

Field Stop Trench IGBT, 20 A, 650 V

FGAF20S65AQ

Using novel field stop IGBT technology, ON Semiconductor'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: $T_J = 175^{\circ}\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(\text{Sat})} = 1.4\text{ V (Typ.)}$ @ $I_C = 20\text{ A}$
- 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

Typical Applications

- PFC, Welder

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V_{CES}	650	V
Gate to Emitter Voltage Transient Gate to Emitter Voltage	V_{GES}	± 20 ± 30	V
Collector Current @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	I_C	40 20	A
Pulsed Collector Current (Note 1)	I_{LM}	60	A
Pulsed Collector Current (Note 2)	I_{CM}	60	A
Diode Forward Current @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	I_F	20 10	A
Pulsed Diode Maximum Forward Current	I_{FM}	60	A
Maximum Power Dissipation @ $T_C = 25^{\circ}\text{C}$ @ $T_C = 100^{\circ}\text{C}$	P_D	75 37	W
Operating Junction / Storage Temperature Range	T_J, T_{STG}	-55 to +175	$^{\circ}\text{C}$
Maximum Lead Temp. for Soldering Purposes, 1/8" from case for 5 seconds	T_L	260	$^{\circ}\text{C}$

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.

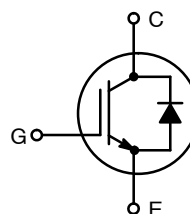
1. $V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $I_C = 60\text{ A}$, $R_G = 23\ \Omega$, Inductive Load, 100% Tested
2. Repetitive rating: pulse width limited by max. Junction temperature



ON Semiconductor®

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20 A, 650 V
 $V_{CE(\text{sat})} = 1.4\text{ V (Typ.)}$



TO-3PF
CASE 340AH

MARKING DIAGRAM



&Y = ON Semiconductor Logo
&E = Designate space on marking
&3 = 3-Digit Data Code
&K = 2-Digit Lot Traceability Code
FGAF20S65AQ = Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
FGAF20S65AQ	TO-3PF-3L	30 Units / Rail

FGAF20S65AQ

Table 1. THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case, for IGBT	$R_{\theta JC}$	2	°C/W
Thermal Resistance, Junction-to-Case, for Diode	$R_{\theta JC}$	3.6	°C/W
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	40	°C/W

Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTIC

Collector-emitter breakdown voltage, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	BV_{CES}	650	–	–	V
Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	$\Delta BV_{CES} / \Delta T_J$	–	0.5	–	V/°C
Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	I_{CES}	–	–	250	μA
Gate leakage current, collector-emitter short-circuited	$V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$	I_{GES}	–	–	±400	nA

ON CHARACTERISTIC

Gate-emitter threshold voltage	$V_{GE} = V_{CE}, I_C = 20\text{ mA}$	$V_{GE(th)}$	2.6	5.3	6.6	V
Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 175^\circ\text{C}$	$V_{CE(sat)}$	–	1.4 1.7	2.1 –	V

DYNAMIC CHARACTERISTIC

Input capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	C_{ies}	–	1319	–	pF
Output capacitance		C_{oes}	–	21	–	
Reverse transfer capacitance		C_{res}	–	6	–	
Gate charge total	$V_{CE} = 400\text{ V}, I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	Q_g	–	38	–	nC
Gate to emitter charge		Q_{ge}	–	9	–	
Gate to collector charge		Q_{gc}	–	11	–	

SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

Turn-on delay time	$T_J = 25^\circ\text{C}$ $V_{CC} = 400\text{ V}, I_C = 5\text{ A}$ $R_g = 23\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(on)}$	–	16	–	ns
Rise time		t_r	–	6.4	–	
Turn-off delay time		$t_{d(off)}$	–	109	–	
Fall time		t_f	–	27	–	
Turn-on switching loss		E_{on}	–	200	–	μJ
Turn-off switching loss		E_{off}	–	56	–	
Total switching loss		E_{ts}	–	256	–	
Turn-on delay time	$T_J = 25^\circ\text{C}$ $V_{CC} = 400\text{ V}, I_C = 10\text{ A}$ $R_g = 23\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(on)}$	–	18	–	ns
Rise time		t_r	–	11	–	
Turn-off delay time		$t_{d(off)}$	–	102	–	
Fall time		t_f	–	21	–	
Turn-on switching loss		E_{on}	–	345	–	μJ
Turn-off switching loss		E_{off}	–	95	–	
Total switching loss		E_{ts}	–	440	–	

