

# 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.

## Features

- Extremely Efficient Trench with Field Stop Technology
- Maximum Junction Temperature –  $T_J = 175^\circ\text{C}$
- 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 ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

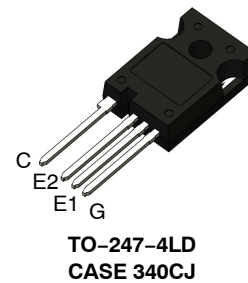
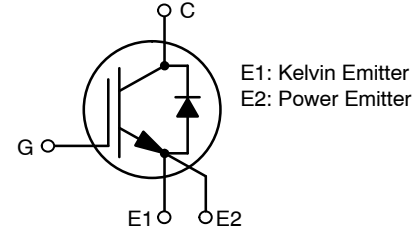
Parameter	Symbol	Value	Unit
Collector-to-Emitter Voltage	$V_{CE}$	1200	V
Gate-to-Emitter Voltage	$V_{GE}$	$\pm 20$	
Transient Gate-to-Emitter Voltage		$\pm 30$	
Collector Current	$I_C$	$T_C = 25^\circ\text{C}$ (Note 1)	73
		$T_C = 100^\circ\text{C}$	60
Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	287
		$T_C = 100^\circ\text{C}$	114
Pulsed Collector Current	$I_{CM}$	180	A
Diode Forward Current	$I_F$	$T_C = 25^\circ\text{C}$ (Note 1)	84
		$T_C = 100^\circ\text{C}$	60
Pulsed Diode Forward Current	$I_{FM}$	180	
Short Circuit Withstand Time $V_{GE} = 15\text{ V}, V_{CC} = 800\text{ V}, T_C = 150^\circ\text{C}$	$T_{SC}$	6	$\mu\text{s}$
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$
Lead Temperature for Soldering Purposes	$T_L$	260	

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

$BV_{CES}$	$V_{CE(sat)}$ TYP	$I_C$ MAX
1200 V	1.68 V	60 A

## PIN CONNECTIONS



## MARKING DIAGRAM



\$Y = onsemi Logo  
 &Z = Assembly Plant Code  
 &3 = 3-Digit Date Code  
 &K = 2-Digit Lot Traceability Code  
 AFGH4L60120RWDSTD = Specific Device Code

## ORDERING INFORMATION

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

# AFGH4L60T120RWD-STD

## THERMAL CHARACTERISTICS

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

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

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

Collector-to-Emitter Breakdown Voltage	$BV_{CES}$	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	1200	-	-	V
Breakdown Voltage Temperature Coefficient	$\Delta BV_{CES} / \Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 9.99\text{ mA}$	-	1226	-	mV/°C
Collector-to-Emitter Cut-Off Current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = V_{CES}$	-	-	40	μA
Gate-to-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}, V_{CE} = 0\text{ V}$	-	-	±400	nA

### ON CHARACTERISTICS

Gate-to-Emitter Threshold Voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 60\text{ mA}$	5.1	6	6.9	V
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 25^\circ\text{C}$	-	1.68	2.01	V
		$V_{GE} = 15\text{ V}, I_C = 60\text{ A}, T_J = 175^\circ\text{C}$	-	2.18	-	

### DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{IES}$	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	-	5252	-	pF
Output Capacitance	$C_{OES}$		-	175	-	
Reverse Transfer Capacitance	$C_{RES}$		-	23	-	
Total Gate Charge	$Q_G$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 60\text{ A}$	-	171	-	nC
Gate-to-Emitter Charge	$Q_{GE}$		-	50.4	-	
Gate-to-Collector Charge	$Q_{GC}$		-	72.8	-	

### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 30\text{ A}, R_G = 6\ \Omega, T_J = 25^\circ\text{C}$	-	62	-	ns
Rise Time	$t_r$		-	26	-	
Turn-Off Delay Time	$t_{d(off)}$		-	305	-	
Fall Time	$t_f$		-	207	-	
Turn-On Switching Loss	$E_{on}$		-	1.48	-	mJ
Turn-Off Switching Loss	$E_{off}$		-	2.32	-	
Total Switching Loss	$E_{ts}$		-	3.8	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 60\text{ A}, R_G = 6\ \Omega, T_J = 25^\circ\text{C}$	-	68	-	ns
Rise Time	$t_r$		-	39	-	
Turn-Off Delay Time	$t_{d(off)}$		-	264	-	
Fall Time	$t_f$		-	203	-	
Turn-On Switching Loss	$E_{on}$		-	3.03	-	mJ
Turn-Off Switching Loss	$E_{off}$		-	3.98	-	
Total Switching Loss	$E_{ts}$		-	7	-	

