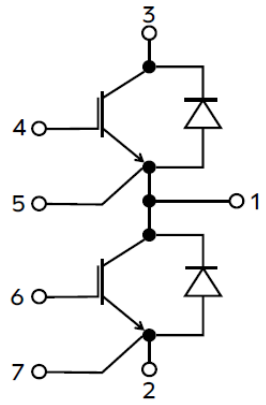
# IGBT Modules

| | |
|---|---|
| $V_{CES}$ | 1700V |
| $I_C$ | 200A |

## Applications

·Motion/servo control
·High frequency switching application
·UPS (Uninterruptible Power Supplies)
·Welding machine

## Circuit




## Features

·Low $V_{ce(sat)}$ with Trench technology
·Low switching losses especially $E_{off}$
·$V_{ce(sat)}$ with positive temperature coefficient
·High short circuit capability(10us)
·Including ultra fast & soft recovery anti-parallel FWD
·Low inductance package
·Maximum junction temperature 175°C

## ● IGBT

**Absolute Maximum Ratings**

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CES}$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA, $T_{vj}$ = 25 °C | 1700 | V |
| Continuous Collector Current | $I_C$ | $T_c$ = 120 °C, $T_{vj}$ = 175 °C | 200 | A |
| Repetitive Peak Collector Current | $I_{CRM}$ | Tp = 1 ms | 400 | A |
| Gate-Emitter Voltage | $V_{GES}$ | $T_{vj}$ = 25 °C | ±20 | V |
| Total Power Dissipation | $P_{tot}$ | $T_c$ = 25 °C<br>$T_{vjmax}$ = 175 °C | 1250 | W |

**Characteristic values**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Gate-emitter Threshold Voltage | $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 10 mA, $T_{vj}$ = 25 °C | 5 | 6.10 | 7.5 | V |
| Collector-Emitter Cut-off Current | $I_{CES}$ | $V_{CE}$ = 1700 V, $V_{GE}$ = 0 V, $T_{vj}$ = 25 °C | | | 1 | mA |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_c$ = 200 A, $V_{GE}$ = 15 V, $T_{vj}$ = 25 °C | | 1.65 | 2 | V |
| | | $I_c$ = 200 A, $V_{GE}$ = 15 V, $T_{vj}$ = 125 °C | | 1.85 | | |
| | | $I_c$ =200 A, $V_{GE}$ = 15 V, $T_{vj}$ = 175 °C | | 2.05 | | |
| Gate Charge | $Q_G$ | $I_c$ = 200 A, $V_{GE}$ = 900 V | | 1.5 | | uC |
| Internal Gate Resistance | $R_{Gint}$ | | | 4.2 | | Ω |
| Input Capacitance | $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, f = 100 kHz, $T_{vj}$ = 25 °C | | 15.3 | | nF |
| Reverse Transfer Capacitance | $C_{res}$ | | | 0.47 | | nF |
| Gate-Emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V, $T_{vj}$ = 25 °C | -0.5 | | 0.5 | nA |
| Turn-on Delay Time | $t_{d(on)}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{vj}$ = 25 °C | | 198 | | ns |
| Rise Time | $t_r$ | | | 28 | | ns |
| Turn-off Delay Time | $t_{d(off)}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{vj}$ = 25 °C | | 524 | | ns |
| Fall Time | $t_f$ | | | 289 | | ns |
| Energy Dissipation During Turn-on Time | $E_{on}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{vj}$ = 25 °C | | 90 | | mJ |
| Energy Dissipation During Turn-off Time | $E_{off}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{vj}$ = 25 °C | | 44 | | mJ |
| Turn-on Delay Time | $t_{d(on)}$ | $I_C$ = 200 A, $V_{CE}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{Vj}$ = 125 °C | | 245 | | ns |
| Rise Time | $t_r$ | | | 31 | | ns |
| Turn-off Delay Time | $t_{d(off)}$ | $I_C$ = 200 A, $V_{CE}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{Vj}$ = 125 °C | | 733 | | ns |
| Fall Time | $t_f$ | | | 432 | | ns |
| Energy Dissipation During Turn-on Time | $E_{on}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{vj}$ = 125 °C | | 116 | | mJ |
| Energy Dissipation During Turn-off Time | $E_{off}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{vj}$ = 125 °C | | 72 | | mJ |
| Turn-on Delay Time | $t_{d(on)}$ | $I_C$ = 200 A, $V_{CE}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{Vj}$ = 175 °C | | 253 | | ns |
| Rise Time | $t_r$ | | | 32 | | ns |
| Turn-off Delay Time | $t_{d(off)}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{vj}$ = 175 °C | | 787 | | ns |
| Fall Time | $t_f$ | | | 619 | | ns |
| Energy Dissipation During Turn-on Time | $E_{on}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4 Ω, $T_{vj}$ = 175 °C | | 122 | | mJ |
| Energy Dissipation During Turn-off Time | $E_{off}$ | $I_C$ = 200 A, $V_{CC}$ = 900 V, $V_{GE}$ = ±15 V, $R_G$ = 4.5 Ω, $T_{vj}$ = 175 °C | | 83 | | mJ |
| SC Data | $I_{sc}$ | $T_p$ ≤ 10 us, $V_{GE}$ = 15 V, $T_{vj}$ = 175 °C, $V_{cc}$ = 1200 V, $V_{CEM}$ ≤ 1700V | | 880 | | A |

