



ON Semiconductor®

# FGH40T65SPD-F085

## 650V, 40A Field Stop Trench IGBT General Description

### Features

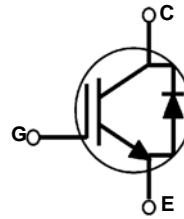
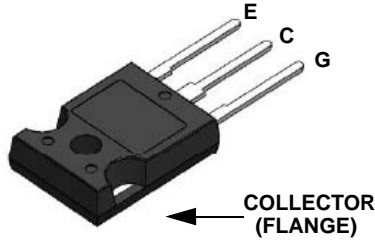
- AEC-Q101 Qualified
- Low Saturation Voltage :  $V_{CE(sat)} = 1.85 \text{ V(Typ.)}$  @  $I_C = 40 \text{ A}$
- 100% of the parts are dynamically tested (Note 1)
- Short Circuit Ruggedness  $> 5 \mu\text{s}$  @  $25 \text{ }^\circ\text{C}$
- Maximum Junction Temperature :  $T_J = 175 \text{ }^\circ\text{C}$
- Fast Switching
- Tight Parameter Distribution
- Positive Temperature Co-efficient for Easy Parallel Operating
- Copacked with soft, fast recovery diode
- RoHS Compliant



Using the novel field stop 3rd generation IGBT technology, FGH40T65SPD-F085 offers the optimum performance with both low conduction loss and switching loss for a high efficiency operation in various applications, while provides 50V higher blocking voltage and rugged high current switching reliability. Meanwhile, this part also offers an advantage of outstanding performance in parallel operation.

### Applications

- Onboard Charger
- AirCon Compressor
- PTC Heater
- Motor Drivers
- Other automotive power-train applications



### Absolute Maximum Ratings

Symbol	Description	Ratings	Units
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
	Transient Gate to Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current @ $T_C = 25 \text{ }^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100 \text{ }^\circ\text{C}$	40	A
$I_{CM}$	Pulsed Collector Current (Note 2)	120	A
$I_F$	Diode Forward Current @ $T_C = 25 \text{ }^\circ\text{C}$	40	A
	Diode Forward Current @ $T_C = 100 \text{ }^\circ\text{C}$	20	A
$I_{FM}$	Pulsed Diode Maximum Forward Current (Note 2)	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25 \text{ }^\circ\text{C}$	267	W
	Maximum Power Dissipation @ $T_C = 100 \text{ }^\circ\text{C}$	134	W
SCWT	Short Circuit Withstand Time @ $T_C = 25 \text{ }^\circ\text{C}$	5	$\mu\text{s}$
$T_J$	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	$^\circ\text{C}$

**Notes:**

- 1:  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $I_C = 120 \text{ A}$ ,  $R_G = 20 \Omega$ , Inductive Load
- 2: Repetitive rating: pulse width limited by max. junction temperature

FGH40T65SPD-F085 650V 40A Field Stop Trench IGBT

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case	-	0.56	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case	-	1.71	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^{\circ}\text{C}/\text{W}$

## Package Marking and Ordering Information

Device Marking	Device	Package	Pacing Type	Qty per Tube
FGH40T65SPD	FGH40T65SPD-F085	TO-247 G03	Tube	30ea

## Electrical Characteristics of the IGBT $T_C = 25^{\circ}\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>Off Characteristics</b>						
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{V}, I_C = 1\text{mA}$	650	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{V}, I_C = 1\text{mA}$	-	0.6	-	$\text{V}/^{\circ}\text{C}$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0\text{V}$	-	-	250	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{V}$	-	-	$\pm 400$	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 40\text{mA}, V_{CE} = V_{GE}$	4.0	5.5	7.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 40\text{A}, V_{GE} = 15\text{V}$	-	1.85	2.4	V
		$I_C = 40\text{A}, V_{GE} = 15\text{V}, T_C = 175^{\circ}\text{C}$	-	2.51	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	1518	-	pF
$C_{oes}$	Output Capacitance		-	91	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	15	-	pF
<b>Switching Characteristics</b>						
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 6\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_C = 25^{\circ}\text{C}$	-	18	-	ns
$T_r$	Rise Time		-	42	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	35	-	ns
$T_f$	Fall Time		-	10	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.16	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.27	-	mJ
$E_{ts}$	Total Switching Loss		-	1.43	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 6\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_C = 175^{\circ}\text{C}$	-	16	-	ns
$T_r$	Rise Time		-	40	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	37	-	ns
$T_f$	Fall Time		-	11	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.59	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.42	-	mJ
$E_{ts}$	Total Switching Loss		-	2.01	-	mJ

