MITSUBISHI ELECTRIC

<IGBT Modules>

# CM1400HA-24S

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

**single pack**

Collector current $I_C$ ..... **1 4 0 0** A
Collector-emitter voltage $V_{CES}$ ..... **1 2 0 0** V
Maximum junction temperature $T_{vjmax}$ ..... **1 7 5** °C

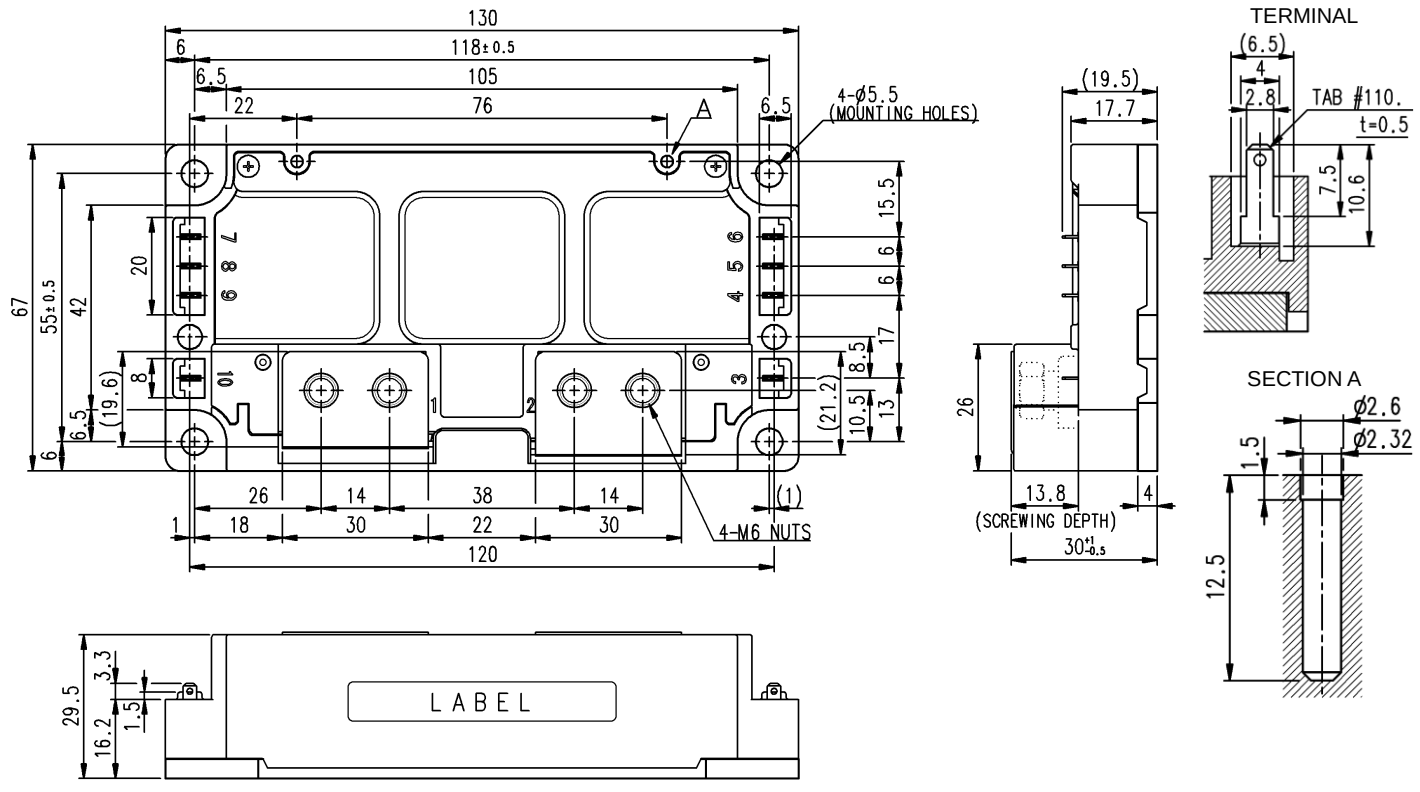
- ●Flat base Type
- ●Copper base plate
- ●Tin plating tab terminals
- ●RoHS Directive compliant
- ●Recognized under UL1557, File E323585

APPLICATION

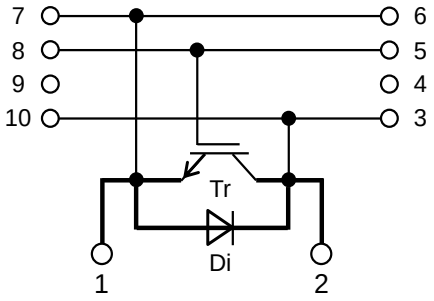
AC Motor Control, Motion/Servo Control, Power supply, Photovoltaic power, Wind power, etc.