## Diode

### Absolute Maximum Ratings

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | $T_{vj}$ = 25 °C | 1700 | V |
| Continuous DC Forward Current | $I_F$ | | 200 | A |
| Repetitive Peak Forward Current | $I_{FRM}$ | $t_p$ = 1 ms | 400 | A |
| $I^2t$-value | $I^2t$ | $V_R$ = 0 V, $t_p$ = 10 ms, $T_j$=150 °C | 4190 | $A^2s$ |

### Characteristic values

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Forward Voltage | $V_F$ | $I_F$ = 200 A, $T_{vj}$ = 25 °C | | 1.7 | 2.1 | V |
| | | $I_F$ = 200 A, $T_{vj}$ = 125 °C | | 1.85 | | |
| | | $I_F$ = 200 A, $T_{vj}$ = 175 °C | | 1.95 | | |
| Recovered Charge | $Q_{rr}$ | $I_F$ = 200 A<br>$V_R$ = 900 V<br>-$di_F/dt$ = 7870 A/us<br>$T_{vj}$ = 25 °C | | 54 | | uC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 220 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 35 | | mJ |
| Recovered Charge | $Q_{rr}$ | $I_F$ = 200 A<br>$V_R$ = 900 V<br>-$di_F/dt$ = 7870 A/us<br>$T_{vj}$ =125 °C | | 83 | | uC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 225 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 57 | | mJ |
| Recovered Charge | $Q_{rr}$ | $I_F$ = 200 A<br>$V_R$ = 900 V<br>-$di_F/dt$ = 7870 A/us<br>$T_{vj}$ = 175 °C | | 98 | | uC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 228 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 69 | | mJ |

