

# IGBT – Power, Co-PAK

## N-Channel, Field Stop VII (FS7), SCR, TO247-3L

### 1200 V, 1.5 V, 60 A

## FGHL60T120RWD

#### Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 3-lead package, FGHL60T120RWD offers the optimum performance with low conduction losses and good switching controllability for a high efficiency operation in various applications like motor control, UPS, data center and high-power switch.

#### Features

- Low Conduction Loss and Optimized Switching
- Maximum Junction Temperature –  $T_J = 175^\circ\text{C}$
- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- 100% of the Parts are Dynamically Tested
- Short Circuit Rated
- RoHS Compliant

#### Applications

- Motor Control
- UPS
- General Application Requiring High Power Switch

#### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

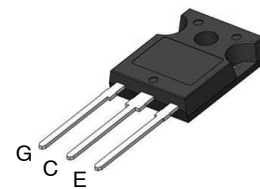
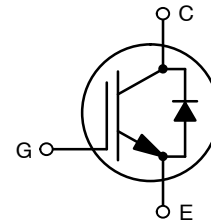
Parameter	Symbol	Value	Unit	
Collector-to-Emitter Voltage	$V_{CES}$	1200	V	
Gate-to-Emitter Voltage	$V_{GES}$	$\pm 20$		
Transient Gate-to-Emitter Voltage		$\pm 30$		
Collector Current	$I_C$	$T_C = 25^\circ\text{C}$ (Note 1)	120	A
		$T_C = 100^\circ\text{C}$	60	
Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	833	W
		$T_C = 100^\circ\text{C}$	416	
Pulsed Collector Current	$I_{CM}$	$T_C = 25^\circ\text{C}$ (Note 2) $t_p = 10 \mu\text{s}$	180	A
Diode Forward Current	$I_F$	$T_C = 25^\circ\text{C}$ (Note 1)	120	
		$T_C = 100^\circ\text{C}$	60	
Pulsed Diode Maximum Forward Current	$I_{FM}$	$T_C = 25^\circ\text{C}$ , $t_p = 10 \mu\text{s}$	180	
Short Circuit Withstand Time $V_{GE} = 15 \text{ V}$ , $V_{CC} = 600 \text{ V}$ , $T_C = 150^\circ\text{C}$	$T_{SC}$	5	$\mu\text{s}$	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$	
Lead Temperature for Soldering Purposes	$T_L$	260	$^\circ\text{C}$	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Value limit by bond wire.
2. Repetitive rating; Pulse width limited by max. junction temperature.

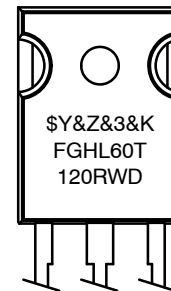
$BV_{CES}$	$V_{CE(SAT)}$	$I_C$
1200 V	1.5 V	60 A

#### PIN CONNECTIONS



TO-247-3LD  
CASE 340CX

#### MARKING DIAGRAM



$\$Y$  = onsemi Logo  
 $\&Z$  = Assembly Plant Code  
 $\&3$  = 3-Digit Date Code  
 $\&K$  = 2-Digit Lot Traceability Code  
 FGHL60T120RWD = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
FGHL60T120RWD	TO-247 (Pb-Free)	30 Units / Tube

# FGHL60T120RWD

## THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case for IGBT	$R_{\theta JC}$	0.18	°C/W
Thermal Resistance, Junction-to-Case for Diode	$R_{\theta JCD}$	0.33	
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	40	

## ELECTRICAL CHARACTERISTICS OF IGBT ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-to-Emitter Breakdown Voltage	$BV_{CES}$	$V_{GE} = 0\text{ V}, I_C = 5\text{ mA}$	1200			V
Collector-to-Emitter Breakdown Voltage Temperature Coefficient	$\frac{\Delta BV_{CES}}{\Delta T_J}$			1225		
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = V_{CES}$			40	μA
Gate-to-Emitter Leakage Current	$I_{GES}$	$V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$			±400	nA

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 60\text{ mA}, T_J = 25^\circ\text{C}$	4.9	5.94	6.7	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 25^\circ\text{C}$	1.2	1.48	1.8	
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 175^\circ\text{C}$		1.81		

### DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{ies}$	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$		7128		pF
Output Capacitance	$C_{oes}$			252		
Reverse Transfer Capacitance	$C_{res}$			25.3		
Total Gate Charge	$Q_g$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		256		nC
Gate-to-Emitter Charge	$Q_{ge}$			64.1		
Gate-to-Collector Charge	$Q_{gc}$			102		

