



ON Semiconductor®

# FGY120T65SPD-F085 650V, 120A Field Stop Trench IGBT With Soft Fast Recovery Diode

## Features

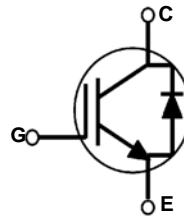
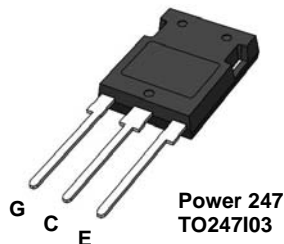
- AEC-Q101 Qualified
- Very low saturation voltage :  $V_{CE(sat)} = 1.5 \text{ V(Typ.)} @ I_C = 120 \text{ A}$
- Maximum junction temperature :  $T_J = 175 \text{ }^\circ\text{C}$
- Positive temperature Co-efficient
- Tight parameter distribution
- High input impedance
- 100% of the parts are dynamically tested
- Short circuit ruggedness  $> 6 \mu\text{s} @ 25 \text{ }^\circ\text{C}$
- Copacked with soft, fast recovery Extremerfast diode

## Benefits

- Very Low conduction and switching losses for a high efficiency operation in various applications
- Rugged transient reliability
- Outstanding parallel operation performance with balance current sharing
- Low EMI

## Applications

- Traction inverter for HEV/EV
- Auxiliary DC/AC converter
- Motor drives
- Other power-train applications requiring high power switch



## 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 (Note1)	@ $T_C = 25 \text{ }^\circ\text{C}$	240
	Collector Current	@ $T_C = 100 \text{ }^\circ\text{C}$	220
$I_{Nominal}$	Nominal Current	120	A
$I_{CM}$	Pulsed Collector Current	378	A
$I_F$	Diode Forward Current (Note1)	@ $T_C = 25 \text{ }^\circ\text{C}$	240
	Diode Forward Current	@ $T_C = 100 \text{ }^\circ\text{C}$	188
$P_D$	Maximum Power Dissipation	@ $T_C = 25 \text{ }^\circ\text{C}$	882
	Maximum Power Dissipation	@ $T_C = 100 \text{ }^\circ\text{C}$	441
SCWT	Short Circuit Withstand Time	@ $T_C = 25 \text{ }^\circ\text{C}$	6
dV/dt	Voltage Transient Ruggedness (Note2)	10	V/ns
$T_J$	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: Limited by bondwire
- 2:  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $I_C = 378 \text{ A}$ , Inductive Load

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case	-	0.17	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case	-	0.32	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	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
FGY120T65SPD	FGY120T65SPD-F085	TP-247	Tube	30ea

### Electrical Characteristics of the IGBT $T_J = 25^{\circ}\text{C}$ 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
$\Delta BV_{CES}$ $\Delta T_J$	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	$V_{CE} = V_{CES}, V_{GE} = 0\text{V}$	-	-	40	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{V}$	-	-	$\pm 250$	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 120\text{mA}, V_{CE} = V_{GE}$	4.2	5.4	6.2	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 120\text{A}, V_{GE} = 15\text{V}$	-	1.5	1.85	V
		$I_C = 120\text{A}, V_{GE} = 15\text{V}, T_J = 175^{\circ}\text{C}$	-	1.8	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	6810	-	pF
$C_{oes}$	Output Capacitance		-	440	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	50	-	pF
$R_G$	Internal Gate Resistance	$f = 1\text{MHz}$	-	3	-	$\Omega$
<b>Switching Characteristics</b>						
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 120\text{A}, R_G = 5\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_J = 25^{\circ}\text{C}$	-	53	-	ns
$T_r$	Rise Time		-	134	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	102	-	ns
$T_f$	Fall Time		-	115	-	ns
$E_{on}$	Turn-On Switching Loss		-	6.8	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	3.5	-	mJ
$E_{ts}$	Total Switching Loss		-	10.3	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{V}, I_C = 120\text{A}, R_G = 5\Omega, V_{GE} = 15\text{V}, \text{Inductive Load}, T_J = 175^{\circ}\text{C}$	-	50	-	ns
$T_r$	Rise Time		-	133	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	109	-	ns
$T_f$	Fall Time		-	138	-	ns
$E_{on}$	Turn-On Switching Loss		-	9.8	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	4.0	-	mJ
$E_{ts}$	Total Switching Loss		-	13.8	-	mJ

