

# IGBT - Field Stop

600 V, 40 A

## FGH40N60SMDF

### Description

Using Novel Field Stop IGBT Technology, ON Semiconductor's new series of field stop 2<sup>nd</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:  $V_{CE(sat)} = 1.9\text{ V (Typ.) @ } I_C = 40\text{ A}$
- High Input Impedance
- Fast Switching:  $E_{OFF} = 6.5\text{ }\mu\text{J/A}$
- Tightened Parameter Distribution
- This Device is Pb-Free, Halogen Free/BFR Free and is RoHS Compliant

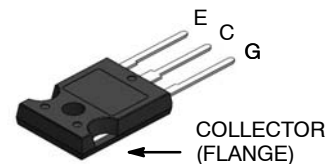
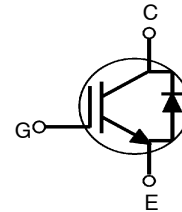
### Applications

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



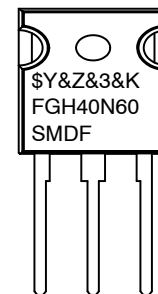
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TO-247-3LD  
CASE 340CK

### MARKING DIAGRAMS



\$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
FGH40N60SMDF	= Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# FGH40N60SMDF

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C, unless otherwise specified)

Parameter		Symbol	Ratings	Unit
Collector to Emitter Voltage		V <sub>CES</sub>	600	V
Gate to Emitter Voltage		V <sub>GES</sub>	±20	V
Collector Current	T <sub>C</sub> = 25°C	I <sub>C</sub>	80	A
Collector Current	T <sub>C</sub> = 100°C		40	A
Pulsed Collector Current (Note 1)	T <sub>C</sub> = 25°C	I <sub>CM</sub>	120	A
Maximum Power Dissipation	T <sub>C</sub> = 25°C	P <sub>D</sub>	349	W
Maximum Power Dissipation	T <sub>C</sub> = 100°C		174	W
Operating Junction Temperature		T <sub>J</sub>	–55 to +175	°C
Storage Temperature Range		T <sub>stg</sub>	–55 to +175	°C
Maximum Lead Temp. for Soldering Purposes, 1/8" from Case for 5 Seconds		T <sub>L</sub>	300	°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

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case (IGBT)	R <sub>θJC</sub>	0.43	°C/W
Thermal Resistance, Junction to Case (Diode)	R <sub>θJC</sub>	1.45	°C/W
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	40	°C/W

## PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FGH40N60SMDF	FGH40N60SMDF	TO-247-3LD	N/A	N/A	30

## ELECTRICAL CHARACTERISTICS OF THE IGBT (T<sub>C</sub> = 25°C unless otherwise noted)

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

Collector to Emitter Breakdown Voltage	BV <sub>CES</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	600	–	–	V
Temperature Coefficient of Breakdown Voltage	ΔBV <sub>CES</sub> / ΔT <sub>J</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA	–	0.6	–	V/°C
Collector Cut-Off Current	I <sub>CES</sub>	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V	–	–	250	μA
G–E Leakage Current	I <sub>GES</sub>	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V	–	–	±400	nA

### ON CHARACTERISTICS

G–E Threshold Voltage	V <sub>GE(th)</sub>	I <sub>C</sub> = 250 μA, V <sub>CE</sub> = V <sub>GE</sub>	3.5	4.6	6.0	V
Collector to Emitter Saturation Voltage	V <sub>CE(sat)</sub>	I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	–	1.9	2.5	V
		I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 150°C	–	2.1	–	V

# FGH40N60SMDF

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ies}$	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	–	1880	–	pF
Output Capacitance	$C_{oes}$		–	180	–	pF
Reverse Transfer Capacitance	$C_{res}$		–	50	–	pF

