



ON Semiconductor®

# FGH40N60SMD-F085 600V, 40A 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:  $V_{CE(sat)} = 1.9\text{V(Typ.)}$  @  $I_C = 40\text{A}$
- High input impedance
- Tightened Parameter Distribution
- RoHS compliant
- Qualified to Automotive Requirements of AEC-Q101

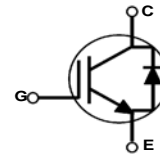
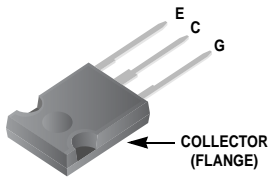


## General Description

Using Novel Field Stop IGBT Technology, ON Semiconductor's new series of Field Stop IGBTs offer the optimum performance for Automotive Chargers, Inverter, and other applications where low conduction and switching losses are essential.

## Applications

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



## Absolute Maximum Ratings

Symbol	Description	Ratings	Units
$V_{CES}$	Collector to Emitter Voltage	600	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C = 25^{\circ}\text{C}$	80	A
	Collector Current @ $T_C = 100^{\circ}\text{C}$	40	A
$I_{CM(1)}$	Pulsed Collector Current	120	A
$I_F$	Diode Forward Current @ $T_C = 25^{\circ}\text{C}$	40	A
	Diode Forward Current @ $T_C = 100^{\circ}\text{C}$	20	A
$I_{FM(1)}$	Pulsed Diode Maximum Forward Current	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^{\circ}\text{C}$	349	W
	Maximum Power Dissipation @ $T_C = 100^{\circ}\text{C}$	174	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	0.43	$^{\circ}\text{C/W}$
$R_{\theta JC(Diode)}$	Thermal Resistance, Junction to Case	1.8	$^{\circ}\text{C/W}$
Symbol	Parameter	Typ.	Units
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (PCB Mount)(2)	45	$^{\circ}\text{C/W}$

## Package Marking and Ordering Information

Device Marking	Device	Package	Packing Type	Qty per Tube
FGH40N60SMD	FGH40N60SMD-F085	TO-247	Tube	30ea

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>Off Characteristics</b>						
$BV_{CES}$	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	$V_{GE} = 0V, I_C = 250\mu A$	-	0.6	-	V/°C
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0V$	-	-	250	$\mu A$
		$I_{CES}$ at 80%* $BV_{CES}, 175^\circ C$	-	-	800	
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0V$	-	-	±400	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 250\mu A, V_{CE} = V_{GE}$	3.5	4.5	6.0	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 40A, V_{GE} = 15V$	-	1.9	2.5	V
		$I_C = 40A, V_{GE} = 15V, T_C = 175^\circ C$	-	2.1	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30V, V_{GE} = 0V, f = 1MHz$	-	1880	2500	pF
$C_{oes}$	Output Capacitance		-	180	240	pF
$C_{res}$	Reverse Transfer Capacitance		-	50	65	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 40A, R_G = 6\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 25^\circ C$	-	18	24	ns
$t_r$	Rise Time		-	28	36.4	ns
$t_{d(off)}$	Turn-Off Delay Time		-	110	143	ns
$t_f$	Fall Time		-	13.2	18.5	ns
$E_{on}$	Turn-On Switching Loss		-	0.92	1.2	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.3	0.39	mJ
$E_{ts}$	Total Switching Loss		-	1.22	1.59	mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400V, I_C = 40A, R_G = 6\Omega, V_{GE} = 15V, \text{Inductive Load}, T_C = 175^\circ C$	-	16.7	23.8	ns
$t_r$	Rise Time		-	27	35.1	ns
$t_{d(off)}$	Turn-Off Delay Time		-	116	151	ns
$t_f$	Fall Time		-	56.5	81	ns
$E_{on}$	Turn-On Switching Loss		-	1.47	1.91	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.73	0.95	mJ
$E_{ts}$	Total Switching Loss		-	2.20	2.86	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	$V_{CE} = 400V, I_C = 40A,$ $V_{GE} = 15V$	-	119	180	nC
$Q_{ge}$	Gate to Emitter Charge		-	13	20	nC
$Q_{gc}$	Gate to Collector Charge		-	58	90	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	$I_F = 20A$	$T_C = 25^\circ C$	-	2.3	2.8	V
			$T_C = 175^\circ C$	-	1.67	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20A, di_F/dt = 200A/\mu s$	$T_C = 175^\circ C$	-	48.9	-	$\mu J$
$t_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ C$	-	36	47	ns
			$T_C = 175^\circ C$	-	110	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ C$	-	46.8	61	nC
		$T_C = 175^\circ C$	-	470	-		

