



ON Semiconductor®

FGH60N60SMD-F085 600V, 60A Field Stop IGBT

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
- RoHS compliant
- Qualified to Automotive Requirements of AEC-Q101

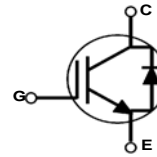
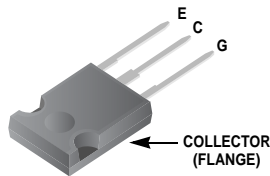


General Description

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.

Applications

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



Absolute Maximum Ratings

Symbol	Description	Ratings	Units
V_{CES}	Collector to Emitter Voltage	600	V
V_{GES}	Gate to Emitter Voltage	± 20	V
I_C	Collector Current @ $T_C = 25^{\circ}\text{C}$	120	A
	Collector Current @ $T_C = 100^{\circ}\text{C}$	60	A
$I_{CM(1)}$	Pulsed Collector Current	180	A
I_F	Diode Forward Current @ $T_C = 25^{\circ}\text{C}$	60	A
	Diode Forward Current @ $T_C = 100^{\circ}\text{C}$	30	A
$I_{FM(1)}$	Pulsed Diode Maximum Forward Current	180	A
P_D	Maximum Power Dissipation @ $T_C = 25^{\circ}\text{C}$	600	W
	Maximum Power Dissipation @ $T_C = 100^{\circ}\text{C}$	300	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	$^{\circ}\text{C}$

Thermal Characteristics

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

FGH60N60SMD-F085 600V 60A Field Stop IGBT

Package Marking and Ordering Information

Device Marking	Device	Package	Packing Type	Qty per Tube
FGH60N60SMD	FGH60N60SMD-F085	TO-247	Tube	30ea

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
Off Characteristics						
BV_{CES}	Collector to Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	600	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	-	0.22	-	V/°C
I_{CES}	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0V$	-	-	250	μA
		I_{CES} at 80% $\cdot B_{V_{CES}}, 175^\circ C$	-	-	1100	
I_{GES}	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0V$	-	-	± 400	nA
On Characteristics						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250\mu A, V_{CE} = V_{GE}$	3.5	4.7	6.0	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 60A, V_{GE} = 15V$	-	1.8	2.5	V
		$I_C = 60A, V_{GE} = 15V, T_C = 175^\circ C$	-	2.14	-	V
Dynamic Characteristics						
C_{ies}	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	-	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	$V_{CC} = 400V, I_C = 60A, R_G = 3\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^\circ C$	-	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	$V_{CC} = 400V, I_C = 60A, R_G = 3\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 175^\circ C$	-	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

Notes:

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

2: Rthjc for TO-247 : according to Mil standard 883-1012 test method. Rthja 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.

Electrical Characteristics of the IGBT (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units
Q_g	Total Gate Charge	$V_{CE} = 400V, I_C = 60A,$ $V_{GE} = 15V$	-	187	280	nC
Q_{ge}	Gate to Emitter Charge		-	20	29	nC
Q_{gc}	Gate to Collector Charge		-	92	138	nC

Electrical Characteristics of the Diode $T_C = 25^\circ C$ unless otherwise noted

