

# IGBT - Field Stop

## 600 V, 60 A

### FGH60N60SMD-F085

#### Description

Using Novel Field Stop IGBT Technology, ON Semiconductor's new series of Field Stop Trench IGBTs offer the optimum performance for Automotive chargers, Solar Inverter, UPS and Digital Power Generator 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:  $V_{CE(sat)} = 1.8\text{ V (Typ.) @ } I_C = 60\text{ A}$
- High Input Impedance
- Tightened Parameter Distribution
- This Device is Pb-Free and is RoHS Compliant
- Qualified to Automotive Requirements of AEC-Q101

#### Applications

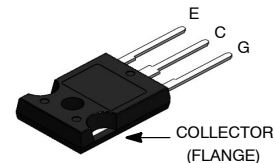
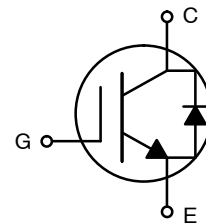
- Automotive Chargers, Converters, High Voltage Auxiliaries
- Solar Inverters, UPS, SMPS, PFC



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$V_{CES}$	$I_C$
600 V	60 A



TO-247-3LD  
CASE 340CK

#### MARKING DIAGRAM



\$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
FGH60N60SMD	= Specific Device Code

#### ORDERING INFORMATION

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

# FGH60N60SMD-F085

## ABSOLUTE MAXIMUM RATINGS

Symbol	Description	Ratings	Unit
$V_{CES}$	Collector to Emitter Voltage	600	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current	$T_C = 25^\circ\text{C}$	A
		$T_C = 100^\circ\text{C}$	A
$I_{CM}$ (Note 1)	Pulsed Collector Current	180	A
$I_F$	Diode Forward Current	$T_C = 25^\circ\text{C}$	A
		$T_C = 100^\circ\text{C}$	A
$I_{FM}$ (Note 1)	Pulsed Diode Maximum Forward Current	180	A
$P_D$	Maximum Power Dissipation	$T_C = 25^\circ\text{C}$	W
		$T_C = 100^\circ\text{C}$	W
$T_J$	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	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.

## THERMAL CHARACTERISTICS

Symbol	Parameter	Max.	Unit
$R_{\theta JC}$ (IGBT) (Note 2)	Thermal Resistance, Junction to Case	0.25	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case	1.1	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (PCB Mount) (Note 2)	45	$^\circ\text{C}/\text{W}$

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	Packing Method	Qty per Tube
FGH60N60SMD	FGH60N60SMD-F085	TO-247	Tube	30ea

# FGH60N60SMD-F085

## ELECTRICAL CHARACTERISTICS OF THE IGBT

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

$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{ V}, I_C = 250\ \mu\text{A}$	600	-	-	V
$\Delta BV_{CES} / \Delta T_J$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V}, I_C = 250\ \mu\text{A}$	-	0.22	-	V/°C
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0\text{ V}$	-	-	250	$\mu\text{A}$
		$I_{CES}$ at 80 % * $BV_{CES}$ , 175 °C	-	-	1100	
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$	-	-	±400	nA

### ON CHARACTERISTICS

$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250\ \mu\text{A}, V_{CE} = V_{GE}$	3.5	4.7	6.0	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 60\text{ A}, V_{GE} = 15\text{ V},$	-	1.8	2.5	V
		$I_C = 60\text{ A}, V_{GE} = 15\text{ V},$ $T_C = 175^\circ\text{C}$	-	2.14	-	V

### DYNAMIC CHARACTERISTICS

$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V},$ $f = 1\text{ MHz}$	-	2780	3700	pF
$C_{oes}$	Output Capacitance		-	260	345	pF
$C_{res}$	Reverse Transfer Capacitance		-	80	110	pF

### SWITCHING CHARACTERISTICS

$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 3\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 25^\circ\text{C}$	-	22	29	ns
$T_r$	Rise Time		-	46	60	ns
$T_{d(off)}$	Turn-Off Delay Time		-	116	151	ns
$T_f$	Fall Time		-	14	18	ns
$E_{on}$	Turn-On Switching Loss		-	1.59	2.23	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.39	0.55	mJ
$E_{ts}$	Total Switching Loss		-	1.98	2.78	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 60\text{ A},$ $R_G = 3\ \Omega, V_{GE} = 15\text{ V},$ Inductive Load, $T_C = 175^\circ\text{C}$	-	22	28	ns
$T_r$	Rise Time		-	44	58	ns
$T_{d(off)}$	Turn-Off Delay Time		-	124	161	ns
$T_f$	Fall Time		-	15	20	ns
$E_{on}$	Turn-On Switching Loss		-	2.41	3.13	mJ
$E_{off}$	Turn-Off Switching Loss		-	1.08	1.42	mJ
$E_{ts}$	Total Switching Loss		-	3.49	4.55	mJ
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}, I_C = 60\text{ A},$ $V_{GE} = 15\text{ V}$	-	187	280	nC
$Q_{ge}$	Gate to Emitter Charge		-	20	29	nC
$Q_{gc}$	Gate to Collector Charge		-	92	138	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.