OUTLINE DRAWING & INTERNAL CONNECTION

**Dimension in mm**




INTERNAL CONNECTION




Terminal code

1: E
2: C
3: $C_S$
4: NC
5: G
6: $E_S$
7: $E_S$
8: G
9: NC
10: $C_S$

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 |
| over 400 | to 1000 | ±2.0 |
| over 1000 | to 2000 | ±3.0 |
| over 2000 | to 4000 | ±4.0 |

# CM1400HA-24S

HIGH POWER SWITCHING USE
INSULATED TYPE

**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, $T_C$=94 °C (Note2, 4) | 1400 | A |
| $I_{CRM}$ | | Pulse, Repetitive (Note3) | 2800 | |
| $P_{tot}$ | Total power dissipation | $T_C$=25 °C (Note2, 4) | 7140 | W |
| $I_E$ (Note1) | Emitter current | DC (Note2) | 1400 | A |
| $I_{ERM}$ (Note1) | | Pulse, Repetitive (Note3) | 2800 | |
| $V_{isol}$ | Isolation voltage | Terminals to base plate, RMS, f=60 Hz, AC 1 min | 4000 | V |
| $T_{vjmax}$ | Maximum junction temperature | Instantaneous event (overload) | 175 | °C |
| $T_{Cmax}$ | Maximum case temperature | (Note4) | 125 | |
| $T_{vjop}$ | Operating junction temperature | Continuous operation (under switching) | -40 ~ +150 | °C |
| $T_{stg}$ | Storage temperature | - | -40 ~ +125 | |

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

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $I_{CES}$ | 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 | $I_C$=140 mA, $V_{CE}$=10 V | | 5.4 | 6.0 | 6.6 | V |
| $V_{CEsat}$ (Terminal) | Collector-emitter saturation voltage | $I_C$=1400 A, $V_{GE}$=15 V, Refer to the figure of test circuit (Note5) | $T_{vj}$=25 °C | - | 1.90 | 2.35 | V |
| | | | $T_{vj}$=125 °C | - | 2.10 | - | |
| | | | $T_{vj}$=150 °C | - | 2.20 | - | |
| $V_{CEsat}$ (Chip) | | $I_C$=1400 A, $V_{GE}$=15 V, (Note5) | $T_{vj}$=25 °C | - | 1.80 | 2.25 | V |
| | | | $T_{vj}$=125 °C | - | 2.00 | - | |
| | | | $T_{vj}$=150 °C | - | 2.10 | - | |
| $C_{ies}$ | Input capacitance | $V_{CE}$=10 V, G-E short-circuited | | - | - | 125 | nF |
| $C_{oes}$ | Output capacitance | | | - | - | 25 | |
| $C_{res}$ | Reverse transfer capacitance | | | - | - | 2.1 | |
| $Q_G$ | Gate charge | $V_{CC}$=600 V, $I_C$=1400 A, $V_{GE}$=15 V | | - | 2.9 | - | μC |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$=600 V, $I_C$=1400 A, $V_{GE}$=±15 V, $R_G$=0 Ω, Inductive load | | - | - | 600 | ns |
| $t_r$ | Rise time | | | - | - | 300 | |
| $t_{d(off)}$ | Turn-off delay time | | | - | - | 600 | |
| $t_f$ | Fall time | | | - | - | 300 | |
| $V_{EC}$ (Note.1) (Terminal) | Emitter-collector voltage | $I_E$=1400 A, G-E short-circuited, Refer to the figure of test circuit (Note5) | $T_{vj}$=25 °C | - | 1.85 | 2.30 | V |
| | | | $T_{vj}$=125 °C | - | 1.90 | - | |
| | | | $T_{vj}$=150 °C | - | 1.90 | - | |
| $V_{EC}$ (Note.1) (Chip) | | $I_E$=1400 A, G-E short-circuited, (Note5) | $T_{vj}$=25 °C | - | 1.75 | 2.20 | V |
| | | | $T_{vj}$=125 °C | - | 1.80 | - | |
| | | | $T_{vj}$=150 °C | - | 1.80 | - | |
| $t_{rr}$ (Note1) | Reverse recovery time | $V_{CC}$=600 V, $I_E$=1400 A, $V_{GE}$=±15 V, $R_G$=0 Ω, Inductive load | | - | - | 300 | ns |
| $Q_{rr}$ (Note1) | Reverse recovery charge | | | - | 150 | - | μC |
| $E_{on}$ | Turn-on switching energy per pulse | $V_{CC}$=600 V, $I_C$=$I_E$=1400 A, $V_{GE}$=±15 V, $R_G$=0 Ω, $T_{vj}$=150 °C, Inductive load | | - | 181 | - | mJ |
| $E_{off}$ | Turn-off switching energy per pulse | | | - | 161 | - | |
| $E_{rr}$ (Note1) | Reverse recovery energy per pulse | | | - | 104 | - | mJ |
| $R_{CC'+EE'}$ | Internal lead resistance | Main terminals-chip, $T_C$=25 °C (Note4) | | - | 0.2 | - | mΩ |
| $r_g$ | Internal gate resistance | - | | - | 2.2 | - | Ω |