## Typical Performance Characteristics

Figure 1. Typical Output Characteristics

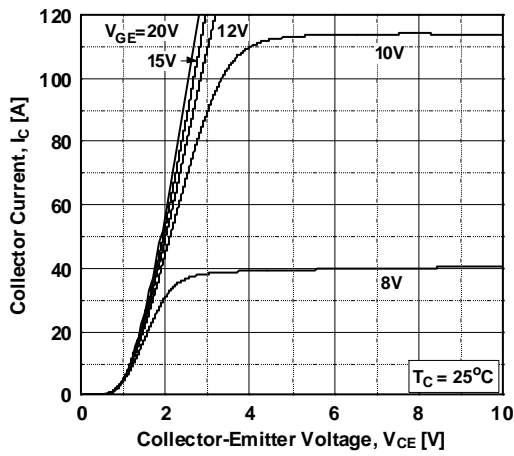


Figure 2. Typical Output Characteristics

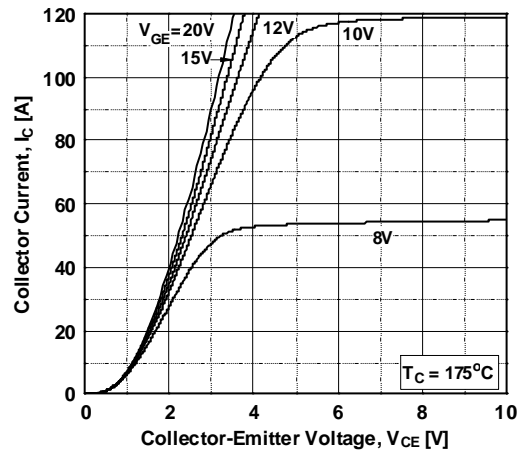


Figure 3. Typical Saturation Voltage Characteristics

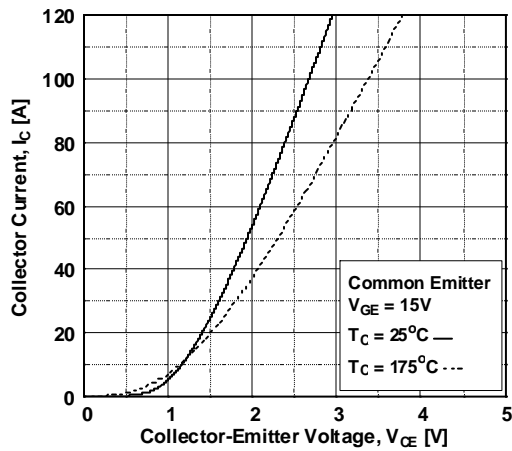


Figure 4. Transfer Characteristics

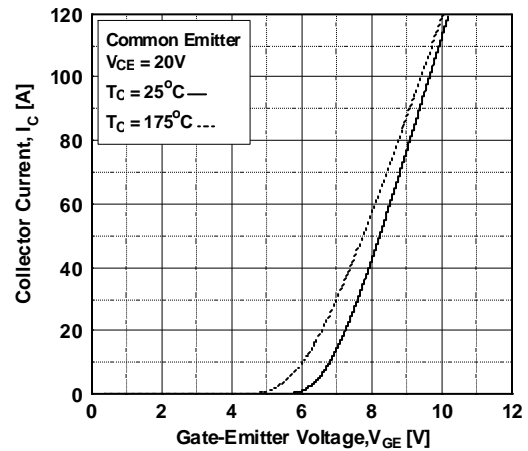


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

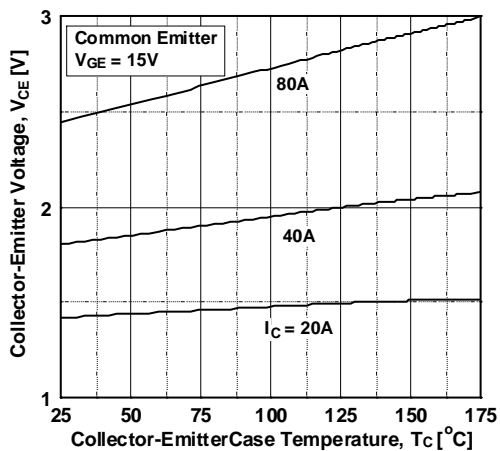
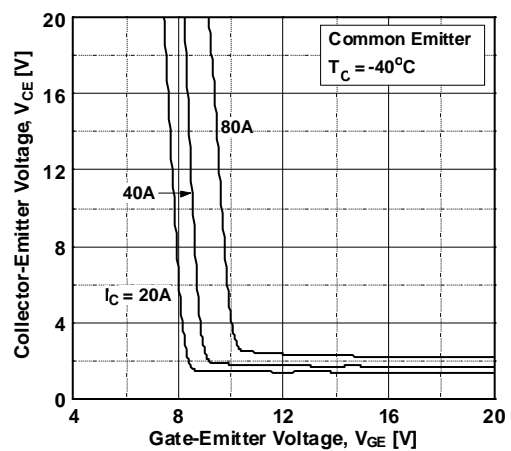


