

IGBT - Field Stop

600 V, 40 A

FGH40N60SMD-F085

Description

Using Novel Field Stop IGBT Technology, **onsemi**'s new series of Field Stop IGBTs offer the optimum performance for Automotive Chargers, Inverter, and other 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: $V_{CE(sat)} = 1.9\text{ V(Typ.) @ } I_C = 40\text{ A}$
- High Input Impedance
- Tightened Parameter Distribution
- AEC Qualified and PPAP Capable
IGBT: AEC-Q101
- This Device is Pb-Free and is RoHS Compliant

Applications

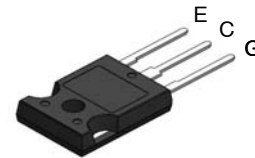
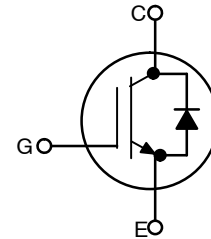
- Automotive Chargers, Converters, High Voltage Auxiliaries
- Inverters, SMPS, PFC, UPS

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Ratings	Unit
Collector to Emitter Voltage	V_{CES}	600	V
Gate to Emitter Voltage	V_{GES}	± 20	V
Collector Current @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	I_C	80 40	A
Pulsed Collector Current	I_{CM} (Note 1)	120	A
Diode Forward Current @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	I_F	40 20	A
Pulsed Diode Maximum Forward Current	I_{FM} (Note 1)	120	A
Maximum Power Dissipation @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	P_D	349 174	W
Operating Junction Temperature	T_J	-55 to $+175$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-55 to $+175$	$^{\circ}\text{C}$
Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds	T_L	300	$^{\circ}\text{C}$

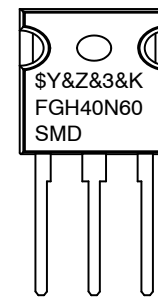
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Repetitive rating: Pulse width limited by max. junction temperature.



TO-247-3LD
CASE 340CK

MARKING DIAGRAM



\$Y = **onsemi** Logo
&Z = Assembly Plant Code
&3 = Numeric Date Code
&K = Lot Code
FGH40N60SMD = Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

FGH40N60SMD-F085

THERMAL CHARACTERISTICS

Parameter	Symbol	Ratings	Unit
Thermal Resistance Junction-to-Case, for IGBT	$R_{\theta JC}$ (Note 2)	0.43	$^{\circ}\text{C/W}$
Thermal Resistance Junction-to-Case, for Diode	$R_{\theta JC}$	1.8	$^{\circ}\text{C/W}$
Parameter	Symbol	Typ.	
Thermal Resistance Junction-to-Ambient (PCB Mount) (Note 2)	$R_{\theta JA}$	45	$^{\circ}\text{C/W}$

2. $R_{\theta JC}$ for TO-247: according to Mil standard 883-1012 test method. $R_{\theta JA}$ for TO-247: according to JESD51-2, test method environmental condition and JESD51-10, test boards for through hole perimeter leaded package thermal measurements. JESD51-3: Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Package.

PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Package Type	Quantity
FGH40N60SMD	FGH40N60SMD-F085	TO-247-3	Tube	30 Units

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
-----------	--------	-----------------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector to Emitter Breakdown Voltage	BV_{CES}	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	600	–	–	V
Temperature Coefficient of Breakdown Voltage	$\Delta BV_{CES}/\Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	–	0.6	–	$\text{V}/^{\circ}\text{C}$
Collector Cut-Off Current	I_{CES}	$V_{CE} = V_{CES}, V_{GE} = 0\text{ V}$	–	–	250	μA
		I_{CES} at 80% * BV_{CES} , 175°C	–	–	800	
G-E Leakage Current	I_{GES}	$V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$	–	–	± 400	nA

ON CHARACTERISTICS

G-E Threshold Voltage	$V_{GE(th)}$	$I_C = 250\text{ }\mu\text{A}, V_{CE} = V_{GE}$	3.5	4.5	6.0	V
Collector to Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	–	1.9	2.5	V
		$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_C = 175^{\circ}\text{C}$	–	2.1	–	V

