

# IGBT - Power, Co-PAK N-Channel, Field Stop VII (FS7), Non-SCR, TO247-3L 1200 V, 1.7 V, 60 A FGY60T120SWD

## Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 3-lead package, FGY60T120SWD offers the optimum performance with low switching and conduction losses for high-efficiency operations in various applications like Solar, UPS, and ESS.

## Features

- Maximum Junction Temperature  $T_J = 175^\circ\text{C}$
- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- Smooth and Optimized Switching
- Low Switching Loss
- RoHS Compliant

## Applications

- Boost and Inverter in Solar System
- UPS
- Energy Storage System

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

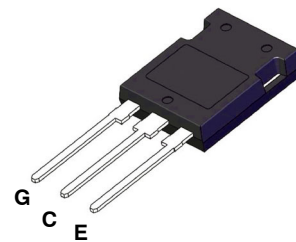
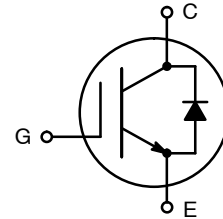
Parameter	Symbol	Value	Unit	
Collector-to-Emitter Voltage	$V_{CES}$	1200	V	
Gate-to-Emitter Voltage	$V_{GES}$	$\pm 20$	V	
Transient Gate-to-Emitter Voltage		$\pm 30$	V	
Collector Current	$I_C$	$T_C = 25^\circ\text{C}$ (Note 1)	105	A
		$T_C = 100^\circ\text{C}$	60	
Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	635	W
		$T_C = 100^\circ\text{C}$	317	
Pulsed Collector Current	$I_{CM}$	240	A	
Diode Forward Current	$I_F$	$T_C = 25^\circ\text{C}$	120	A
		$T_C = 100^\circ\text{C}$	600	
Pulsed Diode Maximum Forward Current	$I_{FM}$	240	A	
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

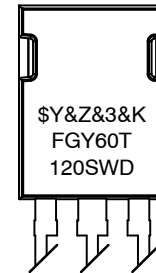
$BV_{CES}$	$V_{CE(SAT)}$	$I_C$
1200 V	1.7 V	60 A

## PIN CONNECTIONS



TO247-3LD  
CASE 340CD

## MARKING DIAGRAM



- \$Y = onsemi Logo
- &Z = Assembly Plant Code
- &3 = 3-Digit Date Code
- &K = 2-Digit Lot Traceability Code
- FGY60T120SWD = Specific Device Code

## ORDERING INFORMATION

Device	Package	Shipping
FGY60T120SWD	TO-247-3LD (Pb-Free)	30 Units / Tube

# FGY60T120SWD

## THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case for IGBT	$R_{\theta JC}$	0.24	°C/W
Thermal Resistance, Junction-to-Case for Diode		0.41	
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 Condition	Min	Typ	Max	Unit
-----------	--------	----------------	-----	-----	-----	------

### 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	$\Delta BV_{CES} / \Delta T_J$			1.5		
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	$V_{GE(TH)}$	$V_{GE} = V_{CE}, I_C = 60\text{ mA}$	5.6	6.55	7.4	V
Collector-to-Emitter Saturation Voltage	$V_{CE(SAT)}$	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 25^\circ\text{C}$	1.35	1.68	2.0	
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 175^\circ\text{C}$		2.25		

### DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{IES}$	$V_{GE} = 0\text{ V}, V_{CE} = 30\text{ V}, f = 1\text{ MHz}$		5093		pF
Output Capacitance	$C_{OES}$			193		
Reverse Transfer Capacitance	$C_{RES}$			25.2		
Total Gate Charge	$Q_G$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 60\text{ A}$		174		nC
Gate-to-Emitter Charge	$Q_{GE}$			43.4		
Gate-to-Collector Charge	$Q_{GC}$			65.1		

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 30\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$		30.4		ns	
Turn-Off Delay Time	$t_{d(off)}$			146.4			
Rise Time	$t_r$			15.2			
Fall Time	$t_f$			68			
Turn-On Switching Loss	$E_{on}$		$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 60\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$		1.6		mJ
Turn-Off Switching Loss	$E_{off}$				0.9		
Total Switching Loss	$E_{ts}$				2.6		
Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 60\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$			31.2		ns
Turn-Off Delay Time	$t_{d(off)}$				130		
Rise Time	$t_r$				40.8		
Fall Time	$t_f$				68.8		
Turn-On Switching Loss	$E_{on}$		$V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 60\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$		4		mJ
Turn-Off Switching Loss	$E_{off}$				1.9		
Total Switching Loss	$E_{ts}$				5.8		

