

# FGW35N60HD

Discrete IGBT

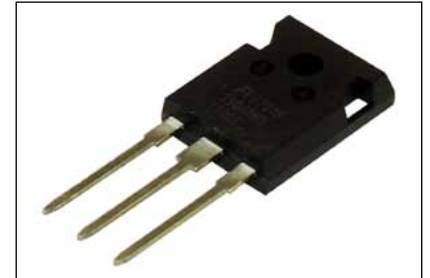
## Discrete IGBT (High-Speed V series) 600V / 35A

### ■ Features

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

### ■ Applications

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



### ■ Maximum Ratings and Characteristics

#### ● Absolute Maximum Ratings (at T<sub>c</sub>=25°C unless otherwise specified)

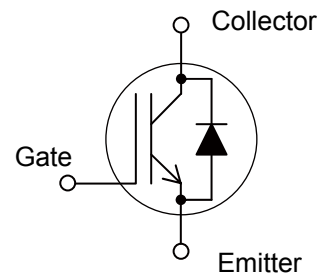
Items	Symbols	Characteristics	Units	Remarks
Collector-Emitter Voltage	V <sub>CEs</sub>	600	V	
Gate-Emitter Voltage	V <sub>GES</sub>	±20	V	
DC Collector Current	I <sub>C@25</sub>	64	A	T <sub>c</sub> =25°C, T <sub>j</sub> =150°C
	I <sub>C@100</sub>	35	A	T <sub>c</sub> =100°C, T <sub>j</sub> =150°C
Pulsed Collector Current	I <sub>CP</sub>	105	A	Note *1
Turn-Off Safe Operating Area	-	105	A	V <sub>CE</sub> ≤600V, T <sub>j</sub> ≤175°C
Diode Forward Current	I <sub>F@25</sub>	30	A	
	I <sub>F@100</sub>	15	A	
Diode Pulsed Current	I <sub>FP</sub>	105	A	Note *1
Short Circuit Withstand Time	t <sub>SC</sub>	5	μs	V <sub>CC</sub> ≤300V, V <sub>GE</sub> =12V T <sub>j</sub> ≤150°C
IGBT Max. Power Dissipation	P <sub>D,IGBT</sub>	230	W	T <sub>c</sub> =25°C
FWD Max. Power Dissipation	P <sub>D,FWD</sub>	80	W	T <sub>c</sub> =25°C
Operating Junction Temperature	T <sub>j</sub>	-40 ~ +175	°C	
Storage Temperature	T <sub>stg</sub>	-55 ~ +175	°C	

Note \*1 : Pulse width limited by T<sub>jmax</sub>.

