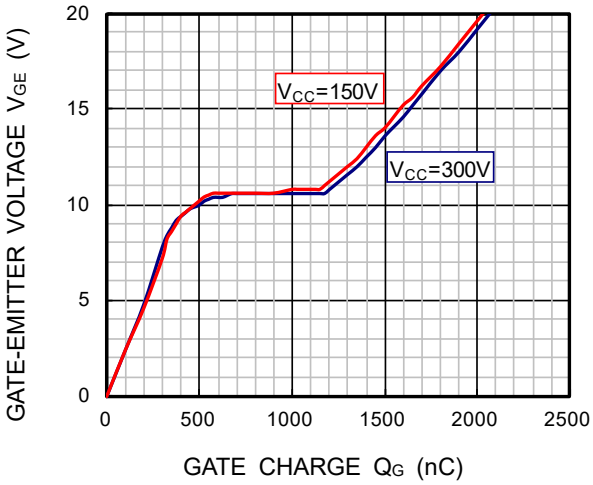



**CAPACITANCE-vs.-VCE CHARACTERISTICS**
**(Representative Example)**

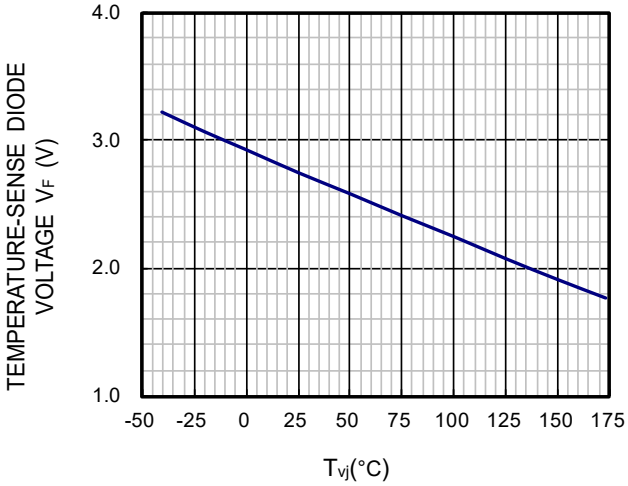
$T_{vj}$=25°C




**GATE CHARGE CHARACTERISTICS**
**(Representative Example)**
$I_C$=600A, $T_{vj}$=25°C

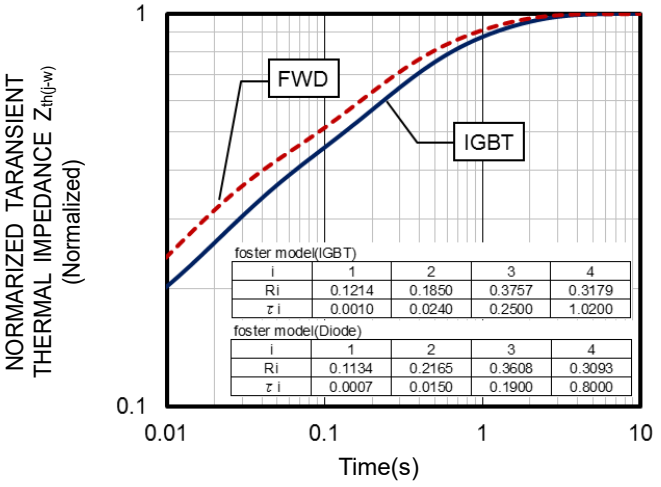



**ON-CHIP TEMPERATURE-SENSE DIODE CHARACTERISTICS**
**(Representative Example)**
$I_F$=200μA



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (Representative Example)**

IGBT part:Per unit base=$R_{th(j-w)Q}$=0.180K/W
FWD part:Per unit base=$R_{th(j-w)D}$=0.205K/W




foster model(IGBT)

