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December 2016

ON Semiconductor®

FGAF40N60SMD
600 V, 40 A Field Stop IGBT

Features

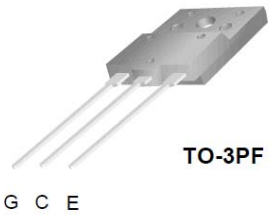
- Maximum Junction Temperature : T_J = 175°C
- Positive Temperaure Co-efficient for easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.9 V(Typ.) @ I_C = 40 A
- High Input Impedance
- Fast Swiching: E_{OFF} = 6.5 uJ/A
- Tightened Parameter Distribution
- RoHS Compliant

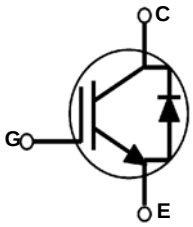
General Description

Using novel field stop IGBT technology, ON semiconductor's new series of field stop 2nd generation IGBTs offer the optimum performance for solar inverter, UPS, welder and PFC applications where low conduction and switching losses are essential.

Applications

- Sewing Machine, CNC
- Home Appliances, Motor-Control





Absolute Maximum Ratings

Symbol	Description		Ratings	Unit
V_{CES}	Collector to Emitter Voltage		600	V
V_{GES}	Gate to Emitter Voltage		± 20	V
I_C	Collector Current	@ T_C = 25°C	80*	A
	Collector Current	@ T_C = 100°C	40*	A
$I_{CM\ (1)}$	Pulsed Collector Current		120*	A
I_F	Diode Forward Current	@ T_C = 25°C	40*	A
	Diode Forward Current	@ T_C = 100°C	20*	A
$I_{FM\ (1)}$	Pulsed Diode Maximum Forward Current		120*	A
P_D	Maximum Power Dissipation	@ T_C = 25°C	115	W
	Maximum Power Dissipation	@ T_C = 100°C	58	W
T_J	Operating Junction Temperature		-55 to +175	°C
T_{stg}	Storage Temperature Range		-55 to +175	°C
T_L	Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds		300	°C

Notes:
*Drain current limited by maximum junction temperature
1: Repetitive rating: Pulse width limited by max. junction temperature

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit
$R_{\theta JC}$(IGBT)	Thermal Resistance, Junction to Case	-	1.3	$^oC/W$
$R_{\theta JC}$(Diode)	Thermal Resistance, Junction to Case	-	3.27	$^oC/W$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^oC/W$

Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FGAF40N60SMD	FGAF40N60SMD	TO-3PF	-	-	30

Electrical Characteristics of the IGBT T_C = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
BV_{CES}	Collector to Emitter Breakdown Voltage	V_{GE} = 0V, I_C = 250μA	600	-	-	V
$\frac{\Delta BV_{CES}}{\Delta T_J}$	Temperature Coefficient of Breakdown Voltage	V_{GE} = 0V, I_C = 250μA	-	0.6	-	$V/^oC$
I_{CES}	Collector Cut-Off Current	V_{CE} = V_{CES}, V_{GE} = 0V	-	-	250	μA
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 = 250μA, 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	-	V
		I_C = 40A, V_{GE} = 15V, T_C = 175°C	-	2.1	-	V
Dynamic Characteristics						
C_{ies}	Input Capacitance	V_{CE} = 30V, V_{GE} = 0V, f = 1MHz	-	1880	-	pF
C_{oes}	Output Capacitance		-	180	-	pF
C_{res}	Reverse Transfer Capacitance		-	50	-	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{CC} = 400V, I_C = 40A, R_G = 6Ω, V_{GE} = 15V, Inductive Load, T_C = 25°C	-	12	-	ns
t_r	Rise Time		-	20	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	92	-	ns
t_f	Fall Time		-	13	17	ns
E_{on}	Turn-On Switching Loss		-	0.87	-	mJ
E_{off}	Turn-Off Switching Loss		-	0.26	0.34	mJ
E_{ts}	Total Switching Loss		-	1.13	-	mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CC} = 400V, I_C = 40A, R_G = 6Ω, V_{GE} = 15V, Inductive Load, T_C = 175°C	-	15	-	ns
t_r	Rise Time		-	22	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	116	-	ns
t_f	Fall Time		-	16	-	ns
E_{on}	Turn-On Switching Loss		-	0.97	-	mJ
E_{off}	Turn-Off Switching Loss		-	0.60	-	mJ
E_{ts}	Total Switching Loss		-	1.57	-	mJ

