

## IGBT - Power, Co-PAK N-Channel, Field Stop VII (FS7), Non SCR, TO247-3L 1200 V, 1.7 V, 40 A

## FGHL40T120SWD

## Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 3-lead package, FGHL40T120SWD 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  $T_J = 175$ °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 Applications
- UPS
- Energy Storage System

## MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise noted)

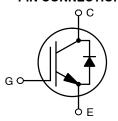
Param	Symbol	Value	Unit	
Collector-to-Emitter Volta	V <sub>CES</sub>	1200	V	
Gate-to-Emitter Voltage		$V_{GES}$	±20	
Transient Gate-to-Emitte	er Voltage		±30	
Collector Current	T <sub>C</sub> = 25°C (Note 1)	I <sub>C</sub>	70	Α
	T <sub>C</sub> = 100°C		40	
Power Dissipation	T <sub>C</sub> = 25°C	P <sub>D</sub>	469	W
	T <sub>C</sub> = 100°C		234	
Pulsed Collector Current	$T_C = 25^{\circ}C \text{ (Note 2)}$ $t_p = 10 \mu s$	I <sub>CM</sub>	160	Α
Diode Forward	T <sub>C</sub> = 25°C (Note 1)	I <sub>F</sub>	80	
Current	T <sub>C</sub> = 100°C		40	
$ \begin{array}{ll} \mbox{Pulsed Diode Maximum} & T_C = 25^{\circ} C, \\ \mbox{Forward Current} & t_p = 10 \ \mu s \end{array} $		I <sub>FM</sub>	160	
Operating Junction and S Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +175	°C	
Lead Temperature for So	TL	260		

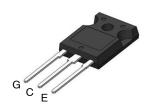
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

BV <sub>CES</sub>	V <sub>CE(SAT)</sub>	Ic
1200 V	1.7 V	40 A

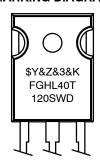
#### **PIN CONNECTIONS**





**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 FGHL40T120SWD = Specific Device Code

## **ORDERING INFORMATION**

Device	Package	Shipping
FGHL40T120SWD	TO-247 (Pb-Free)	30 Units / Tube

## THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case for IGBT	$R_{ heta JC}$	0.32	°C/W
Thermal Resistance, Junction-to-Case for Diode		0.57	
Thermal Resistance, Junction-to-Ambient		40	

## **ELECTRICAL CHARACTERISTICS OF IGBT** (T<sub>J</sub> = 25°C unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
OFF CHARACTERISTICS	•				•	
Collector-to-Emitter Breakdown Voltage	BV <sub>CES</sub>	$V_{GE} = 0 \text{ V}, I_{C} = 5 \text{ mA}$	1200	_	-	V
Collector-to-Emitter Breakdown Voltage	$\Delta BV_CES$	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 5 mA	-	1226	-	mV/°C
Temperature Coefficient	$\Delta T_{J}$					
Zero Gate Voltage Collector Current	I <sub>CES</sub>	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = V <sub>CES</sub>	-	-	40	μΑ
Gate-to-Emitter Leakage Current	I <sub>GES</sub>	V <sub>GE</sub> = 20 V, V <sub>CE</sub> = 0 V	-	-	±400	nA
ON CHARACTERISTICS						
Gate Threshold Voltage	V <sub>GE(th)</sub>	$V_{GE} = V_{CE}$ , $I_C = 40 \text{ mA}$	5.6	6.55	7.4	V
Collector-to-Emitter Saturation Voltage	V <sub>CE(sat)</sub>	$V_{GE} = 15 \text{ V}, I_{C} = 40 \text{ A}, T_{J} = 25^{\circ}\text{C}$	1.35	1.68	2.0	V
		V <sub>GE</sub> = 15 V, I <sub>C</sub> = 40 A, T <sub>J</sub> = 175°C	-	2.26	-	
DYNAMIC CHARACTERISTICS						
Input Capacitance	C <sub>ies</sub>		-	3384	_	pF
Output Capacitance	C <sub>oes</sub>	V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz	-	139	-	
Reverse Transfer Capacitance	C <sub>res</sub>		-	16.2	-	
Gate Charge Total	Qg		-	118	-	nC
Gate-to-Emitter Charge	Q <sub>ge</sub>	$V_{CE} = 600 \text{ V}, V_{GE} = 15 \text{ V},$ $I_{C} = 40 \text{ A}$	-	28.8	-	1
Gate-to-Collector Charge	$Q_{gc}$		-	45.4	-	
SWITCHING CHARACTERISTICS						
Turn-on Delay Time	t <sub>d(on)</sub>		-	22.4	_	ns
Turn-off Delay Time	t <sub>d(off)</sub>		-	160	-	
Rise Time	t <sub>r</sub>		-	14.4	-	
Fall Time	t <sub>f</sub>	$V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}$ $I_{C} = 20 \text{ A R}_{G} = 4.7 \Omega \text{ T}_{J} = 25^{\circ}\text{C}$	-	78.4	-	
Turn-on Switching Loss	E <sub>on</sub>		-	1.1	-	mJ
Turn-off Switching Loss	E <sub>off</sub>		-	0.7	-	
Total Switching Loss	E <sub>ts</sub>		-	1.8	-	
Turn-on Delay Time	t <sub>d(on)</sub>		-	24.0	-	ns
Turn-off Delay Time	t <sub>d(off)</sub>		1	118	-	
Rise Time	t <sub>r</sub>		1	35.2	-	
Fall Time	t <sub>f</sub>	$V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V $I_{C}$ = 40 A $R_{G}$ = 4.7 $\Omega$ $T_{J}$ = 25°C	-	67.4	-	1
Turn-on Switching Loss	E <sub>on</sub>	1071111 <u>G</u> = 4.7 22 1 <u>J</u> = 20 0	_	2.4	-	mJ
Turn-off Switching Loss	E <sub>off</sub>	1	-	1.1	-	1
Total Switching Loss	E <sub>ts</sub>	1	_	3.5	_	

