# 2MBI400XHA170-50

**IGBT Modules**

## Power Module (X series)
## 1700V / 400A / 2-in-1 package

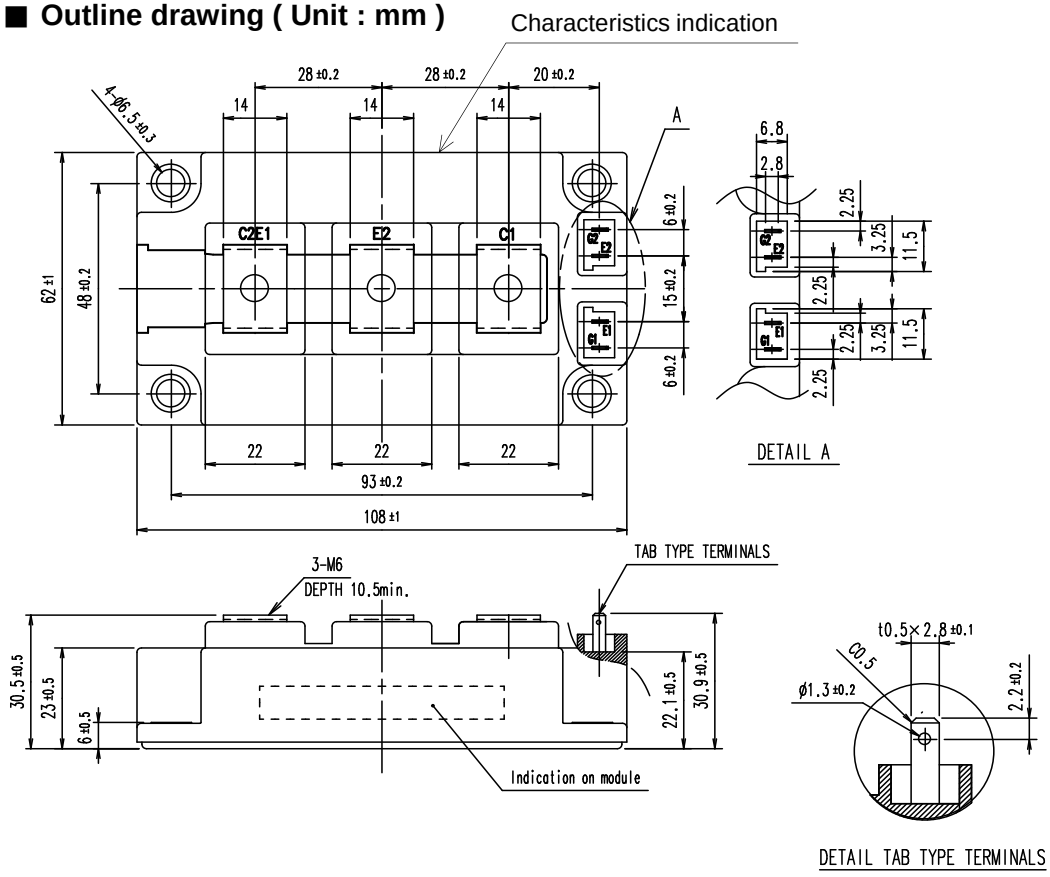
### ■ Features

Low $V_{CE(sat)}$
High speed switching
Low Inductance Module structure

### ■ Applications

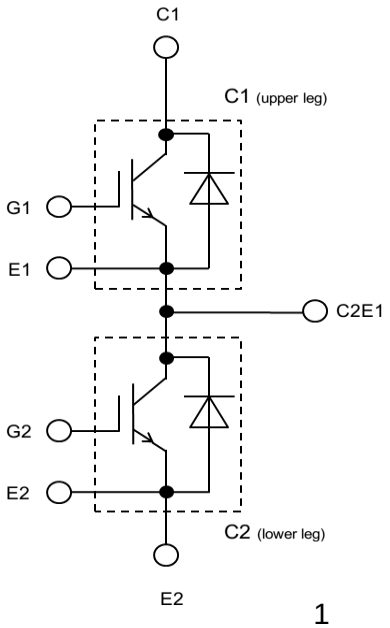
Inverter for Motor Drives, AC and DC Servo Drives
Uniterruptible Power Supply Systems,
Industrial machines,such as Welding machines

### ■ Outline drawing ( Unit : mm )




Weight: 370 g(typ.)