## SWITCHING CHARACTERISTICS

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, $T_C = 25^\circ\text{C}$	–	12	–	ns
Rise Time	$t_r$		–	20	–	ns
Turn-Off Delay Time	$t_{d(off)}$		–	92	–	ns
Fall Time	$t_f$		–	13	20	ns
Turn-On Switching Loss	$E_{on}$		–	1.3	–	mJ
Turn-Off Switching Loss	$E_{off}$		–	0.26	–	mJ
Total Switching Loss	$E_{ts}$		–	1.56	–	mJ
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, $T_C = 150^\circ\text{C}$	–	12	–	ns
Rise Time	$t_r$		–	19	–	ns
Turn-Off Delay Time	$t_{d(off)}$		–	97	–	ns
Fall Time	$t_f$		–	14	21	ns
Turn-On Switching Loss	$E_{on}$		–	2.09	–	mJ
Turn-Off Switching Loss	$E_{off}$		–	0.44	–	mJ
Total Switching Loss	$E_{ts}$		–	2.53	–	mJ
Total Gate Charge	$Q_g$	$V_{CE} = 400\text{ V}, I_C = 40\text{ A},$ $V_{GE} = 15\text{ V}$	–	119	–	nC
Gate to Emitter Charge	$Q_{ge}$		–	13	–	nC
Gate to Collector Charge	$Q_{gc}$		–	58	–	nC

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

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Diode Forward Voltage	V <sub>FM</sub>	I <sub>F</sub> = 20 A	T <sub>C</sub> = 25°C	–	1.3	1.7	V
			T <sub>C</sub> = 150°C	–	1.2	–	
Diode Reverse Recovery Time	t <sub>rr</sub>	I <sub>F</sub> = 20 A, di <sub>F</sub> /dt = 200 A/μs	T <sub>C</sub> = 25°C	–	70	90	ns
			T <sub>C</sub> = 150°C	–	126	–	
Diode Reverse Recovery Charge	Q <sub>rr</sub>		T <sub>C</sub> = 25°C	–	207	290	nC
			T <sub>C</sub> = 150°C	–	638	–	

