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# IGBT – Field Stop, Trench

## 650 V, 50 A

### FGH4L50T65SQD

#### Description

Using novel field stop IGBT technology, ON Semiconductor’s new series of field stop 4<sup>th</sup> 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:  $V_{CE(Sat)} = 1.6\text{ V (Typ.) @ } I_C = 50\text{ A}$
- 100% of the Parts are Tested for  $I_{LM}$
- High Input Impedance
- Fast Switching
- Tight Parameter Distribution
- This Device is Pb-Free and is RoHS Compliant

#### Applications

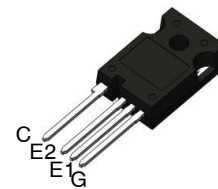
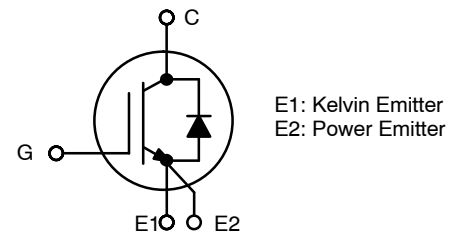
- Solar Inverter, UPS, Welder, Telecom, ESS, PFC



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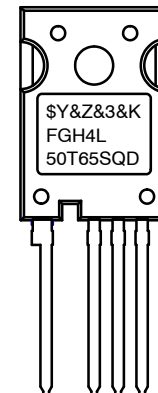
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$V_{CES}$	$I_C$
650 V	50 A



TO-247-4LD  
CASE 340CJ

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FGH4L50T65SQD = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
FGH4L50T65SQD	TO-247-4LD	30 Units / Rail

# FGH4L50T65SQD

## ABSOLUTE MAXIMUM RATINGS

Symbol	Rating	Value	Unit
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage	+20	V
	Transient Gate to Emitter Voltage	+30	V
$I_C$	Collector Current (Note 1) $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	80	A
		50	
$I_{LM}$	Pulsed Collector Current (Note 2), $T_C = 25^\circ\text{C}$	200	A
$I_{CM}$	Pulsed Collector Current (Note 3)	200	A
$I_F$	Diode Forward Current (Note 1) $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	40	A
		30	
$I_{FM}$	Pulsed Diode Maximum Forward Current	200	A
$P_D$	Maximum Power Dissipation $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	268	W
		134	
$T_J$	Operating Junction Temperature	-55 to +175	$^\circ\text{C}$
$T_{STG}$	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. Value limited by bond wire.
2.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $R_G = 15\ \Omega$ , Inductive Load.
3. Repetitive rating: Pulse width limited by max. junction temperature.

## THERMAL CHARACTERISTICS

Symbol	Characteristics	Value	Unit
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case, Max.	0.56	$^\circ\text{C/W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case, Max.	1.25	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	$^\circ\text{C/W}$

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

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

$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	650	-	-	V
$\Delta BV_{CES} / \Delta T_J$	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 Cut-Off Current	$V_{CE} = V_{CES}$ , $V_{GE} = 0\text{ V}$	-	-	250	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}$ , $V_{CE} = 0\text{ V}$	-	-	$\pm 400$	nA

### ON CHARACTERISTICS

$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 50\text{ mA}$ , $V_{CE} = V_{GE}$	2.6	4.5	6.4	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$	-	1.6	2.1	V
		$I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175^\circ\text{C}$	-	1.92	-	V

### DYNAMIC CHARACTERISTICS

$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{ V}$ , $V_{GE} = 0\text{ V}$ , $f = 1\text{ MHz}$	-	3070	-	pF
$C_{oes}$	Output Capacitance		-	84	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	10	-	pF