### ■ Equivalent Circuit






FM5F9450
2019/07

## ■ Absolute Maximum Ratings (at $T_C$= 25°C unless otherwise specified)

| Items | | Symbols | Conditions | | Maximum Ratings | Units |
|---|---|---|---|---|---|---|
| Collector-Emitter voltage, Gate-Emitter short-circuited | | $V_{CES}$ | | | 1700 | V |
| Gate-Emitter voltage, Collector-Emitter short-circuited | | $V_{GES}$ | | | ±20 | V |
| Collector current | | $I_C$ | Continuous | $T_C$=100°C | 400 | A |
| Repetitive peak collector current | | $I_{CRM}$ | 1ms | | 800 | |
| Forward current | | $I_F$ | | | 400 | |
| Repetitive peak forward current | | $I_{FRM}$ | 1ms | | 800 | |
| Total power dissipation | | $P_{tot}$ | 1 device | | 2270 | W |
| Virtual junction temperature | | $T_{vj}$ | | | 175 | °C |
| Operating virtual junction temperature | | $T_{vjop}$ | | | 175 | |
| Case temperature | | $T_c$ | | | 125 | |
| Storage temperature | | $T_{stg}$ | | | -40 ~ 125 | |
| Isolation voltage | between terminals and copper base (*1) | $V_{isol}$ | AC: 1min. | | 4000 | Vrms |
| Mounting torque of screws to heatsink (*2) | | - | M5 or M6 | | 6.0 | N·m |
| Mounting torque of screws to terminals (*2) | | | M5 | | 5.0 | |

(*1) All terminals should be connected together during the test.

(*2) Recommendable Value: Mounting 3.0 ~ 6.0 N·m (M5 or M6)

Recommendable Value: Terminals 2.5 ~ 5.0 N·m (M6)

## ■ Electrical characteristics (at $T_{vj}$= 25°C unless otherwise specified)

| | Symbols | Conditions | | Characteristics min. | Characteristics typ. | Characteristics max. | Units |
|---|---|---|---|---|---|---|---|
| Collector-Emitter cut-off current, Gate-Emitter short-circuited | $I_{CES}$ | $V_{GE}$ = 0V<br>$V_{CE}$ = 1700V | | - | - | 200 | μA |
| Gate leakage current, Collector-Emitter short-circuited | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=±20V | | - | - | 400 | nA |
| Gate-Emitter threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = 20V<br>$I_C$ = 400mA | | 6.0 | 6.5 | 7.0 | V |
| Collector-Emitter saturation voltage | $V_{CE(sat)}$ (terminal) | $V_{GE}$ = 15V<br>$I_C$= 400A | $T_{vj}$=25°C | - | 1.80 | 2.25 | V |
| | $V_{CE(sat)}$ (chip) | | $T_{vj}$=25°C | - | 1.65 | 2.10 | |
| | | | $T_{vj}$=125°C | - | 2.00 | - | |
| | | | $T_{vj}$=150°C | - | 2.10 | - | |
| | | | $T_{vj}$=175°C | - | 2.20 | - | |
| Internal Gate resistance | $r_g$ | - | | - | 2.50 | - | Ω |
| Capacitance | $C_{ies}$ | $V_{CE}$=10V, $V_{GE}$=0V, $f$=1MHz | | - | 54 | - | nF |
| | $C_{oes}$ | | | - | 1.5 | - | |
| | $C_{res}$ | | | - | 0.34 | - | |
| Gate charge | $Q_G$ | $V_{CC}$ = 900V, $I_C$ = 400A<br>$V_{GE}$ = -15 → +15V | | - | 3300 | - | nC |
| Forward voltage | $V_F$ (terminal) | $V_{GE}$ = 0V<br>$I_F$= 400A | $T_{vj}$=25°C | - | 1.85 | 2.30 | V |
| | $V_F$ (chip) | | $T_{vj}$= 25°C | - | 1.70 | 2.15 | |
| | | | $T_{vj}$=125°C | - | 1.85 | - | |
| | | | $T_{vj}$=150°C | - | 1.85 | - | |
| | | | $T_{vj}$=175°C | - | 1.80 | - | |
| Switching time (*1) | $t_{d(on)}$ | $V_{CC}$ = 900V<br>$I_C$, $I_F$ = 400A<br>$V_{GE}$ = ±15V<br>$R_G$ = 0.56 Ω<br>$L_S$ = 30 nH | $T_{vj}$= 25°C | - | 450 | - | ns |
| | | | $T_{vj}$=125°C | - | 460 | - | |
| | | | $T_{vj}$=150°C | - | 460 | - | |
| | | | $T_{vj}$=175°C | - | 465 | - | |
| | $t_r$ | | $T_{vj}$= 25°C | - | 85 | - | |
| | | | $T_{vj}$=125°C | - | 80 | - | |
| | | | $T_{vj}$=150°C | - | 75 | - | |
| | | | $T_{vj}$=175°C | - | 75 | - | |
| | $t_{d(off)}$ | | $T_{vj}$= 25°C | - | 650 | - | |
| | | | $T_{vj}$=125°C | - | 610 | - | |
| | | | $T_{vj}$=150°C | - | 600 | - | |
| | | | $T_{vj}$=175°C | - | 590 | - | |
| | $t_f$ | | $T_{vj}$= 25°C | - | 640 | - | |
| | | | $T_{vj}$=125°C | - | 670 | - | |
| | | | $T_{vj}$=150°C | - | 675 | - | |
| | | | $T_{vj}$=175°C | - | 685 | - | |
| Reverse recovery time | $t_{rr}$ | | $T_{vj}$= 25°C | - | 280 | - | |
| | | | $T_{vj}$=125°C | - | 455 | - | |
| | | | $T_{vj}$=150°C | - | 500 | - | |
| | | | $T_{vj}$=175°C | - | 580 | - | |

