



**THE DATASHEET OF  
FGHL50T65MQDT**



# ON Semiconductor

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# Field Stop Trench IGBT

## 650 V, 50 A

### FGHL50T65MQDT

Field stop 4<sup>th</sup> generation mid speed IGBT technology copacked with full rated current diode.

#### Features

- Maximum Junction Temperature:  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(Sat)} = 1.45\text{ V (Typ.) @ } I_C = 50\text{ A}$
- 100% of the Parts are Tested for  $I_{LM}$  (Note 2)
- Smooth and Optimized Switching
- Tight Parameter Distribution
- RoHS Compliant

#### Typical Applications

- Solar Inverter
- UPS, ESS
- PFC, Converters

#### MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Collector to Emitter Voltage	$V_{CES}$	650	V
Gate to Emitter Voltage Transient Gate to Emitter Voltage	$V_{GES}$	$\pm 20$ $\pm 30$	V
Collector Current (Note 1) @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	$I_C$	80 50	A
Pulsed Collector Current (Note 2)	$I_{LM}$	200	A
Pulsed Collector Current (Note 3)	$I_{CM}$	200	A
Diode Forward Current (Note 1) @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	$I_F$	60 50	A
Pulsed Diode Maximum Forward Current	$I_{FM}$	200	A
Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	$P_D$	268 134	W
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to +175	$^\circ\text{C}$
Maximum Lead Temp. for Soldering Purposes (1/8" from case for 5 s)	$T_L$	260	$^\circ\text{C}$

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.

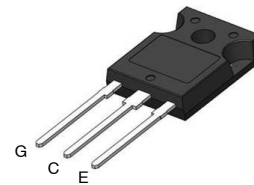
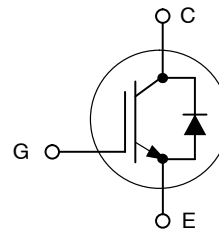
1. Value limit by bond wire
2.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 200\text{ A}$ , Inductive Load, 100% tested
3. Repetitive rating: pulse width limited by max. junction temperature



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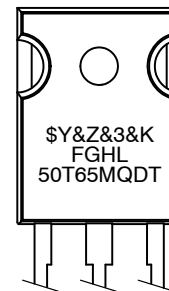
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50 A, 650 V  
 $V_{CESat} = 1.45\text{ V}$



TO-247-3L  
CASE 340CX

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
&Z = Assembly Plant Code  
&3 = 3-Digit Date Code  
&K = 2-Digit Lot Traceability Code  
FGHL50T65MQDT = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
FGHL50T65MQDT	TO-247-3L	30 Units / Tube

# FGHL50T65MQDT

## THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance Junction-to-case, for IGBT	$R_{\theta JC}$	0.56	°C/W
Thermal Resistance Junction-to-case, for Diode	$R_{\theta JC}$	0.74	°C/W
Thermal Resistance Junction-to-ambient	$R_{\theta JA}$	40	°C/W

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

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

Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{ V},$ $I_C = 1\text{ mA}$	$BV_{CES}$	650	-	-	V
Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V},$ $I_C = 1\text{ mA}$	$\frac{\Delta BV_{CES}}{\Delta T_J}$	-	0.6	-	V/°C
Collector-emitter Cut-off Current	$V_{GE} = 0\text{ V},$ $V_{CE} = 650\text{ V}$	$I_{CES}$	-	-	250	μA
Gate Leakage Current	$V_{GE} = 20\text{ V},$ $V_{CE} = 0\text{ V}$	$I_{GES}$	-	-	±400	nA

### ON CHARACTERISTICS

Gate to Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 50\text{ mA}$	$V_{GE(th)}$	3.0	4.5	6.0	V
Collector to Emitter Saturation Voltage	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 25^\circ\text{C}$ $V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 175^\circ\text{C}$	$V_{CE(sat)}$	-	1.45 1.65	1.8 -	V

### DYNAMIC CHARACTERISTICS

Input Capacitance	$V_{CE} = 30\text{ V},$ $V_{GE} = 0\text{ V},$ $f = 1\text{ MHz}$	$C_{ies}$	-	3335	-	pF
Output Capacitance		$C_{oes}$	-	105	-	
Reverse Transfer Capacitance		$C_{res}$	-	11	-	
Gate Charge Total	$V_{CE} = 400\text{ V},$ $I_C = 50\text{ A},$ $V_{GE} = 15\text{ V}$	$Q_g$	-	99	-	nC
Gate to Emitter Charge		$Q_{ge}$	-	17	-	
Gate to Collector Charge		$Q_{gc}$	-	24	-	

### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Turn-on Delay Time	$T_J = 25^\circ\text{C},$ $V_{CC} = 400\text{ V},$ $I_C = 25\text{ A},$ $R_G = 6\ \Omega,$ $V_{GE} = 15\text{ V}$	$t_{d(on)}$	-	19	-	ns
Rise Time		$t_r$	-	11	-	
Turn-off Delay Time		$t_{d(off)}$	-	96	-	
Fall Time		$t_f$	-	58	-	
Turn-on Switching Loss	$T_J = 25^\circ\text{C},$ $V_{CC} = 400\text{ V},$ $I_C = 50\text{ A},$ $R_G = 6\ \Omega,$ $V_{GE} = 15\text{ V}$	$E_{on}$	-	0.47	-	mJ
Turn-off Switching Loss		$E_{off}$	-	0.29	-	
Total Switching Loss		$E_{ts}$	-	0.77	-	
Turn-on Delay Time		$t_{d(on)}$	-	21	-	
Rise Time	$t_r$	-	30	-		
Turn-off Delay Time	$t_{d(off)}$	-	90	-		
Fall Time	$t_f$	-	54	-		
Turn-on Switching Loss	$T_J = 25^\circ\text{C},$ $V_{CC} = 400\text{ V},$ $I_C = 50\text{ A},$ $R_G = 6\ \Omega,$ $V_{GE} = 15\text{ V}$	$E_{on}$	-	1.19	-	mJ
Turn-off Switching Loss		$E_{off}$	-	0.63	-	
Total Switching Loss		$E_{ts}$	-	1.82	-	

# FGHL50T65MQDT

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
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### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Turn-on Delay Time	$T_J = 175^\circ\text{C}$ , $V_{CC} = 400\text{ V}$ , $I_C = 25\text{ A}$ , $R_G = 6\ \Omega$ , $V_{GE} = 15\text{ V}$	$t_{d(on)}$	-	18	-	ns
Rise Time		$t_r$	-	14	-	
Turn-off Delay Time		$t_{d(off)}$	-	98	-	
Fall Time		$t_f$	-	88	-	
Turn-on Switching Loss		$E_{on}$	-	0.9	-	mJ
Turn-off Switching Loss		$E_{off}$	-	0.55	-	
Total Switching Loss		$E_{ts}$	-	1.44	-	
Turn-on Delay Time	$T_J = 175^\circ\text{C}$ , $V_{CC} = 400\text{ V}$ , $I_C = 50\text{ A}$ , $R_G = 6\ \Omega$ , $V_{GE} = 15\text{ V}$	$t_{d(on)}$	-	19	-	ns
Rise Time		$t_r$	-	32	-	
Turn-off Delay Time		$t_{d(off)}$	-	99	-	
Fall Time		$t_f$	-	82	-	
Turn-on Switching Loss		$E_{on}$	-	1.87	-	mJ
Turn-off Switching Loss		$E_{off}$	-	1.08	-	
Total Switching Loss		$E_{ts}$	-	2.95	-	

### DIODE CHARACTERISTICS

Diode Forward Voltage	$I_F = 50\text{ A}$ , $T_J = 25^\circ\text{C}$	$V_F$	-	1.65	2.1	V
	$I_F = 50\text{ A}$ , $T_J = 175^\circ\text{C}$		-	1.55	-	

### DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Reverse Recovery Energy	$T_J = 25^\circ\text{C}$ , $V_{CE} = 400\text{ V}$ , $I_F = 25\text{ A}$ , $di_F/dt = 1000\text{ A}/\mu\text{s}$	$E_{rec}$	-	65	-	$\mu\text{J}$
Diode Reverse Recovery Time		$T_{rr}$	-	44	-	ns
Diode Reverse Recovery Charge		$Q_{rr}$	-	387	-	nC
Diode Reverse Recovery Current		$I_{rr}$	-	18	-	A
Reverse Recovery Energy	$T_J = 25^\circ\text{C}$ , $V_{CE} = 400\text{ V}$ , $I_F = 50\text{ A}$ , $di_F/dt = 1000\text{ A}/\mu\text{s}$	$E_{rec}$	-	128	-	$\mu\text{J}$
Diode Reverse Recovery Time		$T_{rr}$	-	79	-	ns
Diode Reverse Recovery Charge		$Q_{rr}$	-	681	-	nC
Diode Reverse Recovery Current		$I_{rr}$	-	17	-	A
Reverse Recovery Energy	$T_J = 175^\circ\text{C}$ , $V_{CE} = 400\text{ V}$ , $I_F = 25\text{ A}$ , $di_F/dt = 1000\text{ A}/\mu\text{s}$	$E_{rec}$	-	380	-	$\mu\text{J}$
Diode Reverse Recovery Time		$T_{rr}$	-	102	-	ns
Diode Reverse Recovery Charge		$Q_{rr}$	-	1482	-	nC
Diode Reverse Recovery Current		$I_{rr}$	-	29	-	A
Reverse Recovery Energy	$T_J = 175^\circ\text{C}$ , $V_{CE} = 400\text{ V}$ , $I_F = 50\text{ A}$ , $di_F/dt = 1000\text{ A}/\mu\text{s}$	$E_{rec}$	-	544	-	$\mu\text{J}$
Diode Reverse Recovery Time		$T_{rr}$	-	135	-	ns
Diode Reverse Recovery Charge		$Q_{rr}$	-	2023	-	nC
Diode Reverse Recovery Current		$I_{rr}$	-	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.