# FGY60T120SWD

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Turn-On Delay Time	$t_{d(on)}$	$V_{GE} = 0/15\text{ V}, I_C = 30\text{ A}, V_{CE} = 600\text{ V}, R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$		27.2		ns
Turn-Off Delay Time	$t_{d(off)}$			168		
Rise Time	$t_r$			16		
Fall Time	$t_f$			102.4		
Turn-On Switching Loss	$E_{on}$			2.6		mJ
Turn-Off Switching Loss	$E_{off}$			1.2		
Total Switching Loss	$E_{ts}$			3.8		
Turn-On Delay Time	$t_{d(on)}$	$V_{GE} = 0/15\text{ V}, I_C = 60\text{ A}, V_{CE} = 600\text{ V}, R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$		28.8		ns
Turn-Off Delay Time	$t_{d(off)}$			153.6		
Rise Time	$t_r$			38.4		
Fall Time	$t_f$			120		
Turn-On Switching Loss	$E_{on}$			5.7		mJ
Turn-Off Switching Loss	$E_{off}$			2.8		
Total Switching Loss	$E_{ts}$			8.5		

### DIODE CHARACTERISTICS

Forward Voltage	$V_F$	$I_F = 60\text{ A}, T_J = 25^\circ\text{C}$	1.62	1.91	2.22	V
		$I_F = 60\text{ A}, T_J = 175^\circ\text{C}$		2		

### DIODE SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A}, di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$		143		ns
Reverse Recovery Charge	$Q_{rr}$			2262		nC
Reverse Recovery Energy	$E_{rec}$			0.7		mJ
Peak Reverse Recovery Current	$I_{RRM}$			32		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A}, di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$		200		ns
Reverse Recovery Charge	$Q_{rr}$			3486		nC
Reverse Recovery Energy	$E_{rec}$			1.1		mJ
Peak Reverse Recovery Current	$I_{RRM}$			35		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A}, di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$		221		ns
Reverse Recovery Charge	$Q_{rr}$			4908		nC
Reverse Recovery Energy	$E_{rec}$			1.7		mJ
Peak Reverse Recovery Current	$I_{RRM}$			44		A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A}, di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$		334		ns
Reverse Recovery Charge	$Q_{rr}$			8665		nC
Reverse Recovery Energy	$E_{rec}$			3.1		mJ
Peak Reverse Recovery Current	$I_{RRM}$			52		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.