**Electrical Characteristics of the IGBT** (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units
$Q_g$	Total Gate Charge	$V_{CE} = 400V, I_C = 120A,$ $V_{GE} = 15V$	-	162	243	nC
$Q_{ge}$	Gate to Emitter Charge		-	49	-	nC
$Q_{gc}$	Gate to Collector Charge		-	47	-	nC

**Electrical Characteristics of the Diode**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 120A$	$T_J = 25\text{ }^\circ\text{C}$	-	1.3	1.6	V
			$T_J = 175\text{ }^\circ\text{C}$	-	1.2	-	
$E_{rec}$	Reverse Recovery Energy	$V_{CE} = 400V, I_F = 120A,$ $di_F/dt = 1000A/\mu s$	$T_J = 25\text{ }^\circ\text{C}$	-	450	-	$\mu J$
			$T_J = 175\text{ }^\circ\text{C}$	-	3000	-	
$T_{rr}$	Diode Reverse Recovery Time		$T_J = 25\text{ }^\circ\text{C}$	-	123	-	ns
			$T_J = 175\text{ }^\circ\text{C}$	-	240	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_J = 25\text{ }^\circ\text{C}$	-	2.8	-	$\mu C$
			$T_J = 175\text{ }^\circ\text{C}$	-	12.2	-	

