

# FGW50N60HD

Discrete IGBT

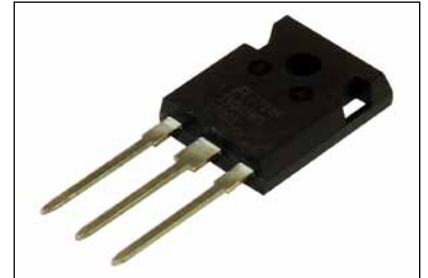
## Discrete IGBT (High-Speed V series) 600V / 50A

### ■ Features

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

### ■ Applications

- Uninterruptible power supply
- Power conditioner
- Power factor correction circuit



### ■ Maximum Ratings and Characteristics

#### ● Absolute Maximum Ratings (at $T_c=25^\circ\text{C}$ unless otherwise specified)

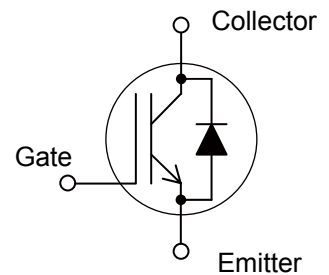
| Items                          | Symbols       | Characteristics | Units            | Remarks                                                                        |
|--------------------------------|---------------|-----------------|------------------|--------------------------------------------------------------------------------|
| Collector-Emitter Voltage      | $V_{CES}$     | 600             | V                |                                                                                |
| Gate-Emitter Voltage           | $V_{GES}$     | $\pm 20$        | V                |                                                                                |
| DC Collector Current           | $I_{C@25}$    | 95              | A                | $T_c=25^\circ\text{C}, T_j=150^\circ\text{C}$                                  |
|                                | $I_{C@100}$   | 50              | A                | $T_c=100^\circ\text{C}, T_j=150^\circ\text{C}$                                 |
| Pulsed Collector Current       | $I_{CP}$      | 150             | A                | Note *1                                                                        |
| Turn-Off Safe Operating Area   | -             | 150             | A                | $V_{CE} \leq 600\text{V}, T_j \leq 175^\circ\text{C}$                          |
| Diode Forward Current          | $I_{F@25}$    | 43              | A                |                                                                                |
|                                | $I_{F@100}$   | 25              | A                |                                                                                |
| Diode Pulsed Current           | $I_{FP}$      | 150             | A                | Note *1                                                                        |
| Short Circuit Withstand Time   | $t_{SC}$      | 5               | $\mu\text{s}$    | $V_{CC} \leq 300\text{V}, V_{GE} = 12\text{V}$<br>$T_j \leq 150^\circ\text{C}$ |
| IGBT Max. Power Dissipation    | $P_{D\_IGBT}$ | 360             | W                | $T_c=25^\circ\text{C}$                                                         |
| FWD Max. Power Dissipation     | $P_{D\_FWD}$  | 125             | W                | $T_c=25^\circ\text{C}$                                                         |
| Operating Junction Temperature | $T_j$         | $-40 \sim +175$ | $^\circ\text{C}$ |                                                                                |
| Storage Temperature            | $T_{stg}$     | $-55 \sim +175$ | $^\circ\text{C}$ |                                                                                |

Note \*1 : Pulse width limited by  $T_{jmax}$ .

