



**THE DATASHEET OF  
FGH40T70SHD-F155**



# IGBT - Field Stop, Trench

700 V, 40 A

## FGH40T70SHD

### Description

Using novel field stop IGBT technology, ON Semiconductor's new series of field stop 3rd generation IGBTs offer the optimum performance for Solar Inverter, UPS, Welder, Telecom, ESS and PFC applications where low conduction and switching losses are essential.

### Features

- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.7\text{ V(Typ.)} @ I_C = 40\text{ A}$
- 100% of the Parts Tested for  $I_{LM}(1)$
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- These Devices are Pb-Free and are RoHS Compliant

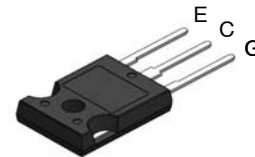
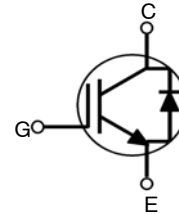
### Applications

- Solar Inverter, UPS, Welder, Telecom, ESS, PFC



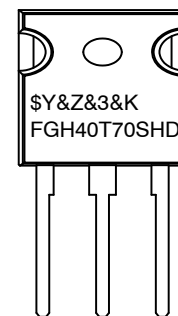
ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)



TO-247-3LD  
CASE 340CH

### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
&Z = Assembly Plant Code  
&3 = Numeric Date Code  
&K = Lot Code  
FGH40T70SHD = Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# FGH40T70SHD

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

Description		Symbol	Rating	Unit
Collector to Emitter Voltage		V <sub>CES</sub>	700	V
Gate to Emitter Voltage		V <sub>GES</sub>	±20	V
Transient Gate to Emitter Voltage			±30	V
Collector Current	T <sub>C</sub> = 25°C	I <sub>C</sub>	80	A
Collector Current	T <sub>C</sub> = 100°C		40	A
Pulsed Collector Current	T <sub>C</sub> = 25°C	I <sub>LM</sub> (Note 1)	120	A
Pulsed Collector Current		I <sub>CM</sub> (Note 2)	120	A
Diode Forward Current	T <sub>C</sub> = 25°C	I <sub>F</sub>	40	A
Diode Forward Current	T <sub>C</sub> = 100°C		20	A
Pulsed Diode Maximum Forward Current		I <sub>FM</sub> (Note 2)	120	A
Maximum Power Dissipation	T <sub>C</sub> = 25°C	P <sub>D</sub>	268	W
Maximum Power Dissipation	T <sub>C</sub> = 100°C		134	W
Operating Junction Temperature		T <sub>J</sub>	-55 to +175	°C
Storage Temperature Range		T <sub>stg</sub>	-55 to +175	°C
Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds		T <sub>L</sub>	300	°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.

- V<sub>CC</sub> = 400 V, V<sub>GE</sub> = 15 V, I<sub>C</sub> = 120 A, R<sub>G</sub> = 30 Ω, Inductive Load
- Repetitive rating: Pulse width limited by max. junction temperature.

## THERMAL CHARACTERISTICS

Parameter	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Case	R <sub>θJC</sub> (IGBT)	-	0.56	°C/W
Thermal Resistance, Junction to Case	R <sub>θJC</sub> (Diode)	-	1.71	°C/W
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	-	40	°C/W

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FGH40T70SHD-F155	FGH40T70SHD	TO-247-3 (Pb-Free)	Tube	-	-	30

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

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

Collector to Emitter Breakdown Voltage	BV <sub>CES</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	700	-	-	V
Temperature Coefficient of Breakdown Voltage	ΔBV <sub>CES</sub> /ΔT <sub>J</sub>	I <sub>C</sub> = 1 mA, Reference to 25°C	-	0.6	-	V/°C
Collector Cut-Off Current	I <sub>CES</sub>	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V	-	-	250	μA
G-E Leakage Current	I <sub>GES</sub>	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V	-	-	±400	nA

### ON CHARACTERISTICS

G-E Threshold Voltage	V <sub>GE(th)</sub>	I <sub>C</sub> = 40 mA, V <sub>CE</sub> = V <sub>GE</sub>	4.0	5.5	7.5	V
Collector to Emitter Saturation Voltage	V <sub>CE(sat)</sub>	I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	-	1.7	2.15	V
		I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 175°C	-	2.37	-	V

