

# IGBT - Field Stop, Trench

## 650 V, 40 A

### FGB40T65SPD-F085

#### General Description

Using the novel field stop 3rd generation IGBT technology, FGB40T65SPD-F085 offers the optimum performance with both low conduction loss and switching loss for a high efficiency operation in various applications, while provides 50 V higher blocking voltage and rugged high current switching reliability. Meanwhile, this part also offers an advantage of outstanding performance in parallel operation.

#### Features

- Low Saturation Voltage:  $V_{CE(sat)} = 2.0 \text{ V (Typ.) @ } I_C = 40 \text{ A}$
- 100% of the Parts are Dynamically Tested \*
- Short Circuit Ruggedness  $> 5 \mu\text{s @ } 25^\circ\text{C}$
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Fast Switching
- Tight Parameter Distribution
- Positive Temperature Coefficient for Easy Parallel Operation
- Copacked with Soft, Fast Recovery Diode
- AEC-Q101 Qualified and PPAP Capable
- This Device is Pb-Free and are RoHS Compliant

\*  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $I_C = 120 \text{ A}$ ,  $R_G = 20 \Omega$ , Inductive Load

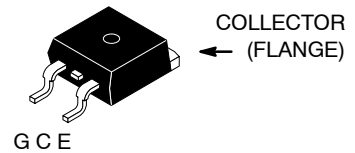
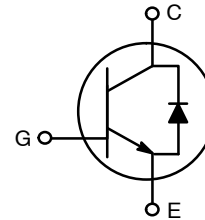
#### Applications

- Onboard Charger
- AirCon Compressor
- PTC Heater
- Motor Drivers
- Other Automotive Power-train and Auxiliary Applications



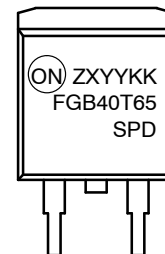
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**D<sup>2</sup>PAK-3 (TO-263, 3-LEAD)**  
**CASE 418AJ**

#### MARKING DIAGRAM



FGB40T65SPD = Specific Device Code  
Z = Assembly Plant Code  
XYK = 3-Digit Data Code  
KK = 2-Digits Lot Run Traceability

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

# FGB40T65SPD-F085

## ABSOLUTE MAXIMUM RATINGS

Symbol	Description	Ratings	Unit
$V_{CES}$	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 @ $T_C = 25^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100^\circ\text{C}$	40	A
$I_{CM}$	Pulsed Collector Current (Note 1)	120	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ\text{C}$	40	A
	Diode Forward Current @ $T_C = 100^\circ\text{C}$	20	A
$I_{FM}$	Pulsed Diode Maximum Forward Current (Note 1)	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	267	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	134	W
SCWT	Short Circuit Withstand Time @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

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. Repetitive rating: pulse width limited by max. junction temperature

## ELECTRICAL CHARACTERISTICS OF THE IGBT ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

$BV_{CES}$	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

### ON CHARACTERISTICS

$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 40\text{ mA}, V_{CE} = V_{GE}$	4.0	5.8	7.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	–	2.0	2.4	V
		$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_C = 175^\circ\text{C}$	–	2.9	–	V

### DYNAMIC CHARACTERISTICS

$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	–	1520	–	pF
$C_{oes}$	Output Capacitance		–	92	–	pF
$C_{res}$	Reverse Transfer Capacitance		–	15	–	pF

### SWITCHING CHARACTERISTICS

$T_{d(on)}$	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		–	26	–	ns
$T_{d(off)}$	Turn-Off Delay Time		–	35	–	ns
$T_f$	Fall Time		–	10	–	ns
$E_{on}$	Turn-On Switching Loss		–	0.97	–	mJ
$E_{off}$	Turn-Off Switching Loss		–	0.28	–	mJ
$E_{ts}$	Total Switching Loss		–	1.25	–	mJ