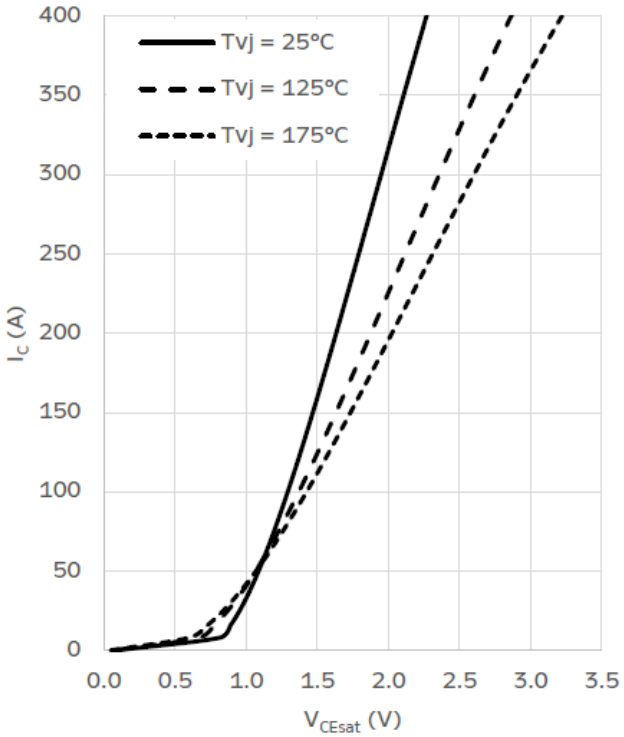
## Module Characteristics

$T_c$=25°C unless otherwise specified

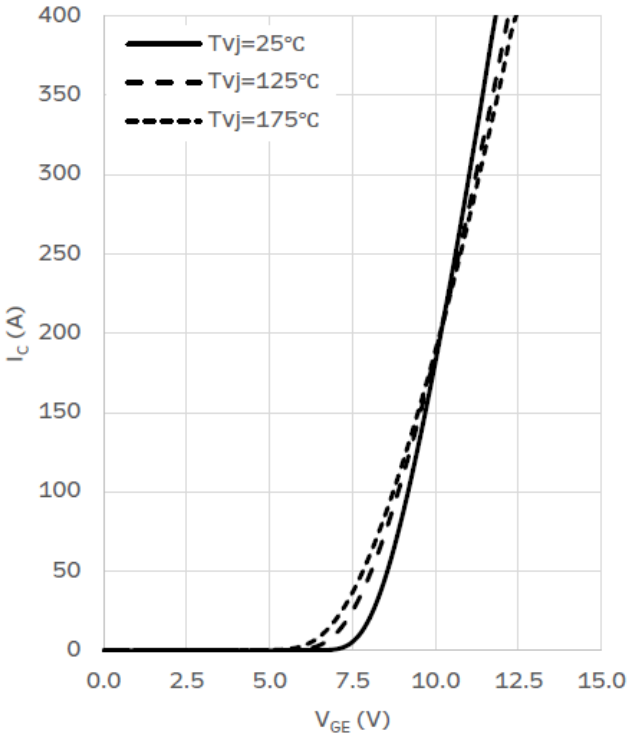
| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Isolation voltage | $V_{isol}$ | t =1 min, f = 50 Hz | | | 4000 | V |
| Maximum Junction Temperature | $T_{jmax}$ | | | | 175 | °C |
| Operating Junction Temperature | $T_{vj(op)}$ | | -40 | | 175 | °C |
| Storage Temperature | $T_{stg}$ | | -40 | | 125 | °C |
| Thermal Resistance Junction-to Case | $R_{\theta JC}$ | per IGBT | | | 0.120 | K/W |
| | | per Diode | | | 0.204 | |
| Comparative Tracking Index | CTI | | >400 | | | |
| Thermal Resistance Case-to Sink | $R_{\theta CS}$ | Conductive grease applied | | 0.057 | | K/W |
| Module ElectrodesTorque | $M_t$ | Recommended(M6) | 2.5 | | 5 | N·m |
| Module-to-SinkTorque | $M_s$ | Recommended(M6) | 3 | | 6 | N·m |
| Mass | m | | | 310 | | g |

## Characteristics

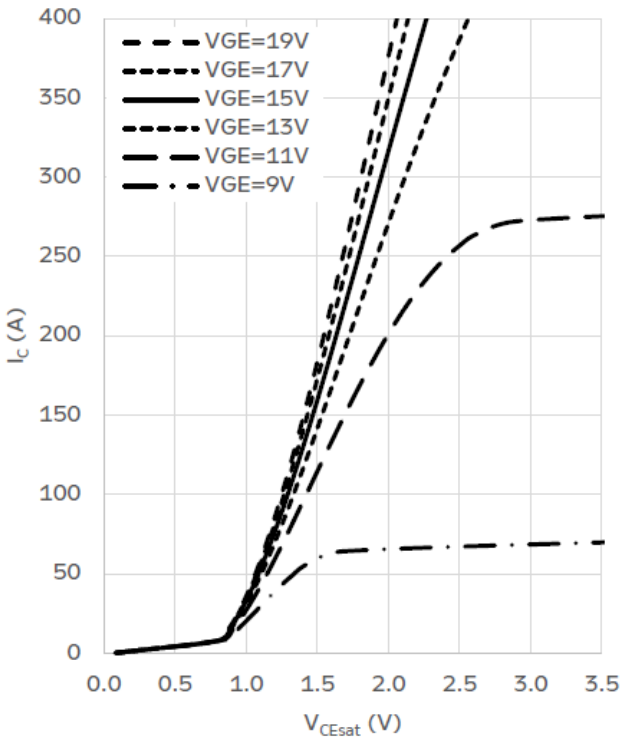
**IGBT on-state characteristics (typical)**
$I_C = f(V_{CE})$
$V_{GE}$ = 15 V