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

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
SWITCHING CHARACTERISTICS						
Turn-on Delay Time	t <sub>d(on)</sub>		-	19.2	-	ns
Turn-off Delay Time	t <sub>d(off)</sub>		-	197	_	
Rise Time	t <sub>r</sub>		-	16.0	-	
Fall Time	t <sub>f</sub>	$V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}$ $I_{C} = 20 \text{ A R}_{G} = 4.7 \Omega \text{ T}_{J} = 175^{\circ}\text{C}$	-	126	-	
Turn-on Switching Loss	E <sub>on</sub>	c	-	1.8	_	mJ
Turn-off Switching Loss	E <sub>off</sub>		-	1.1	-	
Total Switching Loss	E <sub>ts</sub>		-	3.0	-	
Turn-on Delay Time	t <sub>d(on)</sub>		-	20.8	_	ns
Turn-off Delay Time	t <sub>d(off)</sub>		-	138	_	
Rise Time	t <sub>r</sub>		-	35.2	_	
Fall Time	t <sub>f</sub>	$V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}$ $I_{C} = 40 \text{ A R}_{G} = 4.7 \Omega \text{ T}_{J} = 175^{\circ}\text{C}$	-	99.6	-	
Turn-on Switching Loss	E <sub>on</sub>		-	3.6	_	mJ
Turn-off Switching Loss	E <sub>off</sub>		-	1.5	_	
Total Switching Loss	E <sub>ts</sub>		-	5.2	-	
DIODE CHARACTERISTICS						
Forward Voltage	V <sub>F</sub>	I <sub>F</sub> = 40 A, T <sub>J</sub> = 25°C	1.62	1.87	2.22	V
		I <sub>F</sub> = 40 A, T <sub>J</sub> = 175°C	ı	1.84	-	
DIODE SWITCHING CHARACTERISTICS	S, INDUCTIVE LOAI	D				
Reverse Recovery Time	t <sub>rr</sub>		-	113	_	ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>R</sub> = 600 V, I <sub>F</sub> = 20 A,	-	1433	-	nC
Reverse Recovery Energy	E <sub>REC</sub>	$dI_F/dt = 1000 \text{ A/}\mu\text{s}, T_J = 25^{\circ}\text{C}$	-	0.4	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	25.3	_	Α
Reverse Recovery Time	t <sub>rr</sub>		-	185	_	ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>R</sub> = 600 V, I <sub>F</sub> = 40 A,	-	2512	_	nC
Reverse Recovery Energy	E <sub>REC</sub>	$dI_F/dt = 1000 \text{ A/}\mu\text{s}, T_J = 25^{\circ}\text{C}$	-	0.7	_	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	26.9	_	Α
Reverse Recovery Time	t <sub>rr</sub>		-	193	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>R</sub> = 600 V, I <sub>F</sub> = 20 A,	-	3258	_	nC
Reverse Recovery Energy	E <sub>REC</sub>	dl <sub>F</sub> /dt = 1000 A/μs, T <sub>J</sub> = 175°C	_	1.0	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	33.6	-	Α
Reverse Recovery Time	t <sub>rr</sub>		-	275	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>R</sub> = 600 V, I <sub>F</sub> = 40 A,	_	5211	-	nC
Reverse Recovery Energy	E <sub>REC</sub>	dl <sub>F</sub> /dt = 1000 A/μs, T <sub>J</sub> = 175°C	-	1.7	-	mJ
		đ		1		

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.

