

### General Description

This IGBT is produced using advanced Magnachip's Field Stop Trench IGBT 2<sup>nd</sup> Generation Technology, which is not only the highest efficiency capable of switching behavior, but also it is high ruggedness and excellent quality for solar inverter, UPS, IH, welder and PFC application where low conduction losses are essential

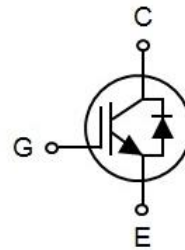
### Features

- High Speed Switching & Low Power Loss
- $V_{CE(sat)} = 1.85V @ I_c = 60A$
- $E_{off} = 0.53mJ @ T_C = 25^\circ C$
- High Input Impedance
- $t_{rr} = 110ns (typ.) @ di_F/dt = 500A/\mu s$
- Maximum Junction Temperature  $175^\circ C$

### Applications

- PFC
- Welder
- UPS
- IH Cooker
- PV Inverter

TO-247



### Maximum Rating

Parameter	Symbol	Rating	Unit
Collector-emitter voltage	$V_{CE}$	650	V
DC collector current, limited by $T_{vjmax}$	$I_c$	$T_C=25^\circ C$	100
		$T_C=100^\circ C$	60
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{cp}$	180	A
Turn off safe operating area $V_{CE} \leq 650V, T_{vj} \leq 175^\circ C$	-	180	A
Diode forward current limited by $T_{vjmax}$	$I_F$	$T_C=25^\circ C$	60
		$T_C=100^\circ C$	30
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fp}$	200	A
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Power dissipation	$P_D$	$T_C=25^\circ C$	535
		$T_C=100^\circ C$	267
Short circuit withstand time $V_{CC} \leq 400V, R_G = 7\Omega, V_{GE} = 15V, T_{vj} = 150^\circ C$	tsc	5	$\mu s$
Operating Junction temperature range	$T_{vj}$	-40~175	$^\circ C$
Storage temperature range	$T_{stg}$	-55~150	$^\circ C$
Soldering temperature Wave soldering 1.6 mm (0.063 in.) from case for 10s		260	$^\circ C$
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

### Thermal Characteristic

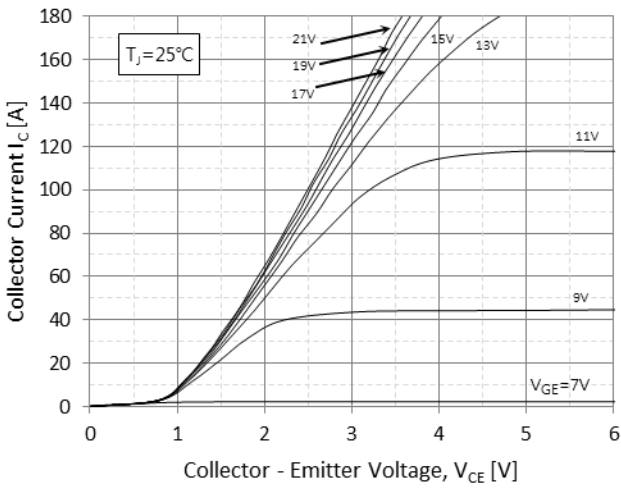
Parameter	Symbol	Rating	Unit
Thermal resistance junction-to-ambient	$R_{\theta JA}$	40	$^\circ C/W$
Thermal resistance junction-to-case for IGBT	$R_{\theta JC}$	0.28	
Thermal resistance junction-to-case for Diode	$R_{\theta JC}$	1.1	

### Ordering Information

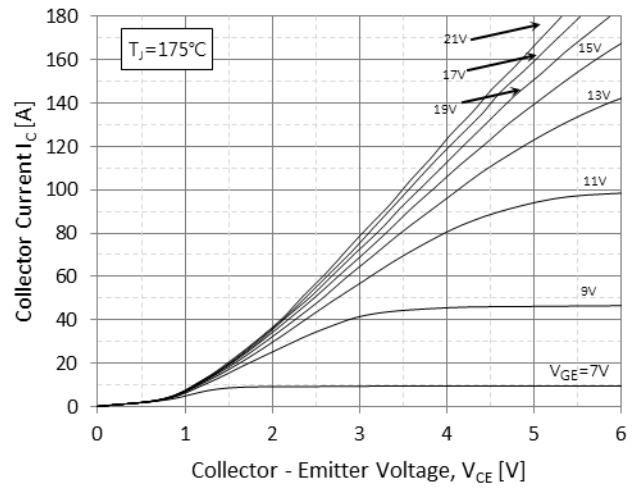
Part Number	Marking	Temp. Range	Package	Packing	RoHS Status
MBQ60T65PESTH	60T65PES	-55~175°C	TO-247	Tube	Halogen Free

