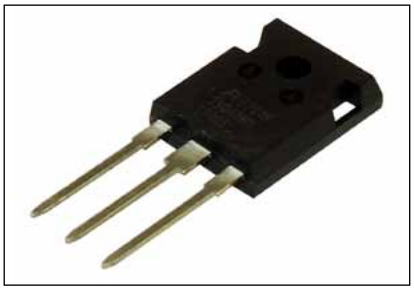
# FGW35N60HD

Discrete IGBT

## Discrete IGBT (High-Speed V series)
## 600V / 35A

### Features
Low power loss
Low switching surge and noise
High reliability, high ruggedness (RBSOA, SCSOA etc.)

### Applications
Uninterruptible power supply
Power coditionner
Power factor correction circuit



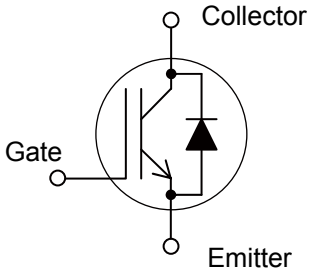
### Maximum Ratings and Characteristics

● **Absolute Maximum Ratings (at $T_c$=25°C unless otherwise specified)**

| Items | Symbols | Characteristics | Units | Remarks |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CES}$ | 600 | V | |
| Gate-Emitter Voltage | $V_{GES}$ | ±20 | V | |
| DC Collector Current | $I_{C@25}$ | 64 | A | $T_C$=25°C,$T_j$=150°C |
| | $I_{C@100}$ | 35 | A | $T_C$=100°C,$T_j$=150°C |
| Pulsed Collector Current | $I_{CP}$ | 105 | A | Note *1 |
| Turn-Off Safe Operating Area | - | 105 | A | $V_{CE}$≤600V,$T_j$≤175°C |
| Diode Forward Current | $I_{F@25}$ | 30 | A | |
| | $I_{F@100}$ | 15 | A | |
| Diode Pulsed Current | $I_{FP}$ | 105 | A | Note *1 |
| Short Circuit Withstand Time | $t_{SC}$ | 5 | μs | $V_{CC}$≤300V,$V_{GE}$=12V<br>$T_j$≤150°C |
| IGBT Max. Power Dissipation | $P_{D\_IGBT}$ | 230 | W | $T_C$=25°C |
| FWD Max. Power Dissipation | $P_{D\_FWD}$ | 80 | | $T_C$=25°C |
| Operating Junction Temperature | $T_j$ | -40 ~ +175 | °C | |
| Storage Temperature | $T_{stg}$ | -55 ~ +175 | °C | |

Note *1 : Pulse width limited by Tjmax.