(*1 Turn on time ($t_{on}$) = $t_{d(on)}$+ $t_r$ , Turn off time ($t_{off}$) = $t_{d(off)}$ + $t_f$

## ■ Electrical characteristics (at $T_{vj}$= 25°C unless otherwise specified)

| Items | Symbols | Conditions | | Characteristics min. | Characteristics typ. | Characteristics max. | Units |
|---|---|---|---|---|---|---|---|
| Switching loss(per pulse) | $E_{on}$ | $V_{CC}$ = 900V<br>$I_C$, $I_F$ = 400A<br>$V_{GE}$ = ±15V<br>$R_G$ = 0.56 Ω<br>$L_S$ = 30 nH | $T_{vj}$= 25°C | - | 68.5 | - | mJ |
| | | | $T_{vj}$=125°C | - | 93.8 | - | |
| | | | $T_{vj}$=150°C | - | 102.2 | - | |
| | | | $T_{vj}$=175°C | - | 117.3 | - | |
| | $E_{off}$ | | $T_{vj}$= 25°C | - | 98.3 | - | |
| | | | $T_{vj}$=125°C | - | 135.3 | - | |
| | | | $T_{vj}$=150°C | - | 147.7 | - | |
| | | | $T_{vj}$=175°C | - | 156.6 | - | |
| | $E_{rr}$ | | $T_{vj}$= 25°C | - | 59.7 | - | |
| | | | $T_{vj}$=125°C | - | 100.2 | - | |
| | | | $T_{vj}$=150°C | - | 113.7 | - | |
| | | | $T_{vj}$=175°C | - | 127.2 | - | |

NOTICE:
The external gate resistance ($R_G$) shown above is one of our recommended value for the purpose of minimum switching loss. However the optimum $R_G$ depends on circuit configuration and/or environment. We recommend that the $R_G$ has to be carefully chosen based on consideration if IGBT module matches design criteria, for example, switching loss, EMC/EMI, spike voltage, surge current and no unexpected oscillation and so on.

## ■Thermal resistance characteristics

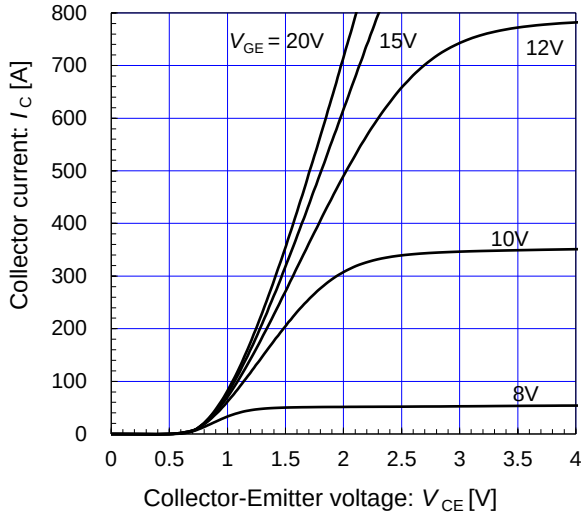
| | Symbols | Conditions | Characteristics min. | Characteristics typ. | Characteristics max. | ns |
|---|---|---|---|---|---|---|
| Thermal resistance (1device) | $R_{th(j-c)}$ | Inverter IGBT | - | - | 0.066 | K/W |
| | | Inverter FWD | - | - | 0.101 | |
| Thermal resistance case to heat sink (1IGBT + 1FWD) (*1) | $R_{th(c-s)}$ | with 1 W/(m·K) thermal grease | - | 0.0125 | - | |

(*1) This is the value which is defined mounting on the additional cooling fin with thermal compound.