### Electrical Characteristic (T<sub>vj</sub> = 25°C unless otherwise specified)

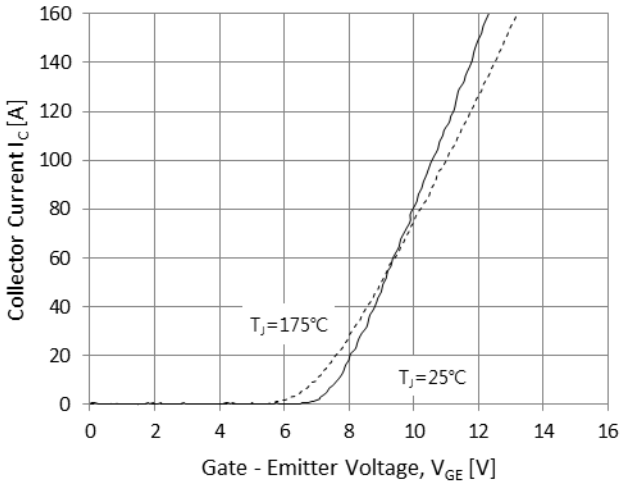
Parameter	Symbol	Conditions	Min	Typ	Max	Unit	
<b>Static Characteristic</b>							
Collector-emitter breakdown voltage	BV <sub>CES</sub>	I <sub>C</sub> = 2mA, V <sub>GE</sub> = 0V	650	-	-	V	
Collector-emitter saturation voltage	V <sub>CE(sat)</sub>	I <sub>C</sub> = 60A, V <sub>GE</sub> = 15V	T <sub>vj</sub> = 25°C	-	1.85	2.4	V
			T <sub>vj</sub> = 175°C	-	2.6	-	
Diode forward voltage	V <sub>F</sub>	V <sub>GE</sub> = 0V, I <sub>F</sub> = 25A	T <sub>vj</sub> = 25°C	-	1.45	2.0	V
			T <sub>vj</sub> = 175°C	-	1.35	-	
Gate-emitter threshold voltage	V <sub>GE(th)</sub>	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 0.5mA	4.0	5.0	6.0	V	
Zero gate voltage collector current	I <sub>CES</sub>	V <sub>CE</sub> = 650V, V <sub>GE</sub> = 0V, T <sub>vj</sub> = 25°C	-	-	40	μA	
Gate-emitter leakage current	I <sub>GES</sub>	V <sub>GE</sub> = 20V, V <sub>CE</sub> = 0V	-	-	±100	nA	
<b>Dynamic Characteristic</b>							
Total gate charge	Q <sub>g</sub>	V <sub>CE</sub> = 520V, I <sub>C</sub> = 60A, V <sub>GE</sub> = 15V	-	95	-	nC	
Gate-emitter charge	Q <sub>ge</sub>		-	19	-		
Gate-collector charge	Q <sub>gc</sub>		-	47	-		
Input capacitance	C <sub>ies</sub>	V <sub>CE</sub> = 25V, V <sub>GE</sub> = 0V, f = 1MHz	-	2327	-	pF	
Reverse transfer capacitance	C <sub>res</sub>		-	55	-		
Output capacitance	C <sub>oes</sub>		-	270	-		
Internal emitter inductance measured 5mm (0.197 in.) from case	LE		-	13.0	-	nH	
<b>Switching Characteristic</b>							
Turn-on delay time	t <sub>d(on)</sub>	V <sub>GE</sub> = 15V, V <sub>CC</sub> = 400V, I <sub>C</sub> = 60A, R <sub>G</sub> = 7Ω, Inductive Load, T <sub>vj</sub> = 25°C	-	42	-	ns	
Rise time	t <sub>r</sub>		-	54	-		
Turn-off delay time	t <sub>d(off)</sub>		-	142	-		
Fall time	t <sub>f</sub>		-	40	-	mJ	
Turn-on switching energy	E <sub>on</sub>		-	0.92	-		
Turn-off switching energy	E <sub>off</sub>		-	0.53	-		
Total switching energy	E <sub>ts</sub>	-	1.45	-			
Turn-on delay time	t <sub>d(on)</sub>	V <sub>GE</sub> = 15V, V <sub>CC</sub> = 400V, I <sub>C</sub> = 60A, R <sub>G</sub> = 7Ω, Inductive Load, T <sub>vj</sub> = 175°C	-	45	-	ns	
Rise time	t <sub>r</sub>		-	58	-		
Turn-off delay time	t <sub>d(off)</sub>		-	152	-		
Fall time	t <sub>f</sub>		-	35	-	mJ	
Turn-on switching energy	E <sub>on</sub>		-	1.43	-		
Turn-off switching energy	E <sub>off</sub>		-	0.53	-		
Total switching energy	E <sub>ts</sub>	-	1.96	-			
Reverse recovery time	t <sub>rr</sub>	I <sub>F</sub> = 25A, di <sub>F</sub> /dt = 500A/μs, T <sub>vj</sub> = 25°C	-	110	-	ns	
Reverse recovery current	I <sub>rr</sub>		-	18	-	A	
Reverse recovery charge	Q <sub>rr</sub>		-	1.10	-	μC	
Reverse recovery time	t <sub>rr</sub>	I <sub>F</sub> = 25A, di <sub>F</sub> /dt = 500A/μs, T <sub>vj</sub> = 175°C	-	205	-	ns	
Reverse recovery current	I <sub>rr</sub>		-	25	-	A	
Reverse recovery charge	Q <sub>rr</sub>		-	2.67	-	μC	



