

# FGHL40S65UQ

## Product Preview

### Field Stop Trench IGBT 40 A, 650 V

Using the novel field stop generation IGBT technology, ON Semiconductor's new series of field stop 4<sup>th</sup> generation of RC IGBTs offer superior conduction and switching performance and easy parallel operation. This device is well suited for the resonant or soft switching application such as induction heating and microwave oven.

#### Features

- Maximum Junction Temperature:  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.36\text{ V (Typ.)}$  @  $I_C = 40\text{ A}$
- 100% of the Parts tested for  $I_{LM}$  (Note 1)
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- RoHS Compliant
- IGBT with Monolithic Reverse Conducting Diode

#### Typical Applications

- Induction Heating
- Microwave Oven
- Soft Switching Application

#### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	$V_{CES}$	650	V
Gate to Emitter Voltage	$V_{GES}$	$\pm 20$	V
Transient Gate to Emitter Voltage		$\pm 30$	
Collector Current @ $T_C = 25^\circ\text{C}$	$I_C$	80	A
@ $T_C = 100^\circ\text{C}$		40	
Pulsed Collector Current (Note 1)	$I_{LM}$	120	A
Pulsed Collector Current (Note 2)	$I_{CM}$	120	A
Diode Forward Current @ $T_C = 25^\circ\text{C}$	$I_F$	40	A
@ $T_C = 100^\circ\text{C}$		20	
Pulsed Diode Maximum Forward Current	$I_{FM}$	120	A
Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	$P_D$	231	W
@ $T_C = 100^\circ\text{C}$		115	
Operating Junction / 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 seconds	$T_L$	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.

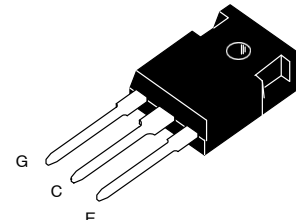
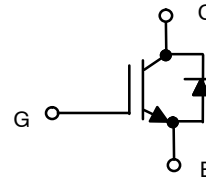
1.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 120\text{ A}$ ,  $R_G = 7\ \Omega$ , Inductive Load, 100% Tested.
2. Repetitive rating: pulse width limited by max. Junction temperature.



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40 A, 650 V  
 $V_{CE(sat)} = 1.36\text{ V (Typ.)}$



TO-247-3L  
CASE 340CX

#### MARKING DIAGRAM



&Y = ON Semiconductor Logo  
&Z = Assembly Plant Code  
&3 = 3-Digit Data Code  
&K = 2-Digit Lot Traceability Code  
FGHL40S65UQ = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
FGHL40S65UQ	TO-247-3L	30 Units / Rail

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.

# FGHL40S65UQ

## THEMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal resistance junction-to-case, for IGBT	$R_{\theta JC}$	0.65	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction-to-case, for Diode	$R_{\theta JC}$	1.69	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction-to-ambient	$R_{\theta JA}$	40	$^{\circ}\text{C}/\text{W}$

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

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

Collector-emitter breakdown voltage, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	$BV_{CES}$	650	–	–	V
Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	$\Delta BV_{CES} / \Delta T_J$	–	0.5	–	$\text{V}/^{\circ}\text{C}$
Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	$I_{CES}$	–	–	250	$\mu\text{A}$
Gate leakage current, collector-emitter short-circuited	$V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$	$I_{GES}$	–	–	$\pm 400$	nA

### ON CHARACTERISTIC

Gate-emitter threshold voltage	$V_{GE} = V_{CE}, I_C = 40\text{ mA}$	$V_{GE(th)}$	2.5	4.7	6.5	V
Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175^{\circ}\text{C}$	$V_{CE(sat)}$	–	1.36 1.6	1.7 –	V

