

# **IGBT** – Power, Co-PAK **N-Channel, Field Stop VII** (FS7), SCR, TO247-4L 1200 V, 1.68 V, 60 A AFGH4L60T120RWD-STD

#### Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 4-lead package, this device offers good performance with low on state voltage and low switching losses for both hard and soft switching topologies in automotive applications.

- Extremely Efficient Trench with Field Stop Technology
- Maximum Junction Temperature T<sub>J</sub> =175°C
- Short Circuit Rated and Low Saturation Voltage
- Fast Switching and Tightened Parameter Distribution
- AEC-Q101 Qualified, PPAP Available Upon Request
- This Device is Pb-Free, Halogen Free/BFR Free and is RoHS Compliant

#### **Applications**

• Automotive E-compressor / Automotive EV PTC Heater / OBC

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

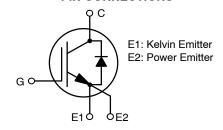
Param	Symbol	Value	Unit	
Collector-to-Emitter Volta	$V_{CE}$	1200	V	
Gate-to-Emitter Voltage	$V_{\sf GE}$	±20		
Transient Gate-to-Emitte		±30		
Collector Current	collector Current $T_C = 25^{\circ}C$ (Note 1)		73	Α
	T <sub>C</sub> = 100°C		60	
Power Dissipation	ssipation T <sub>C</sub> = 25°C		287	W
	T <sub>C</sub> = 100°C		114	
Pulsed Collector Current	Collector Current T <sub>C</sub> = 25°C (Note 2)		180	Α
Diode Forward Current T <sub>C</sub> = 25°C (Note 1)		IF	84	
	T <sub>C</sub> = 100°C		60	
Pulsed Diode Forward Current T <sub>C</sub> = 25°C (Note 2)		I <sub>FM</sub>	180	
Short Circuit Withstand Ti V <sub>GE</sub> = 15 V, V <sub>CC</sub> = 800 V,	T <sub>SC</sub>	6	μs	
Operating Junction and S Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +175	°C	
Lead Temperature for Sol	TL	260	1	

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> TYP	I <sub>C</sub> MAX
1200 V	1.68 V	60 A

#### PIN CONNECTIONS





TO-247-4LD CASE 340CJ

#### MARKING DIAGRAM



\$Y = onsemi Logo

&Z = Assembly Plant Code &3

= 3-Digit Date Code = 2-Digit Lot Traceability Code

AFGH4L60120RWDSTD = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping			
AFGH4L60T120RWD-STD	TO-247-4L (Pb-Free)	30 Units / Tube			

1

### THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case for IGBT	$R_{ heta JC}$	0.26	°C/W
Thermal Resistance, Junction-to-Case for Diode	$R_{ heta JCD}$	0.46	
Thermal Resistance, Junction-to-Ambient	$R_{ heta JA}$	40	