Figure 6. Saturation Voltage vs. VGE



## Typical Performance Characteristics

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

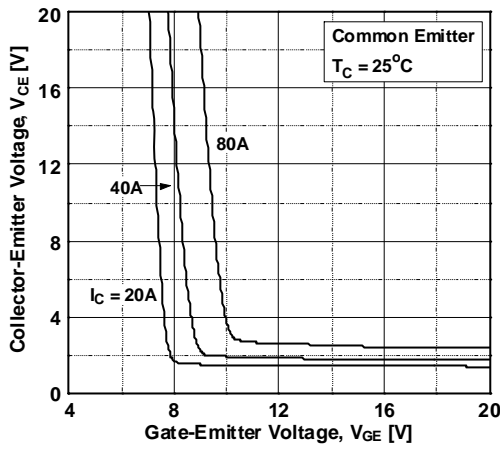


Figure 8. Saturation Voltage vs.  $V_{GE}$

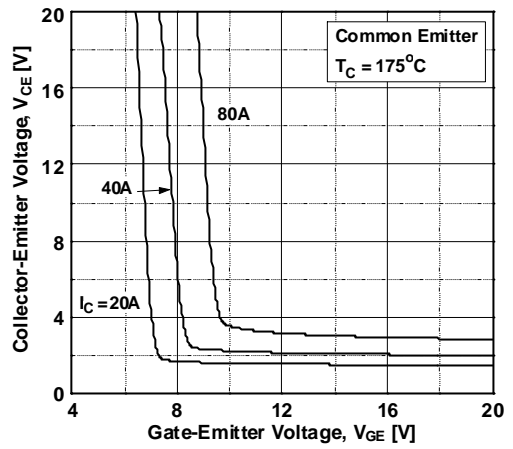


Figure 9. Capacitance Characteristics

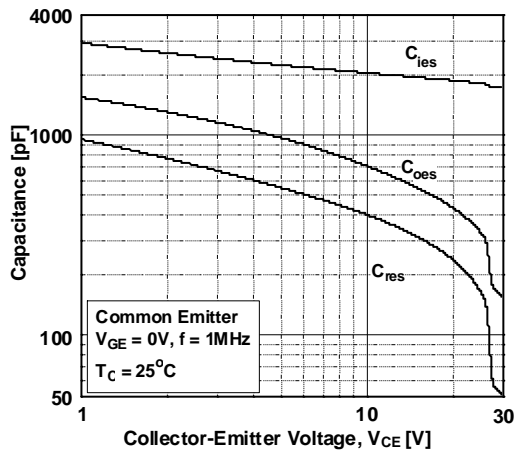


Figure 10. Gate charge Characteristics

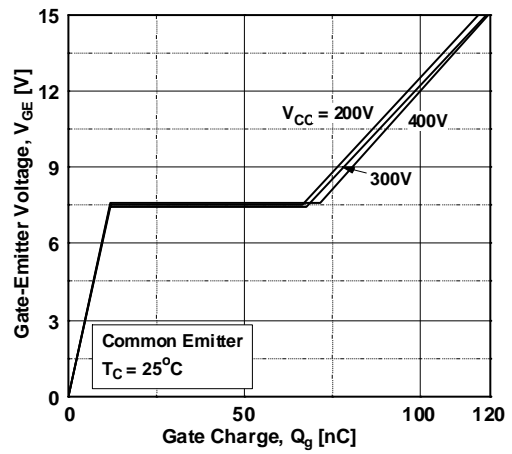


Figure 11. SOA Characteristics

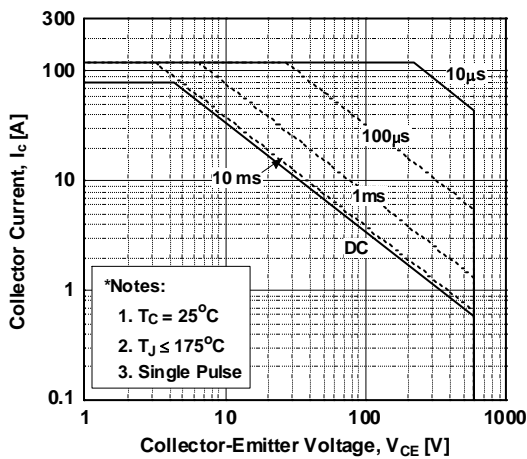
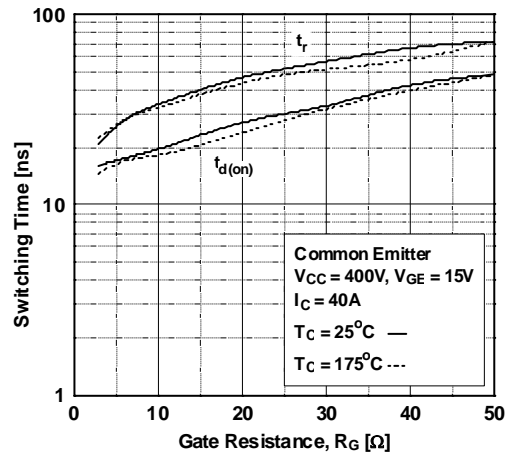


