## Possible IGBT Snubber Capacitors

| Mitsubishi IGBT Type | RS Part Numbers | Suggested ICEL Snubber | Value Cn | Image (not to scale) | RS Part Numbers |
|---|---|---|---|---|---|
| **CM450DY-24T#300G** | 207-4970<br>207-4971 | **PMB2123390KSPB** | 0.39uF | | **207-4991** (low qty) and **207-4990** (higher qty)<br>https://uk.rs-online.com/web/cp/2074990,2074991/?pst=PMB2123390KSPB |
|  | | **PMB2123560KSP** | 0.56uF |  | **207-4993** (low qty) and **207-4992** (higher qty)<br>https://uk.rs-online.com/web/cp/2074992,2074993/?pst=PMB2123560KSP |
| | | **PMB2124100KSP** | 1.0uF | | **207-4995** (low qty) and **207-4994** (higher qty)<br>https://uk.rs-online.com/web/cp/2074994,2074995/?pst=PMB2124100KSP&sra=p&r=t |
| | | **PMB2124150KSP** | 1.5uF | Direct screw mounting onto IGBT modules or busbars.<br>Available for all main manufacturers IGBT packages. | **207-4998** (low qty) and **207-4997** (higher qty)<br>https://uk.rs-online.com/web/cp/2074997,2074998/?pst=PMB2124150KSP&sra=p&r=t |

**POLYPROPYLENE FILM CAPACITORS**

**Features**

Polypropylene film capacitors have superior electrical characteristics;
Low dissipation factor and absorption.
Very high insulation resistance and high dielectric strength.
Excellent moisture resistance.
Good long-term stability and excellent self-healing properties.

**Typical Applications**

Polypropylene film capacitors are typically used in AC and pulse applications at high frequencies and as DC-Link capacitors.
They are further used in switched mode power supplies (SMPS), electronic ballasts and snubber applications, in frequency discrimination and filter circuits as well as in energy storage and sample and hold applications.

**Suggested types are for Information and guidance only. Clients must select and verify parts for their own operating conditions and applcations.**

**CONTINUE FOR IGBT DATA SHEET**

MITSUBISHI ELECTRIC

<IGBT Modules>

# CM450DY-24T

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

dual switch (half-bridge)

Collector current $I_C$ ....................................... 4 5 0 A

Collector-emitter voltage $V_{CES}$ .................. 1 2 0 0 V

Maximum junction temperature $T_{vjmax}$ ......... 1 7 5 °C

- ●Flat base type
- ●Nickel-plating tab terminals
- ●RoHS Directive compliant
- ●UL Recognized under UL1557, File No.E323585

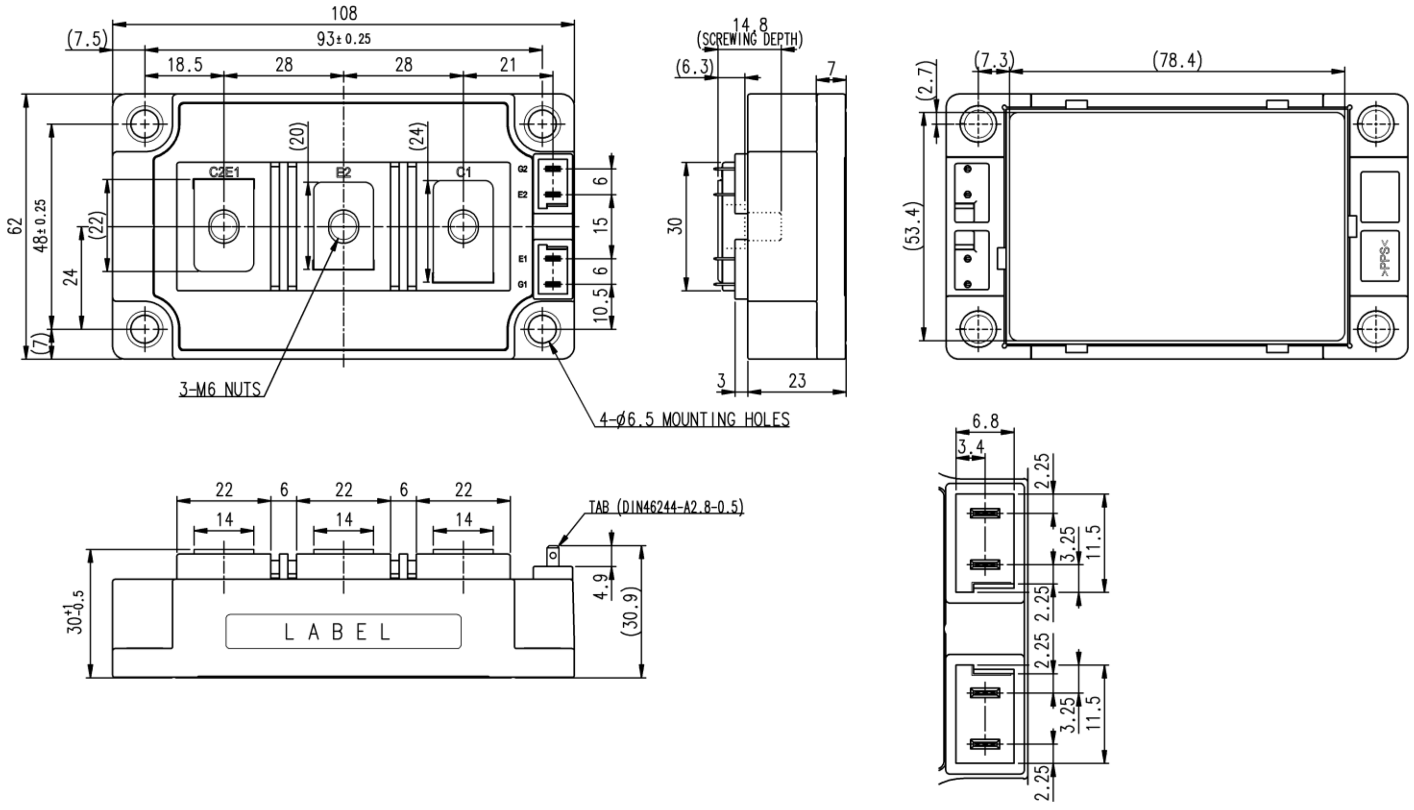
**APPLICATION**

AC Motor Control, Motion/Servo Control, Power supply, etc.