# FGHL50T65MQDT

## TYPICAL CHARACTERISTICS

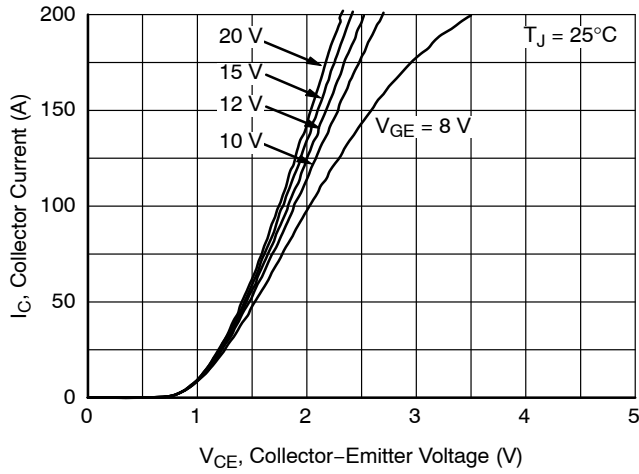


Figure 1. Typical Output Characteristics ( $T_J = 25^\circ\text{C}$ )

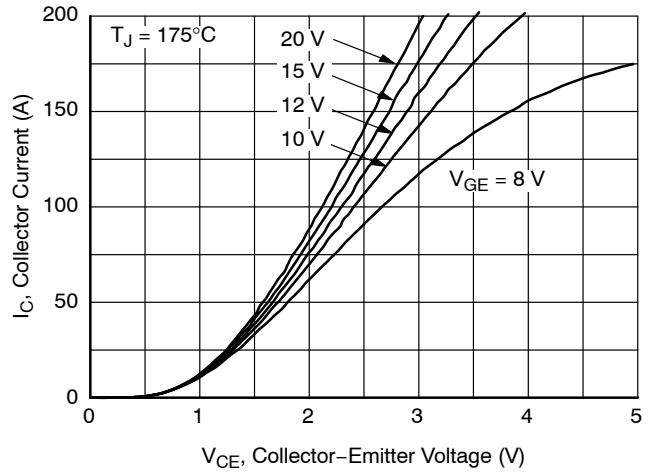


Figure 2. Typical Output Characteristics ( $T_J = 175^\circ\text{C}$ )