## FGH60N60SMD-F085

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
$V_{FM}$	Diode Forward Voltage	$I_F = 30\text{ A}$	$T_C = 25^\circ\text{C}$	-	2.1	2.7	V
			$T_C = 175^\circ\text{C}$	-	1.48	-	
$T_{rr}$	Diode Reverse Recovery Time	$I_F = 30\text{ A},$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 25^\circ\text{C}$	-	33	42	ns
			$T_C = 175^\circ\text{C}$	-	115	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ\text{C}$	-	53	69	nC
			$T_C = 175^\circ\text{C}$	-	606	-	

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 PERFORMANCE CHARACTERISTICS

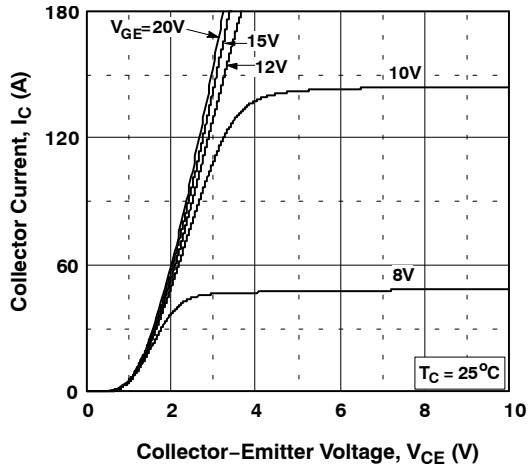


Figure 1. Typical Output Characteristics

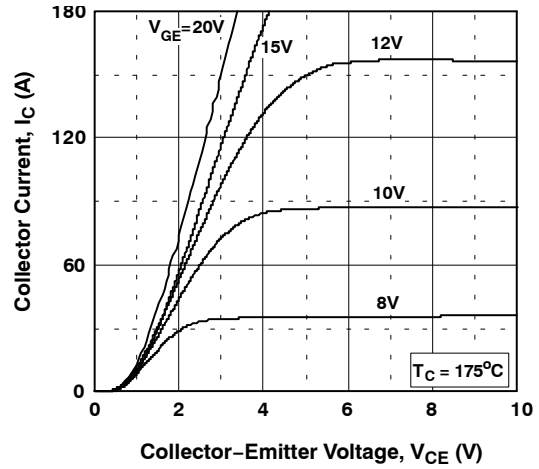


Figure 2. Typical Output Characteristics

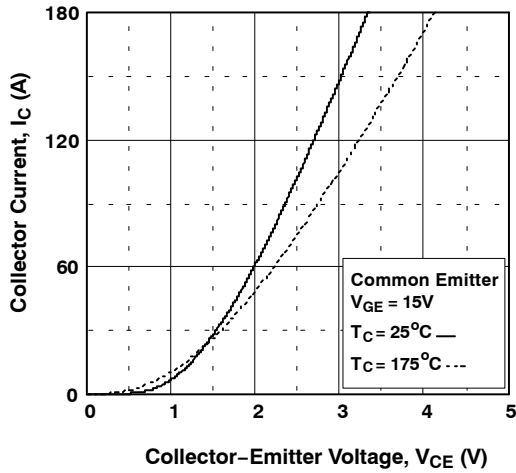


Figure 3. Typical Saturation Voltage Characteristics

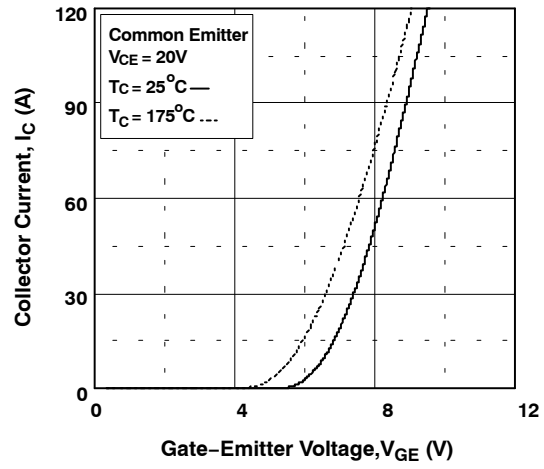


Figure 4. Transfer Characteristics

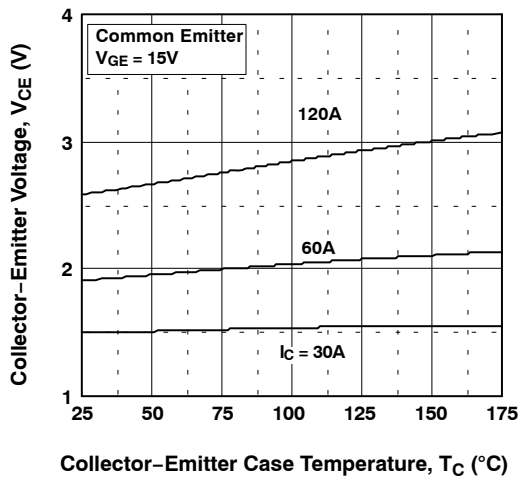


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

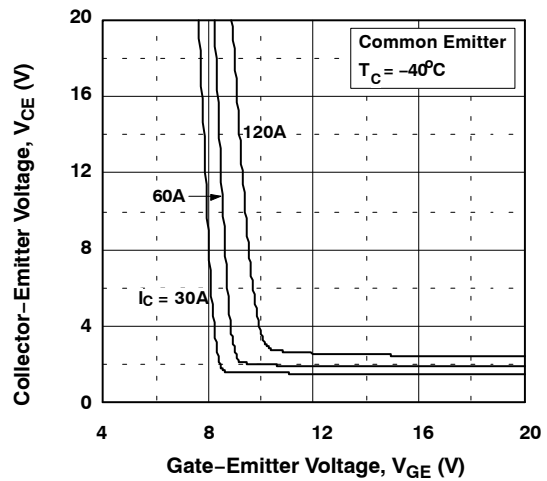


Figure 6. Saturation Voltage vs. Vge

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