### Electrical Characteristics of the IGBT (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units
$Q_g$	Total Gate Charge	$V_{CE} = 400V, I_C = 40A,$ $V_{GE} = 15V$	-	36	-	nC
$Q_{ge}$	Gate to Emitter Charge		-	11	-	nC
$Q_{gc}$	Gate to Collector Charge		-	12	-	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	$I_F = 20A$	$T_C = 25^\circ C$	-	2.2	2.7	V
			$T_C = 175^\circ C$	-	1.9	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20A,$ $di_F/dt = 200A/\mu s$	$T_C = 175^\circ C$	-	51	-	$\mu J$
$T_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ C$	-	35	-	ns
			$T_C = 175^\circ C$	-	214	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ C$	-	58	-	$\mu C$
		$T_C = 175^\circ C$	-	776	-		

## Typical Performance Characteristics

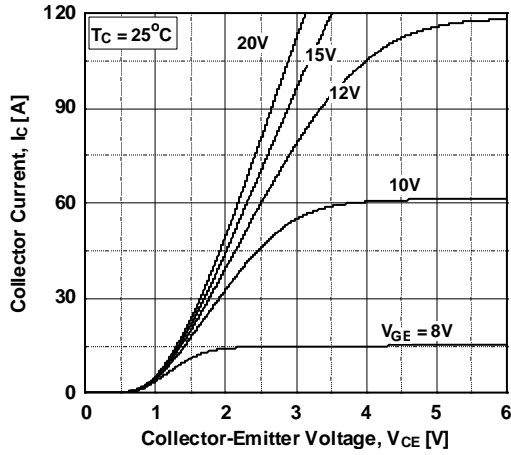


Figure 1. Typical Output Characteristics

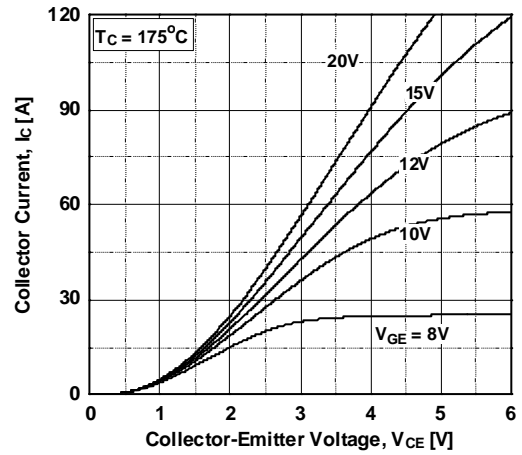


Figure 2. Typical Output Characteristics

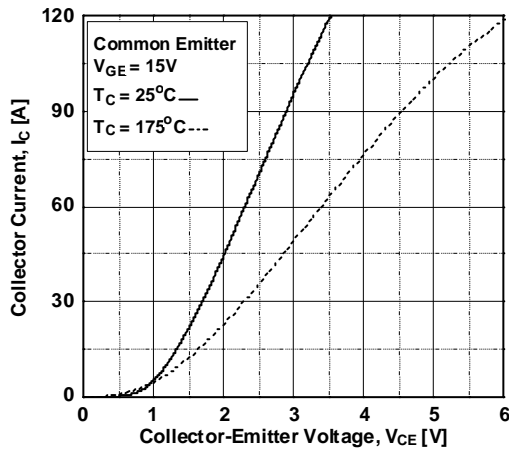


Figure 3. Typical Saturation Voltage Characteristics

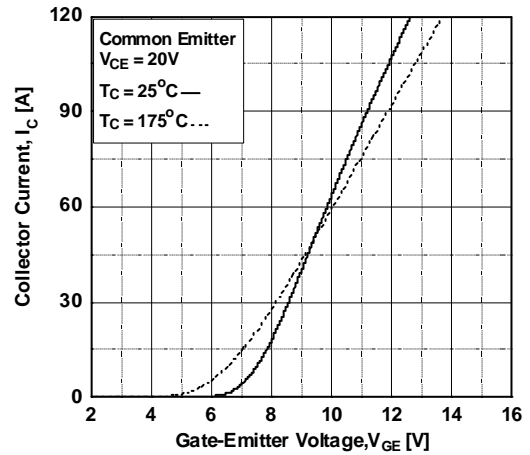