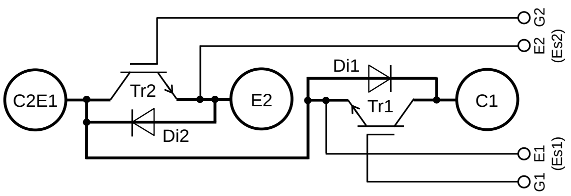
**OPTION** (Below options are available.)

- ●PC-TIM (Phase Change Thermal Interface Material) pre-apply (Note8)
- ●$V_{CEsat}$ selection for parallel connection

**OUTLINE DRAWING & INTERNAL CONNECTION** **Dimension in mm**




INTERNAL CONNECTION




Tolerance otherwise specified

| Division of Dimension | | | Tolerance |
|---|---|---|---|
| | 0.5 | to 3 | ±0.2 |
| over | 3 | to 6 | ±0.3 |
| over | 6 | to 30 | ±0.5 |
| over | 30 | to 120 | ±0.8 |
| over | 120 | to 400 | ±1.2 |

JIS B 0405 c

## MAXIMUM RATINGS ($T_{vj}$=25 °C, unless otherwise specified)

| Symbol | Item | Conditions | Rating | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage | G-E short-circuited | 1200 | V |
| $V_{GES}$ | Gate-emitter voltage | C-E short-circuited | ± 20 | V |
| $I_C$ | Collector current | DC, $T_C$=145 °C* (Note2, 4) | 450 | A |
| $I_{CRM}$ | | Pulse, Repetitive (Note3) | 900 | |
| $P_{tot}$ | Total power dissipation | $T_C$=25 °C (Note2, 4) | 4835 | W |
| $I_E$ (Note1) | Emitter current | DC (Note2) | 450 | A |
| $I_{ERM}$ (Note1) | | Pulse, Repetitive (Note3) | 900 | |
| $V_{isol}$ | Isolation voltage | Terminals to base plate, RMS, f=60 Hz, AC 1 min | 4000 | V |
| $T_{vjmax}$ | Maximum junction temperature | Instantaneous event (overload) (Note8) | 175 | °C |
| $T_{Cmax}$ | Maximum case temperature | (Note4,8) | 150* | |
| $T_{vjop}$ | Operating junction temperature | Continuous operation (under switching) (Note8) | -40 ~ +150 | °C |
| $T_{stg}$ | Storage temperature | - | -40 ~ +150* | |

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

| Symbol | Item | Conditions | | Limits Min. | Limits Typ. | Limits Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CES}$ | Collector-emitter cut-off current | $V_{CE}$=$V_{CES}$, G-E short-circuited | | - | - | 1.0 | mA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{GE}$=$V_{GES}$, C-E short-circuited | | - | - | 0.5 | μA |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $I_C$=45 mA, $V_{CE}$=10 V | | 5.4 | 6.0 | 6.6 | V |
| $V_{CEsat}$ (Terminal) | Collector-emitter saturation voltage | $I_C$=450 A, $V_{GE}$=15 V, Refer to the figure of test circuit (Note5) | $T_{vj}$=25 °C | - | 1.70 | 2.00 | V |
| | | | $T_{vj}$=125 °C | - | 1.95 | - | |
| | | | $T_{vj}$=150 °C | - | 2.00 | - | |
| $V_{CEsat}$ (Chip) | | $I_C$=450 A, $V_{GE}$=15 V, (Note5) | $T_{vj}$=25 °C | - | 1.55 | 1.80 | V |
| | | | $T_{vj}$=125 °C | - | 1.75 | - | |
| | | | $T_{vj}$=150 °C | - | 1.80 | - | |
| $C_{ies}$ | Input capacitance | $V_{CE}$=10 V, G-E short-circuited | | - | - | 92.3 | nF |
| $C_{oes}$ | Output capacitance | | | - | - | 2.7 | |
| $C_{res}$ | Reverse transfer capacitance | | | - | - | 1.1 | |
| $Q_G$ | Gate charge | $V_{CC}$=600 V, $I_C$=450 A, $V_{GE}$=15 V | | - | 3.0 | - | μC |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$=600 V, $I_C$=450 A, $V_{GE}$=±15 V, $R_G$=1.0 Ω, Inductive load | | - | - | 500 | ns |
| $t_r$ | Rise time | | | - | - | 200 | |
| $t_{d(off)}$ | Turn-off delay time | | | - | - | 600 | |
| $t_f$ | Fall time | | | - | - | 300 | |
| $V_{EC}$ (Note.1) (Terminal) | Emitter-collector voltage | $I_E$=450 A, G-E short-circuited, Refer to the figure of test circuit (Note5) | $T_{vj}$=25 °C | - | 1.80 | 2.20 | V |
| | | | $T_{vj}$=125 °C | - | 1.95 | - | |
| | | | $T_{vj}$=150 °C | - | 1.95 | - | |
| $V_{EC}$ (Note.1) (Chip) | | $I_E$=450 A, G-E short-circuited, (Note5) | $T_{vj}$=25 °C | - | 1.65 | 2.00 | V |
| | | | $T_{vj}$=125 °C | - | 1.65 | - | |
| | | | $T_{vj}$=150 °C | - | 1.65 | - | |
| $t_{rr}$ (Note1) | Reverse recovery time | $V_{CC}$=600 V, $I_E$=450 A, $V_{GE}$=±15 V, $R_G$=1.0 Ω, Inductive load | | - | - | 400 | ns |
| $Q_{rr}$ (Note1) | Reverse recovery charge | | | - | 45 | - | μC |
| $E_{on}$ | Turn-on switching energy per pulse | $V_{CC}$=600 V, $I_C$=$I_E$=450 A, $V_{GE}$=±15 V, $R_G$=1.0 Ω, $T_{vj}$=150 °C, Inductive load | | - | 40.9 | - | mJ |
| $E_{off}$ | Turn-off switching energy per pulse | | | - | 47 | - | |
| $E_{rr}$ (Note1) | Reverse recovery energy per pulse | | | - | 31.6 | - | mJ |
| $R_{CC'+EE'}$ | Internal lead resistance | Main terminals-chip, per switch, $T_C$=25 °C (Note4) | | - | 0.3 | - | mΩ |
| $r_g$ | Internal gate resistance | Per switch | | - | 1.0 | - | Ω |