# FGY60T120SWD

## TYPICAL CHARACTERISTICS

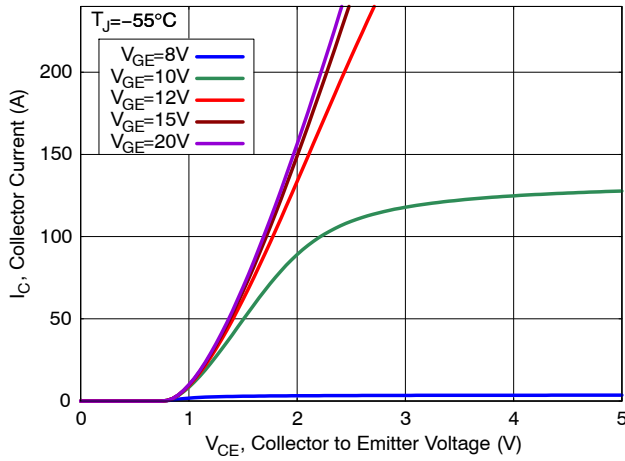


Figure 1. Output Characteristics

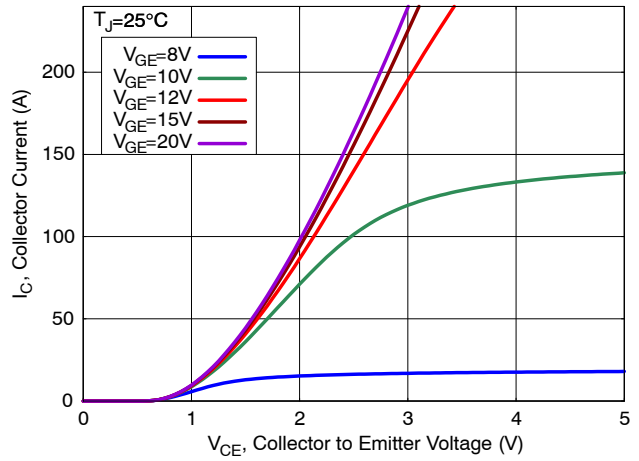


Figure 2. Output Characteristics

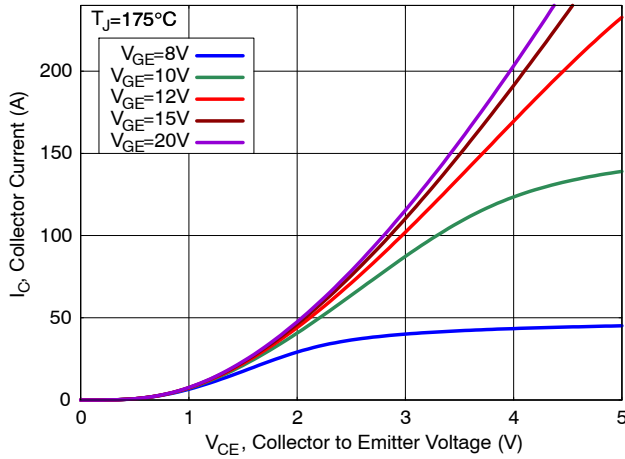


Figure 3. Output Characteristics

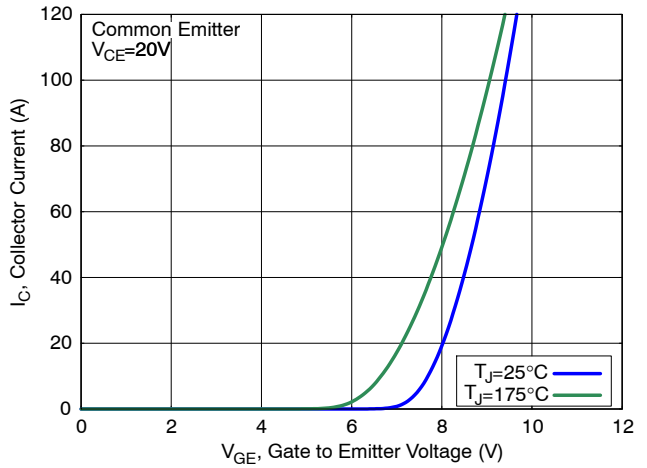


Figure 4. Transfer Characteristics

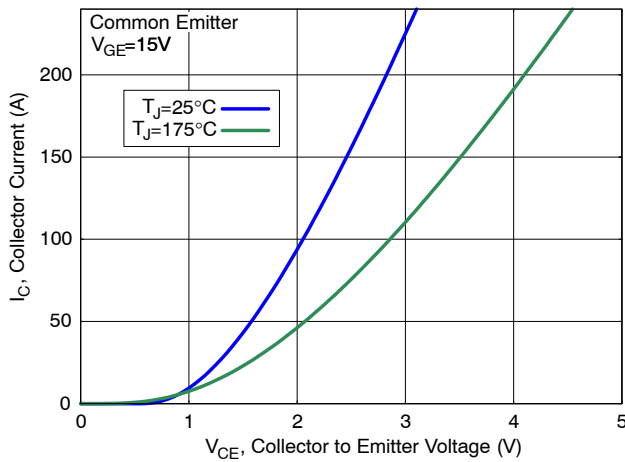