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Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTIC, INDUCTIVE LOAD						
Turn-on delay time	$T_J = 175^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 5\text{ A}$ $R_g = 23\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(\text{on})}$	–	14.4	–	ns
Rise time		t_r	–	6.4	–	
Turn-off delay time		$t_{d(\text{off})}$	–	118	–	
Fall time		t_f	–	51	–	
Turn-on switching loss		E_{on}	–	301	–	μJ
Turn-off switching loss		E_{off}	–	94	–	
Total switching loss		E_{ts}	–	395	–	
Turn-on delay time	$T_J = 175^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 10\text{ A}$ $R_g = 23\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$t_{d(\text{on})}$	–	16	–	ns
Rise time		t_r	–	12	–	
Turn-off delay time		$t_{d(\text{off})}$	–	114	–	
Fall time		t_f	–	46	–	
Turn-on switching loss		E_{on}	–	466	–	μJ
Turn-off switching loss		E_{off}	–	177	–	
Total switching loss		E_{ts}	–	643	–	
DIODE CHARACTERISTIC						
Forward Voltage	$I_F = 10\text{ A}$ $I_F = 10\text{ A}, T_J = 175^{\circ}\text{C}$	V_F	– –	1.3 1.3	1.6 –	V
Reverse Recovery Energy	$I_F = 10\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$	E_{rec}	–	179	–	μJ
Diode Reverse Recovery Time	$I_F = 10\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$ $I_F = 10\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, T_J = 175^{\circ}\text{C}$	T_{rr}	–	235 302	–	nS
Diode Reverse Recovery Charge	$I_F = 10\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}$ $I_F = 10\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, T_J = 175^{\circ}\text{C}$	Q_{rr}	–	802 1286	–	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.