# FGB40T65SPD-F085

## ELECTRICAL CHARACTERISTICS OF THE IGBT ( $T_C = 25^\circ\text{C}$ unless otherwise noted) (continued)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
<b>SWITCHING CHARACTERISTICS</b>						
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 6\ \Omega$ , $V_{GE} = 15\text{ V}$ , Inductive Load, $T_C = 175^\circ\text{C}$	–	14	–	ns
$T_r$	Rise Time		–	35	–	ns
$T_{d(off)}$	Turn-Off Delay Time		–	38	–	ns
$T_f$	Fall Time		–	13	–	ns
$E_{on}$	Turn-On Switching Loss		–	1.61	–	mJ
$E_{off}$	Turn-Off Switching Loss		–	0.47	–	mJ
$E_{ts}$	Total Switching Loss		–	2.08	–	mJ
$T_{SC}$	Short Circuit Withstand Time	$V_{CC} = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$	5	–	–	$\mu\text{s}$
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$	–	36	–	nC
$Q_{ge}$	Gate to Emitter Charge		–	12	–	nC
$Q_{gc}$	Gate to Collector Charge		–	11	–	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.

## ELECTRICAL CHARACTERISTICS OF THE DIODE ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
$V_{FM}$	Diode Forward Voltage	$I_F = 20\text{ A}$	–	$T_C = 25^\circ\text{C}$ 2.0	$T_C = 25^\circ\text{C}$ 2.7	V
				$T_C = 175^\circ\text{C}$ 1.8	$T_C = 175^\circ\text{C}$ –	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20\text{ A}$ , $di_F/dt = 200\text{ A}/\mu\text{s}$	–	$T_C = 175^\circ\text{C}$ 51	$T_C = 175^\circ\text{C}$ –	$\mu\text{J}$
$T_{rr}$	Diode Reverse Recovery Time		–	$T_C = 25^\circ\text{C}$ 34	$T_C = 25^\circ\text{C}$ –	ns
			–	$T_C = 175^\circ\text{C}$ 206	$T_C = 175^\circ\text{C}$ –	
$Q_{rr}$	Diode Reverse Recovery Charge		–	$T_C = 25^\circ\text{C}$ 56	$T_C = 25^\circ\text{C}$ –	
			–	$T_C = 175^\circ\text{C}$ 731	$T_C = 175^\circ\text{C}$ –	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.