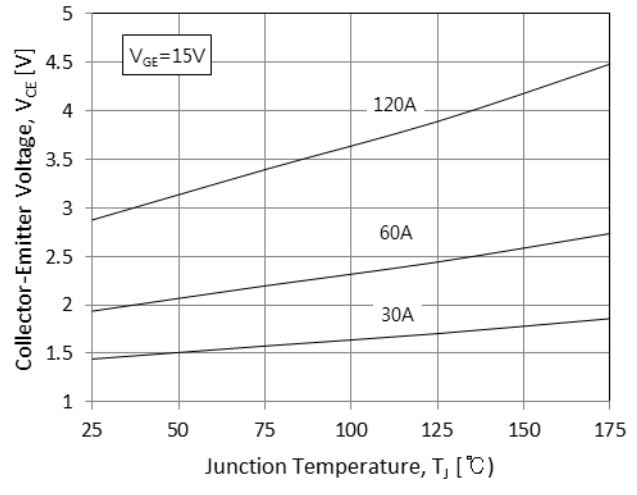
**Fig.1 Typical Output Characteristics ( $T_J = 25^\circ\text{C}$ )**



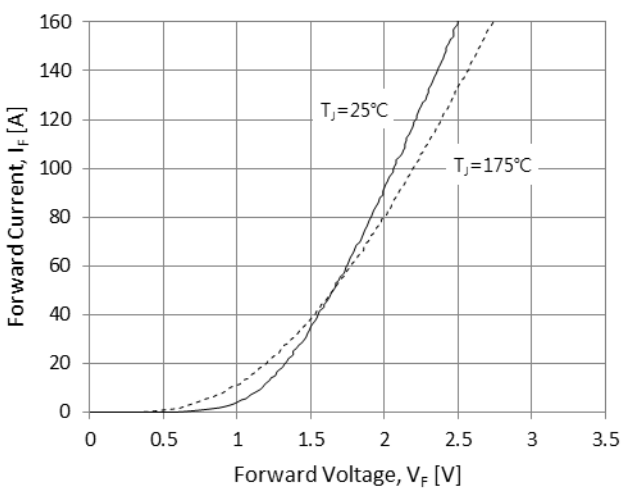
**Fig.2 Typical Output Characteristics ( $T_J = 175^\circ\text{C}$ )**



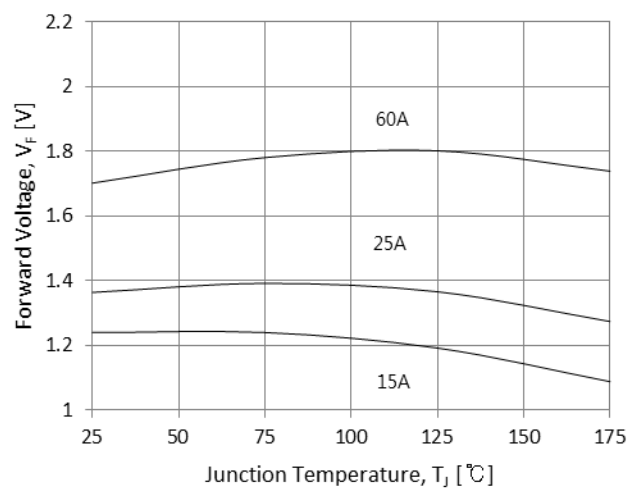
**Fig.3 Typical Transfer Characteristics**