Figure 5. Saturation Characteristics

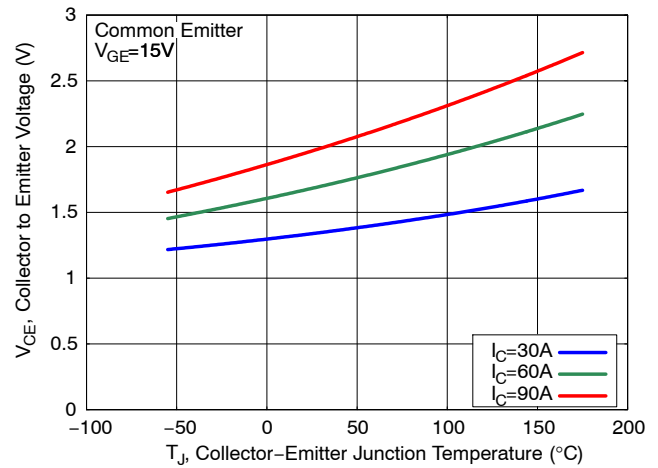


Figure 6. Saturation Voltage vs. Junction Temperature

# FGY60T120SWD

## TYPICAL CHARACTERISTICS

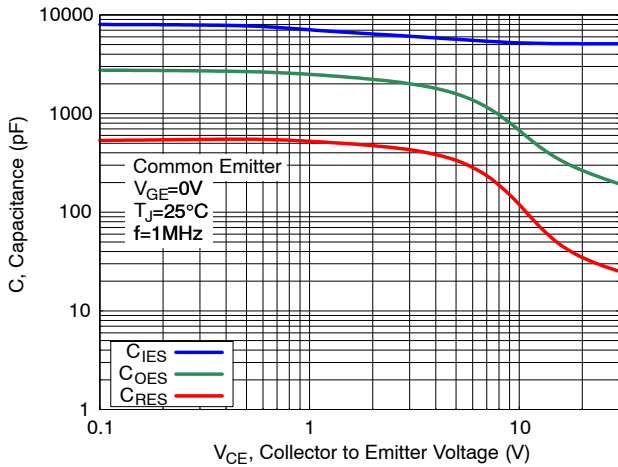


Figure 7. Capacitance Characteristics

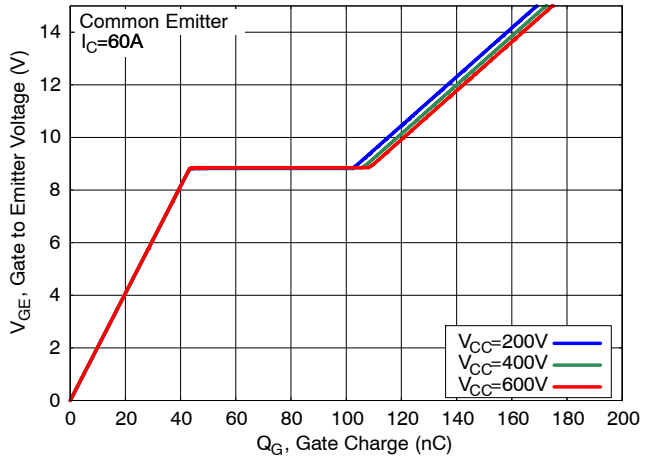


Figure 8. Gate Charge Characteristics

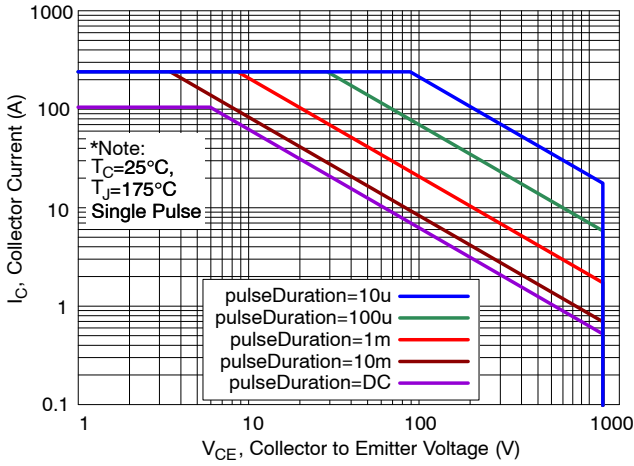