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

Typical Performance Characteristics

Figure 1. Typical Output Characteristics

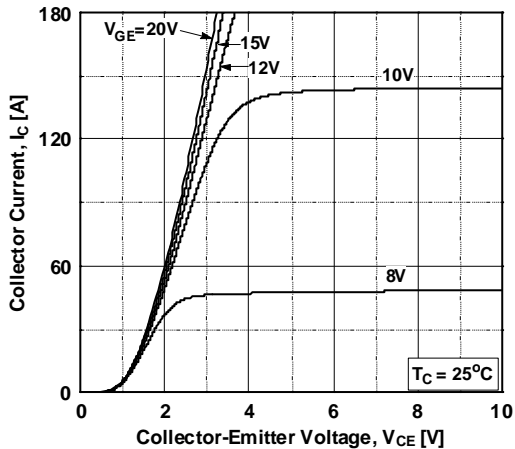


Figure 2. Typical Output Characteristics

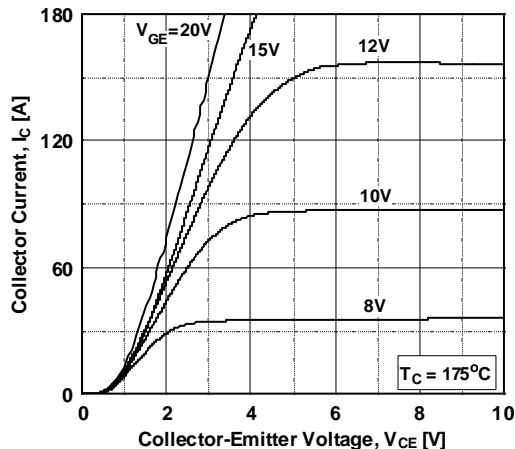


Figure 3. Typical Saturation Voltage Characteristics

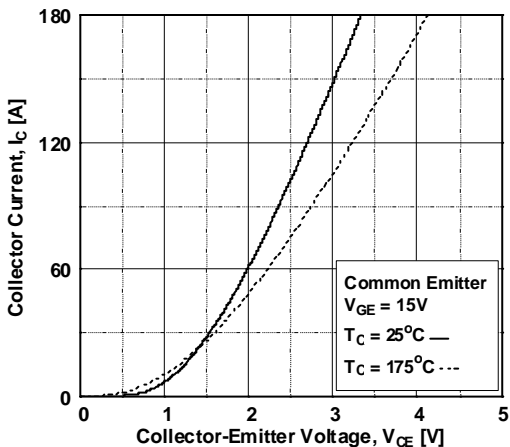


Figure 4. Transfer Characteristics

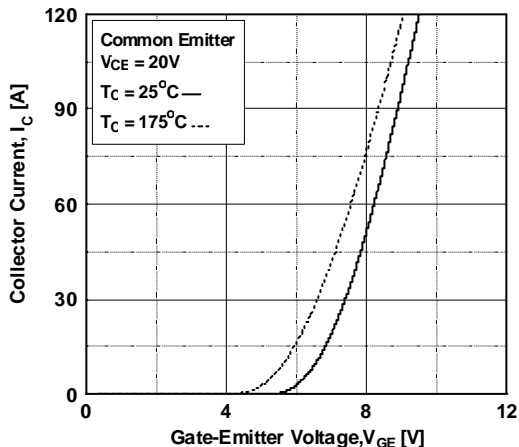


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

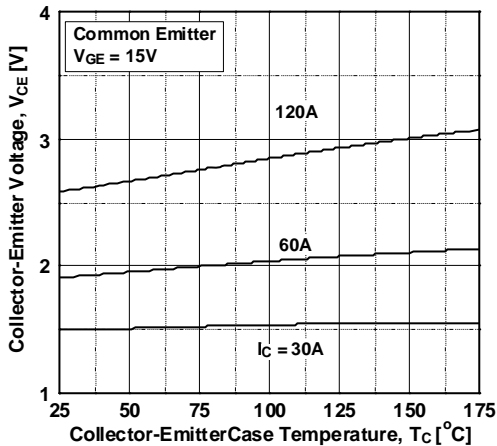
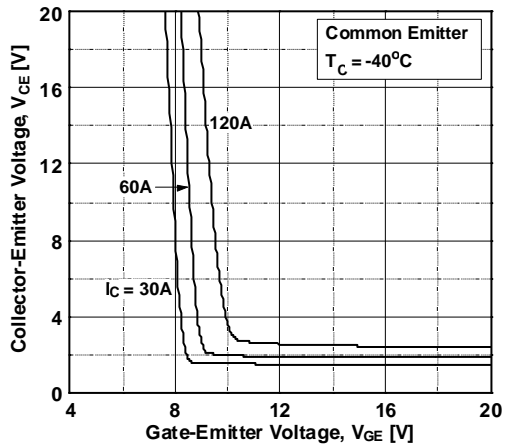