#### ● Electrical characteristics (at T<sub>j</sub>= 25°C unless otherwise specified)

Items	Symbols	Conditions	Characteristics			Units	
			min.	typ.	max.		
Collector-Emitter Breakdown Voltage	V <sub>(BR)CES</sub>	I <sub>c</sub> = 250μA, V <sub>GE</sub> = 0V	600	-	-	V	
Zero Gate Voltage Collector Current	I <sub>CES</sub>	V <sub>CE</sub> = 600V, V <sub>GE</sub> = 0V	T <sub>j</sub> =25°C	-	-	250	μA
			T <sub>j</sub> =175°C	-	-	10	mA
Gate-Emitter Leakage Current	I <sub>GES</sub>	V <sub>CE</sub> = 0V, V <sub>GE</sub> = ±20V	-	-	200	nA	
Gate-Emitter Threshold Voltage	V <sub>GE(th)</sub>	V <sub>CE</sub> = +20V, I <sub>c</sub> = 35mA	4.0	5.0	6.0	V	
Collector-Emitter Saturation Voltage	V <sub>CE(sat)</sub>	V <sub>GE</sub> = +15V, I <sub>c</sub> = 35A	T <sub>j</sub> =25°C	-	1.50	1.95	V
			T <sub>j</sub> =175°C	-	1.80	-	
Input Capacitance	C <sub>ies</sub>	V <sub>CE</sub> =25V	-	2800	-	pF	
Output Capacitance	C <sub>oes</sub>	V <sub>GE</sub> =0V	-	140	-		
Reverse Transfer Capacitance	C <sub>res</sub>	f=1MHz	-	100	-		
Gate Charge	Q <sub>G</sub>	V <sub>CC</sub> = 400V I <sub>c</sub> = 35A V <sub>GE</sub> = 15V	-	210	-	nC	
Turn-On Delay Time	t <sub>d(on)</sub>	T <sub>j</sub> = 25°C	-	32	-	ns	
Rise Time	t <sub>r</sub>	V <sub>CC</sub> = 400V	-	60	-		
Turn-Off Delay Time	t <sub>d(off)</sub>	I <sub>c</sub> = 35A	-	200	-		
Fall Time	t <sub>f</sub>	V <sub>GE</sub> = 15V	-	40	-		
Turn-On Energy	E <sub>on</sub>	R <sub>GE</sub> = 10Ω L = 500μH	-	0.90	-	mJ	
Turn-Off Energy	E <sub>off</sub>	Energy loss include "tail" and FWD reverse recovery.	-	0.85	-		
Turn-On Delay Time	t <sub>d(on)</sub>	T <sub>j</sub> = 175°C	-	33	-	ns	
Rise Time	t <sub>r</sub>	V <sub>CC</sub> = 400V	-	60	-		
Turn-Off Delay Time	t <sub>d(off)</sub>	I <sub>c</sub> = 35A	-	225	-		
Fall Time	t <sub>f</sub>	V <sub>GE</sub> = 15V	-	50	-		
Turn-On Energy	E <sub>on</sub>	R <sub>GE</sub> = 10Ω L = 500μH	-	1.40	-	mJ	
Turn-Off Energy	E <sub>off</sub>	Energy loss include "tail" and FWD reverse recovery.	-	1.25	-		

### ■ Equivalent circuit



● FWD Characteristics

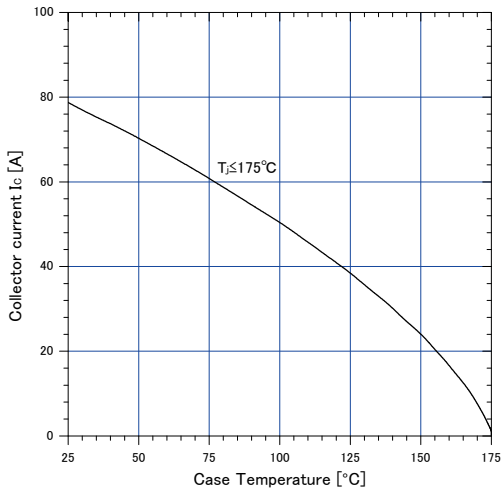
Description	Symbol	Conditions	Characteristics			Unit	
			min.	typ.	max.		
Forward Voltage Drop	$V_F$	$I_F=15A$	$T_J=25^{\circ}C$	-	2.0	2.6	V
			$T_J=175^{\circ}C$	-	1.4	-	V
Diode Reverse Recovery Time	$t_{rr1}$	$V_{CC}=30V, I_F = 1.5A$ $-di/dt=200A/\mu s$	-	24	31	ns	
Diode Reverse Recovery Time	$t_{rr2}$	$V_{CC}=400V$ $I_F=15A$	-	0.03	-	$\mu s$	
Diode Reverse Recovery Charge	$Q_{rr}$	$-di_F/dt=200A/\mu s$ $T_J=25^{\circ}C$	-	0.06	-	$\mu C$	
Diode Reverse Recovery Time	$t_{rr2}$	$V_{CC}=400V$ $I_F=15A$	-	0.15	-	$\mu s$	
Diode Reverse Recovery Charge	$Q_{rr}$	$-di_F/dt=200A/\mu s$ $T_J=175^{\circ}C$	-	0.65	-	$\mu C$	