*: The value of PC-TIM applied module is limited by the heat resistant temperature of PC-TIM.

## THERMAL RESISTANCE CHARACTERISTICS

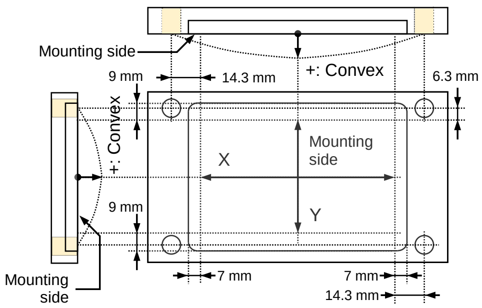
| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to case, per Inverter IGBT (Note4) | | - | - | 31 | K/kW |
| $R_{th(j-c)D}$ | | Junction to case, per Inverter FWD (Note4) | | - | - | 54 | |
| $R_{th(c-s)}$ | Contact thermal resistance | Case to heat sink, per 1 module | Thermal grease applied (Note4,6,8) | - | 13.3 | - | K/kW |

## MECHANICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $M_t$ | Mounting torque | Main terminals | M 6 screw | 3.5 | 4.0 | 4.5 | N·m |
| $M_s$ | Mounting torque | Mounting to heat sink | M 6 screw | 3.5 | 4.0 | 4.5 | N·m |
| $d_s$ | Creepage distance | Terminal to terminal | | 17.3 | - | - | mm |
| | | Terminal to base plate | | 25.3 | - | - | |
| $d_a$ | Clearance | Terminal to terminal | | 12.6 | - | - | mm |
| | | Terminal to base plate | | 21.8 | - | - | |
| $e_c$ | Flatness of base plate | On the centerline X, Y (Note7) | | ±0 | - | +200 | μm |
| m | mass | - | | - | 260 | - | g |

*: This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/ 2011/65/EU and (EU) 2015/863.EU.

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).
2. Junction temperature ($T_{vj}$) should not increase beyond $T_{vjmax}$ rating.
3. Pulse width and repetition rate should be such that the device junction temperature ($T_{vj}$) dose not exceed $T_{vjmax}$ rating.
4. Case temperature ($T_C$) and heat sink temperature ($T_S$) are defined on the each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.
5. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.
6. Typical value is measured by using thermally conductive grease of λ=3.0W/(m·K)/$D_{(C-S)}$=50 μm.
7. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