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

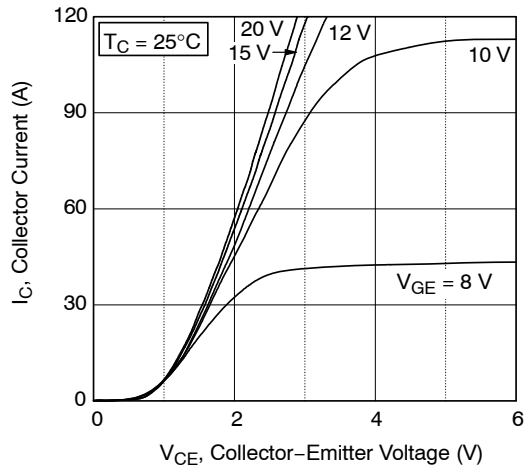


Figure 1. Typical Output Characteristics

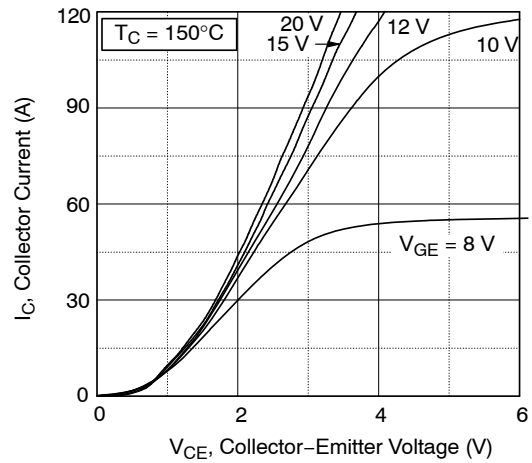


Figure 2. Typical Output Characteristics

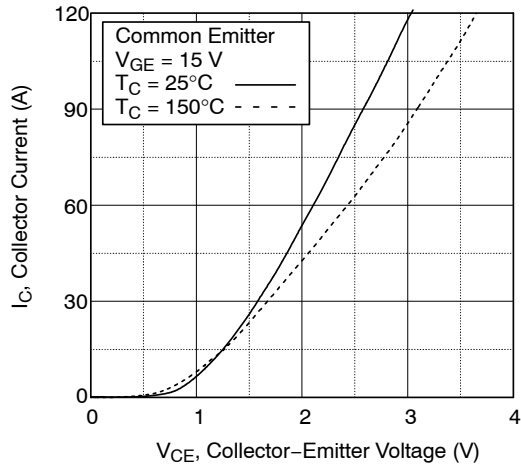


Figure 3. Typical Saturation Voltage Characteristics

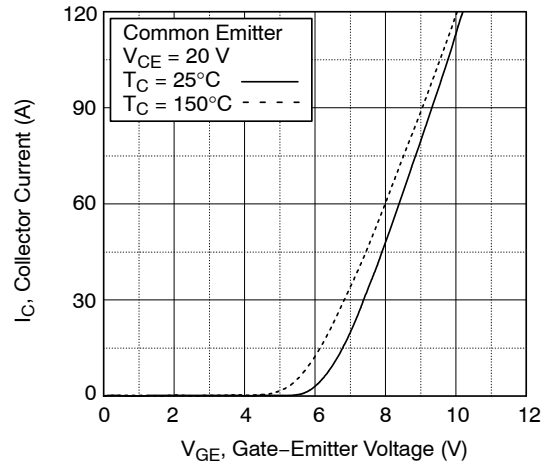


Figure 4. Transfer Characteristics

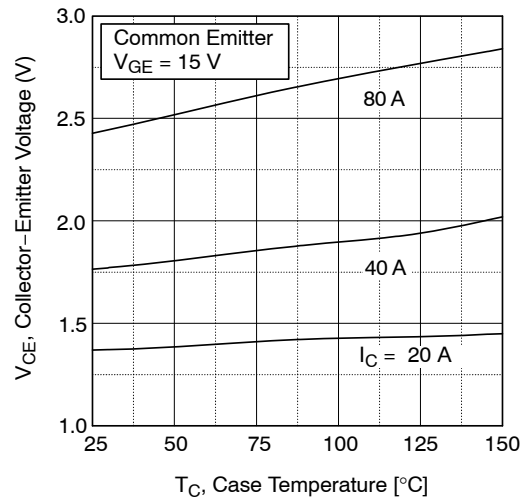


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