● Thermal resistance characteristics

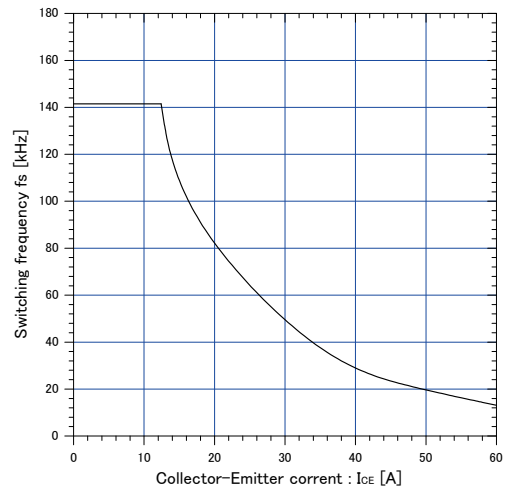
Items	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Thermal Resistance, Junction-Ambient	$R_{th(j-a)}$	-	-	-	50	$^{\circ}C/W$
Thermal Resistance, IGBT Junction to Case	$R_{th(j-c)}_{IGBT}$	-	-	-	0.641	
Thermal Resistance, FWD Junction to Case	$R_{th(j-c)}_{FWD}$	-	-	-	1.786	

■ Characteristics (Representative)

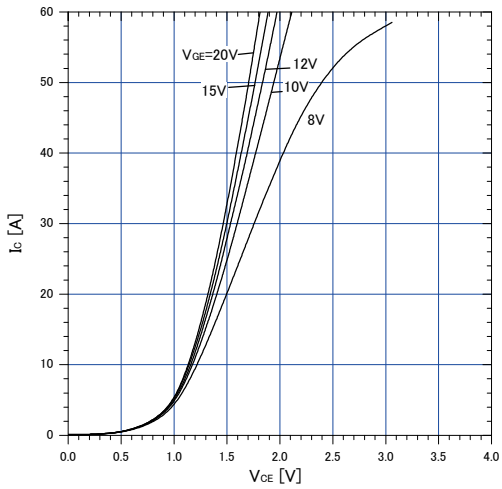
Graph.1  
DC Collector Current vs  $T_c$   
 $V_{GE} \geq +15V, T_c \leq 175^\circ C$



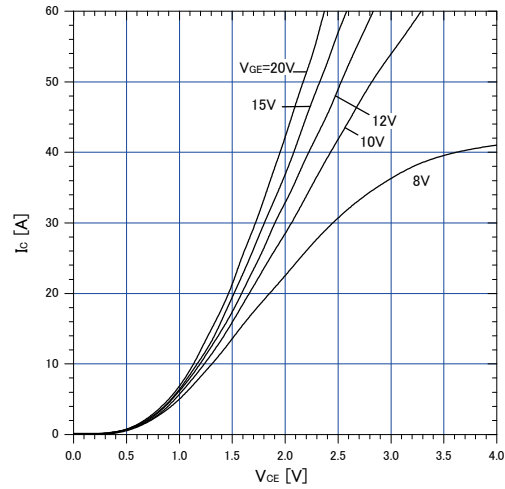
Graph.2  
Collector Current vs. switching frequency  
 $V_{GE} = +15V, T_c \leq 175^\circ C, V_{CE} = 400V, D = 0.5, R_G = 10\Omega, T_c = 100^\circ C$



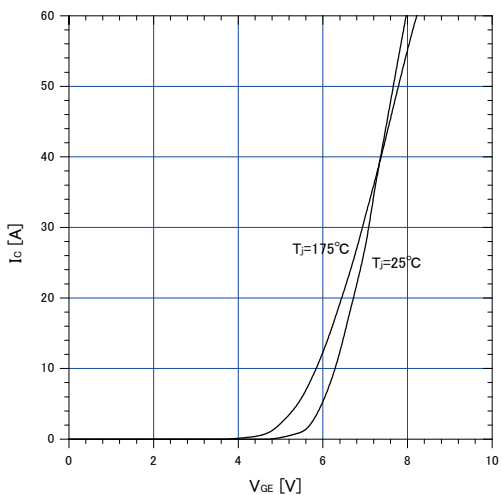
Graph.3  
Typical Output Characteristics ( $V_{CE}-I_c$ )  
 $T_j = 25^\circ C$