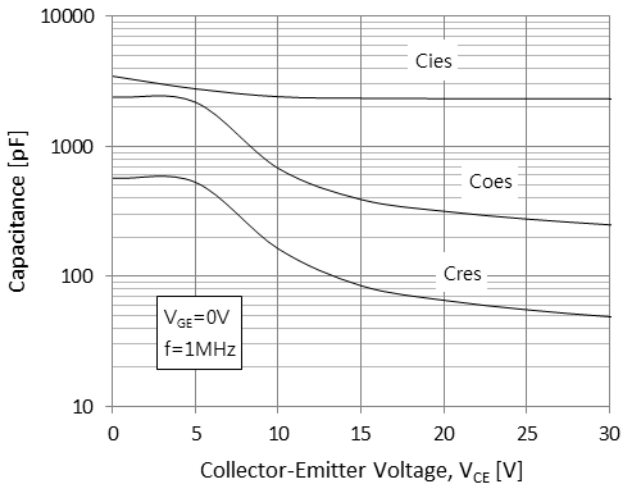
**Fig.4 Typical Collector-Emitter Saturation Voltage - Junction Temperature**



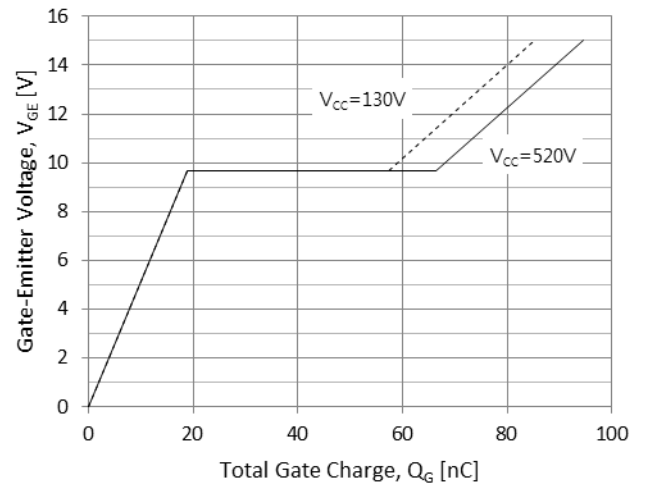
**Fig.5 Diode Forward Characteristics**



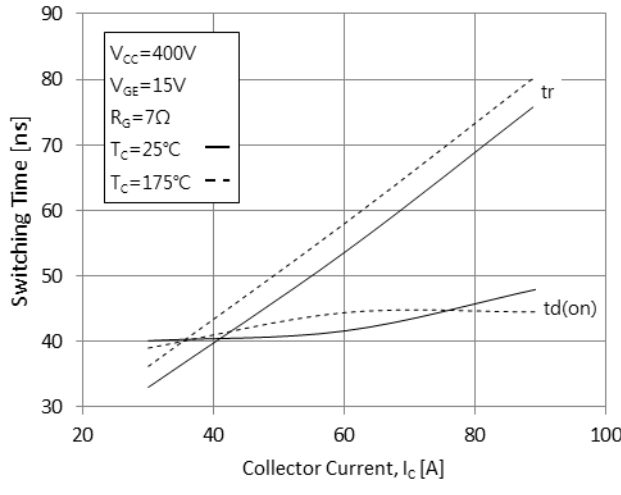
**Fig.6 Diode Forward-Junction Temperature**



