

# IGBT - Field Stop, Trench 650 V, 50 A

## Product Preview FGHL50T65SQDT

Using novel field stop IGBT technology, ON Semiconductor's new series of field stop 4th 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:  $V_{CE(Sat)} = 1.47\text{ V (Typ.) @ } I_C = 50\text{ A}$
- 100% of the Parts tested for  $I_{LM}(1)$
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- This Device is Pb-Free and is RoHS Compliant

### Typical Applications

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

Table 1. MAXIMUM RATING

Symbol	Rating	Value	Unit
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage Transient Gate to Emitter Voltage	$\pm 20$ $\pm 30$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	100 50	A
$I_{LM}$	Pulsed Collector Current (Note 1)	200	A
$I_{CM}$	Pulsed Collector Current (Note 2)	200	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	75 50	A
$I_{FM}$	Pulsed Diode Maximum Forward Current	300	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	268 134	W
$T_J, T_{STG}$	Operating Junction / Storage Temperature Range	-55 to +175	$^\circ\text{C}$
$T_L$	Maximum Lead Temp. for Soldering Purposes, 1/8" from case for 5 seconds	265	$^\circ\text{C}$

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.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $R_G = 3\ \Omega$ , Inductive Load, 100% Tested
2. Repetitive rating; pulse width limited by max. Junction temperature

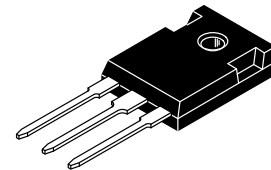
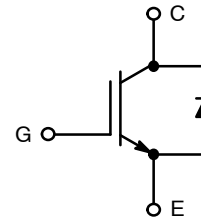
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50 A, 650 V  
 $V_{CE(Sat)} = 1.47\text{ V (Typ.)}$



TO-247-3LD  
CASE 340CX

### MARKING DIAGRAM



FGHL50T65SQDT = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Assembly Lot Number

### ORDERING INFORMATION

Device	Package	Shipping
FGHL50T65SQDT	TO-247-3L	30 Units / Rail

# FGHL50T65SQDT

## THERMAL CHARACTERISTICS

Symbol	Rating	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, for IGBT	0.56	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max for Diode	0.65	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max	40	$^{\circ}\text{C}/\text{W}$

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

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

$V_{CES}$	Collector-emitter breakdown voltage, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	650	-	-	V
$\frac{\Delta V_{CES}}{\Delta T_j}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	-	0.6	-	$\text{V}/^{\circ}\text{C}$
$I_{CES}$	Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, V_{CE} = V_{CES}$	-	-	250	$\mu\text{A}$
$I_{GES}$	Gate leakage current, collector-emitter short-circuited	$V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$	-	-	$\pm 400$	nA

### ON CHARACTERISTICS

$V_{GE(th)}$	Gate-emitter threshold voltage	$V_{GE} = V_{CE}, I_C = 50\text{ mA}$	2.6	4.5	6.4	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_c = 175^{\circ}\text{C}$	-	1.47	2.1	V
			-	1.7	-	

### DYNAMIC CHARACTERISTICS

$C_{ies}$	Input capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	-	3081	-	$\mu\text{F}$
$C_{oes}$	Output capacitance		-	136	-	
$C_{res}$	Reverse transfer capacitance		-	10.8	-	

### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

$t_{d(on)}$	Turn-on delay time	$T_C = 25^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 12.5\text{ A}$ $R_g = 4.7\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	-	22.8	-	ns	
$t_r$	Rise time		-	5.20	-		
$t_{d(off)}$	Turn-off delay time		-	70	-		
$t_f$	Fall time		-	27.20	-		
$E_{on}$	Turn-on switching loss		-	223	-		$\mu\text{J}$
$E_{off}$	Turn-off switching loss		-	91.13	-		
$E_{ts}$	Total switching loss		-	314.13	-		
$t_{d(on)}$	Turn-on delay time	$T_C = 25^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 25\text{ A}$ $R_g = 4.7\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	-	23.60	-	ns	
$t_r$	Rise time		-	10.40	-		
$t_{d(off)}$	Turn-off delay time		-	66.40	-		
$t_f$	Fall time		-	10.20	-		
$E_{on}$	Turn-on switching loss		-	515.60	-		$\mu\text{J}$
$E_{off}$	Turn-off switching loss		-	133	-		
$E_{ts}$	Total switching loss		-	648.60	-		