## THERMAL RESISTANCE CHARACTERISTICS

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to case, IGBT (Note4) | - | - | 21 | K/kW |
| $R_{th(j-c)D}$ | | Junction to case, FWD (Note4) | - | - | 32 | |
| $R_{th(c-s)}$ | Contact thermal resistance | Case to heat sink, Thermal grease applied (Note4, 6) | - | 18 | - | K/kW |

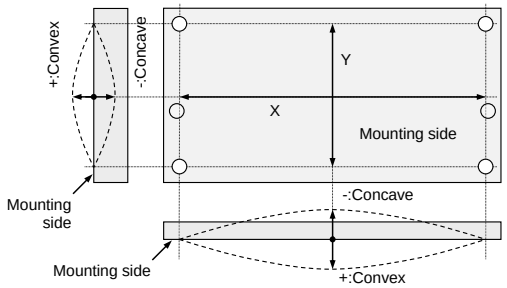
## MECHANICAL CHARACTERISTICS

| 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 5 screw | 2.5 | 3.0 | 3.5 | N·m |
| $d_s$ | Creepage distance | Terminal to terminal | 22.0 | - | - | mm |
| | | Terminal to base plate | 21.9 | - | - | |
| $d_a$ | Clearance | Terminal to terminal | 16.5 | - | - | mm |
| | | Terminal to base plate | 12.5 | - | - | |
| $e_c$ | Flatness of base plate | On the centerline X, Y (Note7) | -50 | - | +100 | μm |
| m | mass | - | - | 490 | - | g |

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

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).

2. Junction temperature ($T_{vj}$) should not exceed $T_{vjmax}$ 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=0.9 W/(m·K)/$D_{(C-S)}$=100 μm.
7. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.




8. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.
The length of the screw depends on the PCB thickness (t1.0).

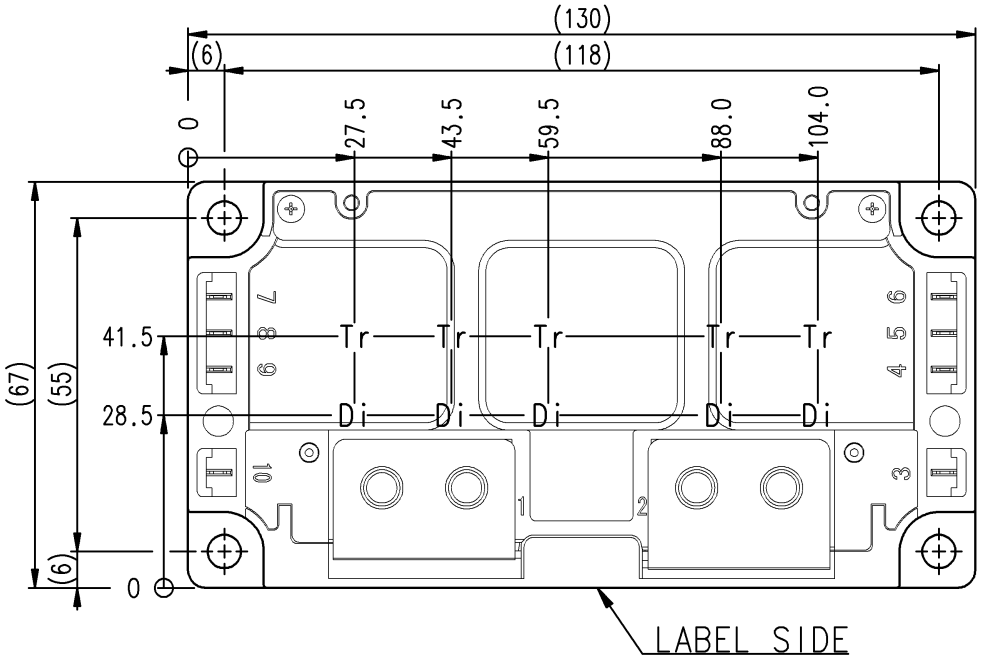
| Type | Size | Tightening torque | Recommended tightening method |
|---|---|---|---|
| (1) PT® | K25×8 | 0.55 ± 0.055 N・m | by handwork (equivalent to 30 r/min ~ 600 r/min (by mechanical screw driver) by mechanical screw driver) |
| (2) PT® | K25×10 | 0.85 ± 0.085 N・m | |
| (3) DELTA PT® | 25×8 | 0.55 ± 0.055 N・m | |
| (4) DELTA PT® | 25×10 | 0.85 ± 0.085 N・m | |
| (5) B1 tapping screw | φ2.6×10 or φ2.6×12 | 0.85 ± 0.085 N・m | |