### Equivalent circuit




● **Electrical characteristics (at $T_j$= 25°C unless otherwise specified)**

| Items | Symbols | Conditions | | Characteristics min. | Characteristics typ. | Characteristics max. | Units |
|---|---|---|---|---|---|---|---|
| Collector-Emitter Breakdown Voltage | $V_{(BR)CES}$ | $I_C$ = 250μA, $V_{GE}$ = 0V | | 600 | - | - | V |
| Zero Gate Voltage Collector Current | $I_{CES}$ | $V_{CE}$ = 600V, $V_{GE}$ = 0V | $T_j$=25°C | - | - | 250 | μA |
| | | | $T_j$=175°C | - | - | 10 | mA |
| Gate-Emitter Leakage Current | $I_{GES}$ | $V_{CE}$ = 0V, $V_{GE}$ = ±20V | | - | - | 200 | nA |
| Gate-Emitter Threshold Voltage | $V_{GE\ (th)}$ | $V_{CE}$ = +20V, $I_C$ = 35mA | | 4.0 | 5.0 | 6.0 | V |
| Collector-Emitter Saturation Voltage | $V_{CE\ (sat)}$ | $V_{GE}$ = +15V, $I_C$ = 35A | $T_j$=25°C | - | 1.50 | 1.95 | V |
| | | | $T_j$=175°C | - | 1.80 | - | |
| Input Capacitance | $C_{ies}$ | $V_{CE}$=25V | | - | 2800 | - | pF |
| Output Capacitance | $C_{oes}$ | $V_{GE}$=0V | | - | 140 | - | |
| Reverse Transfer Capacitance | $C_{res}$ | f=1MHz | | - | 100 | - | |
| Gate Charge | $Q_G$ | $V_{CC}$ = 400V<br>$I_C$ = 35A<br>$V_{GE}$ = 15V | | - | 210 | - | nC |
| Turn-On Delay Time | $t_{d(on)}$ | $T_j$ = 25°C | | - | 32 | - | ns |
| Rise Time | $t_r$ | $V_{CC}$ = 400V | | - | 60 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | $I_C$ = 35A | | - | 200 | - | |
| Fall Time | $t_f$ | $V_{GE}$ = 15V | | - | 40 | - | |
| Turn-On Energy | $E_{on}$ | $R_G$ = 10Ω | | - | 0.90 | - | mJ |
| Turn-Off Energy | $E_{off}$ | L = 500μH<br>Energy loss include “tail” and FWD reverse recovery. | | - | 0.85 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $T_j$ = 175°C | | - | 33 | - | ns |
| Rise Time | $t_r$ | $V_{CC}$ = 400V | | - | 60 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | $I_C$ = 35A | | - | 225 | - | |
| Fall Time | $t_f$ | $V_{GE}$ = 15V | | - | 50 | - | |
| Turn-On Energy | $E_{on}$ | $R_G$ = 10Ω | | - | 1.40 | - | mJ |
| Turn-Off Energy | $E_{off}$ | L = 500μH<br>Energy loss include “tail” and FWD reverse recovery. | | - | 1.25 | - | |

## ● FWD Characteristics

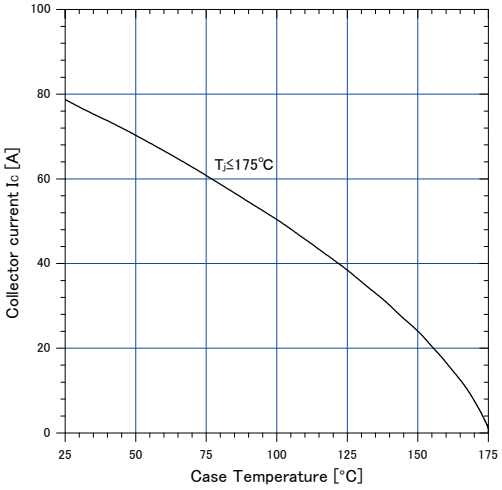
| Description | Symbol | Conditions | | Characteristics min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|---|
| Forward Voltage Drop | $V_F$ | $I_F$=15A | $T_j$=25°C | - | 2.0 | 2.6 | V |
| | | | $T_j$=175°C | - | 1.4 | - | V |
| Diode Reverse Recovery Time | $t_{rr1}$ | $V_{CC}$=30V,$I_F$ = 1.5A<br>-di/dt=200A/μs | | - | 24 | 31 | ns |
| Diode Reverse Recovery Time | $t_{rr2}$ | $V_{CC}$=400V<br>$I_F$=15A<br>-di$_F$/dt=200A/μs<br>$T_j$=25°C | | | 0.03 | - | μs |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | | - | 0.06 | - | μC |
| Diode Reverse Recovery Time | $t_{rr2}$ | $V_{CC}$=400V<br>$I_F$=15A<br>-di$_F$/dt=200A/μs<br>$T_j$=175°C | | - | 0.15 | - | μs |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | | - | 0.65 | - | μC |