#### ● Electrical characteristics (at $T_j=25^\circ\text{C}$ unless otherwise specified)

| Items                                | Symbols       | Conditions                                                            | Characteristics |      |      | Units         |
|--------------------------------------|---------------|-----------------------------------------------------------------------|-----------------|------|------|---------------|
|                                      |               |                                                                       | min.            | typ. | max. |               |
| Collector-Emitter Breakdown Voltage  | $V_{(BR)CES}$ | $I_C = 250\mu\text{A}, V_{GE} = 0\text{V}$                            | 600             | -    | -    | V             |
| Zero Gate Voltage Collector Current  | $I_{CES}$     | $V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$                            | -               | -    | 250  | $\mu\text{A}$ |
| Gate-Emitter Leakage Current         | $I_{GES}$     | $V_{CE} = 0\text{V}, V_{GE} = \pm 20\text{V}$                         | -               | -    | 10   | nA            |
| Gate-Emitter Threshold Voltage       | $V_{GE(th)}$  | $V_{CE} = +20\text{V}, I_C = 50\text{mA}$                             | 4.0             | 5.0  | 6.0  | V             |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE} = +15\text{V}, I_C = 50\text{A}$                              | -               | 1.50 | 1.95 | V             |
| Input Capacitance                    | $C_{ies}$     | $V_{CE}=25\text{V}$                                                   | -               | 4320 | -    | pF            |
| Output Capacitance                   | $C_{oes}$     | $V_{GE}=0\text{V}$                                                    | -               | 210  | -    | pF            |
| Reverse Transfer Capacitance         | $C_{res}$     | $f=1\text{MHz}$                                                       | -               | 160  | -    | pF            |
| Gate Charge                          | $Q_G$         | $V_{CC} = 400\text{V}$<br>$I_C = 50\text{A}$<br>$V_{GE} = 15\text{V}$ | -               | 305  | -    | nC            |
| Turn-On Delay Time                   | $t_{d(on)}$   | $T_j = 25^\circ\text{C}$                                              | -               | 35   | -    | ns            |
| Rise Time                            | $t_r$         | $V_{CC} = 400\text{V}$                                                | -               | 75   | -    | ns            |
| Turn-Off Delay Time                  | $t_{d(off)}$  | $I_C = 50\text{A}$                                                    | -               | 310  | -    | ns            |
| Fall Time                            | $t_f$         | $V_{GE} = 15\text{V}$                                                 | -               | 60   | -    | ns            |
| Turn-On Energy                       | $E_{on}$      | $R_G = 10\Omega$<br>$L = 500\mu\text{H}$                              | -               | 1.4  | -    | mJ            |
| Turn-Off Energy                      | $E_{off}$     | Energy loss include "tail" and FWD reverse recovery.                  | -               | 1.7  | -    | mJ            |
| Turn-On Delay Time                   | $t_{d(on)}$   | $T_j = 175^\circ\text{C}$                                             | -               | 40   | -    | ns            |
| Rise Time                            | $t_r$         | $V_{CC} = 400\text{V}$                                                | -               | 85   | -    | ns            |
| Turn-Off Delay Time                  | $t_{d(off)}$  | $I_C = 50\text{A}$                                                    | -               | 335  | -    | ns            |
| Fall Time                            | $t_f$         | $V_{GE} = 15\text{V}$                                                 | -               | 72   | -    | ns            |
| Turn-On Energy                       | $E_{on}$      | $R_G = 10\Omega$<br>$L = 500\mu\text{H}$                              | -               | 2.4  | -    | mJ            |
| Turn-Off Energy                      | $E_{off}$     | Energy loss include "tail" and FWD reverse recovery.                  | -               | 2.2  | -    | mJ            |

### ■ Equivalent circuit



## ● FWD Characteristics

| Description                   | Symbol    | Conditions                                      | Characteristics |      |      | Unit    |
|-------------------------------|-----------|-------------------------------------------------|-----------------|------|------|---------|
|                               |           |                                                 | min.            | typ. | max. |         |
| Forward Voltage Drop          | $V_F$     | $I_F=25A$                                       | -               | 2.0  | 2.6  | V       |
|                               |           | $T_J=25^{\circ}C$<br>$T_J=175^{\circ}C$         | -               | 1.4  | -    | V       |
| Diode Reverse Recovery Time   | $t_{rr1}$ | $V_{CC}=30V, I_F = 2.5A$<br>$-di/dt=200A/\mu s$ | -               | 25   | 33   | ns      |
| Diode Reverse Recovery Time   | $t_{rr2}$ | $V_{CC}=400V$<br>$I_F=25A$                      | -               | 0.04 | -    | $\mu s$ |
| Diode Reverse Recovery Charge | $Q_{rr}$  | $-di_F/dt=200A/\mu s$<br>$T_J=25^{\circ}C$      | -               | 0.08 | -    | $\mu C$ |
| Diode Reverse Recovery Time   | $t_{rr2}$ | $V_{CC}=400V$<br>$I_F=25A$                      | -               | 0.16 | -    | $\mu s$ |
| Diode Reverse Recovery Charge | $Q_{rr}$  | $-di_F/dt=200A/\mu s$<br>$T_J=175^{\circ}C$     | -               | 0.75 | -    | $\mu C$ |