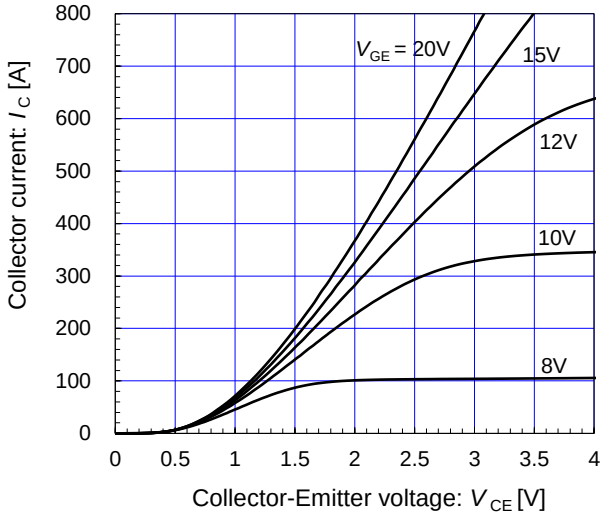
# 2MBI400XHA170-50



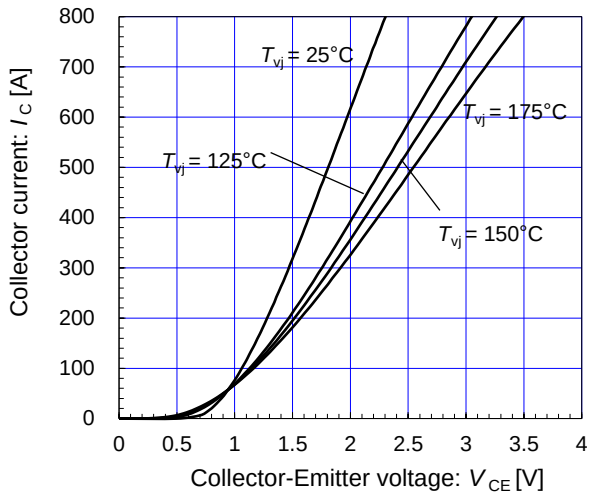
[Inverter]
Collector current vs. Collector-Emitter voltage
$T_{vj}$ = 25°C / chip



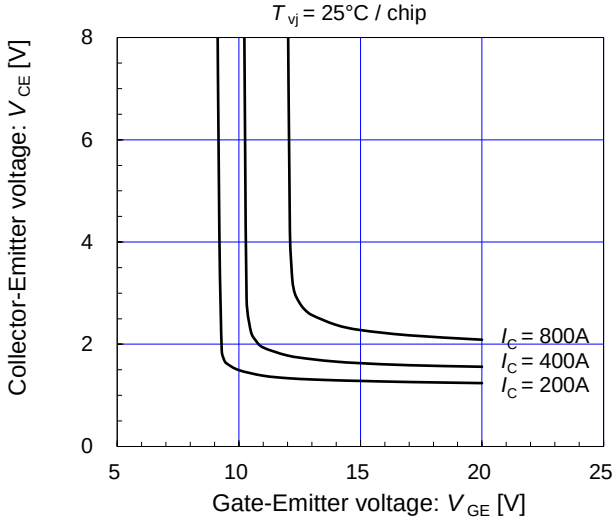

[Inverter]
Collector current vs. Collector-Emitter voltage
$T_{vj}$ = 175°C / chip



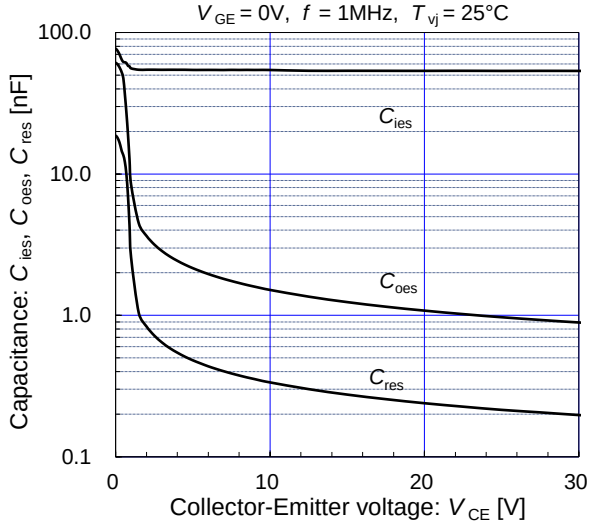

[Inverter]
Collector current vs. Collector-Emitter voltage
$V_{GE}$ = 15V / chip



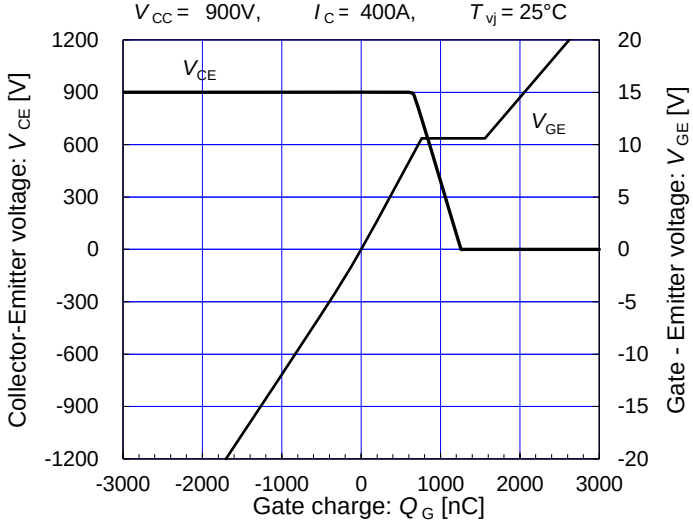

[Inverter]
Collector-Emitter voltage vs. Gate-Emitter
$T_{vj}$ = 25°C / chip




[Inverter]
Capacitance vs. Collector-Emitter Voltage
$V_{GE}$ = 0V, $f$ = 1MHz, $T_{vj}$ = 25°C



