

# IGBT - Field Stop 600 V, 40 A

## FGH40N60SMD-F085

### Description

Using Novel Field Stop IGBT Technology, ON Semiconductor'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	$V_{GES}$	$\pm 20$	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	$^\circ\text{C}$

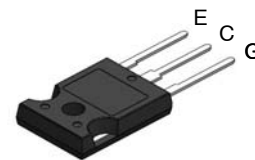
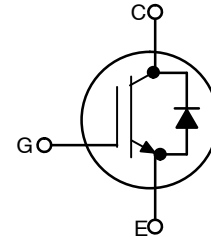
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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



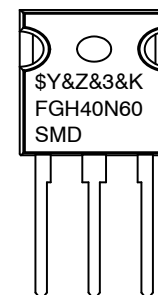
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TO-247-3LD  
CASE 340CK

### MARKING DIAGRAM



\$Y = ON Semiconductor 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

## THEMAL CHARACTERISTICS

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

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 ( $T_C = 25^{\circ}C$ unless otherwise noted)

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

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

### ON CHARACTERISTICS

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

### DYNAMIC CHARACTERISTICS

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

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400 V, I_C = 40 A, R_G = 6 \Omega, V_{GE} = 15 V, \text{Inductive Load}, T_C = 25^{\circ}C$	-	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
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400 V, I_C = 40 A, R_G = 6 \Omega, V_{GE} = 15 V, \text{Inductive Load}, T_C = 175^{\circ}C$	-	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

## 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
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	$V_{FM}$	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	2.3	2.8	V
			$T_C = 175^\circ\text{C}$	-	1.67	-	
Reverse Recovery Energy	$E_{rec}$	$I_F = 20\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 175^\circ\text{C}$	-	48.9	-	$\mu\text{J}$
Diode Reverse Recovery Time	$t_{rr}$		$T_C = 25^\circ\text{C}$	-	36	47	ns
			$T_C = 175^\circ\text{C}$	-	110	-	
Diode Reverse Recovery Charge	$Q_{rr}$		$T_C = 25^\circ\text{C}$	-	46.8	61	nC
		$T_C = 175^\circ\text{C}$	-	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