Figure 9. SOA Characteristics

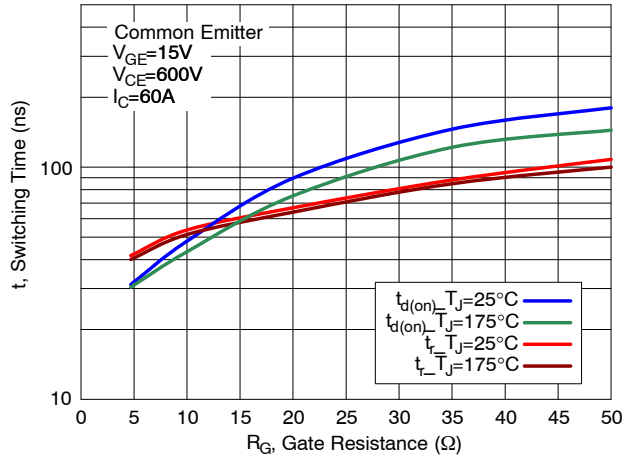


Figure 10. Turn-On Switching Time vs. Gate Resistance

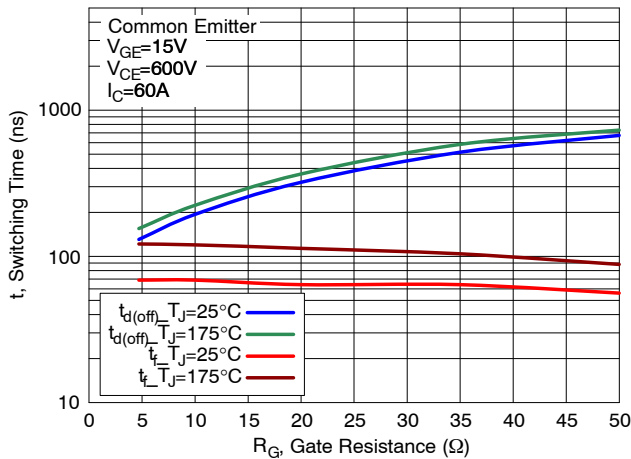


Figure 11. Turn-Off Switching Time vs. Gate Resistance

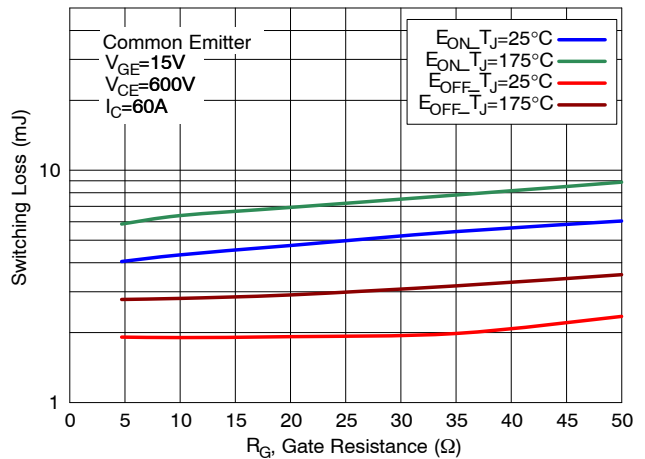
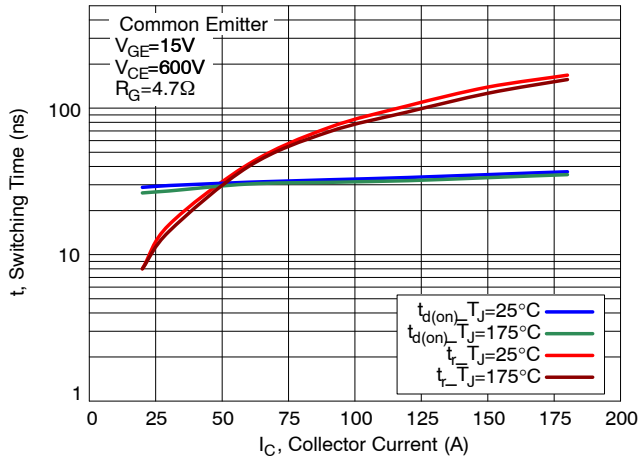


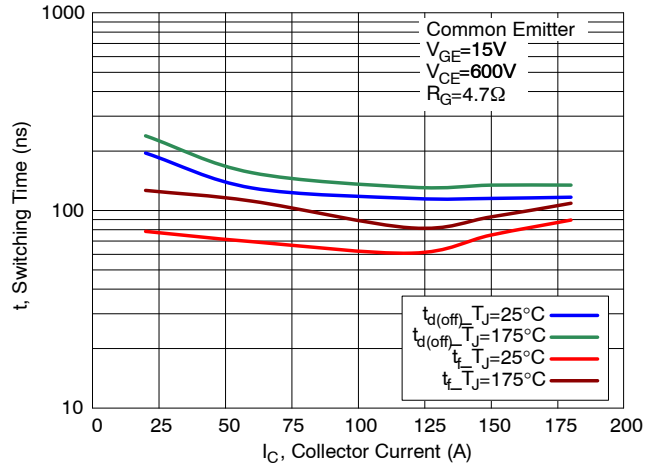
Figure 12. Switching Loss vs. Gate Resistance