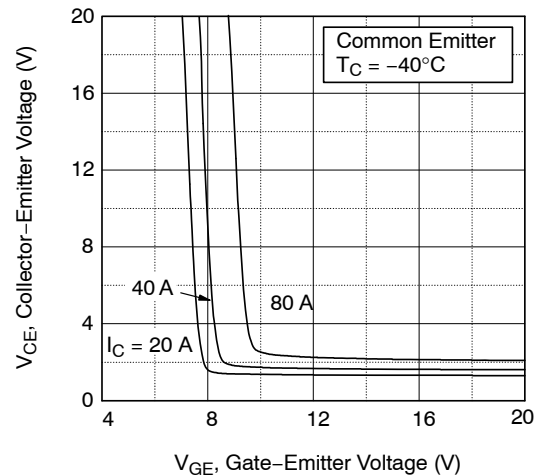


Figure 6. Saturation Voltage vs  $V_{GE}$

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

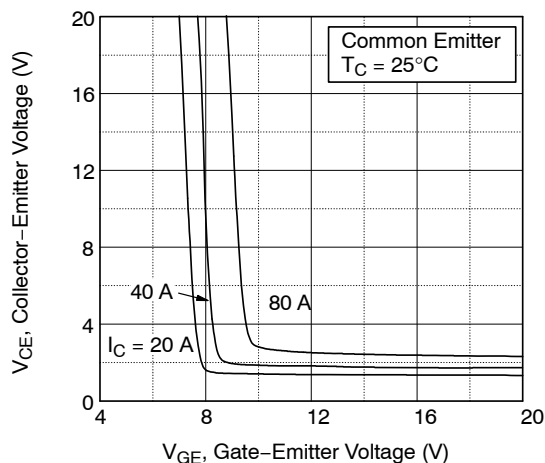


Figure 7. Saturation Voltage vs.  $V_{GE}$

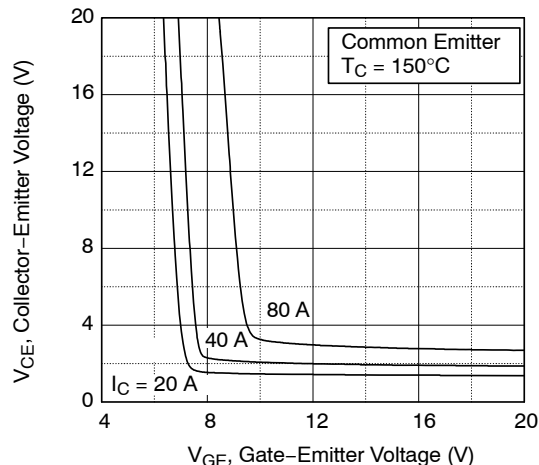


Figure 8. Saturation Voltage vs.  $V_{GE}$

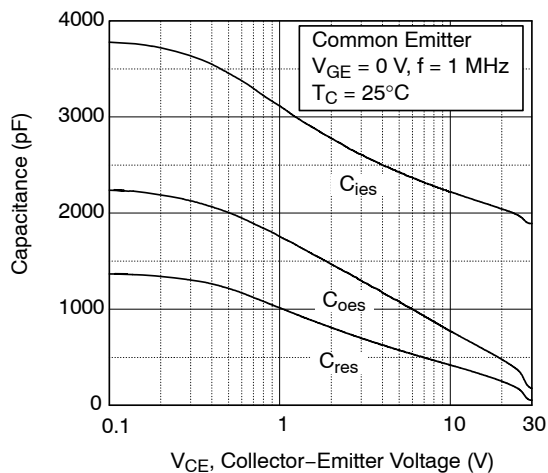


Figure 9. Capacitance Characteristics

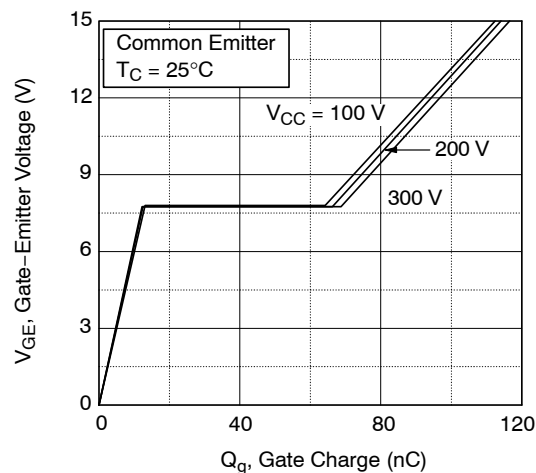


Figure 10. Gate Charge Characteristics

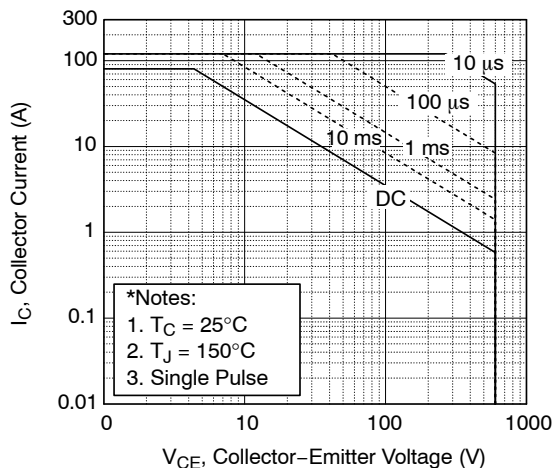