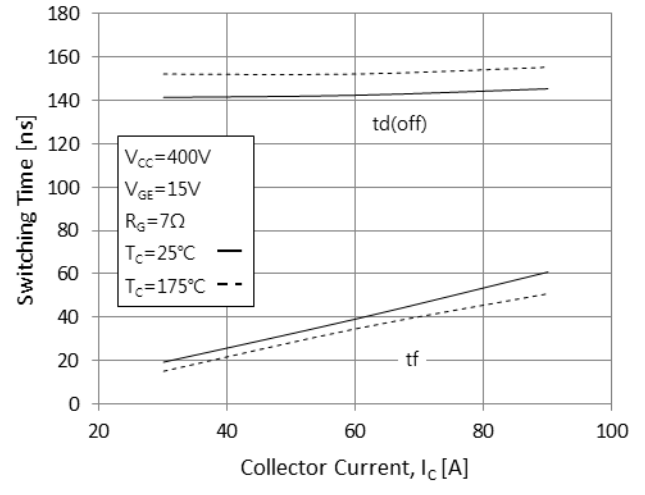
**Fig.7 Typical Capacitance**



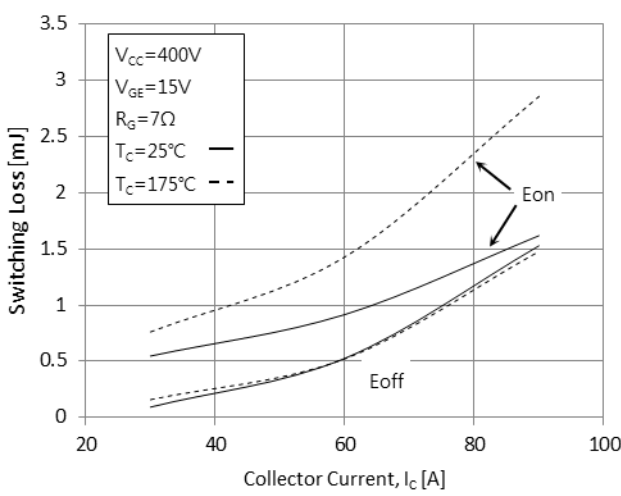
**Fig.8 Typical Gate Charge**



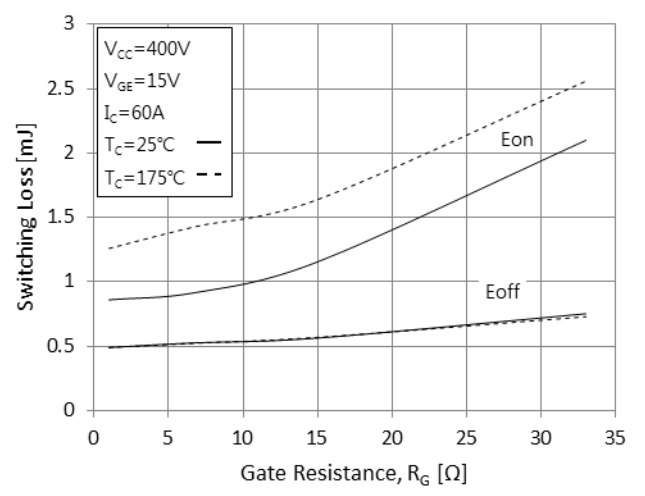
**Fig.9 Typical Turn on-Collector Current**



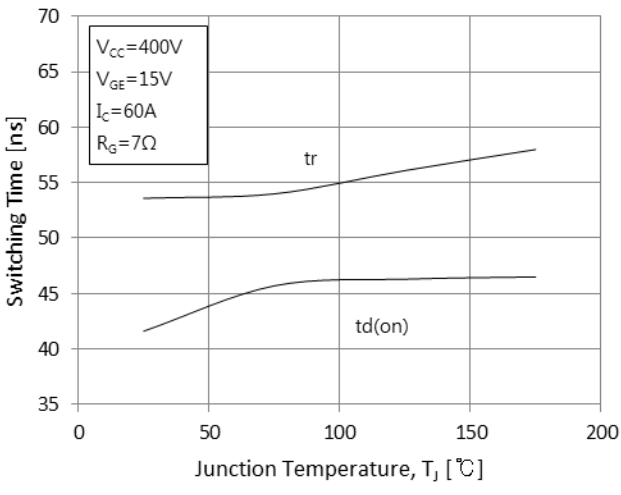
**Fig.10 Typical Turn off-Collector Current**



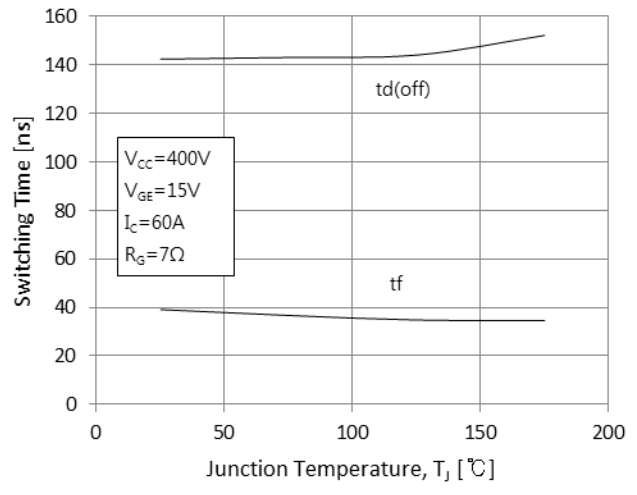
**Fig.11 Switching Loss-Collector Current**