# FGH40T70SHD

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

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

Input Capacitance	$C_{ies}$	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	-	2028	-	pF
Output Capacitance	$C_{oes}$		-	75	-	pF
Reverse Transfer Capacitance	$C_{res}$		-	26	-	pF

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 25^\circ\text{C}$	-	22	-	ns
Rise Time	$t_r$		-	40	-	ns
Turn-Off Delay Time	$t_{d(off)}$		-	66	-	ns
Fall Time	$t_f$		-	10	-	ns
Turn-On Switching Loss	$E_{on}$		-	1150	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{off}$		-	271	-	$\mu\text{J}$
Total Switching Loss	$E_{ts}$		-	1421	-	$\mu\text{J}$
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 175^\circ\text{C}$	-	20	-	ns
Rise Time	$t_r$		-	36	-	ns
Turn-Off Delay Time	$t_{d(off)}$		-	68	-	ns
Fall Time	$t_f$		-	13	-	ns
Turn-On Switching Loss	$E_{on}$		-	1760	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{off}$		-	455	-	$\mu\text{J}$
Total Switching Loss	$E_{ts}$		-	2215	-	$\mu\text{J}$
Total Gate Charge	$Q_g$	$V_{CE} = 400\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	-	69	-	nC
Gate to Emitter Charge	$Q_{ge}$		-	13	-	nC
Gate to Collector Charge	$Q_{gc}$		-	26	-	nC

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
Diode Forward Voltage	$V_{FM}$	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	2.0	2.5	V
			$T_C = 175^\circ\text{C}$	-	1.73	-	
Reverse Recovery Energy	$E_{rec}$	$I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 175^\circ\text{C}$	-	54	-	$\mu\text{J}$
Diode Reverse Recovery Time	$t_{rr}$		$T_C = 25^\circ\text{C}$	-	37	-	ns
			$T_C = 175^\circ\text{C}$	-	235	-	
Diode Reverse Recovery Charge	$Q_{rr}$		$T_C = 25^\circ\text{C}$	-	65	-	nC
		$T_C = 175^\circ\text{C}$	-	944	-		