Figure 11. SOA Characteristics

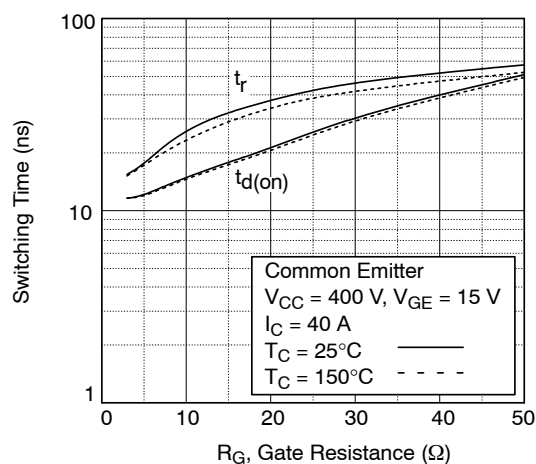


Figure 12. Turn-On Characteristics vs. Gate Resistance

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

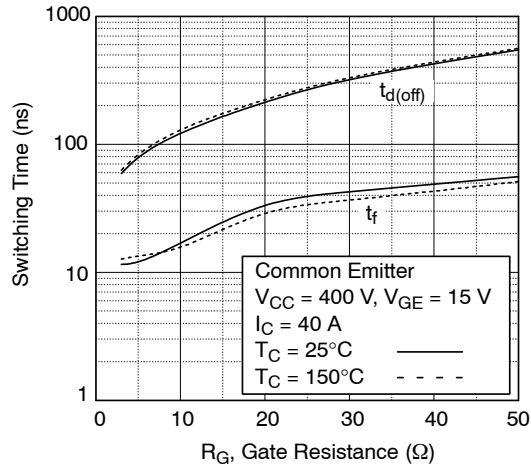


Figure 13. Turn-Off Characteristics vs. Gate Resistance

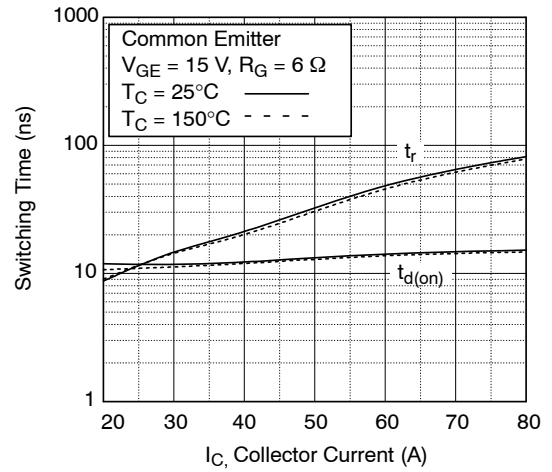


Figure 14. Turn-On Characteristics vs. Collector Current

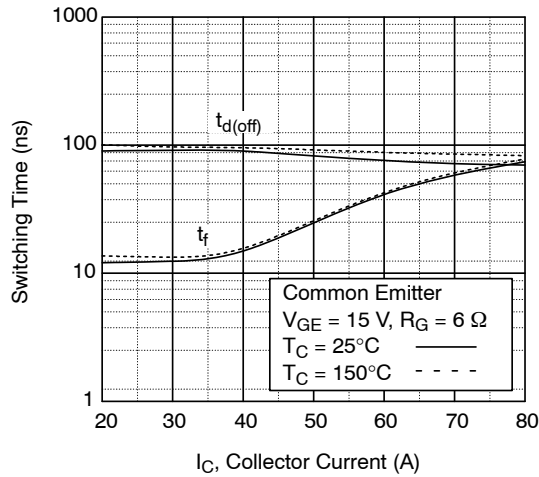


Figure 15. Turn-Off Characteristics vs. Collector Current