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

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
<b>SWITCHING CHARACTERISTICS, INDUCTIVE LOAD</b>						
$t_{d(on)}$	Turn-on delay time	$T_C = 175^\circ\text{C}$ $V_{CC} = 400\text{ V}$ , $I_C = 12.5\text{ A}$ $R_g = 4.7\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	-	23.60	-	ns
$t_r$	Rise time		-	7.20	-	
$t_{d(off)}$	Turn-off delay time		-	87	-	
$t_f$	Fall time		-	72	-	
$E_{on}$	Turn-on switching loss		-	259.20	-	$\mu\text{J}$
$E_{off}$	Turn-off switching loss		-	221	-	
$E_{ts}$	Total switching loss		-	480.20	-	
$t_{d(on)}$	Turn-on delay time	$T_C = 175^\circ\text{C}$ $V_{CC} = 400\text{ V}$ , $I_C = 25\text{ A}$ $R_g = 4.7\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	-	25.60	-	ns
$t_r$	Rise time		-	14.80	-	
$t_{d(off)}$	Turn-off delay time		-	78	-	
$t_f$	Fall time		-	42	-	
$E_{on}$	Turn-on switching loss		-	578.90	-	$\mu\text{J}$
$E_{off}$	Turn-off switching loss		-	406.80	-	
$E_{ts}$	Total switching loss		-	985.70	-	
Qg	Total Gate Charge	$V_{CE} = 400\text{ V}$ , $I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$	-	99.7	-	nC
Qge	Gate to Emitter Charge		-	18.3	-	nC
Qgc	Gate to collector Charge		-	25.90	-	nC

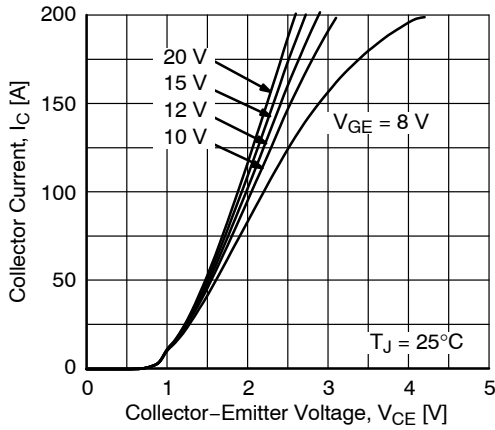
## DIODE CHARACTERISTICS

$V_F$	Forward voltage	$I_F = 50\text{ A}$ , $T_C = 25^\circ\text{C}$ $I_F = 50\text{ A}$ , $T_C = 175^\circ\text{C}$	-	2 1.6	2.6 -	V
Erec	Reverse Recovery Energy	$I_F = 50\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$ , $T_C = 175^\circ\text{C}$	-	80.14	-	$\mu\text{J}$
Trr	Diode Reverse Recovery Time	$I_F = 50\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$ $I_F = 50\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$ , $T_C = 175^\circ\text{C}$	-	35.60 201	-	nS
Qrr	Diode Reverse Recovery Charge	$I_F = 50\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$ $I_F = 50\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$ , $T_C = 175^\circ\text{C}$	-	66.22 1135.65	-	nC