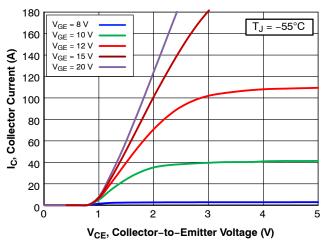
## **ELECTRICAL CHARACTERISTICS** ( $T_J = 25^{\circ}C$ unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
OFF CHARACTERISTICS			•	•		•
Collector-to-Emitter Breakdown Voltage	BV <sub>CES</sub>	$V_{GE} = 0 \text{ V}, I_{C} = 1 \text{ mA}$	1200	_	-	V
Breakdown Voltage Temperature Coefficient	ΔBV <sub>CES</sub> / ΔΤ <sub>J</sub>	$V_{GE} = 0 \text{ V, I}_{C} = 9.99 \text{ mA}$	-	1226	-	mV/°C
Collector-to-Emitter Cut-Off 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-to-Emitter Threshold Voltage	V <sub>GE(th)</sub>	$V_{GE} = V_{CE}$ , $I_C = 60 \text{ mA}$	5.1	6	6.9	V
Collector-to-Emitter Saturation	V <sub>CE(sat)</sub>	V <sub>GE</sub> = 15 V, I <sub>C</sub> = 60 A, T <sub>J</sub> = 25°C	_	1.68	2.01	٧
Voltage		V <sub>GE</sub> = 15 V, I <sub>C</sub> = 60 A, T <sub>J</sub> = 175°C	-	2.18	_	1
DYNAMIC CHARACTERISTICS			•	•	-	•
Input Capacitance	C <sub>IES</sub>	$V_{CE} = 30 \text{ V}, V_{GE} = 0 \text{ V}, f = 1 \text{ MHz}$	_	5252	_	pF
Output Capacitance	C <sub>OES</sub>		-	175	_	1
Reverse Transfer Capacitance	C <sub>RES</sub>		-	23	_	1
Total Gate Charge	$Q_{G}$	V <sub>CE</sub> = 600 V, V <sub>GE</sub> = 15 V, I <sub>C</sub> = 60 A	-	171	_	nC
Gate-to-Emitter Charge	Q <sub>GE</sub>		-	50.4	_	1
Gate-to-Collector Charge	Q <sub>GC</sub>		-	72.8	_	1
SWITCHING CHARACTERISTICS, INI	DUCTIVE LOAD	)	•	•	-	•
Turn-On Delay Time	t <sub>d(on)</sub>	$V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $I_{C}$ = 30 A, $R_{G}$ = 6 $\Omega$ ,	_	62	_	ns
Rise Time	t <sub>r</sub>	$I_C = 30 \text{ A}, H_G = 6 \Omega,$ $T_J = 25^{\circ}\text{C}$	_	26	_	1
Turn-Off Delay Time	t <sub>d(off)</sub>	Ü	-	305	_	1
Fall Time	t <sub>f</sub>		-	207	_	1
Turn-On Switching Loss	E <sub>on</sub>		-	1.48	_	mJ
Turn-Off Switching Loss	E <sub>off</sub>		-	2.32	_	1
Total Switching Loss	E <sub>ts</sub>		-	3.8	_	1
Turn-On Delay Time	t <sub>d(on)</sub>	$V_{CE} = 600 \text{ V}, V_{GE} = 15 \text{ V},$	-	68	_	ns
Rise Time	t <sub>r</sub>	$I_{C}$ = 60 A, $R_{G}$ = 6 $\Omega$ , $T_{J}$ = 25°C	-	39	_	1
Turn-Off Delay Time	t <sub>d(off)</sub>	- -	-	264	_	1
Fall Time	t <sub>f</sub>		_	203	-	1
Turn-On Switching Loss	E <sub>on</sub>		_	3.03	-	mJ
Turn-Off Switching Loss	E <sub>off</sub>		_	3.98	-	1
Total Switching Loss	E <sub>ts</sub>		_	7	_	1