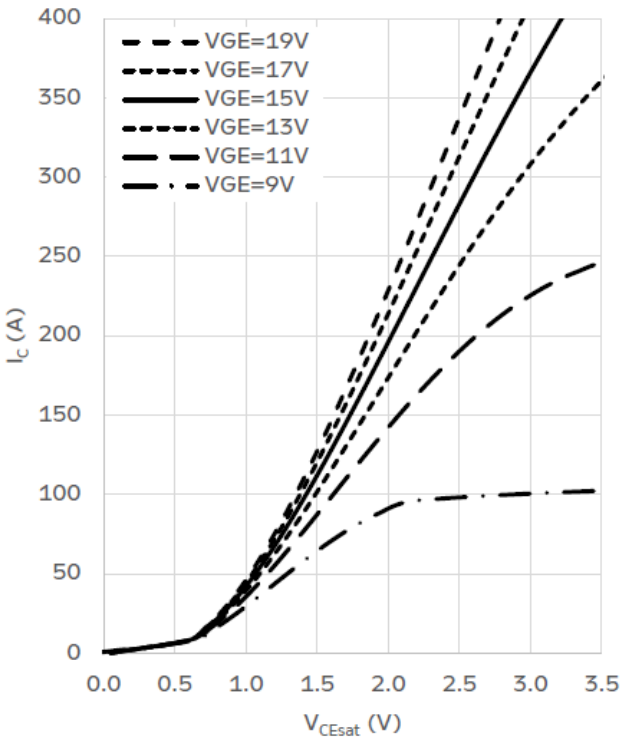

**IGBT transfer characteristics (typical)**
$I_C = f(V_{GE})$
$V_{CE}$ = 20V



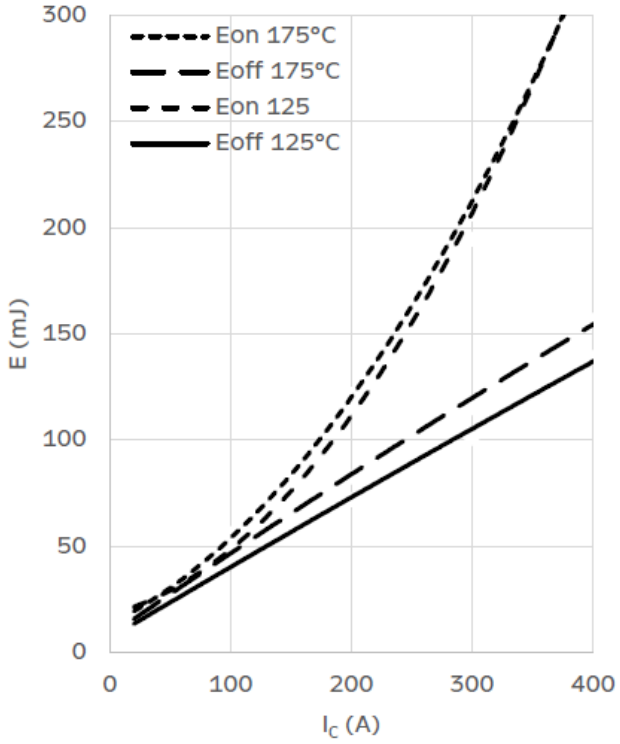

**IGBT output characteristics (typical)**
$I_C = f(V_{CE})$
$T_{vj}$ = 25 °C



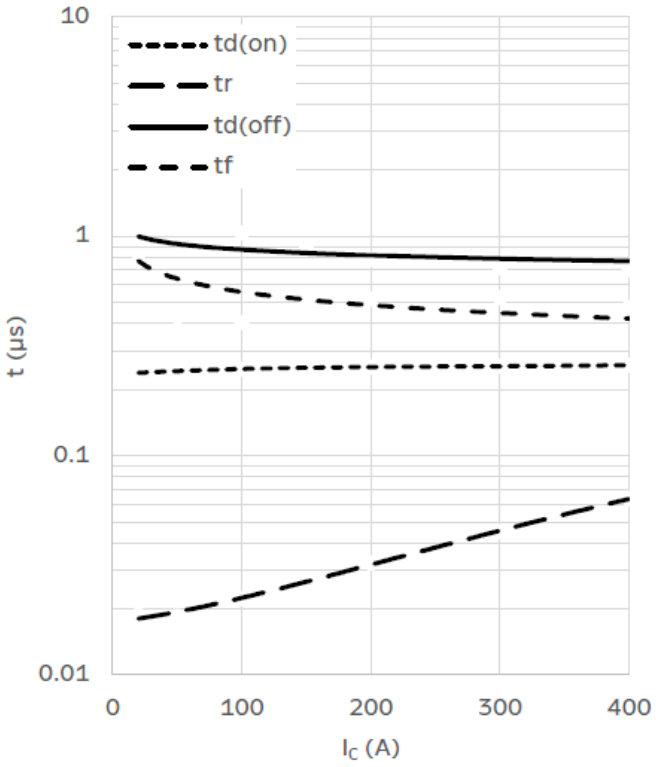

**IGBT output characteristics (typical)**
$I_C = f(V_{CE})$
$T_{vj}$ = 175 °C



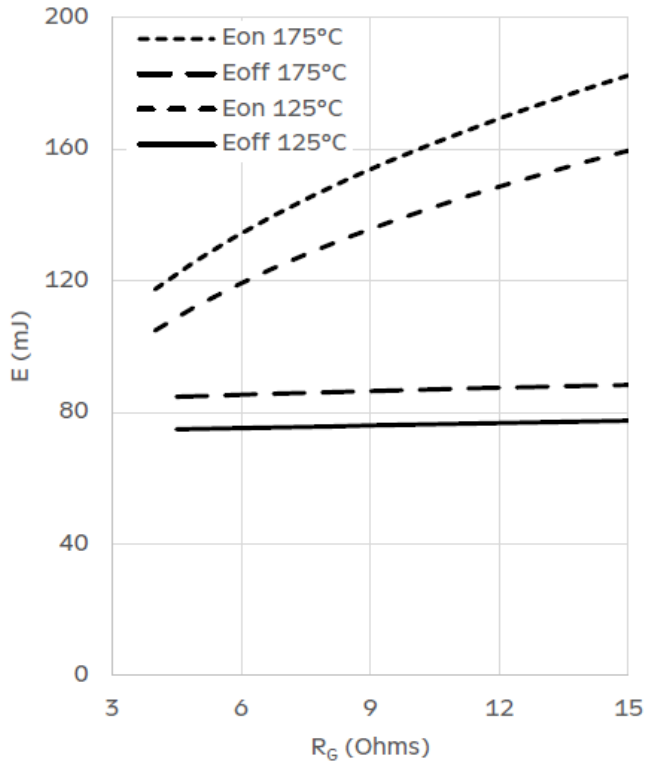
**IGBT switching losses (typical)**
E = f($I_{CE}$)
$V_{CE}$ = 900 V, $R_{Gon}$ = 4 Ω, $R_{Goff}$ = 4.5 Ω, $V_{GE}$ = -15/+15 V