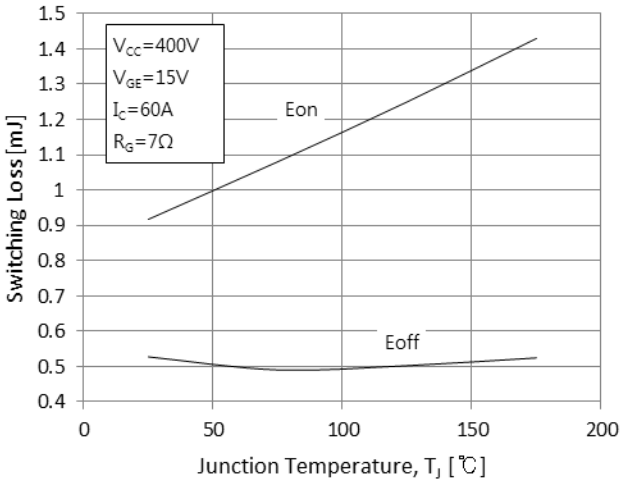
**Fig.12 Switching Loss-Gate Resistance**



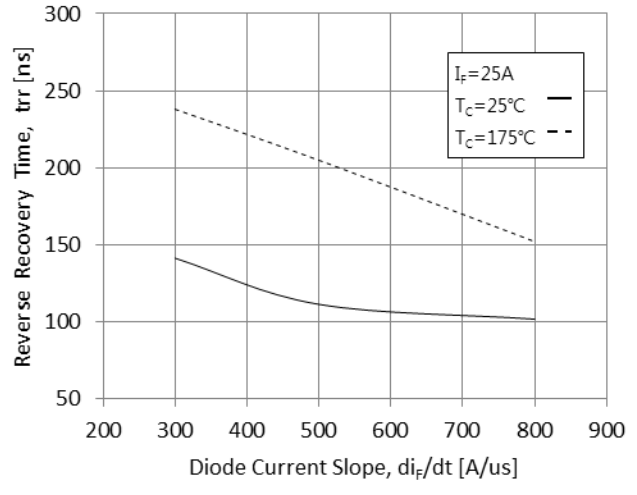
**Fig.13 Turn on Characteristics-Junction Temperature**



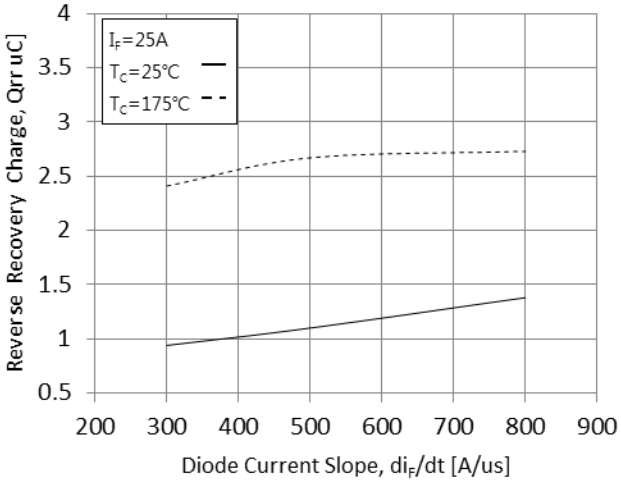
**Fig.14 Turn off Characteristics-Junction Temperature**



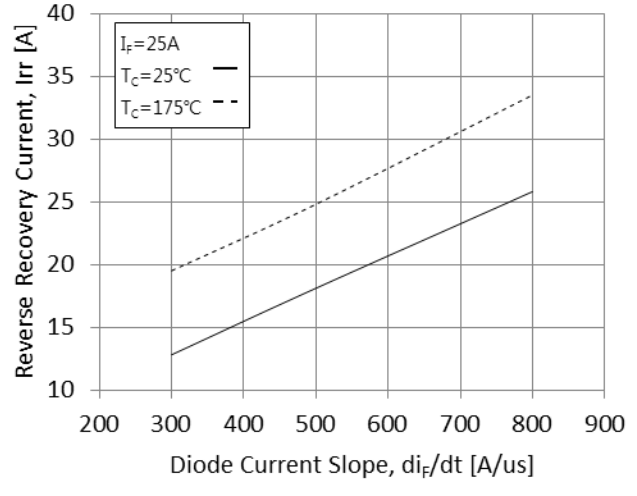
**Fig.15 Switching Loss-Junction Temperature**