TYPICAL PERFORMANCE CHARACTERISTICS

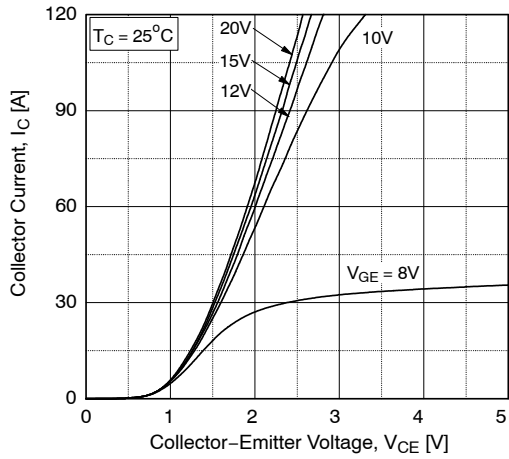


Figure 1. Typical Output Characteristics

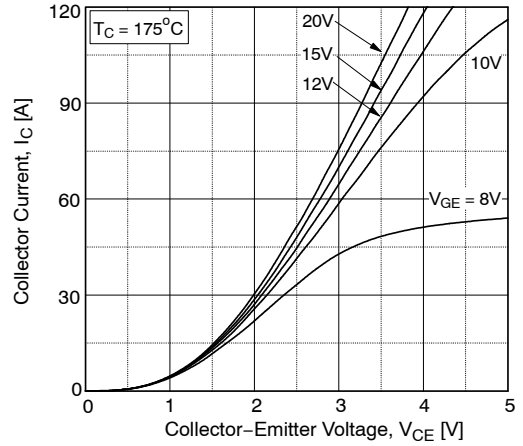


Figure 2. Typical Output Characteristics

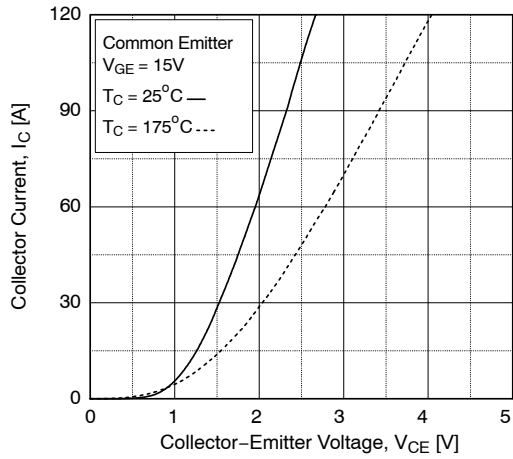


Figure 3. Typical Saturation Voltage Characteristics

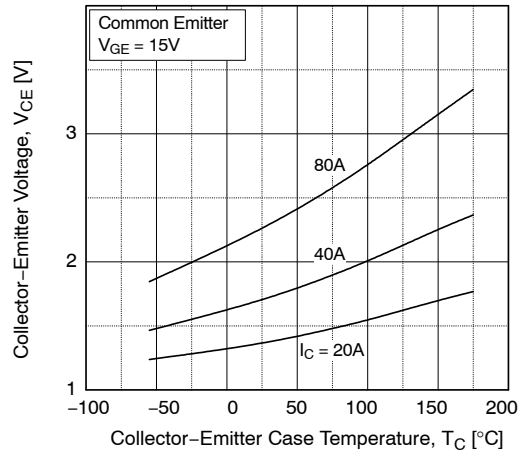


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

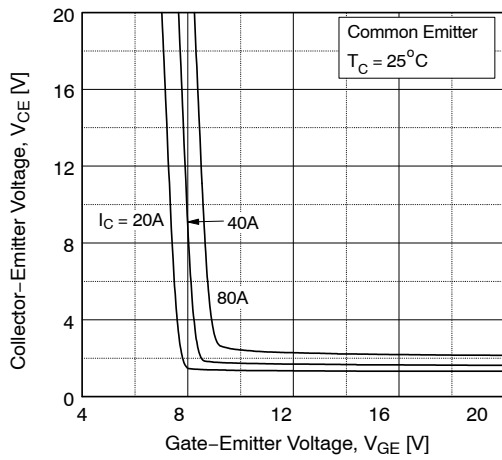


Figure 5. Saturation Voltage vs Vge

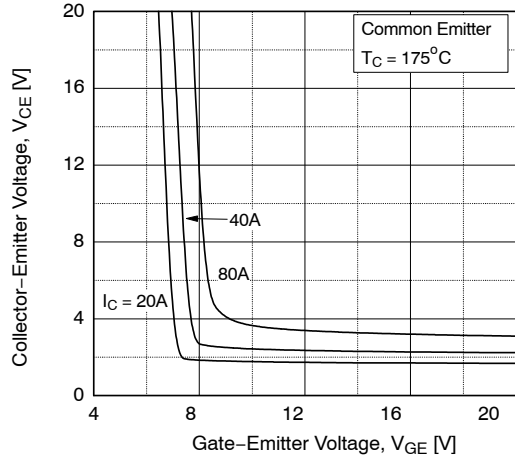


Figure 6. Saturation Voltage vs Vge