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

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
SWITCHING CHARACTERISTICS, I	NDUCTIVE LOAD		•	•		•
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>CE</sub> = 600 V, V <sub>GE</sub> = 15 V,	-	59	-	ns
Rise Time	t <sub>r</sub>	$I_{C} = 30 \text{ A}, R_{G} = 6 \Omega,$ $T_{J} = 175^{\circ}\text{C}$	-	34	_	1
Turn-Off Delay Time	t <sub>d(off)</sub>		-	347	-	1
Fall Time	t <sub>f</sub>		-	349	-	1
Turn-On Switching Loss	E <sub>on</sub>		-	2.68	-	mJ
Turn-Off Switching Loss	E <sub>off</sub>		-	3.03	-	1
Total Switching Loss	E <sub>ts</sub>		-	5.7	-	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>CE</sub> = 600 V, V <sub>GE</sub> = 15 V,	-	67	-	ns
Rise Time	t <sub>r</sub>	$I_C$ = 60 A, $R_G$ = 6 Ω, $T_J$ = 175°C	-	52	-	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	313	-	1
Fall Time	t <sub>f</sub>		-	355	-	1
Turn-On Switching Loss	E <sub>on</sub>		-	5.61	-	mJ
Turn-Off Switching Loss	E <sub>off</sub>		-	5.67	-	
Total Switching Loss	E <sub>ts</sub>		-	11.28	-	
ELECTRICAL DIODE CHARACTER	ISTICS					
Diode Forward Voltage	V <sub>F</sub>	I <sub>F</sub> = 60 A, T <sub>J</sub> = 25°C	-	1.72	2.09	V
	I <sub>F</sub> = 60 A, T <sub>J</sub> = 175°C	-	1.8	-		
DIODE SWITCHING CHARACTERIS	STICS, INDUCTIVE	LOAD				
Reverse Recovery Time	t <sub>rr</sub>	$V_R = 600 \text{ V}, I_F = 30 \text{ A},$	-	217	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>	$dI_F/dt = 500 \text{ A/}\mu\text{s}, T_J = 25^{\circ}\text{C}$	-	2731	-	nC
Reverse Recovery Energy	E <sub>rec</sub>		-	0.98	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	21	-	Α
Reverse Recovery Time	t <sub>rr</sub>	$V_{R} = 600 \text{ V}, I_{F} = 60 \text{ A},$	-	308	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>	$dI_F/dt = 500 \text{ A/}\mu\text{s}, T_J = 25^{\circ}\text{C}$	-	3963	-	nC
Reverse Recovery Energy	E <sub>rec</sub>		-	1.48	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	22	-	Α
Reverse Recovery Time	t <sub>rr</sub>	$V_{R} = 600 \text{ V}, I_{F} = 30 \text{ A},$ $dI_{F}/dt = 500 \text{ A}/\mu\text{s}, T_{J} = 175^{\circ}\text{C}$	-	364	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>		-	5822	-	nC
Reverse Recovery Energy	E <sub>rec</sub>		-	2.29	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	29	-	Α
Reverse Recovery Time	t <sub>rr</sub>	$V_R = 600 \text{ V}, I_F = 60 \text{ A},$	-	506	-	ns
Reverse Recovery Charge	Q <sub>rr</sub>	$dI_F/dt = 500 \text{ A/}\mu\text{s}, T_J = 175^{\circ}\text{C}$	-	8388	-	nC
Reverse Recovery Energy	E <sub>rec</sub>		-	3.36	-	mJ
Peak Reverse Recovery Current	I <sub>RRM</sub>		-	30	-	Α

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. Typical Output Characteristics** 