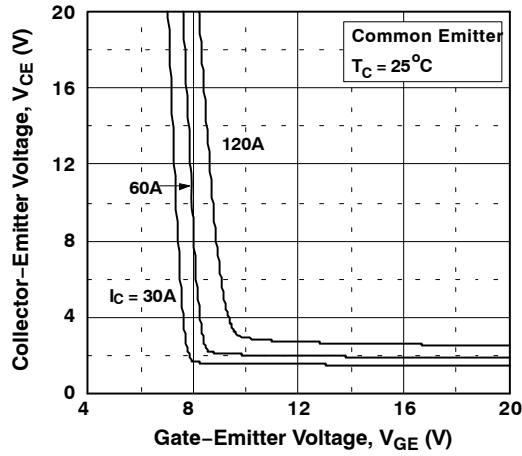


Figure 7. Saturation Voltage vs.  $V_{GE}$

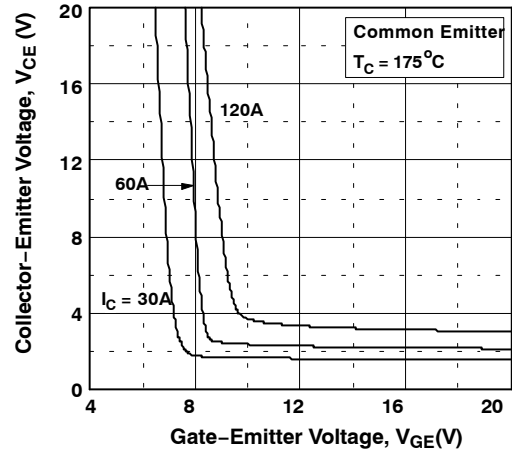


Figure 8. Saturation Voltage vs.  $V_{GE}$

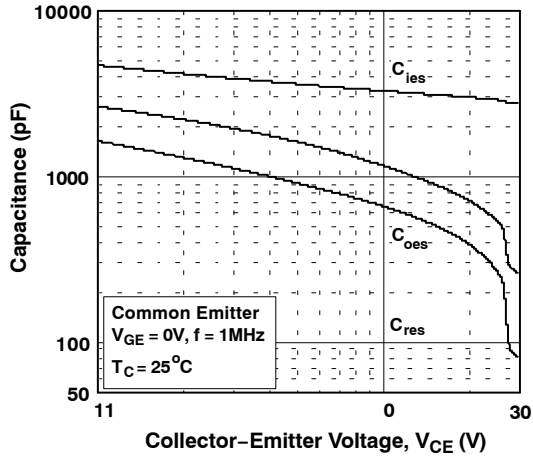


Figure 9. Capacitance Characteristics

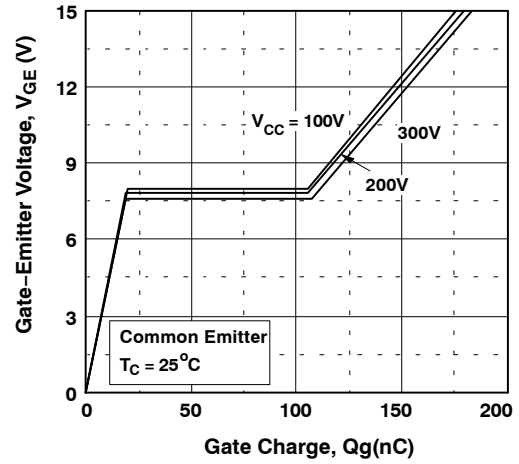


Figure 10. Gate Charge Characteristics

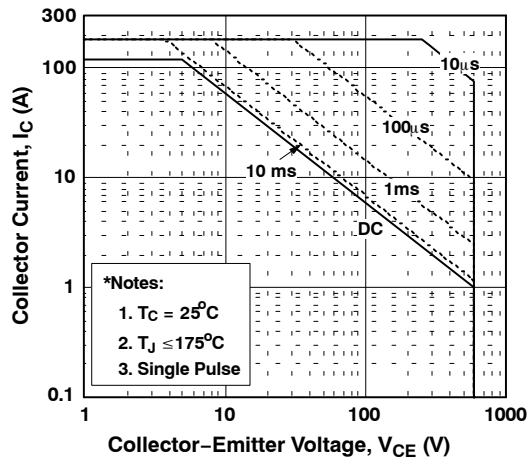


Figure 11. SOA Characteristics

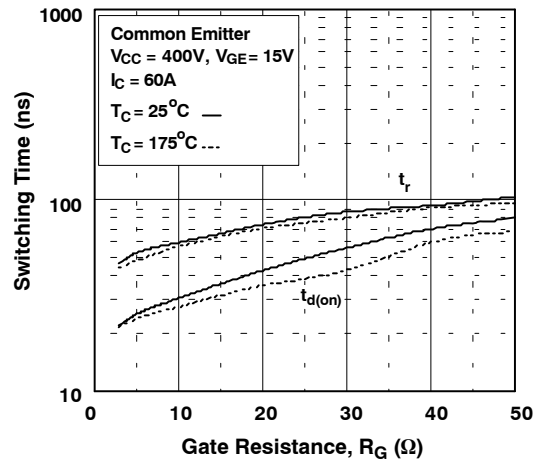


Figure 12. Turn-on Characteristics vs. Gate Resistance

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

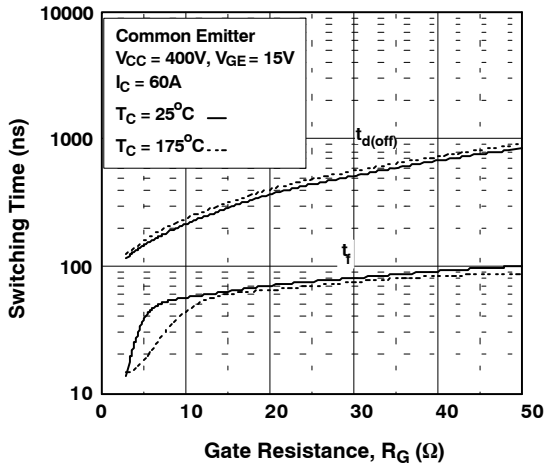