DYNAMIC CHARACTERISTICS

Input Capacitance	C_{ies}	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	–	1880	2500	pF
Output Capacitance	C_{oes}		–	180	240	pF
Reverse Transfer Capacitance	C_{res}		–	50	65	pF

SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, I_C = 40\text{ A},$ $R_G = 6\text{ }\Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 25^{\circ}\text{C}$	–	18	24	ns
Rise Time	t_r		–	28	36.4	ns
Turn-Off Delay Time	$t_{d(off)}$		–	110	143	ns
Fall Time	t_f		–	13.2	18.5	ns
Turn-On Switching Loss	E_{on}		–	0.92	1.2	mJ
Turn-Off Switching Loss	E_{off}		–	0.3	0.39	mJ
Total Switching Loss	E_{ts}		–	1.22	1.59	mJ

FGH40N60SMD-F085

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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, $T_C = 175^\circ\text{C}$	–	16.7	23.8	ns
Rise Time	t_r		–	27	35.1	ns
Turn-Off Delay Time	$t_{d(off)}$		–	116	151	ns
Fall Time	t_f		–	56.5	81	ns
Turn-On Switching Loss	E_{on}		–	1.47	1.91	mJ
Turn-Off Switching Loss	E_{off}		–	0.73	0.95	mJ
Total Switching Loss	E_{ts}		–	2.20	2.86	mJ
Total Gate Charge	Q_g	$V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$	–	119	180	nC
Gate to Emitter Charge	Q_{ge}		–	13	20	nC
Gate to Collector Charge	Q_{gc}		–	58	90	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 A	T _C = 25°C	–	2.3	2.8	V
			T _C = 175°C	–	1.67	–	
Reverse Recovery Energy	E _{rec}	I _F = 20 A, di _F /dt = 200 A/μs	T _C = 175°C	–	48.9	–	μJ
Diode Reverse Recovery Time	t _{rr}		T _C = 25°C	–	36	47	ns
			T _C = 175°C	–	110	–	
Diode Reverse Recovery Charge	Q _{rr}		T _C = 25°C	–	46.8	61	nC
		T _C = 175°C	–	470	–		

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.