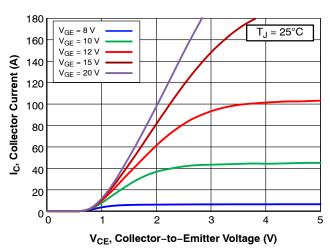


Figure 2. Typical Output Characteristics

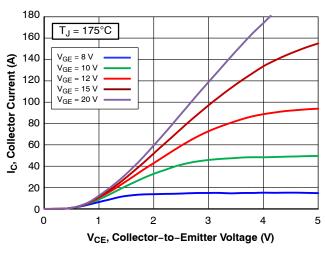


Figure 3. Typical Output Characteristics

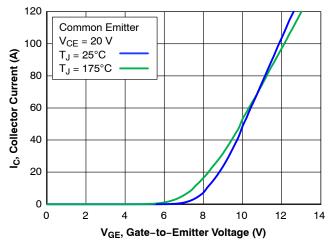


Figure 4. Transfer Characteristics

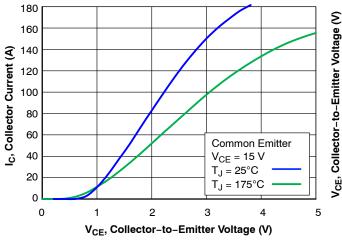


Figure 5. Saturation Voltage Characteristics

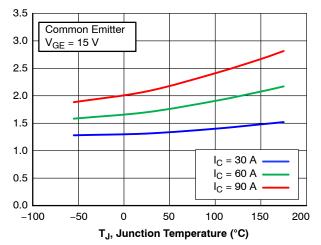


Figure 6. Saturation Voltage vs. Junction Temperature

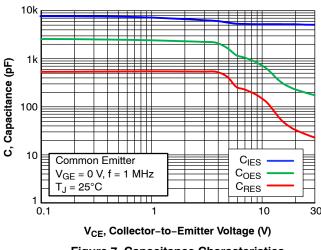


Figure 7. Capacitance Characteristics

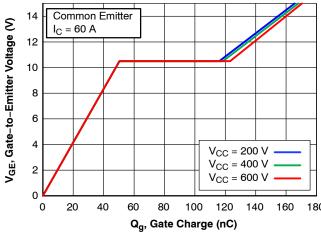


Figure 8. Gate Charge Characteristics

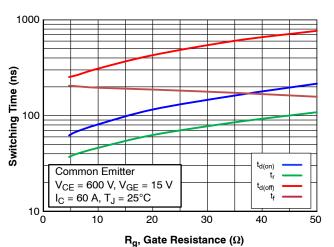


Figure 9. Switching Time vs. Gate Resistance

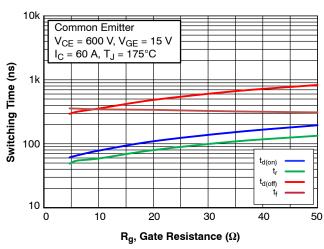


Figure 10. Switching Time vs. Gate Resistance

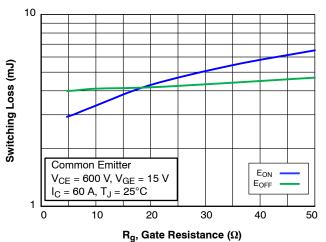


Figure 11. Switching Loss vs. Gate Resistance

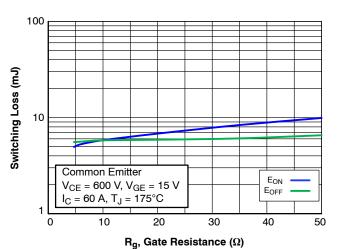


Figure 12. Switching Loss vs. Gate Resistance

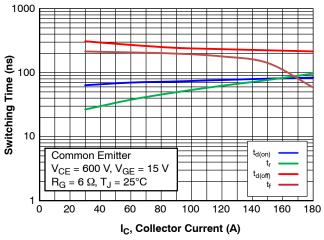


Figure 13. Switching Time vs. Collector Current

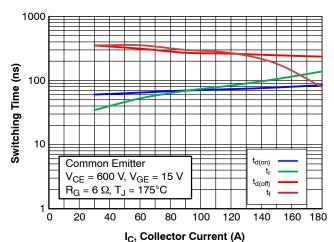


Figure 14. Switching Time vs. Collector
Current

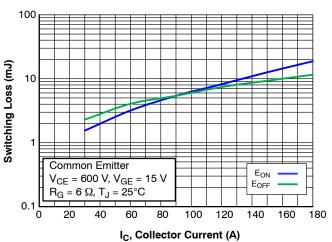


Figure 15. Switching Loss vs Collector
Current

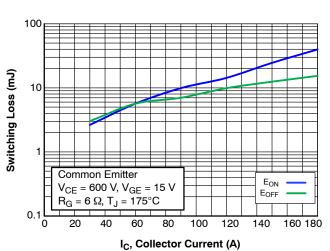


Figure 16. Switching Loss vs Collector
Current

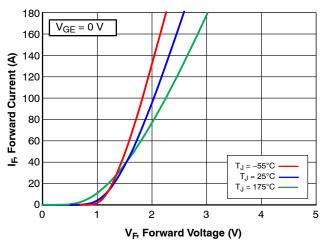


Figure 17. Diode Forward Characteristics

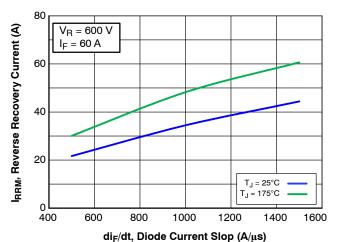
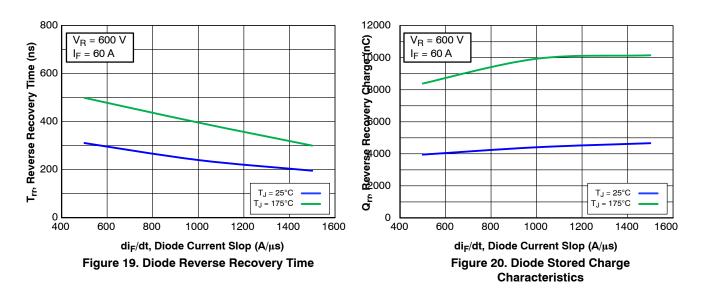