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>SWITCHING CHARACTERISTICS, INDUCTIVE LOAD</b>						
Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V},$ $I_C = 30\text{ A}, R_G = 6\ \Omega,$ $T_J = 175^\circ\text{C}$	-	59	-	ns
Rise Time	$t_r$		-	34	-	
Turn-Off Delay Time	$t_{d(off)}$		-	347	-	
Fall Time	$t_f$		-	349	-	
Turn-On Switching Loss	$E_{on}$		-	2.68	-	mJ
Turn-Off Switching Loss	$E_{off}$		-	3.03	-	
Total Switching Loss	$E_{ts}$		-	5.7	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V},$ $I_C = 60\text{ A}, R_G = 6\ \Omega,$ $T_J = 175^\circ\text{C}$	-	67	-	ns
Rise Time	$t_r$		-	52	-	
Turn-Off Delay Time	$t_{d(off)}$		-	313	-	
Fall Time	$t_f$		-	355	-	
Turn-On Switching Loss	$E_{on}$		-	5.61	-	mJ
Turn-Off Switching Loss	$E_{off}$		-	5.67	-	
Total Switching Loss	$E_{ts}$		-	11.28	-	

## ELECTRICAL DIODE CHARACTERISTICS

Diode Forward Voltage	$V_F$	$I_F = 60\text{ A}, T_J = 25^\circ\text{C}$	-	1.72	2.09	V
		$I_F = 60\text{ A}, T_J = 175^\circ\text{C}$	-	1.8	-	

## DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$	-	217	-	ns
Reverse Recovery Charge	$Q_{rr}$		-	2731	-	nC
Reverse Recovery Energy	$E_{rec}$		-	0.98	-	mJ
Peak Reverse Recovery Current	$I_{RRM}$		-	21	-	A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$	-	308	-	ns
Reverse Recovery Charge	$Q_{rr}$		-	3963	-	nC
Reverse Recovery Energy	$E_{rec}$		-	1.48	-	mJ
Peak Reverse Recovery Current	$I_{RRM}$		-	22	-	A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	-	364	-	ns
Reverse Recovery Charge	$Q_{rr}$		-	5822	-	nC
Reverse Recovery Energy	$E_{rec}$		-	2.29	-	mJ
Peak Reverse Recovery Current	$I_{RRM}$		-	29	-	A
Reverse Recovery Time	$t_{rr}$	$V_R = 600\text{ V}, I_F = 60\text{ A},$ $di_F/dt = 500\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	-	506	-	ns
Reverse Recovery Charge	$Q_{rr}$		-	8388	-	nC
Reverse Recovery Energy	$E_{rec}$		-	3.36	-	mJ
Peak Reverse Recovery Current	$I_{RRM}$		-	30	-	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.