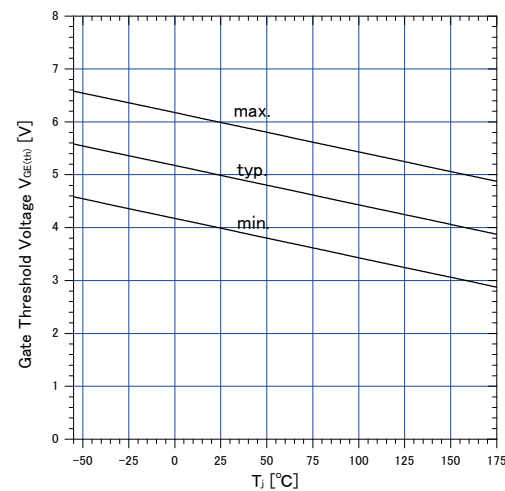
Graph.4  
Typical Output Characteristics ( $V_{CE}-I_c$ )  
 $T_j = 175^\circ C$



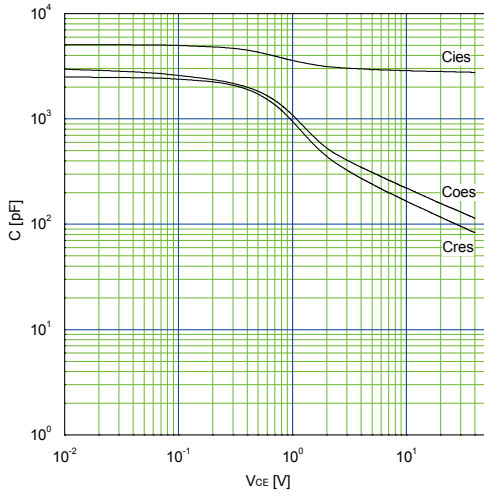
Graph.5  
Typical Transfer Characteristics  
 $V_{GE} = +15V$



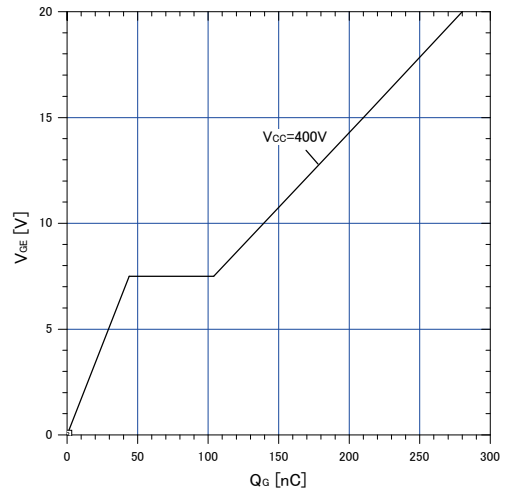
Graph.6  
Gate Threshold Voltage vs.  $T_j$   
 $I_c = 35mA, V_{CE} = 20V$



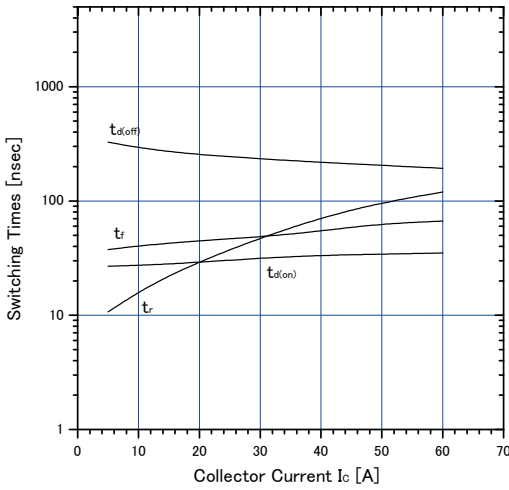
Graph.7  
Typical Capacitance  
 $V_{GE}=0V, f=1MHz, T_j=25^{\circ}C$



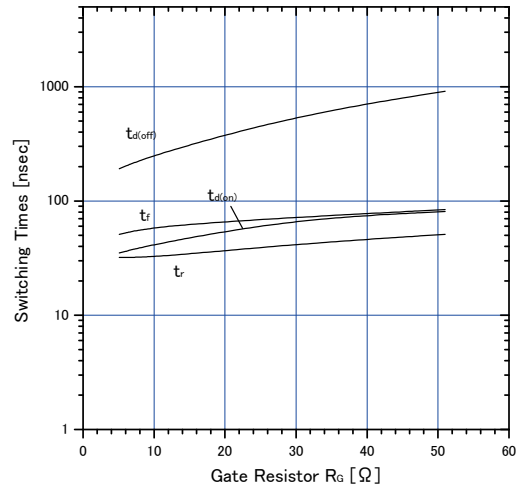
Graph.8  
Typical Gate Charge  
 $V_{CC}=400V, I_c=35A, T_j=25^{\circ}C$