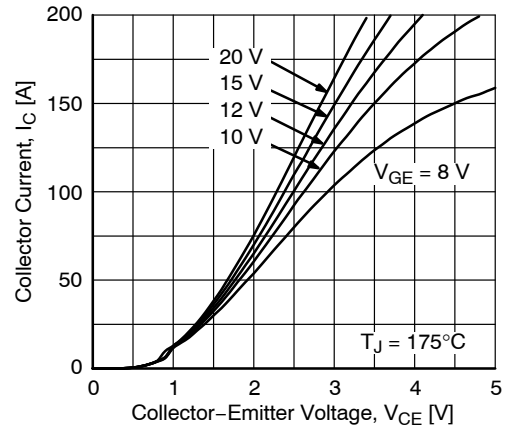
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# FGHL50T65SQDT

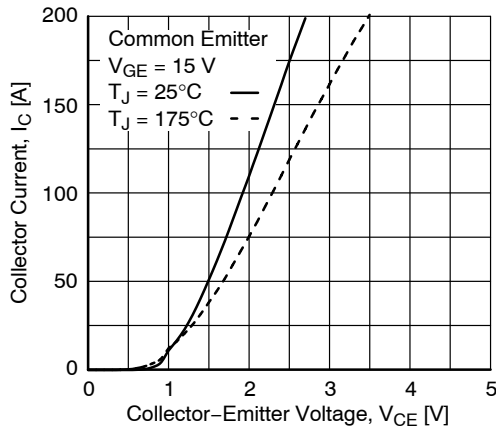
## TYPICAL CHARACTERISTICS



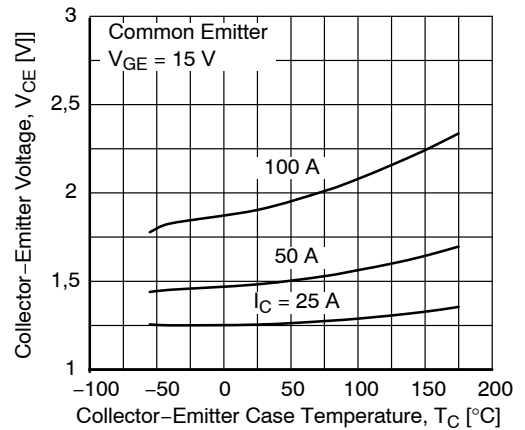
**Figure 1. Typical Output Characteristics**  
( $T_J = 25^\circ\text{C}$ )



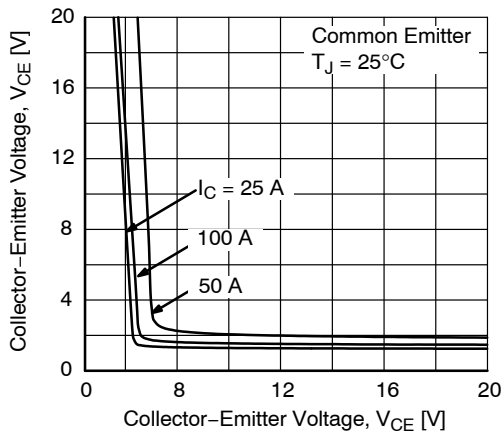
**Figure 2. Typical Output Characteristics**  
( $T_J = 175^\circ\text{C}$ )



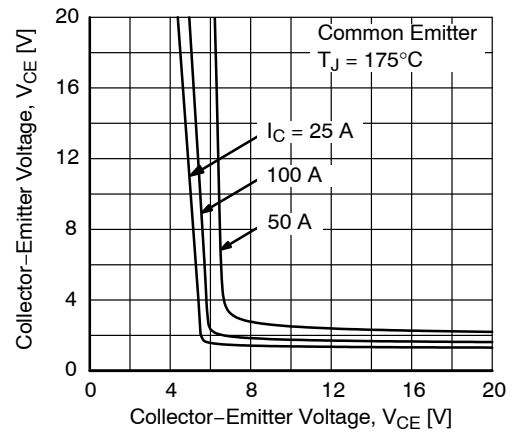
**Figure 3. Typical Saturation Voltage Characteristics**