Figure 12. Turn-on Characteristics vs. Gate Resistance



## Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Gate Resistance

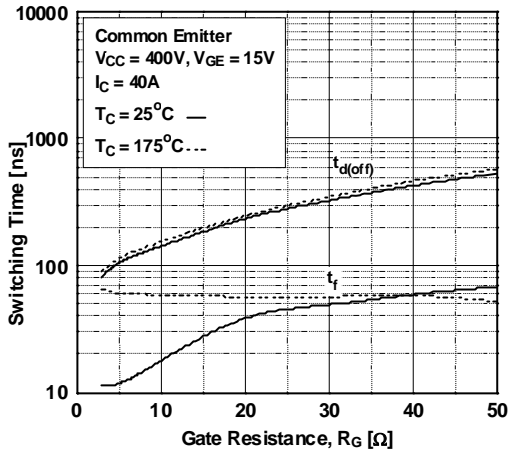


Figure 14. Turn-on Characteristics vs. Collector Current

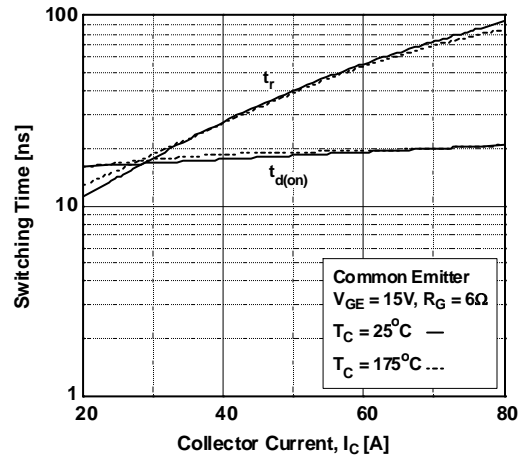