**RECOMMENDED OPERATING CONDITIONS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{CC}$ | (DC) Supply voltage | Applied across C-E terminals | - | 600 | 850 | V |
| $V_{GEon}$ | Gate (-emitter drive) voltage | Applied across G-Es terminals | 13.5 | 15.0 | 16.5 | V |
| $R_G$ | External gate resistance | - | 0 | - | 15 | Ω |

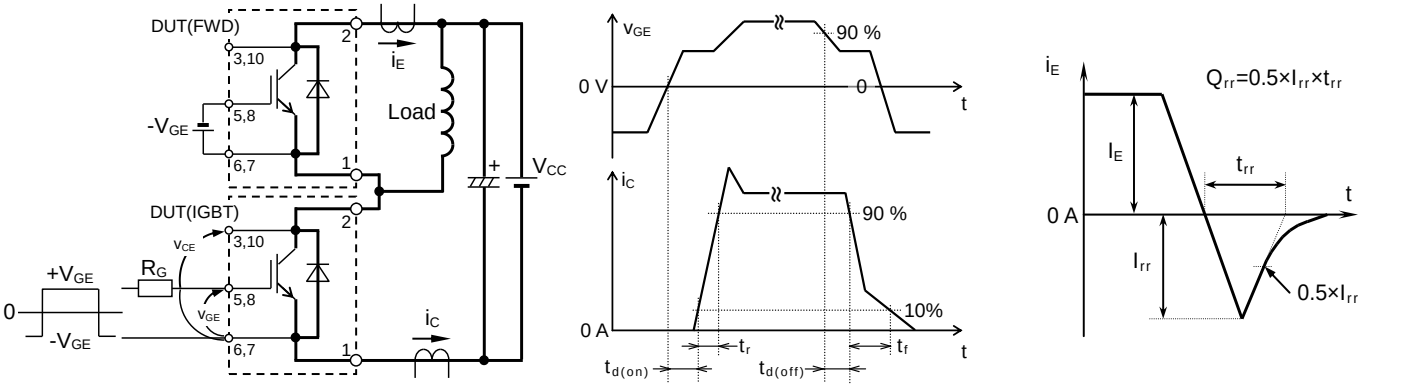
**CHIP LOCATION (Top view)**

Dimension in mm, tolerance: ±1 mm



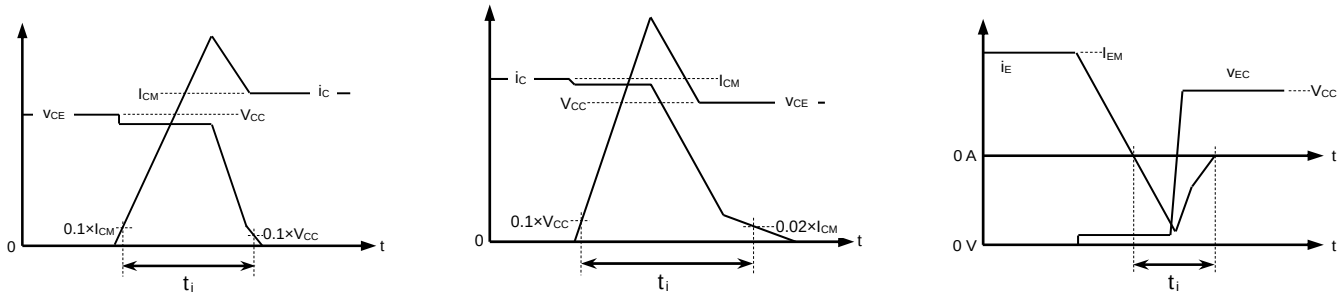

Tr: IGBT, Di: FWD

**TEST CIRCUIT AND WAVEFORMS**




Switching characteristics test circuit and waveforms

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



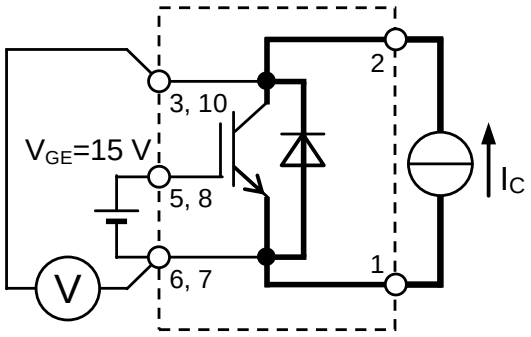

IGBT Turn-on switching energy

IGBT Turn-off switching energy

FWD Reverse recovery energy

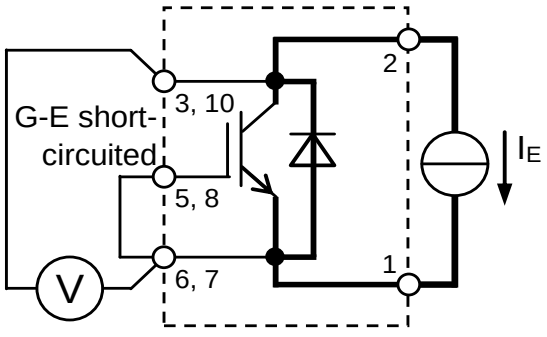
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