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



**Figure 5. Saturation Voltage vs.  $V_{GE}$**   
( $T_J = 25^\circ\text{C}$ )



**Figure 6. Saturation Voltage vs.  $V_{GE}$**   
( $T_J = 175^\circ\text{C}$ )

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## TYPICAL CHARACTERISTICS (continued)

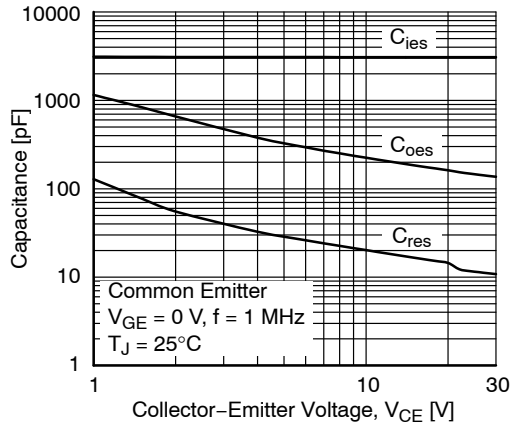


Figure 7. Capacitance Characteristics

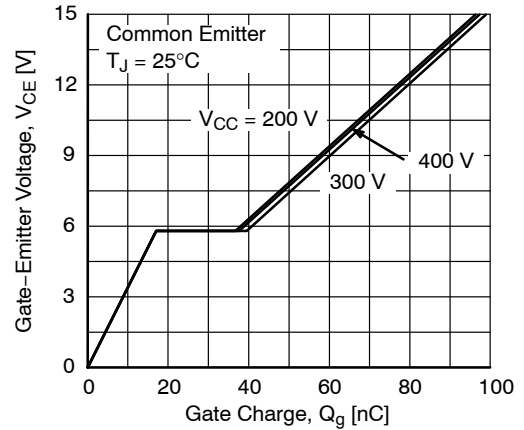


Figure 8. Gate Charge Characteristic

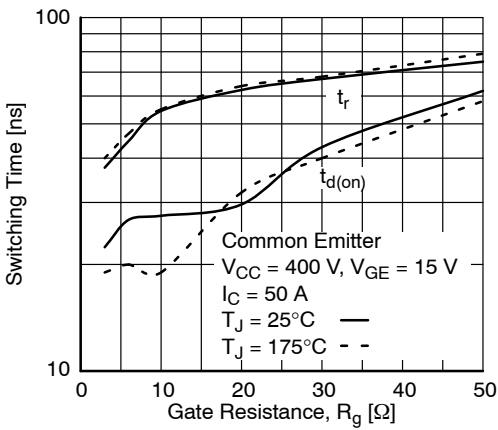