TYPICAL CHARACTERISTICS

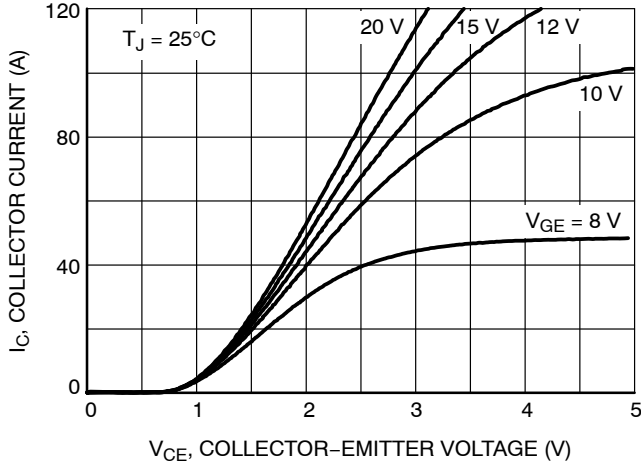


Figure 1. Typical Output Characteristics

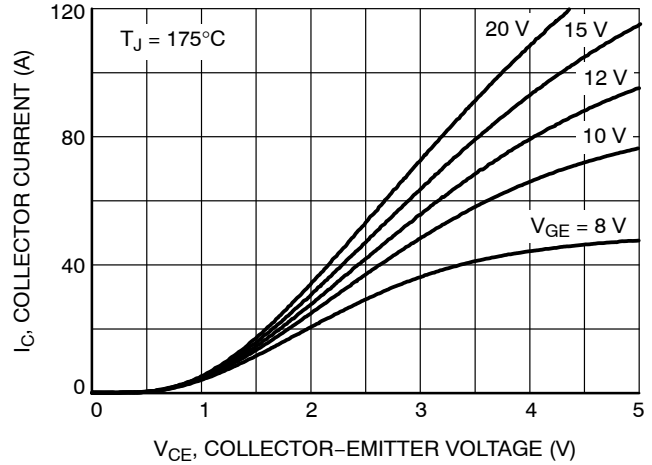


Figure 2. Typical Output Characteristics

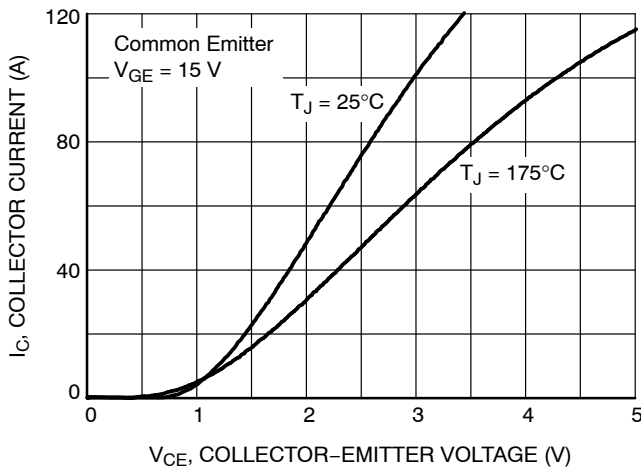


Figure 3. Typical Saturation Voltage Characteristics

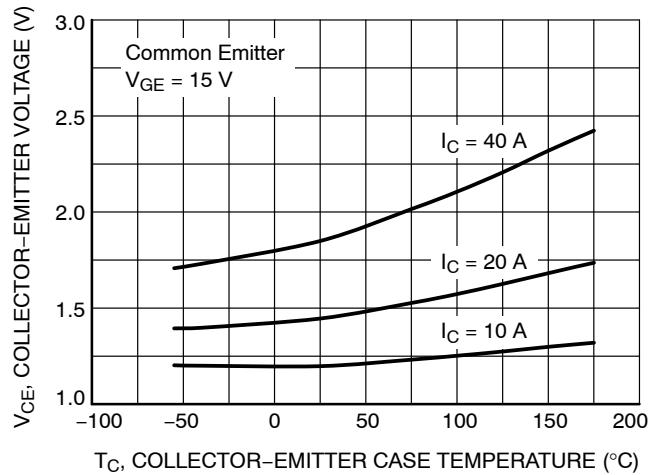


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