TYPICAL CHARACTERISTICS

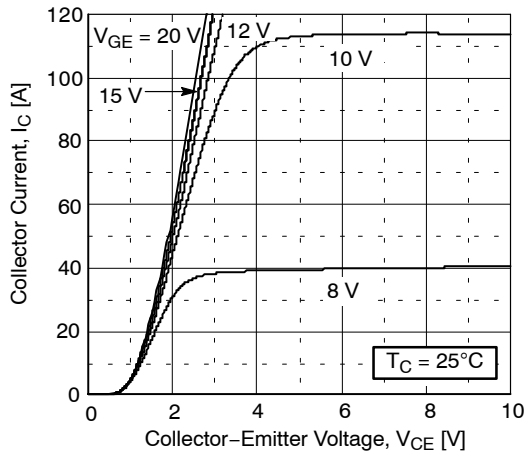


Figure 1. Typical Output Characteristics

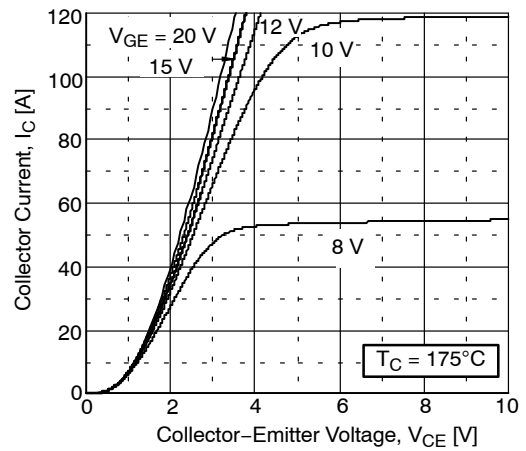


Figure 2. Typical Output Characteristics

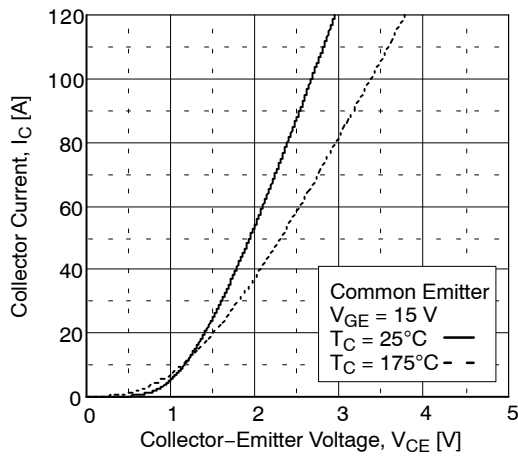


Figure 3. Typical Saturation Voltage Characteristics

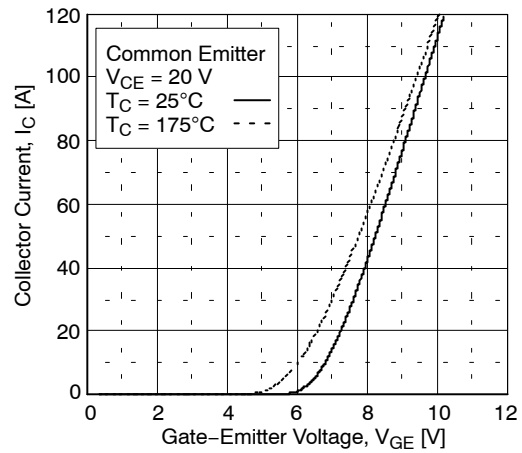


Figure 4. Transfer Characteristics

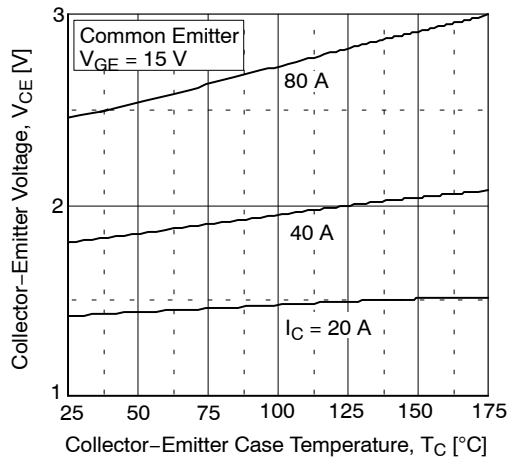


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

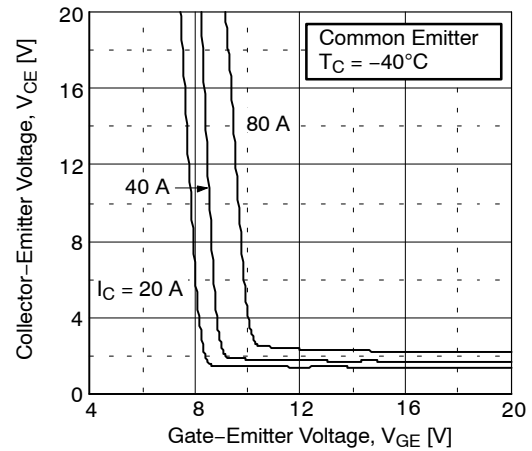