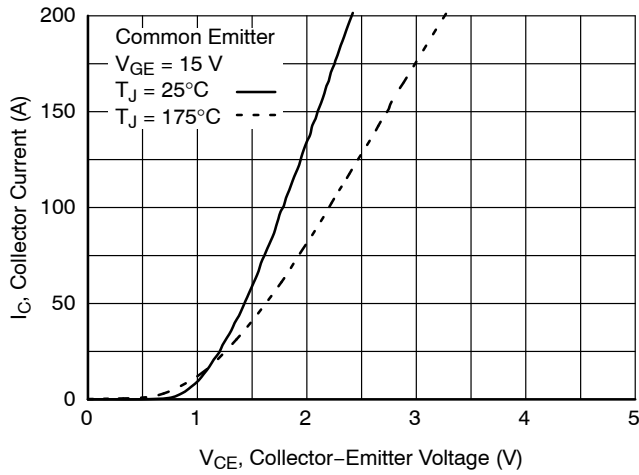


Figure 3. Typical Saturation Voltage Characteristics

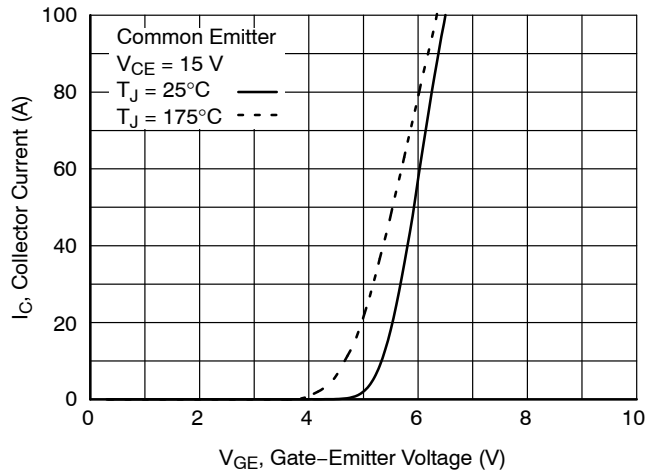


Figure 4. Typical Transfer Characteristics

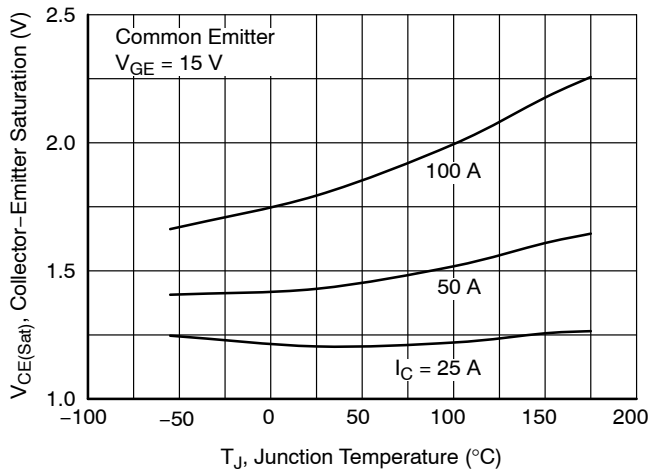


Figure 5. Saturation Voltage vs. Junction Temperature

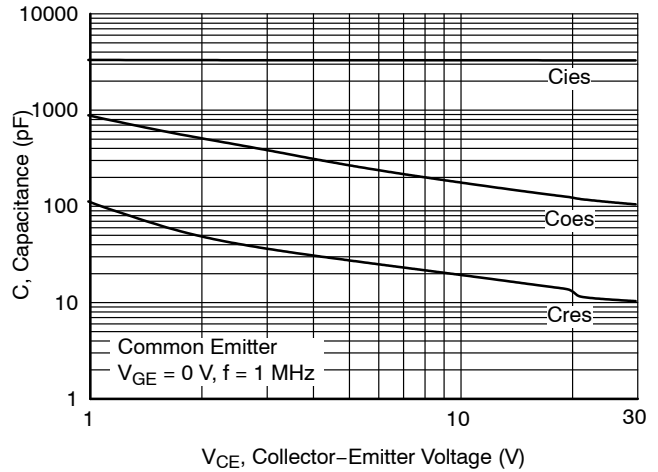
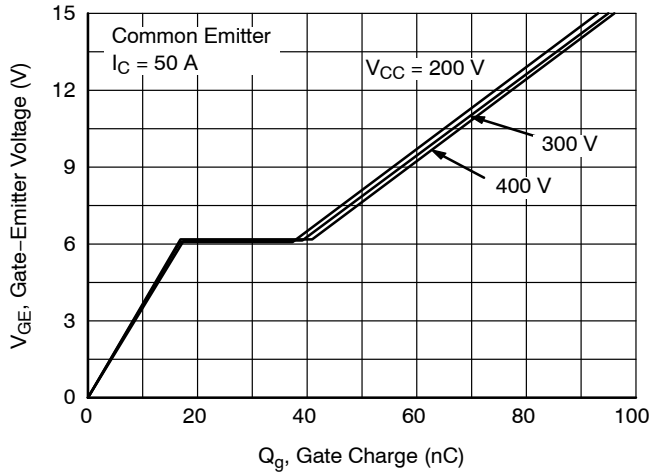