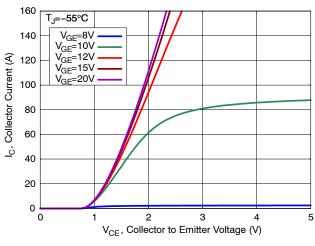


Figure 1. Output Characteristics

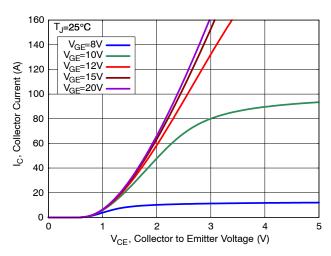


Figure 2. Output Characteristics

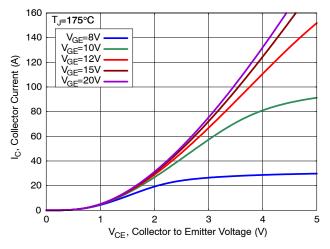


Figure 3. Output Characteristics

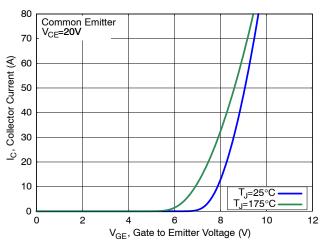


Figure 4. Transfer Characteristics

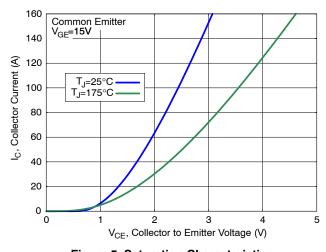


Figure 5. Saturation Characteristics

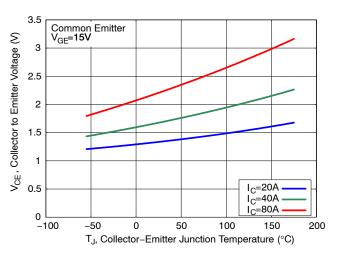


Figure 6. Saturation Voltage vs. Junction Temperature

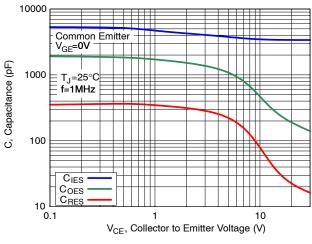


Figure 7. Capacitance Characteristics

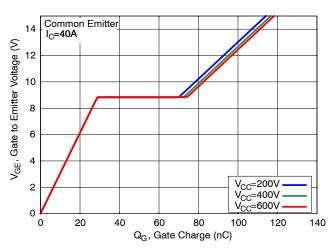


Figure 8. Gate Charge Characteristics

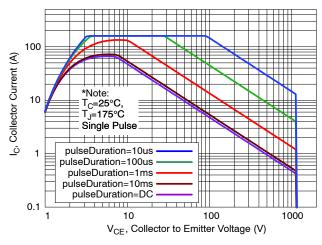


Figure 9. SOA Characteristics

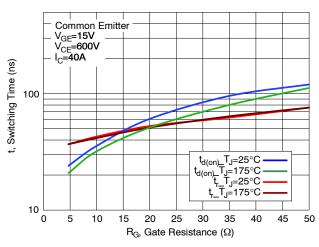


Figure 10. Turn-On Switching Time vs. Gate Resistance

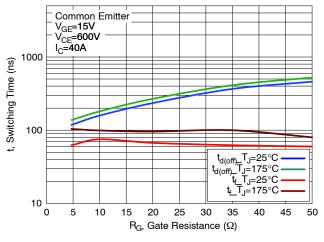


Figure 11. Turn-Off Switching Time vs. Gate Resistance

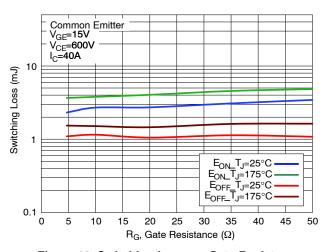


Figure 12. Switching Loss vs. Gate Resistance

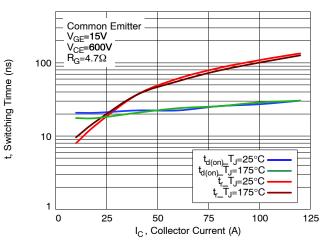
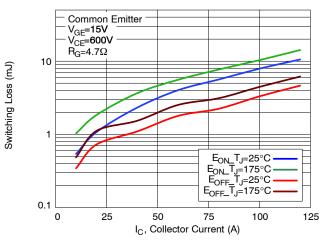


