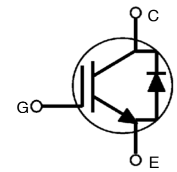
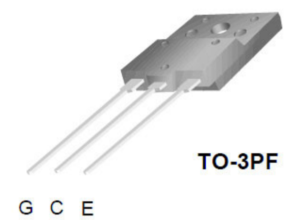
Field Stop Trench IGBT

650 V, 40 A

FGAF40S65AQ

V_{CES}	I_C
650 V	40 A





TO−3PF
CASE 340AH

Description

Using novel field stop IGBT technology, **onsemi**'s new series of field stop 4th generation of RC IGBTs offer the optimum performance for PFC applications and welder where low conduction and switching losses are essential.

Features

- Maximum Junction Temperature: T_J = 175°C
- Positive Temperature Co−efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.6 V (Typ.) @ I_C = 40 A
- 100% of the Parts Tested for I_{LM} (Note 1)
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- IGBT with Monolithic Reverse Conducting Diode
- This Device is Pb−Free and is RoHS Compliant

Applications

- PFC, Welder

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Device Marking	Package	Reel Size	Tape Width	Quantity per Tube
FGAF40S65AQ	FGAF40S65AQ	TO−3PF	–	–	30

Table 1. ABSOLUTE MAXIMUM RATINGS

Symbol	Description		FGAF40S65AQ	Unit
V_{CES}	Collector to Emitter Voltage		650	V
V_{GES}	Gate to Emitter Voltage		±20	V
	Transient Gate to Emitter Voltage		±30	V
I_C	Collector Current	@ T_C = 25°C	80	A
		@ T_C = 100°C	40	
I_{LM} (Note 1)	Pulsed Collector Current	@ T_C = 25°C	160	A
I_{CM} (Note 2)	Pulsed Collector Current		160	A
I_F	Diode Forward Current	@ T_C = 25°C	40	A
		@ T_C = 100°C	20	A
I_{FM} (Note 2)	Pulsed Diode Maximum Forward Current		160	A
P_D	Maximum Power Dissipation	@ T_C = 25°C	94	W
		@ T_C = 100°C	47	W
T_J	Operating Junction Temperature Range		−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 sec		300	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. V_{CC} = 400 V, V_{GE} = 15 V, I_C = 160 A, R_G = 7 Ω, Inductive Load.
2. Repetitive rating: Pulse width limited by max. junction temperature.

Table 2. THERMAL CHARACTERISTICS

Symbol	Parameter	FGAF40S65AQ	Unit
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case, Max.	1.6	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	°C/W

Table 3. 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} = 0 V, I_C = 1 mA	650	–	–	V
$\Delta BV_{CES} / \Delta T_J$	Temperature Coefficient of Breakdown Voltage	V_{GE} = 0 V, I_C = 1 mA	–	0.5	–	V/°C
I_{CES}	Collector Cut−Off Current	$V_{CE} = V_{CES}$, V_{GE} = 0 V	–	–	250	μA
I_{GES}	G−E Leakage Current	$V_{GE} = V_{GES}$, V_{CE} = 0 V	–	–	±400	nA
ON CHARACTERISTICS						
$V_{GE(th)}$	G−E Threshold Voltage	I_C = 40 mA, $V_{CE} = V_{GE}$	2.6	5.3	6.6	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	I_C = 40 A, V_{GE} = 15 V	–	1.6	2.1	V
		I_C = 40 A, V_{GE} = 15 V, T_C = 175°C	–	1.9	–	V
DYNAMIC CHARACTERISTICS						
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	2590	–	pF
C_{oes}	Output Capacitance		–	35	–	pF
C_{res}	Reverse Transfer Capacitance		–	10	–	pF
SWITCHING CHARACTERISTICS						
$T_{d(on)}$	Turn−On Delay Time	V_{CC} = 400 V, I_C = 10 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 25°C	–	17.8	–	ns
T_r	Rise Time		–	6.3	–	ns
$T_{d(off)}$	Turn−Off Delay Time		–	81.6	–	ns
T_f	Fall Time		–	9.3	–	ns
E_{on}	Turn−On Switching Loss		–	132	–	μJ
E_{off}	Turn−Off Switching Loss		–	62	–	μJ
E_{ts}	Total Switching Loss		–	194	–	μJ
$T_{d(on)}$	Turn−On Delay Time	V_{CC} = 400 V, I_C = 20 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 25°C	–	19.5	–	ns
T_r	Rise Time		–	9.6	–	ns
$T_{d(off)}$	Turn−Off Delay Time		–	76.8	–	ns
T_f	Fall Time		–	7.4	–	ns
E_{on}	Turn−On Switching Loss		–	296	–	μJ
E_{off}	Turn−Off Switching Loss		–	111	–	μJ
E_{ts}	Total Switching Loss		–	407	–	μJ
$T_{d(on)}$	Turn−On Delay Time	V_{CC} = 400 V, I_C = 10 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 175°C	–	17.5	–	ns
T_r	Rise Time		–	6.8	–	ns
$T_{d(off)}$	Turn−Off Delay Time		–	88	–	ns
T_f	Fall Time		–	9.7	–	ns
E_{on}	Turn−On Switching Loss		–	285	–	μJ
E_{off}	Turn−Off Switching Loss		–	106	–	μJ
E_{ts}	Total Switching Loss		–	391	–	μJ