Figure 6. Saturation Voltage vs. V_{GE}

TYPICAL CHARACTERISTICS

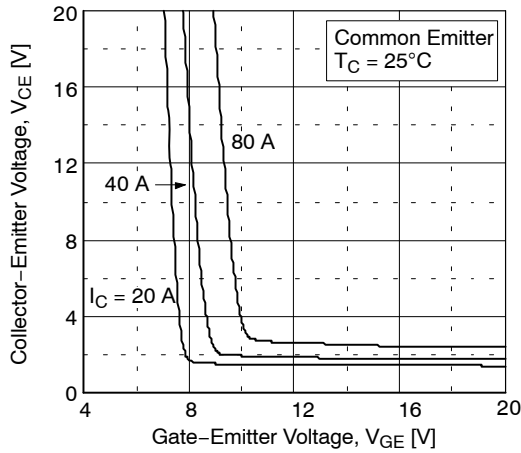


Figure 7. Saturation Voltage vs. V_{GE}

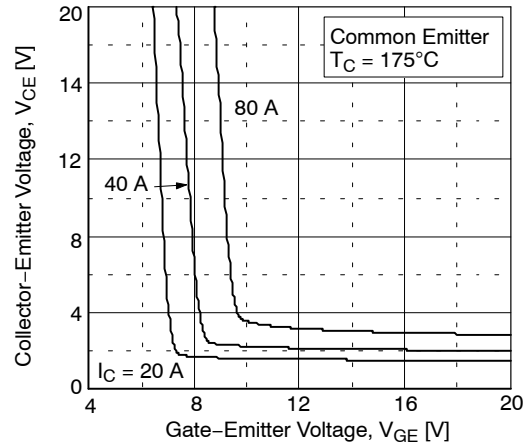


Figure 8. Saturation Voltage vs. V_{GE}

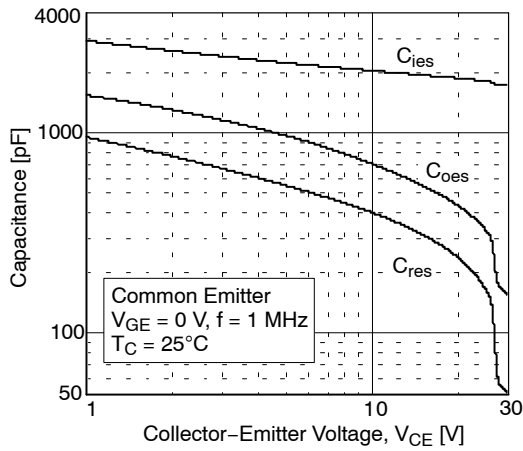


Figure 9. Capacitance Characteristics

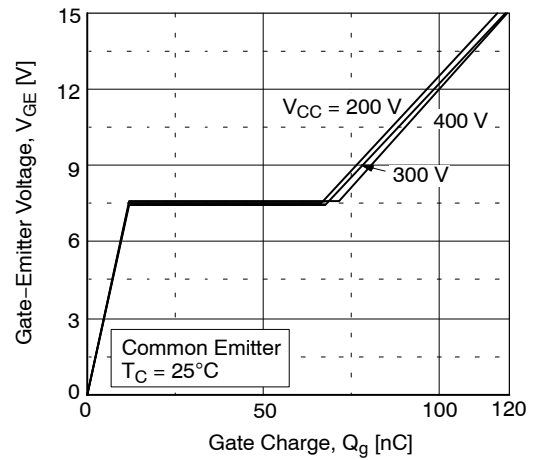


Figure 10. Gate Charge Characteristics

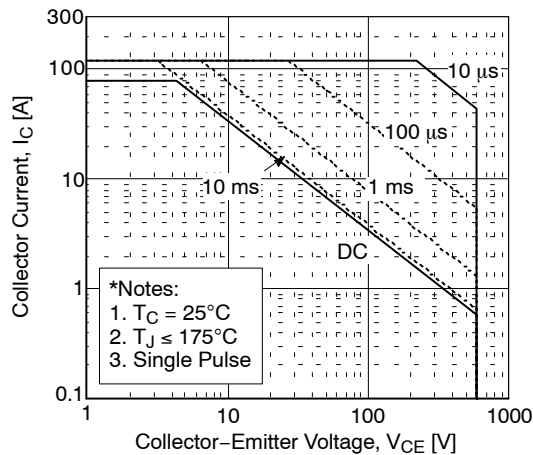


Figure 11. SOA Characteristics

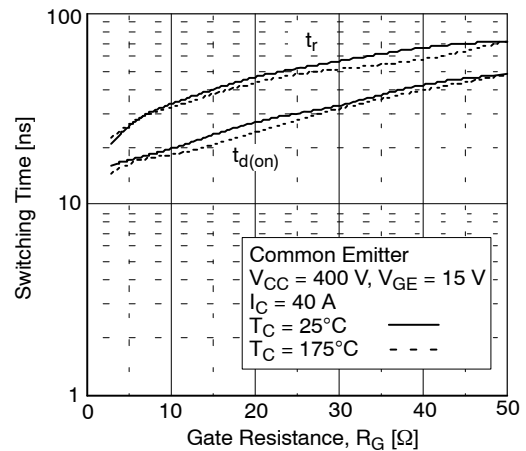