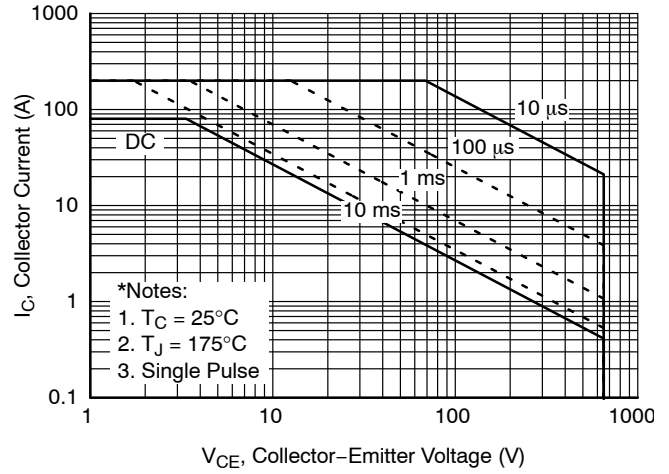
Figure 6. Capacitance Characteristics

# FGHL50T65MQDT

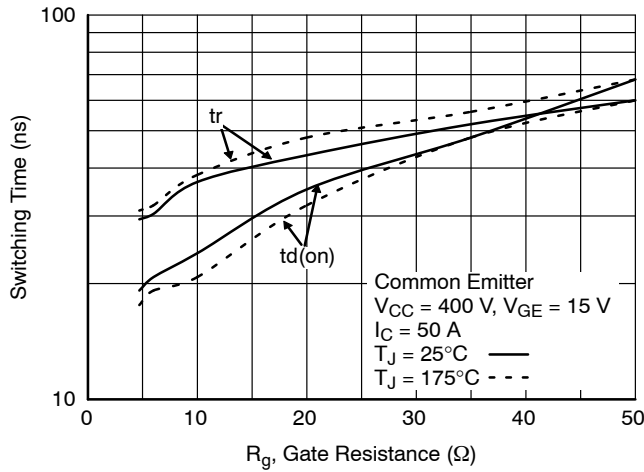
## TYPICAL CHARACTERISTICS (continued)



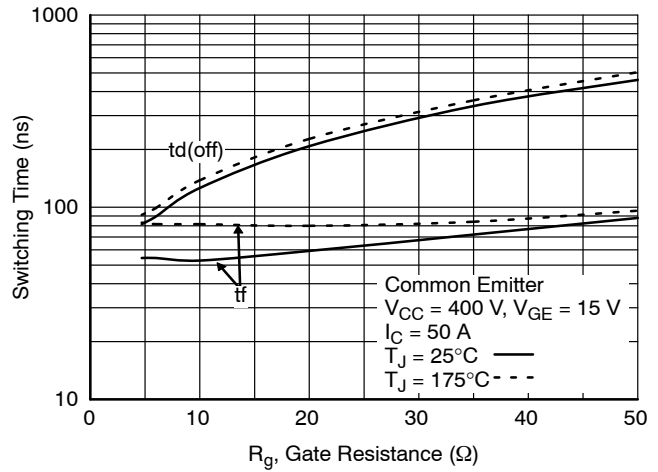
**Figure 7. Gate Charge Characteristics**



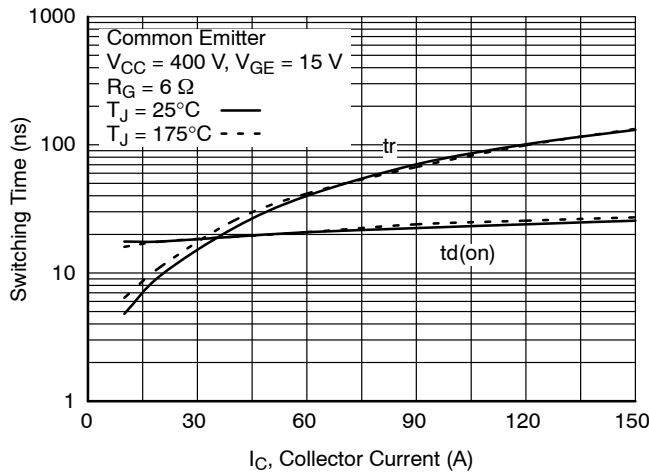
**Figure 8. SOA Characteristics**



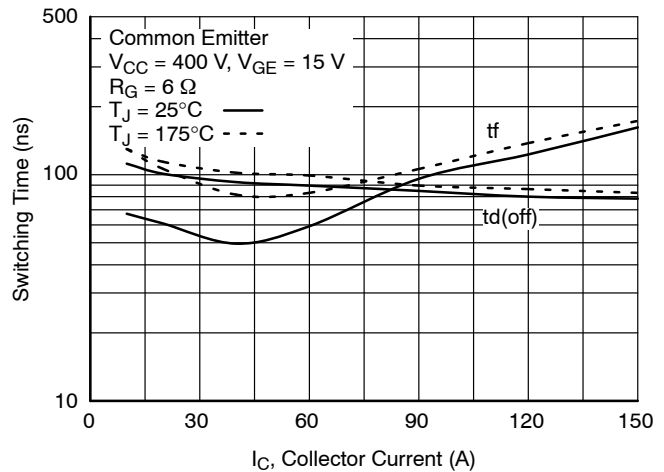
**Figure 9. Turn-on Characteristics vs. Gate Resistance**