TYPICAL PERFORMANCE CHARACTERISTICS

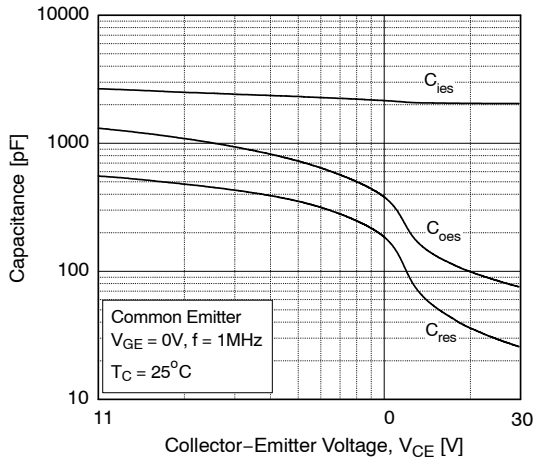


Figure 7. Capacitance Characteristics

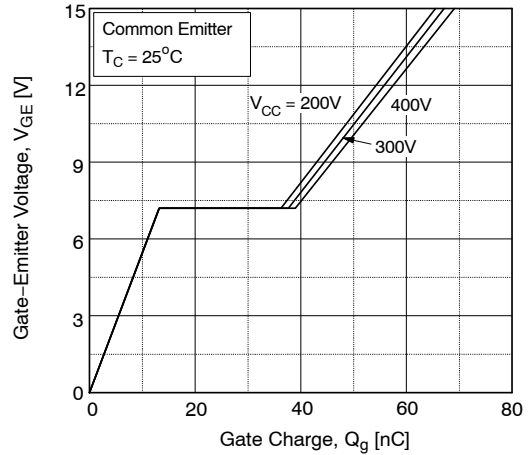


Figure 8. Gate Charge Characteristic

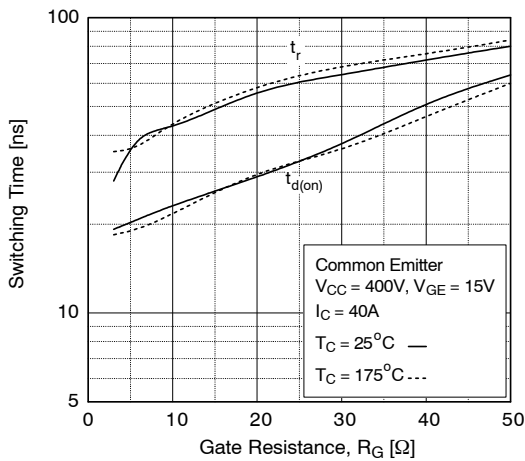


Figure 9. Turn-On Characteristics vs. Gate Resistance

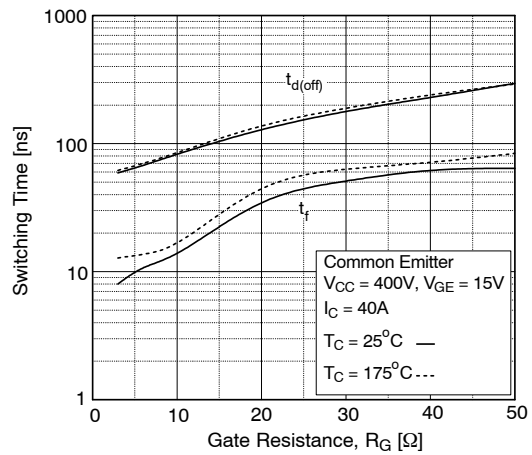


Figure 10. Turn-Off Characteristics vs. Gate Resistance

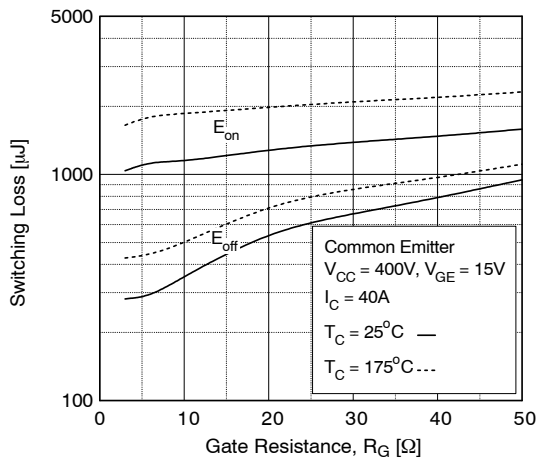


Figure 11. Switching Loss vs. Gate Resistance

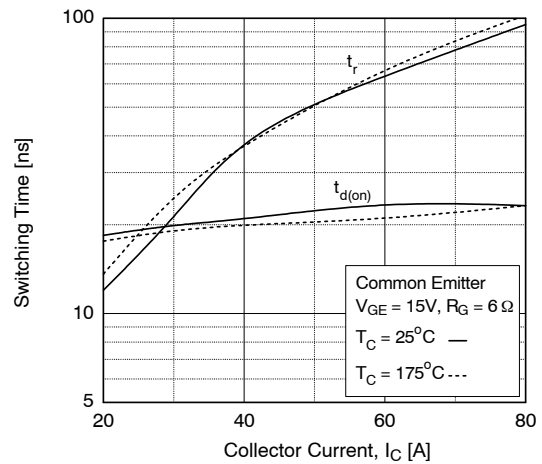
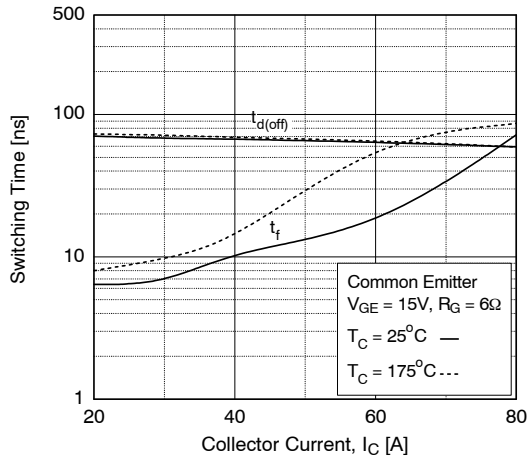