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## TYPICAL CHARACTERISTICS

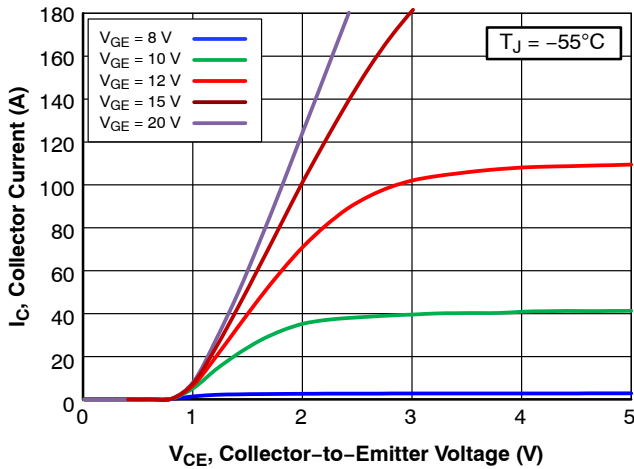


Figure 1. Typical Output Characteristics

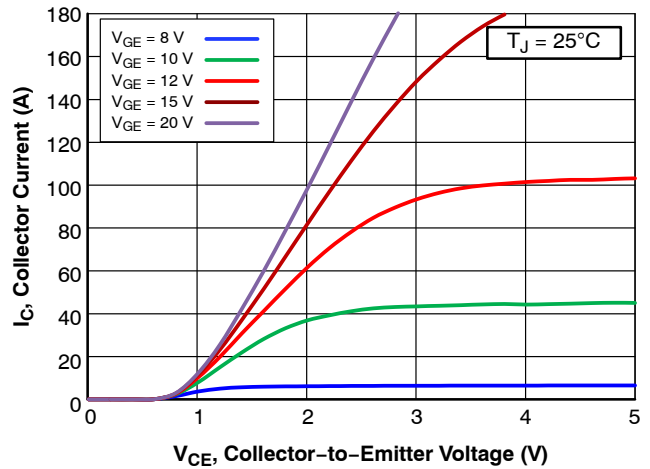


Figure 2. Typical Output Characteristics

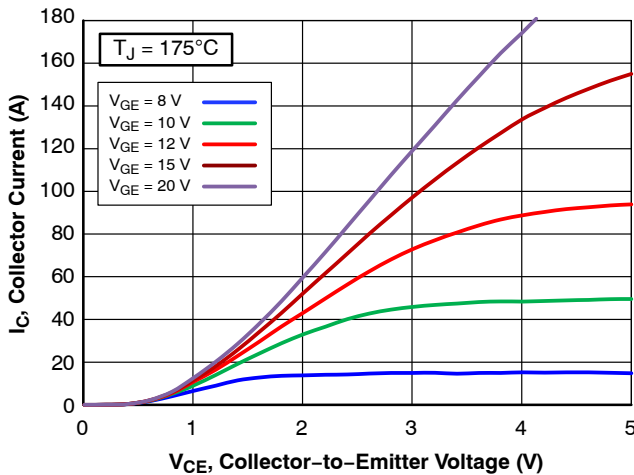


Figure 3. Typical Output Characteristics

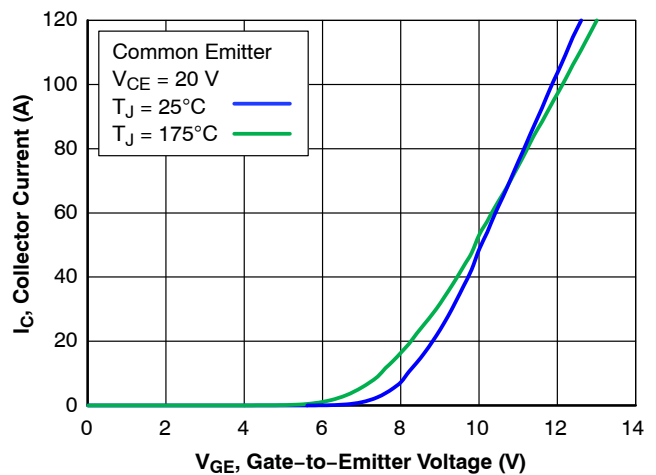


Figure 4. Transfer Characteristics

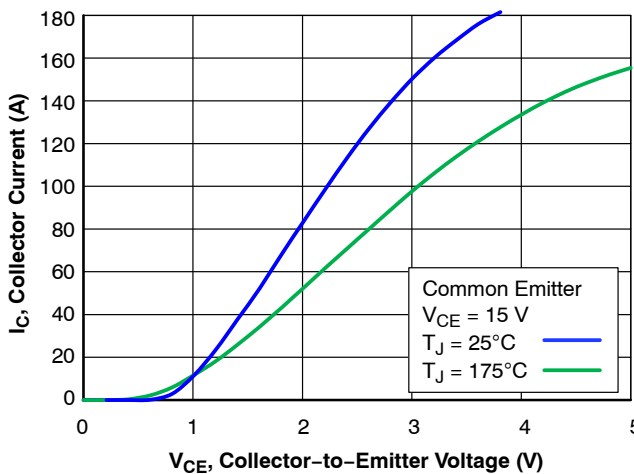