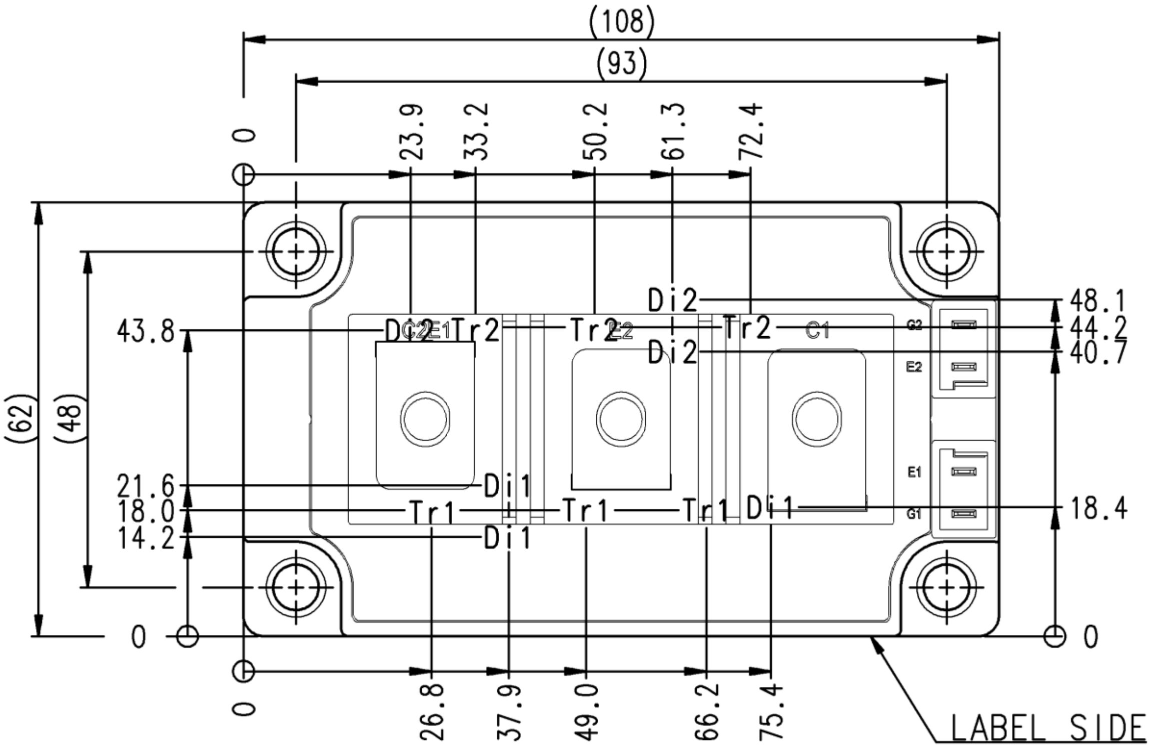

8. Long term performance related to thermal conductive grease and PC-TIM (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Each temperature condition ($T_{vj\,max}$, $T_{vj\,op}$, $T_{C\,max}$) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{CC}$ | (DC) Supply voltage | Applied across C1-E2 terminals | - | 600 | 850 | V |
| $V_{GEon}$ | Gate (-emitter drive) voltage | Applied across G1-Es1/G2-Es2 terminals | 13.5 | 15.0 | 16.5 | V |
| $R_G$ | External gate resistance | Per switch | 1.0 | - | 10 | Ω |