Table 3. ELECTRICAL CHARACTERISTICS OF THE IGBT (T_C = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS						
$T_{d(on)}$	Turn−On Delay Time	V_{CC} = 400 V, I_C = 20 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 175°C	–	19.1	–	ns
T_r	Rise Time		–	11.2	–	ns
$T_{d(off)}$	Turn−Off Delay Time		–	81.6	–	ns
T_f	Fall Time		–	9.2	–	ns
E_{on}	Turn−On Switching Loss		–	552	–	μJ
E_{off}	Turn−Off Switching Loss		–	186	–	μJ
E_{ts}	Total Switching Loss		–	738	–	μJ
Q_g	Total Gate Charge	V_{CE} = 400 V, I_C = 40 A, V_{GE} = 15 V	–	75	–	nC
Q_{ge}	Gate to Emitter Charge		–	15	–	nC
Q_{gc}	Gate to Collector Charge		–	18	–	nC

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

Table 4. 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 = 20 A	T_C = 25°C	–	1.2	1.6	V
			T_C = 175°C	–	1.16	–	
E_{rec}	Reverse Recovery Energy	I_F = 20 A, dI_F/dt = 200 A/μs	T_C = 175°C	–	325	–	μJ
T_{rr}	Diode Reverse Recovery Time		T_C = 25°C	–	274	–	ns
			T_C = 175°C	–	362	–	
Q_{rr}	Diode Reverse Recovery Charge		T_C = 25°C	–	1596	–	nC
			T_C = 175°C	–	2651	–	