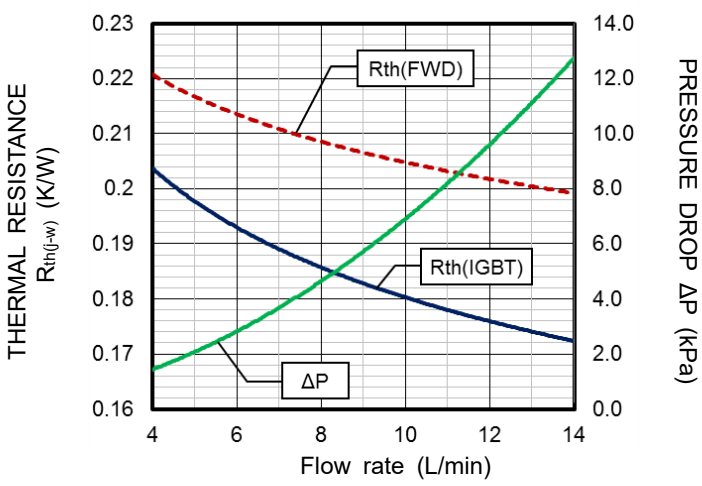
| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ri | 0.1214 | 0.1850 | 0.3757 | 0.3179 |
| τ i | 0.0010 | 0.0240 | 0.2500 | 1.0200 |

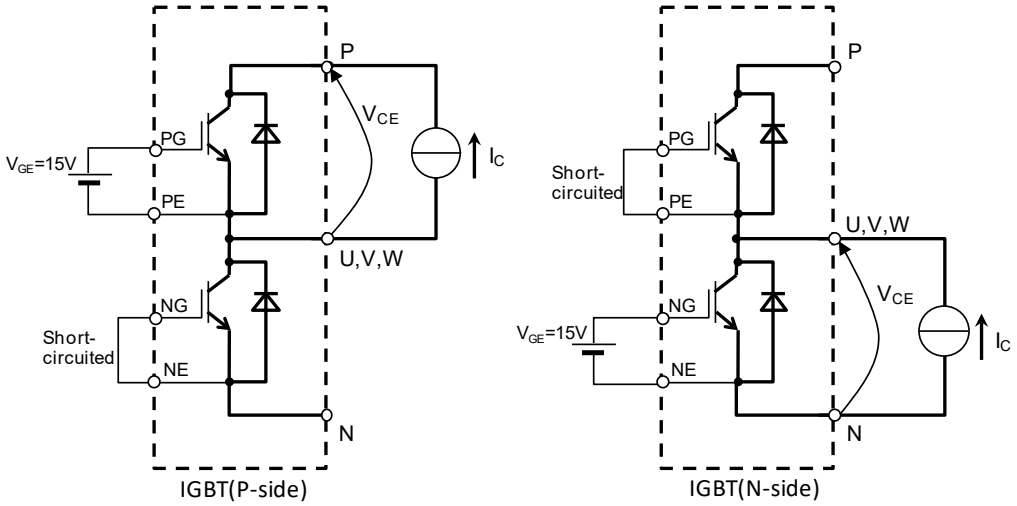
foster model(Diode)

| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ri | 0.1134 | 0.2165 | 0.3608 | 0.3093 |
| τ i | 0.0007 | 0.0150 | 0.1900 | 0.8000 |