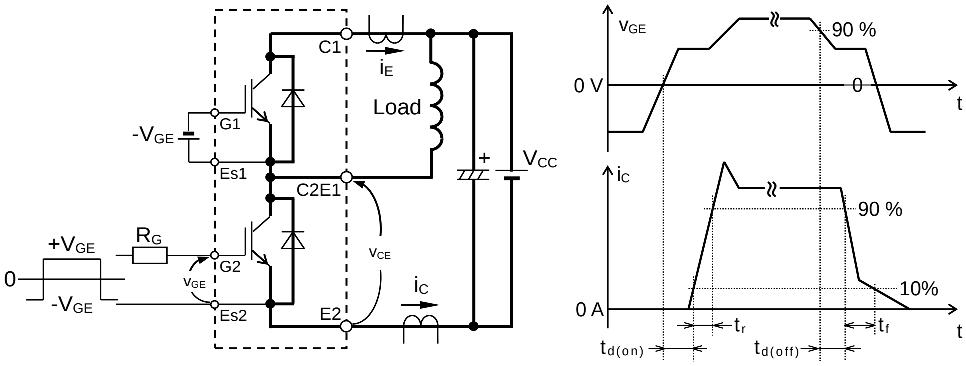
**CHIP LOCATION (Top view)**

Dimension in mm, tolerance: ±1 mm

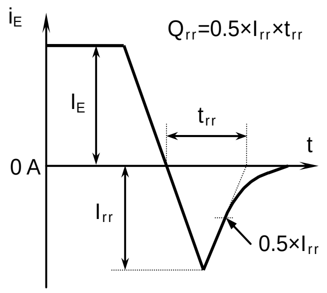



Tr1/Tr2: IGBT, Di1/Di2: FWD

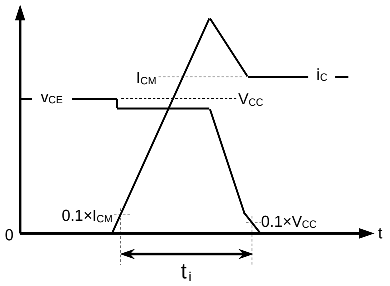
## TEST CIRCUIT AND WAVEFORMS



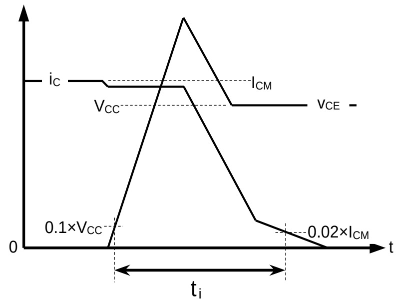

Switching characteristics test circuit and waveforms



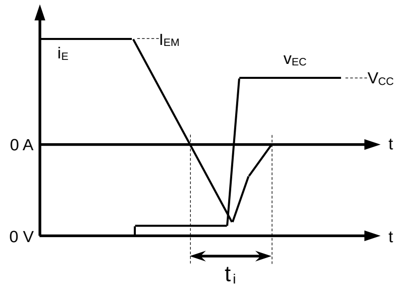

$t_{rr}$, $Q_{rr}$ characteristics test waveform




IGBT Turn-on switching energy



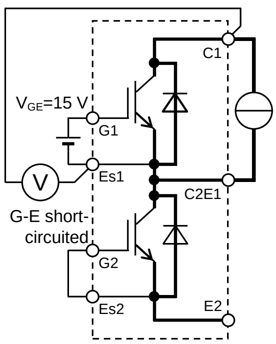

IGBT Turn-off switching energy



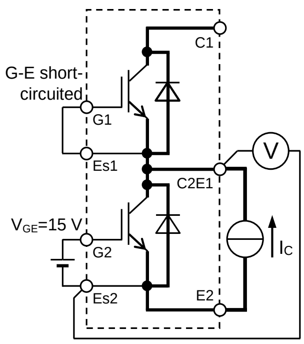

FWD Reverse recovery energy

Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

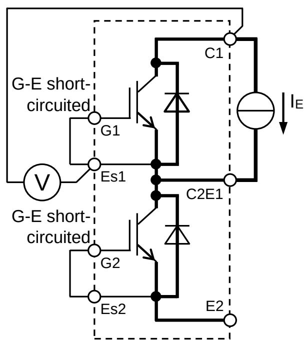



Tr1

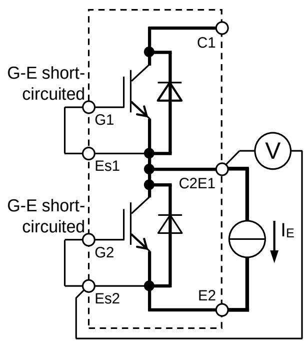



Tr2

$V_{CEsat}$ characteristics test circuit




Di1