**Figure 10. Turn-off Characteristics vs. Gate Resistance**



**Figure 11. Turn-on Characteristics vs. Collector Current**



**Figure 12. Turn-off Characteristics vs. Collector Current**

# FGHL50T65MQDT

## TYPICAL CHARACTERISTICS (continued)

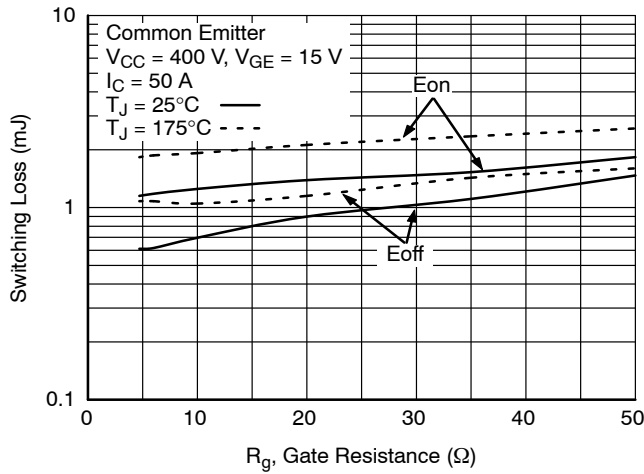


Figure 13. Switching Loss vs. Gate Resistance

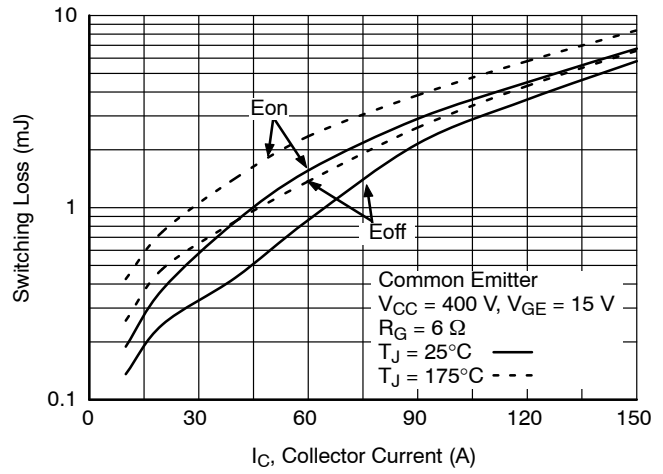


Figure 14. Switching Loss vs. Collector Current

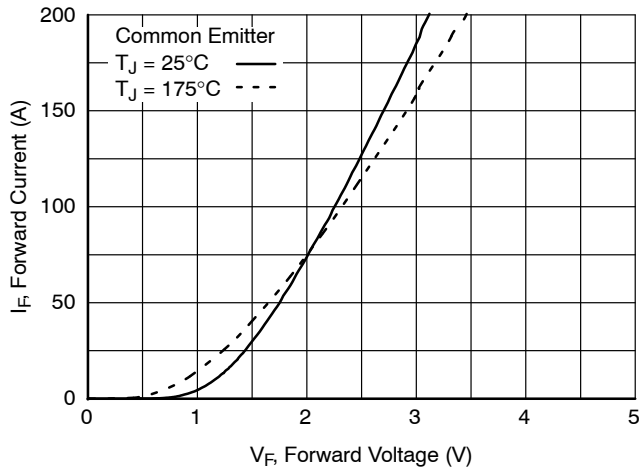


Figure 15. Forward Characteristics

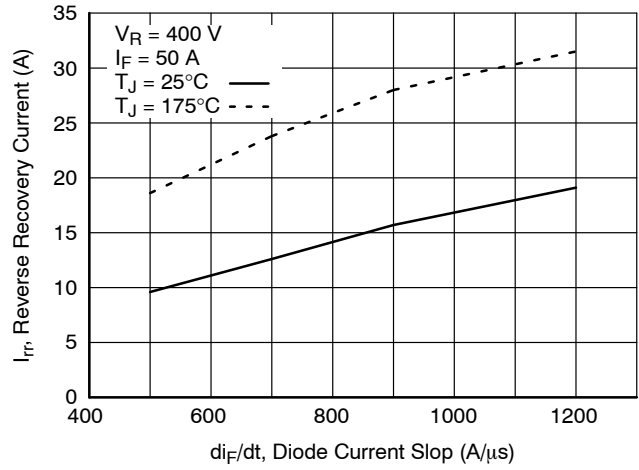


Figure 16. Reverse Recovery Current

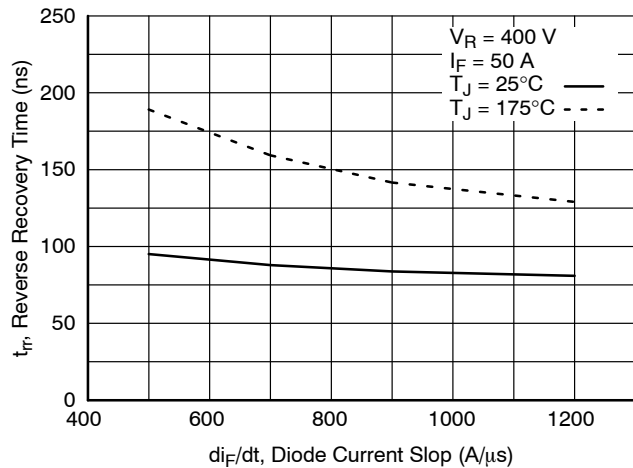


Figure 17. Reverse Recovery Time

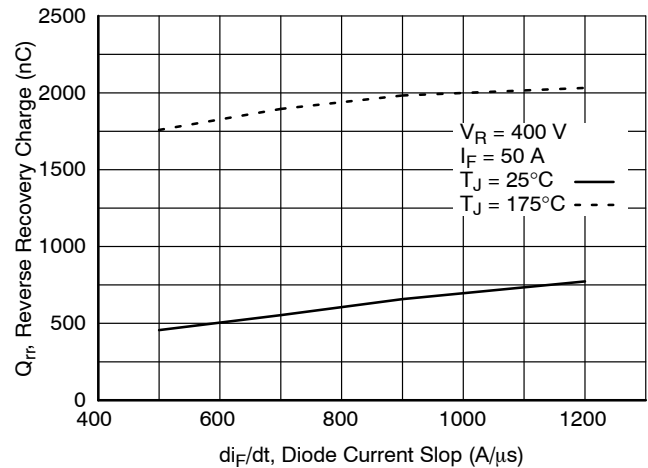


Figure 18. Stored Charge

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## TYPICAL CHARACTERISTICS (continued)