Figure 15. Turn-off Characteristics vs. Collector Current

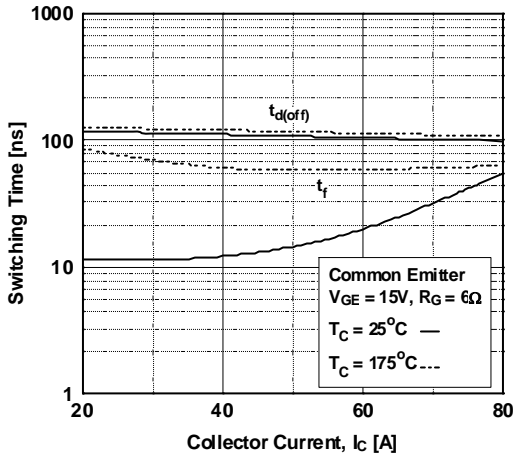


Figure 16. Switching Loss vs. Gate Resistance

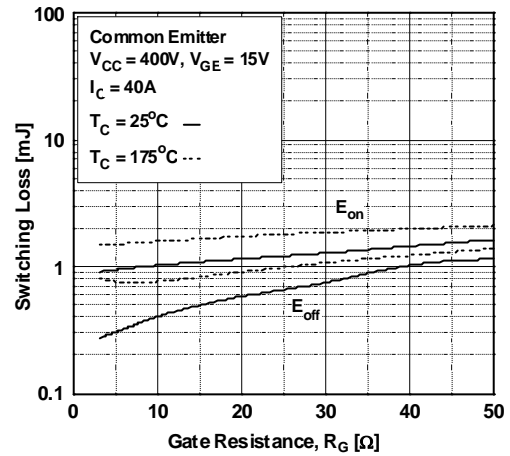


Figure 17. Switching Loss vs. Collector Current

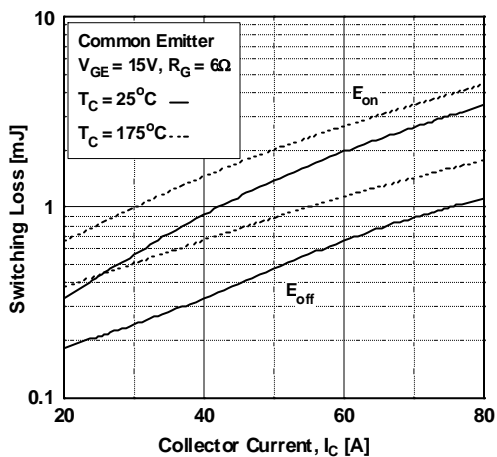
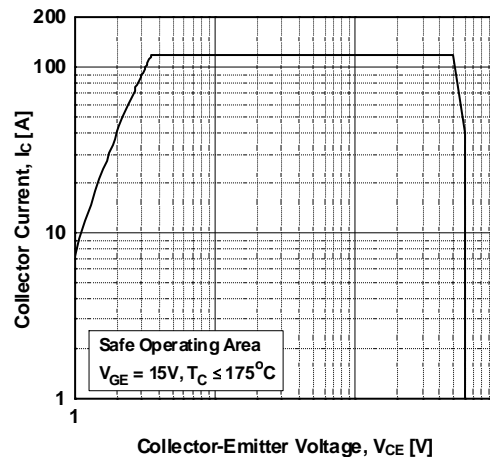