# FGH4L50T65SQD

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>SWITCHING CHARACTERISTICS, INDUCTIVE LOAD</b>						
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 25\text{ A},$ $R_G = 15\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 25^\circ\text{C}$	-	22.40	-	ns
$T_r$	Rise Time		-	11.20	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	162	-	ns
$T_f$	Fall Time		-	8	-	ns
$E_{on}$	Turn-On Switching Loss		-	0.28	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.20	-	mJ
$E_{ts}$	Total Switching Loss		-	0.48	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 15\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 25^\circ\text{C}$	-	24	-	ns
$T_r$	Rise Time		-	20.80	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	158.40	-	ns
$T_f$	Fall Time		-	11.20	-	ns
$E_{on}$	Turn-On Switching Loss		-	0.66	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.44	-	mJ
$E_{ts}$	Total Switching Loss		-	1.10	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 25\text{ A},$ $R_G = 15\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 175^\circ\text{C}$	-	19.20	-	ns
$T_r$	Rise Time		-	16	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	178	-	ns
$T_f$	Fall Time		-	6.40	-	ns
$E_{on}$	Turn-On Switching Loss		-	0.59	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.32	-	mJ
$E_{ts}$	Total Switching Loss		-	0.91	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 50\text{ A},$ $R_G = 15\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 175^\circ\text{C}$	-	22.40	-	ns
$T_r$	Rise Time		-	26.40	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	168	-	ns
$T_f$	Fall Time		-	11.20	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.16	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.68	-	mJ
$E_{ts}$	Total Switching Loss		-	1.84	-	mJ
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}, I_C = 50\text{ A},$ $V_{GE} = 15\text{ V}$	-	92	-	nC
$Q_{ge}$	Gate to Emitter Charge		-	17	-	nC
$Q_{gc}$	Gate to Collector Charge		-	21	-	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.

# FGH4L50T65SQD

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
$V_{FM}$	Diode Forward Voltage	$I_F = 30\text{ A}$	$T_J = 25^\circ\text{C}$	-	2.1	2.6	V
			$T_J = 175^\circ\text{C}$	-	1.8	-	

## DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

$E_{rec}$	Reverse Recovery Energy	$T_J = 25^\circ\text{C}, V_{CE} = 400\text{ V}, I_F = 15\text{ A},$ $di_F/dt = 1000\text{ A}/\mu\text{s}$	-	11	-	$\mu\text{J}$
$T_{rr}$	Diode Reverse Recovery Time		-	25	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		-	175	-	nC
$I_{rr}$	Diode Reverse Recovery Current		-	14	-	A
$E_{rec}$	Reverse Recovery Energy	$T_J = 25^\circ\text{C}, V_{CE} = 400\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 1000\text{ A}/\mu\text{s}$	-	11	-	$\mu\text{J}$
$T_{rr}$	Diode Reverse Recovery Time		-	29	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		-	205	-	nC
$I_{rr}$	Diode Reverse Recovery Current		-	14	-	A
$E_{rec}$	Reverse Recovery Energy	$T_J = 175^\circ\text{C}, V_{CE} = 400\text{ V}, I_F = 15\text{ A},$ $di_F/dt = 1000\text{ A}/\mu\text{s}$	-	98	-	$\mu\text{J}$
$T_{rr}$	Diode Reverse Recovery Time		-	70	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		-	830	-	nC
$I_{rr}$	Diode Reverse Recovery Current		-	23	-	A
$E_{rec}$	Reverse Recovery Energy	$T_J = 175^\circ\text{C}, V_{CE} = 400\text{ V}, I_F = 30\text{ A},$ $di_F/dt = 1000\text{ A}/\mu\text{s}$	-	112	-	$\mu\text{J}$
$T_{rr}$	Diode Reverse Recovery Time		-	89	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		-	1031	-	nC
$I_{rr}$	Diode Reverse Recovery Current		-	23	-	A