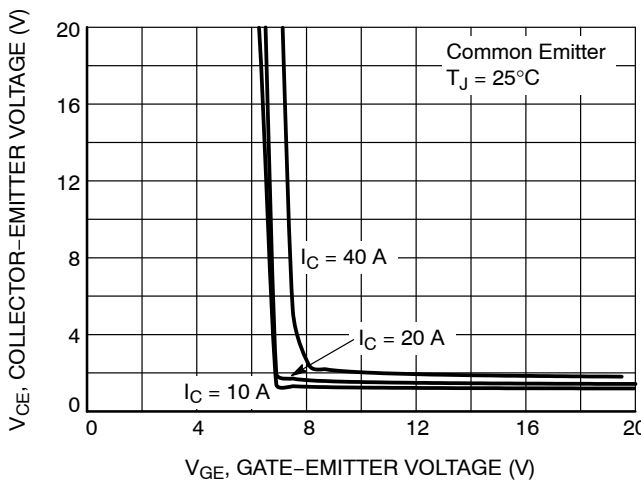


Figure 5. Saturation Voltage vs. V_{GE}

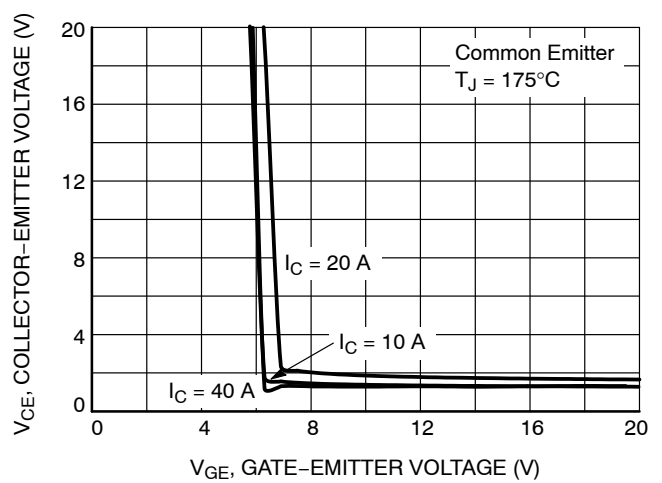


Figure 6. Saturation Voltage vs. V_{GE}

TYPICAL CHARACTERISTICS

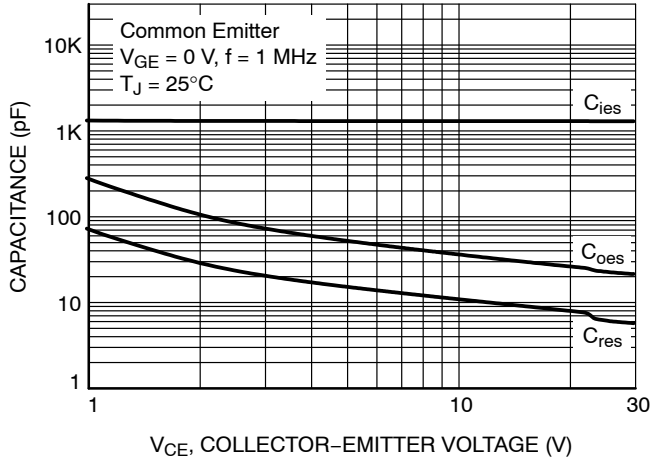


Figure 7. Capacitance Characteristics

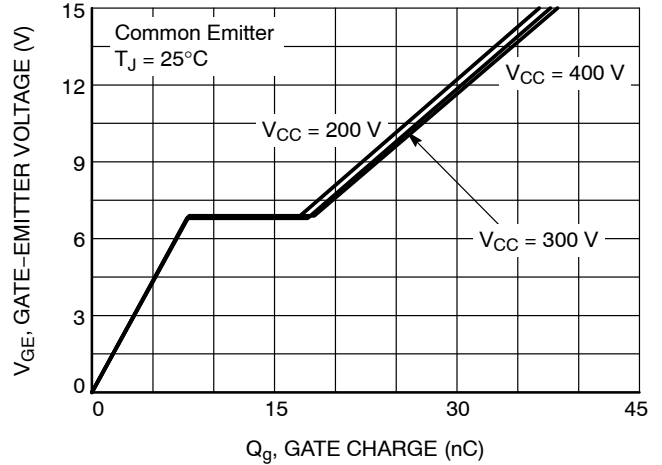


Figure 8. Gate Charge