Figure 4. Transfer Characteristic

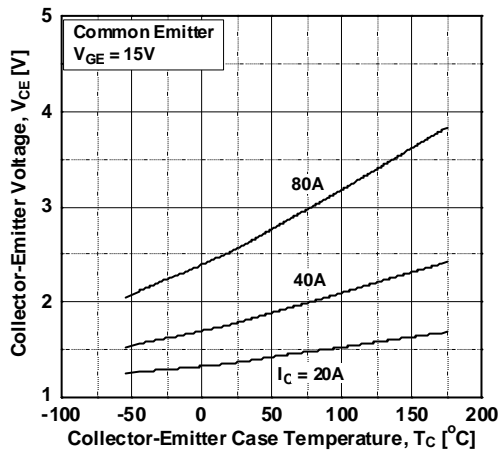


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

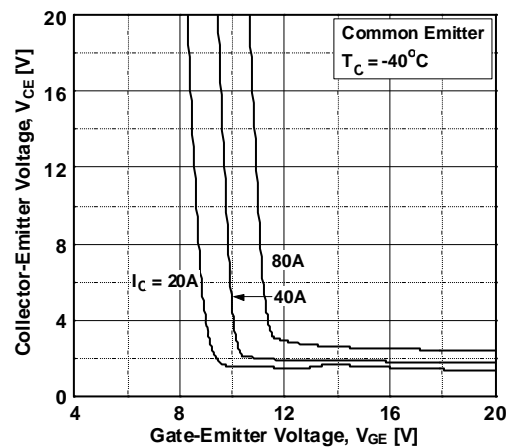


Figure 6. Saturation Voltage vs.  $V_{GE}$

### Typical Performance Characteristics

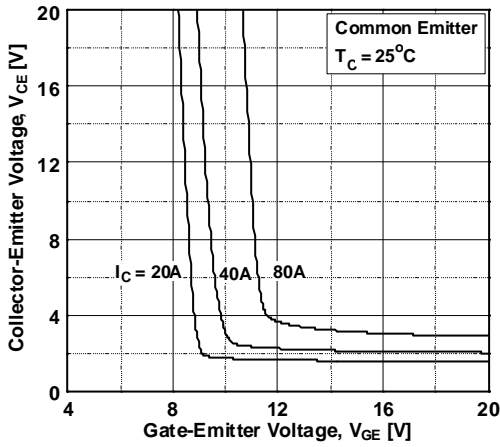


Figure 7. Saturation Voltage vs.  $V_{GE}$

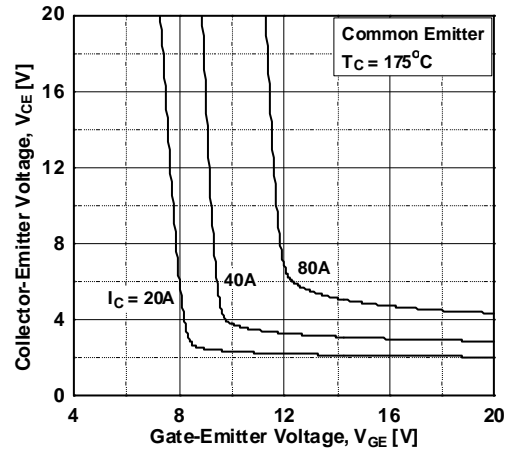


Figure 8. Saturation Voltage vs.  $V_{GE}$

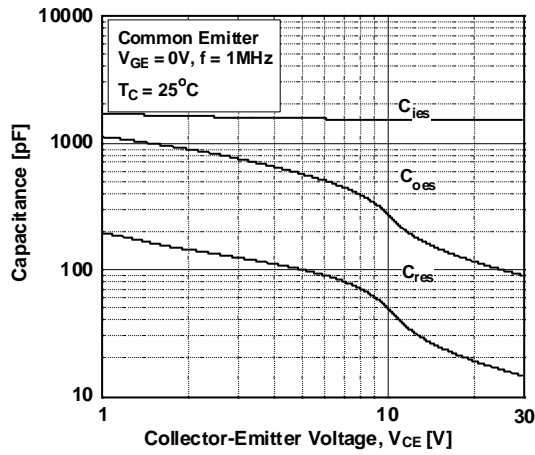


Figure 9. Capacitance Characteristics