TYPICAL CHARACTERISTICS

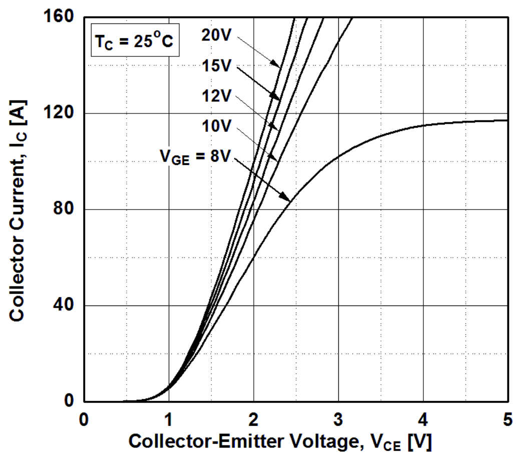


Figure 1. Typical Output Characteristics

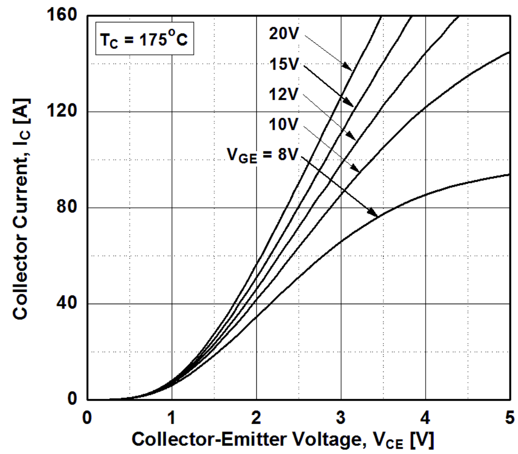


Figure 2. Typical Output Characteristics

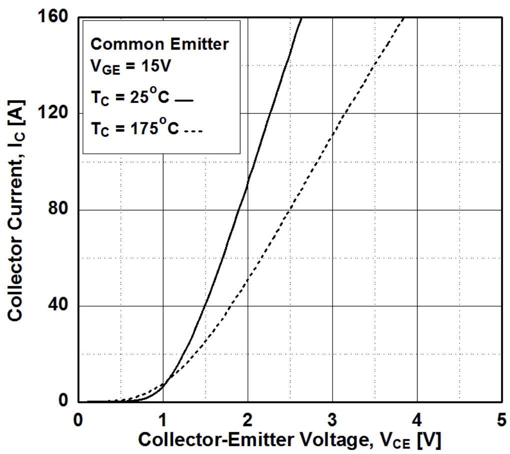


Figure 3. Typical Saturation Voltage Characteristics

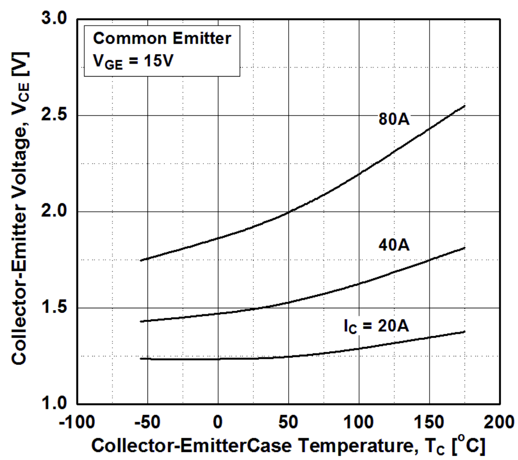


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

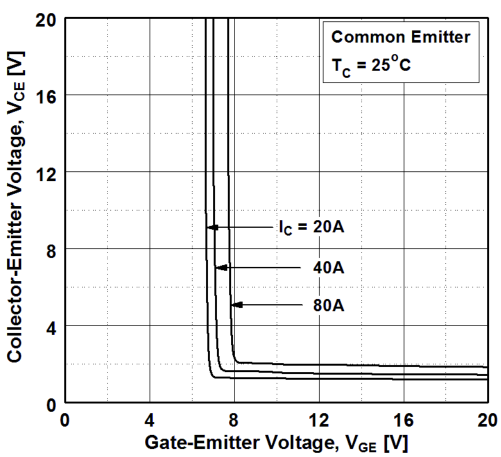


Figure 5. Saturation Voltage vs. V_{GE}

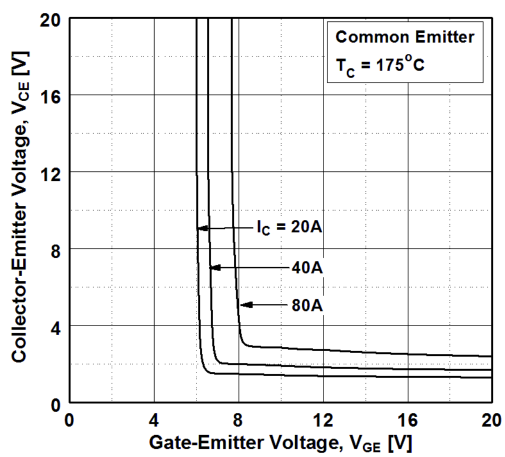


Figure 6. Saturation Voltage vs. V_{GE}

TYPICAL CHARACTERISTICS (continued)