Figure 5. Saturation Voltage Characteristics

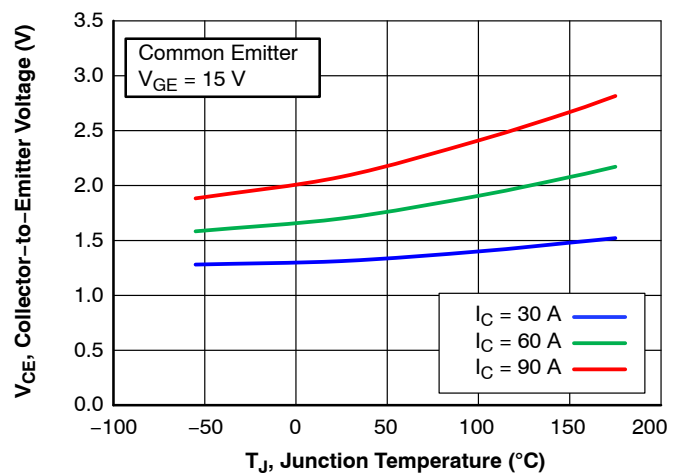


Figure 6. Saturation Voltage vs. Junction Temperature

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## TYPICAL CHARACTERISTICS

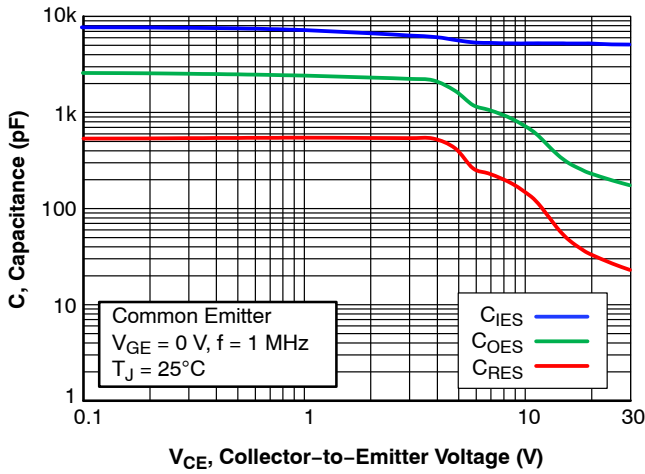


Figure 7. Capacitance Characteristics

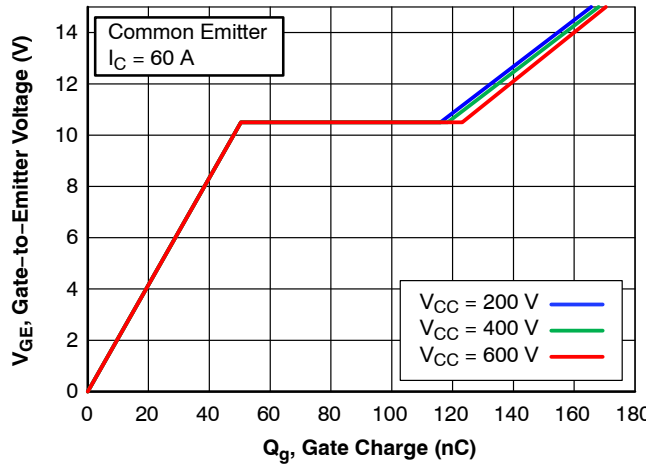


Figure 8. Gate Charge Characteristics

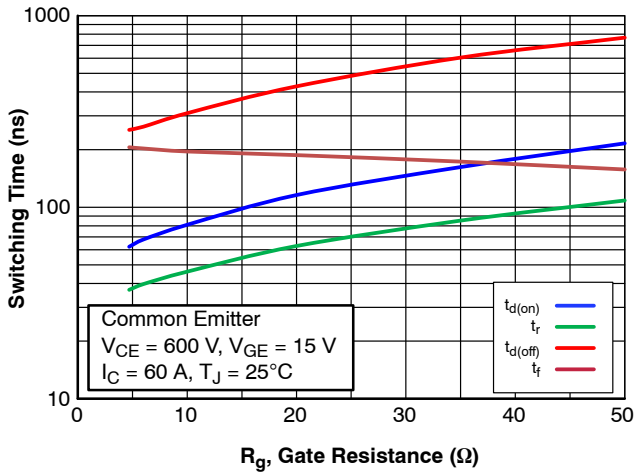


Figure 9. Switching Time vs. Gate Resistance