Figure 12. Turn-on Characteristics vs. Gate Resistance

TYPICAL CHARACTERISTICS

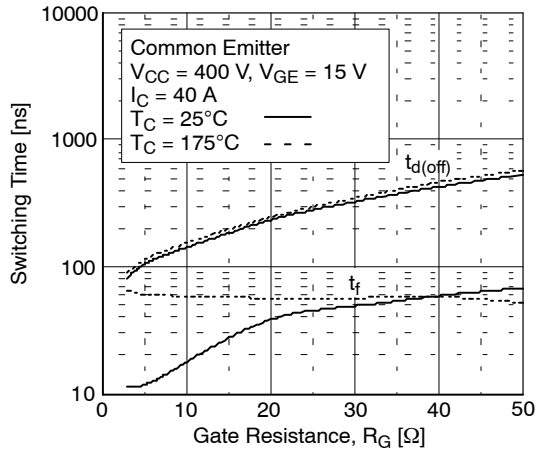


Figure 13. Turn-off Characteristics vs. Gate Resistance

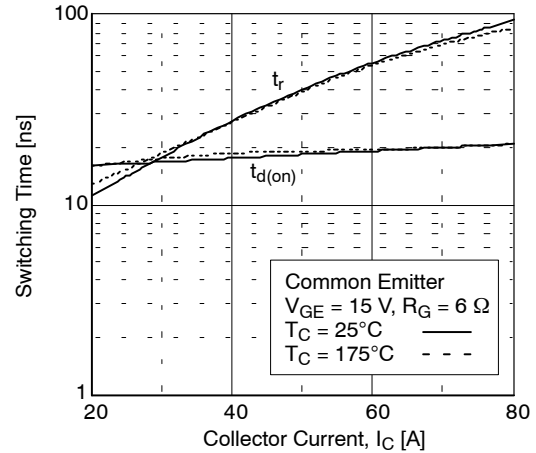


Figure 14. Turn-on Characteristics vs. Collector Current

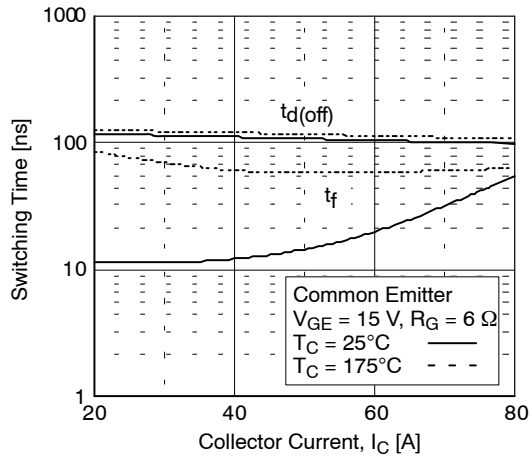


Figure 15. Turn-off Characteristics vs. Collector Current

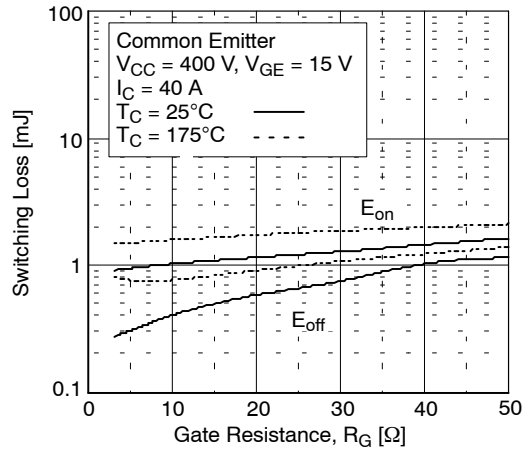


Figure 16. Switching Loss vs. Gate Resistance

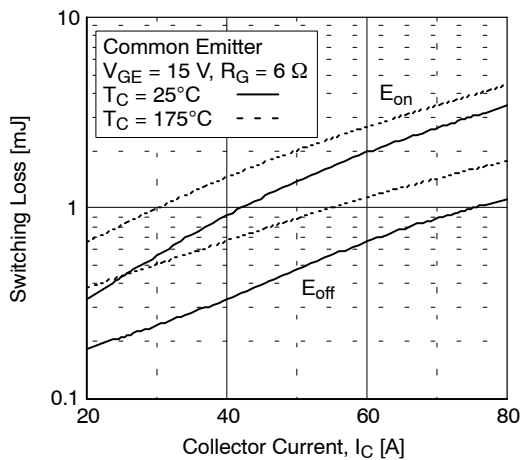


Figure 17. Switching Loss vs. Collector Current