Figure 13. Turn-On Switching Time vs. Collector Current

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



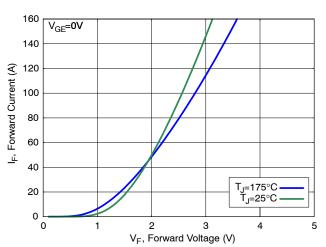
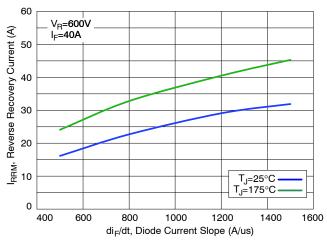


Figure 15. Switching Loss vs. Collector Current

Figure 16. Diode Forward Characteristics



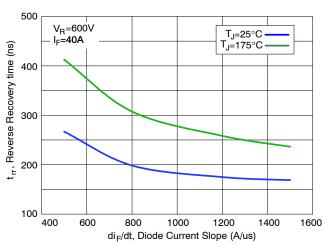


Figure 17. Diode Reverse Recovery Current

Figure 18. Diode Reverse Recovery Time

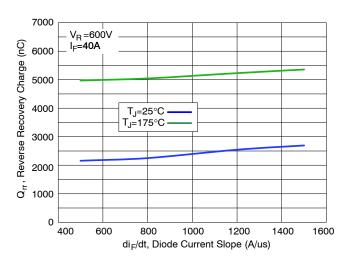


Figure 19. Diode Stored Charge Characteristics

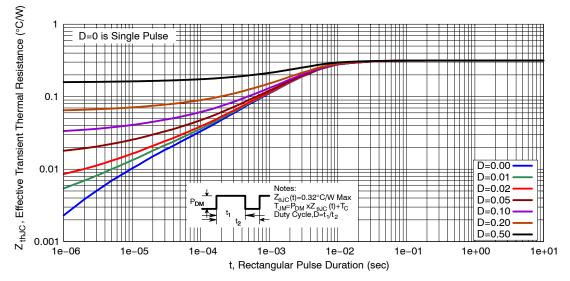


Figure 20. Transient Thermal Impedance of IGBT

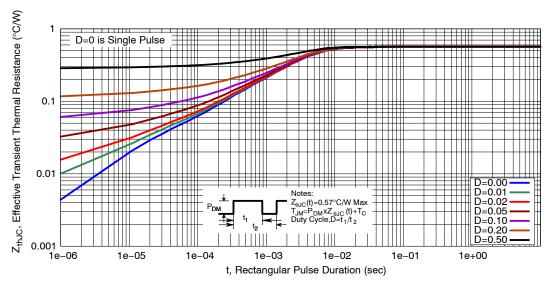
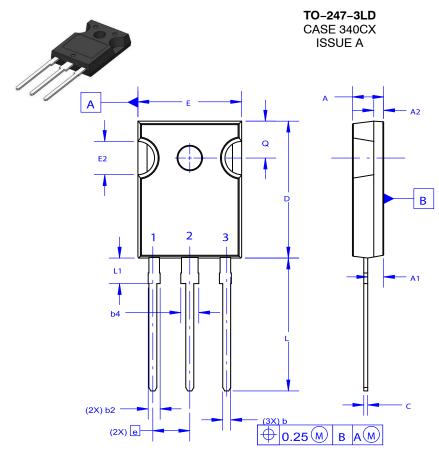


Figure 21. Transient Thermal Impedance of Diode

**DATE 06 JUL 2020** 





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.

# GENERIC MARKING DIAGRAM\*



XXXXX = Specific Device Code A = Assembly Location

Y = Year
WW = Work Week

WW = Work Week
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot " •", may or may not be present. Some products may not follow the Generic Marking.

Ø <sub>P</sub> —		Φ <sub>P1</sub> D2
E1 —	2	D1

DIM	MILLIMETERS				
DIM	MIN	NOM	MAX		
Α	4.58	4.70	4.82		
<b>A</b> 1	2.20	2.40	2.60		
A2	1.40	1.50	1.60		
D	20.32	20.57	20.82		
Е	15.37	15.62	15.87		
E2	4.96	5.08	5.20		
е	~	5.56	~		
L	19.75	20.00	20.25		
L1	3.69	3.81	3.93		
ØΡ	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		
С	0.51	0.61	0.71		
D1	13.08	~	~		
D2	0.51	0.93	1.35		
E1	12.81	~	~		
ØP1	6.60	6.80	7.00		

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DESCRIPTION:	TO-247-3LD		PAGE 1 OF 1	

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