### SWITCHING CHARACTERISTICS

Turn-on Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 30\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$		48		ns
Turn-off Delay Time	$t_{d(off)}$			290		
Rise Time	$t_r$			30		
Fall Time	$t_f$			138		
Turn-on Switching Loss	$E_{on}$			1.9		
Turn-off Switching Loss	$E_{off}$		1.8			
Total Switching Loss	$E_{ts}$		3.7			
Turn-on Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 60\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$		51		ns
Turn-off Delay Time	$t_{d(off)}$			250		
Rise Time	$t_r$			64		
Fall Time	$t_f$			139		
Turn-on Switching Loss	$E_{on}$			4.5		mJ
Turn-off Switching Loss	$E_{off}$			3.4		
Total Switching Loss	$E_{ts}$			8.0		

# FGHL60T120RWD

## ELECTRICAL CHARACTERISTICS OF IGBT ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>SWITCHING CHARACTERISTICS</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}$ $I_C = 30\text{ A}, R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$		45		ns
Turn-off Delay Time	$t_{d(off)}$			328		
Rise Time	$t_r$			35		
Fall Time	$t_f$			228		
Turn-on Switching Loss	$E_{on}$			3.3		mJ
Turn-off Switching Loss	$E_{off}$			2.4		
Total Switching Loss	$E_{ts}$			5.7		
Turn-on Delay Time	$t_{d(on)}$		$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}$ $I_C = 60\text{ A}, R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$		52	
Turn-off Delay Time	$t_{d(off)}$			296		
Rise Time	$t_r$			68		
Fall Time	$t_f$			224		
Turn-on Switching Loss	$E_{on}$			6.9		mJ
Turn-off Switching Loss	$E_{off}$			5.1		
Total Switching Loss	$E_{ts}$			12.0		

### DIODE CHARACTERISTICS

Forward Voltage	$V_F$	$I_F = 60\text{ A}, T_J = 25^\circ\text{C}$	1.46	1.74	2.08	V
		$I_F = 60\text{ A}, T_J = 175^\circ\text{C}$		1.7		

### DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$		183		ns
Reverse Recovery Charge	$Q_{rr}$			1815		nC
Reverse Recovery Energy	$E_{REC}$			0.5		mJ
Peak Reverse Recovery Current	$I_{RRM}$			19.9		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$		257		ns
Reverse Recovery Charge	$Q_{rr}$			2651		nC
Reverse Recovery Energy	$E_{REC}$			0.9		mJ
Peak Reverse Recovery Current	$I_{RRM}$			20.6		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$		279		ns
Reverse Recovery Charge	$Q_{rr}$			4008		nC
Reverse Recovery Energy	$E_{REC}$			1.4		mJ
Peak Reverse Recovery Current	$I_{RRM}$			28.7		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$		420		ns
Reverse Recovery Charge	$Q_{rr}$			6392		nC
Reverse Recovery Energy	$E_{REC}$			2.5		mJ
Peak Reverse Recovery Current	$I_{RRM}$			30.3		A