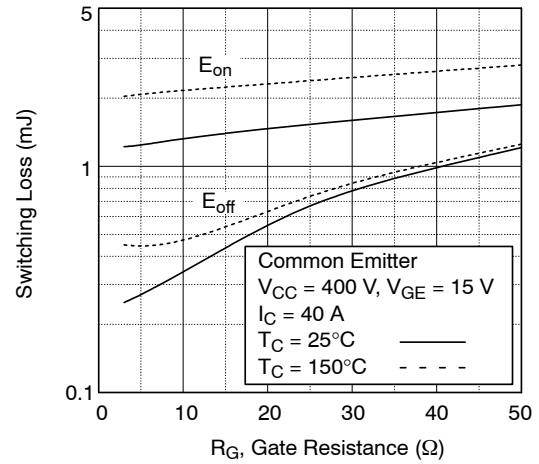


Figure 16. Switching Loss vs. Gate Resistance

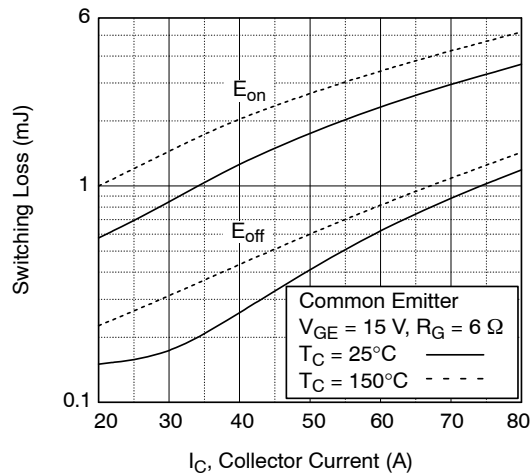


Figure 17. Switching Loss vs. Collector Current

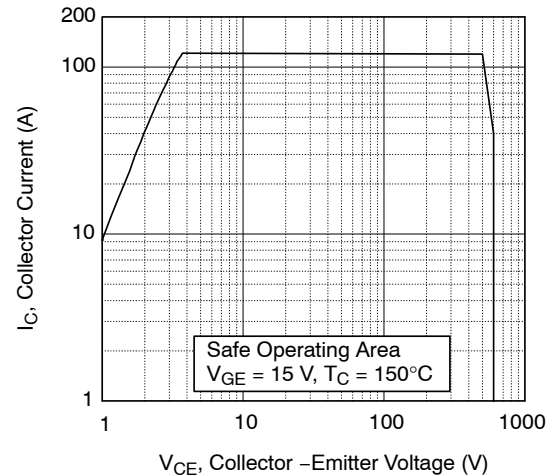


Figure 18. Turn-Off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

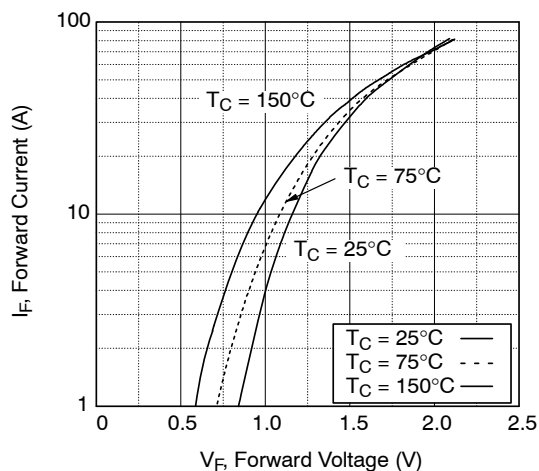


Figure 19. Forward Characteristics

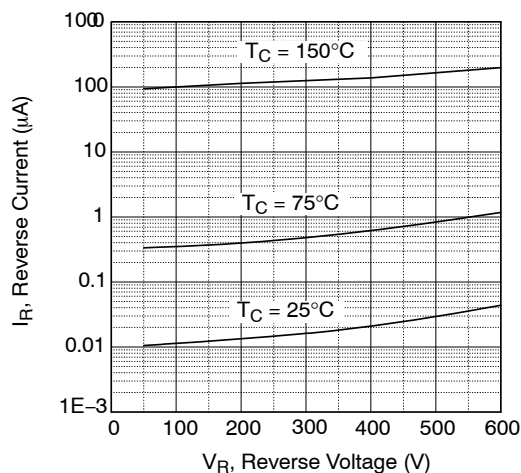


Figure 20. Reverse Current

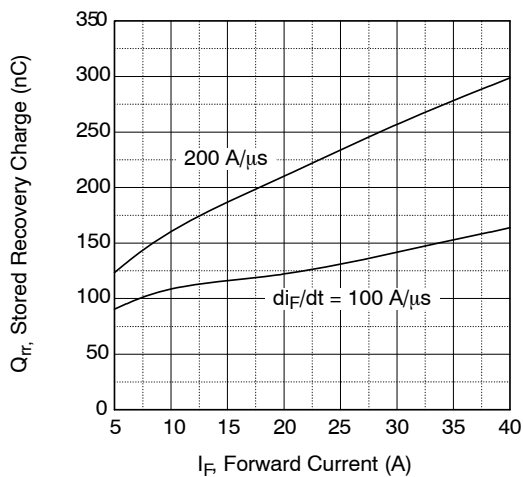