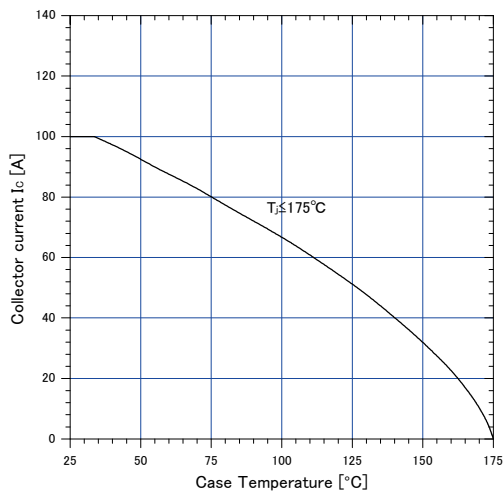
## ● Thermal resistance characteristics

| Items                                     | Symbols              | Conditions | Characteristics |      |       | Units         |
|-------------------------------------------|----------------------|------------|-----------------|------|-------|---------------|
|                                           |                      |            | min.            | typ. | max.  |               |
| Thermal Resistance, Junction-Ambient      | $R_{th(j-a)}$        | -          | -               | -    | 50    | $^{\circ}C/W$ |
| Thermal Resistance, IGBT Junction to Case | $R_{th(j-c)}_{IGBT}$ | -          | -               | -    | 0.417 |               |
| Thermal Resistance, FWD Junction to Case  | $R_{th(j-c)}_{FWD}$  | -          | -               | -    | 1.191 |               |

## ■ Characteristics (Representative)

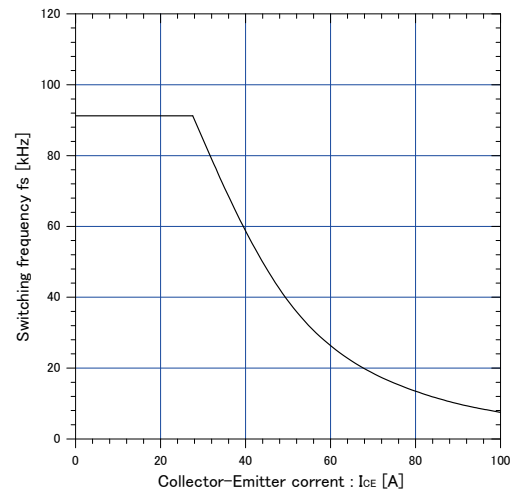
Graph.1

DC Collector Current vs  $T_c$   
 $V_{GE} \geq +15V$ ,  $T_J \leq 175^\circ C$



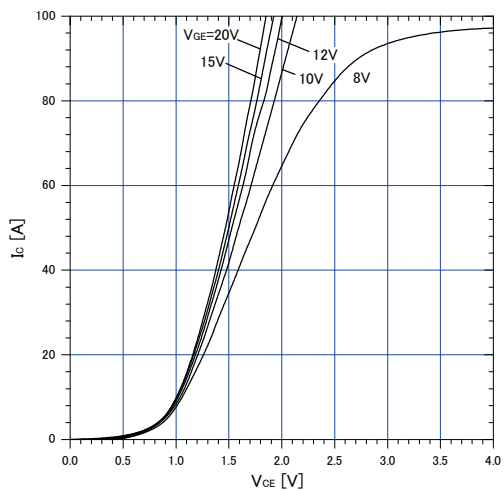
Graph.2

Collector Current vs. switching frequency  
 $V_{GE} = +15V$ ,  $T_c \leq 175^\circ C$ ,  $V_{CE} = 400V$ ,  $D = 0.5$ ,  
 $R_G = 10\Omega$ ,  $T_c = 100^\circ C$