Figure 6. Saturation Voltage vs. Vge



Typical Performance Characteristics

Figure 7. Saturation Voltage vs. V_{GE}

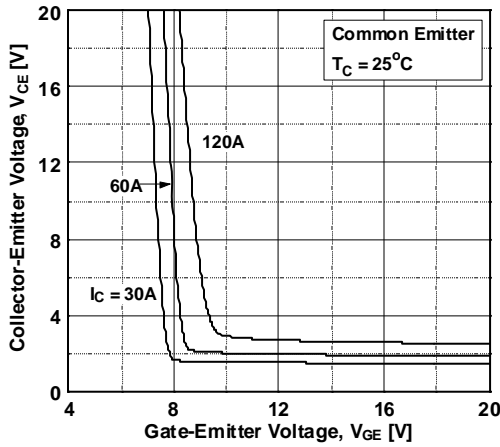


Figure 8. Saturation Voltage vs. V_{GE}

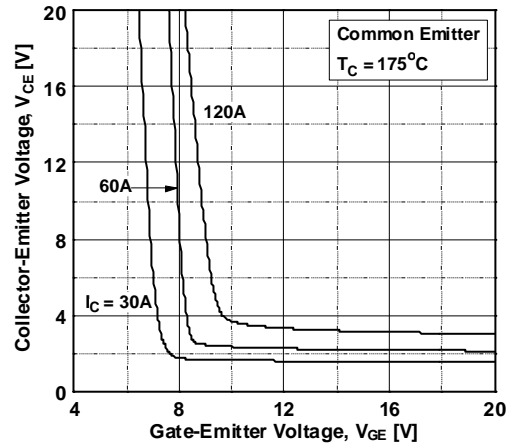


Figure 9. Capacitance Characteristics

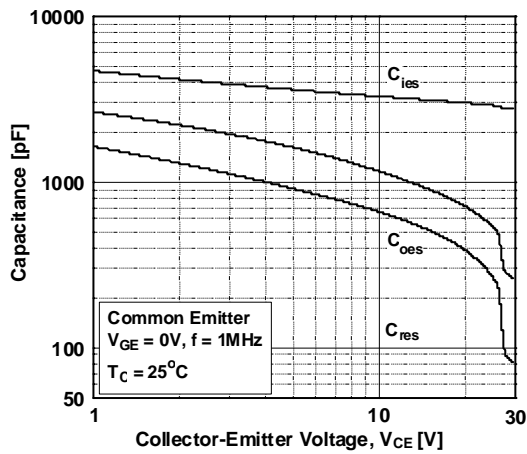


Figure 10. Gate charge Characteristics

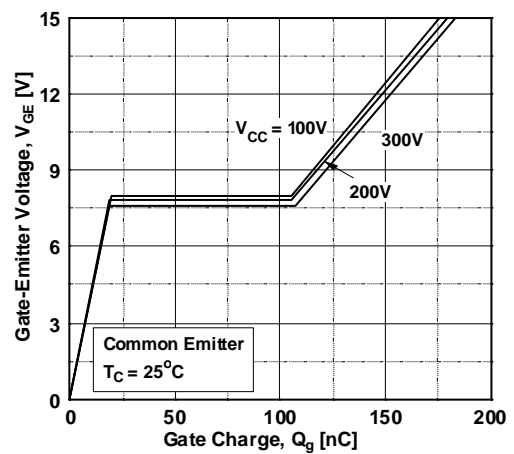


Figure 11. SOA Characteristics

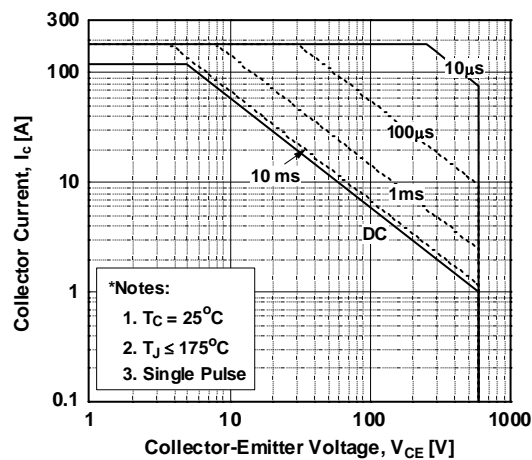
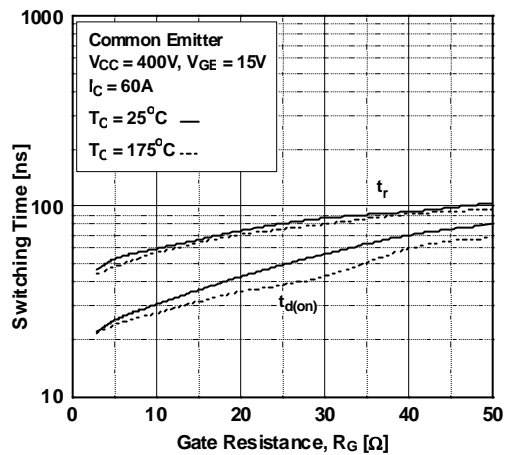