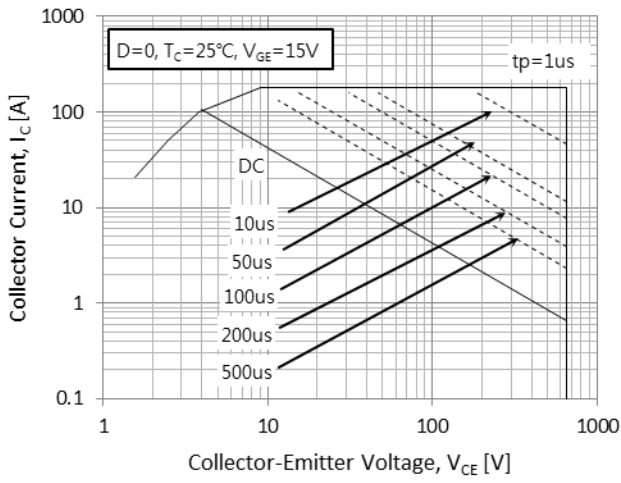
**Fig.16 Reverse Recovery Time - Diode Current Slope**



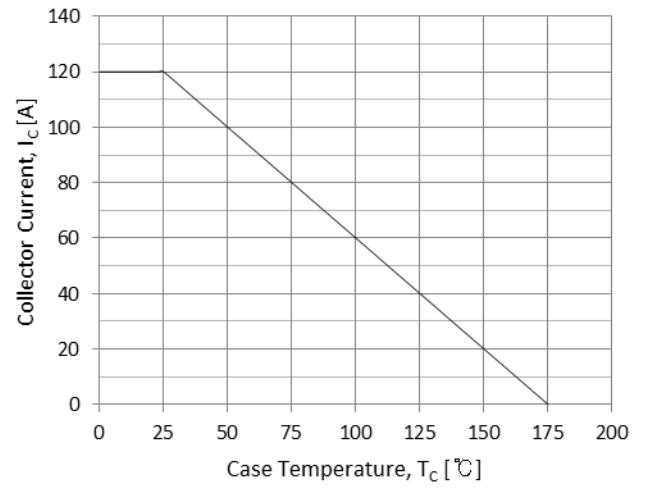
**Fig.17 Reverse Recovery Charge - Diode Current Slope**



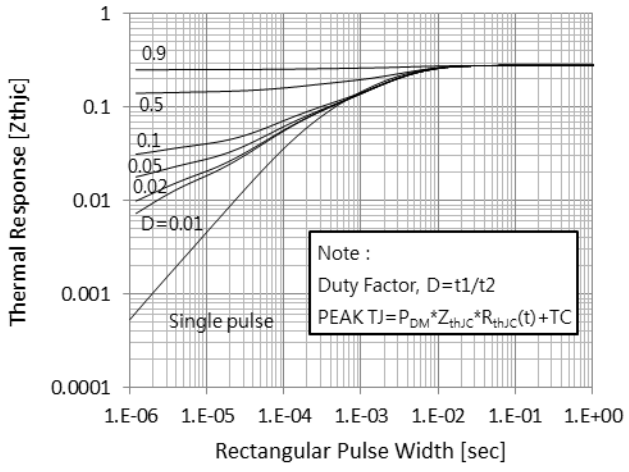
**Fig.18 Reverse Recovery Current - Diode Current Slope**



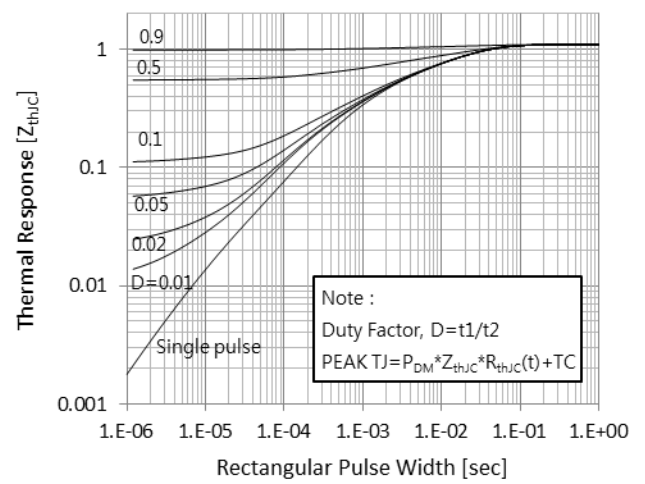
**Fig.19 Forward Bias Safe Operating Area**