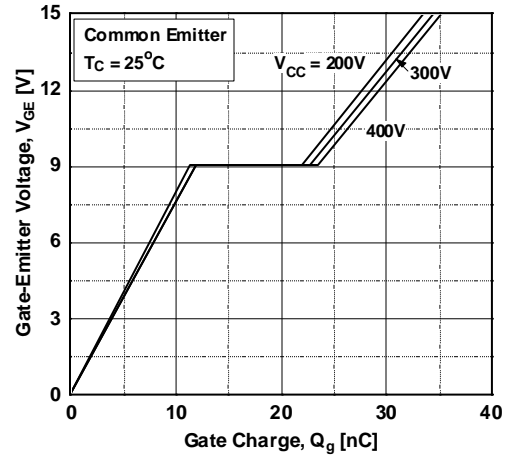


Figure 10. Gate charge Characteristics

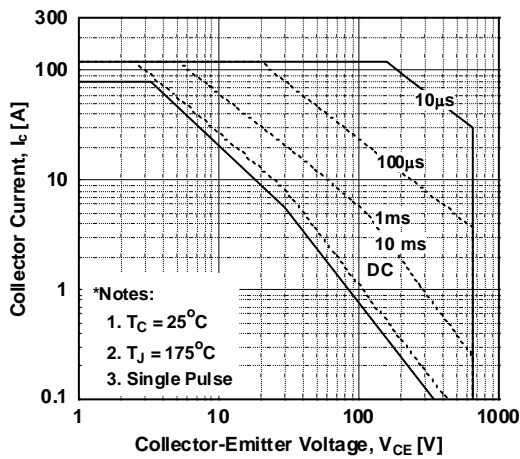


Figure 11. SOA Characteristics

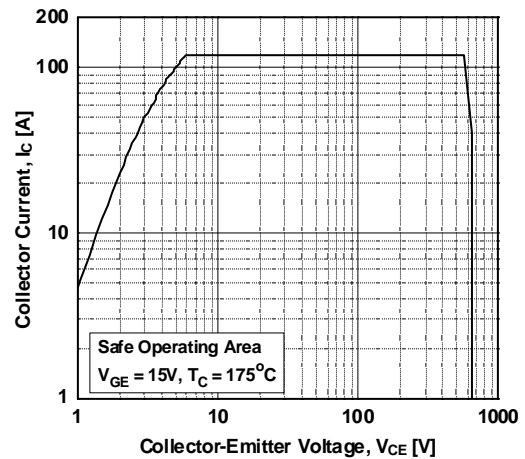


Figure 12. Turn off Switching SOA Characteristics

## Typical Performance Characteristics

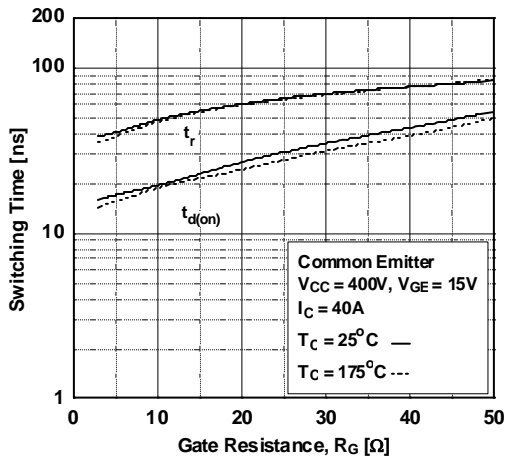


Figure 13. Turn-on Characteristics vs. Gate Resistance

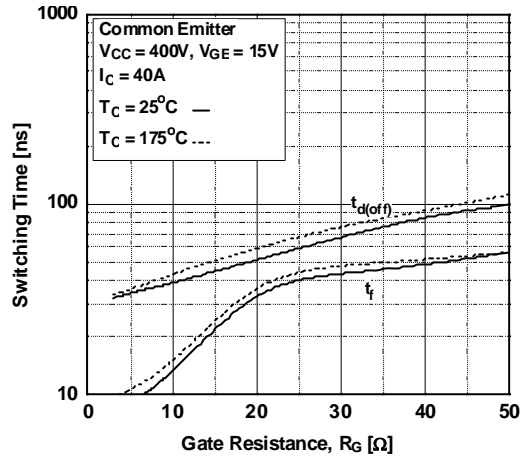


Figure 14. Turn-off Characteristics vs. Gate Resistance

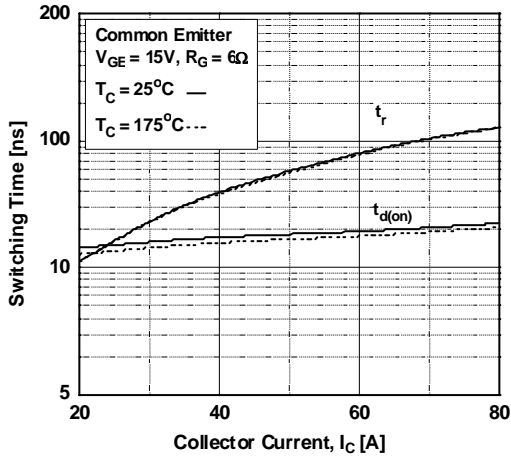