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## TYPICAL CHARACTERISTICS

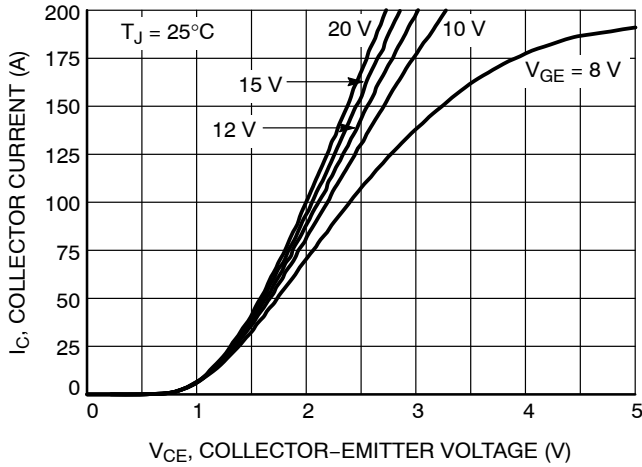


Figure 1. Typical Output Characteristics

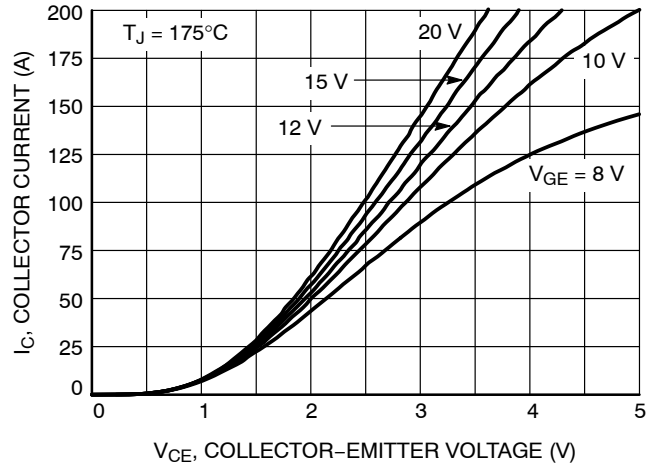


Figure 2. Typical Output Characteristics

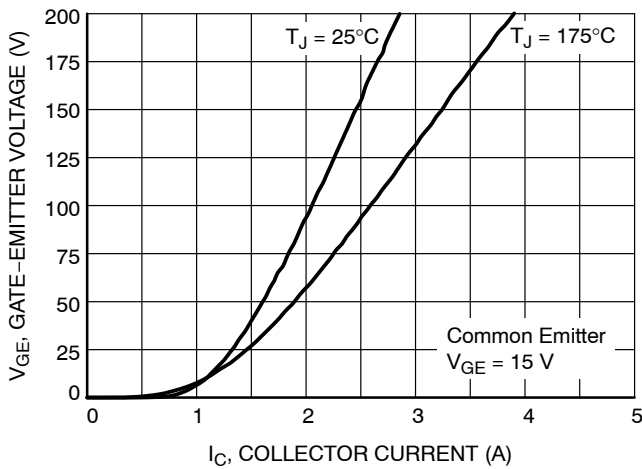


Figure 3. Typical Saturation Voltage Characteristics

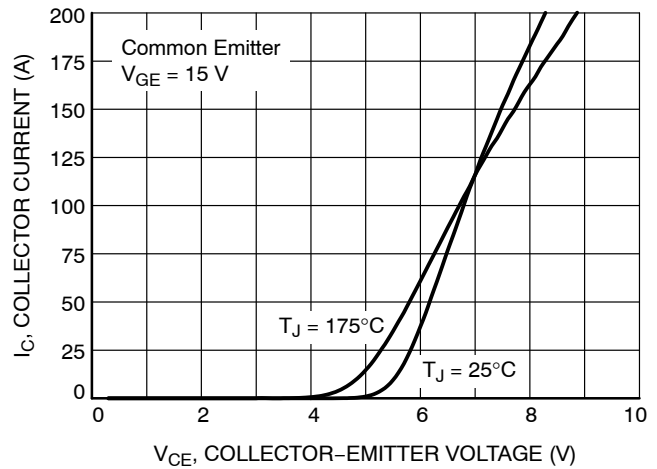


Figure 4. Typical Transfer Characteristics