## ● Thermal resistance characteristics

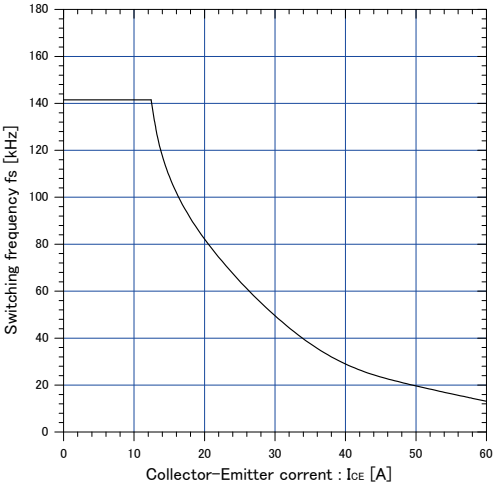
| Items | Symbols | Conditions | Characteristics min. | typ. | max. | Units |
|---|---|---|---|---|---|---|
| Thermal Resistance, Junction-Ambient | $R_{th(j-a)}$ | - | - | - | 50 | °C/W |
| Thermal Resistance, IGBT Junction to Case | $R_{th(j-c)\_IGBT}$ | - | - | - | 0.641 | |
| Thermal Resistance, FWD Junction to Case | $R_{th(j-c)\_FWD}$ | - | - | - | 1.786 | |

## ■ Characteristics (Representative)

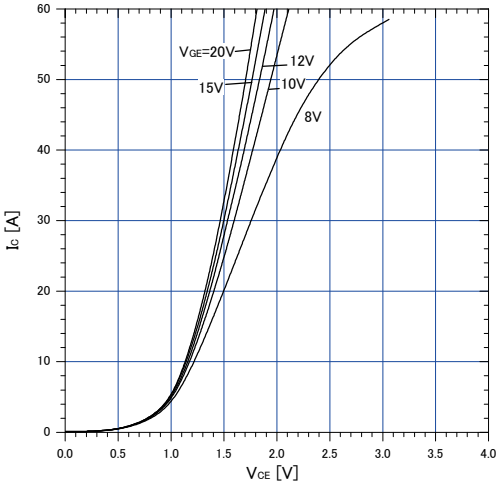
Graph.1
DC Collector Current vs $T_C$
$V_{GE}$≥+15V, $T_j$≤175°C



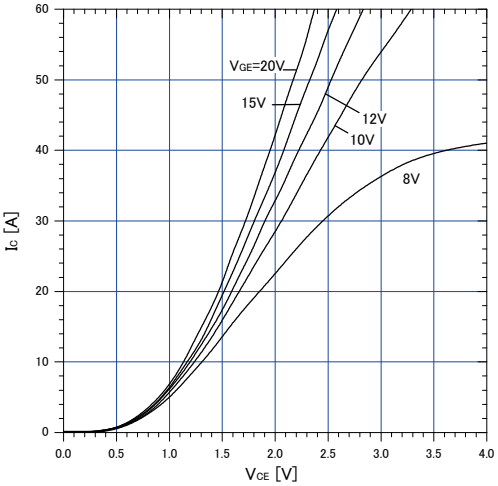

Graph.2
Collector Current vs. switching frequency
$V_{GE}$=+15V, $T_c$≤175°C, $V_{CC}$=400V, D=0.5,
$R_G$=10Ω, $T_C$=100°C