## THERMAL CHARACTERISTICS

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

TYPICAL PERFORMANCE CHARACTERISTICS

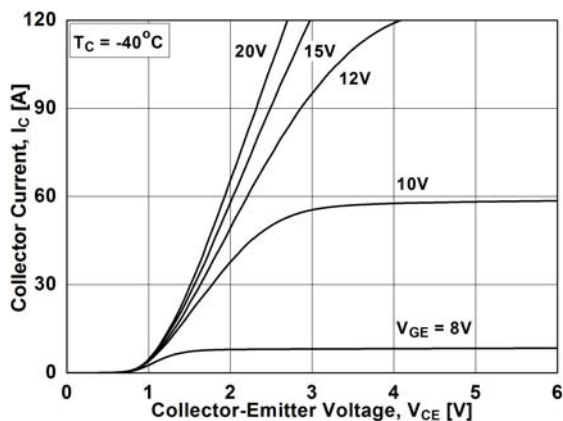


Figure 1. Typical Output Characteristics

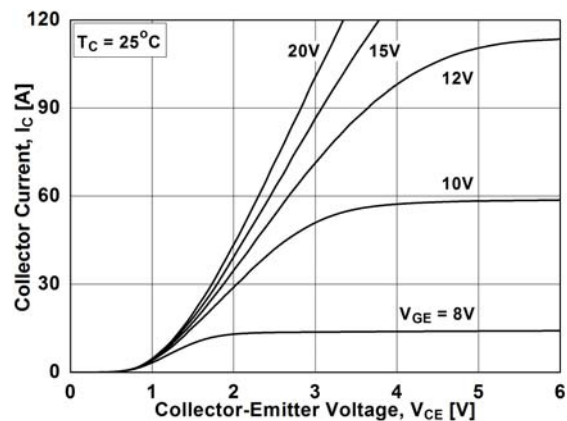


Figure 2. Typical Output Characteristics

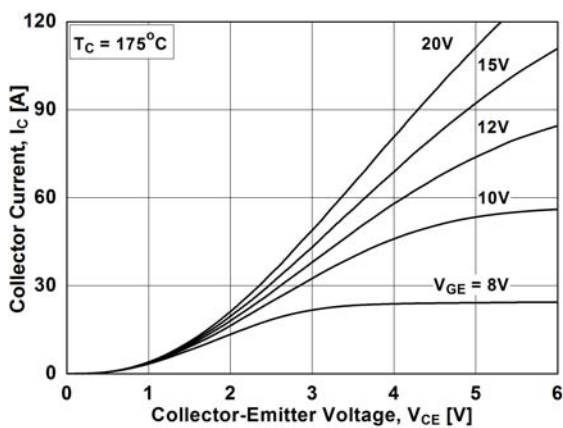


Figure 3. Typical Output Characteristics

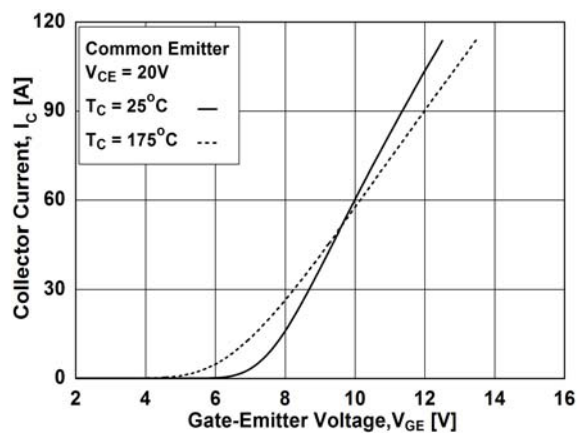


Figure 4. Transfer Characteristic

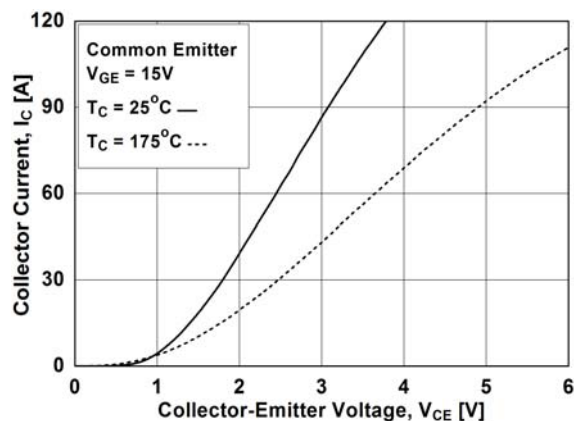


Figure 5. Typical Saturation Voltage

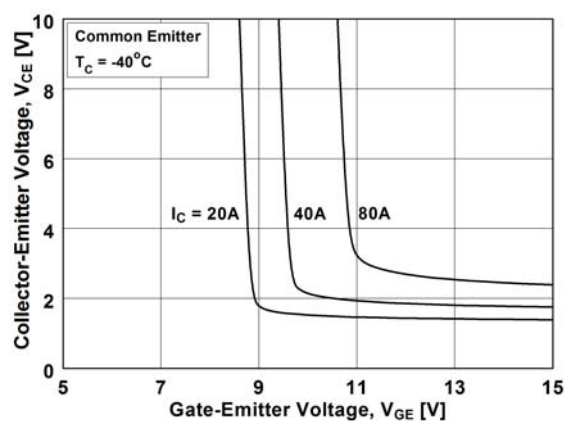


Figure 6. Saturation Voltage vs.  $V_{GE}$  Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