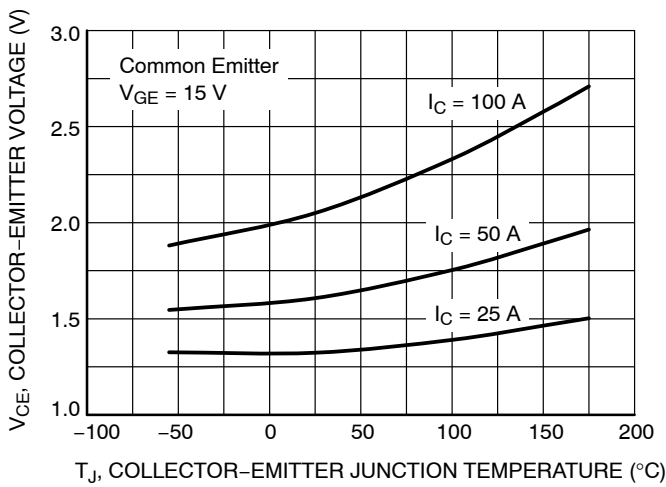


Figure 5. Saturation Voltage vs. Junction Temperature

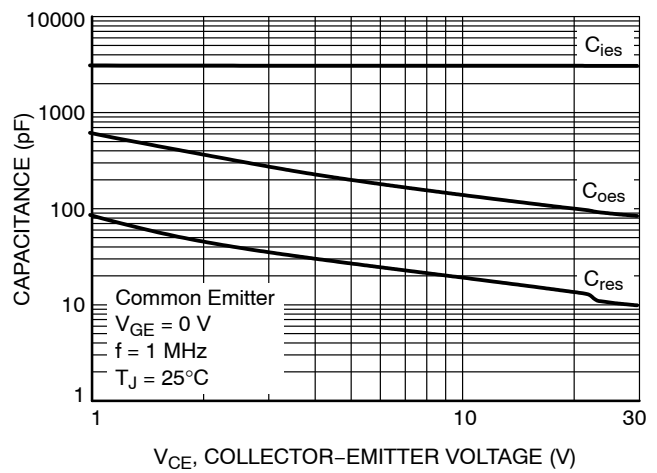


Figure 6. Capacitance Characteristics

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## TYPICAL CHARACTERISTICS

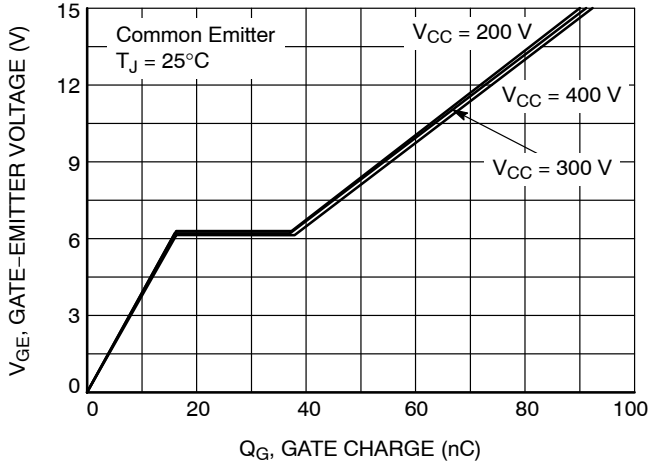


Figure 7. Gate Charge Characteristic

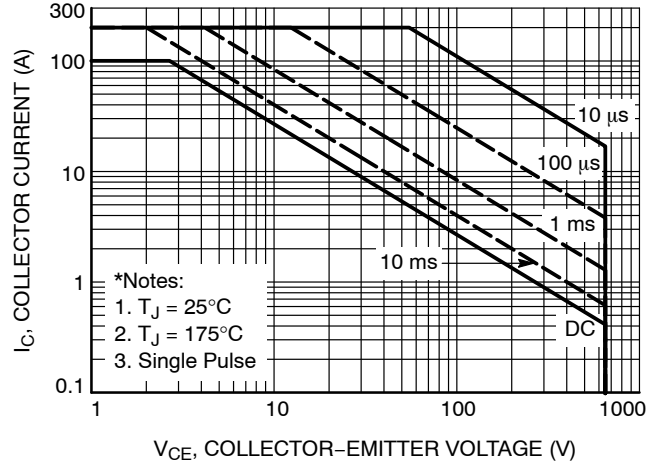


Figure 8. SOA Characteristics (FBSOA)