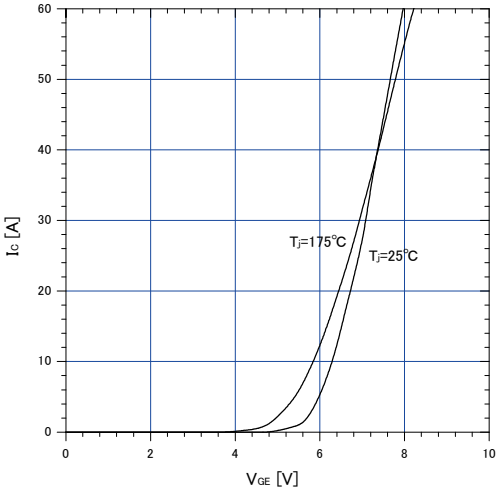

Graph.3
Typical Output Characteristics ($V_{CE}$-$I_C$)
$T_j$=25°C



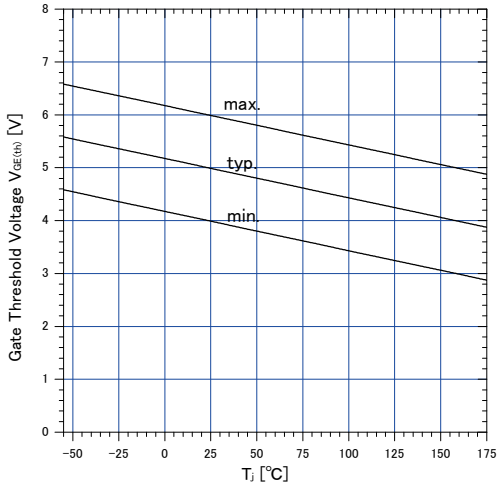

Graph.4
Typical Output Characteristics ($V_{CE}$-$I_C$)
$T_j$=175°C



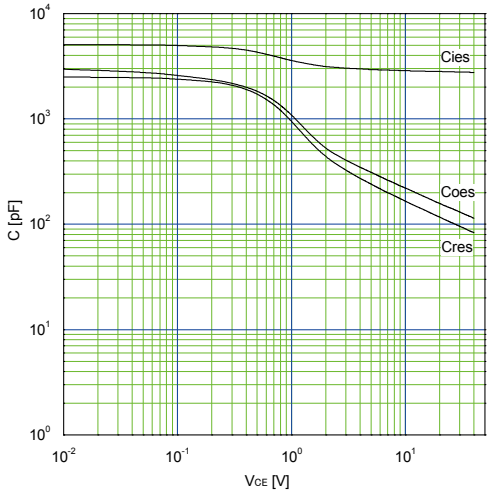

Graph.5
Typical Transfer Characteristics
$V_{GE}$=+15V



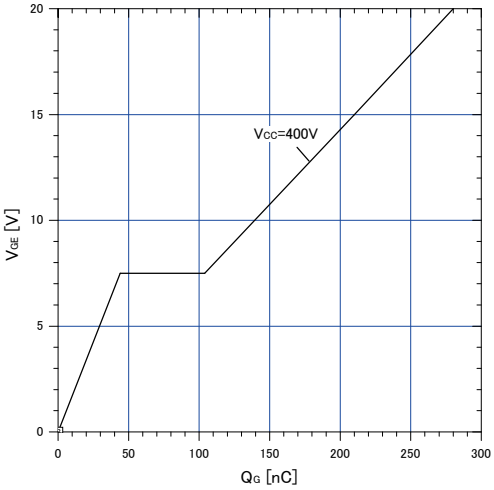

Graph.6
Gate Threshold Voltage vs. $T_j$
$I_C$=35mA, $V_{CE}$=20V



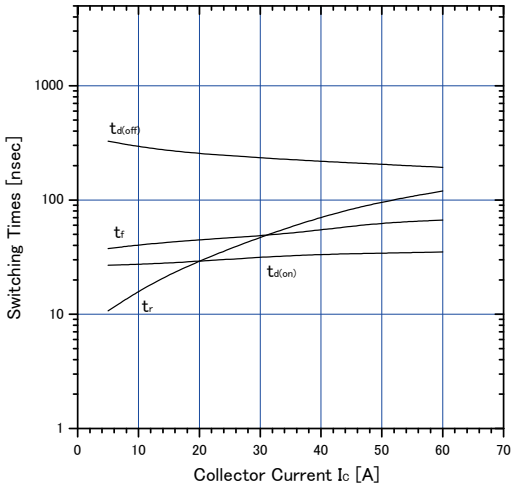
Graph.7
Typical Capacitance
$V_{GE}$=0V,f=1MHz,$T_j$=25°C