## Typical Performance Characteristics

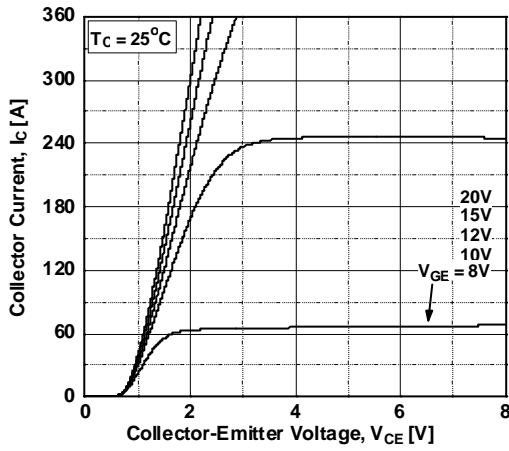


Figure 1. Typical Output Characteristics

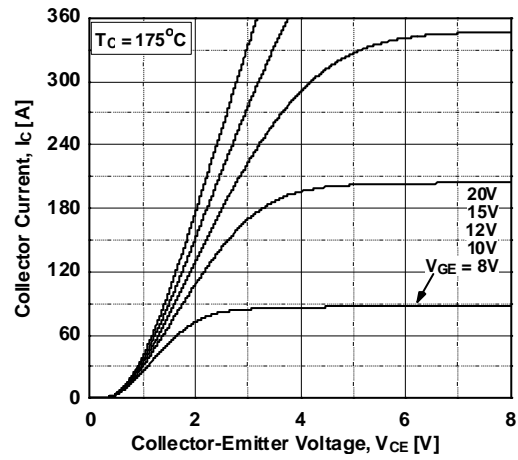


Figure 2. Typical Output Characteristics

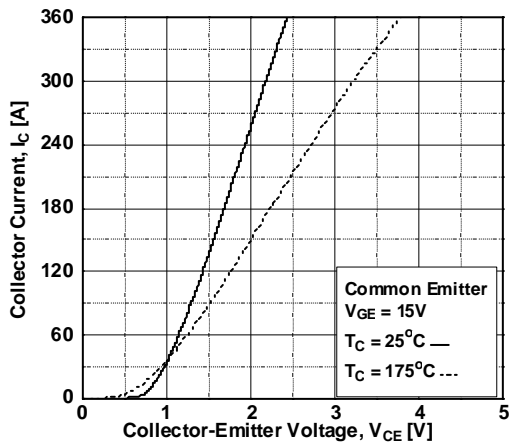


Figure 3. Typical Saturation Voltage Characteristics

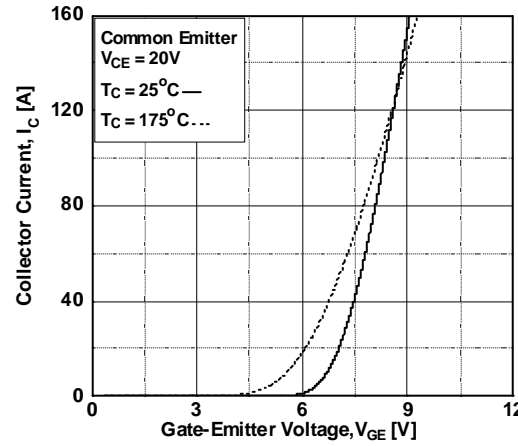


Figure 4. Transfer Characteristics

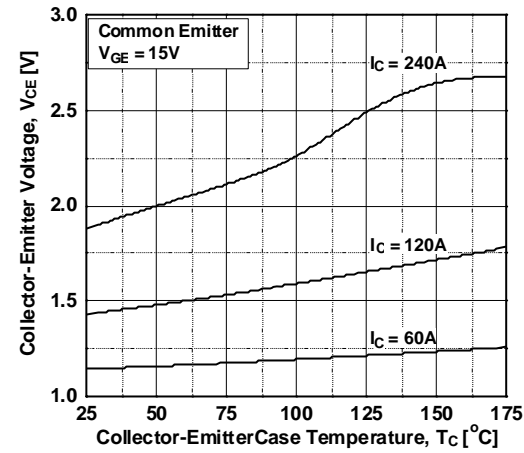


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