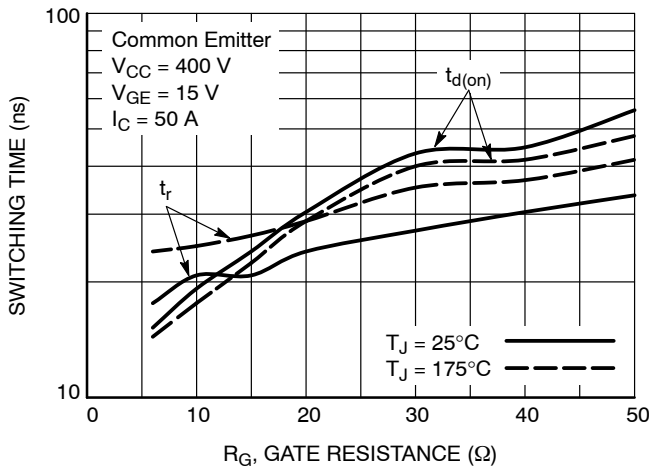


Figure 9. Turn-On Characteristics vs. Gate Resistance

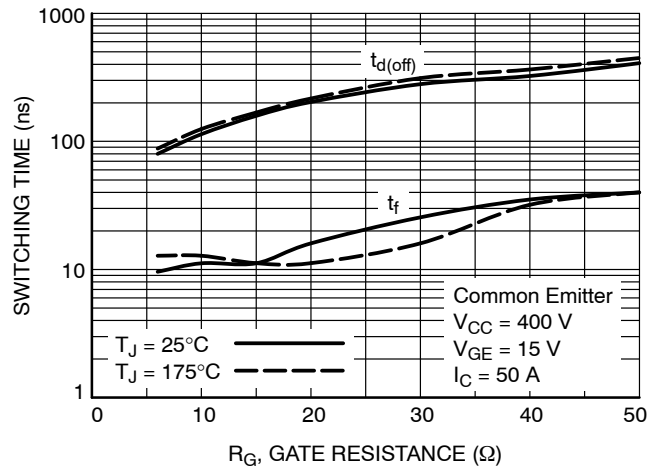


Figure 10. Turn-Off Characteristics vs. Gate Resistance

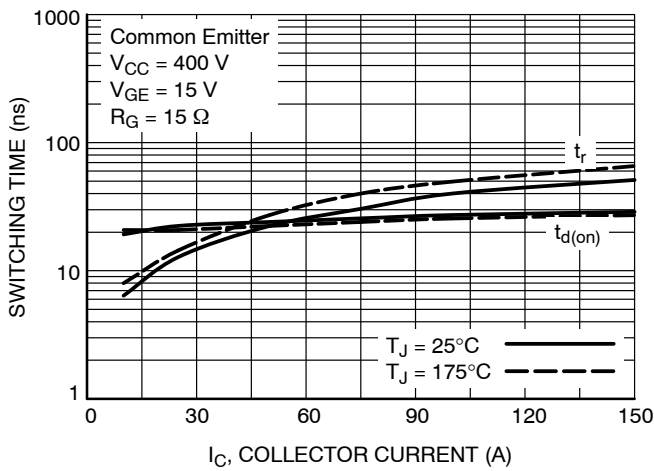


Figure 11. Turn-On Characteristics vs. Collector Current

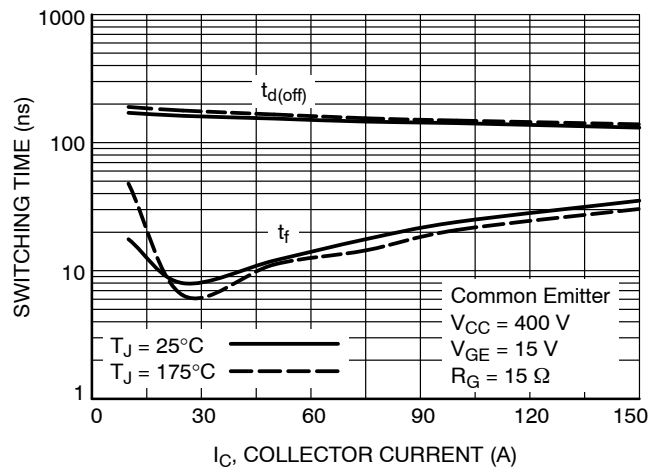


Figure 12. Turn-Off Characteristics vs. Collector Current

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## TYPICAL CHARACTERISTICS

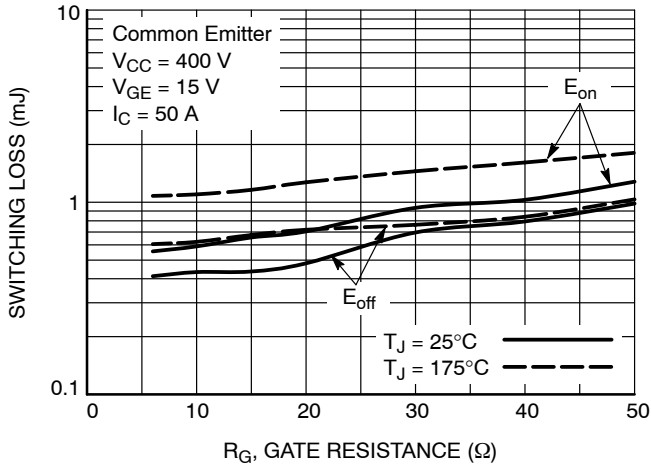