### DYNAMIC CHARACTERISTIC

Input capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	$C_{ies}$	–	6054	–	pF
Output capacitance		$C_{oes}$	–	36	–	
Reverse transfer capacitance		$C_{res}$	–	30	–	
Gate charge total	$V_{CE} = 400\text{ V}, I_C = 40\text{ A},$ $V_{GE} = 15\text{ V}$	$Q_g$	–	306	–	nC
Gate to emitter charge		$Q_{ge}$	–	30	–	
Gate to collector charge		$Q_{gc}$	–	99	–	

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

Turn-on delay time	$T_J = 25^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A},$ $R_G = 6\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(on)}$	–	32	–	ns
Rise time		$t_r$	–	20	–	
Turn-off delay time		$t_{d(off)}$	–	260	–	
Fall time		$t_f$	–	13	–	
Turn-on switching loss		$E_{ON}$	–	1760	–	$\mu\text{J}$
Turn-off switching loss		$E_{OFF}$	–	362	–	
Total switching loss		$E_{TS}$	–	2122	–	
Turn-on delay time	$T_J = 175^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A},$ $R_G = 6\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(on)}$	–	30	–	ns
Rise time		$t_r$	–	28	–	
Turn-off delay time		$t_{d(off)}$	–	284	–	
Fall time		$t_f$	–	56	–	
Turn-on switching loss		$E_{ON}$	–	2050	–	$\mu\text{J}$
Turn-off switching loss		$E_{OFF}$	–	590	–	
Total switching loss		$E_{TS}$	–	2640	–	

# FGHL40S65UQ

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
<b>DIODE CHARACTERISTIC</b>						
Forward voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_J = 175^\circ\text{C}$	$V_F$	– –	1.24 1.24	1.6 –	V
Reverse Recovery Energy	$I_F = 20\text{ A}, \Delta I_F/\Delta t = 200\text{ A}/\mu\text{s}$	$E_{REC}$	–	359	–	$\mu\text{J}$
Diode Reverse Recovery Time	$I_F = 20\text{ A}, \Delta I_F/\Delta t = 200\text{ A}/\mu\text{s}$ $I_F = 20\text{ A}, \Delta I_F/\Delta t = 200\text{ A}/\mu\text{s},$ $T_J = 175^\circ\text{C}$	$T_{RR}$	–	319 430	–	nS
Diode Reverse Recovery Charge	$I_F = 20\text{ A}, \Delta I_F/\Delta t = 200\text{ A}/\mu\text{s}$ $I_F = 20\text{ A}, \Delta I_F/\Delta t = 200\text{ A}/\mu\text{s},$ $T_J = 175^\circ\text{C}$	$Q_{RR}$	–	1853 3007	–	nC