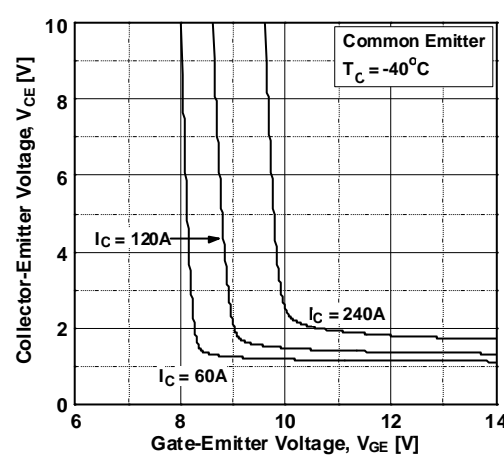


Figure 6. Saturation Voltage vs.  $V_{GE}$

## Typical Performance Characteristics

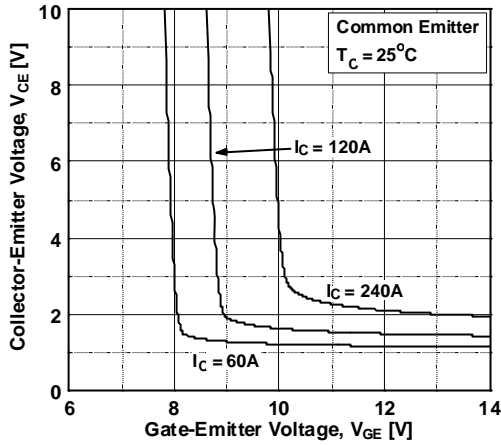


Figure 7. Saturation Voltage vs.  $V_{GE}$

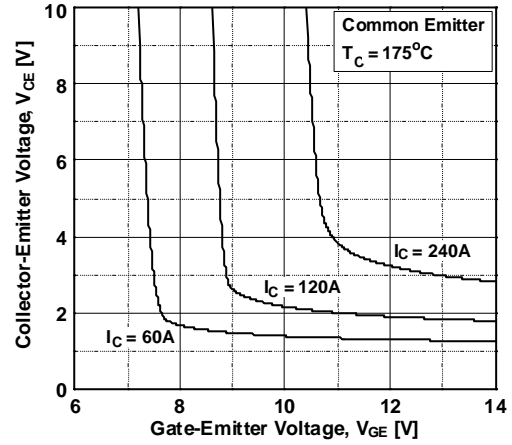


Figure 8. Saturation Voltage vs.  $V_{GE}$

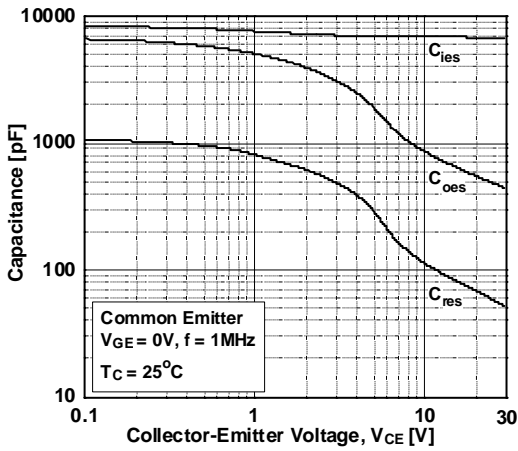


Figure 9. Capacitance Characteristics

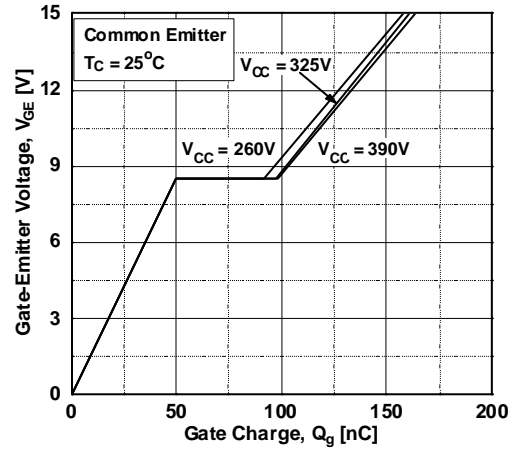


Figure 10. Gate charge Characteristics

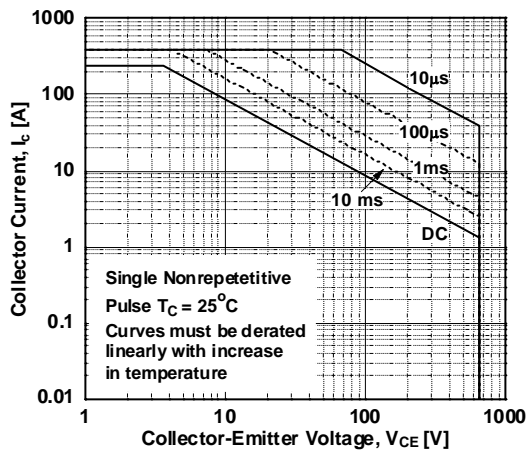