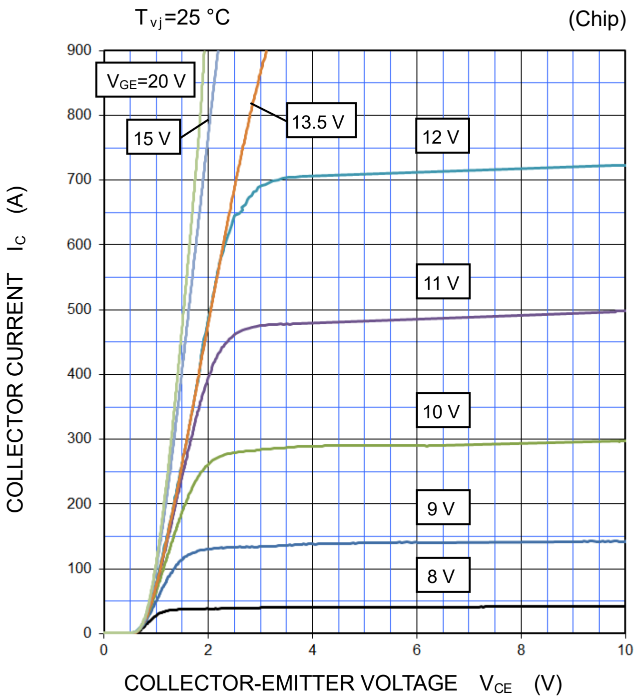



Di2

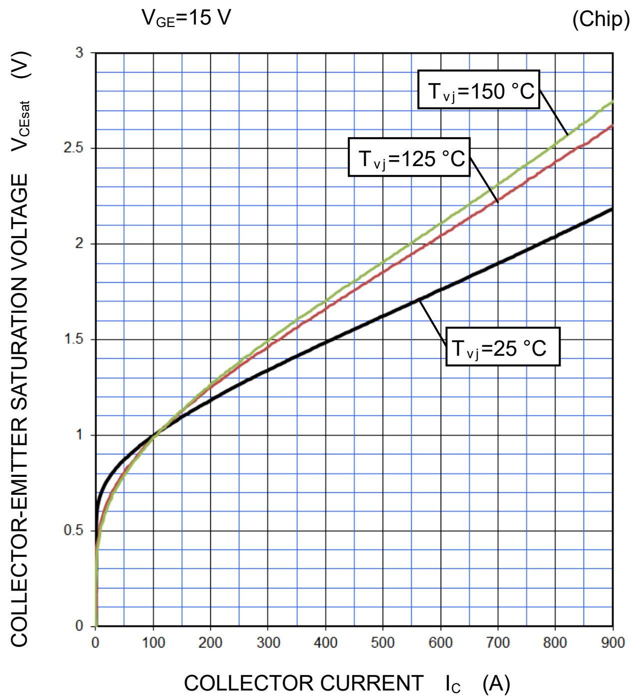
$V_{EC}$ characteristics test circuit

## PERFORMANCE CURVES

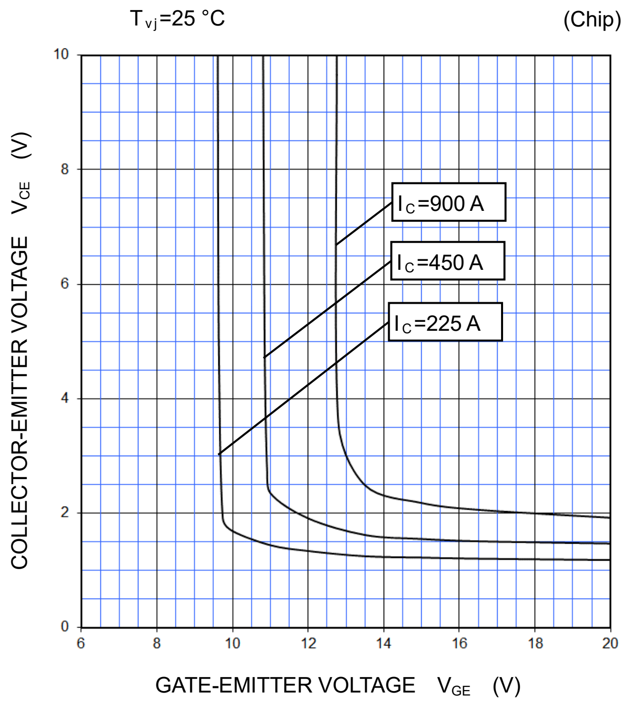
**OUTPUT CHARACTERISTICS (TYPICAL)**



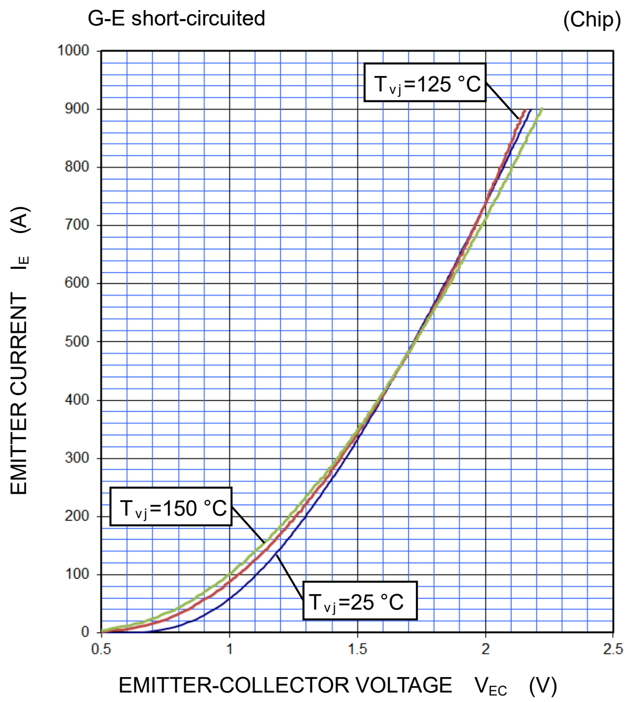

**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**




**COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS (TYPICAL)**



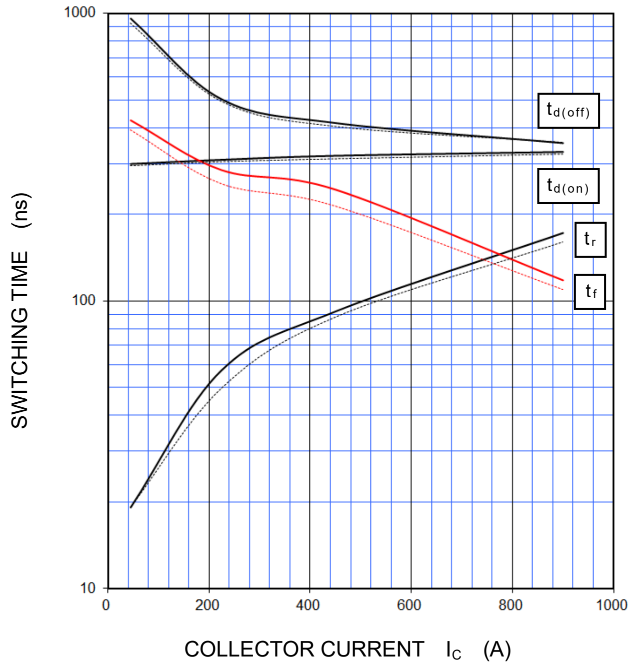

**FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)**



## PERFORMANCE CURVES

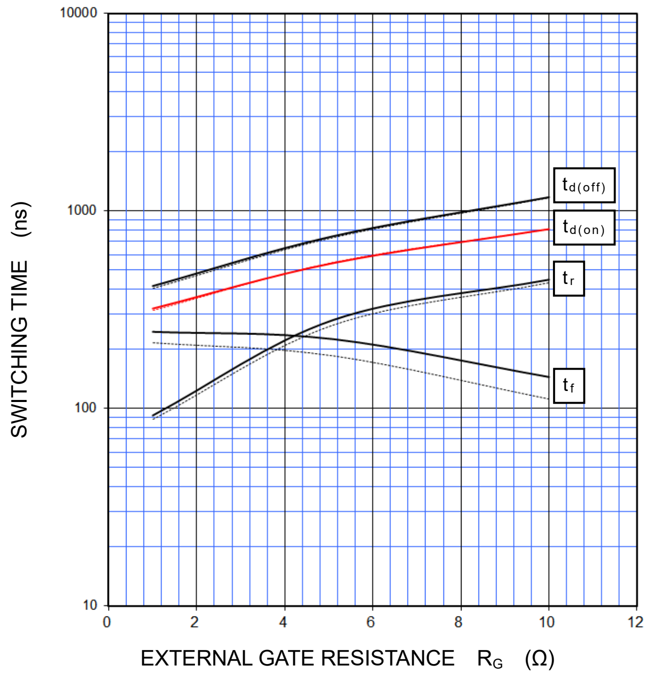
### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=1.0 Ω, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



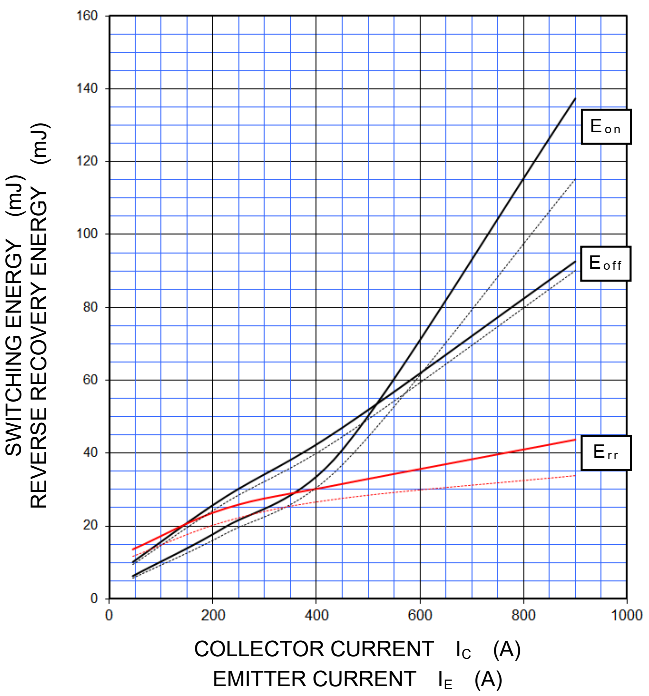

### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $I_C$=450 A, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