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## TYPICAL CHARACTERISTICS

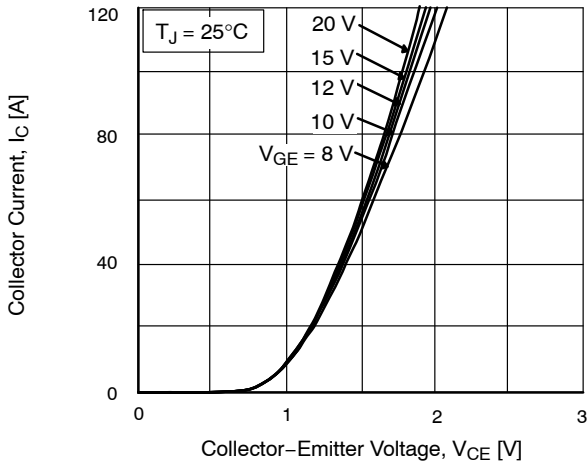


Figure 1. Typical Output Characteristics

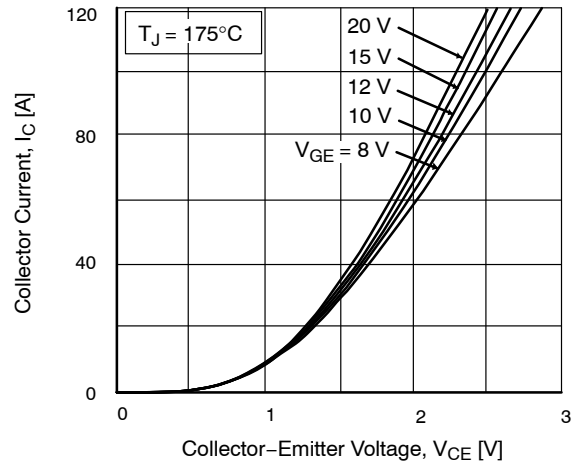


Figure 2. Typical Output Characteristics

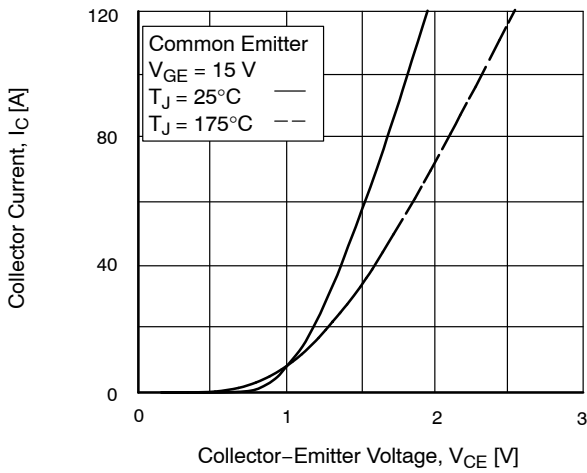


Figure 3. Typical Saturation Voltage Characteristics

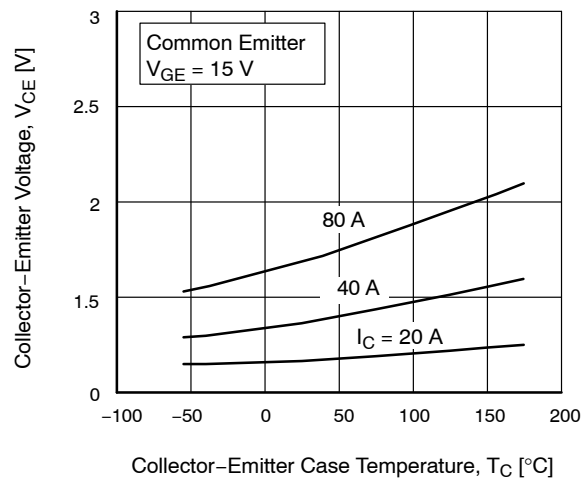


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