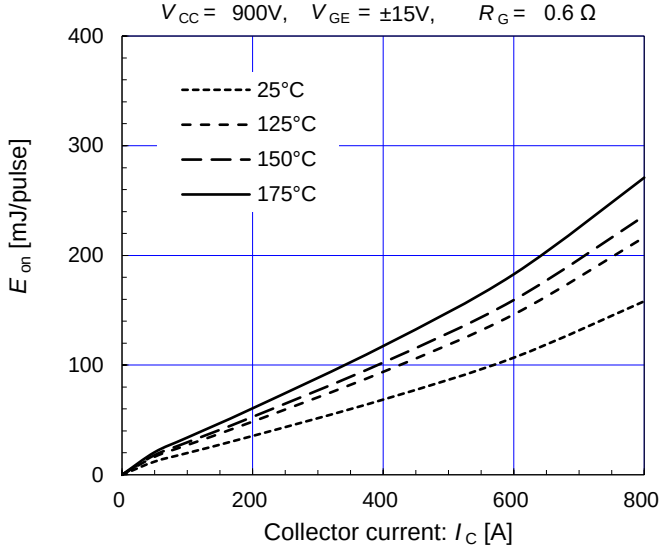

[Inverter]
Dynamic Gate Charge (typ.)
$V_{CC}$ = 900V, $I_C$ = 400A, $T_{vj}$ = 25°C



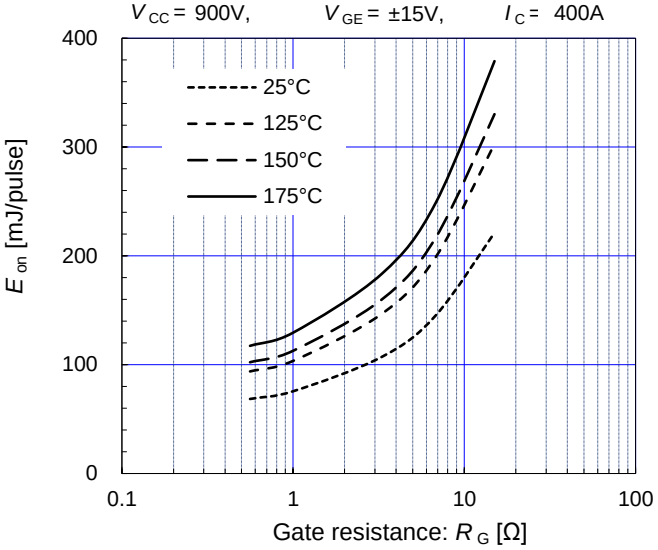
# 2MBI400XHA170-50



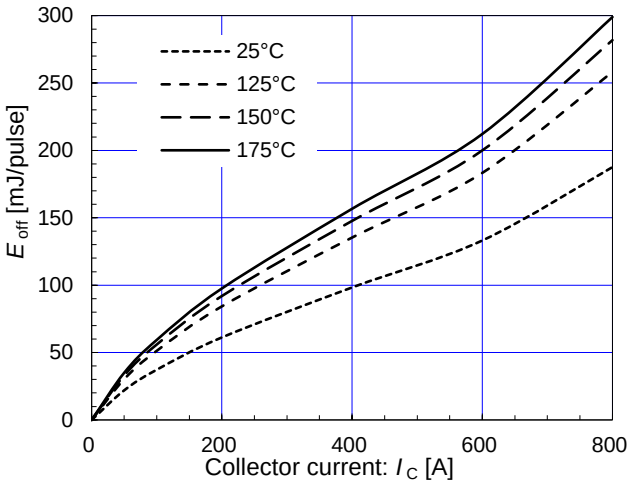
[Inverter]
$E_{on}$ vs. Collector current (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $R_G$ = 0.6 Ω



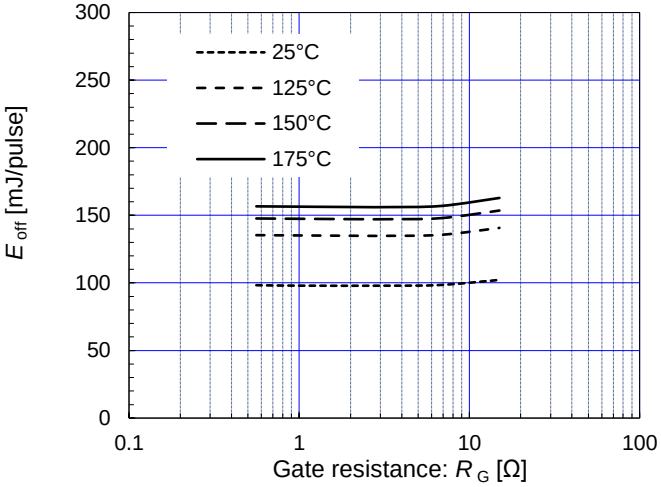

[Inverter]
$E_{on}$ vs. Gate resistance (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $I_C$ = 400A