Figure 9. Turn-on Characteristics vs. Gate Resistance

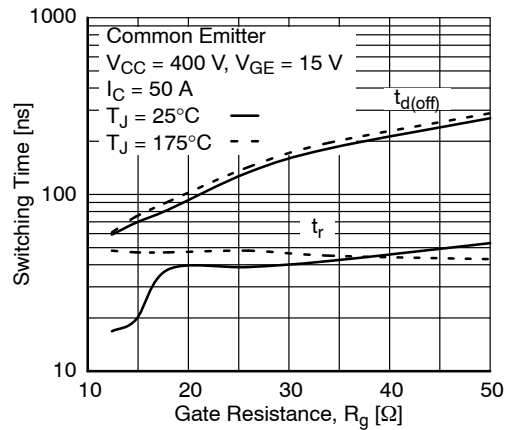


Figure 10. Turn-off Characteristics vs. Gate Resistance

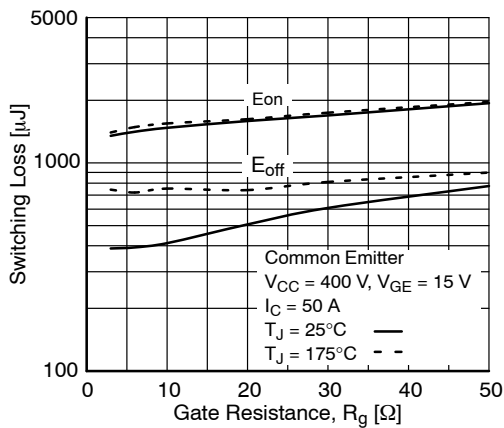


Figure 11. Switching Loss vs Gate Resistance

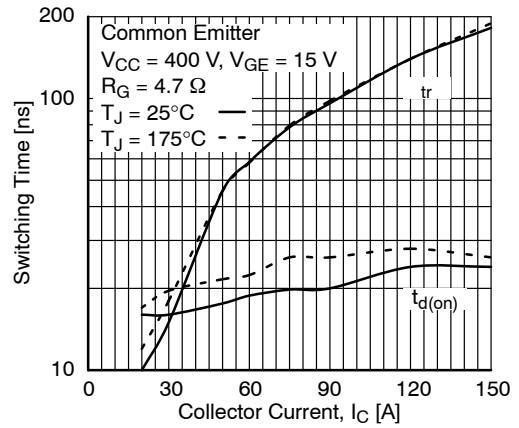
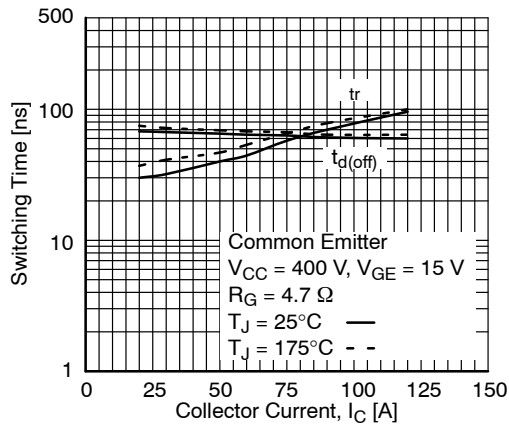


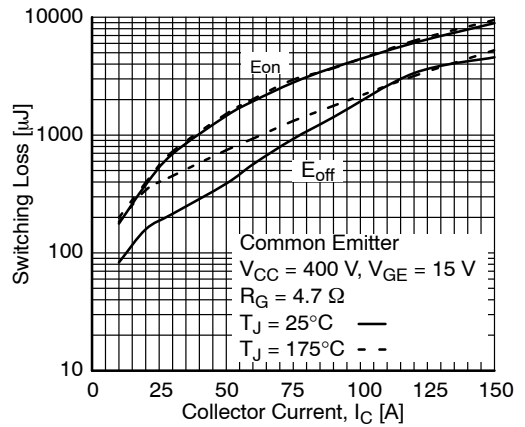
Figure 12. Turn-on Characteristics vs. Collector Current

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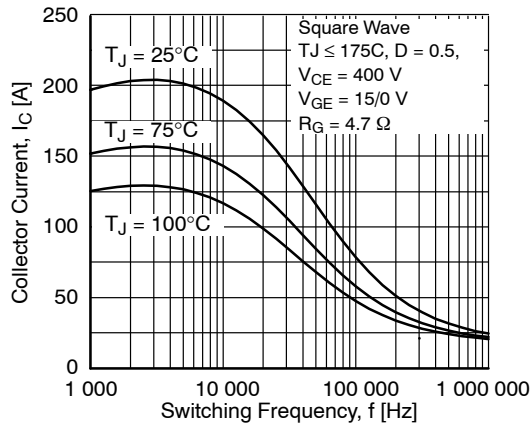
## TYPICAL CHARACTERISTICS (continued)