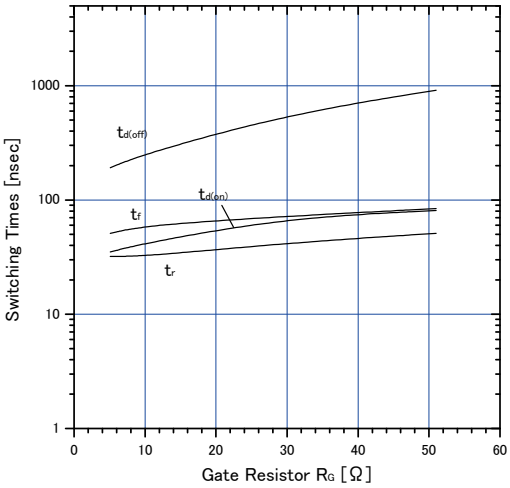

Graph.8
Typical Gate Charge
$V_{CC}$=400V,$I_C$=35A,$T_j$=25°C



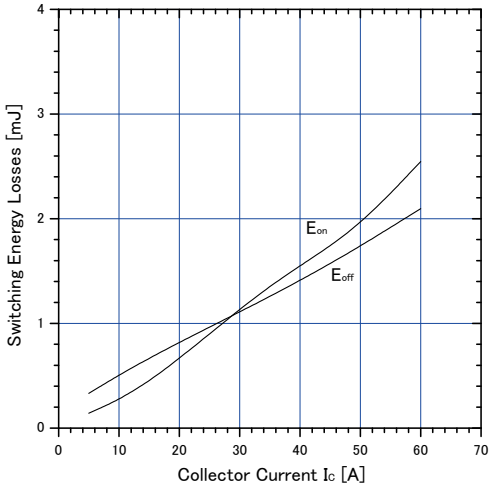

Graph.9
Typical switching time vs. $I_C$
$T_j$=175°C,$V_{CC}$=400V,L=500µH
$V_{GE}$=15V,$R_G$=10Ω



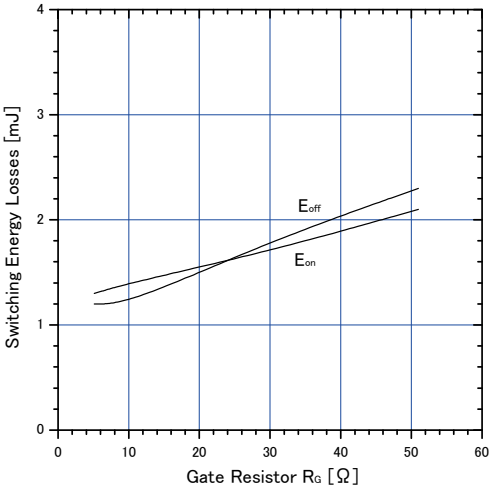

Graph.10
Typical switching time vs. $R_G$
$T_j$=175°C,$V_{CC}$=400V,$I_C$=35A,L=500µH
$V_{GE}$=15V



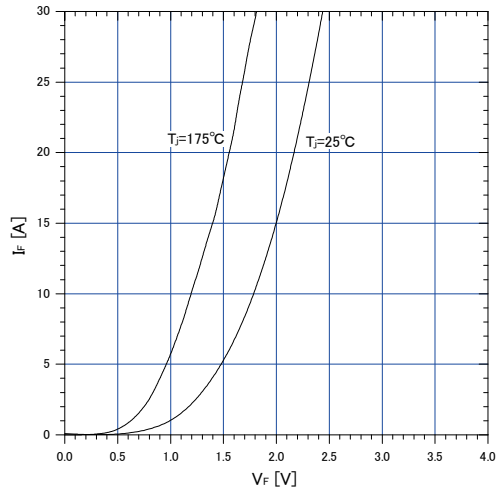

Graph.11
Typical switching losses vs. $I_C$
$T_j$=175°C,$V_{CC}$=400V,L=500µH
$V_{GE}$=15V,$R_G$=10Ω



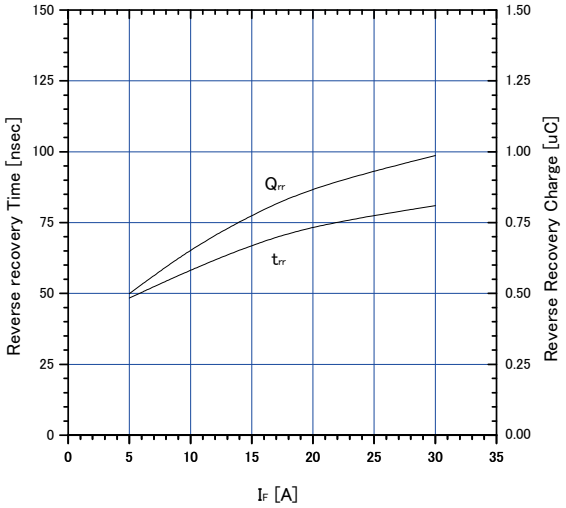

Graph.12
Typical switching losses vs. $R_G$
$T_j$=175°C,$V_{CC}$=400V,$I_C$=35A,L=500µH
$V_{GE}$=15V