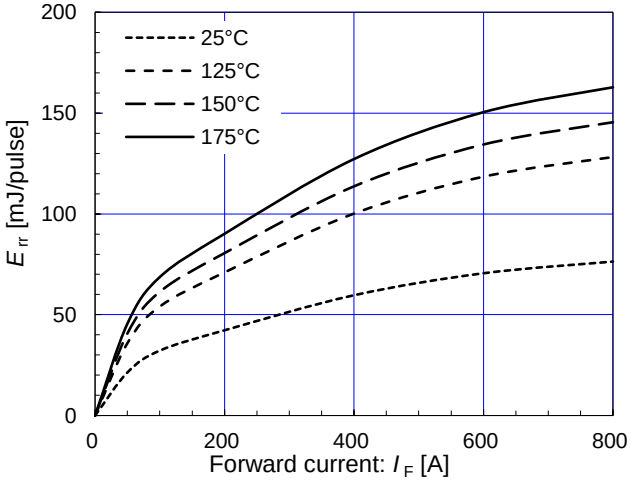

[Inverter]
$E_{off}$ vs. Collector current (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $R_G$ = 0.56 Ω



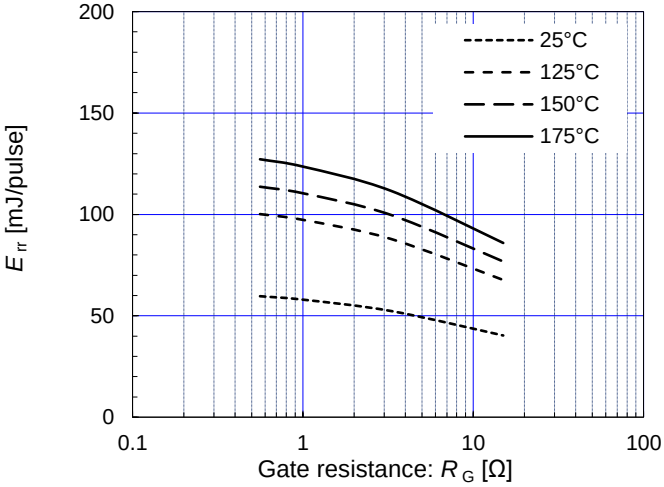

[Inverter]
$E_{off}$ vs. Gate resistance (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $I_F$ = 400A




[Inverter]
$E_{rr}$ vs. Forward current (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $R_G$ = 0.6 Ω



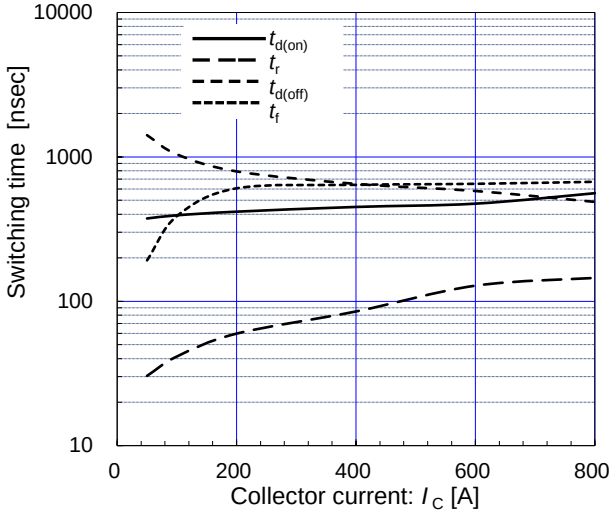

[Inverter]
$E_{rr}$ vs. Gate resistance (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $I_F$ = 400A