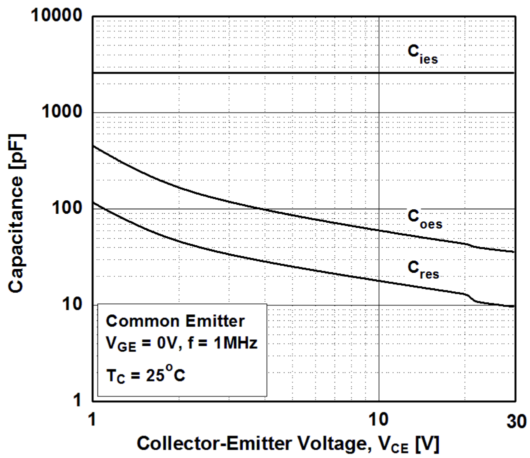


Figure 7. Capacitance Characteristics

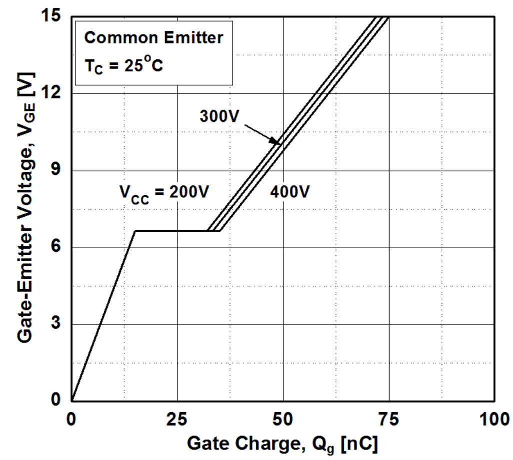


Figure 8. Gate Charge Characteristics

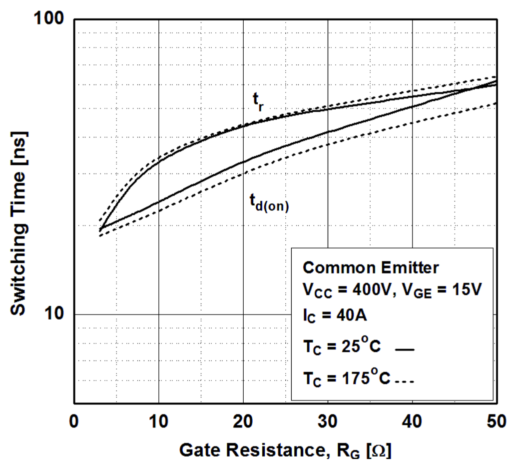


Figure 9. Turn−on Characteristics vs. Gate Resistance

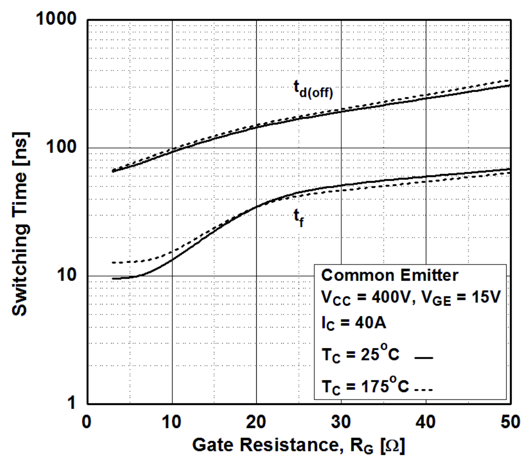


Figure 10. Turn−off Characteristics vs. Gate Resistance

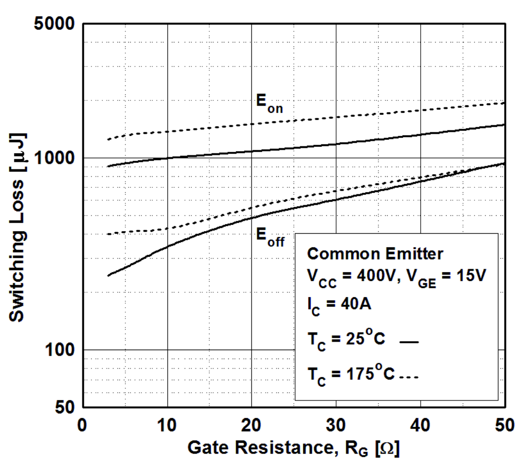


Figure 11. Switching Loss vs. Gate Resistance

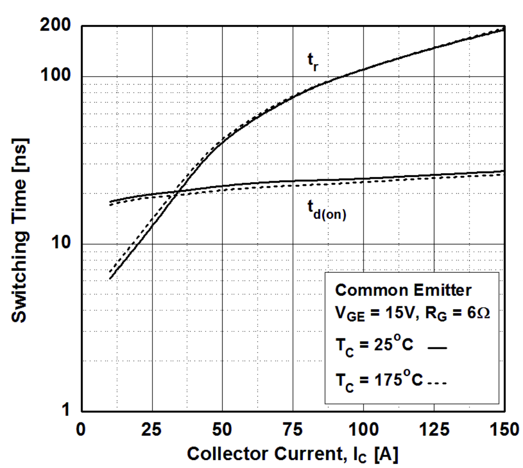


Figure 12. Turn−on Characteristics vs. Collector Current

TYPICAL CHARACTERISTICS (continued)