Figure 13. Turn-off Characteristics vs. Gate Resistance

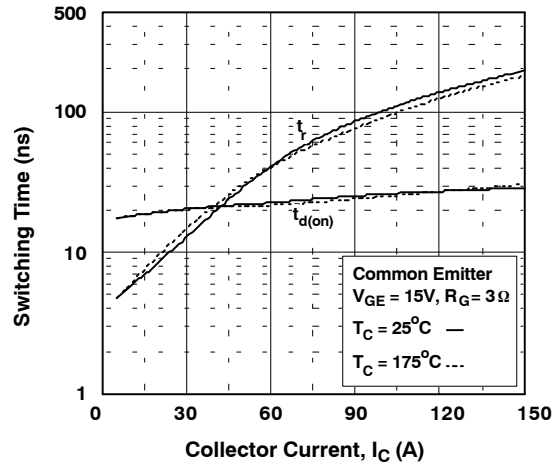


Figure 14. Turn-on Characteristics vs. Collector Current

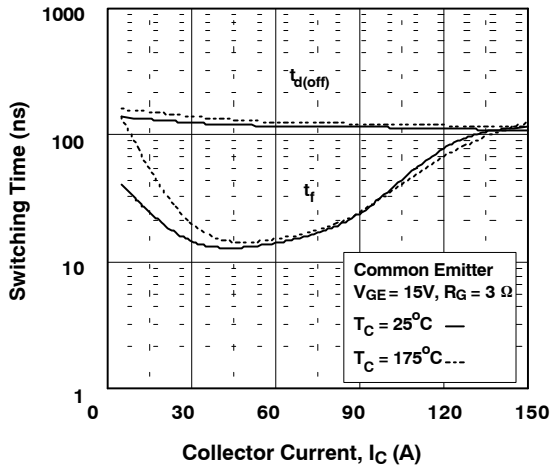


Figure 15. Turn-off Characteristics vs. Collector Current

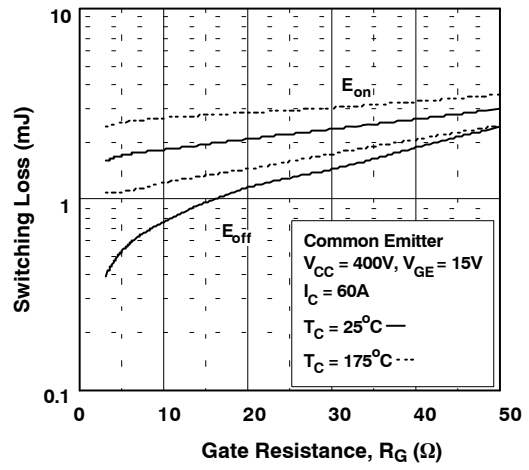


Figure 16. Switching Loss vs. Gate Resistance

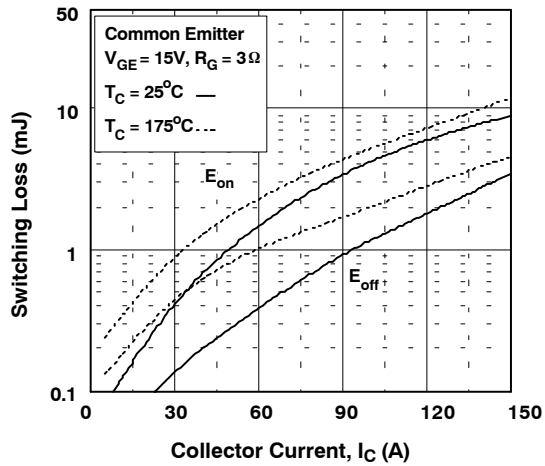


Figure 17. Switching Loss vs. Collector Current

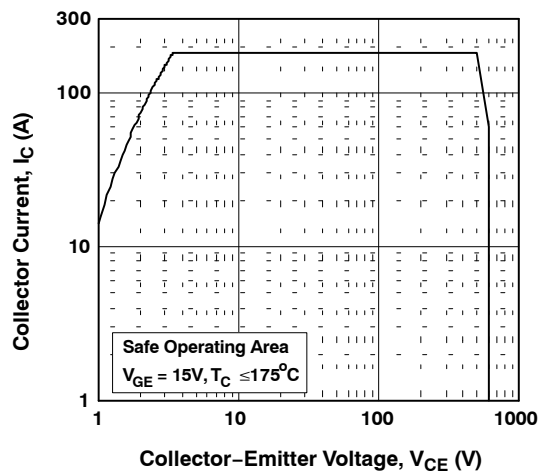


Figure 18. Turn Off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