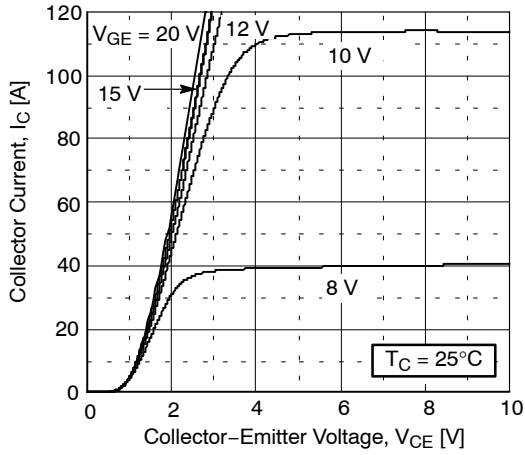


Figure 1. Typical Output Characteristics

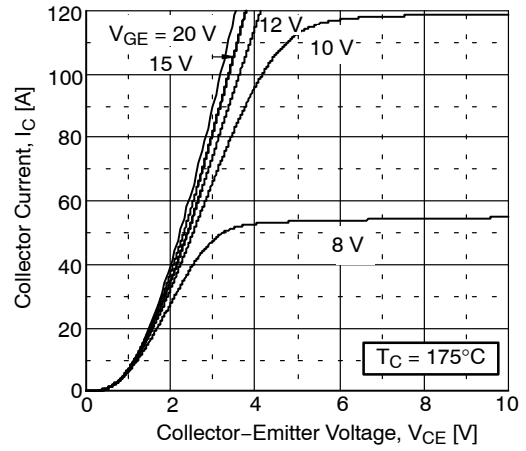


Figure 2. Typical Output Characteristics

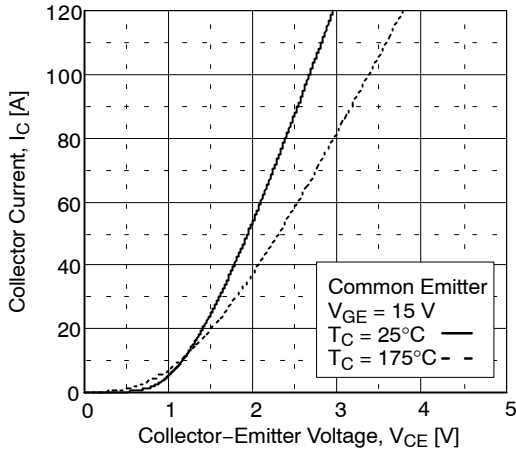


Figure 3. Typical Saturation Voltage Characteristics

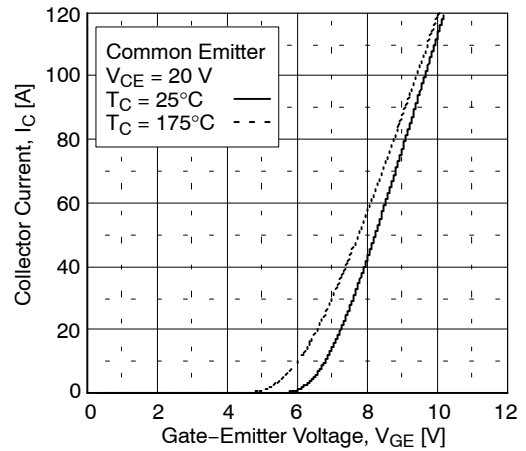


Figure 4. Transfer Characteristics

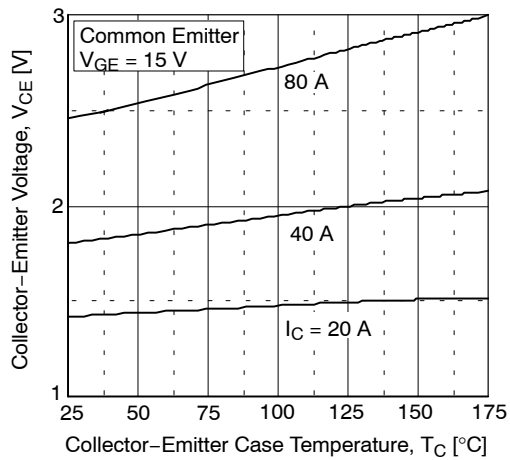


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