Figure 13. Switching Loss vs. Gate Resistance

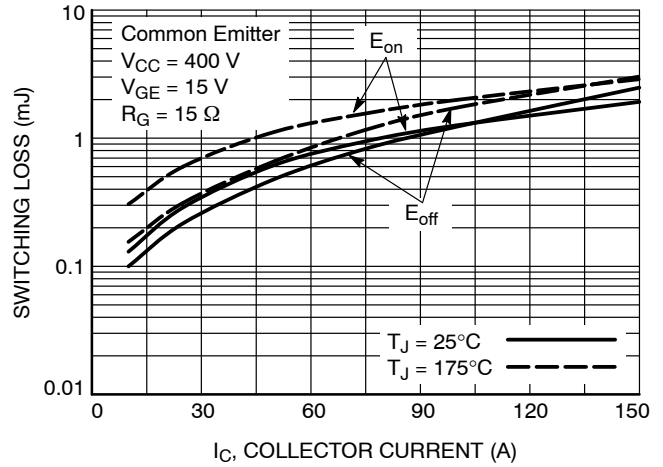


Figure 14. Switching Loss vs. Collector Current

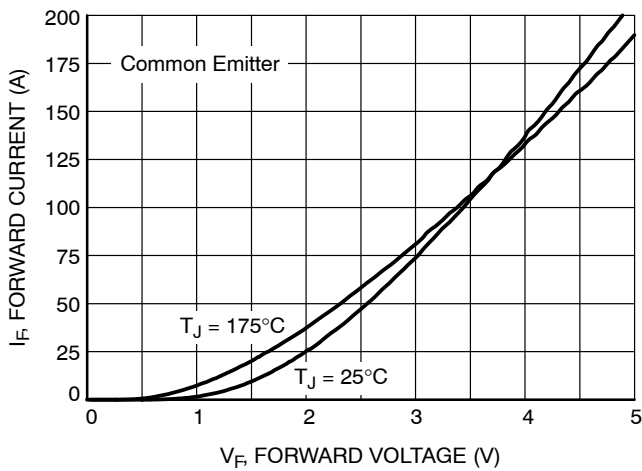


Figure 15. (Diode) Forward Characteristics

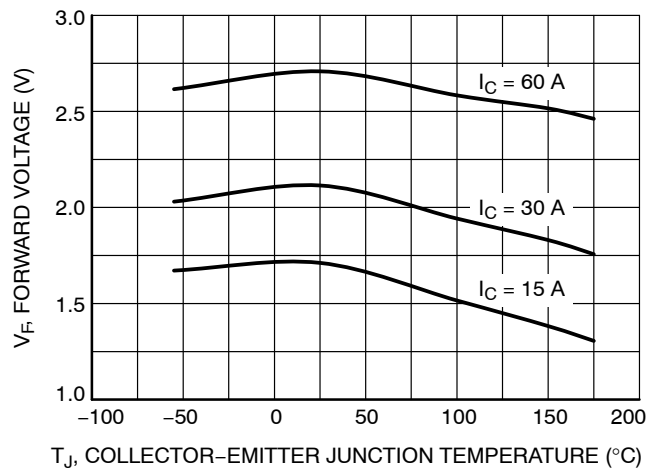


Figure 16. (Diode) Forward Voltage vs. Junction Temperature

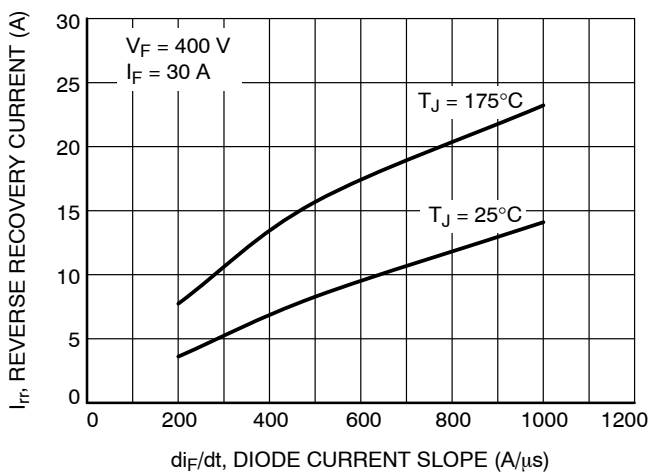


Figure 17. Reverse Recovery Current ( $I_{rr}$ )

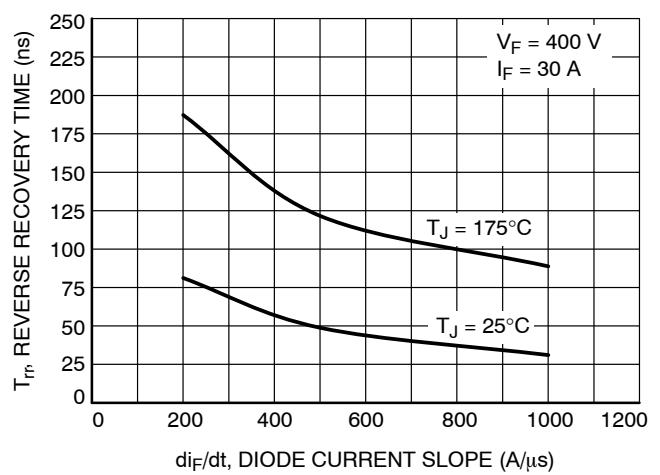


Figure 18. Reverse Recovery Time ( $T_{rr}$ )