Figure 12. Turn-on Characteristics vs. Gate Resistance



Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Gate Resistance

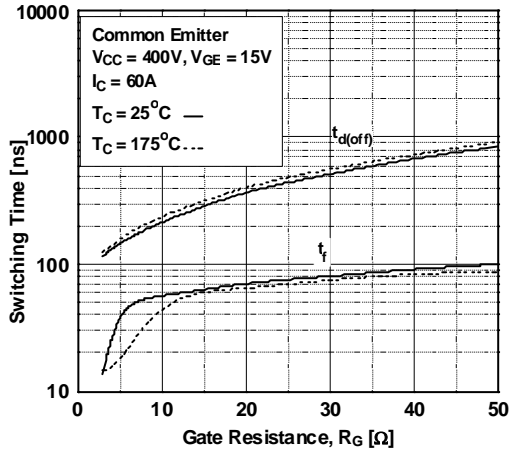


Figure 14. Turn-on Characteristics vs. Collector Current

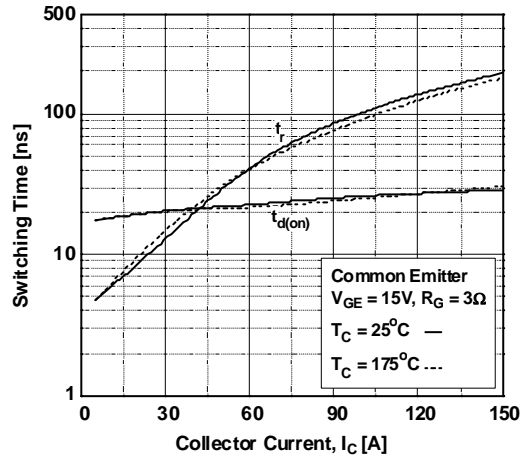


Figure 15. Turn-off Characteristics vs. Collector Current

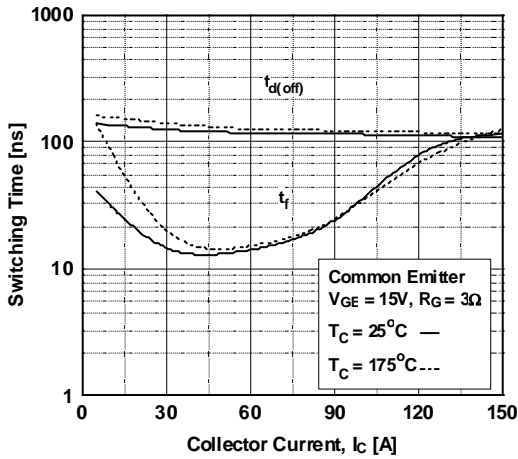


Figure 16. Switching Loss vs. Gate Resistance

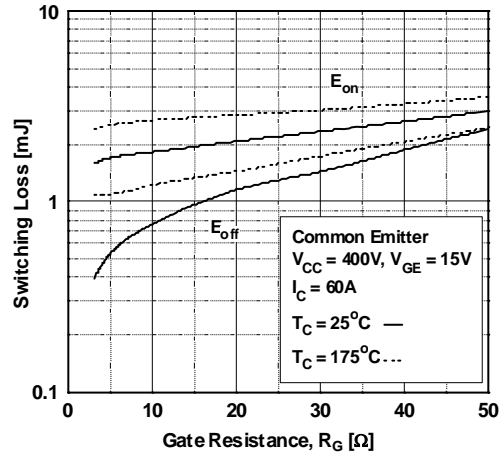


Figure 17. Switching Loss vs. Collector Current

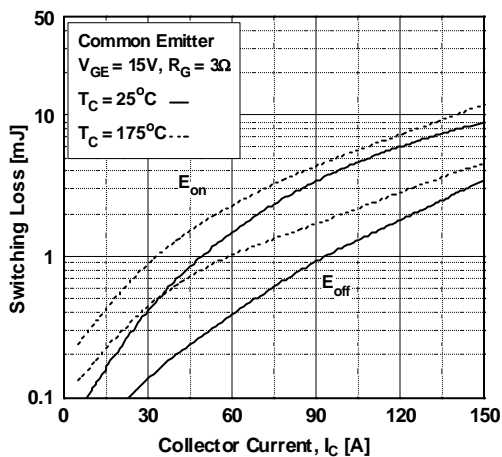
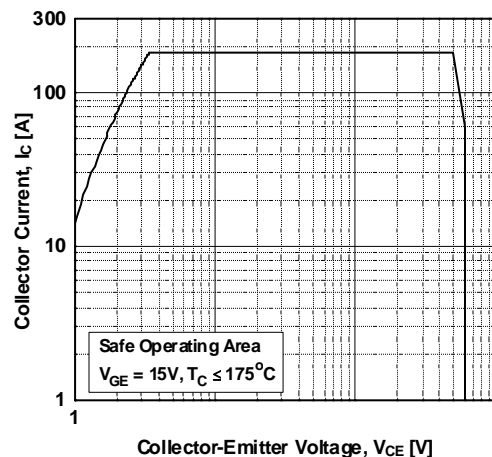