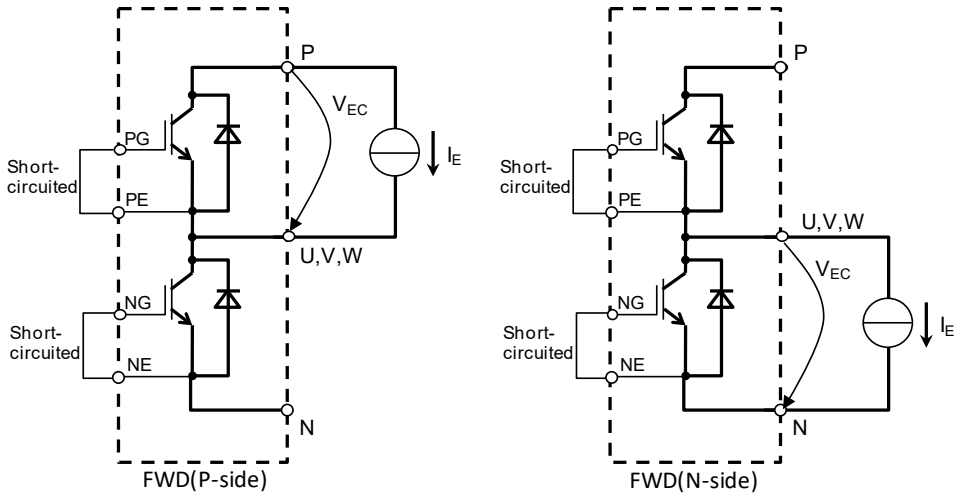
**THERMAL RESISTANCE, PRESSURE DROP CHARACTERISTICS (Representative Example)**

Tw=60°C, 50%LLC
cooling jacket(J1WJB)