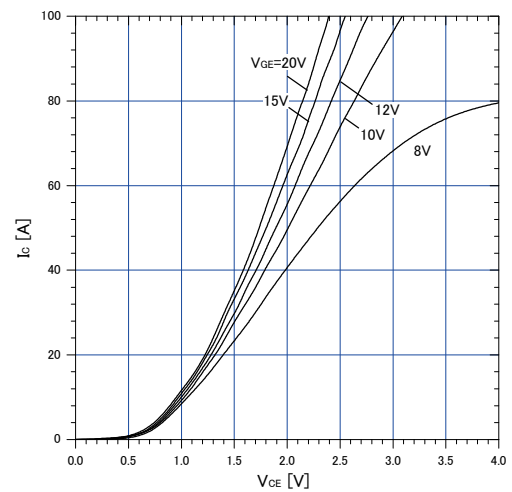
Graph.3

Typical Output Characteristics ( $V_{CE} - I_c$ )  
 $T_J = 25^\circ C$



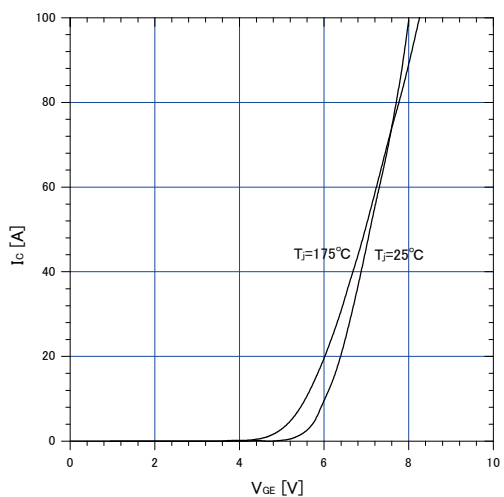
Graph.4

Typical Output Characteristics ( $V_{CE} - I_c$ )  
 $T_J = 175^\circ C$



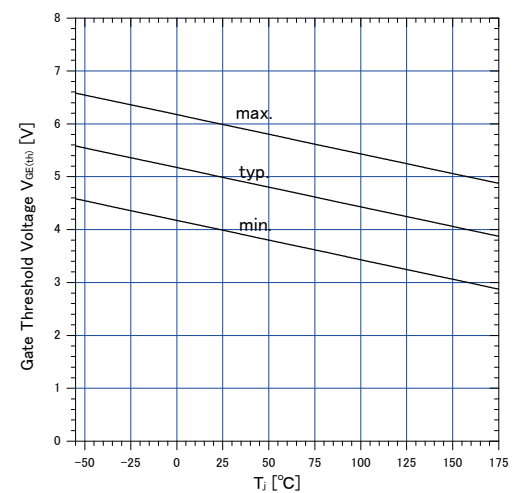
Graph.5

Typical Transfer Characteristics  
 $V_{CE} = +15V$

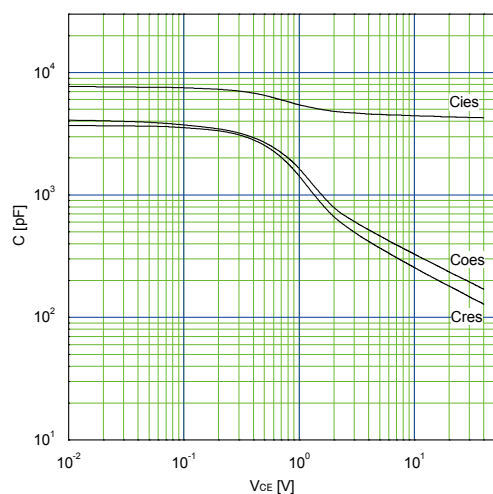


Graph.6

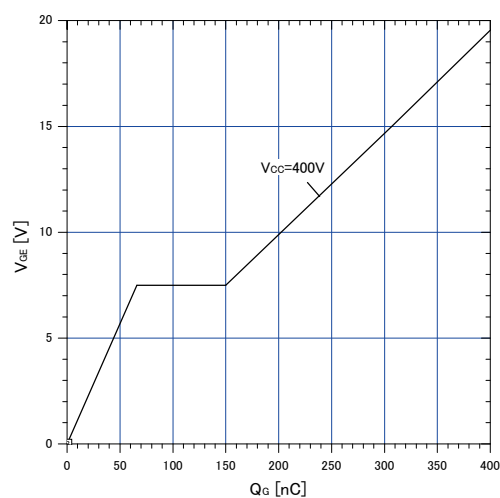