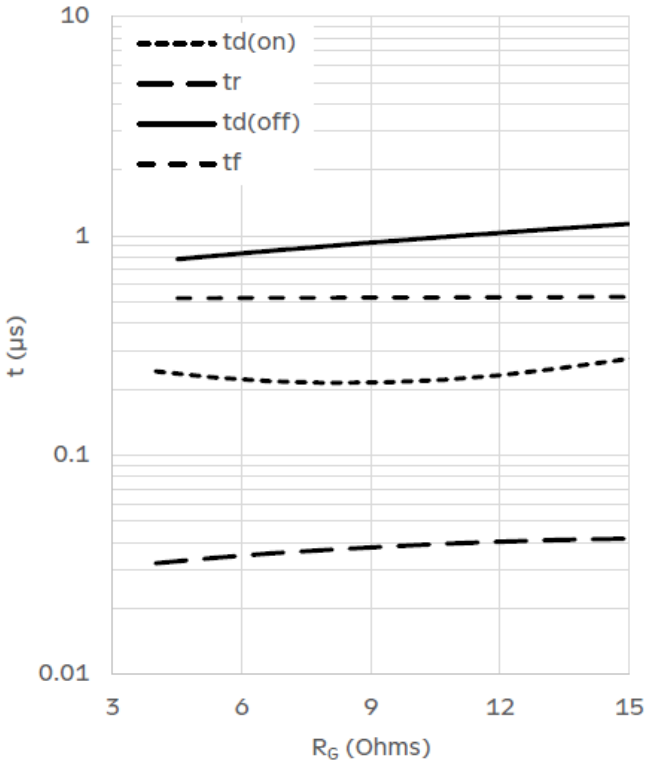

**IGBT switching times (typical)**
t = f($I_{CE}$), $T_{vj}$ = 175 °C
$V_{CE}$ = 900 V, $R_{Gon}$ = 4 Ω, $R_{Goff}$ = 4.5 Ω, $V_{GE}$ =-15/+15 V