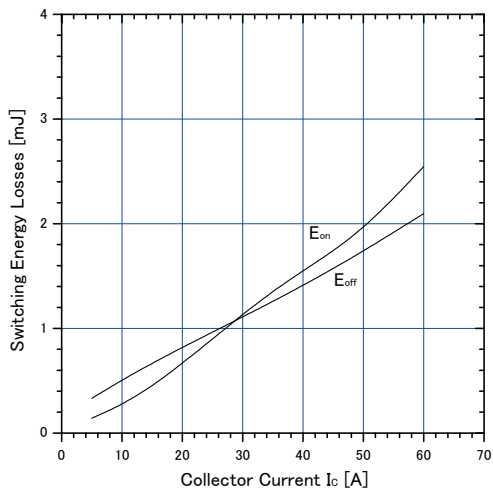
Graph.9  
Typical switching time vs.  $I_c$   
 $T_j=175^{\circ}C, V_{CC}=400V, L=500\mu H$   
 $V_{GE}=15V, R_G=10\Omega$



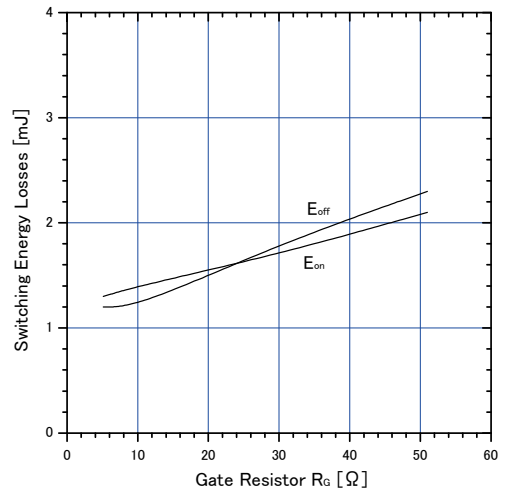
Graph.10  
Typical switching time vs.  $R_G$   
 $T_j=175^{\circ}C, V_{CC}=400V, I_c=35A, L=500\mu H$   
 $V_{GE}=15V$



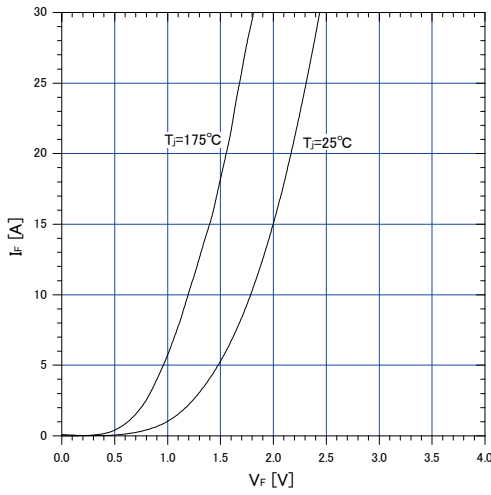
Graph.11  
Typical switching losses vs.  $I_c$   
 $T_j=175^{\circ}C, V_{CC}=400V, L=500\mu H$   
 $V_{GE}=15V, R_G=10\Omega$