Gate Threshold Voltage vs.  $T_J$   
 $I_c = 50mA$ ,  $V_{CE} = 20V$



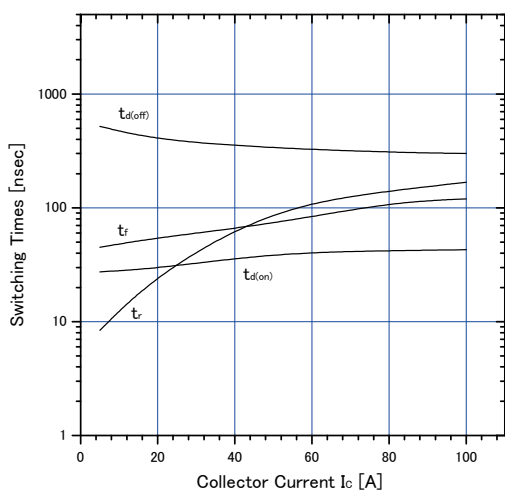
Graph.7  
Typical Capacitance  
 $V_{GE}=0V, f=1MHz, T_J=25^{\circ}C$



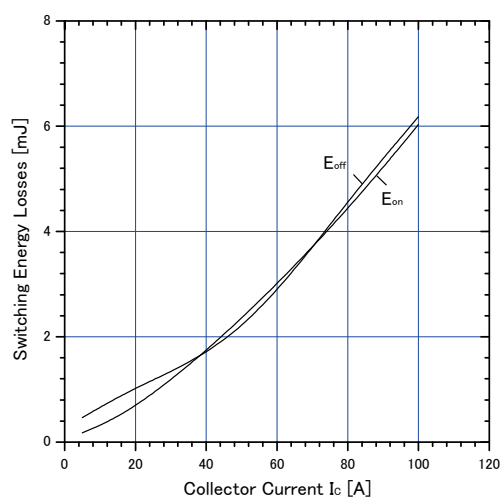
Graph.8  
Typical Gate Charge  
 $V_{CC}=400V, I_C=50A, T_J=25^{\circ}C$



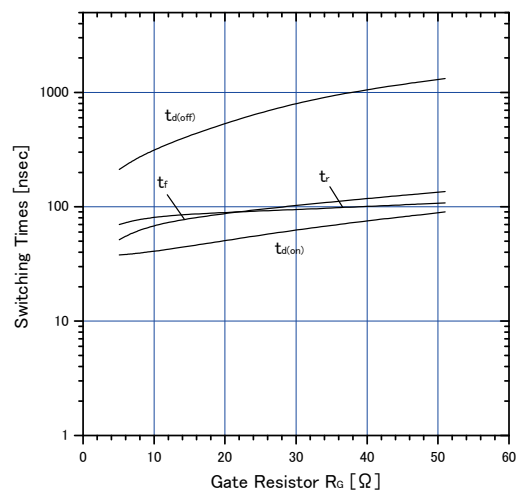
Graph.9  
Typical switching time vs.  $I_C$   
 $T_J=175^{\circ}C, V_{CC}=400V, L=500\mu H$   
 $V_{GE}=15V, R_G=10\Omega$