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# FGHL60T120RWD

## TYPICAL CHARACTERISTICS

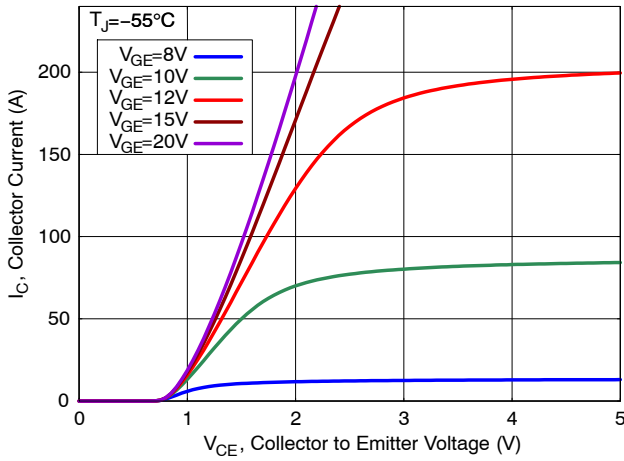


Figure 1. Output Characteristics

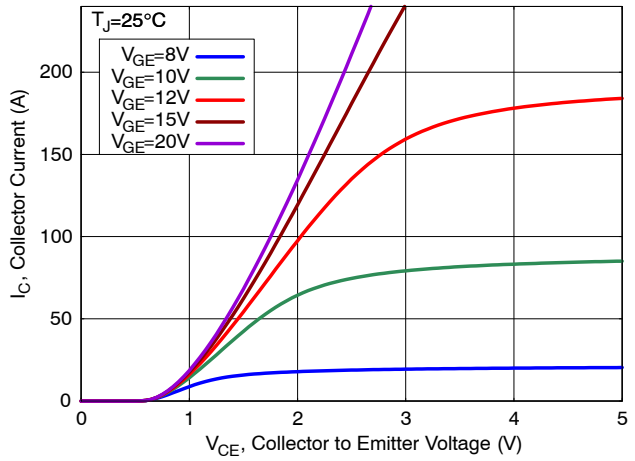


Figure 2. Output Characteristics

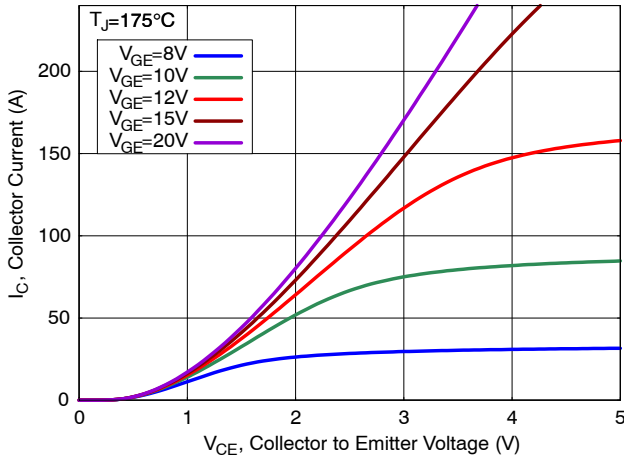


Figure 3. Output Characteristics

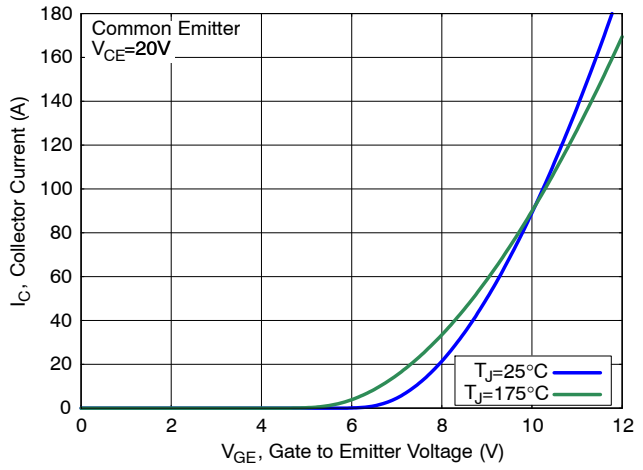


Figure 4. Transfer Characteristics