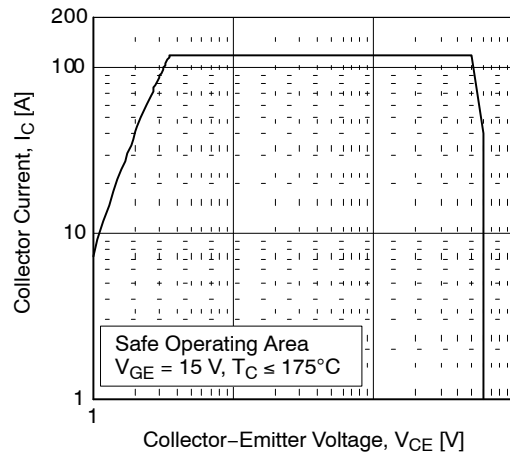


Figure 18. Turn-off Switching SOA Characteristics

TYPICAL CHARACTERISTICS

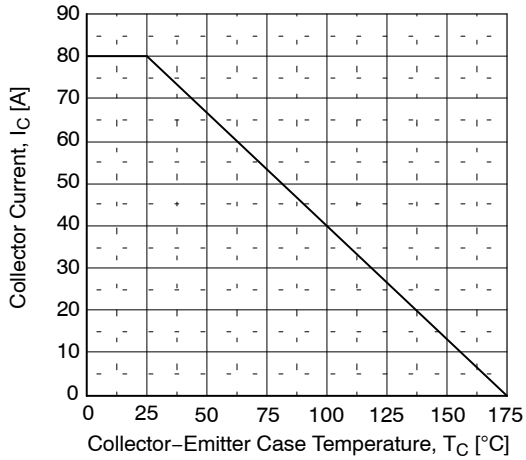


Figure 19. Current Derating

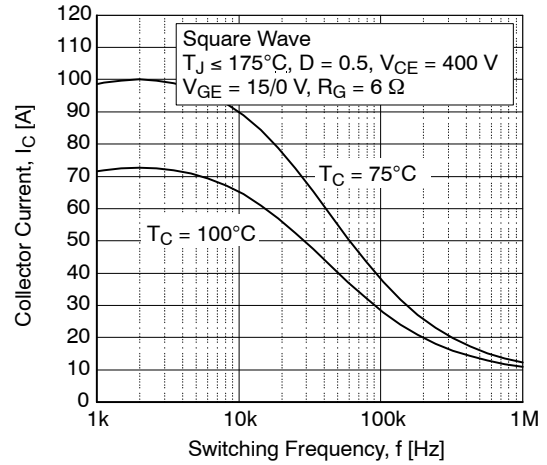


Figure 20. Load Current vs. Frequency

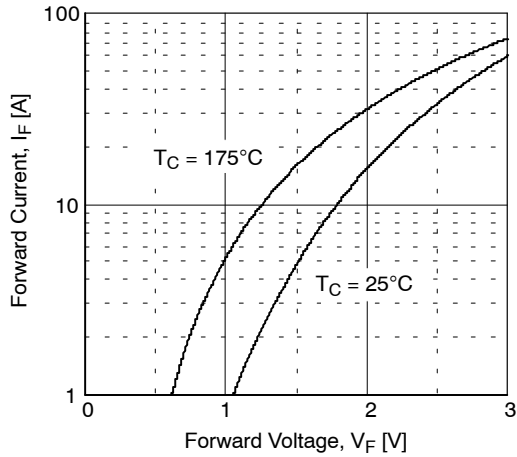


Figure 21. Forward Characteristics

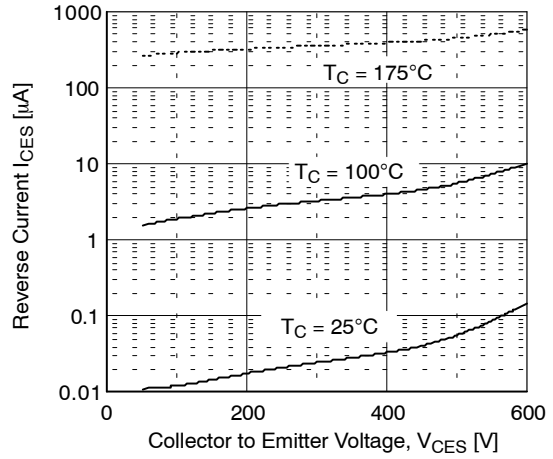


Figure 22. Reverse Current

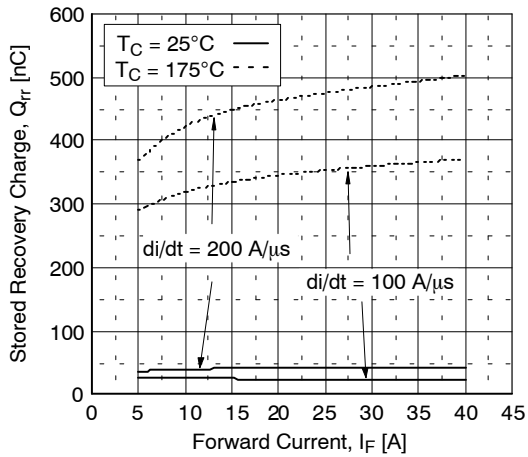


Figure 23. Stored Charge

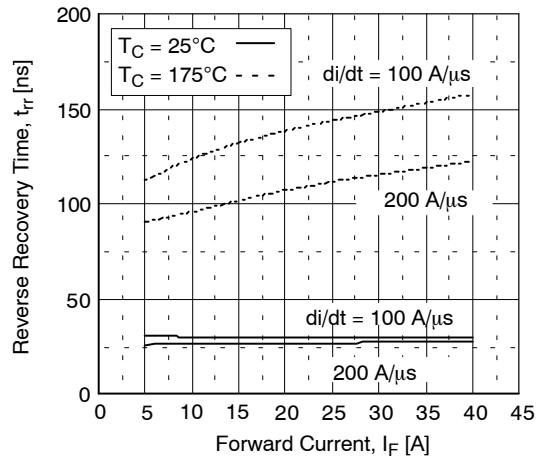