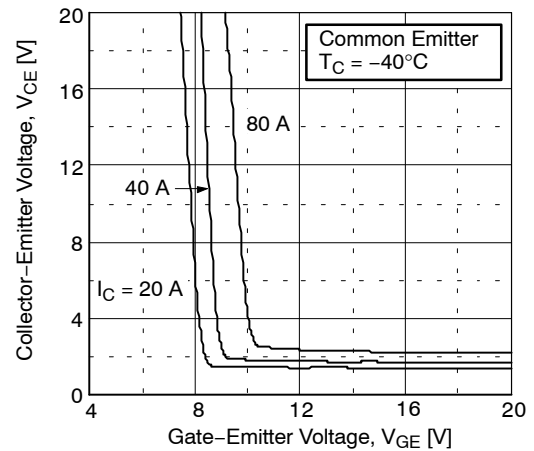


Figure 6. Saturation Voltage vs.  $V_{GE}$

TYPICAL CHARACTERISTICS

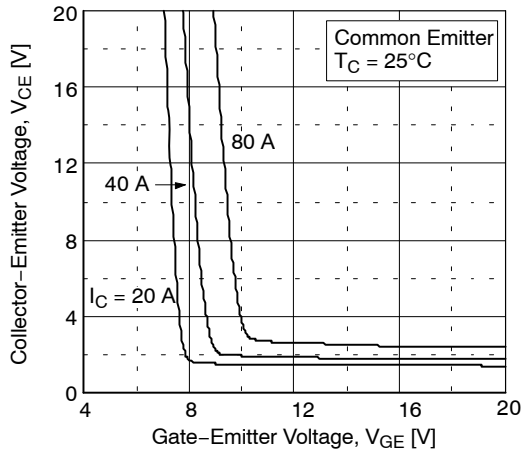


Figure 7. Saturation Voltage vs.  $V_{GE}$

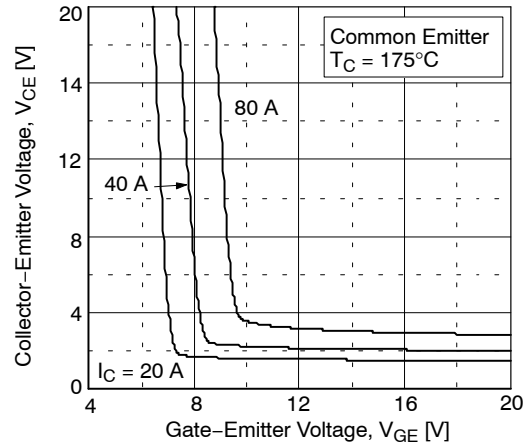


Figure 8. Saturation Voltage vs.  $V_{GE}$

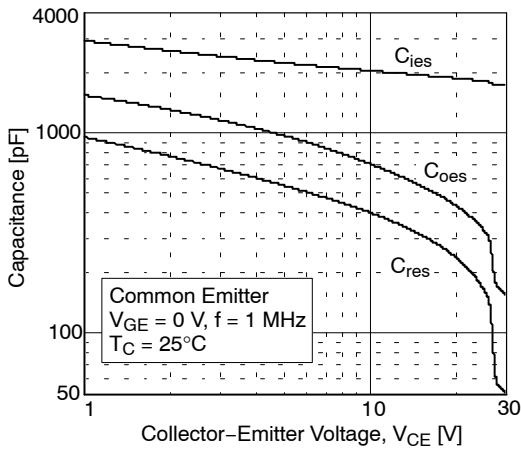


Figure 9. Capacitance Characteristics

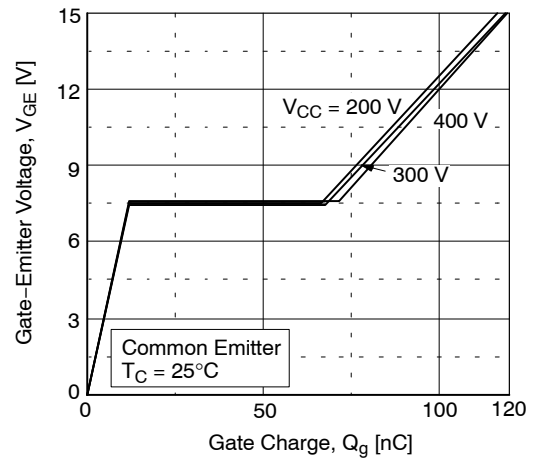


Figure 10. Gate Charge Characteristics

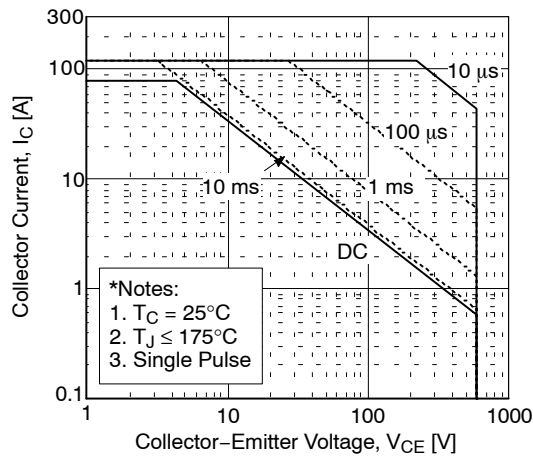