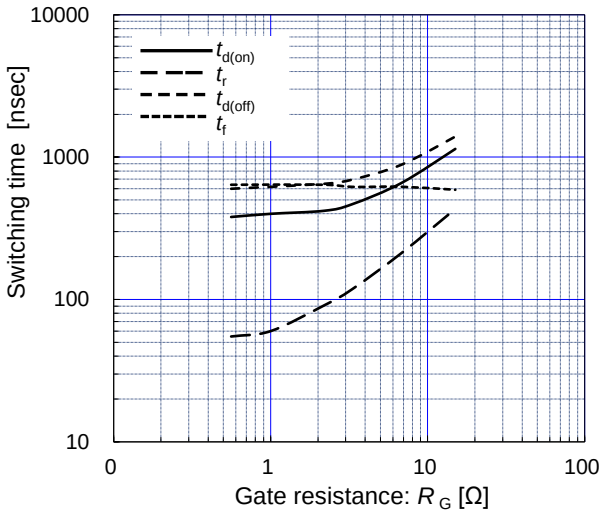
# 2MBI400XHA170-50



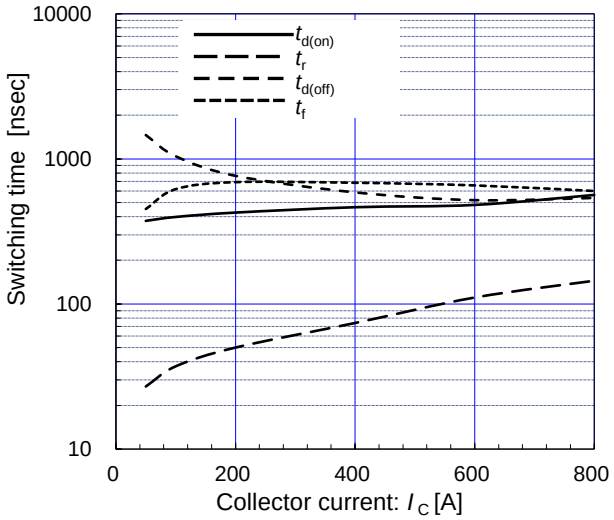
[Inverter]
Switching time vs. Collector current (typ.)
$V_{CC}$ = 900V, $R_G$ = 0.56 Ω $V_{GE}$ = ±15V, $T_{vj}$ = 25°C



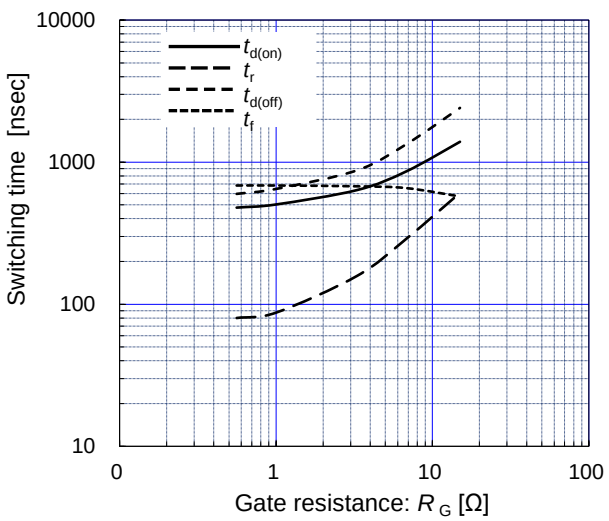

[Inverter]
Switching time vs. Gate resistance (typ.)
$V_{CC}$ = 900V, $I_C$ = 400A, $V_{GE}$ = ±15V, $T_{vj}$ = 25°C



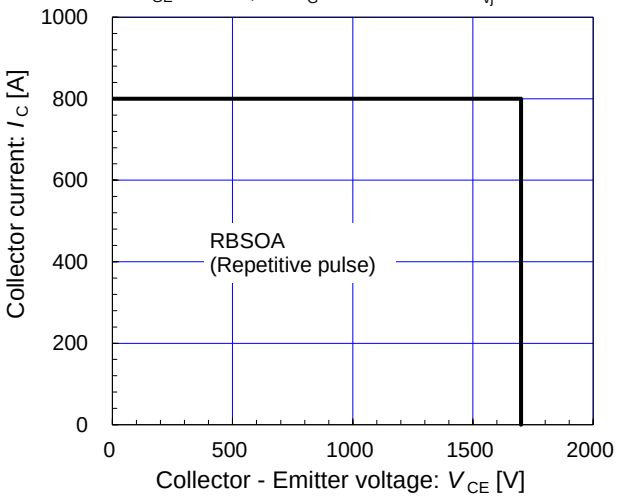

[Inverter]
Switching time vs. Collector current (typ.)
$V_{CC}$ = 900V, $R_G$ = 0.56 Ω $V_{GE}$ = ±15V, $T_{vj}$ = 175°C




[Inverter]
Switching time vs. Gate resistance (typ.)
$V_{CC}$ = 900V, $I_C$ = 400A, $V_{GE}$ = ±15V, $T_{vj}$ = 175°C



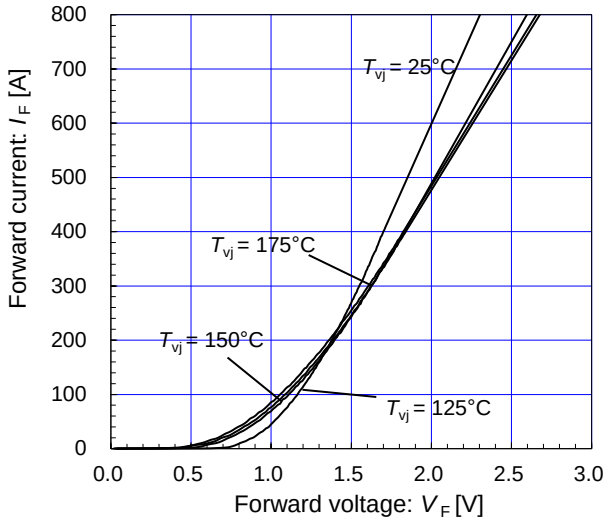

[Inverter]
Reverse bias safe operating area (max.)
$V_{GE}$ = ±15V, $R_G$ = 0.6 Ω $T_{vj}$ = 175°C