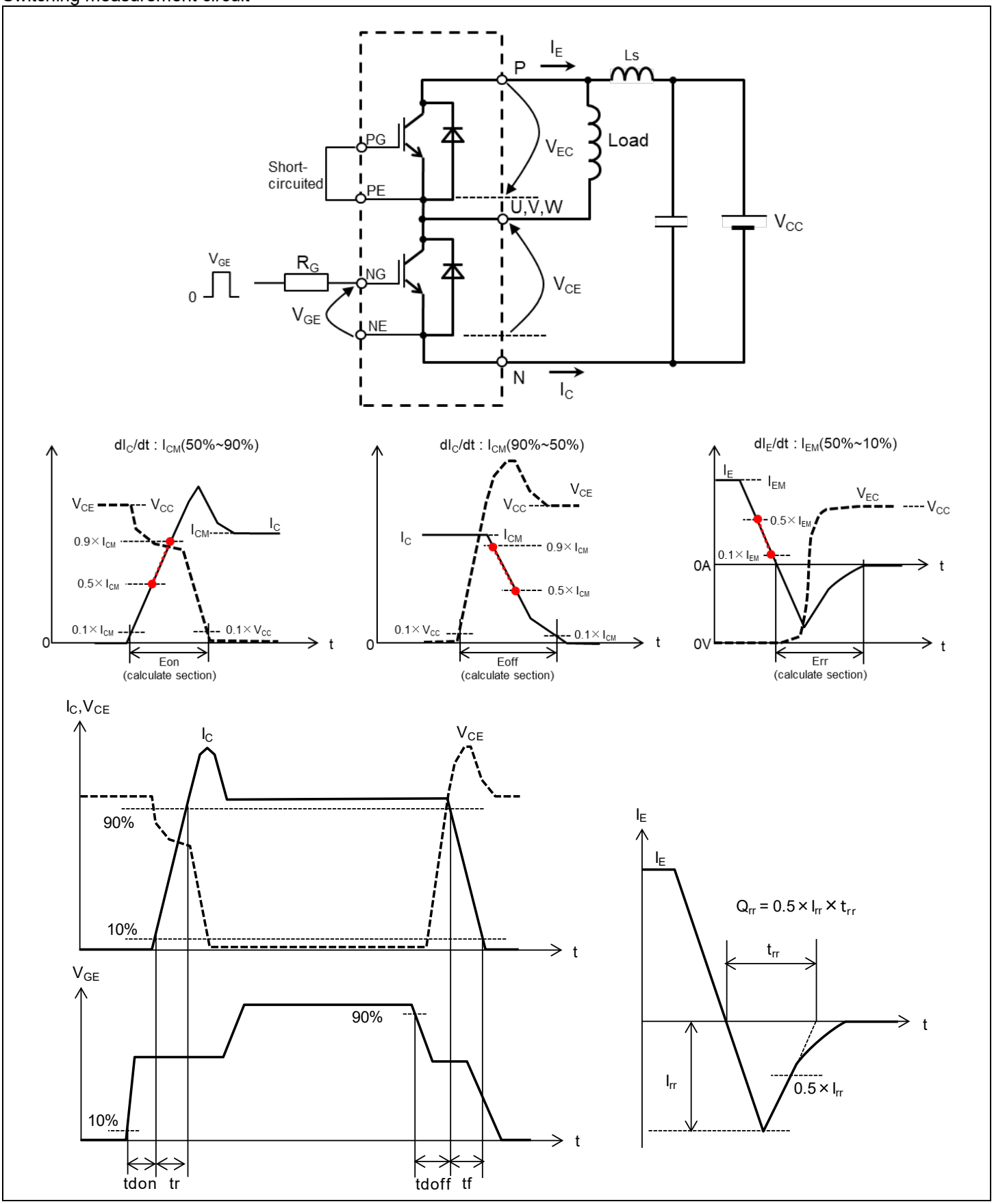




$V_{CEsat}$ Measurement circuit (Main terminal)




$V_{EC}$ Measurement circuit (Main terminal)

Switching measurement circuit



## Correct and Safety Use of Power Module

Unsuitable operation (such as electrical, mechanical stress and so on) may lead to damage of power modules.
Please pay attention to the following descriptions and use Mitsubishi Electric's IGBT modules according to the guidance.

| ⚠ CAUTION | |
|---|---|
| During Transit | (1) Keep shipping cartons right side up. If stress is applied by either placing a carton upside down or by leaning a box against something, terminals can be bent and/or resin packages can be damaged.<br>(2) Tossing or dropping of a carton may damage devices inside.<br>(3) If a device gets wet with water, malfunctioning and failure may result. Special care should be taken during rain or snow to prevent the devices from getting wet. |
| Storage | The temperature and humidity of the storage place should be 5~35°C and 45~75% respectively. The performance and reliability of devices may be jeopardized if devices are stored in an environment far above or below the range indicated above. |
| Prolonged Storage | When storing devices more than one year, dehumidifying measures should be provided for the storage place. When using devices after a long period of storage, make sure to check the exterior of the devices is free from scratches, dirt, rust, and so on. |
| Operating Environment | Devices should not be exposed to water, organic solvents, corrosive gases, explosive gases, fine particles, or corrosive agents, since any of those can lead to a serious accident. |
| Flame Resistance | Although the epoxy resin is in conformity with UL 94-V0 standards, it should be noted that those are not non-flammable. |
| Anti-electrostatic Measures | Following precautions should be taken for MOS-gated devices to prevent static buildup which could damage the devices.<br>(1) Precautions against the device rupture caused by static electricity<br>Static electricity of human bodies and cartons and/or excessive voltage applied across the gate to emitter may damage and rupture devices. Sense-emitter and temperature-sensor are also vulnerable to excessive voltage. The basis of anti-electrostatic is suppression of build-up and quick dissipation of the charged electricity.<br>① Containers that are susceptible to static electricity should not be used for transit or for storage.<br>② Signal terminals to emitter should be always shorted with a carbon cloth or the like until right before a module is used. Never touch the signal terminals with bare hands.<br>③ Always ground the equipment and your body during installation (after removing a carbon cloth or the like. It is advisable to cover the workstation and its surrounding floor with conductive mats and ground them.<br>④ It should be noted that devices may get damaged by the static electricity charged to a printed circuit board if the signal terminals to emitter of the circuit board are open.<br>⑤ Use soldering irons with grounded tips.<br>(2) Precautions when the signal terminals to emitter are open<br>① Voltage should not be applied across the collector to emitter when the signal terminals to emitter are open.<br>② The signal terminals to emitter should be shorted before removing a device from a unit. |

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