Figure 11. SOA Characteristics

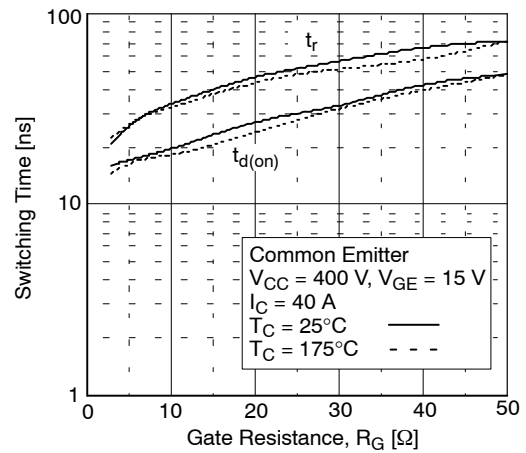


Figure 12. Turn-on Characteristics vs. Gate Resistance

TYPICAL CHARACTERISTICS

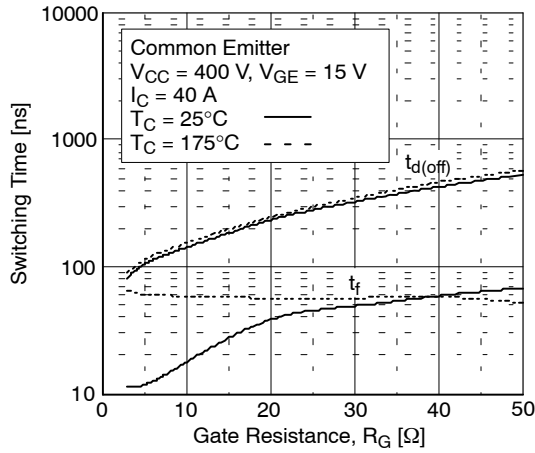


Figure 13. Turn-off Characteristics vs. Gate Resistance

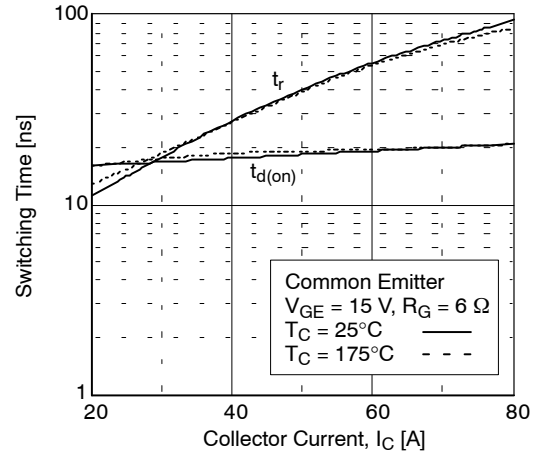


Figure 14. Turn-on Characteristics vs. Collector Current

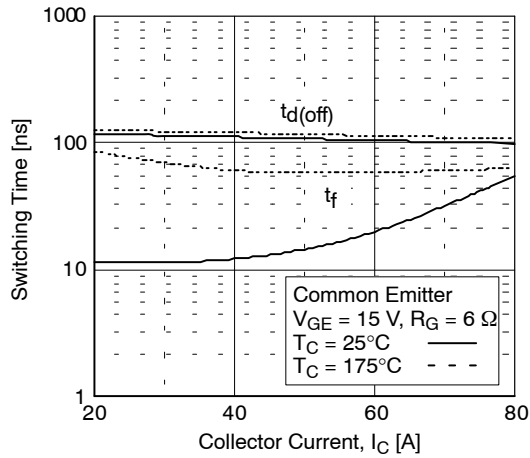


Figure 15. Turn-off Characteristics vs. Collector Current