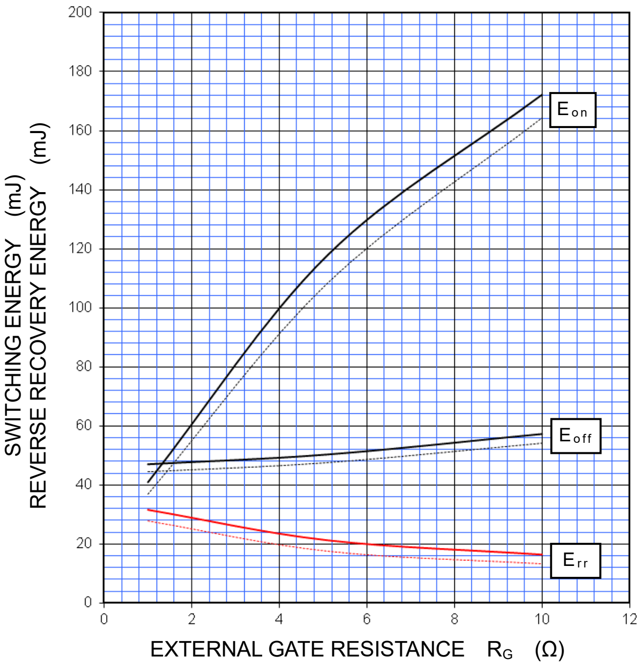

### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=1.0 Ω, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C




### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

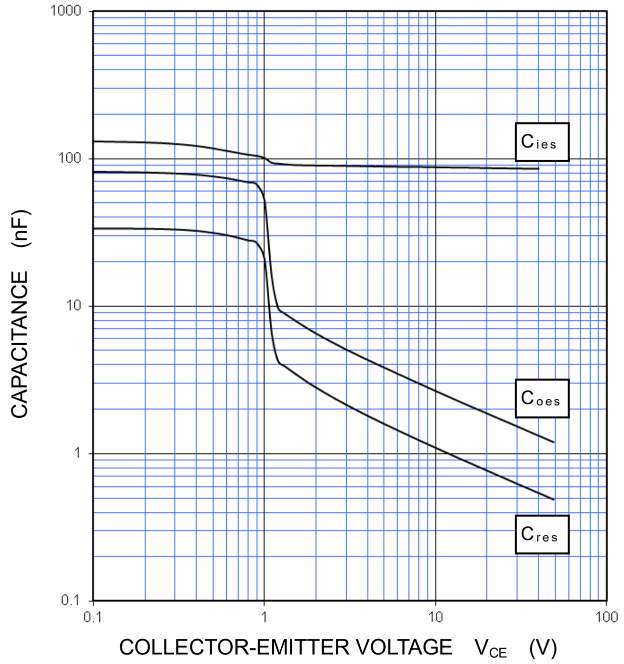
$V_{CC}$=600 V, $V_{GE}$=±15 V, $I_C$=450 A, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



## PERFORMANCE CURVES

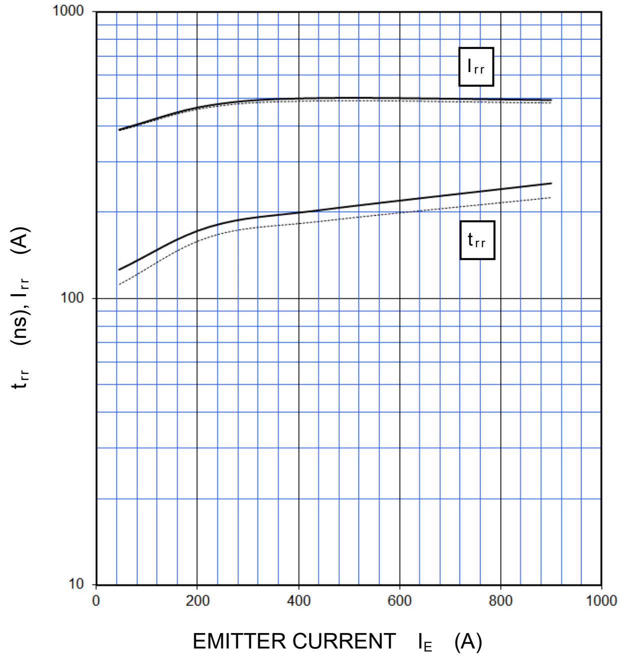
### CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, $T_{vj}$=25 °C



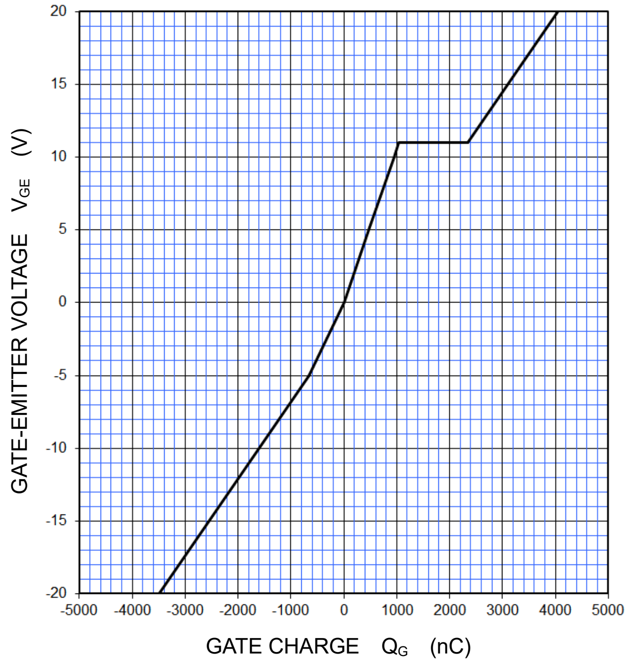

### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=1.0 Ω, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