**TEST CIRCUIT**




Tr

$V_{CEsat}$ characteristics test circuit



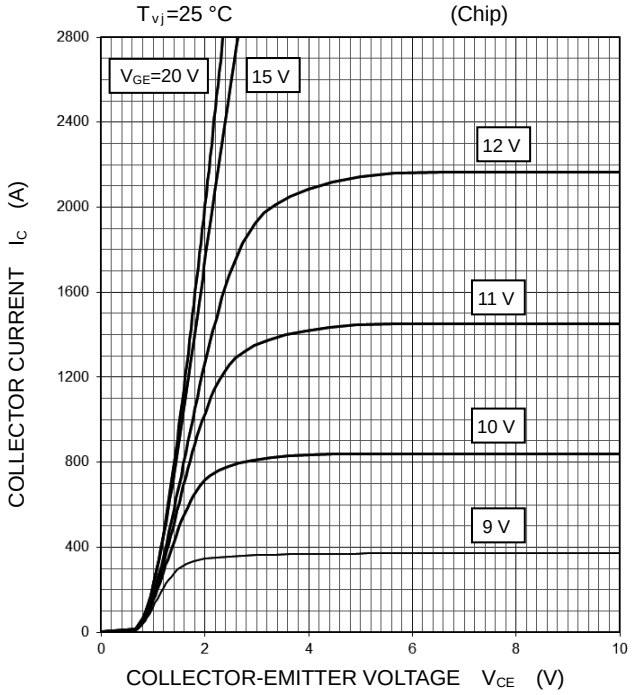

Di

$V_{EC}$ characteristics test circuit

**PERFORMANCE CURVES**

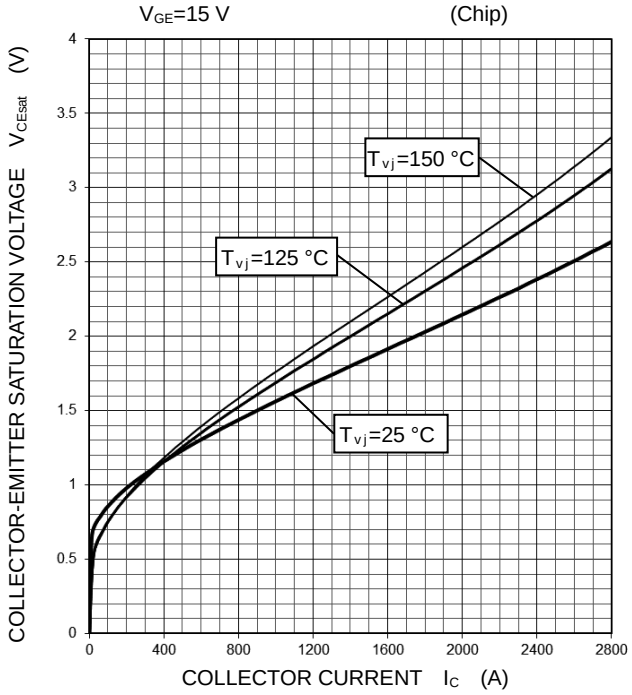
**OUTPUT CHARACTERISTICS**

**(TYPICAL)**



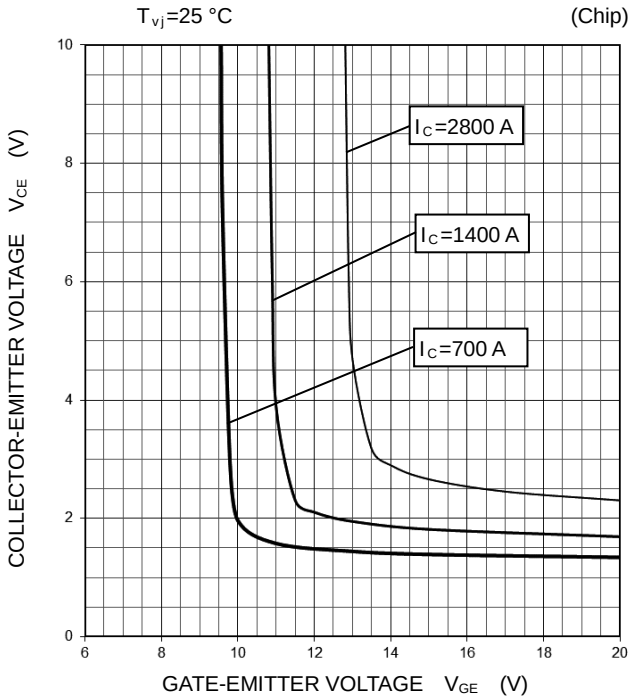

**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS**