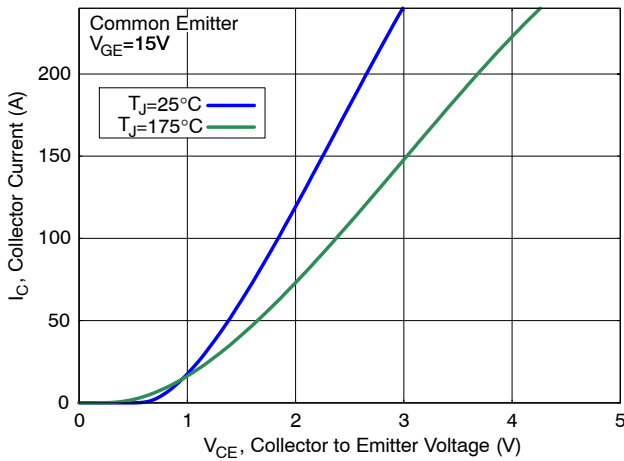


Figure 5. Saturation Characteristics

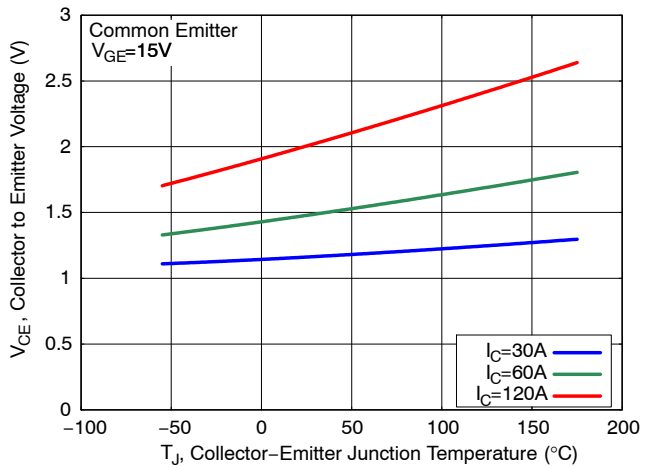


Figure 6. Saturation Voltage vs. Junction Temperature

# FGHL60T120RWD

## TYPICAL CHARACTERISTICS

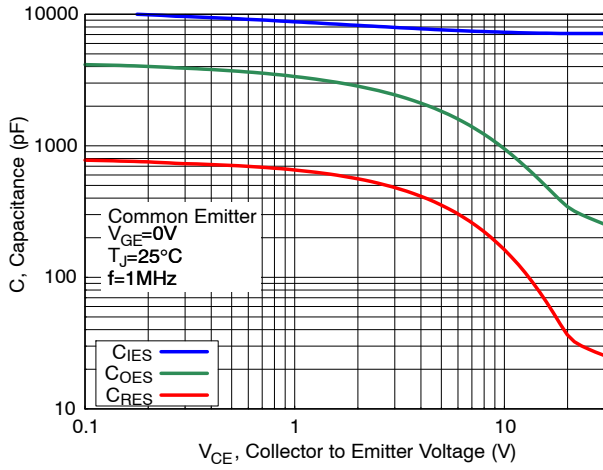


Figure 7. Capacitance Characteristics

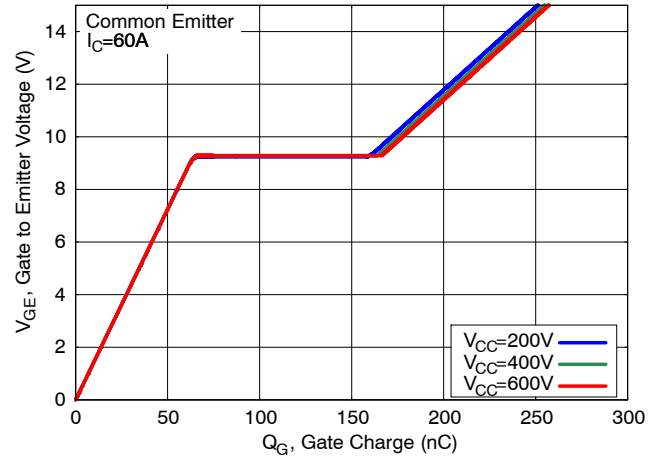


Figure 8. Gate Charge Characteristics

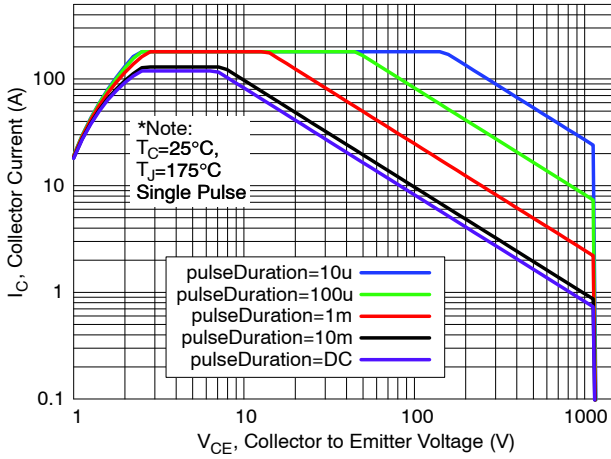