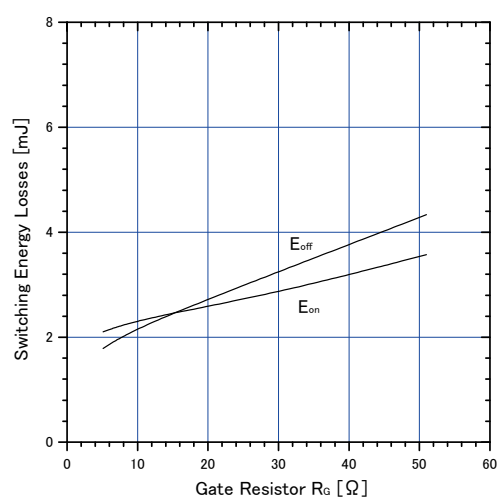
Graph.11  
Typical switching losses vs.  $I_C$   
 $T_J=175^{\circ}C, V_{CC}=400V, L=500\mu H$   
 $V_{GE}=15V, R_G=10\Omega$



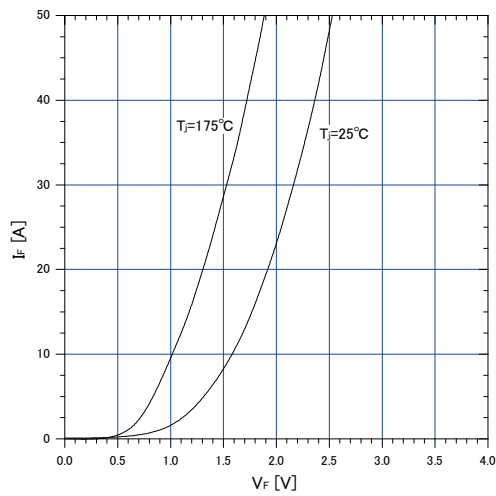
Graph.10  
Typical switching time vs.  $R_G$   
 $T_J=175^{\circ}C, V_{CC}=400V, I_C=50A, L=500\mu H$   
 $V_{GE}=15V$



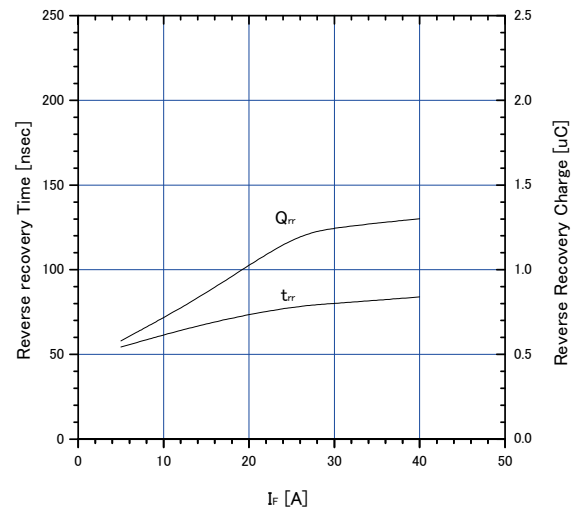
Graph.12  
Typical switching losses vs.  $R_G$   
 $T_J=175^{\circ}C, V_{CC}=400V, I_C=50A, L=500\mu H$   
 $V_{GE}=15V$



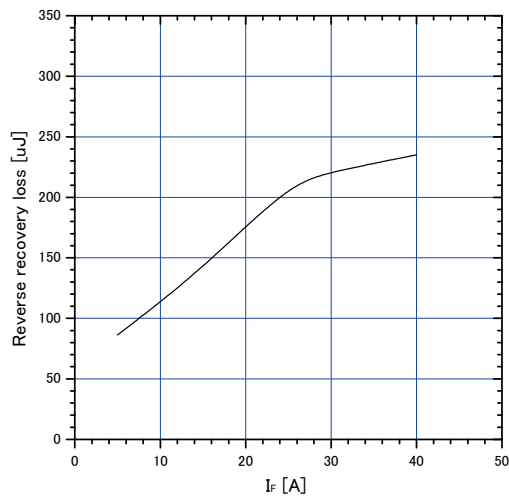
Graph.13  
FWD Forward voltage drop ( $V_F-I_F$ )