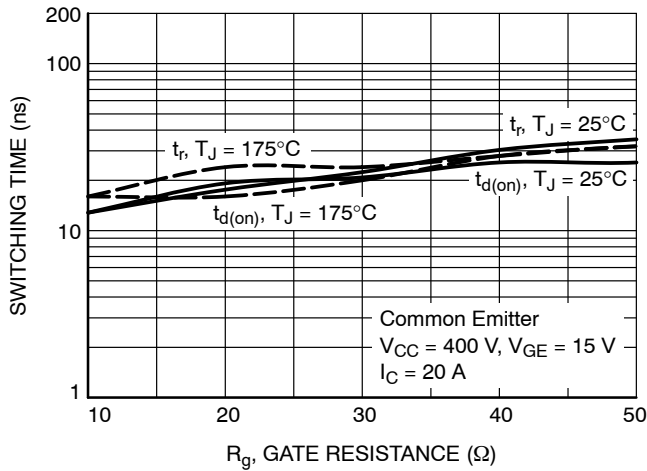


Figure 9. Turn-On Characteristics vs. Gate Resistance

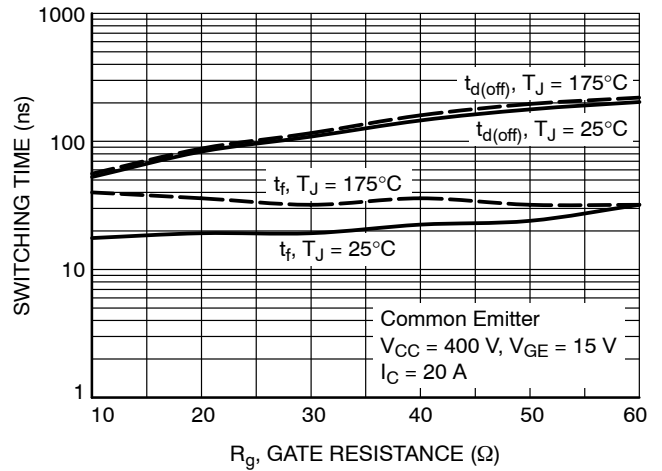


Figure 10. Turn-Off Characteristics vs. Gate Resistance

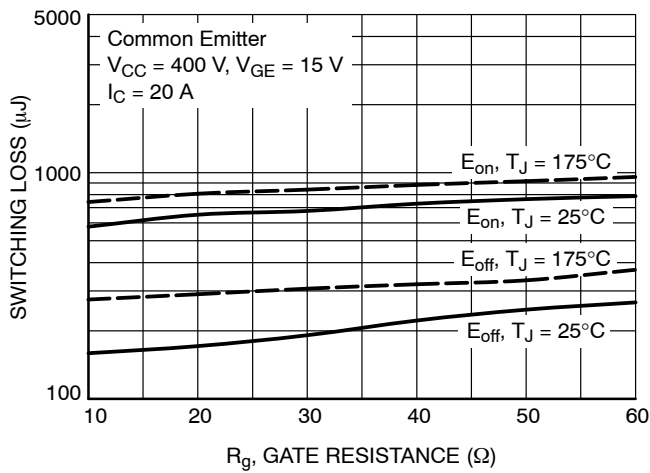


Figure 11. Switching Loss vs. Gate Resistance

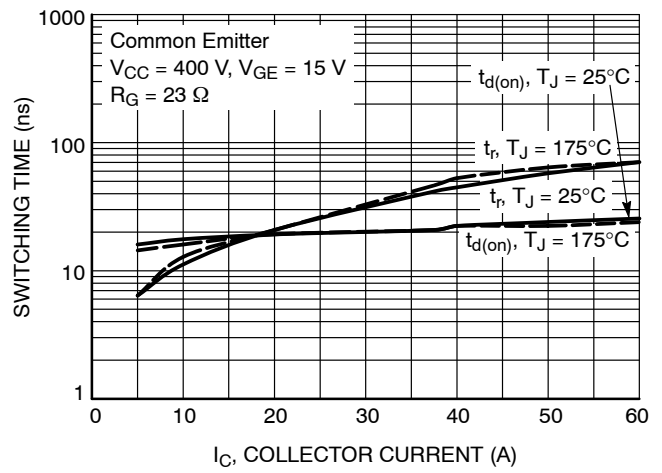


Figure 12. Turn-On Characteristics vs. Collector Current