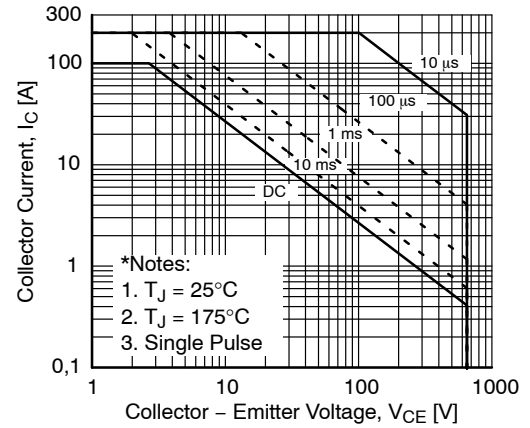
**Figure 13. Turn-Off Characteristics vs. Collector Current**



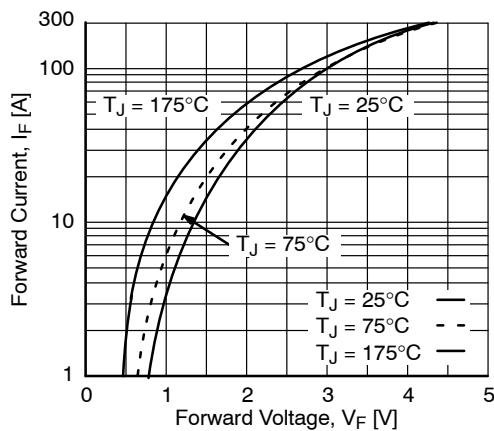
**Figure 14. Switching Loss vs. Collector Current**



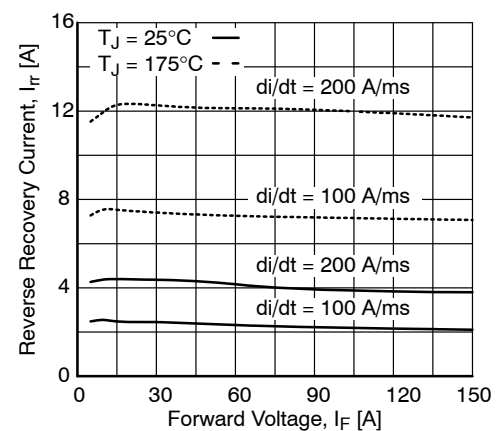
**Figure 15. Load Current vs. Frequency**