Figure 9. SOA Characteristics

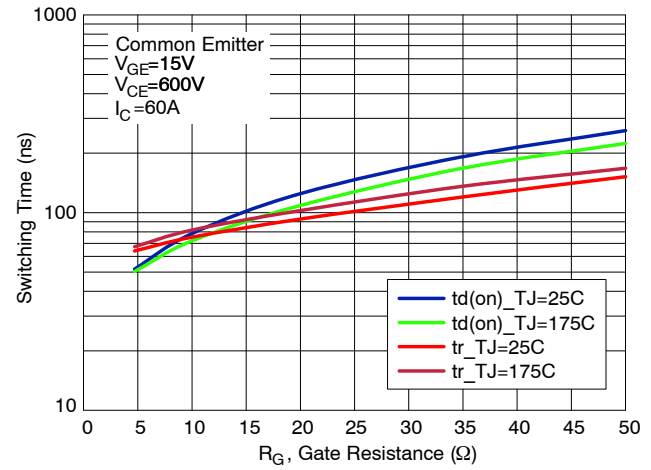


Figure 10. Turn-On Switching Time vs. Gate Resistance

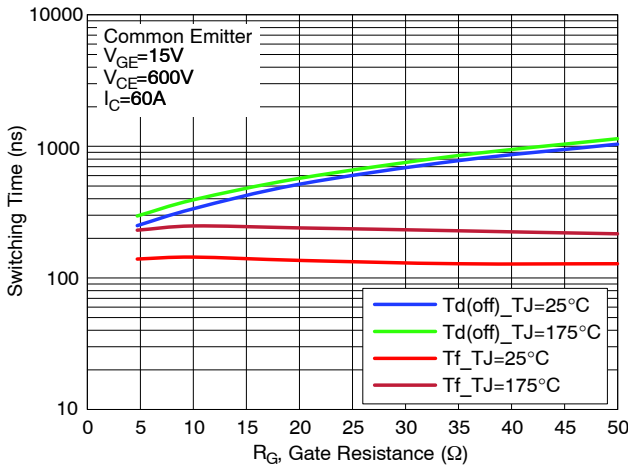


Figure 11. Turn-Off Switching Time vs. Gate Resistance

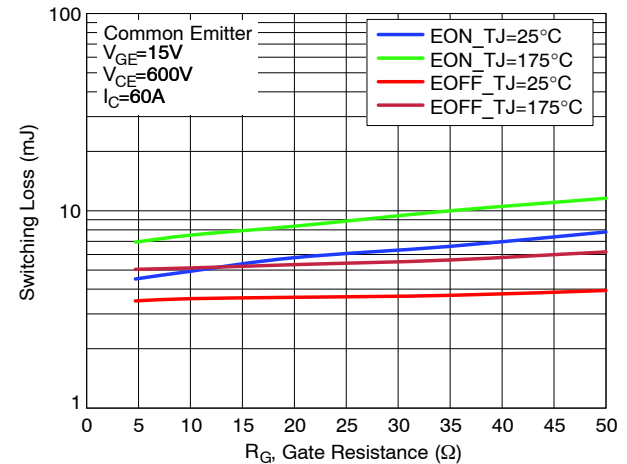
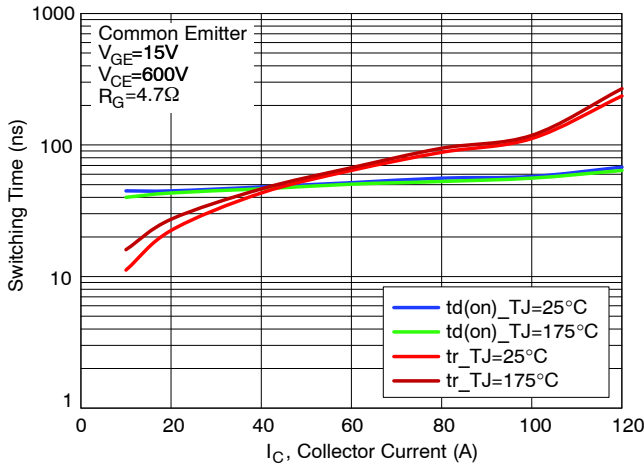


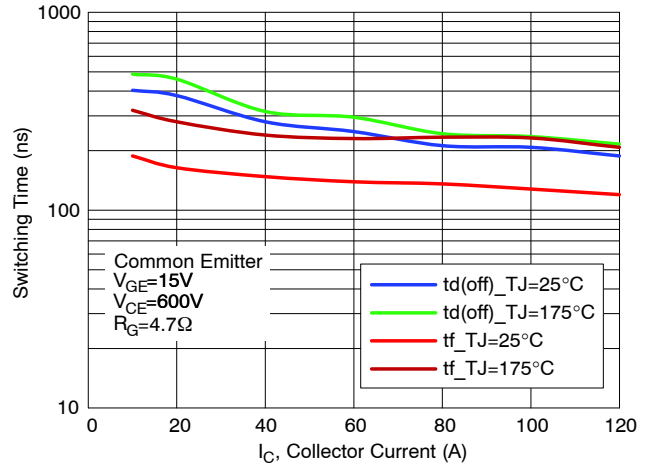
Figure 12. Switching Loss vs. Gate Resistance