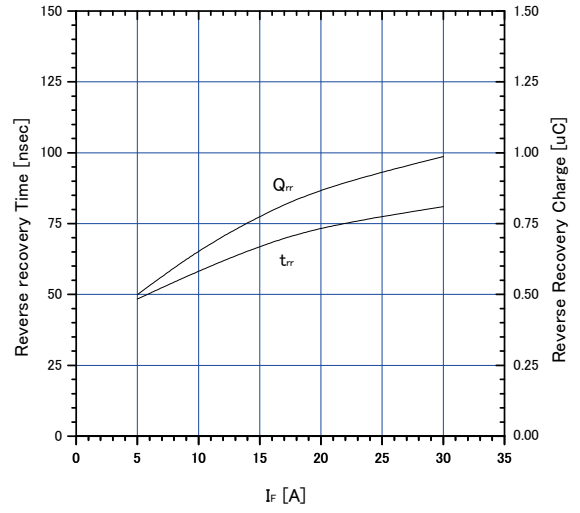
Graph.12  
Typical switching losses vs.  $R_G$   
 $T_j=175^{\circ}C, V_{CC}=400V, I_c=35A, L=500\mu H$   
 $V_{GE}=15V$



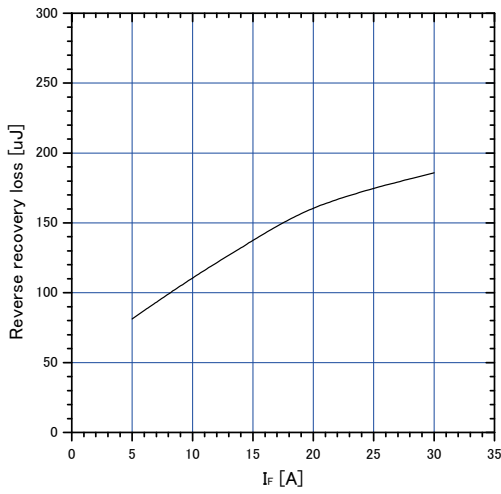
Graph.13  
FWD Forward voltage drop ( $V_F-I_F$ )



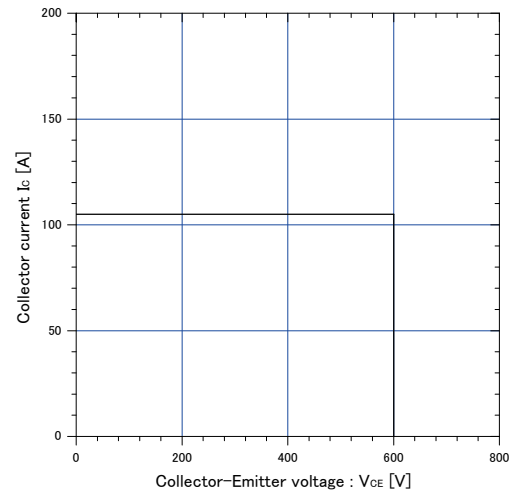
Graph.14  
Typical reverse recovery characteristics vs.  $I_F$   
 $T_j=175^\circ\text{C}$ ,  $V_{CC}=400\text{V}$ ,  $L=500\mu\text{H}$   
 $V_{GE}=15\text{V}$ ,  $R_G=10\Omega$



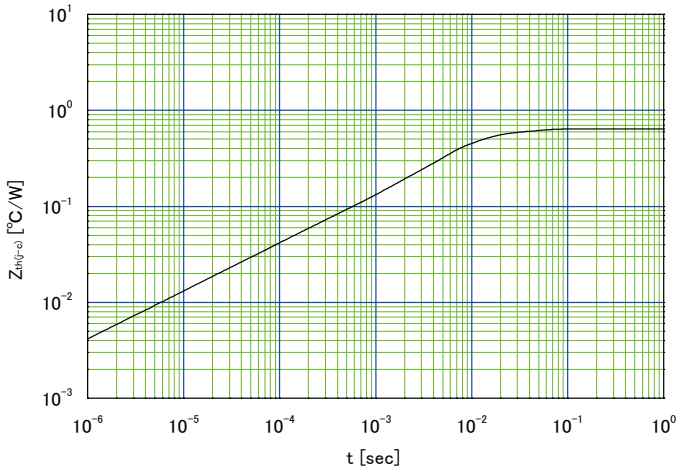
Graph.15  
Typical reverse recovery loss vs.  $I_F$   
 $T_j=175^\circ\text{C}$ ,  $V_{CC}=400\text{V}$ ,  $L=500\mu\text{H}$   
 $V_{GE}=15\text{V}$ ,  $R_G=10\Omega$