Figure 11. SOA Characteristics

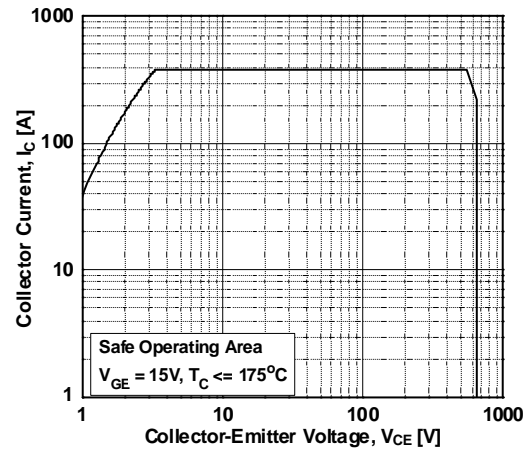


Figure 12. Turn off Switching SOA Characteristics

## Typical Performance Characteristics

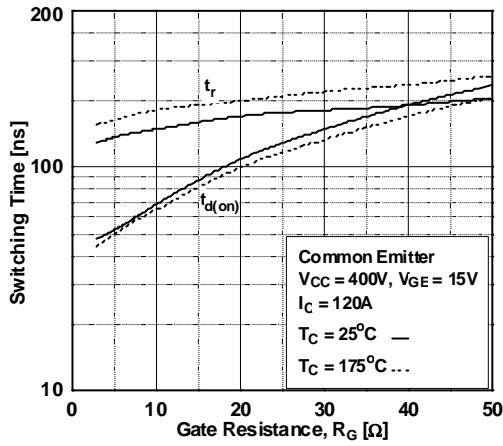


Figure 13. Turn-on Characteristics vs. Gate Resistance

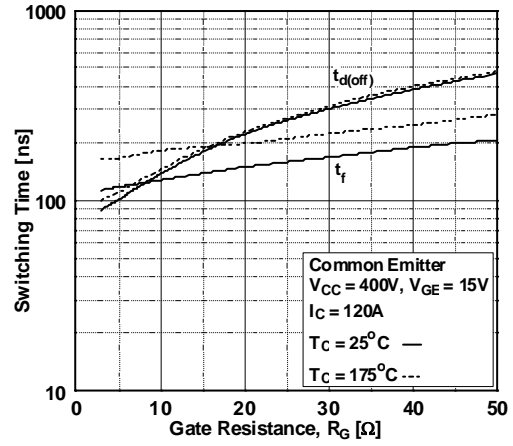


Figure 14. Turn-off Characteristics vs. Gate Resistance

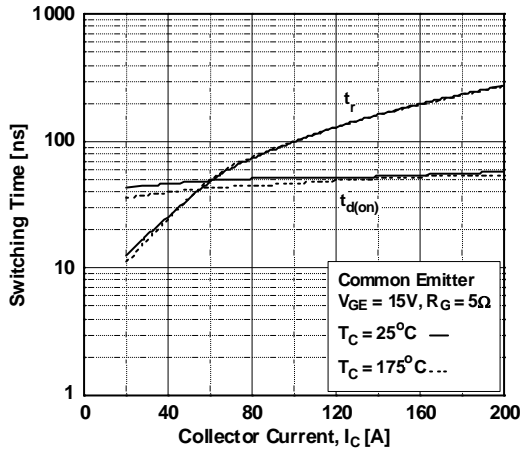


Figure 15. Turn-on Characteristics vs. Collector Current

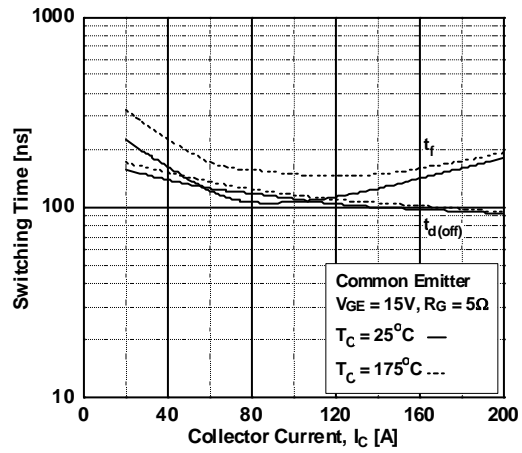