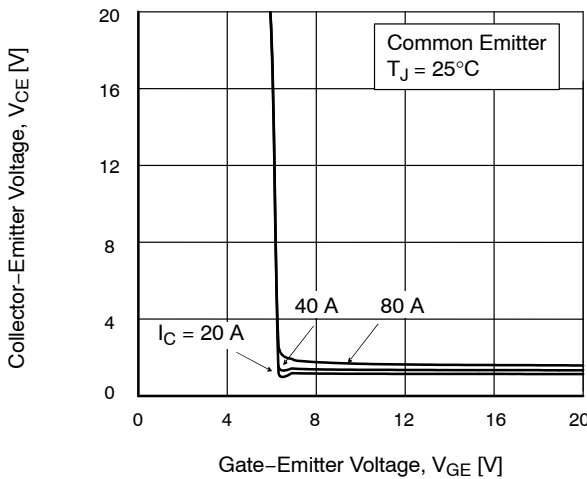


Figure 5. Saturation Voltage vs  $V_{GE}$

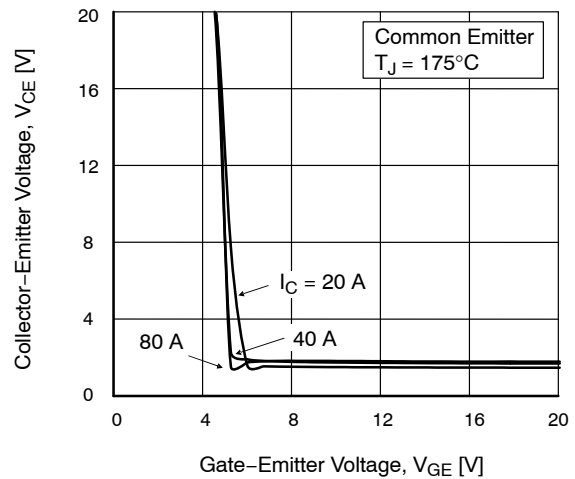
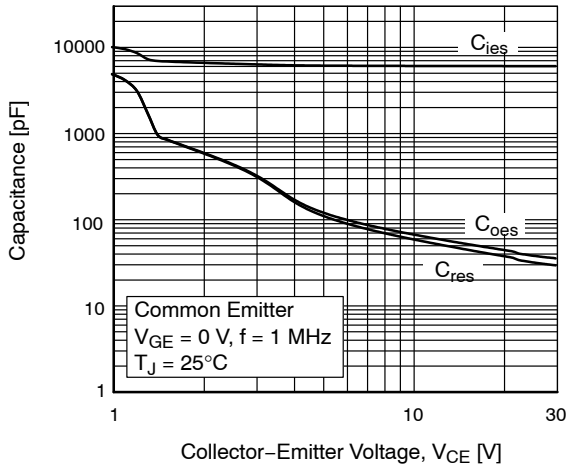


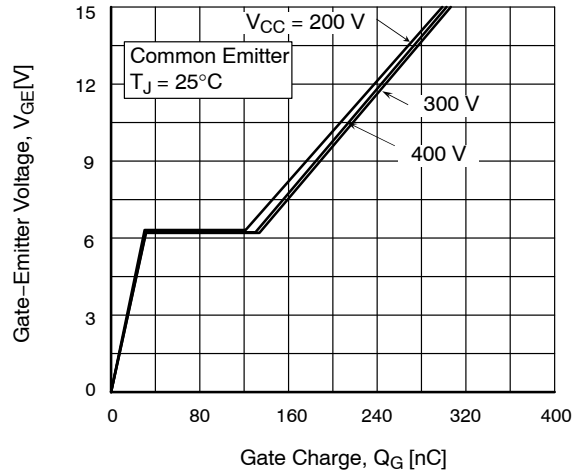
Figure 6. Saturation Voltage vs  $V_{GE}$

# FGHL40S65UQ

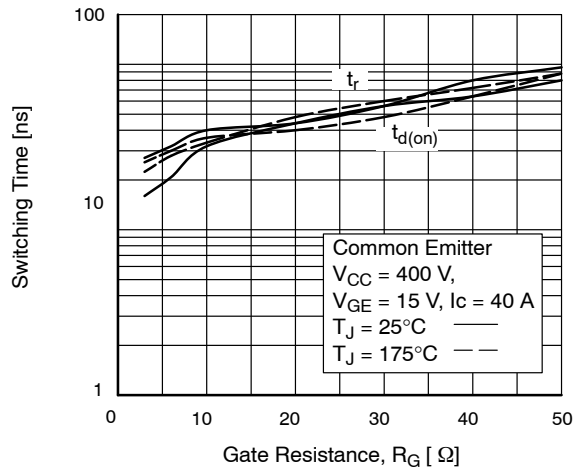
## TYPICAL CHARACTERISTICS (continued)



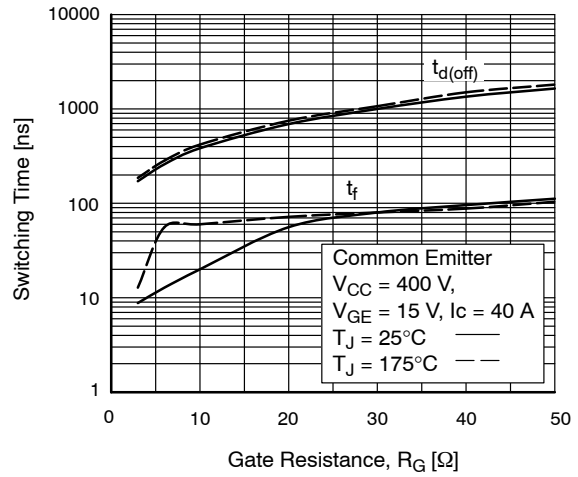
**Figure 7. Capacitance Characteristics**