Figure 18. Turn off Switching SOA Characteristics



Typical Performance Characteristics

Figure 19. Forward Characteristics

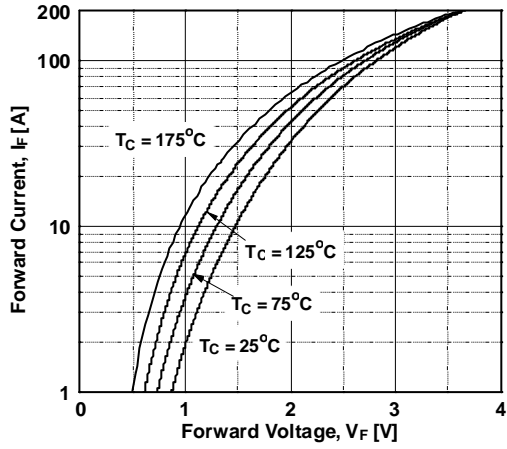


Figure 20. Reverse Recovery Current

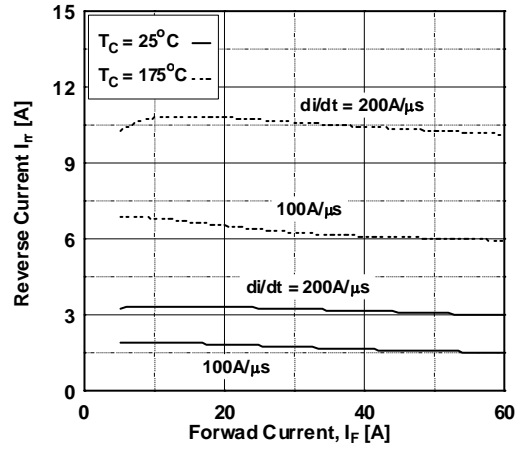


Figure 21. Stored Charge

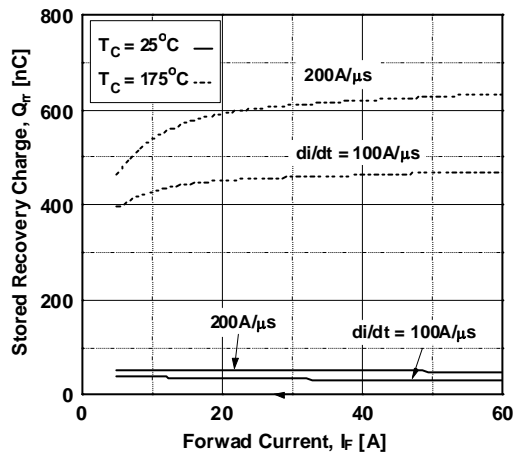


Figure 22. Reverse Recovery Time

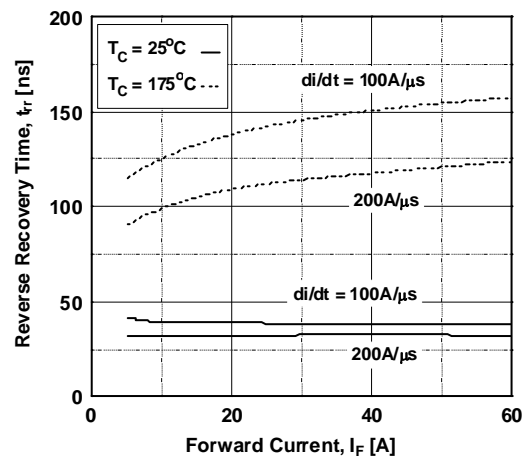
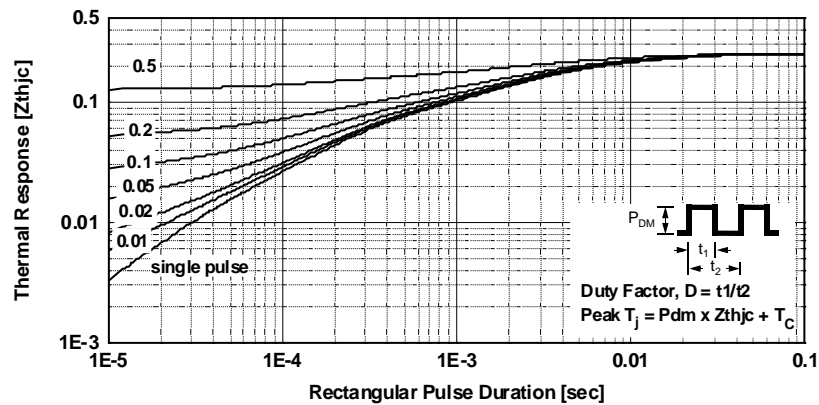


Figure 23. Transient Thermal Impedance of IGBT



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