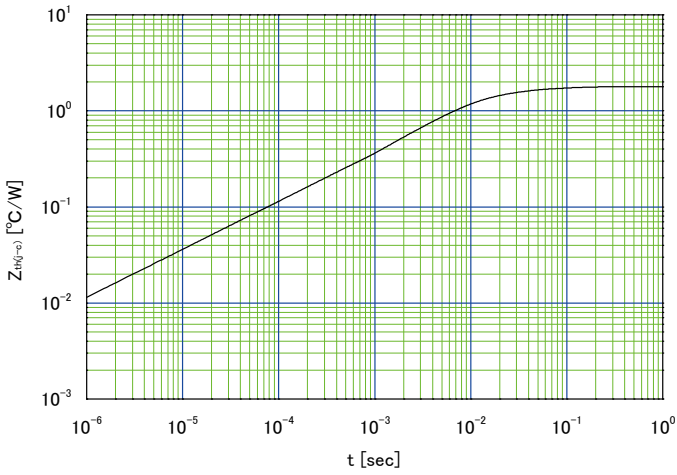
Graph.16  
Reverse biased Safe Operating Area  
 $T_j \leq 175^\circ\text{C}$ ,  $V_{GE}=+15\text{V}/0\text{V}$ ,  $R_G=10\Omega$



Graph.17  
Transient thermal resistance of IGBT

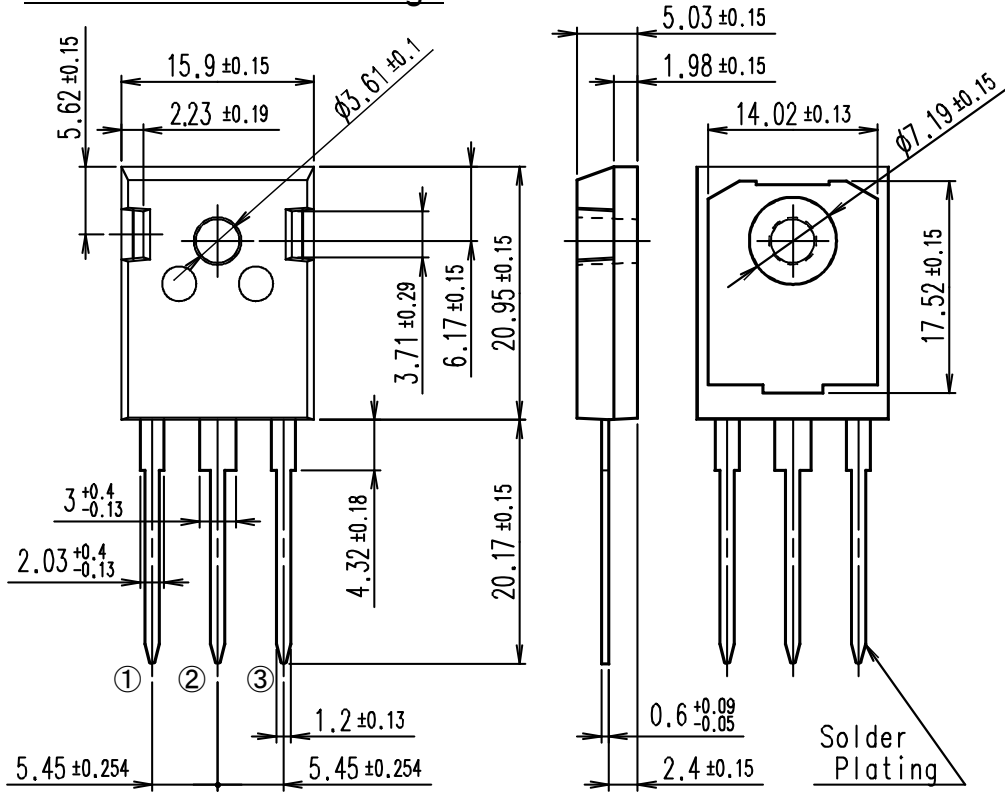


Graph.18  
Transient thermal resistance of FWD



■ Outline Drawings, mm

Outview : TO-247 Package



CONNECTION

- ① GATE
- ② COLLECTOR
- ③ EMITTER

DIMENSIONS ARE IN MILLIMETERS.

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