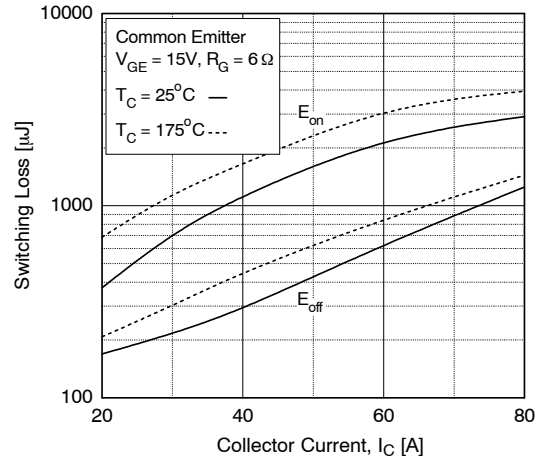
Figure 12. Turn-On Characteristics vs. Collector Current

# FGH40T70SHD

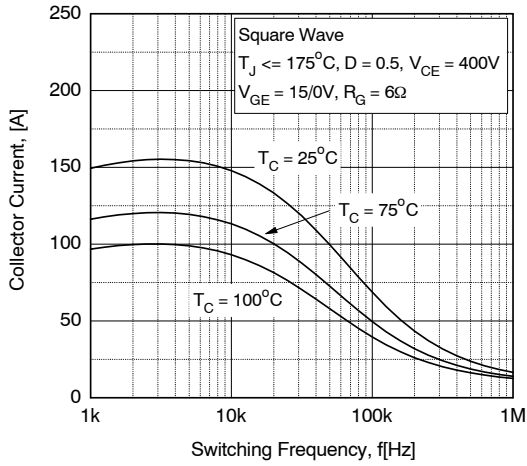
## TYPICAL PERFORMANCE CHARACTERISTICS



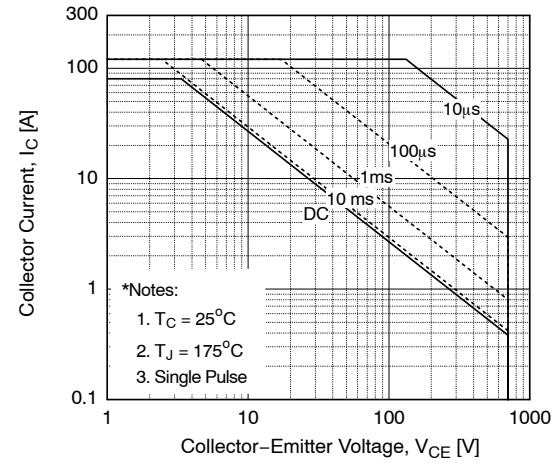
**Figure 13. Turn-Off Characteristics vs. Collector Current**



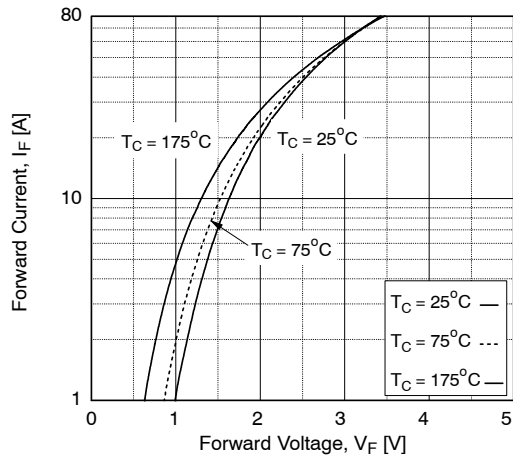
**Figure 14. Switching Loss vs. Collector Current**