Figure 16. Turn-off Characteristics vs. Collector Current

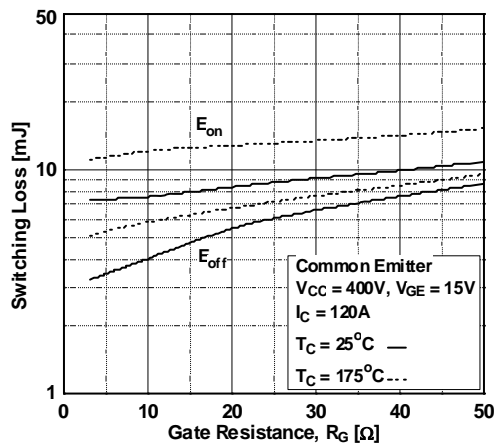


Figure 17. Switching Loss vs Gate Resistance

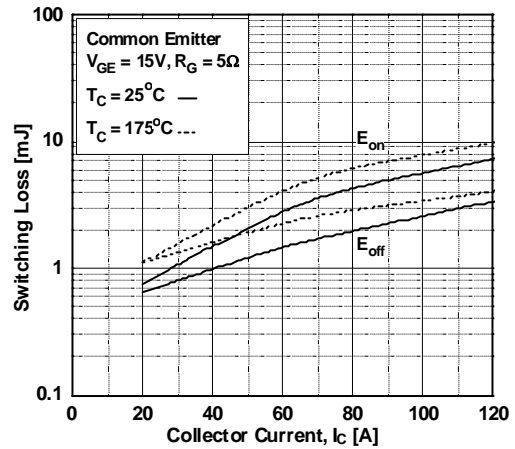


Figure 18. Switching Loss vs Collector Current

## Typical Performance Characteristics

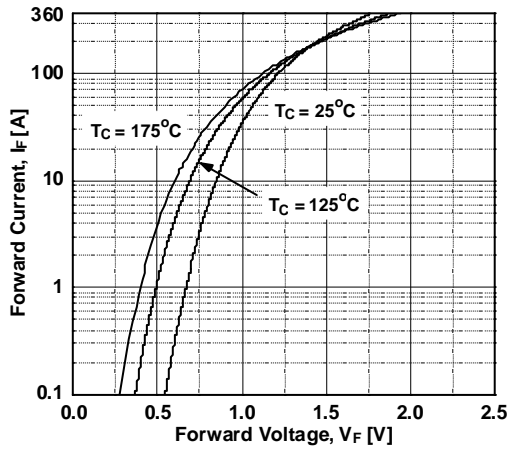


Figure 19. Forward Characteristics

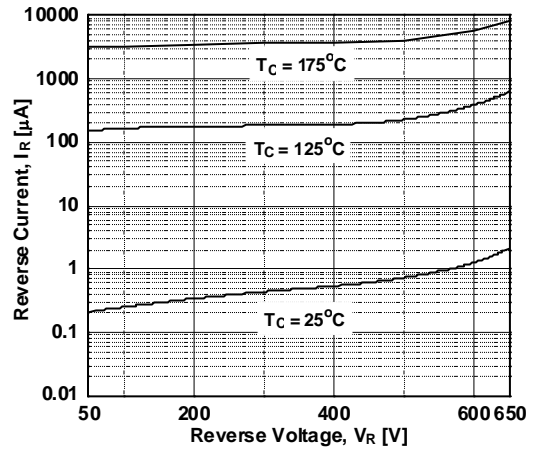


Figure 20. Reverse Current

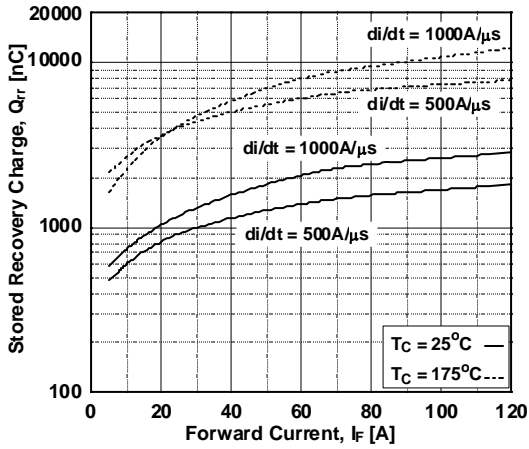


Figure 21. Stored Charge