# FGY60T120SWD

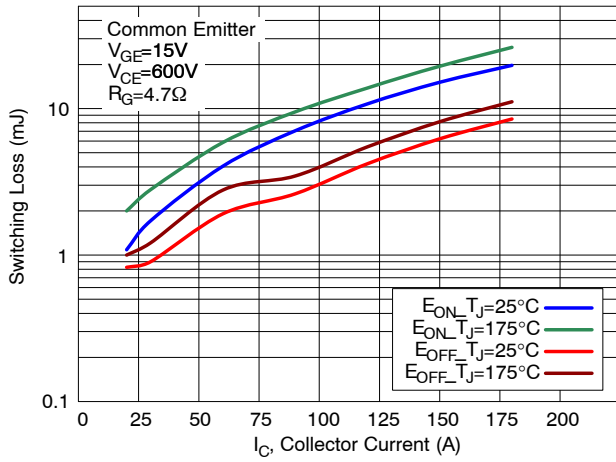
## TYPICAL CHARACTERISTICS



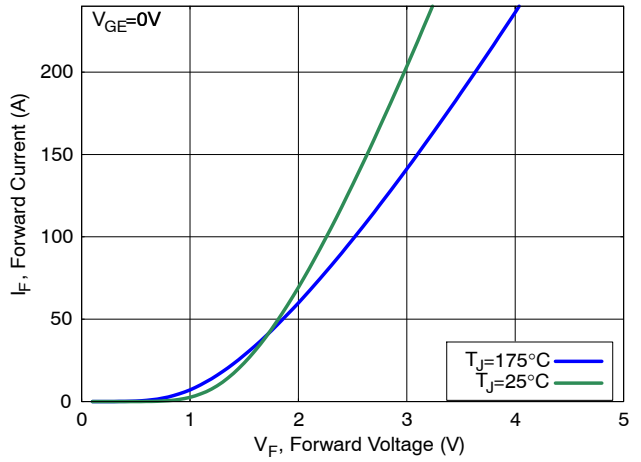
**Figure 13. Turn-On Switching Time vs. Collector Current**



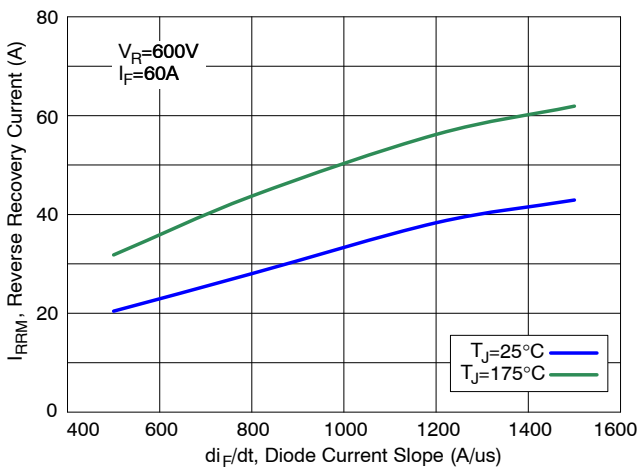
**Figure 14. Turn-Off Switching Time vs. Collector Current**



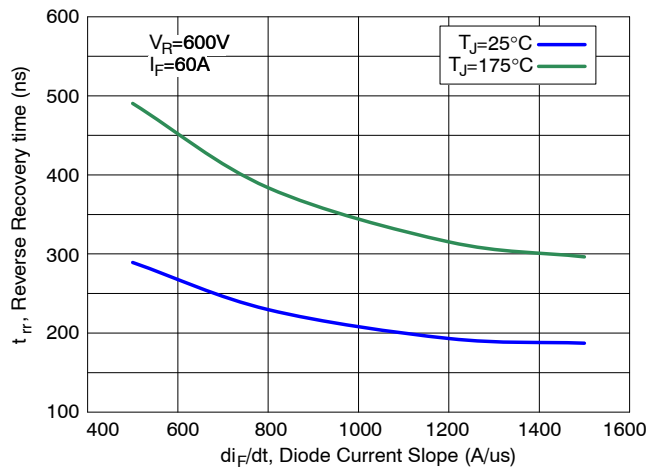
**Figure 15. Switching Loss vs. Collector Current**