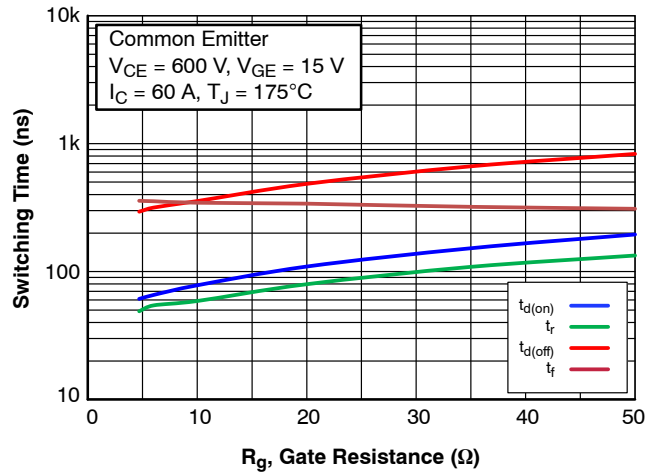


Figure 10. Switching Time vs. Gate Resistance

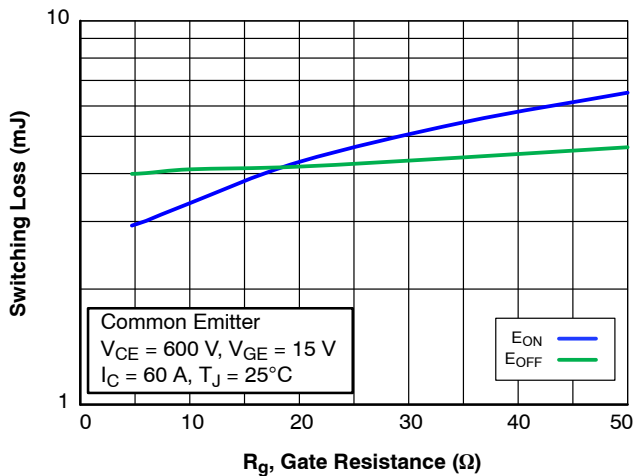


Figure 11. Switching Loss vs. Gate Resistance

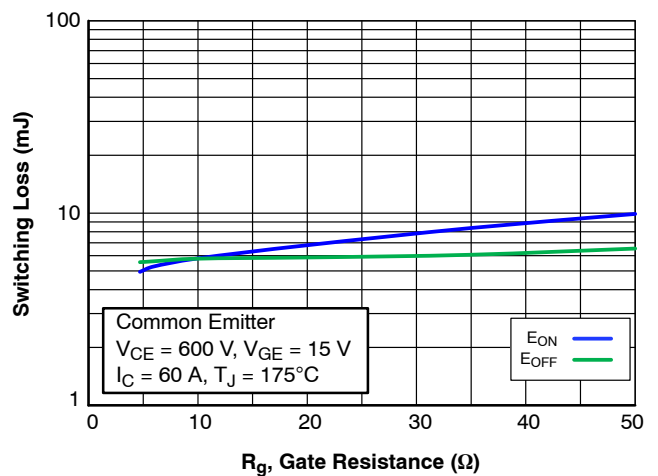


Figure 12. Switching Loss vs. Gate Resistance

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## TYPICAL CHARACTERISTICS

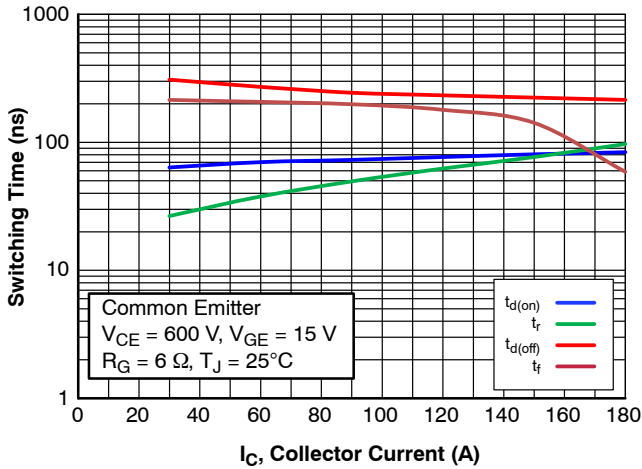


Figure 13. Switching Time vs. Collector Current

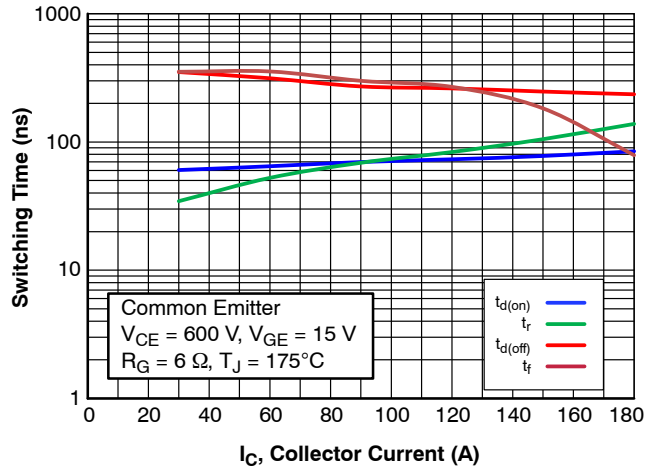