Figure 24. Reverse Recovery Time

FGH40N60SMD-F085

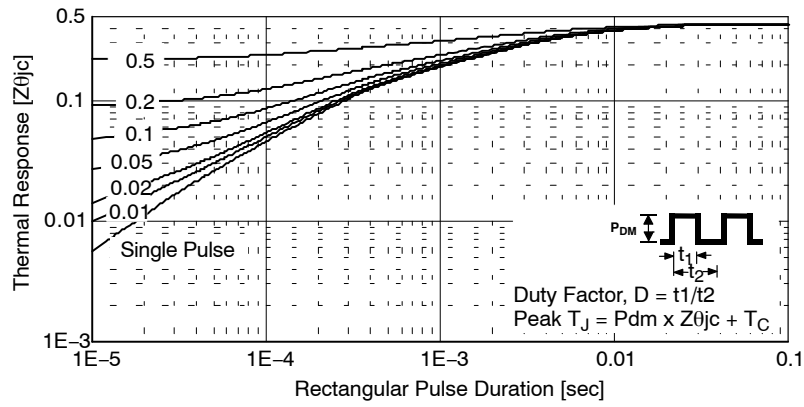


Figure 25. Transient Thermal Impedance of IGBT

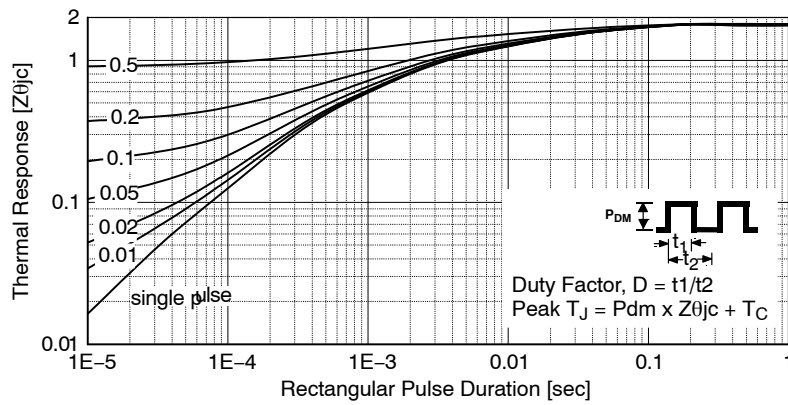
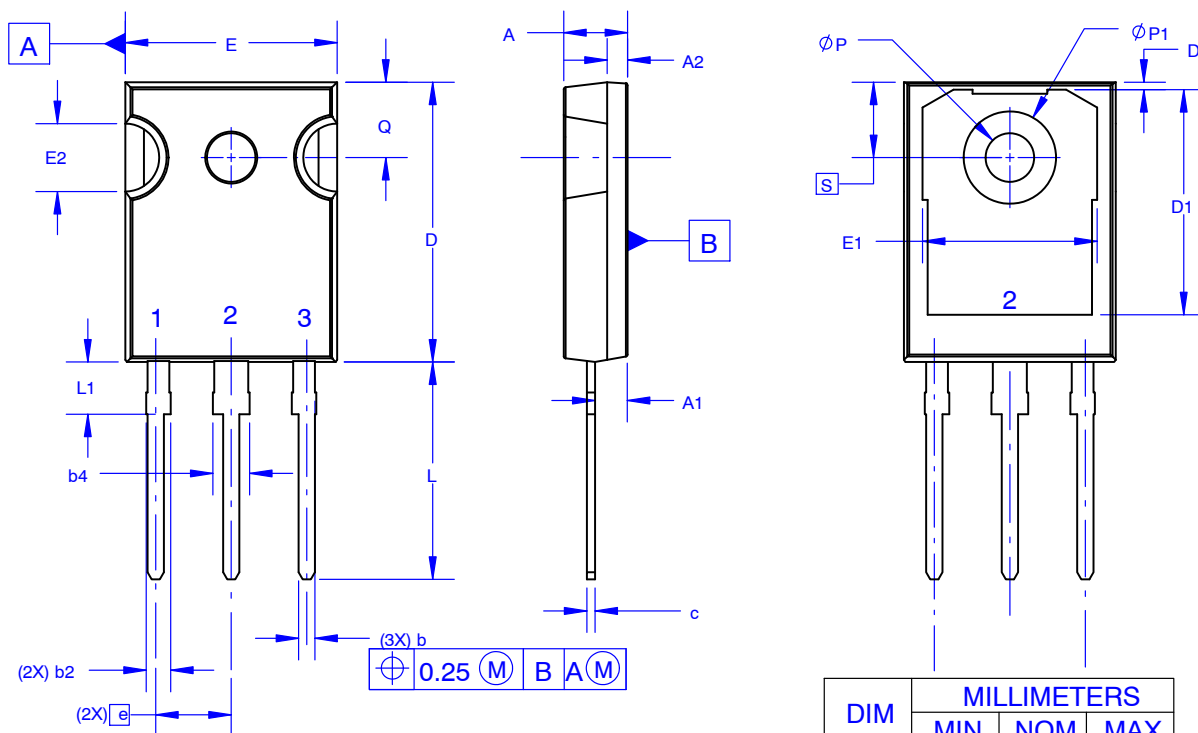


Figure 26. Transient Thermal Impedance of Diode

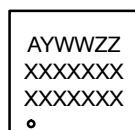
TO-247-3LD SHORT LEAD
CASE 340CK
ISSUE A

DATE 31 JAN 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
ZZ = Assembly Lot Code

*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	2.20	2.40	2.60
A2	1.40	1.50	1.60
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
D	20.32	20.57	20.82
D1	13.08	~	~
D2	0.51	0.93	1.35
E	15.37	15.62	15.87
E1	12.81	~	~
E2	4.96	5.08	5.20
e	~	5.56	~
L	15.75	16.00	16.25
L1	3.69	3.81	3.93
ϕP	3.51	3.58	3.65
$\phi P1$	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

DOCUMENT NUMBER:	98AON13851G	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	TO-247-3LD SHORT LEAD	PAGE 1 OF 1

onsemi and Onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at
www.onsemi.com/support/sales