Figure 18. Turn off Switching SOA Characteristics



## Typical Performance Characteristics

Figure 19. Current Derating

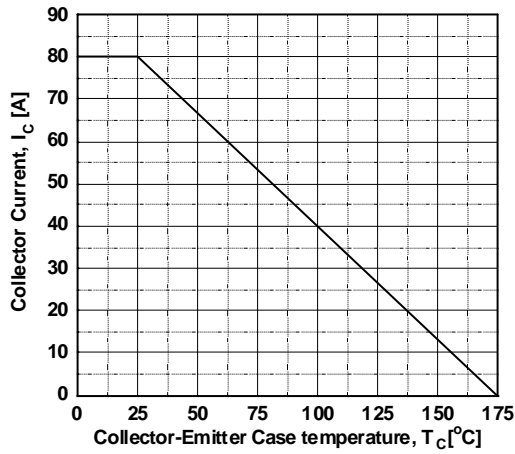


Figure 20. Load Current Vs. Frequency

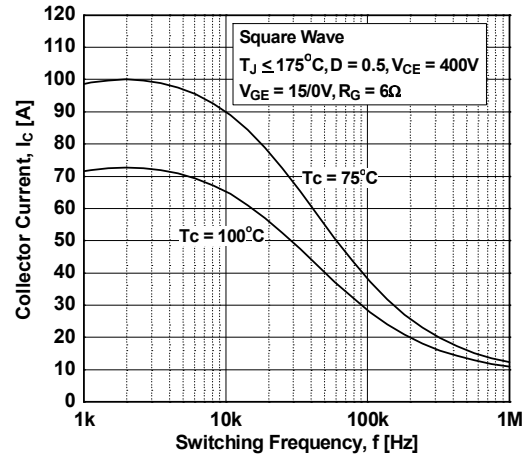


Figure 21. Forward Characteristics

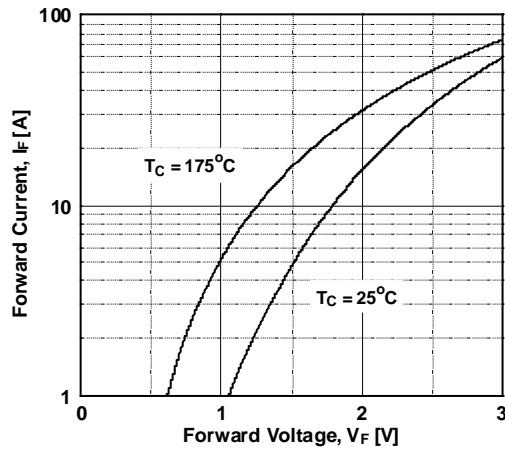