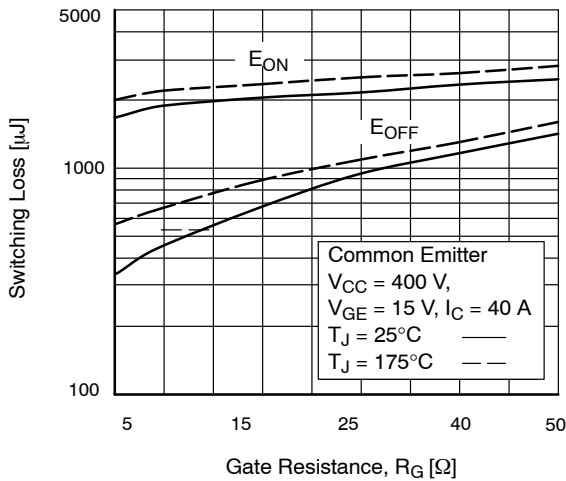
**Figure 8. Gate Charge Characteristics**



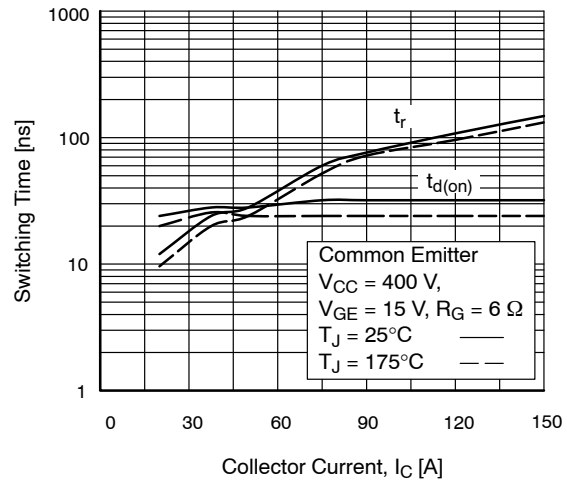
**Figure 9. Turn-on Characteristics vs. Gate Resistance**



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



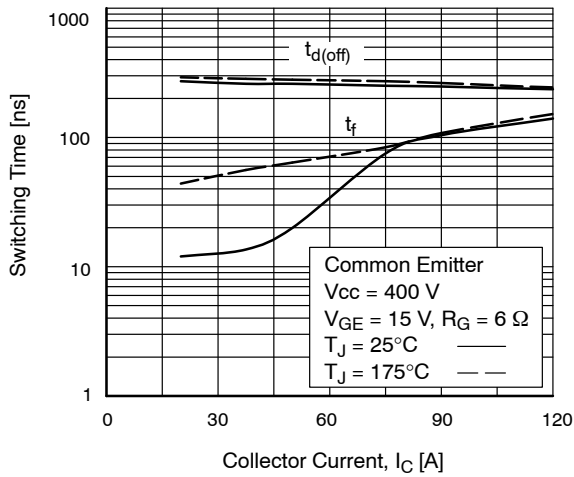
**Figure 11. Switching Loss vs Gate Resistance**



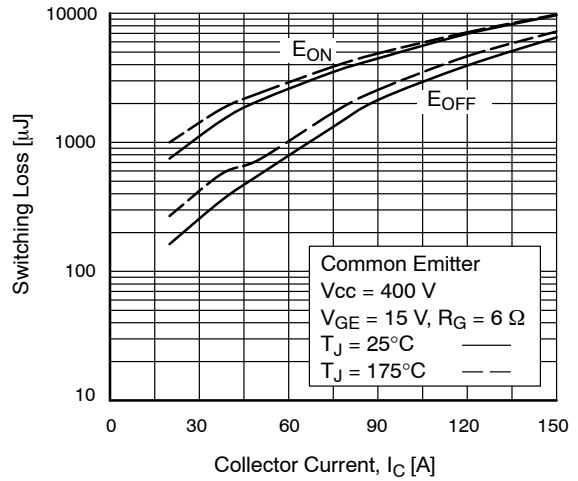
**Figure 12. Turn-on Characteristics vs. Collector Current**