Electrical Characteristics of the IGBT (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
Q_g	Total Gate Charge	V_{CE} = 400V, I_C = 40A, V_{GE} = 15V	-	119	-	nC
Q_{ge}	Gate to Emitter Charge		-	13	-	nC
Q_{gc}	Gate to Collector Charge		-	58	-	nC

Electrical Characteristics of the Diode T_C = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min.	Typ.	Max	Unit
V_{FM}	Diode Forward Voltage	I_F = 20A	T_C = 25°C	-	2.3	-	V
			T_C = 175°C	-	1.67	-	
E_{rec}	Reverse Recovery Energy	I_F =20A, dI_F/dt = 200A/μs	T_C = 175°C	-	48.9	-	uJ
t_{rr}	Diode Reverse Recovery Time		T_C = 25°C	-	36	-	ns
			T_C = 175°C	-	110	-	
Q_{rr}	Diode Reverse Recovery Charge		T_C = 25°C	-	46.8	-	nC
			T_C = 175°C	-	445	-	

Typical Performance Characteristics

Figure 1. Typical Output Characteristics

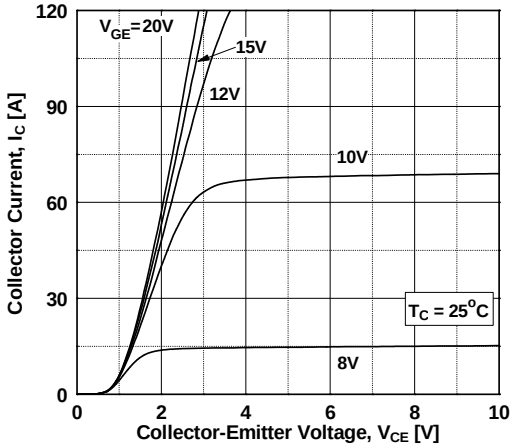


Figure 2. Typical Output Characteristics

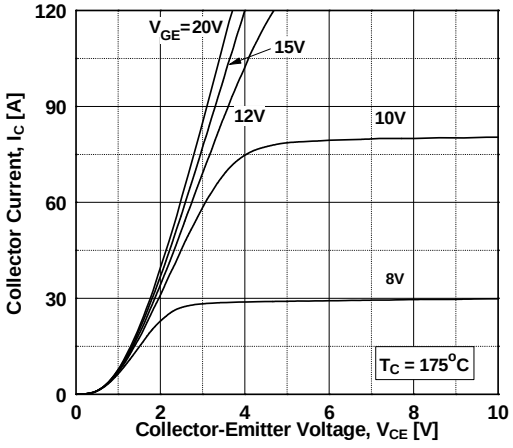


Figure 3. Typical Saturation Voltage Characteristics

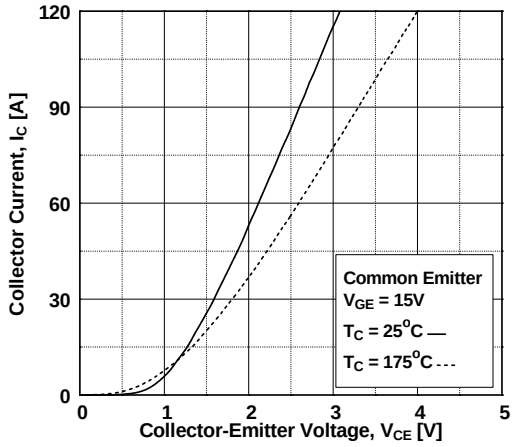


Figure 4. Transfer Characteristics

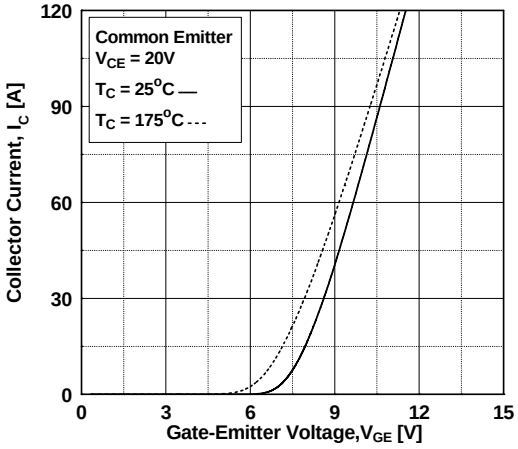


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

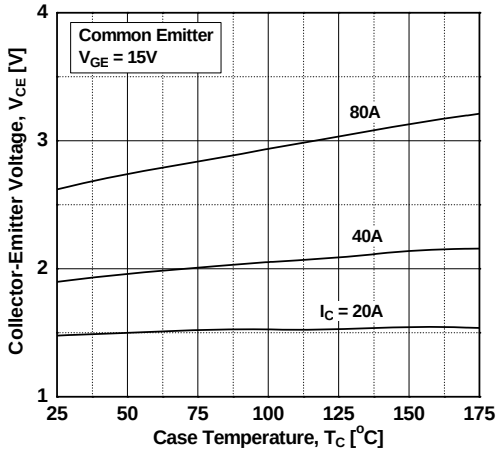
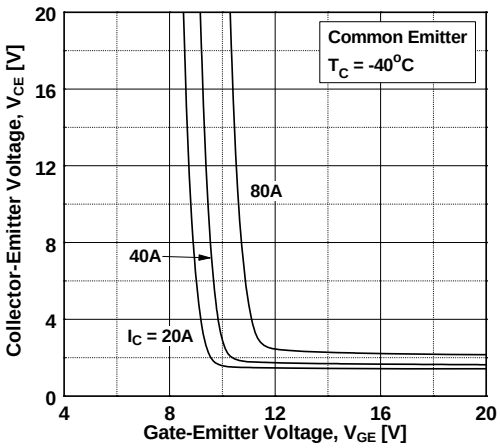