Figure 15. Turn-on Characteristics vs. Collector Current

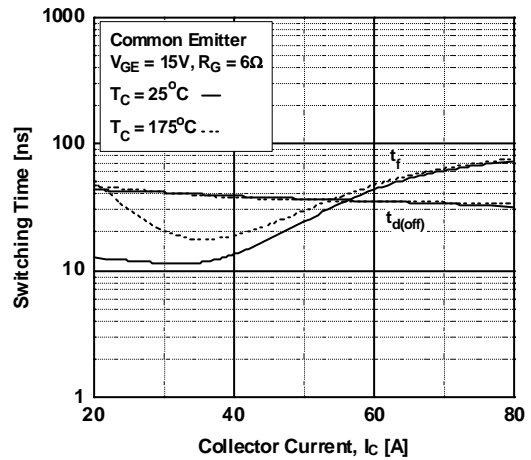


Figure 16. Turn-off Characteristics vs. Collector Current

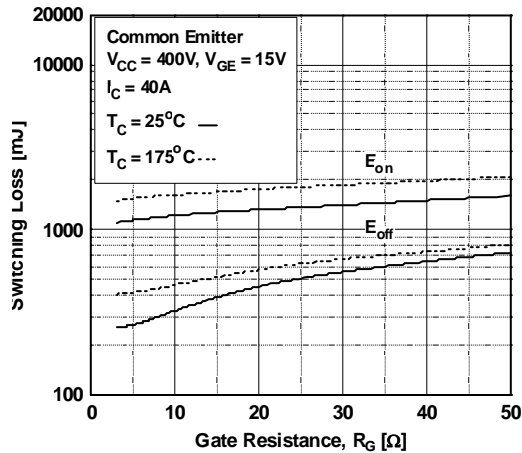


Figure 17. Switching Loss vs Gate Resistance

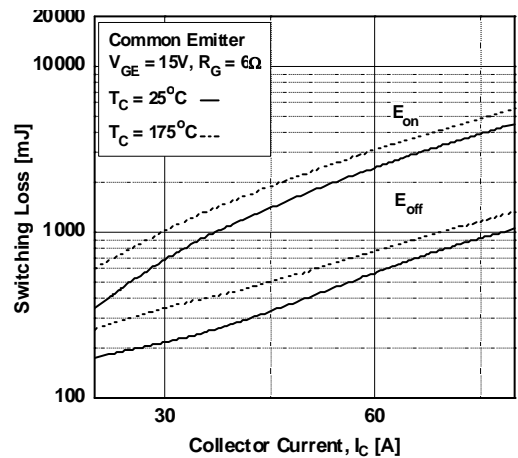


Figure 18. Switching Loss vs Collector Current

## Typical Performance Characteristics

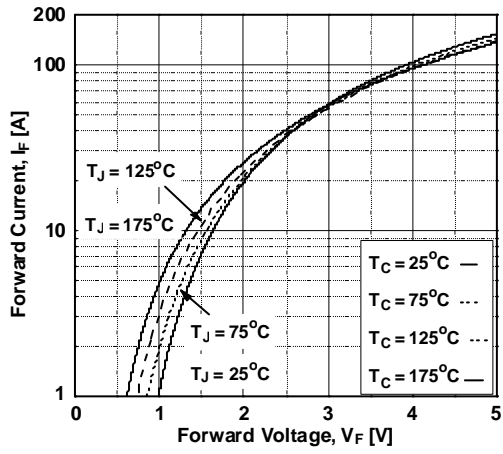


Figure 19. Forward Characteristics

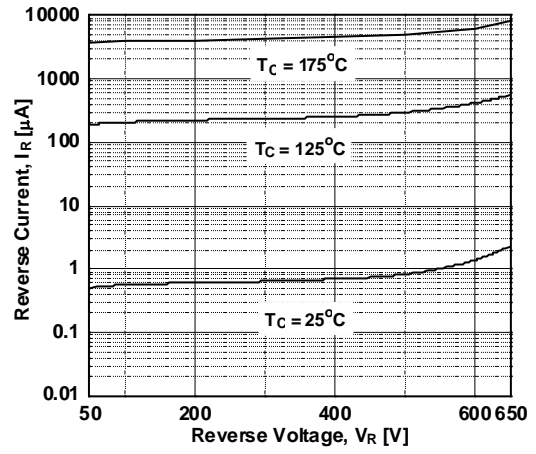