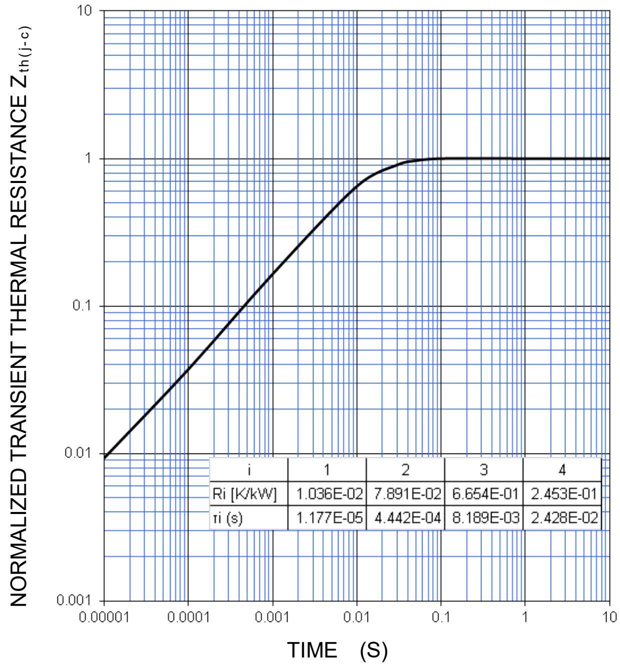

### GATE CHARGE CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $I_C$=450 A, $T_{vj}$=25 °C




### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, $T_C$=25 °C
$R_{th(j-c)Q}$=31 K/kW, $R_{th(j-c)D}$=54 K/kW

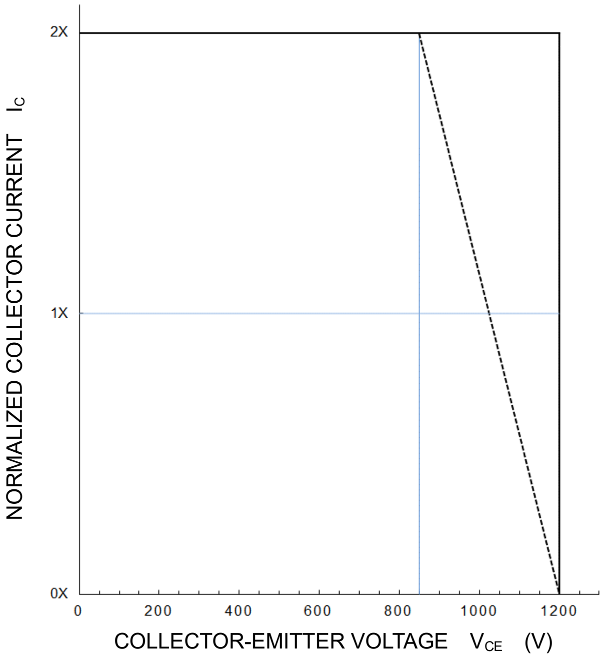



| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ri [K/kW] | 1.036E-02 | 7.891E-02 | 6.654E-01 | 2.453E-01 |
| τi (s) | 1.177E-05 | 4.442E-04 | 8.189E-03 | 2.428E-02 |

## PERFORMANCE CURVES

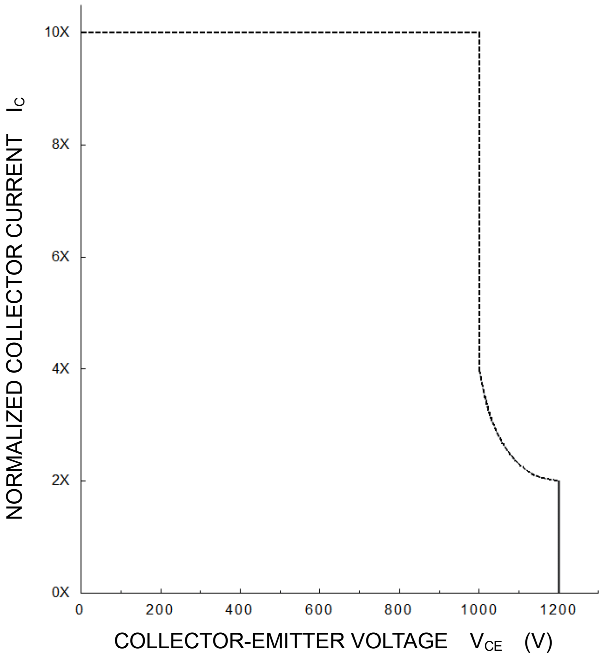
**TURN-OFF SWITCHING SAFE OPERATING AREA (REVERSE BIAS SAFE OPERATING AREA) (MAXIMUM)**

$V_{CC}$≤850 V, $V_{GE}$=±15 V, $R_G$=1.0~10 Ω,
———: $T_{vj}$=25~150 °C (Normal load operations (Continuous)
- - - - - -: $T_{vj}$=175 °C (Unusual load operations (Limited period)




**SHORT-CIRCUIT SAFE OPERATING AREA (MAXIMUM)**

$V_{CC}$≤800 V, $V_{GE}$=±15 V, $R_G$=1.0~10 Ω,
$T_{vj}$= 25 ~ 150 °C, $t_W$≤8 μs, Non-Repetitive




Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

## Important Notice

The information contained in this datasheet shall in no event be regarded as a guarantee of conditions or characteristics. This product has to be used within its specified maximum ratings, and is subject to customer's compliance with any applicable legal requirement, norms and standards.

Except as otherwise explicitly approved by Mitsubishi Electric Corporation in a written document signed by authorized representatives of Mitsubishi Electric Corporation, our products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

In usage of power semiconductor, there is always the possibility that trouble may occur with them by the reliability lifetime such as Power Cycle, Thermal Cycle or others, or when used under special circumstances (e.g. condensation, high humidity, dusty, salty, highlands, environment with lots of organic matter / corrosive gas / explosive gas, or situations which terminals of semiconductor products receive strong mechanical stress). Therefore, please pay sufficient attention to such circumstances. Further, depending on the technical requirements, our semiconductor products may contain environmental regulation substances, etc. If there is necessity of detailed confirmation, please contact our nearest sales branch or distributor.

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## Keep safety first in your circuit designs!

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