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## TYPICAL CHARACTERISTICS

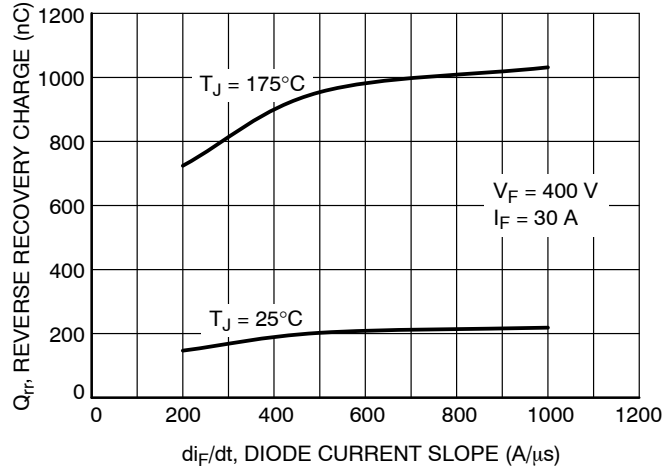


Figure 19. Stored Charge ( $Q_{rr}$ )

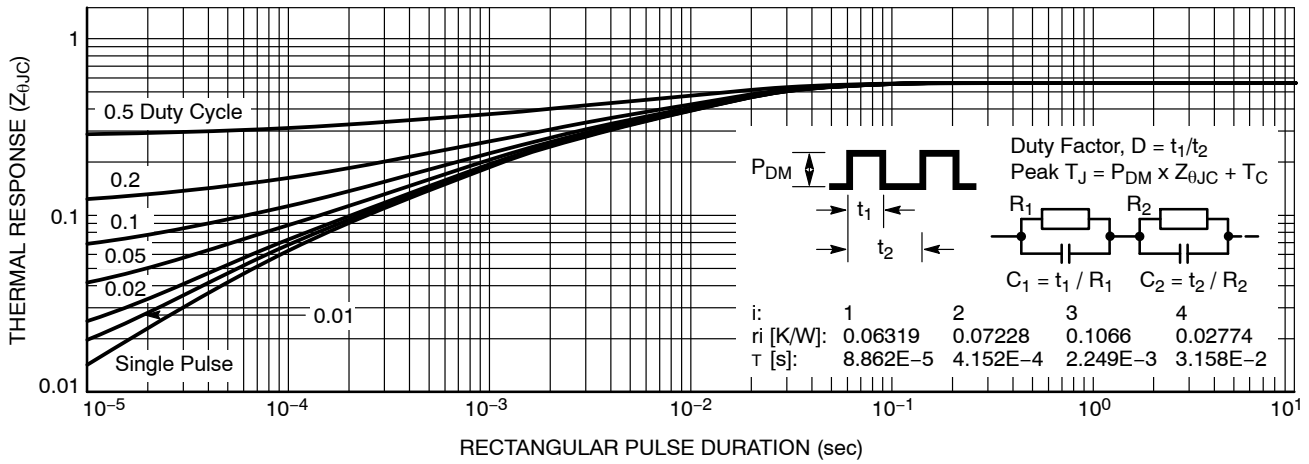


Figure 20. Transient Thermal Impedance of IGBT

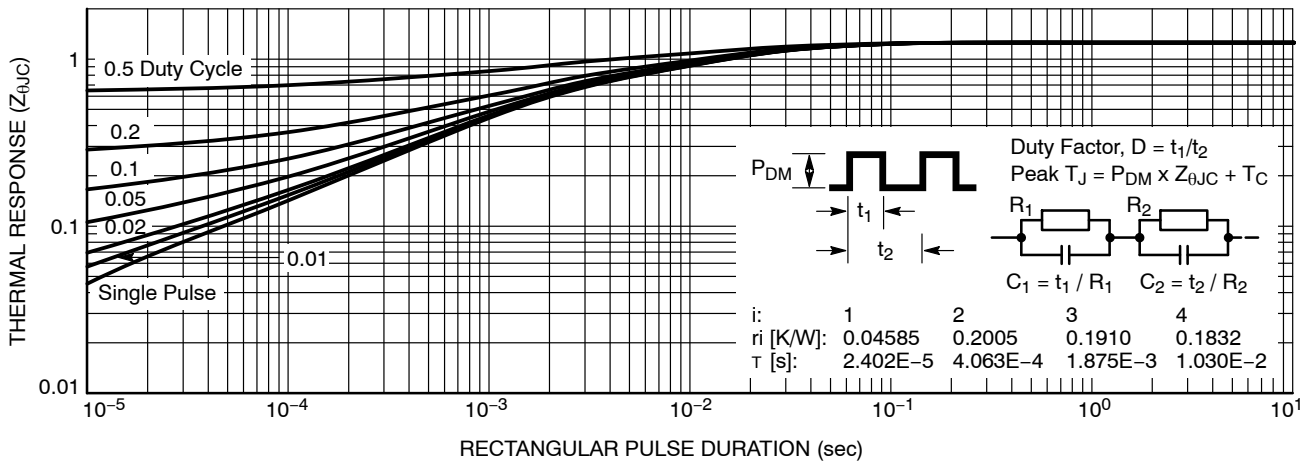