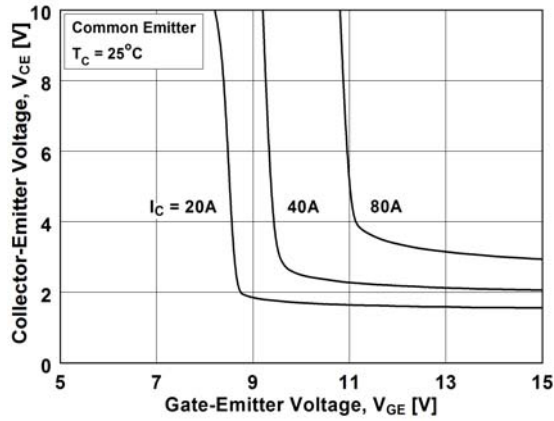


Figure 7. Saturation Voltage vs.  $V_{GE}$

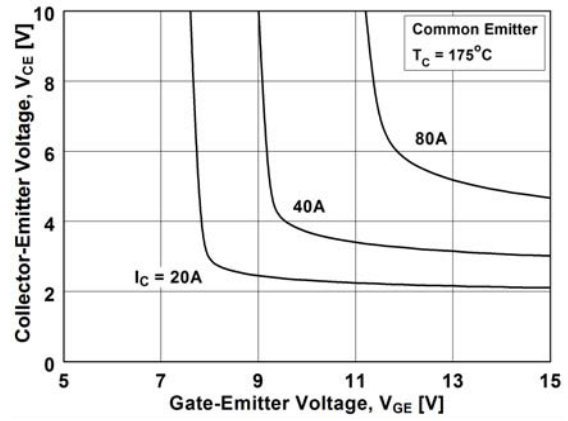


Figure 8. Saturation Voltage vs.  $V_{GE}$

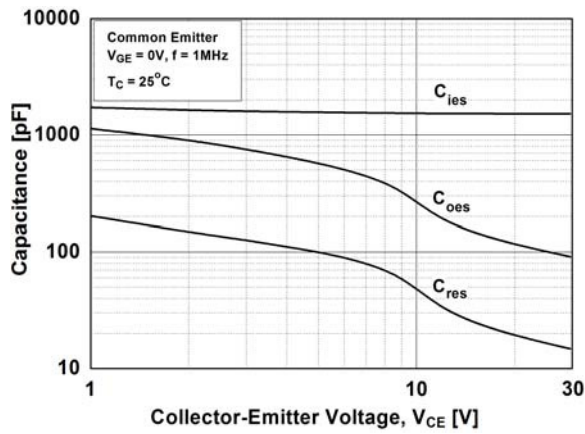


Figure 9. Capacitance Characteristics

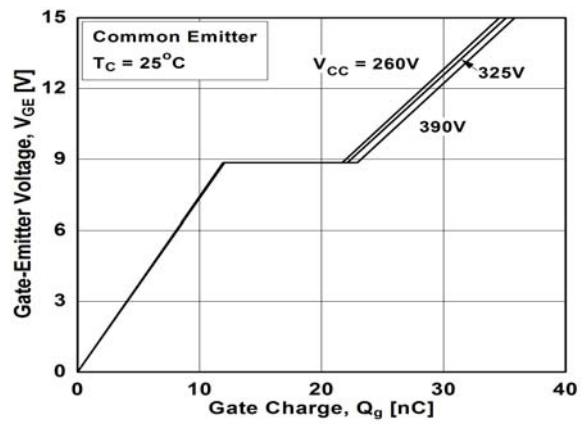


Figure 10. Gate Charge Characteristics

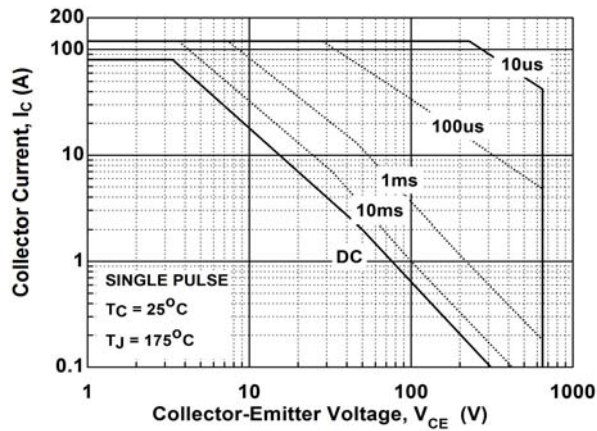


Figure 11. SOA Characteristics

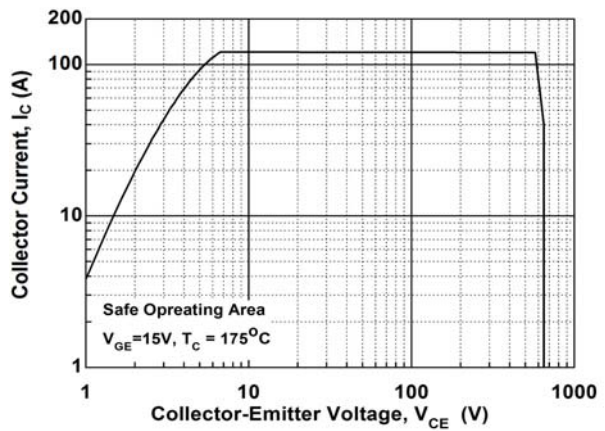