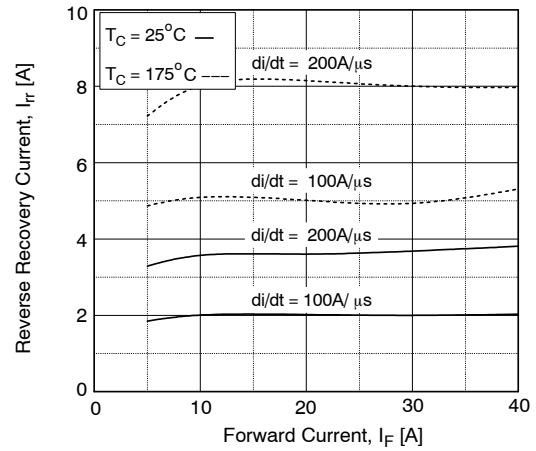
**Figure 15. Load Current vs. Frequency**



**Figure 16. SOA Characteristics**



**Figure 17. Forward Characteristics**



**Figure 18. Reverse Recovery Current**

# FGH40T70SHD

## TYPICAL PERFORMANCE CHARACTERISTICS

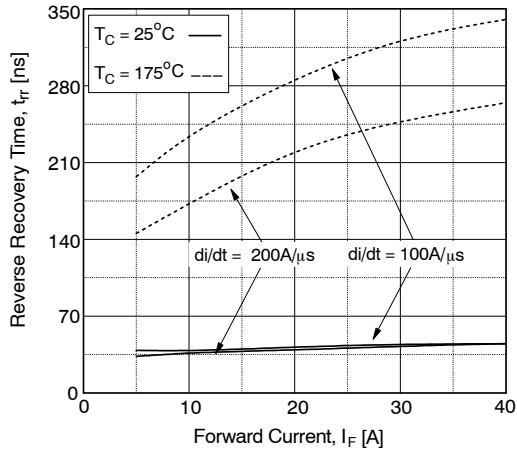


Figure 19. Reverse Recovery Time

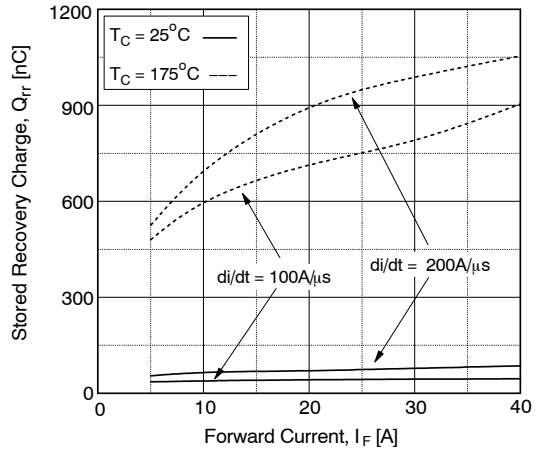


Figure 20. Stored Charge

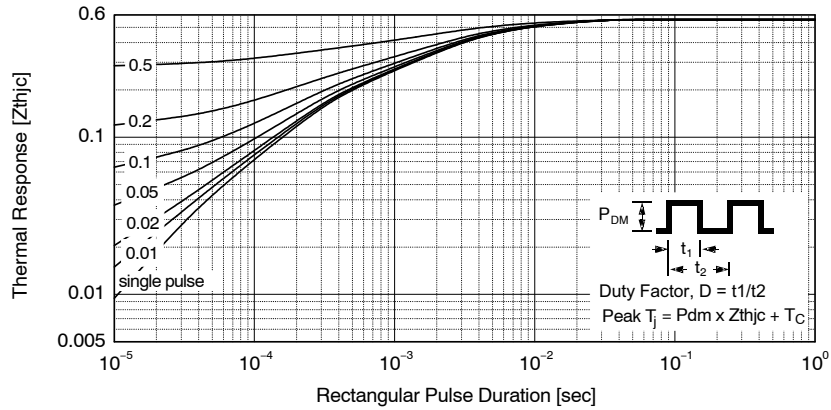


Figure 21. Transient Thermal Impedance of IGBT

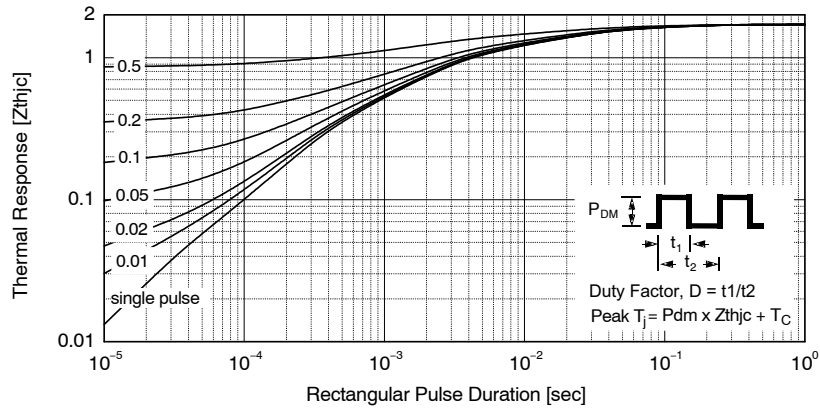


Figure 22. Transient Thermal Impedance of Diode

# MECHANICAL CASE OUTLINE

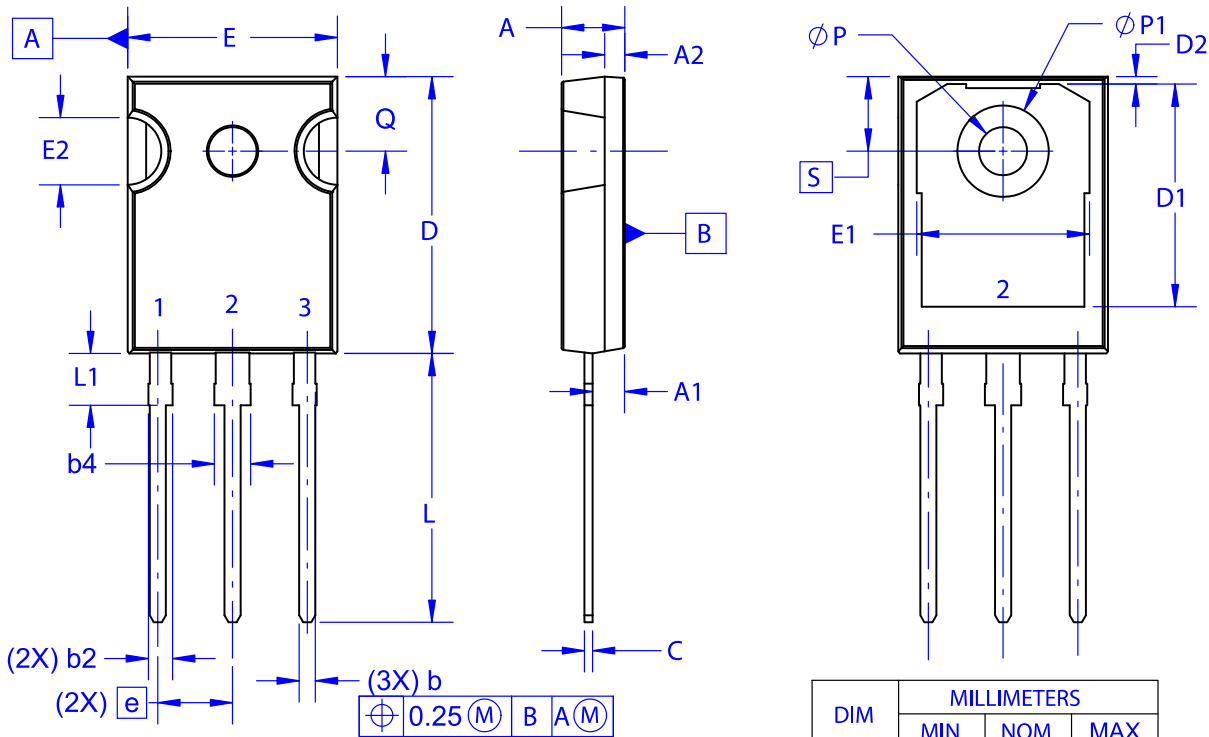
## PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-3LD  
CASE 340CH  
ISSUE A

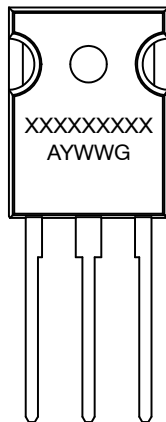
DATE 09 OCT 2019



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\*



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
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.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.29	2.475	2.66
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
∅P	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	~	~
∅P1	6.61	6.73	6.85

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-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management