Figure 6. Saturation Voltage vs. V_{GE}



Typical Performance Characteristics

Figure 7. Saturation Voltage vs. V_{GE}

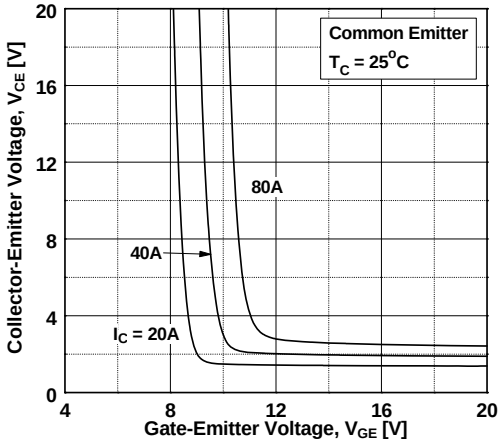


Figure 8. Saturation Voltage vs. V_{GE}

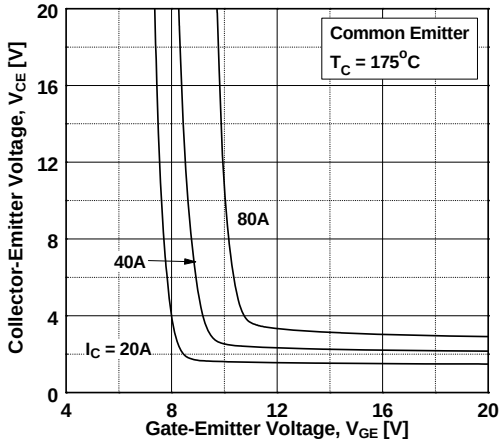


Figure 9. Capacitance Characteristics

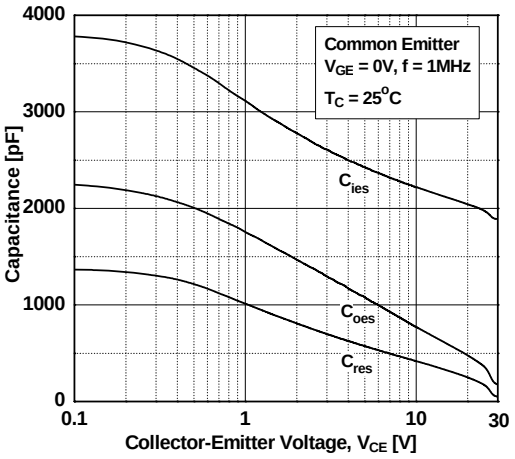


Figure 10. Gate charge Characteristics

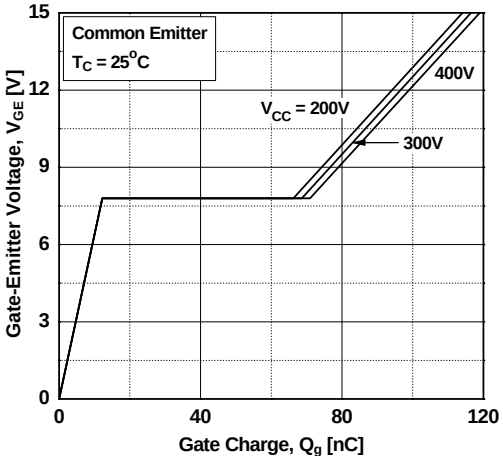


Figure 11. SOA Characteristics

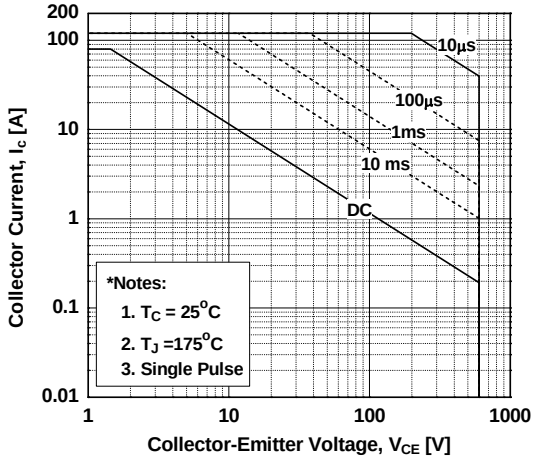
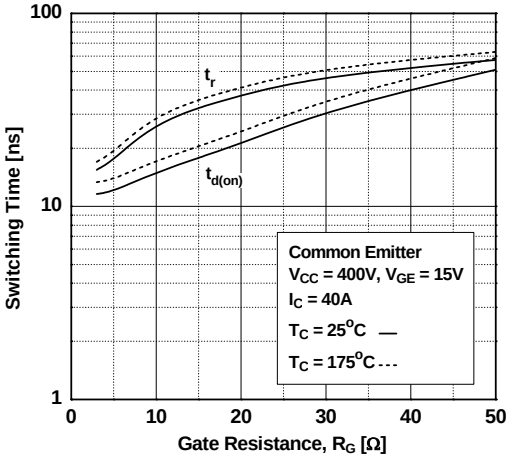