TYPICAL CHARACTERISTICS

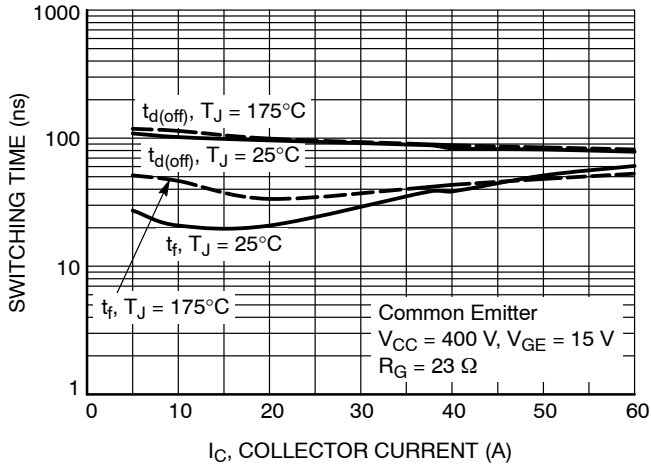


Figure 13. Turn-Off Characteristics vs. Collector Current

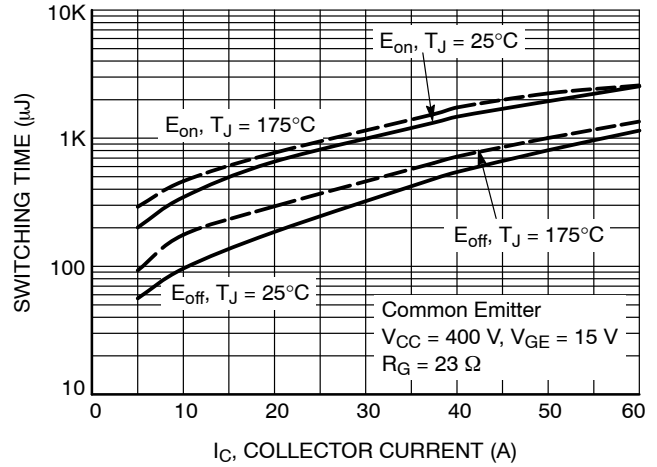


Figure 14. Switching Loss vs. Collector Current

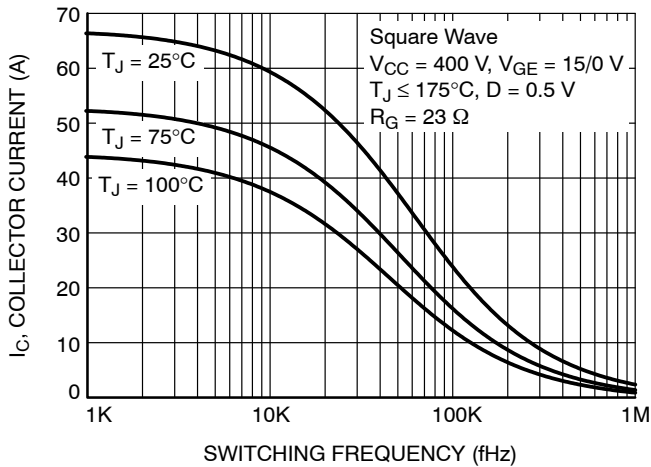


Figure 15. Load Current vs. Frequency

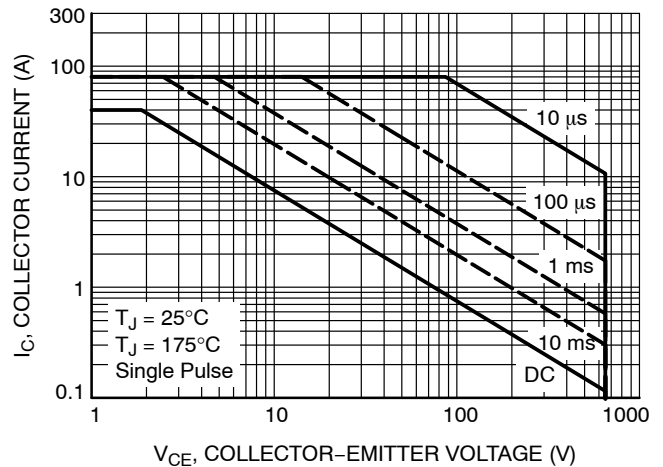


Figure 16. SOA Characteristics (FBSOA)