Figure 18. Diode Reverse Recovery Current



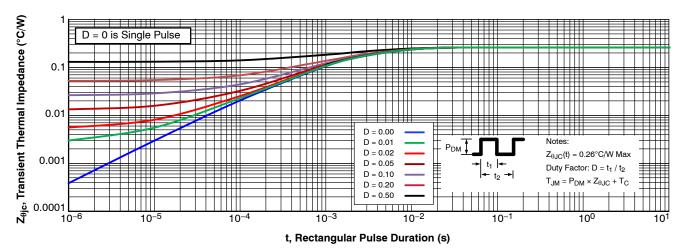


Figure 21. Transient Thermal Impedance of IGBT

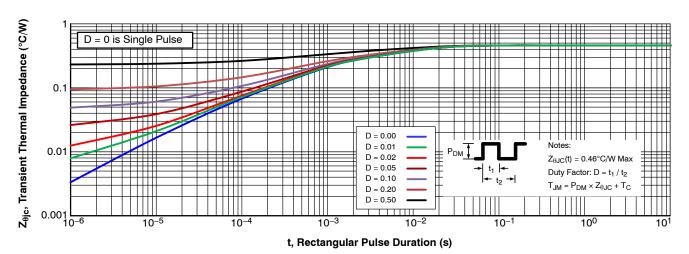
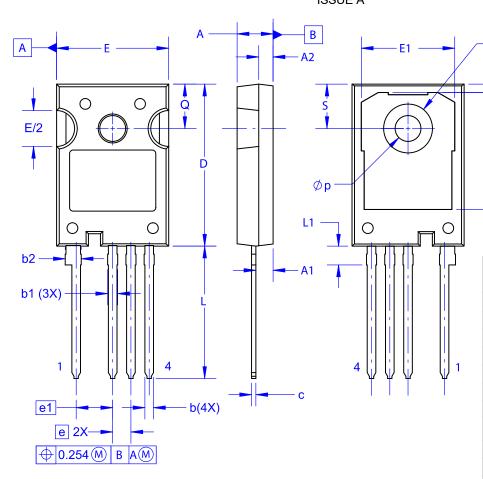


Figure 22. Transient Thermal Impedance of Diode

## PACKAGE DIMENSIONS

#### TO-247-4LD CASE 340CJ **ISSUE A**



#### NOTES:

- A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
  B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD
  FLASH, AND TIE BAR EXTRUSIONS.
  C. ALL DIMENSIONS ARE IN MILLIMETERS.
  D. DRAWING CONFORMS TO ASME Y14.5-2009.

DIM	MIL	LIMETER	S
DIM	MIN	NOM	MAX
Α	4.80	5.00	5.20
A1	2.10	2.40	2.70
A2	1.80	2.00	2.20
b	1.07	1.20	1.33
b1	1.20	1.40	1.60
b2	2.02	2.22	2.42
С	0.50	0.60	0.70
D	22.34	22.54	22.74
D1	16.00	16.25	16.50
D2	0.97	1.17	1.37
е	2	2.54 BSC	
e1	Ę	5.08 BSC	2
Е	15.40	15.60	15.80
E1	12.80	13.00	13.20
E/2	4.80	5.00	5.20
L	18.22	18.42	18.62
L1	2.42	2.62	2.82
р	3.40	3.60	3.80
p1	6.60	6.80	7.00
Q	5.97	6.17	6.37
S	5.97	6.17	6.37
S	5.97	6.17	6.37

Ø**p1** 

D1

- D2

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