**(TYPICAL)**



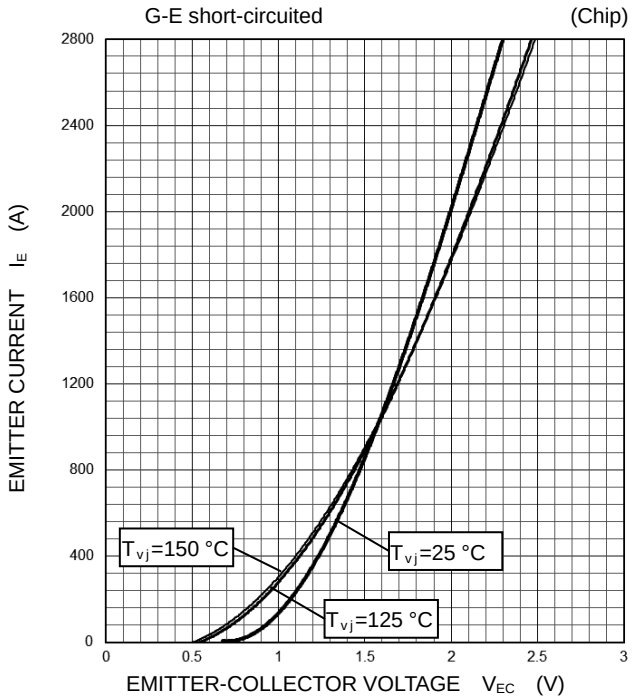

**COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS**

**(TYPICAL)**




**FREE WHEELING DIODE FORWARD CHARACTERISTICS**

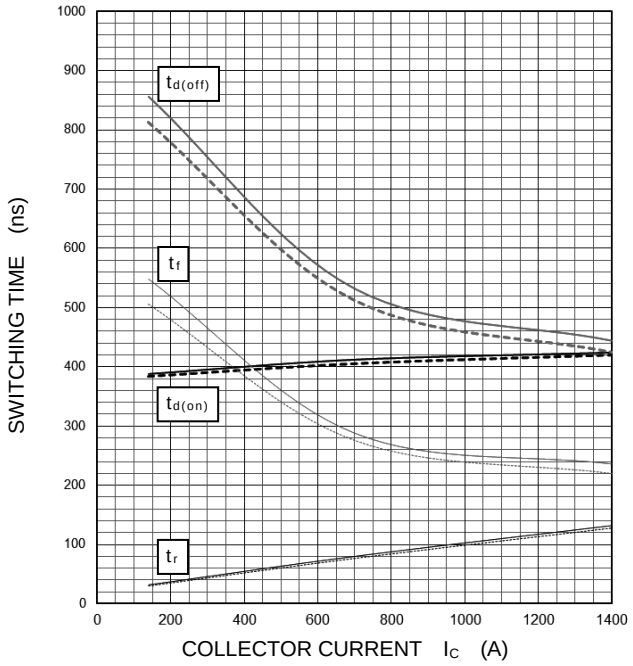
**(TYPICAL)**



**PERFORMANCE CURVES**

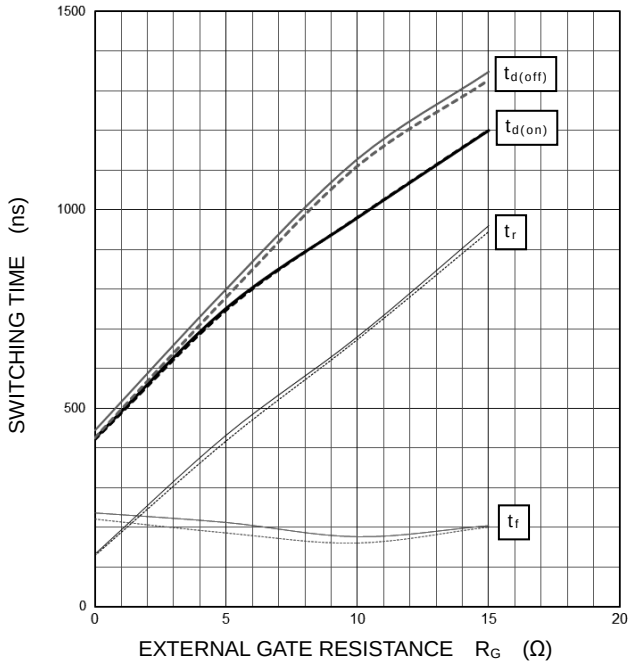
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