Figure 12. Turn-on Characteristics vs. Gate Resistance



Typical Performance Characteristics

Figure 13. Turn-off Characteristics vs. Gate Resistance

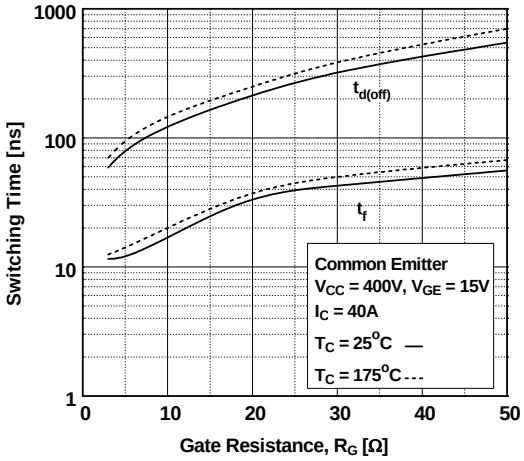


Figure 14. Turn-on Characteristics vs. Collector Current

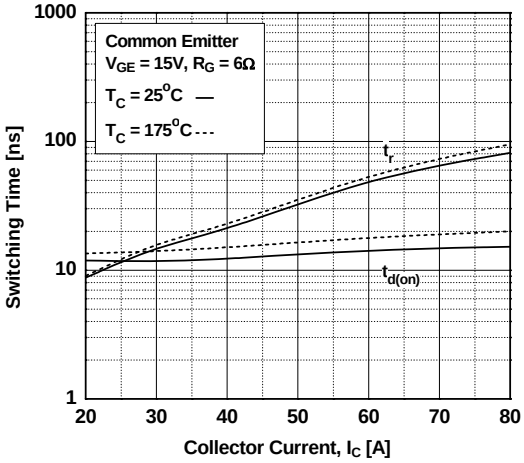


Figure 15. Turn-off Characteristics vs. Collector Current

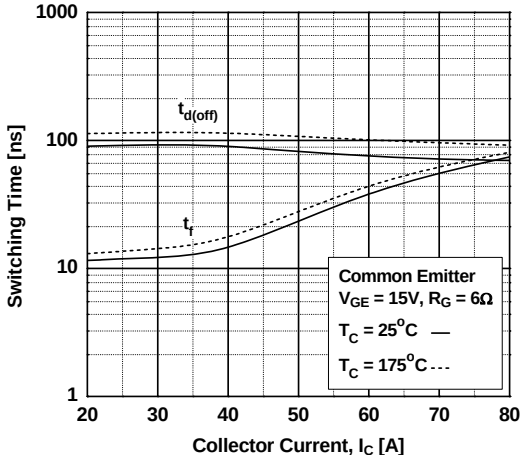


Figure 16. Switching Loss vs. Gate Resistance

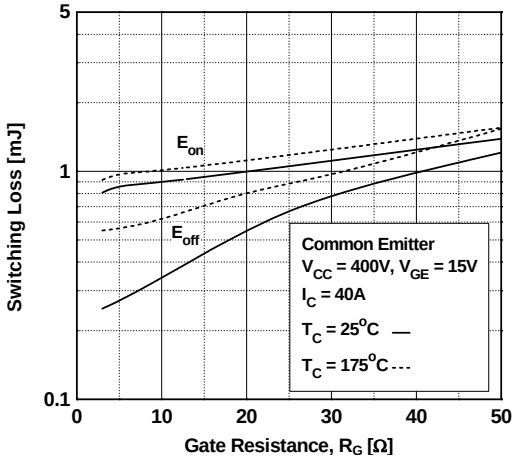


Figure 17. Switching Loss vs. Collector Current

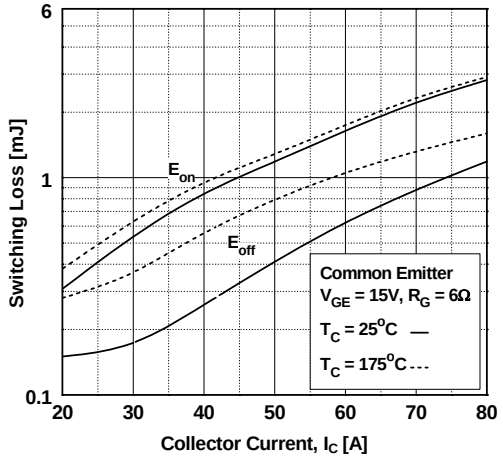
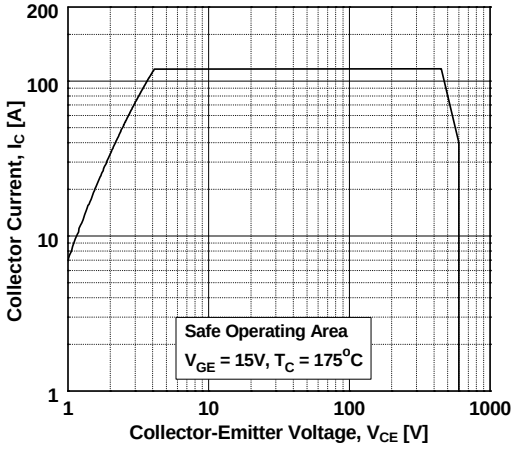