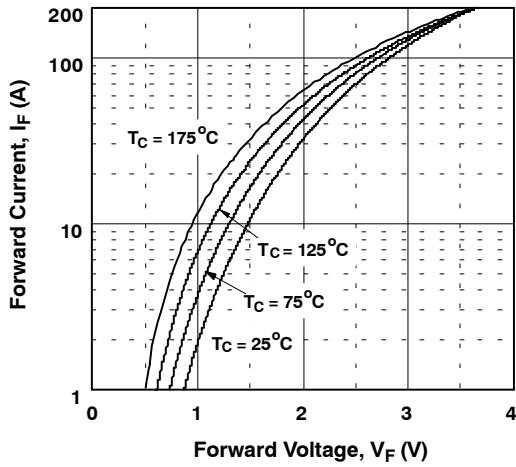


Figure 19. Forward Characteristics

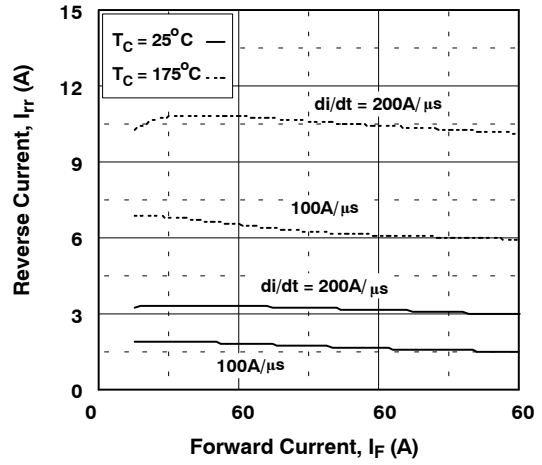


Figure 20. Reverse Recovery Current

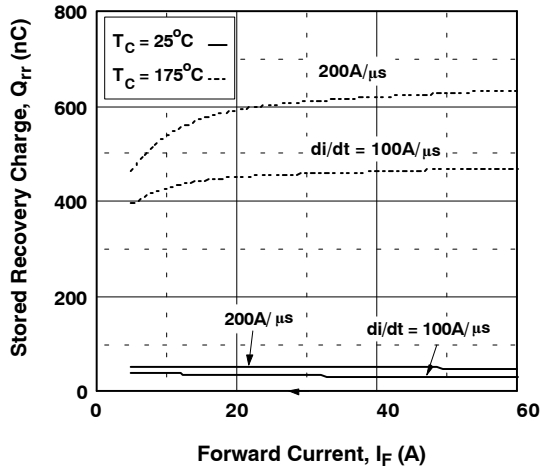


Figure 21. Stored Charge

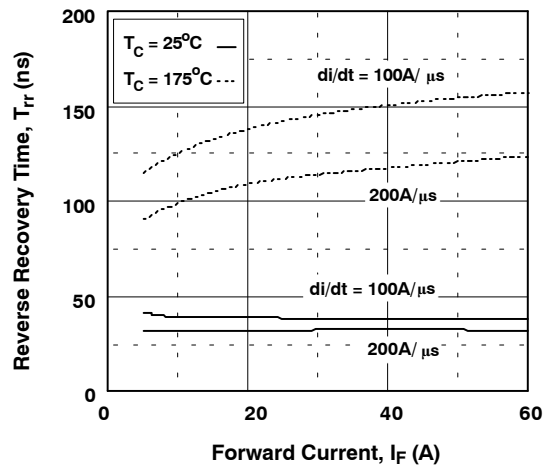


Figure 22. Reverse Recovery Time

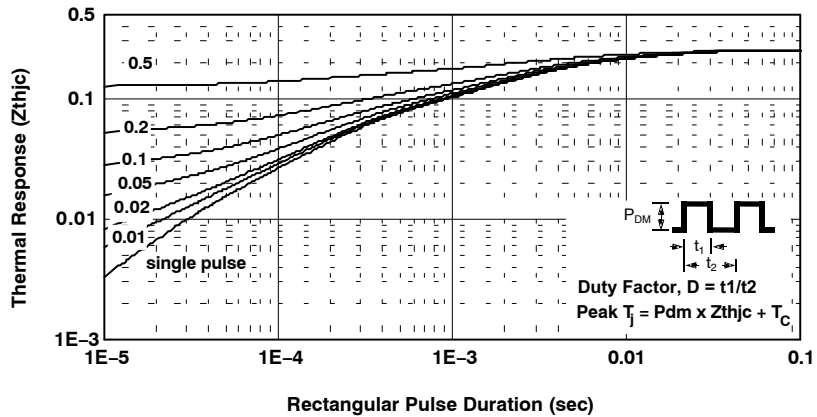


Figure 23. Transient Thermal Impedance of IGBT





**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
ØP	3.51	3.58	3.65
ØP1	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

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