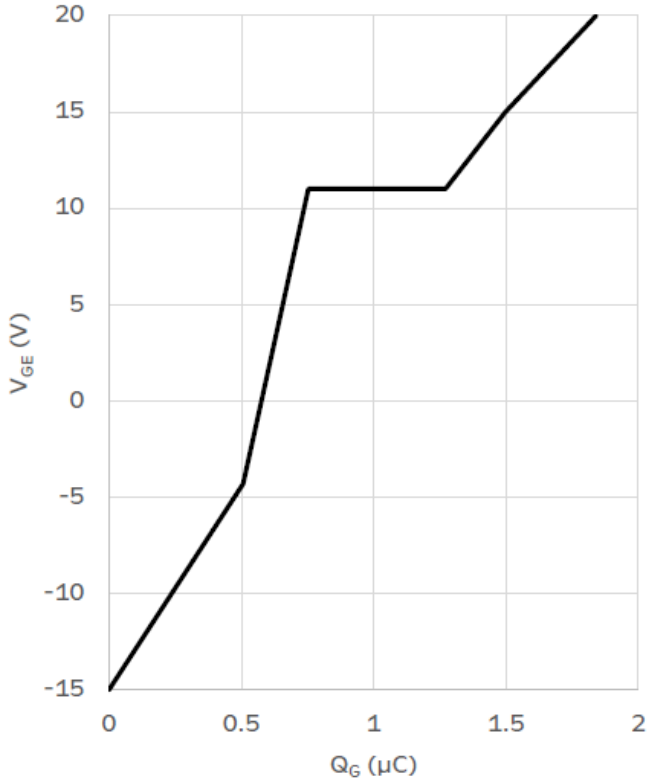

**IGBT switching losses (typical)**
E = f($R_G$)
$V_{CE}$ = 900 V, $I_C$ = 200 A, $V_{GE}$ = -15/+15 V



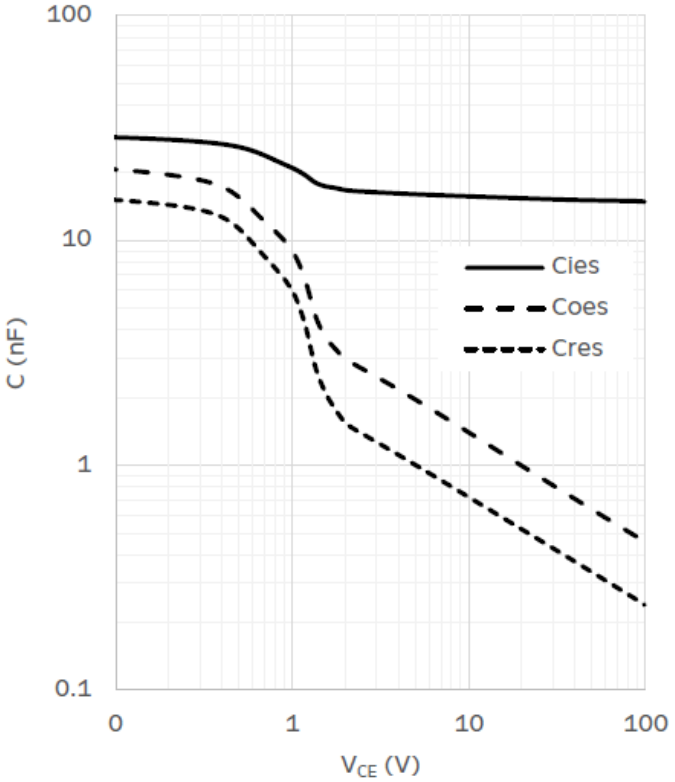

**IGBT switching times (typical)**
t = f($R_G$), $T_{vj}$ = 175 °C
$V_{CE}$ = 900 V, $I_C$ = 200 A, $V_{GE}$ = -15/+15 V



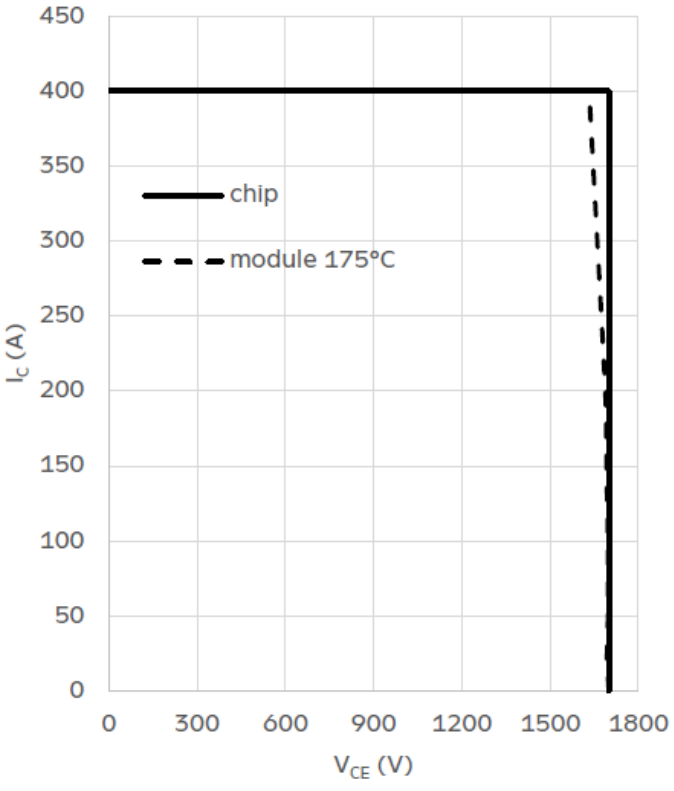
**IGBT gate charge (typical)**
$V_{GE} = f(Q_G)$, $T_{vj} = 25$ °C
$V_{CE} = 900$ V, $I_C = 200$ A