Figure 18. Turn off Switching SOA Characteristics



Typical Performance Characteristics

Figure 19. Current Derating

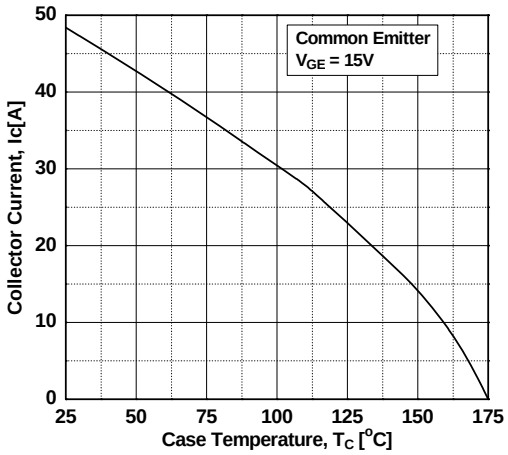


Figure 20. Power Dissipation

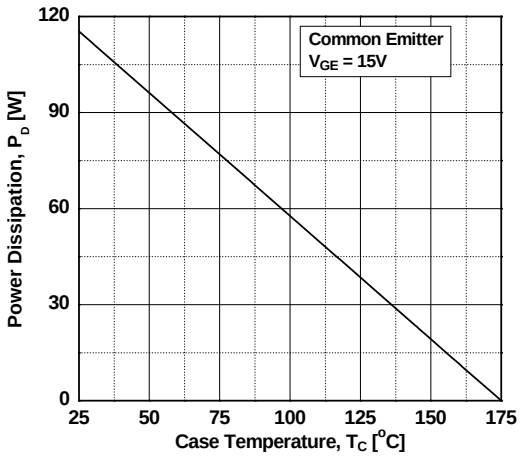


Figure 21. Load Current Vs. Frequency

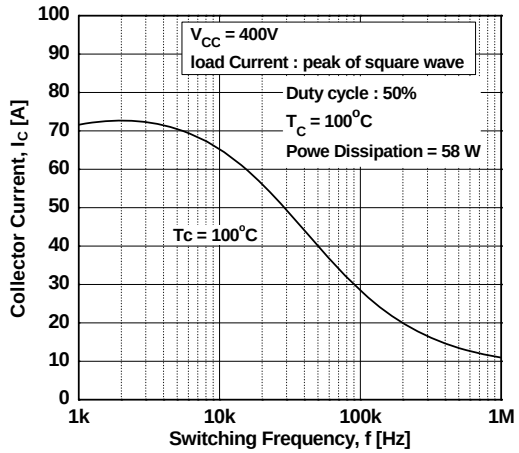


Figure 22. Forward Characteristics

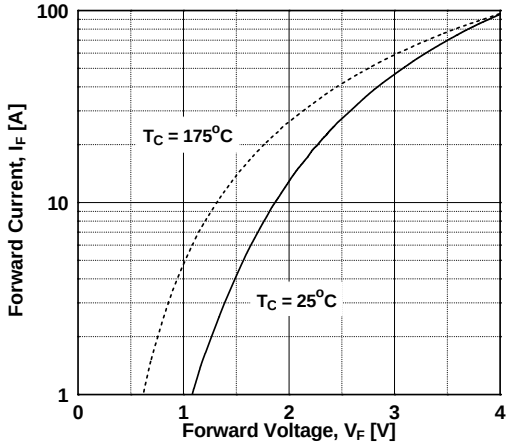


Figure 23. Reverse Current

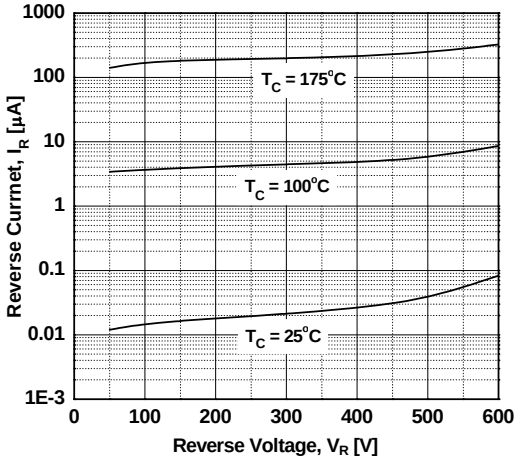
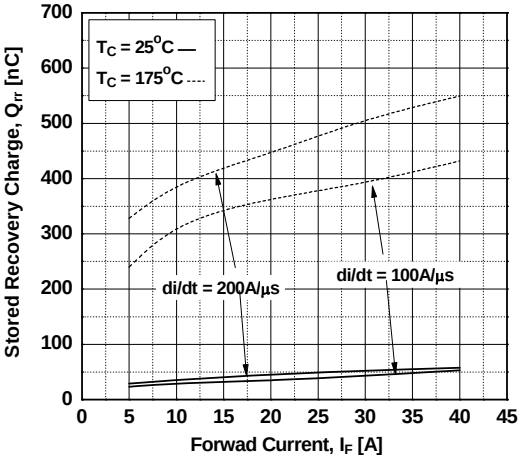