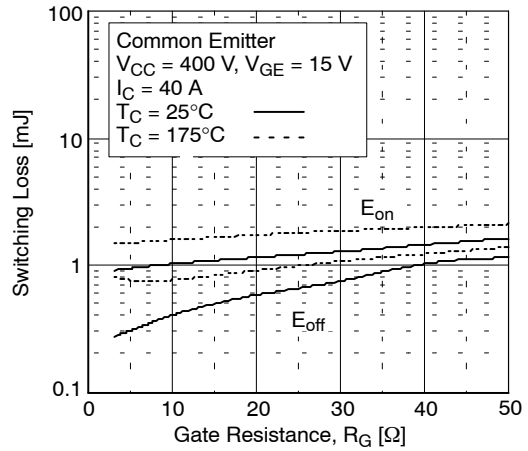


Figure 16. Switching Loss vs. Gate Resistance

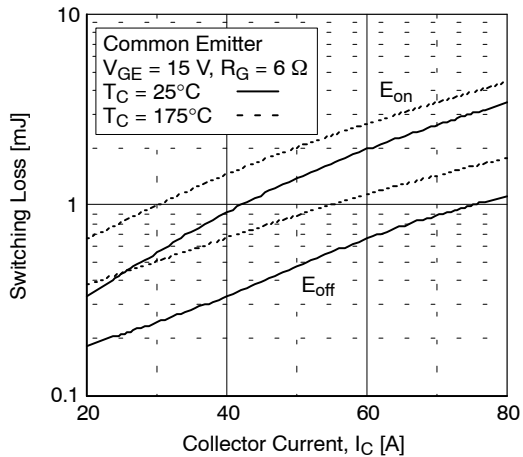


Figure 17. Switching Loss vs. Collector Current

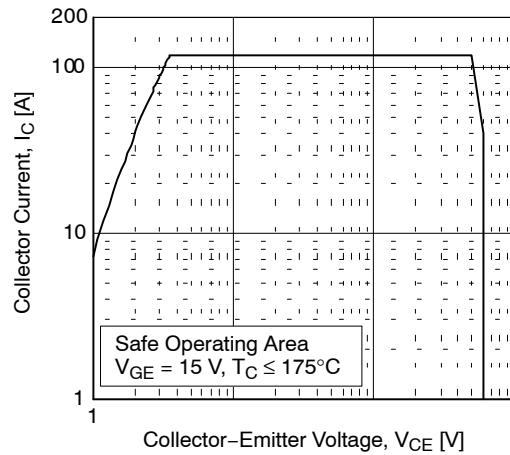


Figure 18. Turn-off Switching SOA Characteristics

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## TYPICAL CHARACTERISTICS

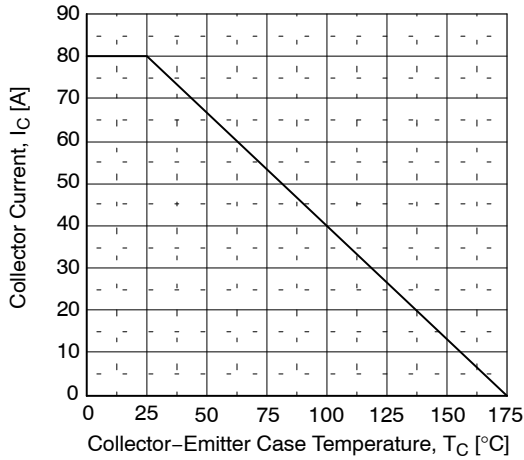


Figure 19. Current Derating