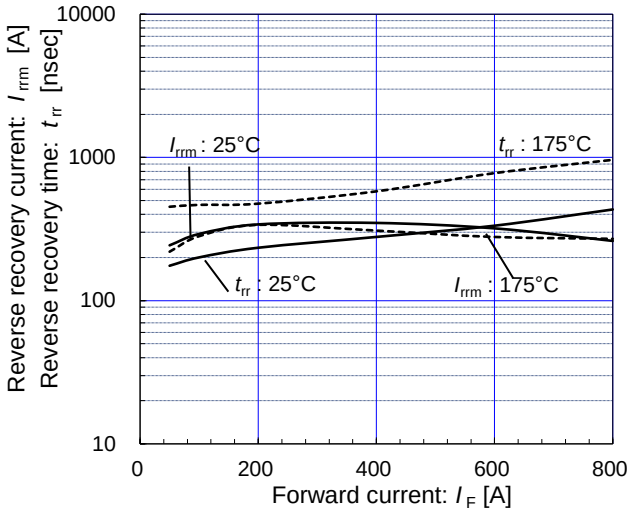
# 2MBI400XHA170-50



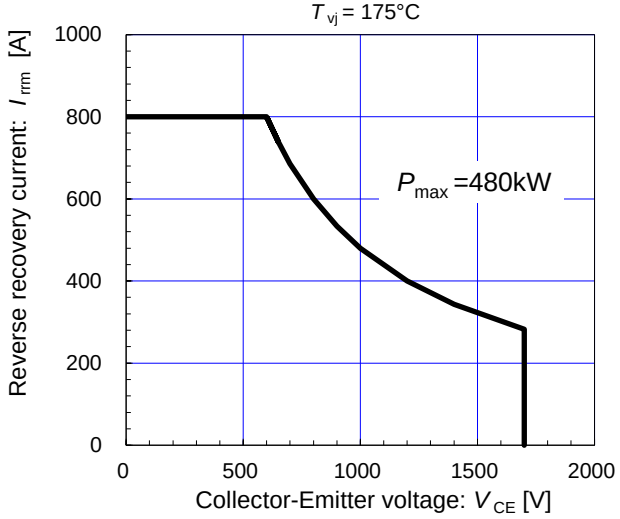
[Inverter]
Forward current vs. Forward voltage (typ.)
chip



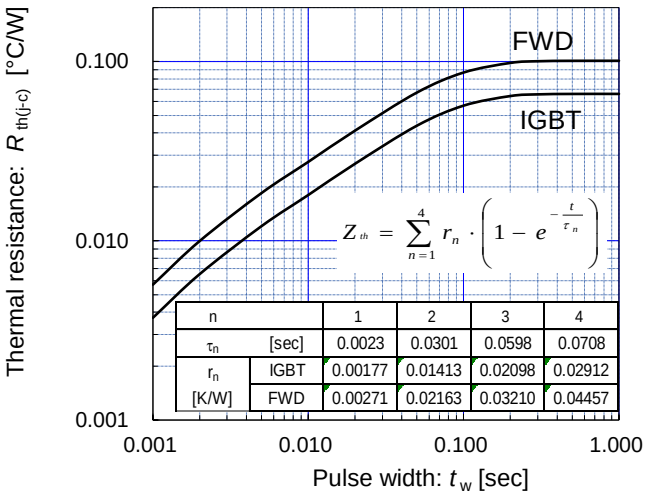

[Inverter]
Reverse recovery characteristics (typ.)
$V_{CC}$ = 900V, $V_{GE}$ = ±15V, $R_G$ = 0.6 Ω




[Inverter]
FWD safe operation area (max.)
$T_{vj}$ = 175°C




[Inverter]
Transient thermal resistance(max.)




| n | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| $\tau_n$ | [sec] | 0.0023 | 0.0301 | 0.0598 | 0.0708 |
| $r_n$ [K/W] | IGBT | 0.00177 | 0.01413 | 0.02098 | 0.02912 |
| | FWD | 0.00271 | 0.02163 | 0.03210 | 0.04457 |

# Warnings

1. This Catalog contains the product specifications, characteristics, data, materials, and structures as of 7/2019. The contents are subject to change without notice for specification changes or other reasons. When using a product listed in this Catalog, be sure to obtain the latest specifications.

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・Machine tools ・Audiovisual equipment ・Electrical home appliances ・Personal equipment ・Industrial robots etc.

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・Traffic-signal control equipment ・Gas leakage detectors with an auto-shut-off feature
・Emergency equipment for responding to disasters and anti-burglary devices ・Safety devices ・Medical equipment

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7. 

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