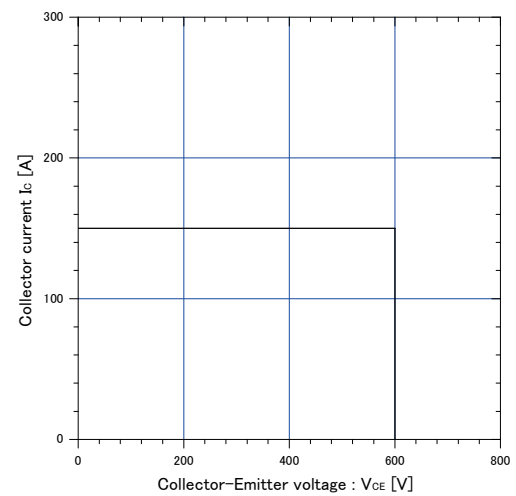
Graph.14  
Typical reverse recovery characteristics vs.  $I_F$   
 $T_J = 175^\circ\text{C}$ ,  $V_{CC} = 400\text{V}$ ,  $L = 500\mu\text{H}$   
 $V_{GE} = 15\text{V}$ ,  $R_G = 10\Omega$



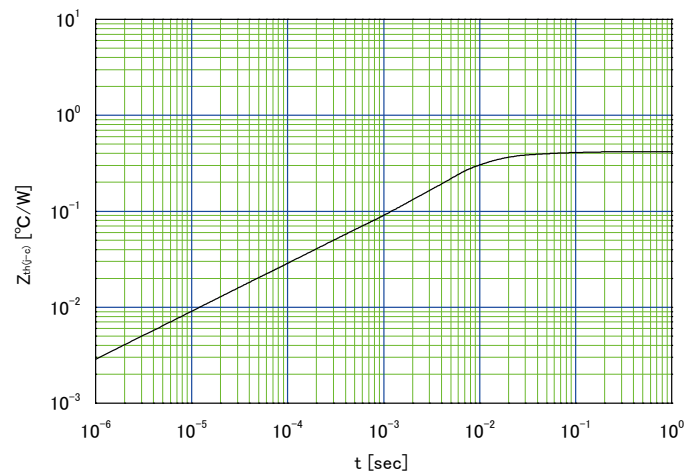
Graph.15  
Typical reverse recovery loss vs.  $I_F$   
 $T_J = 175^\circ\text{C}$ ,  $V_{CC} = 400\text{V}$ ,  $L = 500\mu\text{H}$   
 $V_{GE} = 15\text{V}$ ,  $R_G = 10\Omega$



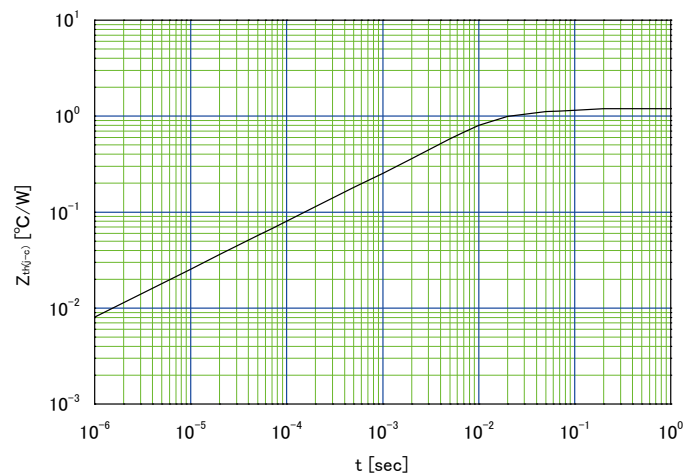
Graph.16  
Reverse biased Safe Operating Area  
 $T_J \leq 175^\circ\text{C}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $R_G = 10\Omega$