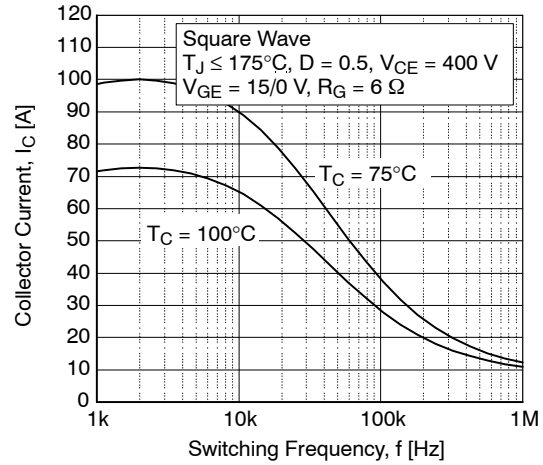


Figure 20. Load Current vs. Frequency

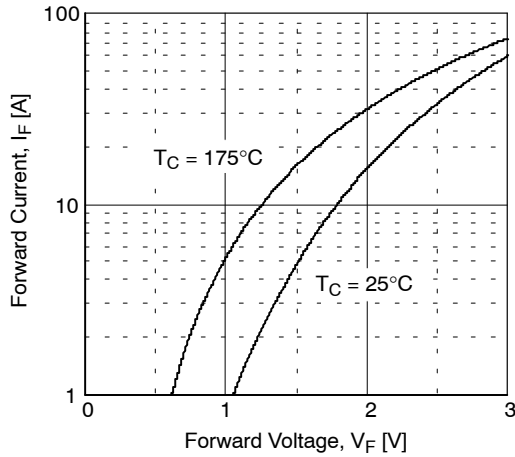


Figure 21. Forward Characteristics

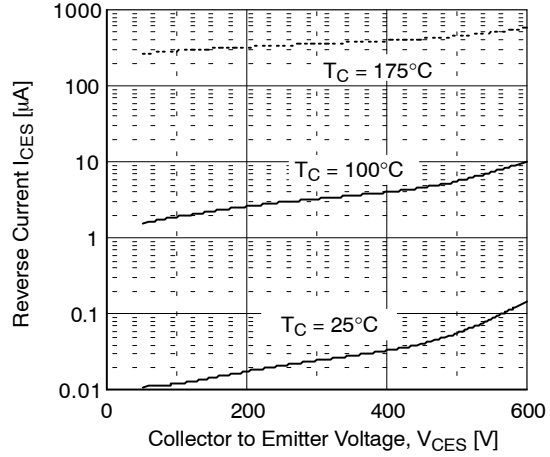


Figure 22. Reverse Current

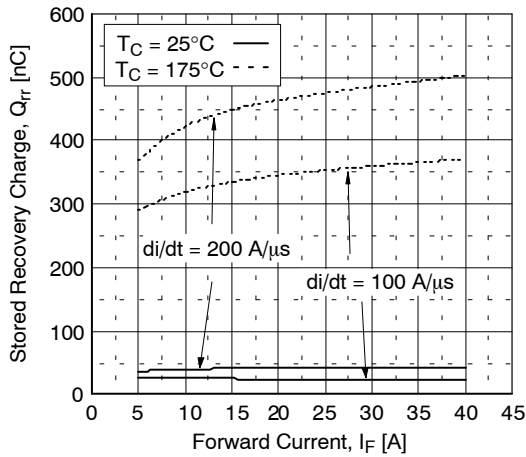


Figure 23. Stored Charge

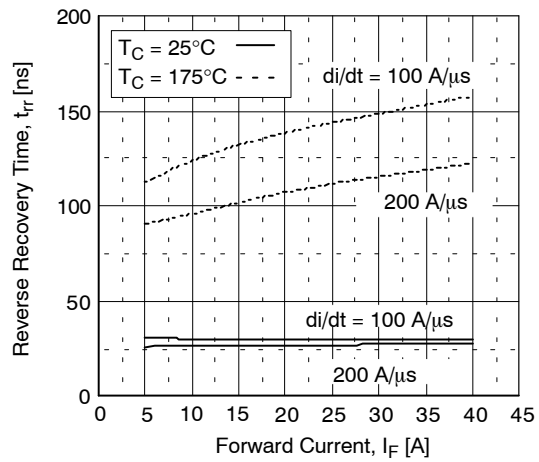


Figure 24. Reverse Recovery Time

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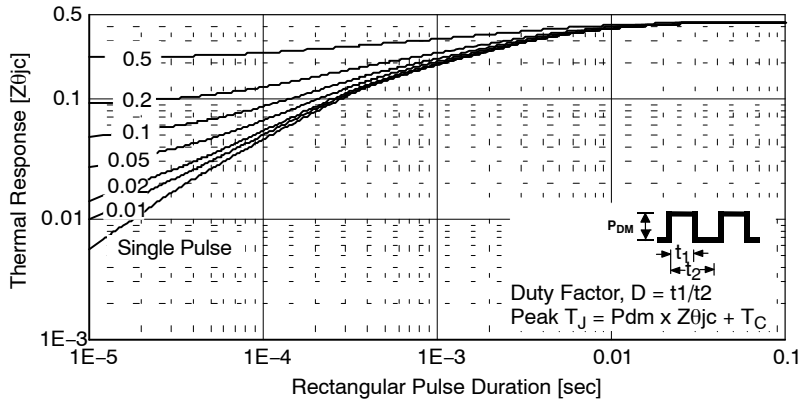