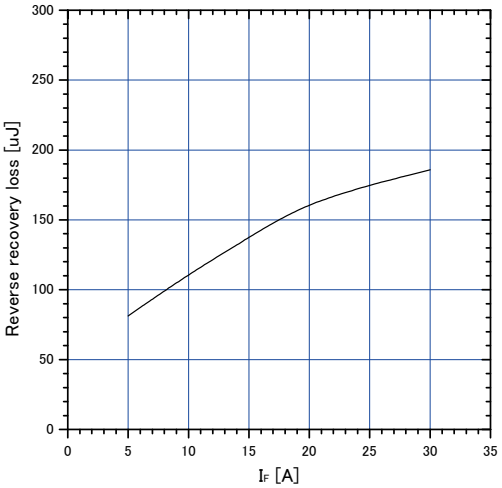
Graph.13
FWD Forward voltage drop ($V_F$-$I_F$)



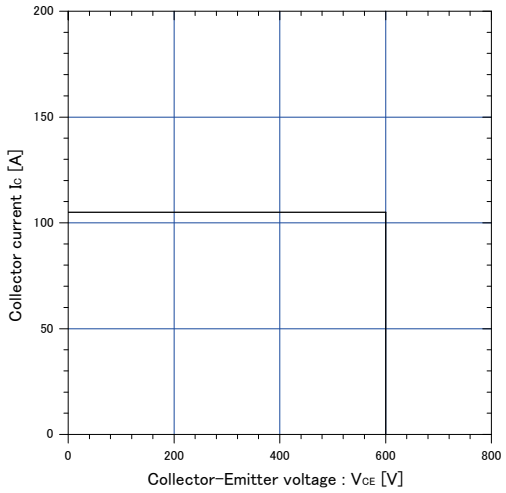

Graph.14
Typical reverse recovery characteristics vs. $I_F$
$T_j$=175°C, $V_{CC}$=400V, L=500µH
$V_{GE}$=15V, $R_G$=10Ω



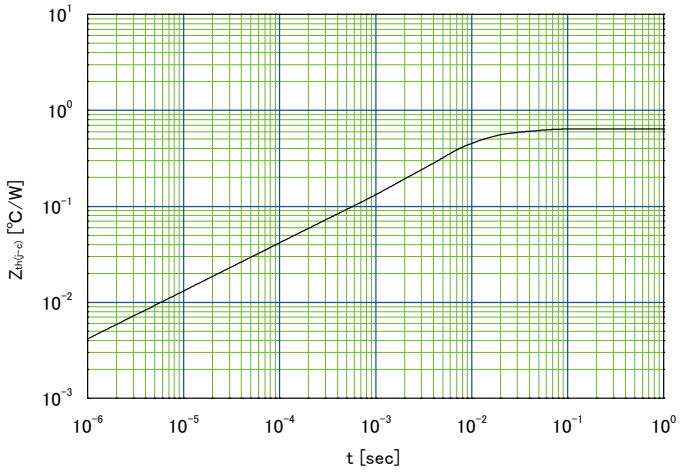

Graph.15
Typical reverse recovery loss vs. $I_F$
$T_j$=175°C, $V_{CC}$=400V, L=500µH
$V_{GE}$=15V, $R_G$=10Ω