Graph.17  
Transient thermal resistance of IGBT

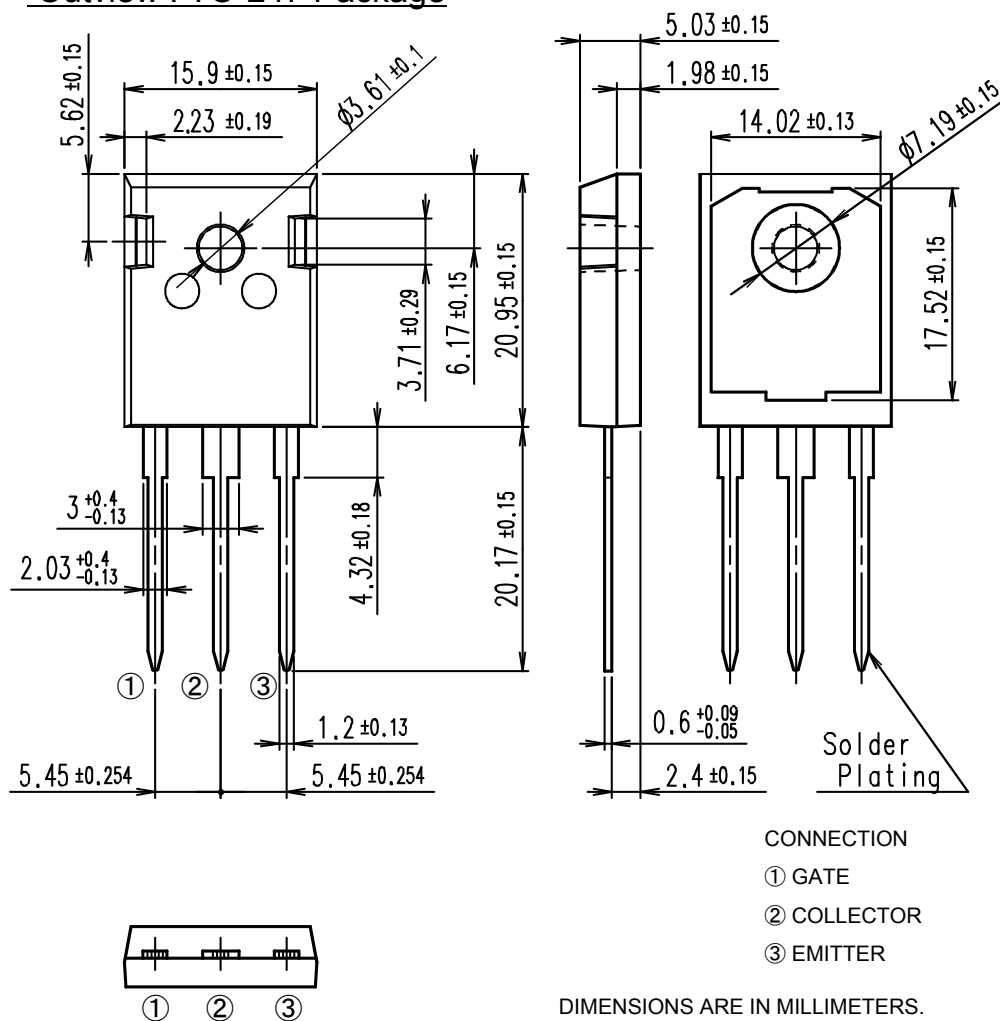


Graph.18  
Transient thermal resistance of FWD



### ■ Outline Drawings, mm

### Outview : TO-247 Package



DIMENSIONS ARE IN MILLIMETERS.

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|                 |                         |                                               |                          |
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| • Machine tools | • Audiovisual equipment | • Electrical home appliances                  | • Personal equipment     |
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|                                                                             |                                                       |
|-----------------------------------------------------------------------------|-------------------------------------------------------|
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|                                |                        |                             |
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