Figure 22. Reverse Current

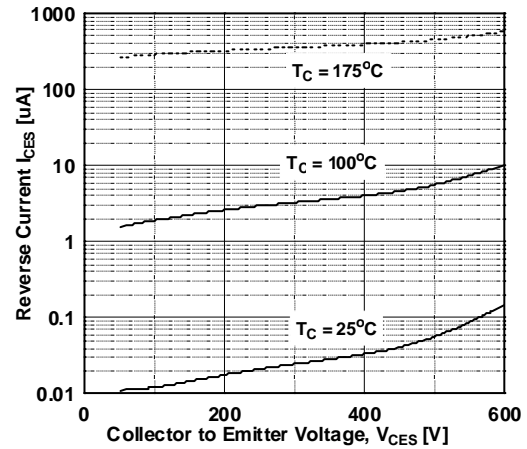


Figure 23. Stored Charge

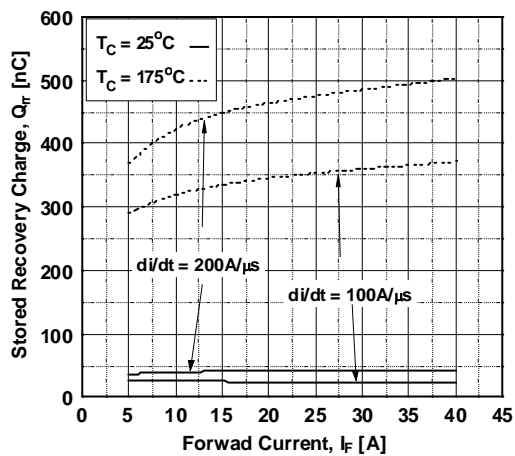


Figure 24. Reverse Recovery Time

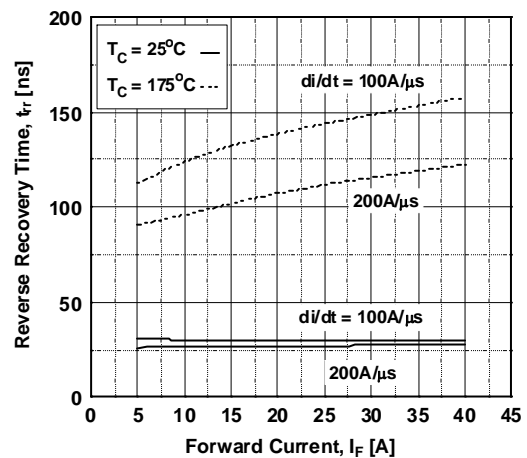


Figure 25. Transient Thermal Impedance of IGBT

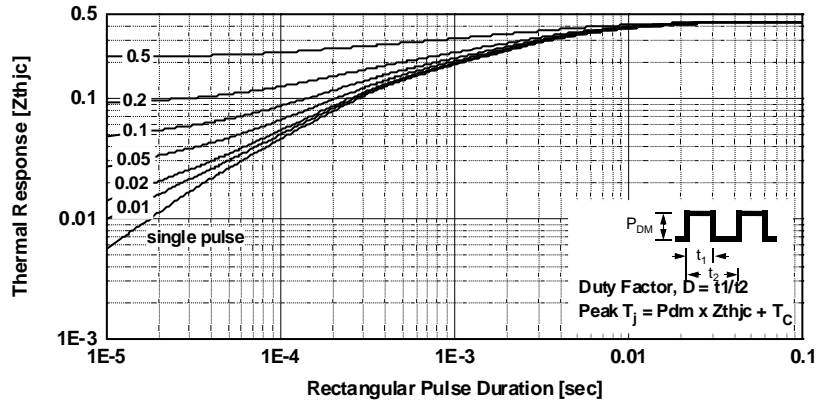
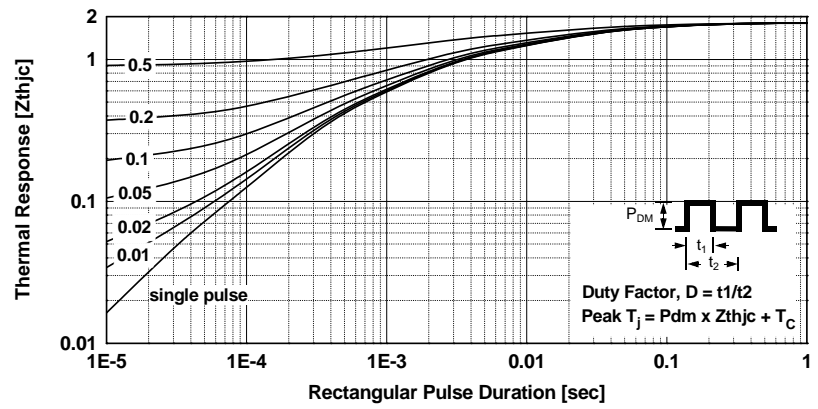