Figure 14. Switching Time vs. Collector Current

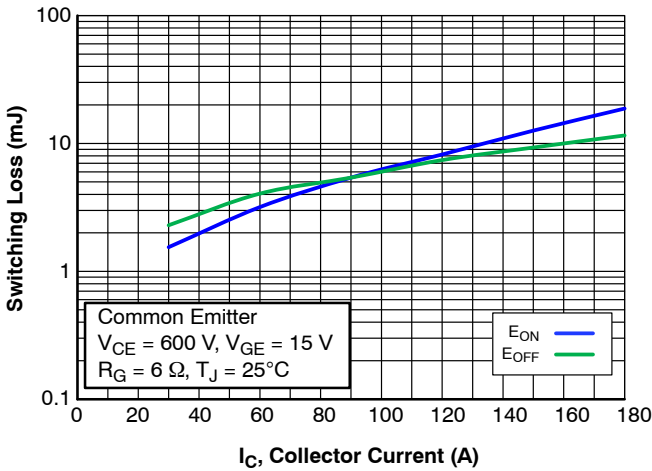


Figure 15. Switching Loss vs. Collector Current

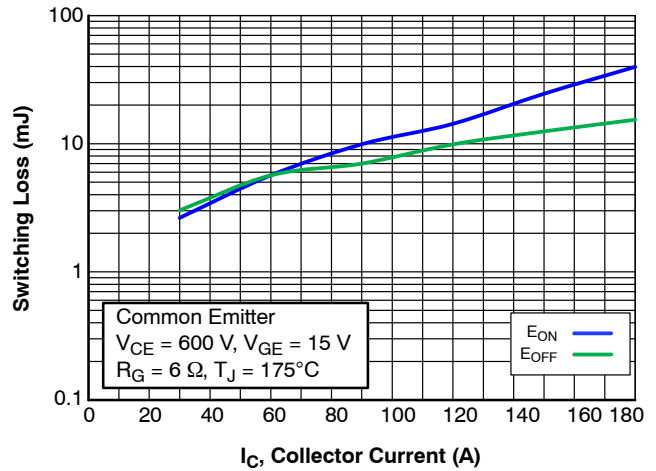


Figure 16. Switching Loss vs. Collector Current

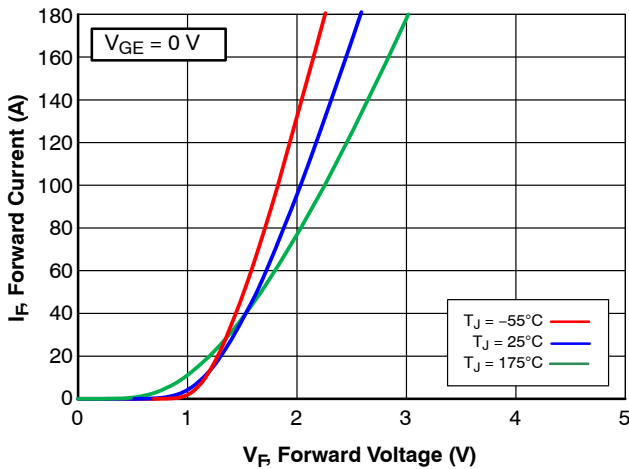


Figure 17. Diode Forward Characteristics

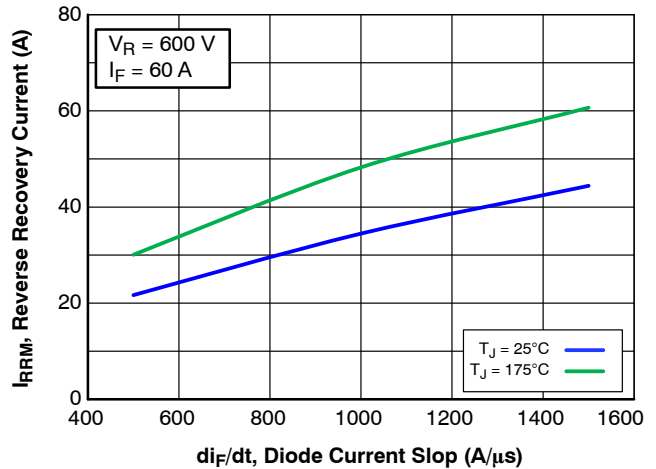


Figure 18. Diode Reverse Recovery Current

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## TYPICAL CHARACTERISTICS