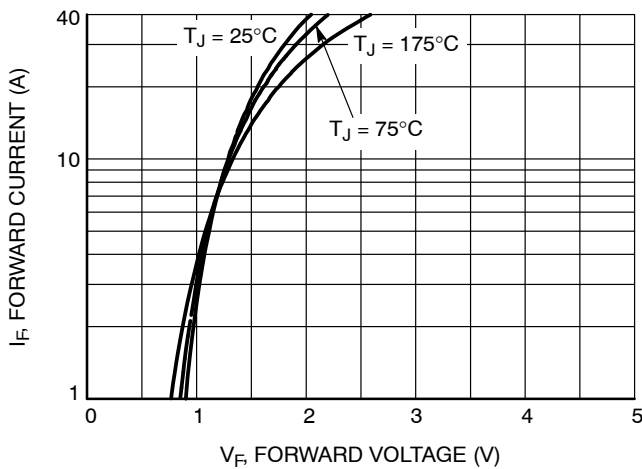


Figure 17. Forward Characteristics

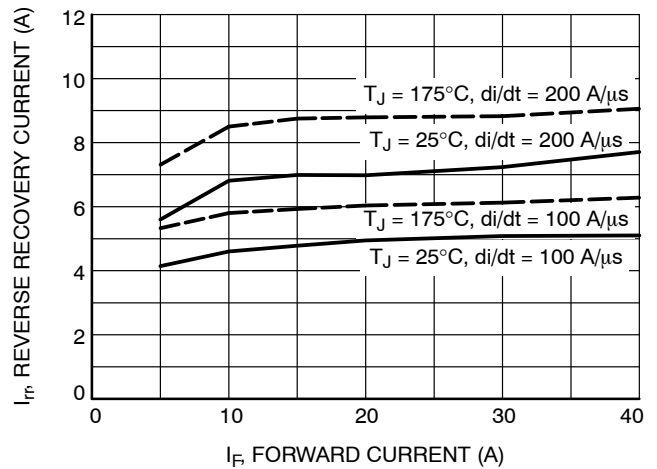


Figure 18. Reverse Recovery Current

TYPICAL CHARACTERISTICS

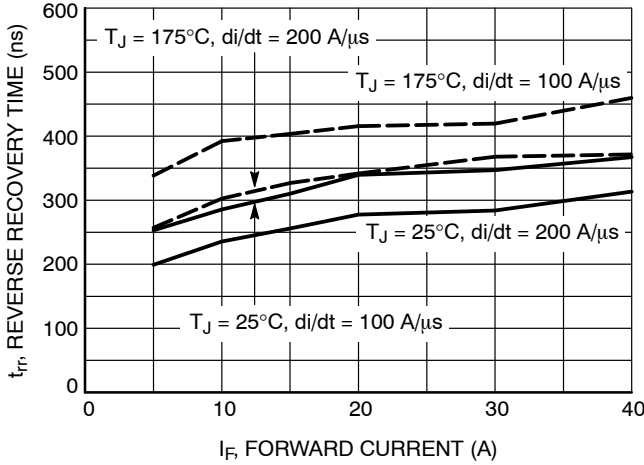


Figure 19. Reverse Recovery Time

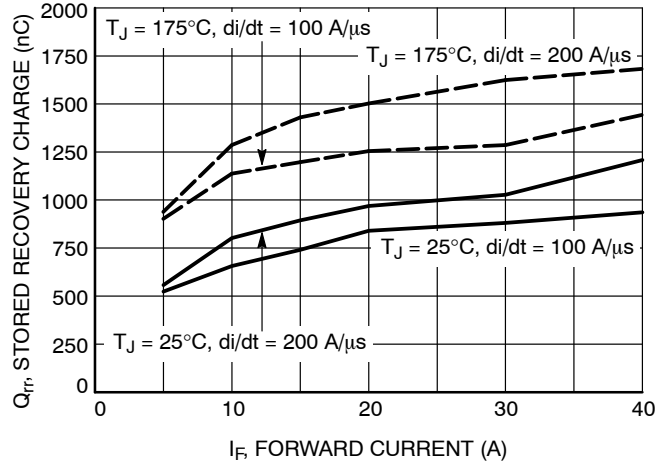


Figure 20. Stored Charge

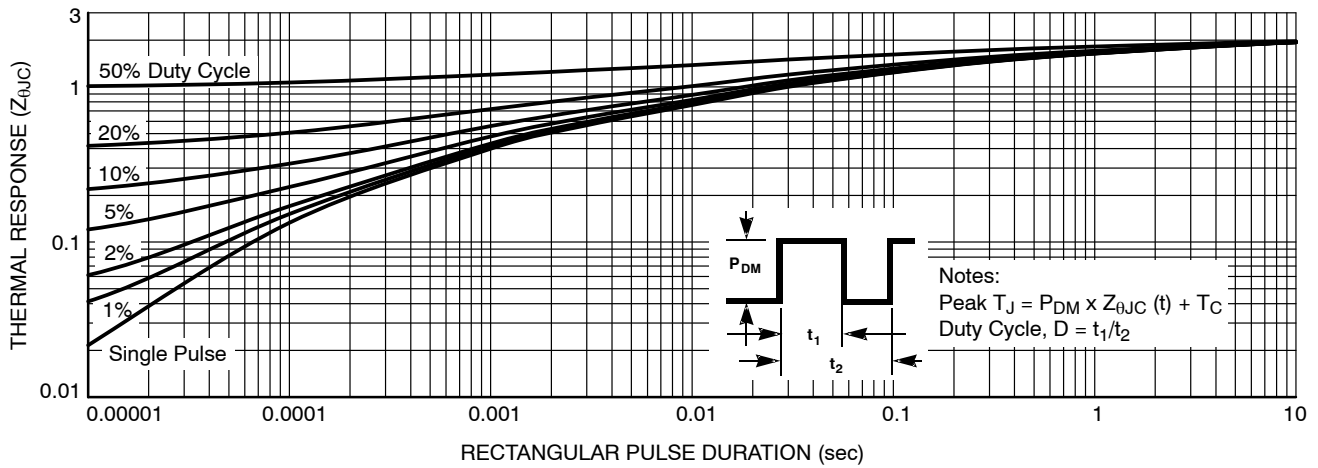


Figure 21. Transient Thermal Impedance of IGBT