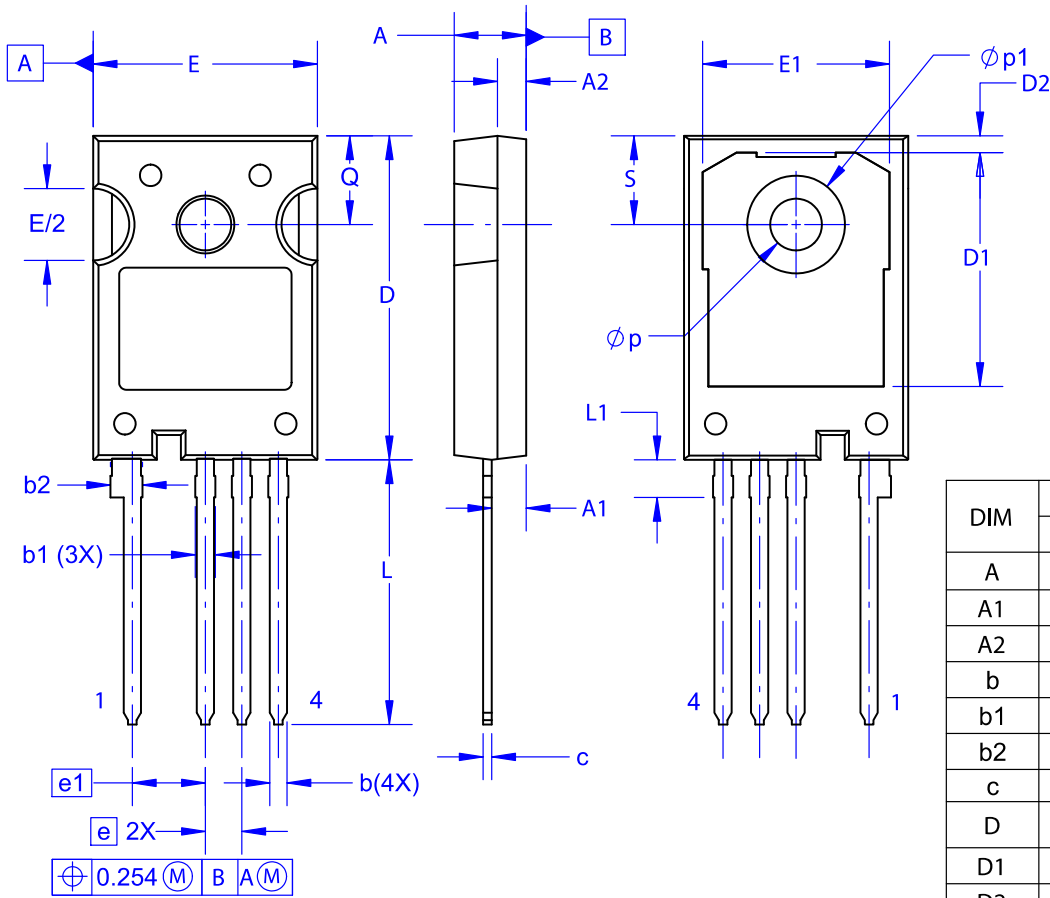


Figure 21. Transient Thermal Impedance of Diode

# FGH4L50T65SQD

## 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.
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- D. DRAWING CONFORMS TO ASME Y14.5-2009.

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