# FGHL60T120RWD

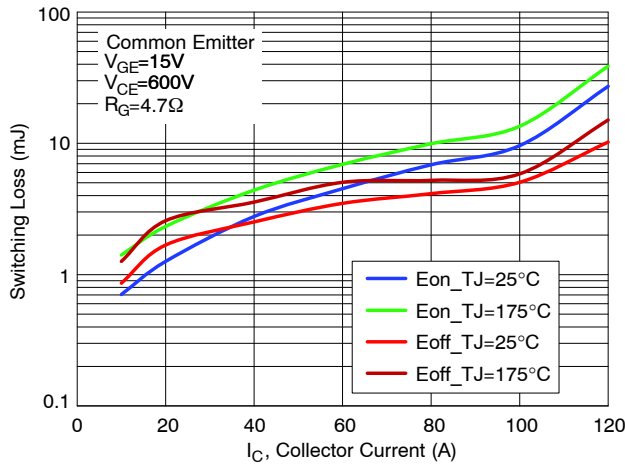
## TYPICAL CHARACTERISTICS



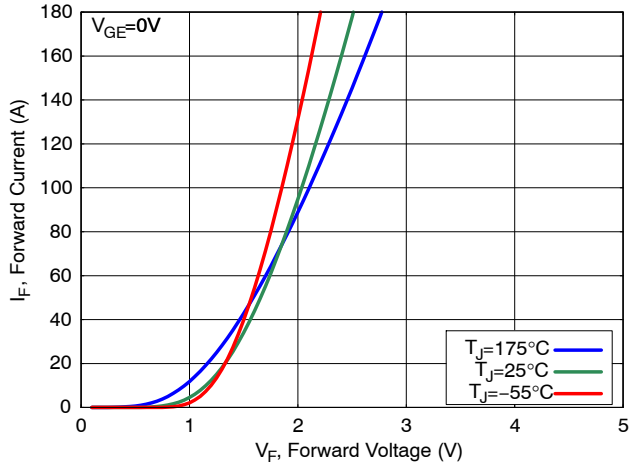
**Figure 13. Turn-On Switching Time vs. Collector Current**



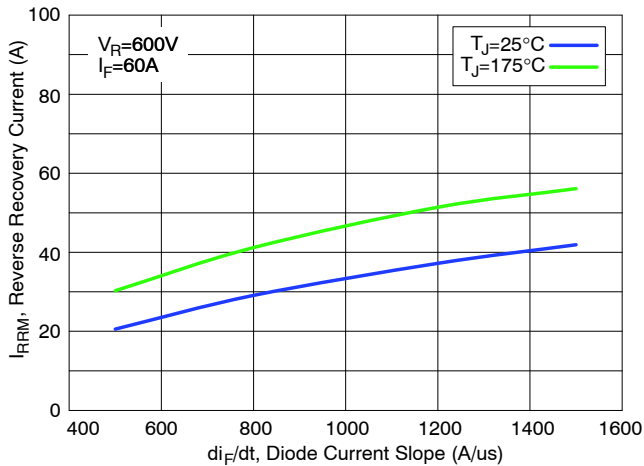
**Figure 14. Turn-Off Switching Time vs. Collector Current**



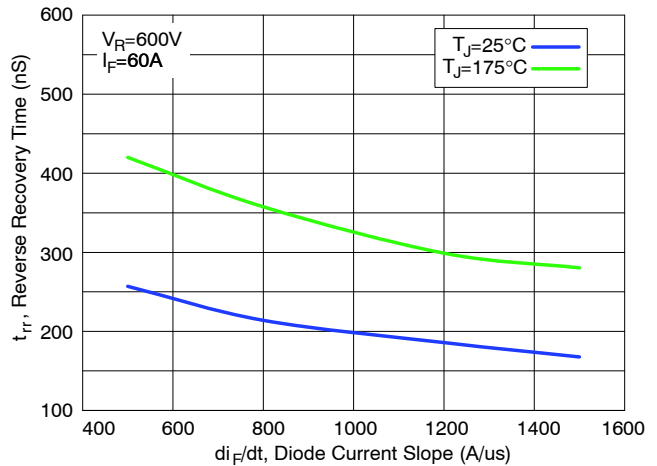
**Figure 15. Switching Loss vs. Collector Current**