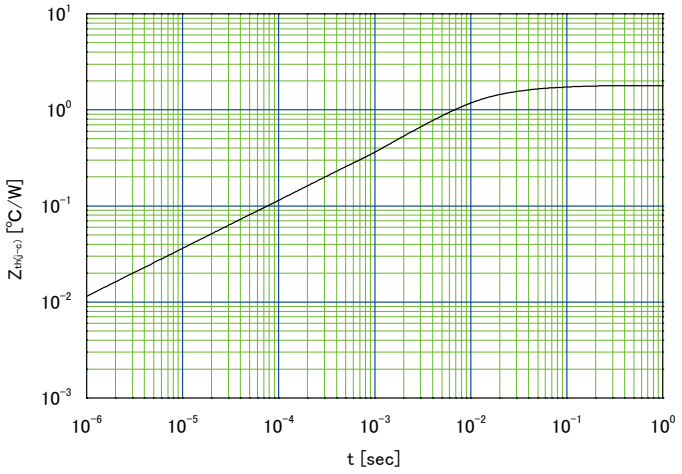

Graph.16
Reverse biased Safe Operating Area
$T_j$≤175°C, $V_{GE}$=+15V/0V, $R_G$=10Ω



Graph.17
Transient thermal resistance of IGBT

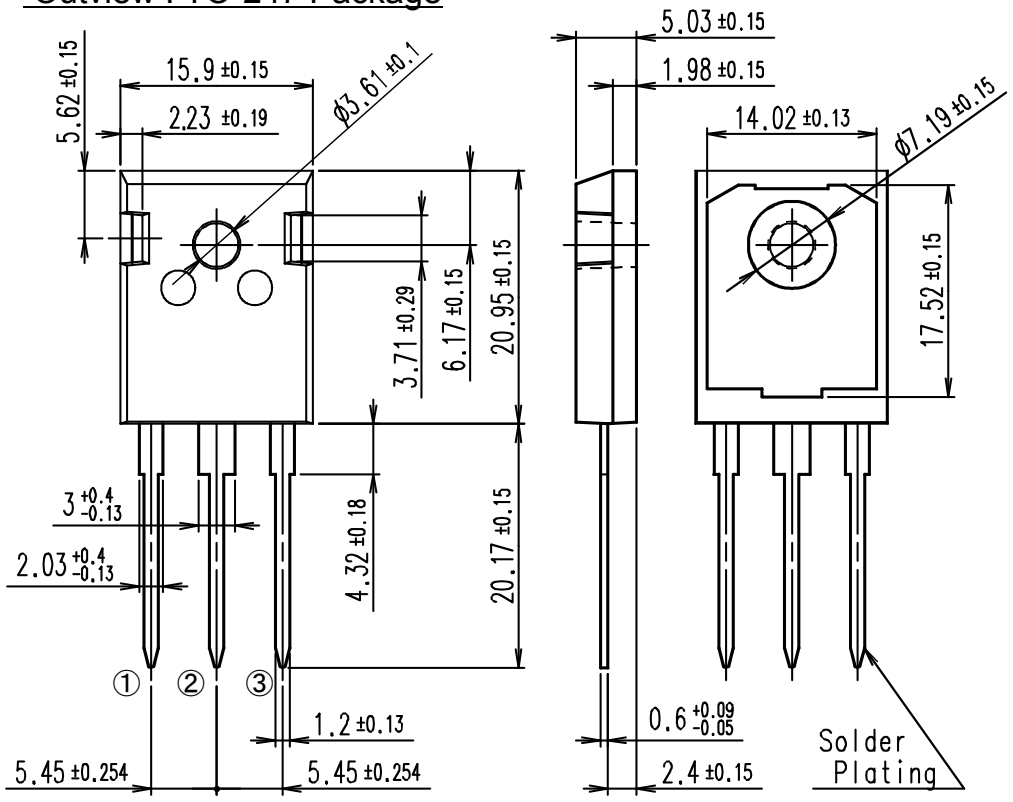


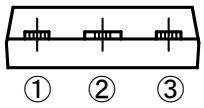

Graph.18
Transient thermal resistance of FWD



## ■ Outline Drawings, mm

Outview : TO-247 Package




CONNECTION

① GATE

② COLLECTOR

③ EMITTER

DIMENSIONS ARE IN MILLIMETERS.

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