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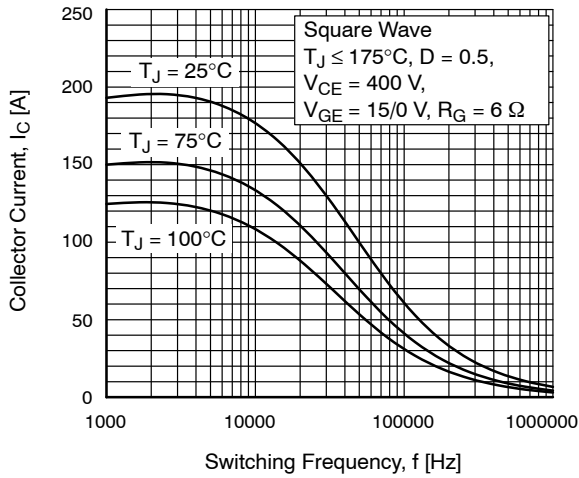
## TYPICAL CHARACTERISTICS (continued)



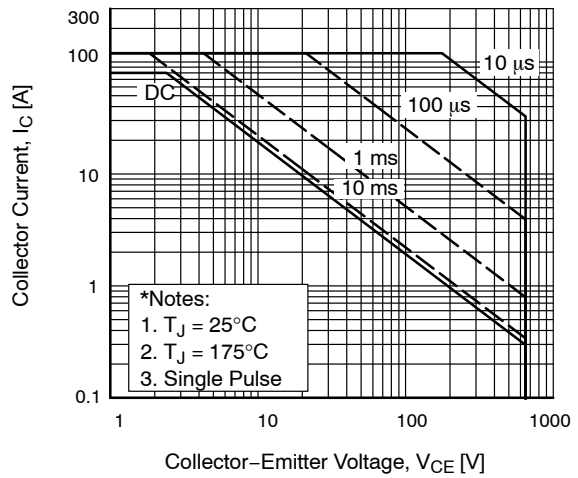
**Figure 13. Turn-Off Characteristics vs. Collector Current**



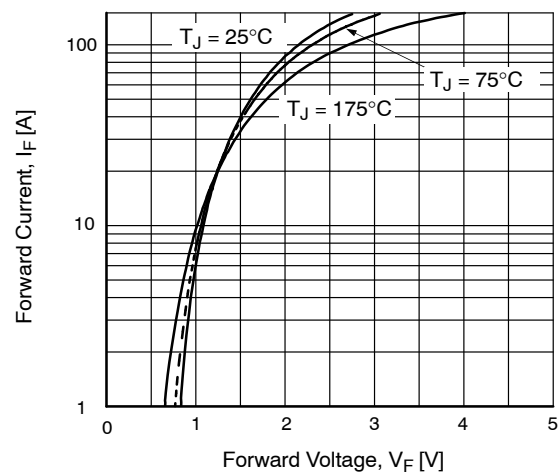
**Figure 14. Switching Loss vs. Collector Current**



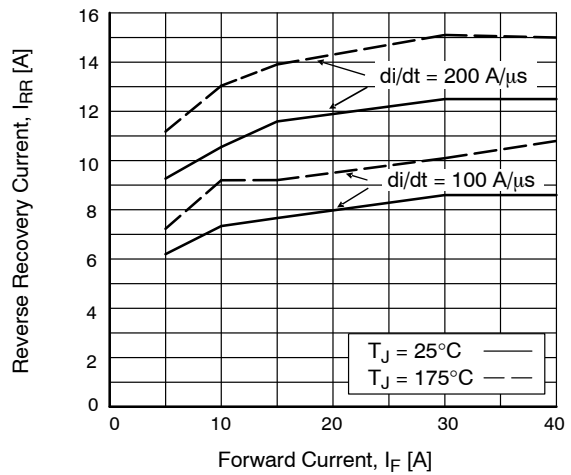
**Figure 15. Load Current vs Frequency**