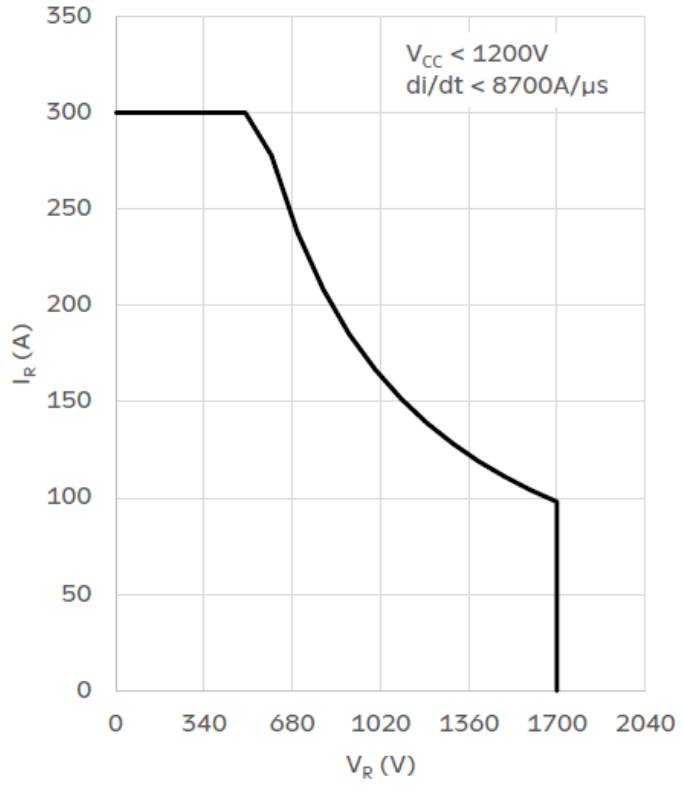

**Capacitance characteristics (typical)**
$C = f(V_{CE})$, $T_{vj} = 25$ °C
$f = 100$ kHz, $V_{GE} = 0$ V



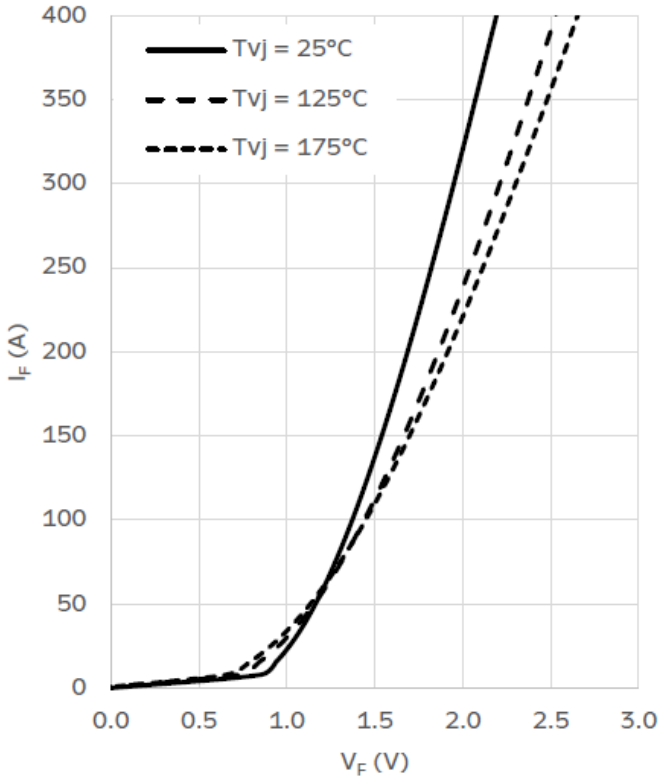

**IGBT RBSOA**
$I_C = f(V_{CEm})$
$R_{Goff} = 4.5\ \Omega$, $V_{GE} = \pm 15$ V



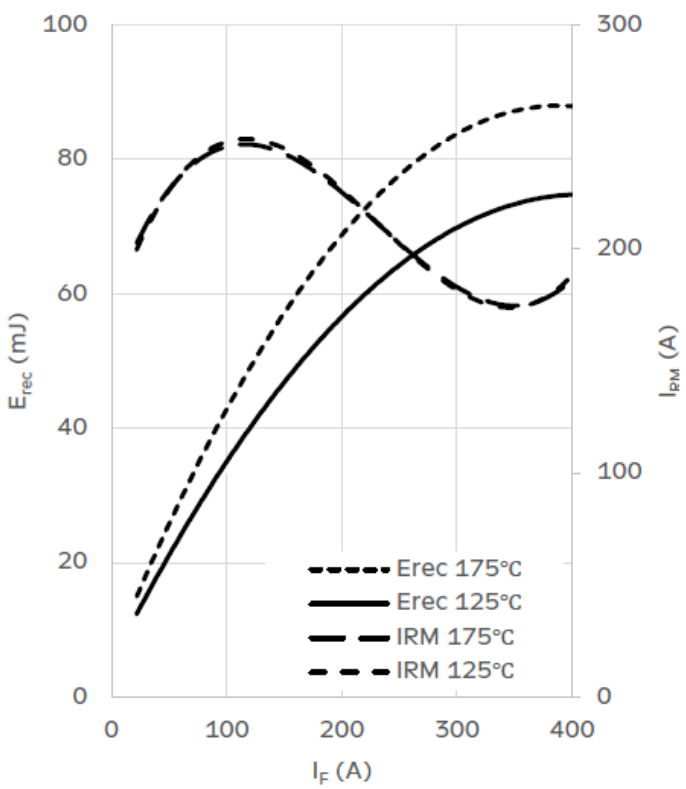

**Diode SOA**
$T_{vj} \leq 175$ °C



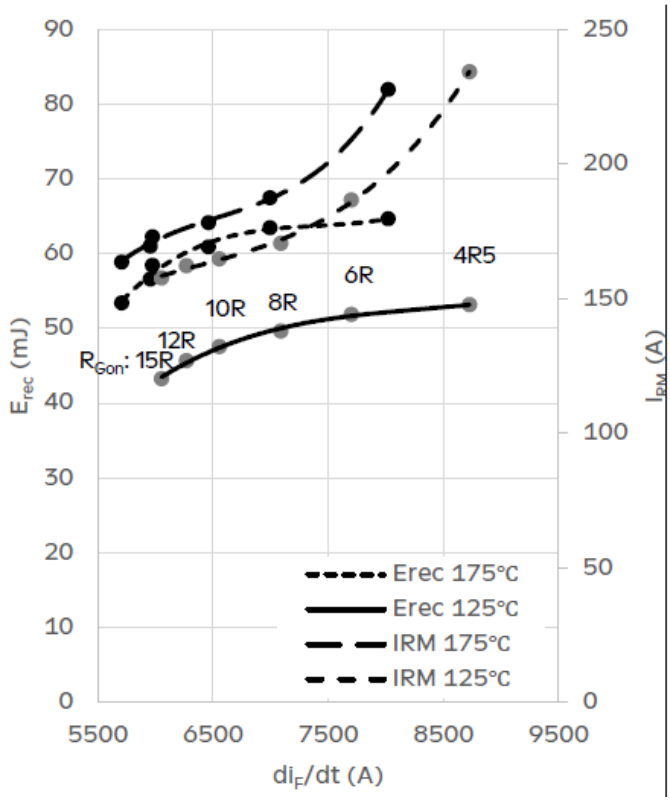
**Diode forward characteristic (typical)**
$I_F = f(V_F)$



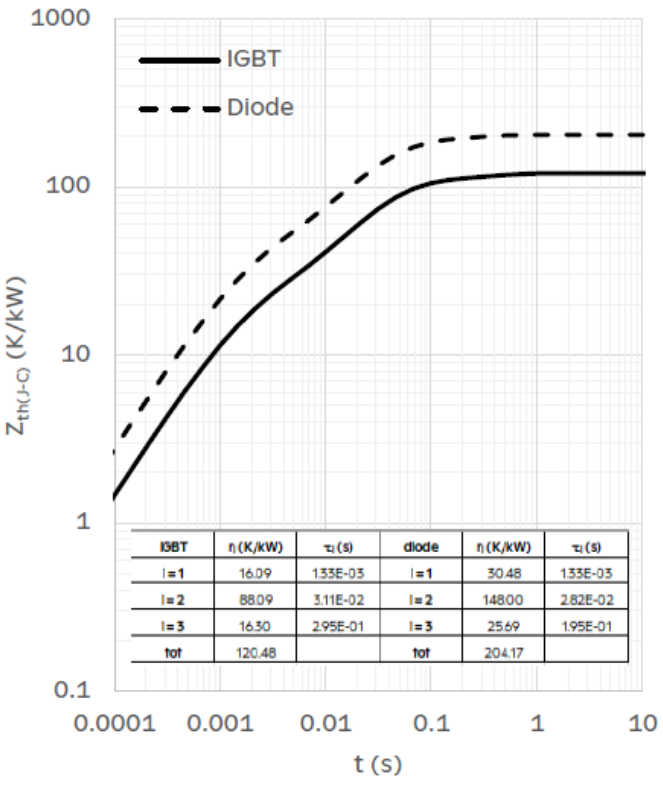

**Diode switching characteristics (typical)**
$E_{rec} = f(I_F)$, $I_{RM} = f(I_F)$
$V_{DC}$ = 900 V, $R_{Gon}$ = 4 Ω (IGBT), $V_{GE}$ =-15/+15 V (IGBT)