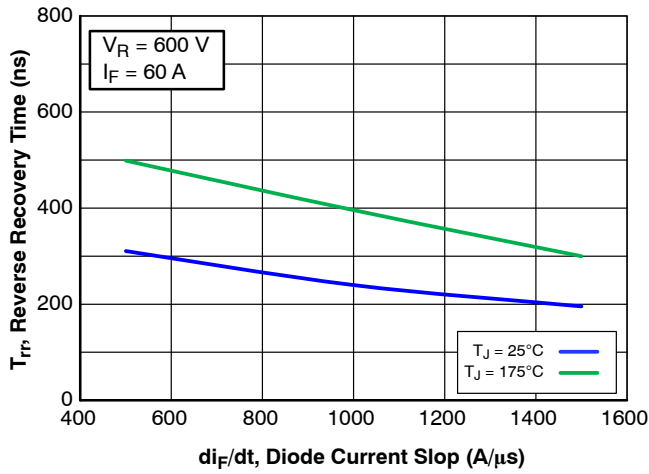


Figure 19. Diode Reverse Recovery Time

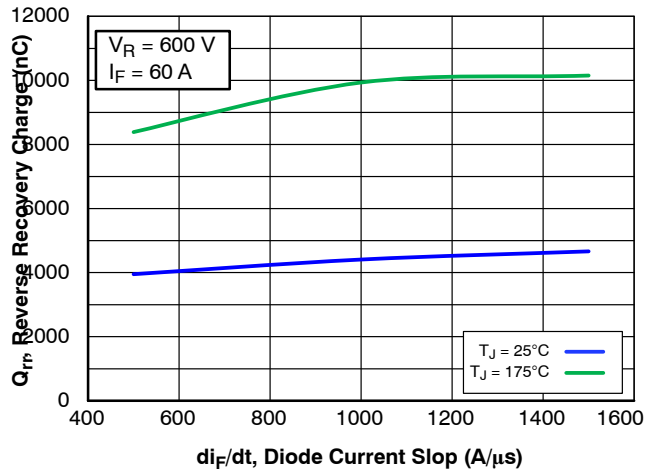


Figure 20. Diode Stored Charge Characteristics

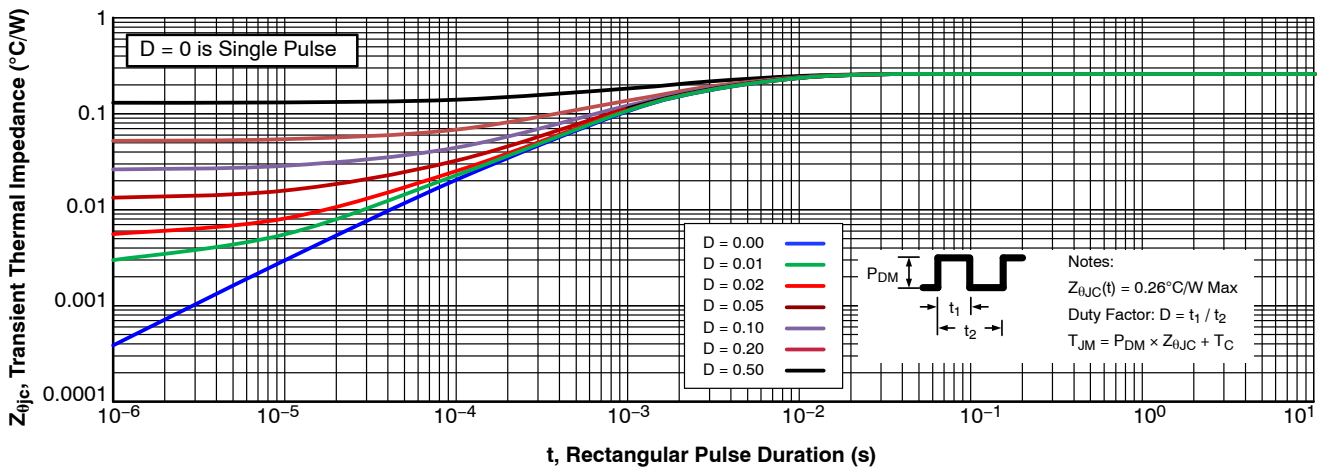


Figure 21. Transient Thermal Impedance of IGBT

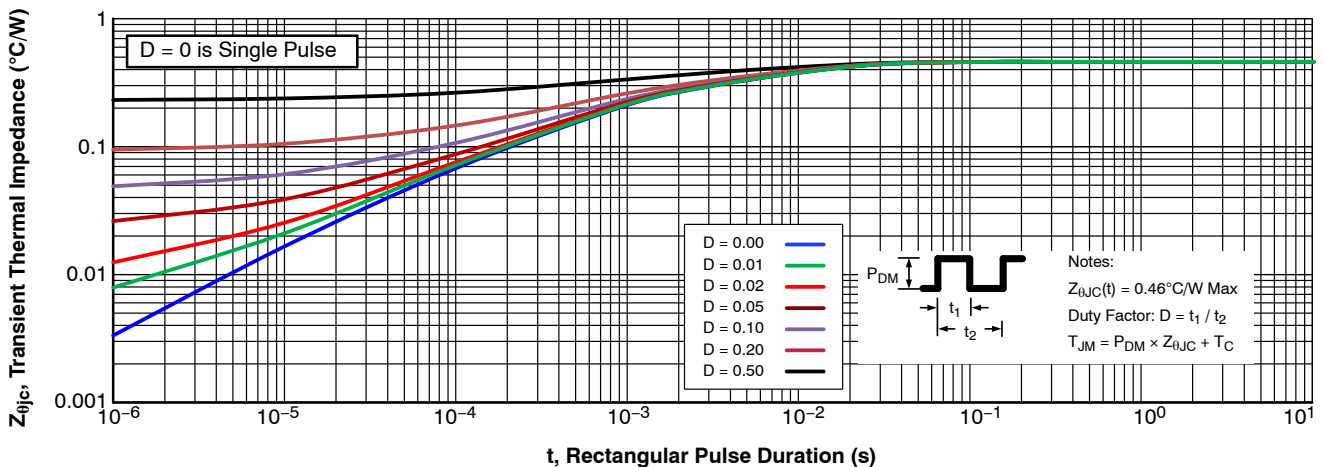
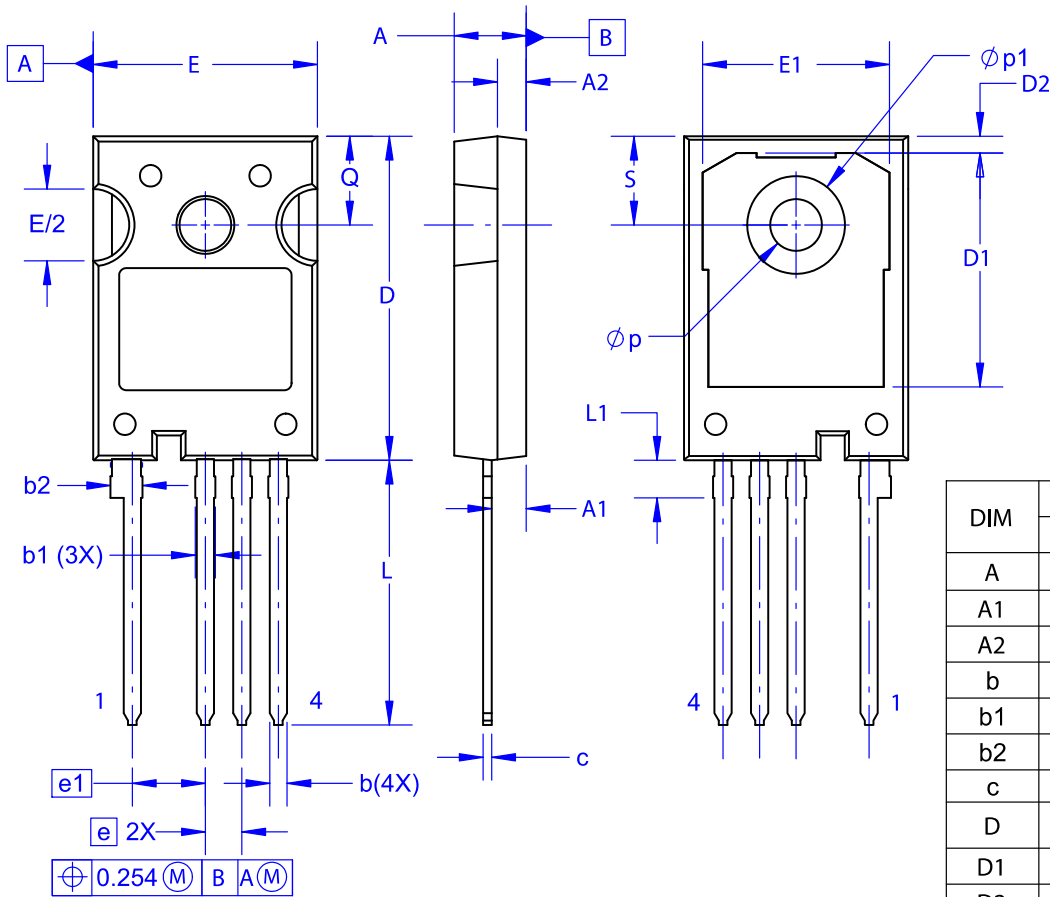


Figure 22. Transient Thermal Impedance of Diode

# AFGH4L60T120RWD-STD

## PACKAGE DIMENSIONS

TO-247-4LD  
CASE 340CJ  
ISSUE A



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	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
c	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
e	2.54 BSC		
e1	5.08 BSC		
E	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
p	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

**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.

# AFGH4L60T120RWD-STD

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