Figure 21. Stored Charge

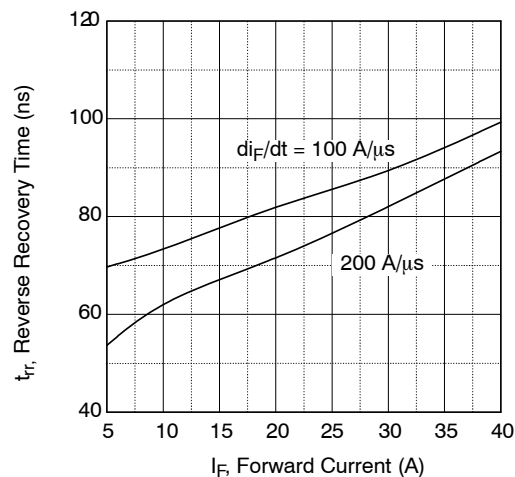


Figure 22. Reverse Recovery Time

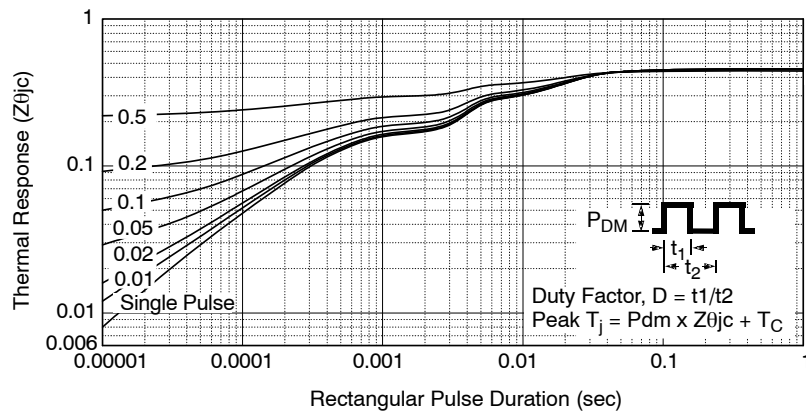
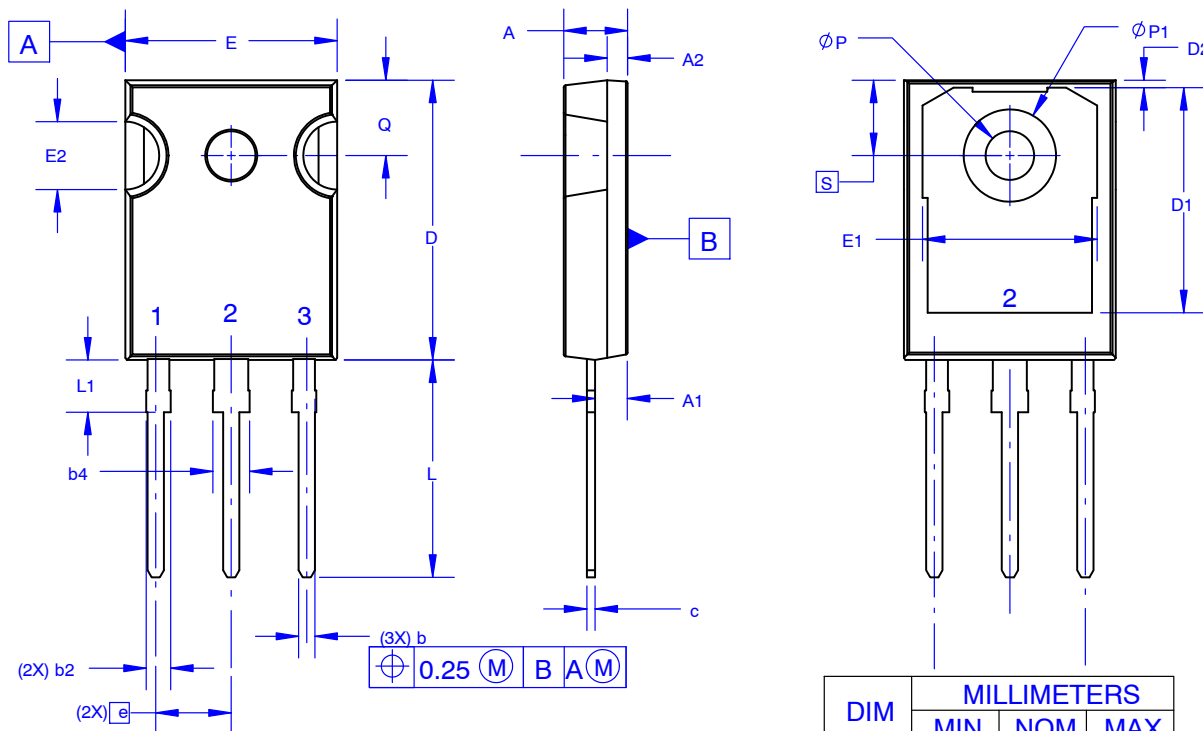


Figure 23. Transient Thermal Impedance of IGBT

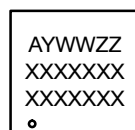
**TO-247-3LD SHORT LEAD**  
**CASE 340CK**  
**ISSUE A**

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
$\phi P$	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

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