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



**Figure 17. Forward Characteristics**



**Figure 18. Reverse Recovery Current**

# FGHL40S65UQ

## TYPICAL CHARACTERISTICS (continued)

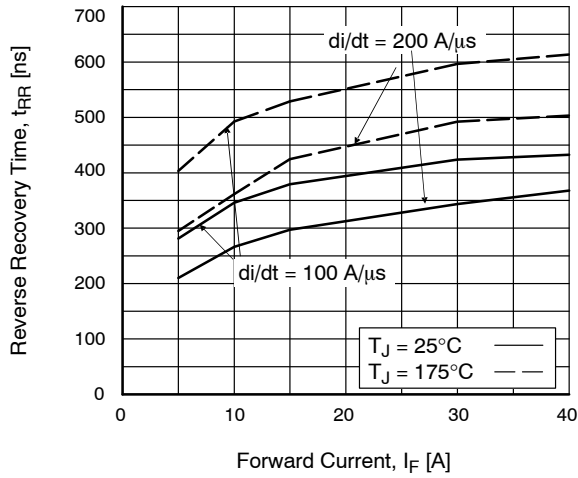


Figure 19. Reverse Recovery Time

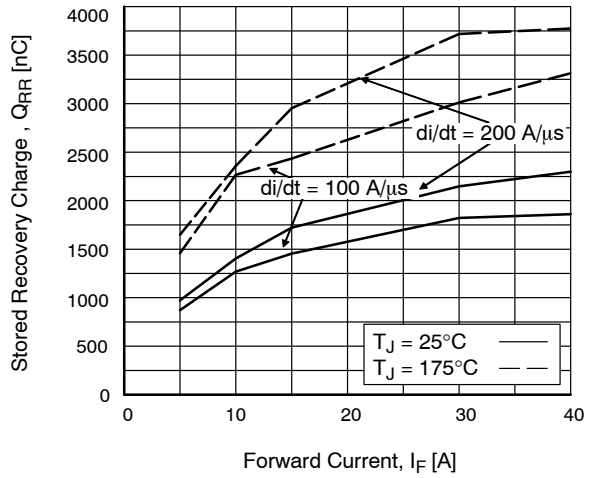


Figure 20. Stored Charge

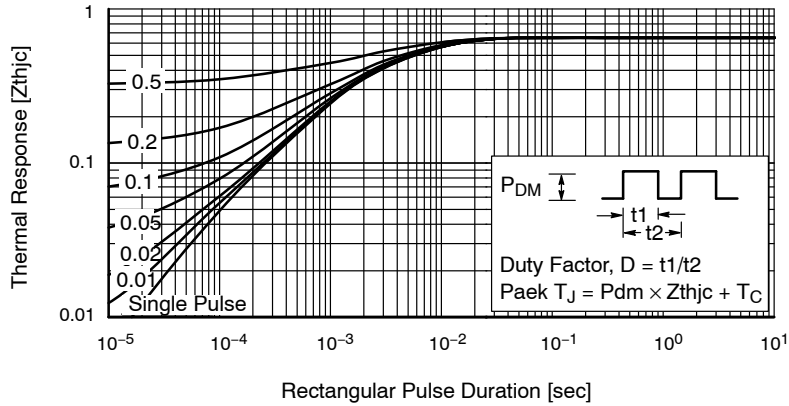