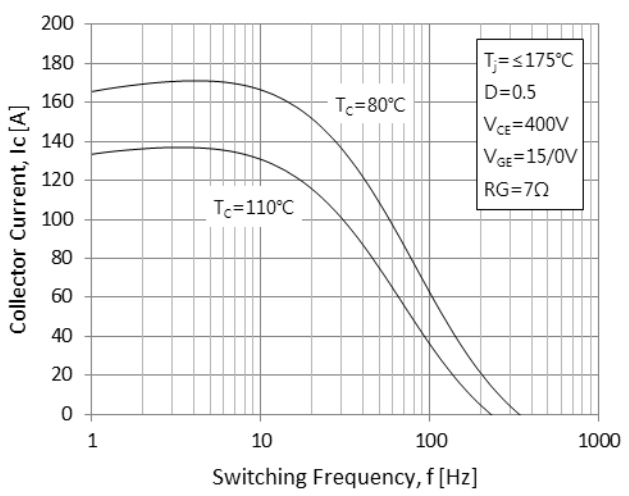
**Fig.20 Case Temperature-Collector Current**



**Fig.21 IGBT Transient Thermal Impedance**



**Fig.22 FRD Transient Thermal Impedance**

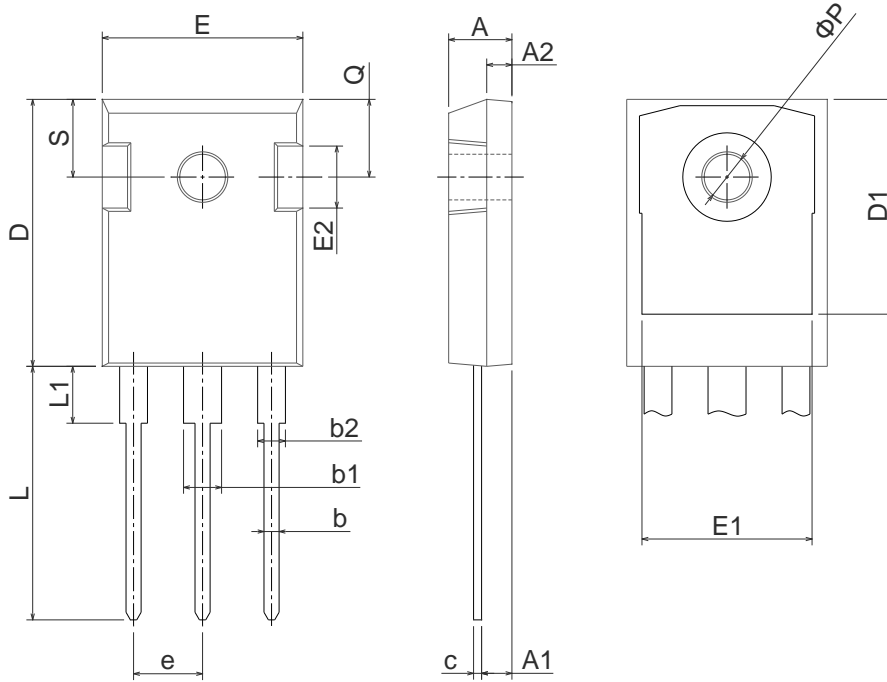


**Fig.23 Collector Current - Switching Frequency**

**Physical Dimension**

**TO-247**

Dimensions are in millimeters, unless otherwise specified




Dimension	Min(mm)	Max(mm)
A	4.70	5.31
A1	2.20	2.60
A2	1.50	2.49
b	0.99	1.40
b1	2.59	3.43
b2	1.65	2.39
c	0.38	0.89
D	20.30	21.46
D1	13.08	-
E	15.45	16.26
E1	13.06	14.02
E2	4.32	5.49
e	5.45BSC	
L	19.81	20.57
L1	-	4.50
ΦP	3.50	3.70
Q	5.38	6.20
S	6.15BSC	

Note : Package body size, length and width do not include mold flash, protrusions and gate burrs.

**DISCLAIMER:**

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