**Figure 16. Diode Forward Characteristics**



**Figure 17. Diode Reverse Recovery Current**



**Figure 18. Diode Reverse Recovery Time**

# FGHL60T120RWD

## TYPICAL CHARACTERISTICS

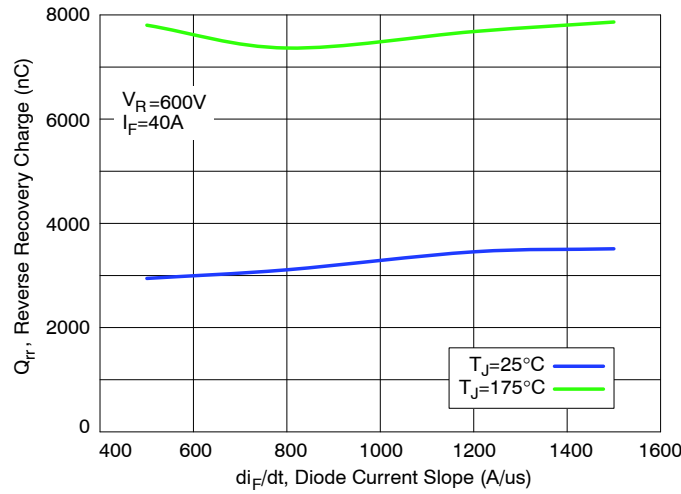


Figure 19. Diode Stored Charge Characteristics

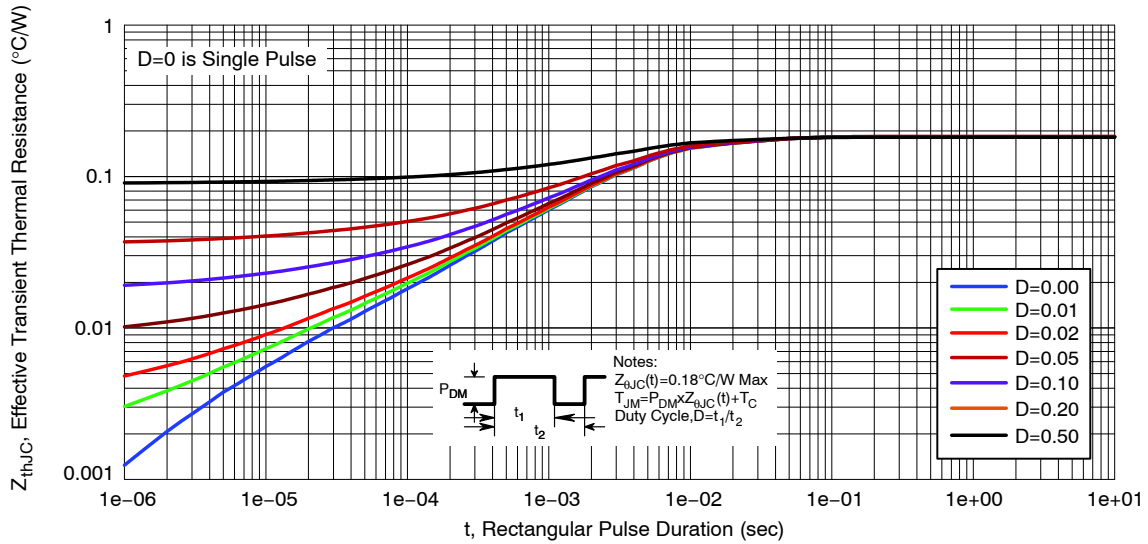


Figure 20. Transient Thermal Impedance of IGBT

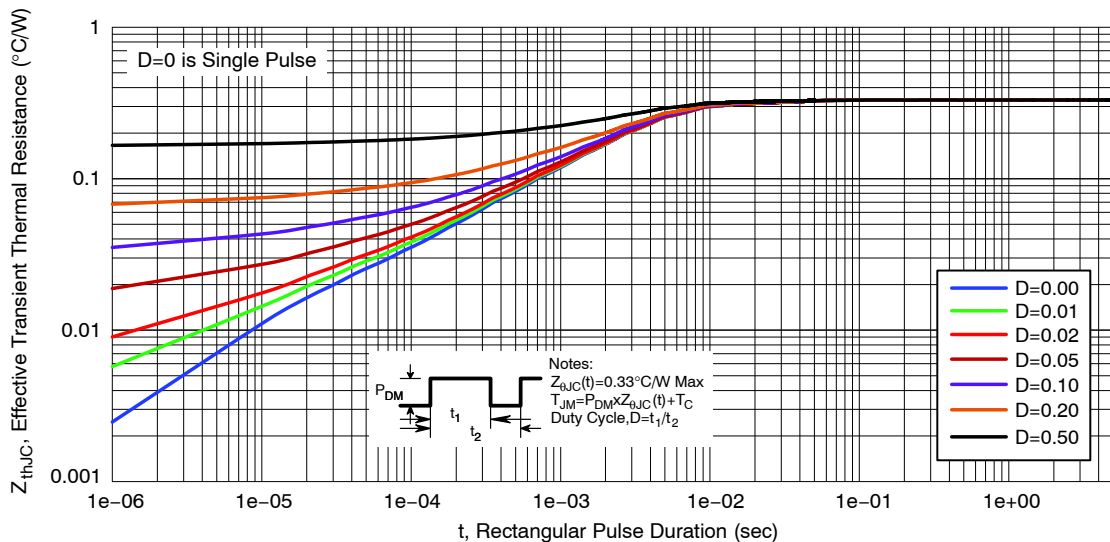
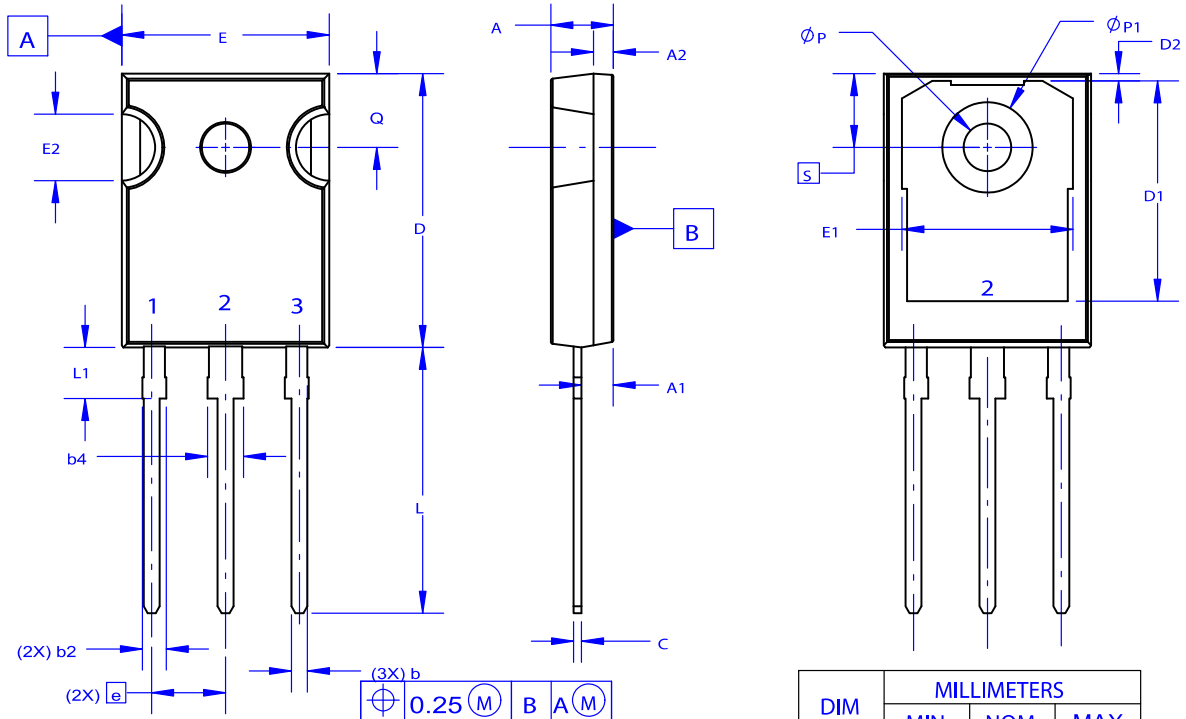


Figure 21. Transient Thermal Impedance of Diode

# FGHL60T120RWD

## PACKAGE DIMENSIONS

TO-247-3LD  
CASE 340CX  
ISSUE A



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.40	1.50	1.60
D	20.32	20.57	20.82
E	15.37	15.62	15.87
E2	4.96	5.08	5.20
e	~	5.56	~
L	19.75	20.00	20.25
L1	3.69	3.81	3.93
φP	3.51	3.58	3.65
Q	5.34	5.46	5.58
S	5.34	5.46	5.58
b	1.17	1.26	1.35
b2	1.53	1.65	1.77
b4	2.42	2.54	2.66
c	0.51	0.61	0.71
D1	13.08	~	~
D2	0.51	0.93	1.35
E1	12.81	~	~
φP1	6.60	6.80	7.00

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