**Diode switching characteristics (typical)**
$E_{rec} = f(di/dt)$, $I_{RM} = f(di/dt)$
$V_{DC}$ = 900 V, $I_F$ = 200 A, $V_{GE}$ =-15/+15 V (IGBT)

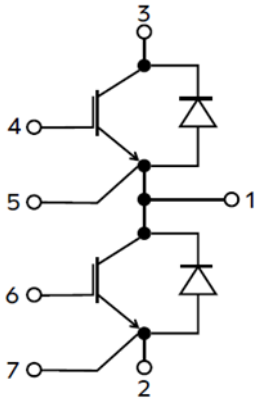



**Thermal impedance (typical)**
$Z_{th(j-c)} = f(t)$




| IGBT | $R_i$ (K/kW) | $\tau_i$ (s) | diode | $R_i$ (K/kW) | $\tau_i$ (s) |
|---|---|---|---|---|---|
| i = 1 | 16.09 | 1.33E-03 | i = 1 | 30.48 | 1.33E-03 |
| i = 2 | 88.09 | 3.11E-02 | i = 2 | 148.00 | 2.82E-02 |
| i = 3 | 16.30 | 2.95E-01 | i = 3 | 25.69 | 1.95E-01 |
| tot | 120.48 | | tot | 204.17 | |

- **Circuit Diagram**




- **Package Outline Information**