**Figure 16. SOA Characteristics (FBSOA)**



**Figure 17. Forward Characteristics**



**Figure 18. Reverse Recover Current**

# FGHL50T65SQDT

## TYPICAL CHARACTERISTICS (continued)

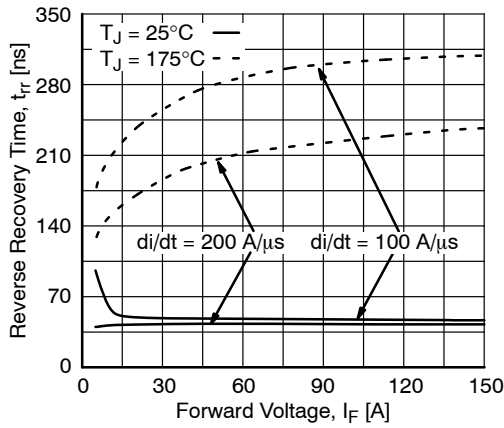


Figure 19. Reverse Recovery Time

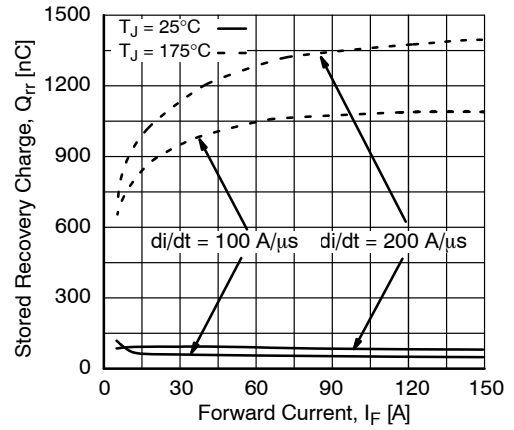


Figure 20. Stored Charge

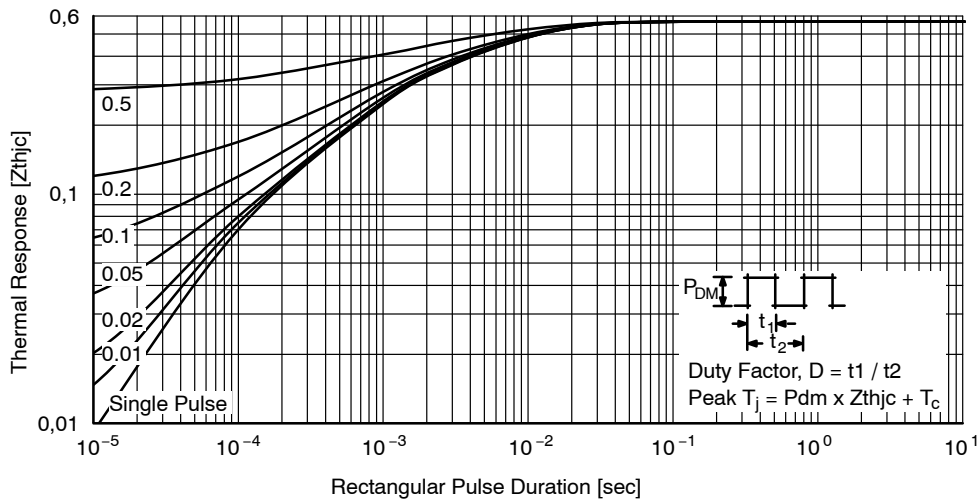


Figure 21. Transient Thermal Impedance of IGBT

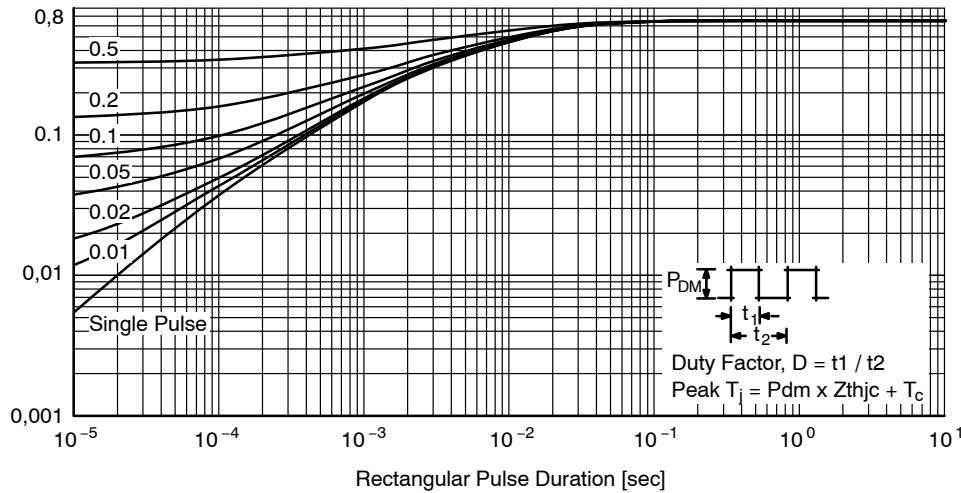


Figure 22. Transient Thermal Impedance of Diode

# MECHANICAL CASE OUTLINE

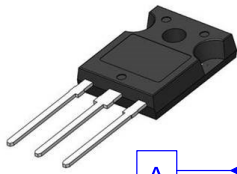
## PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-3LD  
CASE 340CX  
ISSUE A

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.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
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
ØP	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	~	~
ØP1	6.60	6.80	7.00

### GENERIC MARKING DIAGRAM\*



- XXXXX = 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.

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