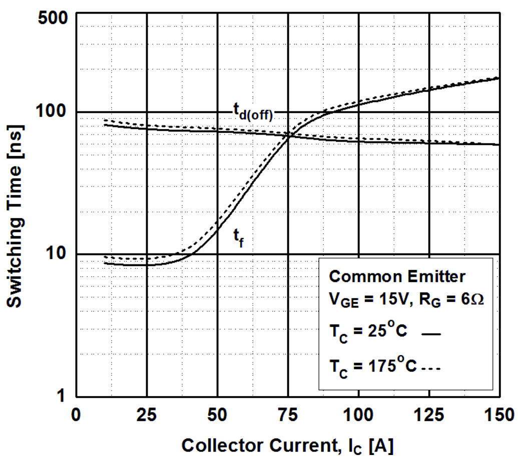


Figure 13. Turn−off Characteristics vs. Collector Current

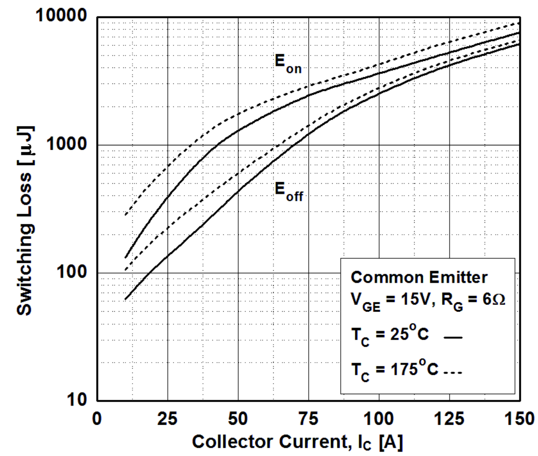


Figure 14. Switching Loss vs. Collector Current

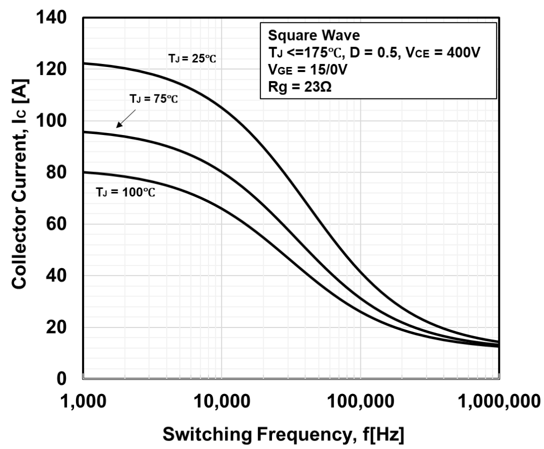


Figure 15. Load Current vs. Frequency

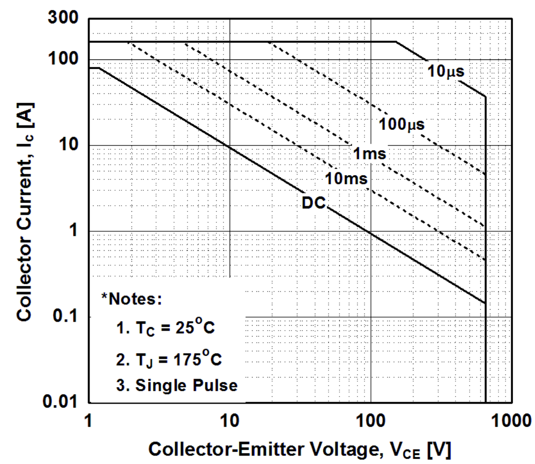


Figure 16. SOA Characteristics

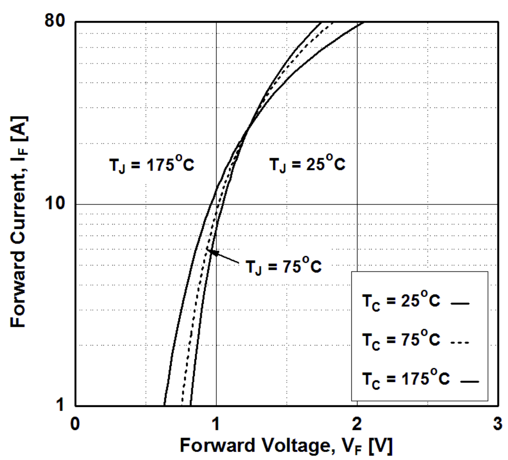


Figure 17. Forward Characteristics

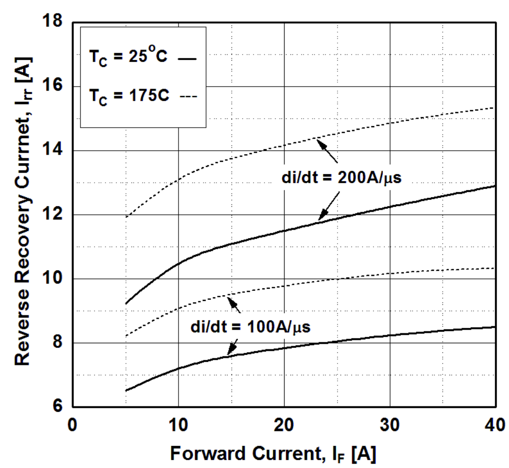


Figure 18. Reverse Recovery Current

TYPICAL CHARACTERISTICS (continued)