Figure 24. Stored Charge



Typical Performance Characteristics

Figure 25. Reverse Recovery Time

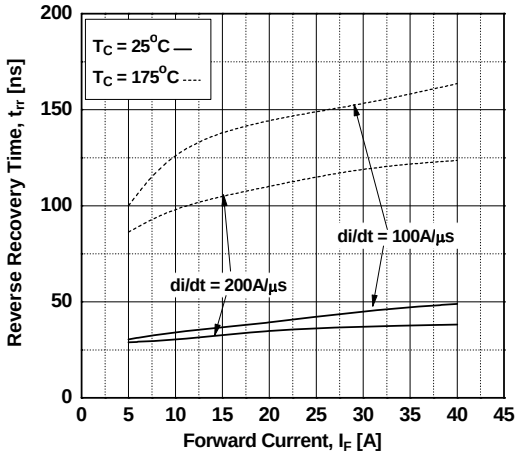


Figure 26.Transient Thermal Impedance of IGBT

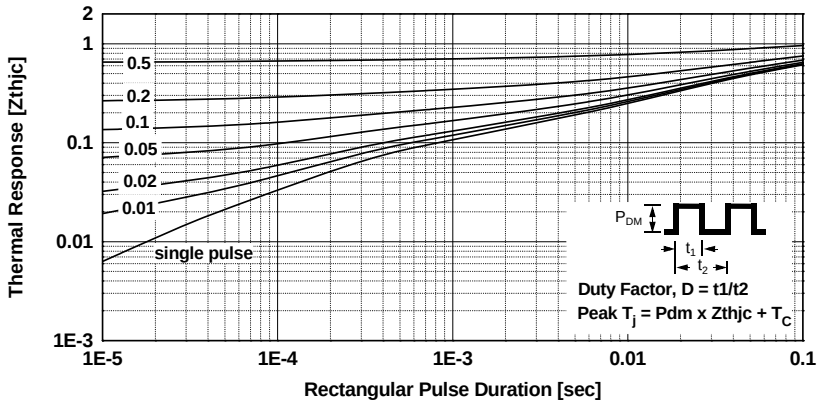
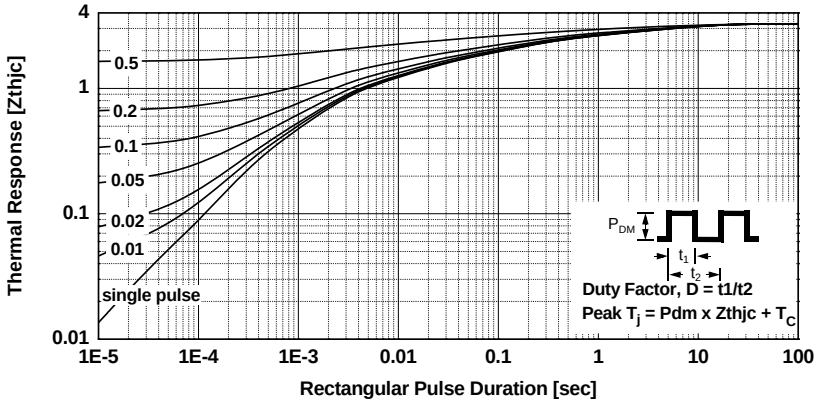
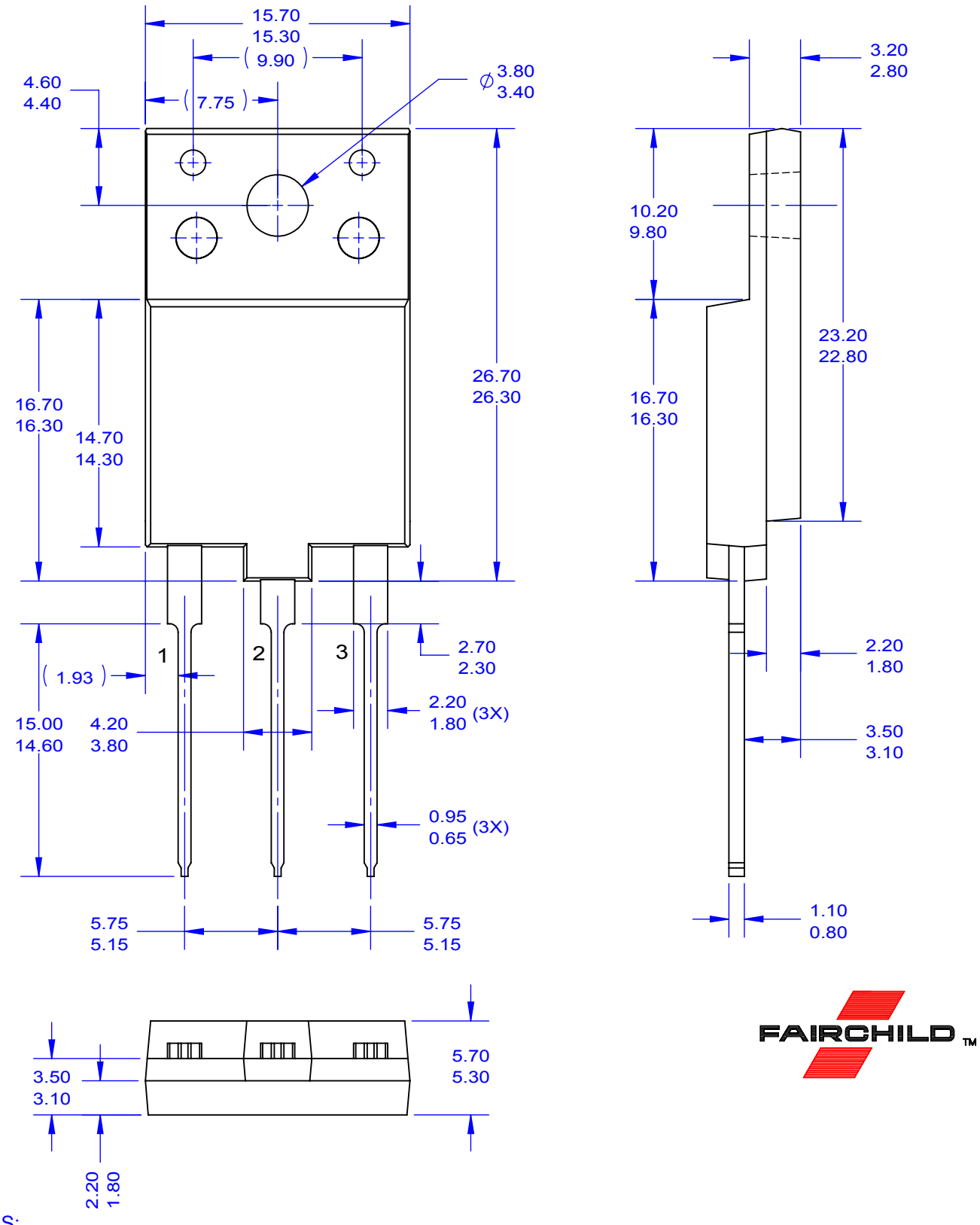


Figure 27.Transient Thermal Impedance of Diode





NOTES:

A. THIS PACKAGE CONFORMS TO SC94
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B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS ARE EXCLUSIVE OF BURRS,
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