Figure 25. Transient Thermal Impedance of IGBT

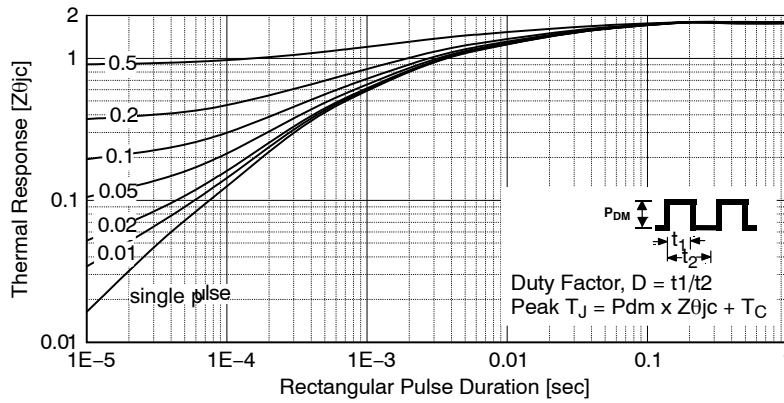
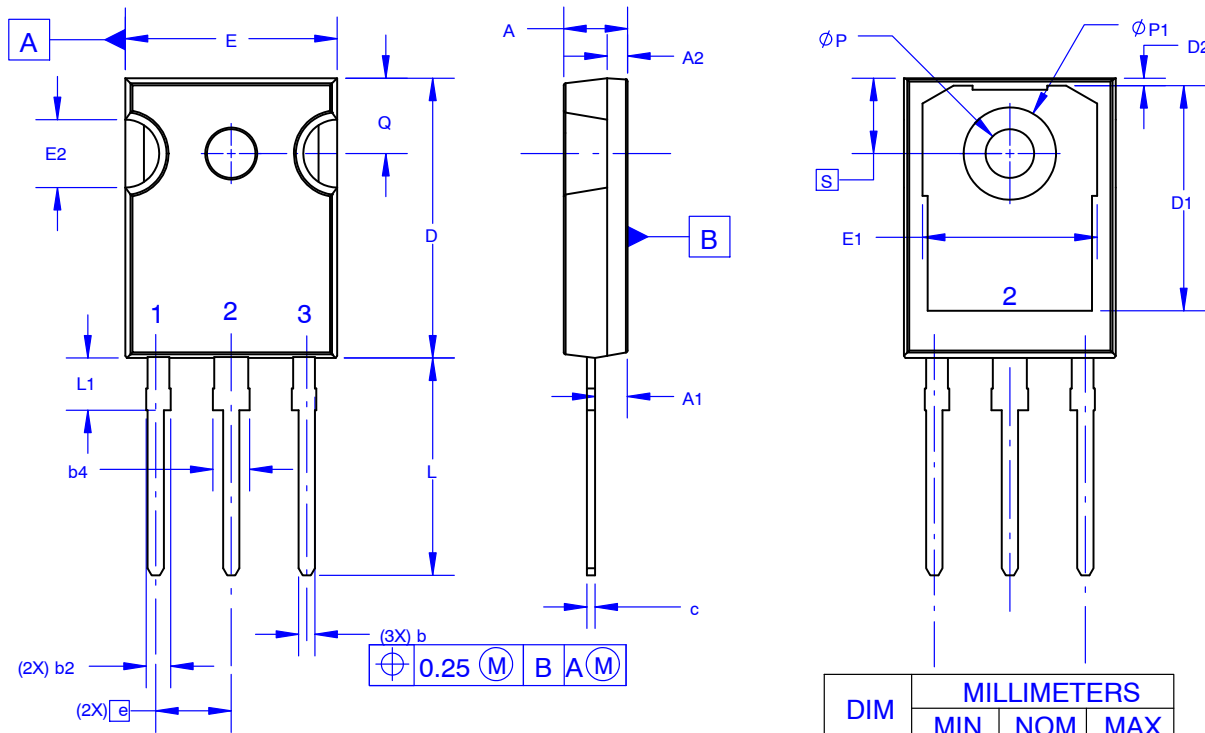


Figure 26. Transient Thermal Impedance of Diode



**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.

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