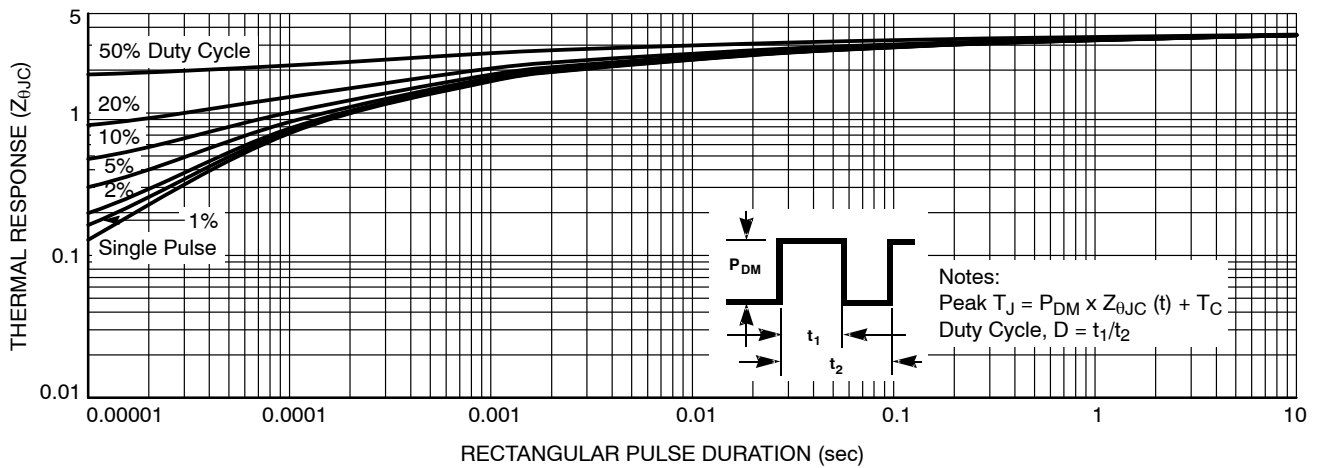
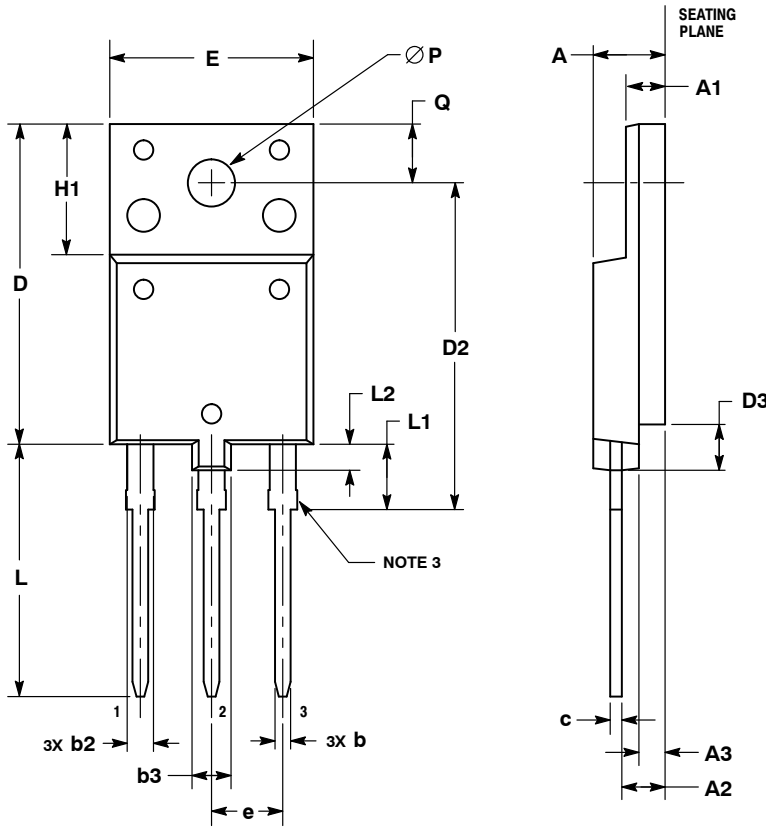


Figure 22. Transient Thermal Impedance of Diode

FGAF20S65AQ

PACKAGE DIMENSIONS

TO-3PF-3L CASE 340AH ISSUE A



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.

DIM	MILLIMETERS	
	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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