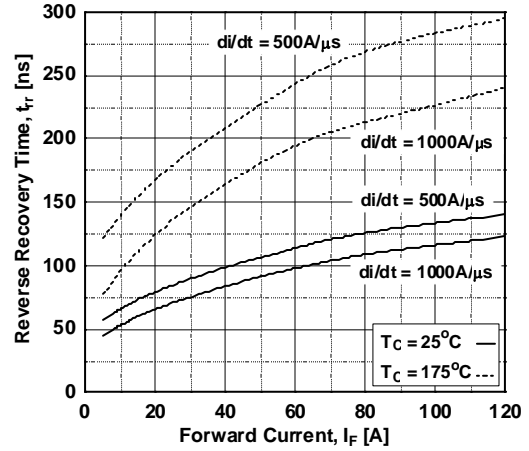


Figure 22. Reverse Recovery Time

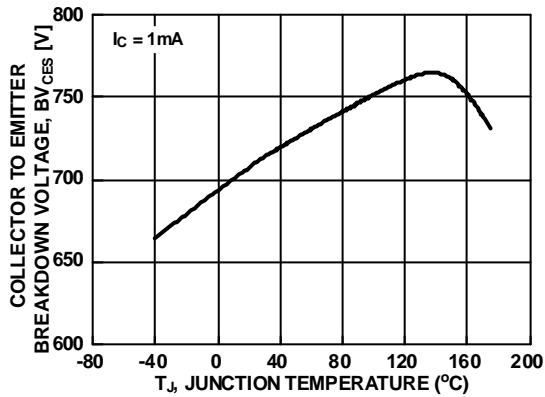


Figure 23. Collector to Emitter Breakdown Voltage vs. Junction Temperature

Typical Performance Characteristics

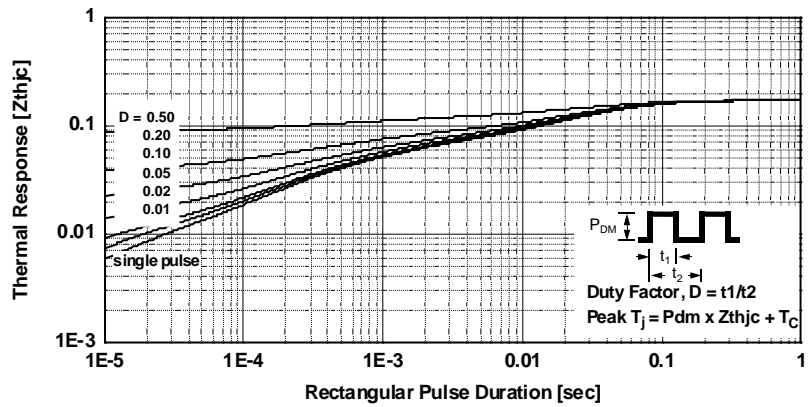


Figure 24. Transient Thermal Impedance of IGBT

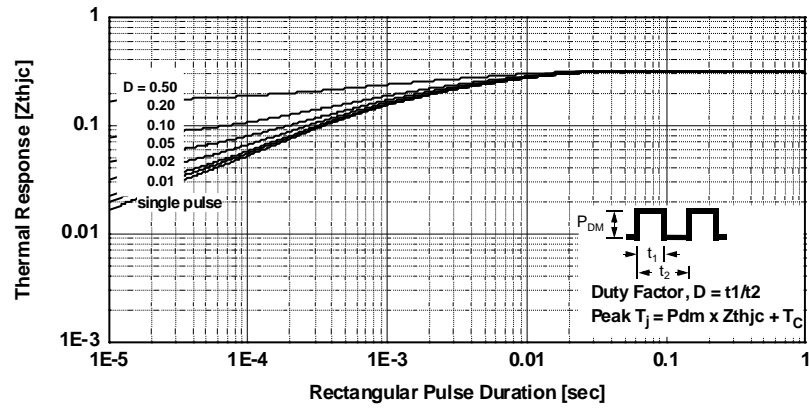


Figure 25. Transient Thermal Impedance of Diode

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local  
Sales Representative