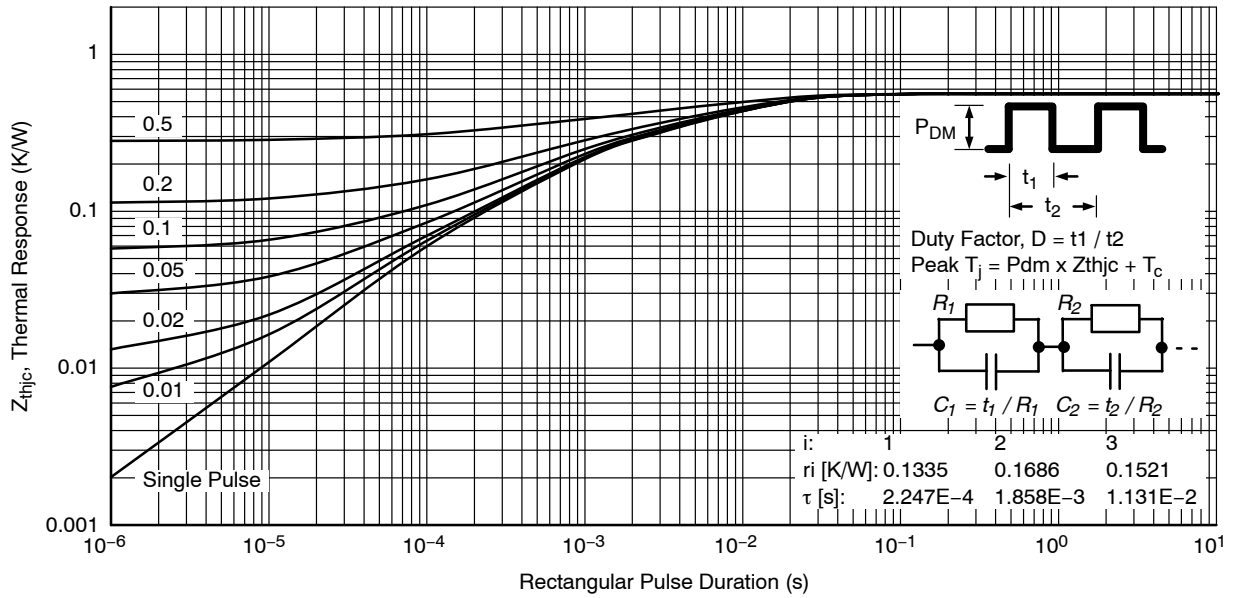


Figure 19. Transient Thermal Impedance of IGBT

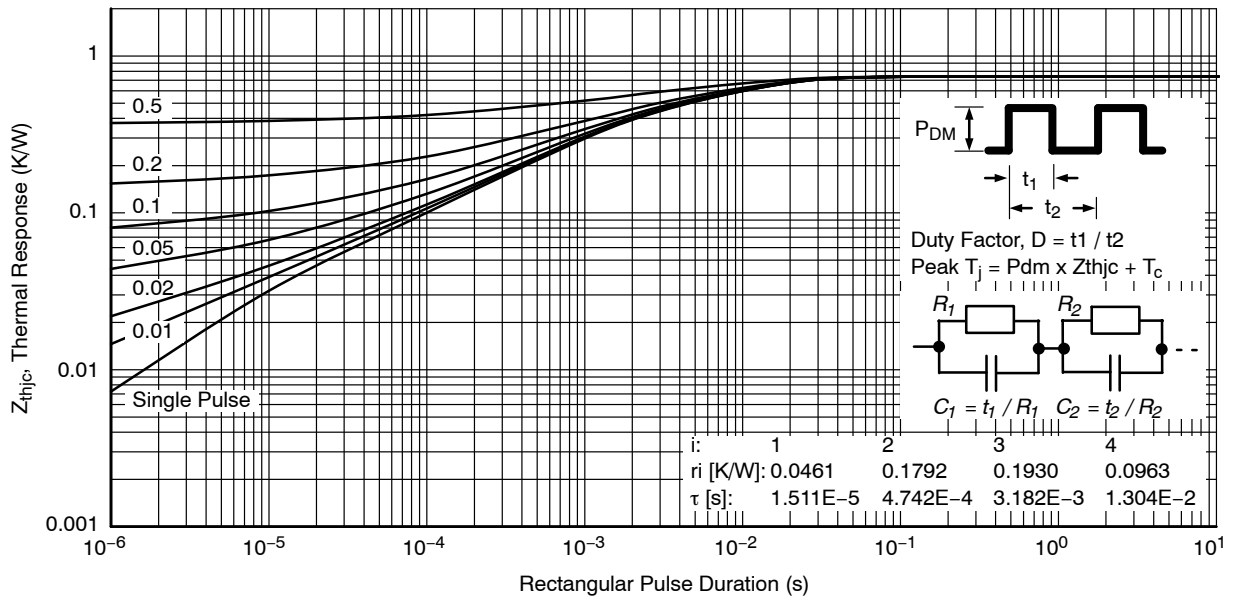
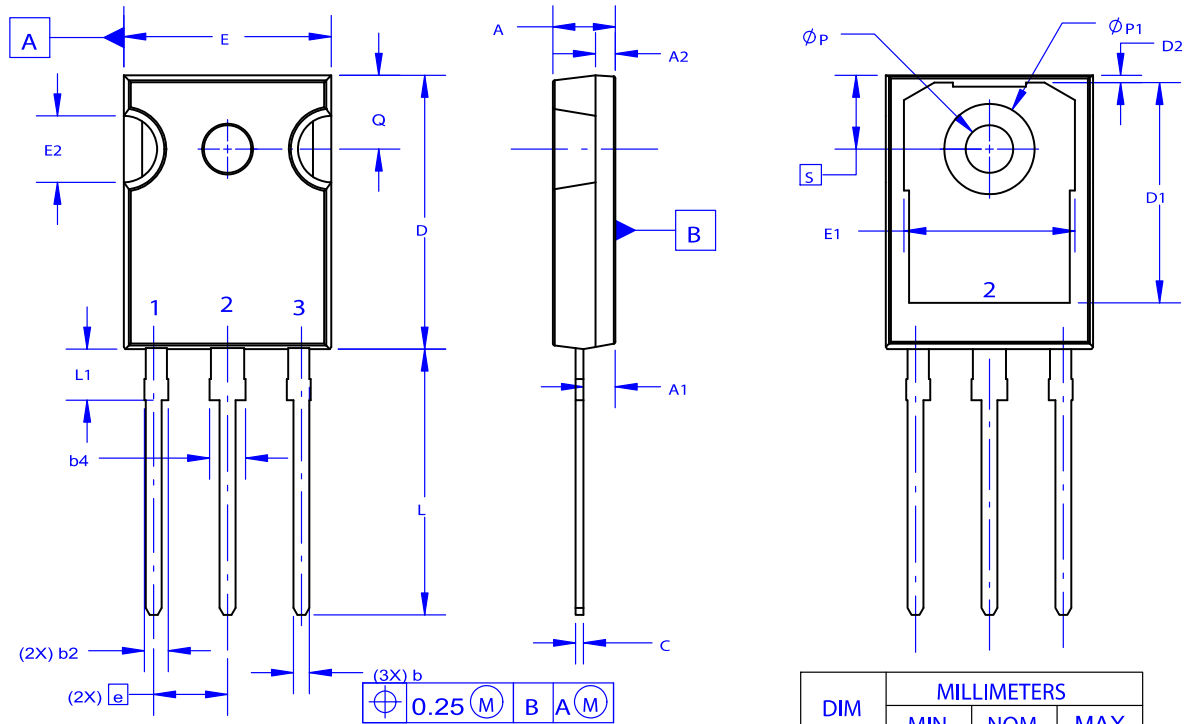


Figure 20. Transient Thermal Impedance of Diode

# FGHL50T65MQDT

## PACKAGE DIMENSIONS

TO-247-3LD  
CASE 340CX  
ISSUE A




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
phi 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	~	~
phi P1	6.60	6.80	7.00

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