Figure 21. Transient Thermal Impedance of IGBT

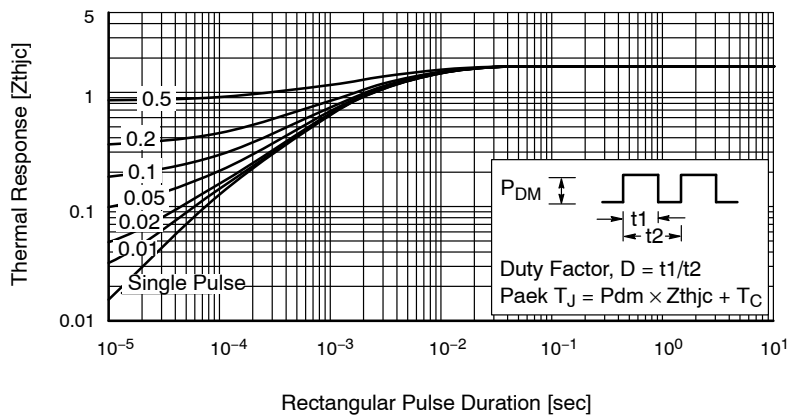
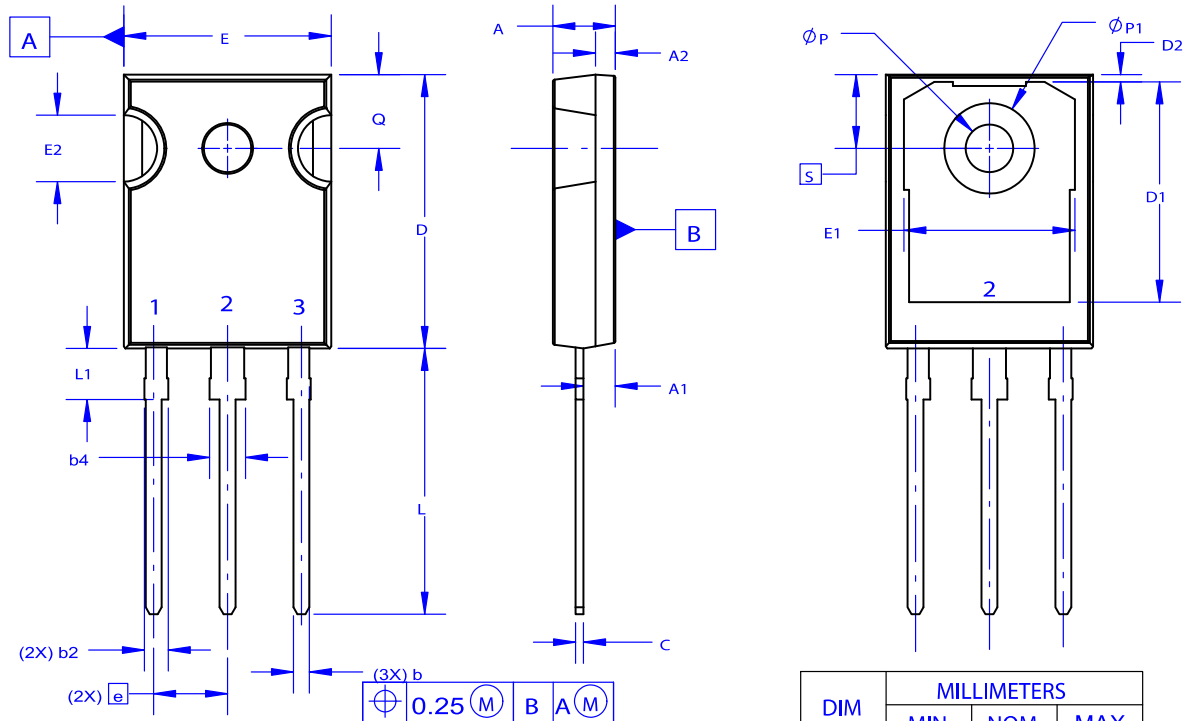


Figure 22. Transient Thermal Impedance of Diode

# FGHL40S65UQ

TO-247-3LD  
CASE 340CX  
ISSUE O




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



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