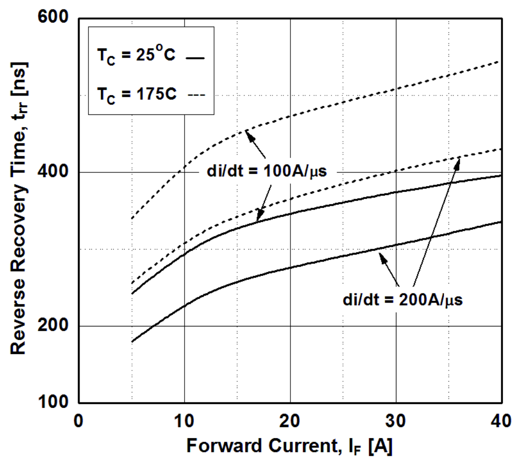


Figure 19. Reverse Recovery Time

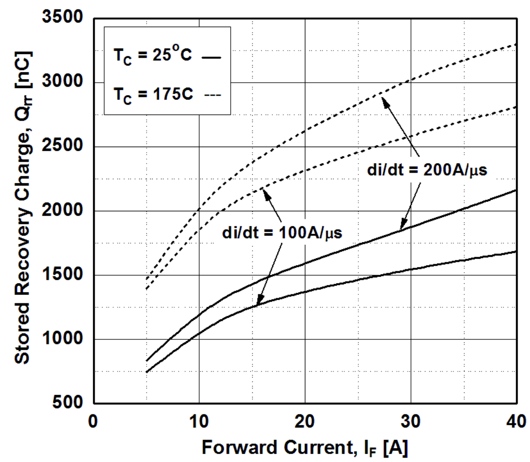


Figure 20. Stored Charge

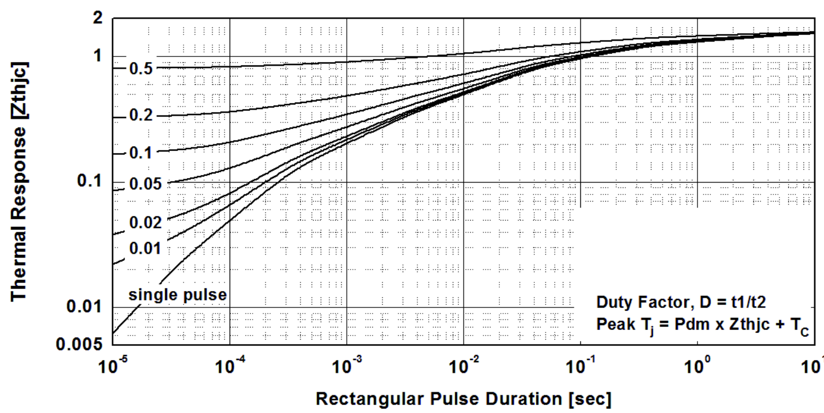
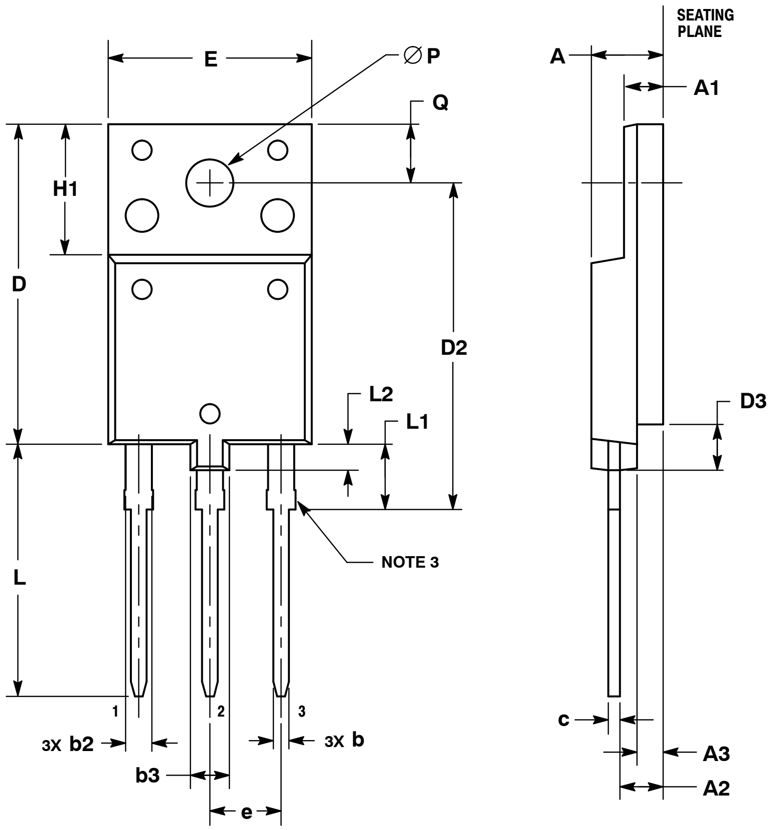


Figure 21. Transient Thermal Impedance of IGBT

TO−3PF−3L
CASE 340AH
ISSUE A

DATE 09 JAN 2015



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR UNCONTROLLED IN THIS AREA (6 PLACES).
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.13 PER SIDE. THESE DIMENSIONS ARE TO BE MEASURED AT THE OUTERMOST EXTREME OF THE PLASTIC BODY.
5. DIMENSION b2 DOES NOT INCLUDE DAMBAR PROTRUSION. LEAD WIDTH INCLUDING PROTRUSION SHALL NOT EXCEED 2.20.

	MILLIMETERS	
DIM	MIN	MAX
A	5.30	5.70
A1	2.80	3.20
A2	3.10	3.50
A3	1.80	2.20
b	0.65	0.95
b2	1.90	2.15
b3	3.80	4.20
c	0.80	1.10
D	24.30	24.70
D2	24.70	25.30
D3	3.30	3.70
E	15.30	15.70
e	5.35	5.55
H1	9.80	10.20
L	19.10	19.50
L1	4.80	5.20
L2	1.90	2.20
P	3.40	3.80
Q	4.30	4.70

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DESCRIPTION:	**TO−3PF−3L**	**PAGE 1 OF 1**

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