**Figure 16. Diode Forward Characteristics**



**Figure 17. Diode Reverse Recovery Current**



**Figure 18. Diode Reverse Recovery Time**

# FGY60T120SWD

## TYPICAL CHARACTERISTICS

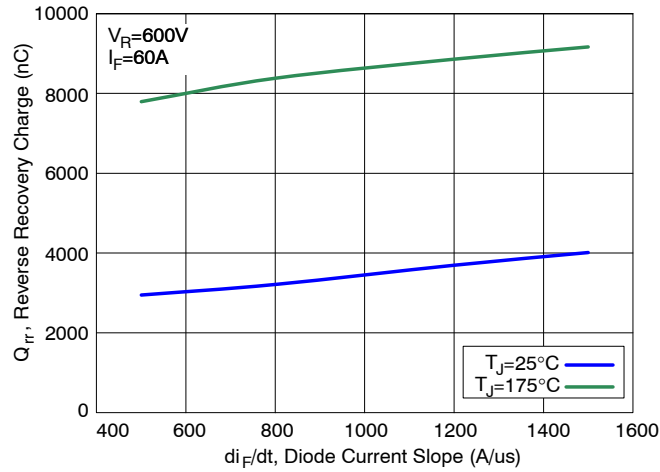


Figure 19. Diode Stored Charge Characteristics

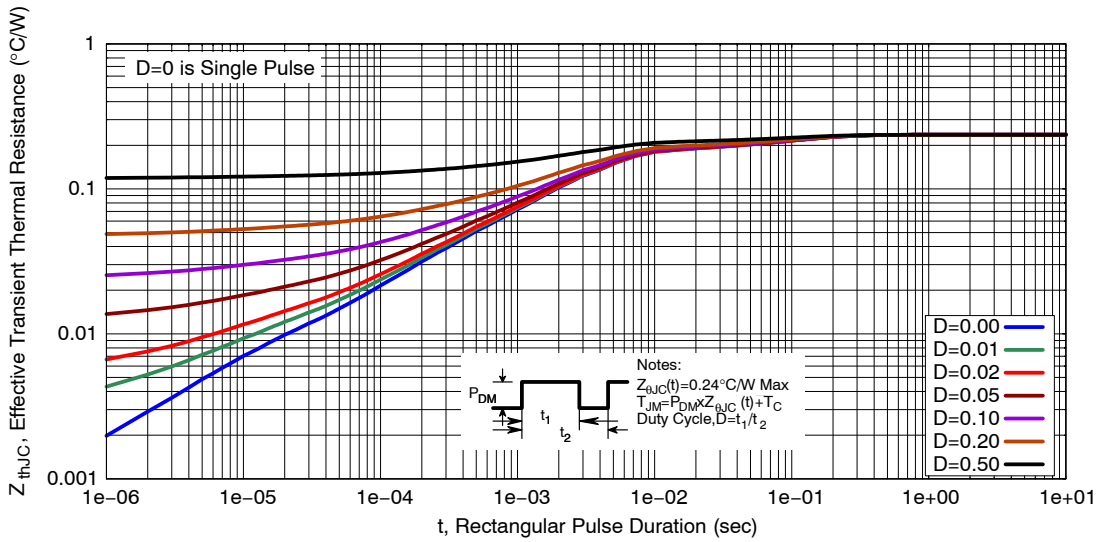


Figure 20. Transient Thermal Impedance of IGBT

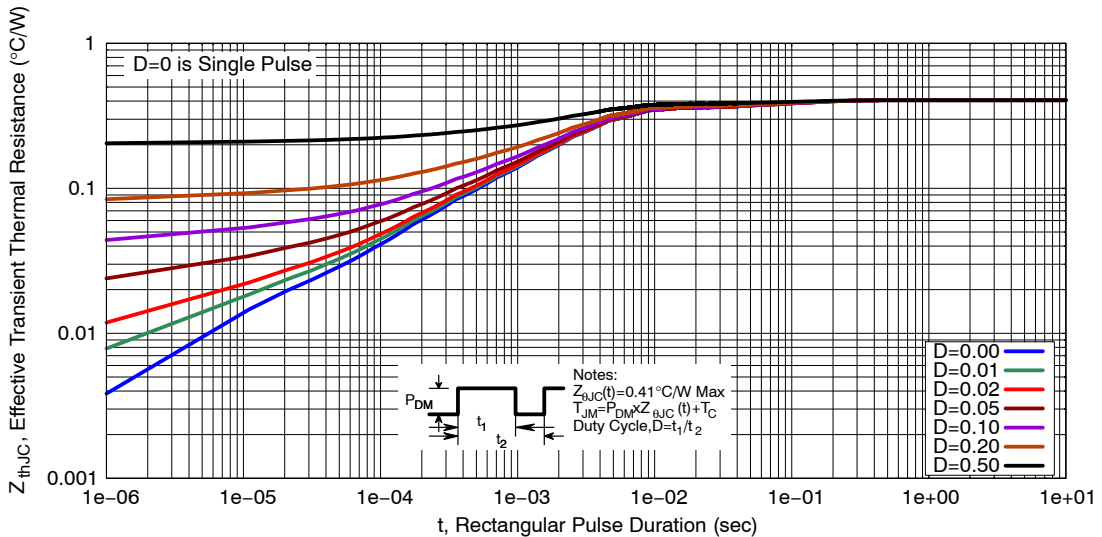


Figure 21. Transient Thermal Impedance of Diode

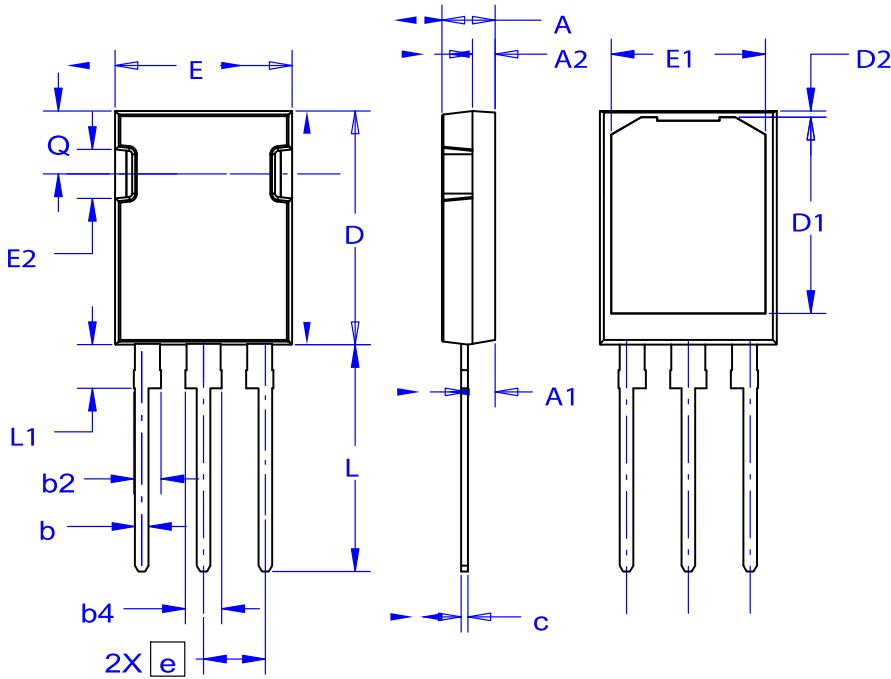
# FGY60T120SWD

## PACKAGE DIMENSIONS

TO-247-3LD  
CASE 340CD  
ISSUE A

### NOTES:

- A. THIS PACKAGE DOES NOT CONFORM TO ANY STANDARDS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.80	2.00	2.20
D	20.32	20.57	20.82
E	15.37	15.62	15.87
E2	4.12	4.32	4.52
e	~	5.45	~
L	19.90	20.00	20.10
L1	3.69	3.81	3.93
Q	5.34	5.46	5.58
b	1.10	1.20	1.30
b2	2.10	2.24	2.39
b4	2.87	3.04	3.20
c	0.51	0.61	0.71
D1	16.63	16.83	17.03
D2	0.51	0.93	1.35
E1	13.40	13.60	13.80

**onsemi, Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marketing.pdf](http://www.onsemi.com/site/pdf/Patent-Marketing.pdf). onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using onsemi products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by onsemi. "Typical" parameters which may be provided in onsemi data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. onsemi does not convey any license under any of its intellectual property rights nor the rights of others. onsemi products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use onsemi products for any such unintended or unauthorized application, Buyer shall indemnify and hold onsemi and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that onsemi was negligent regarding the design or manufacture of the part. onsemi is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

### PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:  
Email Requests to: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

TECHNICAL SUPPORT  
North American Technical Support:  
Voice Mail: 1 800-282-9855 Toll Free USA/Canada  
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:  
Phone: 00421 33 790 2910  
For additional information, please contact your local Sales Representative