Figure 20. Reverse Current

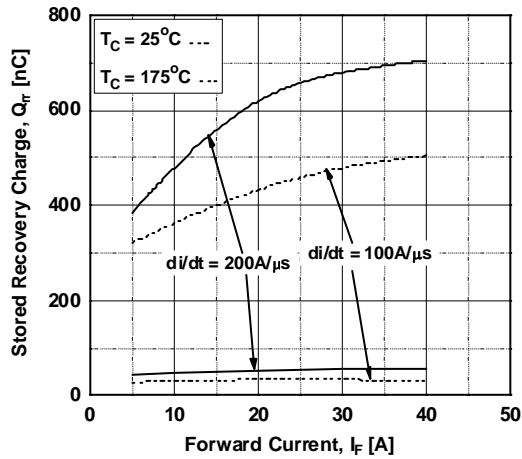


Figure 21. Stored Charge

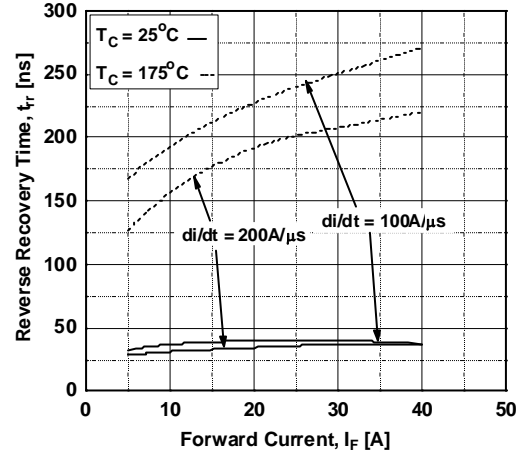


Figure 22. Reverse Recovery Time

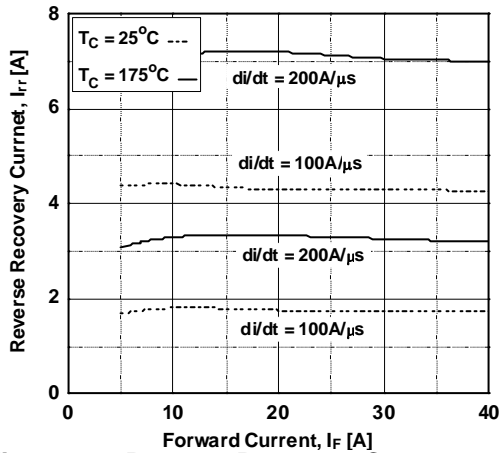


Figure 23. Reverse Recovery Current

Typical Performance Characteristics

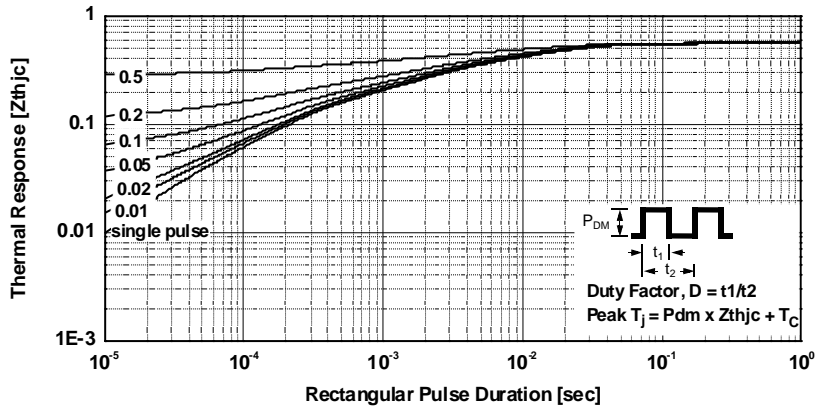


Figure 24. Transient Thermal Impedance of IGBT

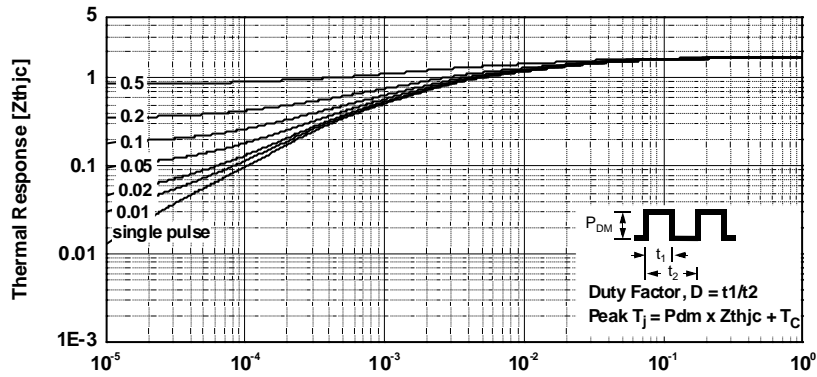


Figure 25. Transient Thermal Impedance of Diode



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