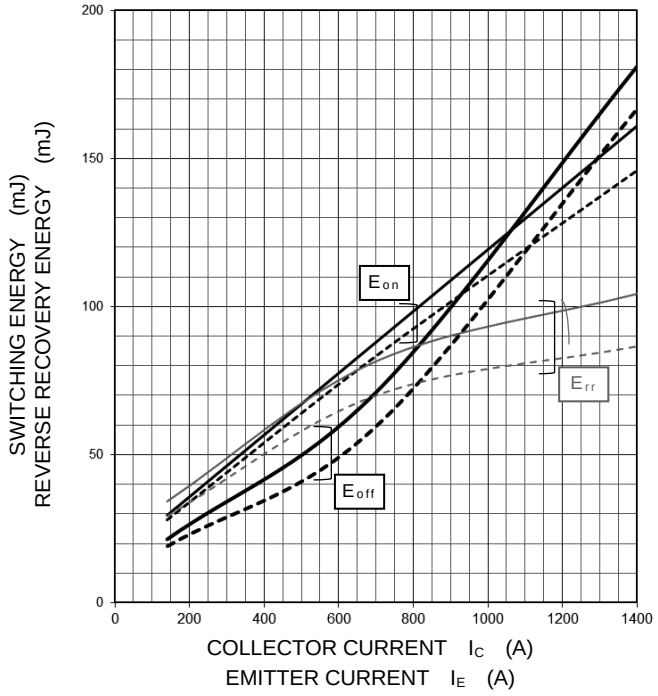

**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}$=600 V, $V_{GE}$=±15 V, $I_C$=1400 A, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



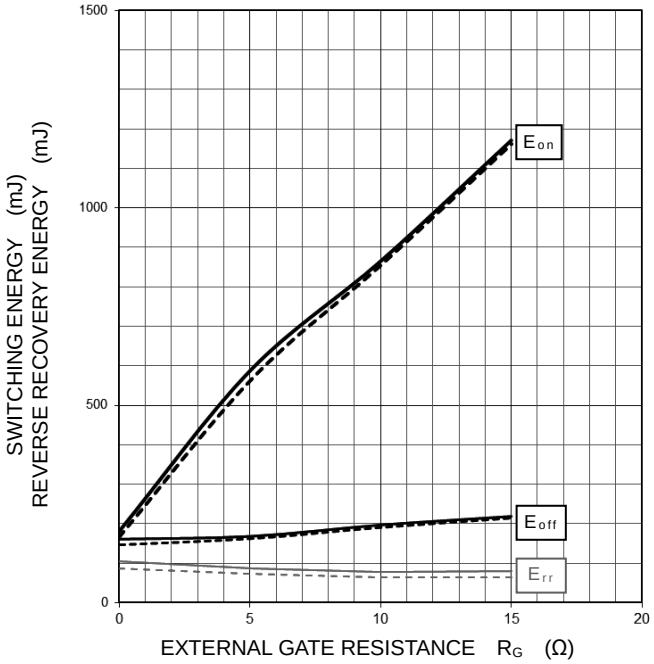

**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω,
INDUCTIVE LOAD, PER PULSE
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C




**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

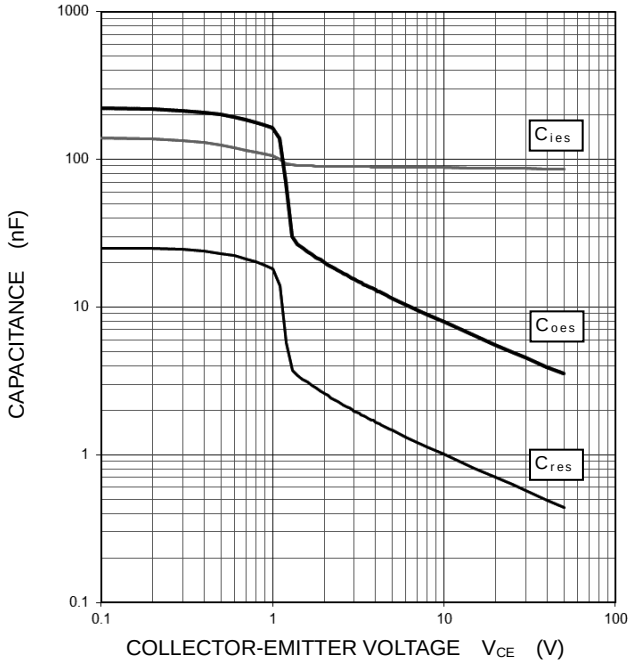
$V_{CC}$=600 V, $V_{GE}$=±15 V, $I_C$/$I_E$=1400 A,
INDUCTIVE LOAD, PER PULSE
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