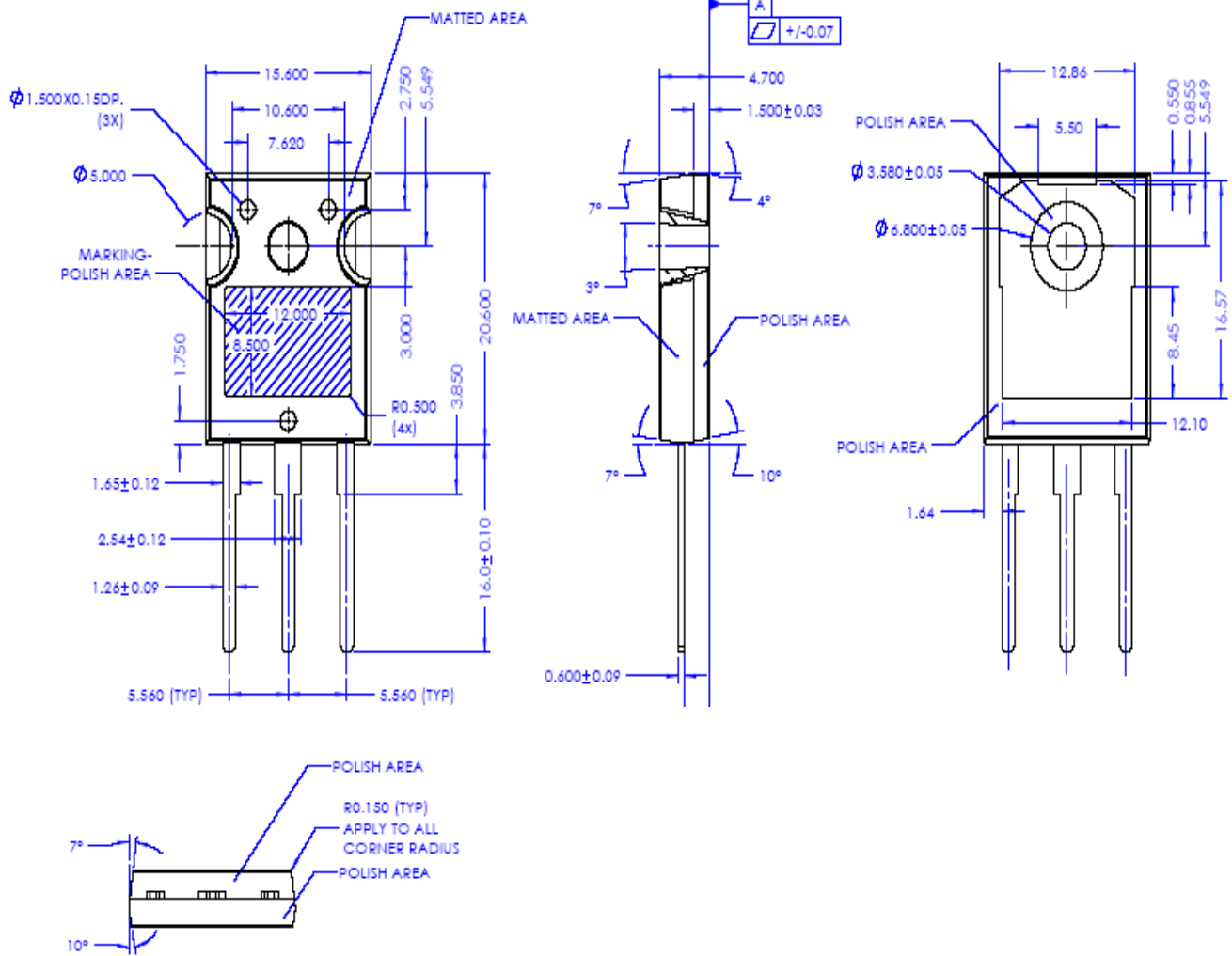
Figure 26. Transient Thermal Impedance of Diode






## Mechanical Dimensions

### TO - 247AB (FKS PKG CODE 001)



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