## PERFORMANCE CURVES

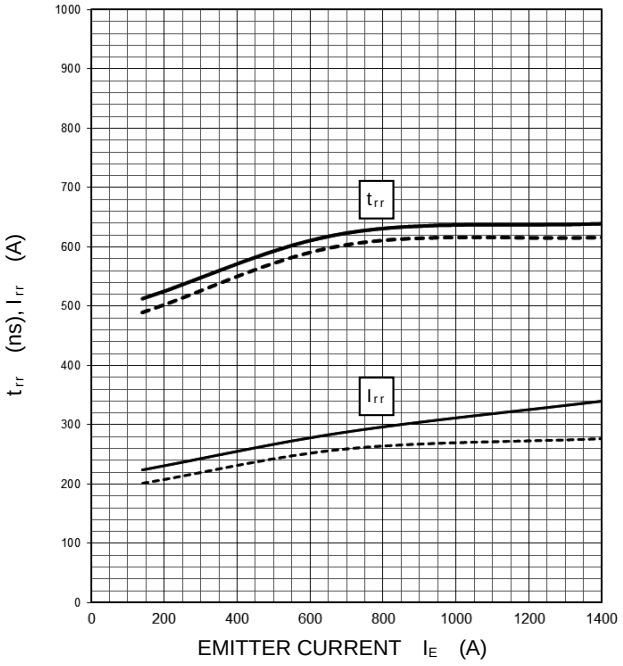
### CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, $T_{vj}$=25 °C



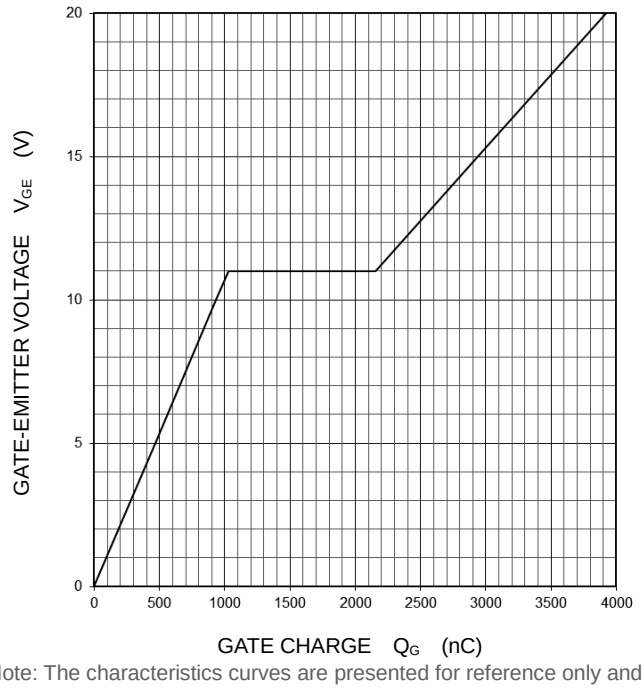

### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω, INDUCTIVE LOAD
———: $T_{vj}$=150 °C, - - - - -: $T_{vj}$=125 °C



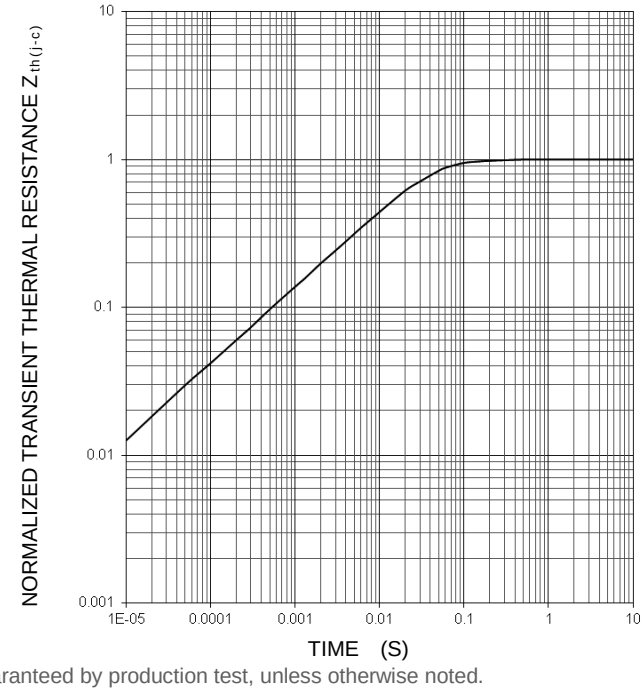

### GATE CHARGE CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $I_C$=1400 A, $T_{vj}$=25 °C




### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, $T_C$=25 °C
$R_{th(j-c)Q}$=21 K/kW, $R_{th(j-c)D}$=32 K/kW




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

## Keep safety first in your circuit designs!

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