Figure 12. Turn Off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

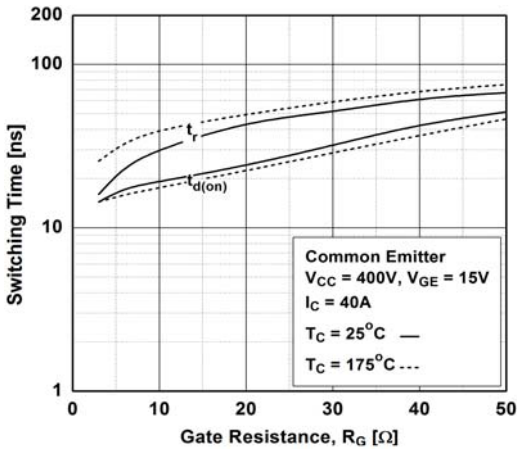


Figure 13. Turn-on Characteristics vs. Gate Resistance

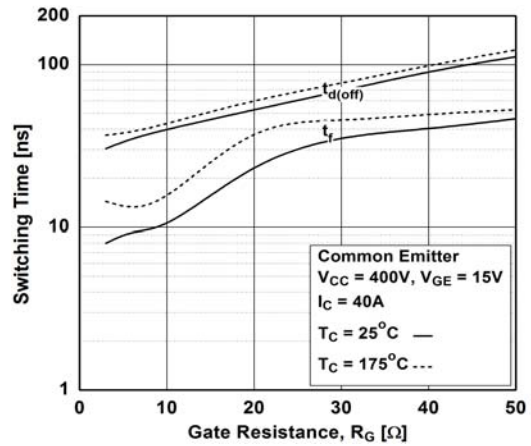


Figure 14. Turn-off Characteristics vs. Gate Resistance

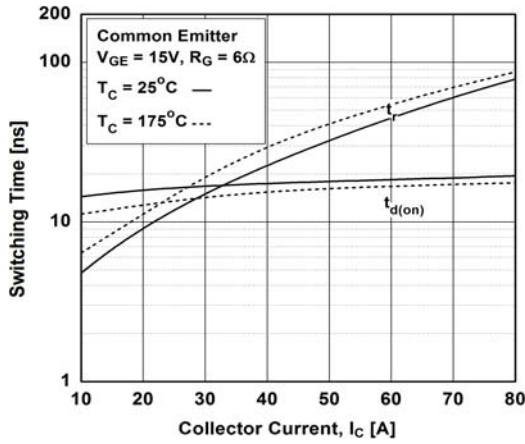


Figure 15. Turn-on Characteristics vs. Collector Current

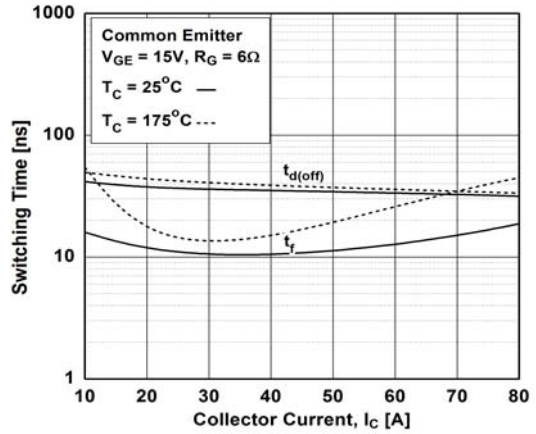


Figure 16. Turn-off Characteristics vs. Collector Current

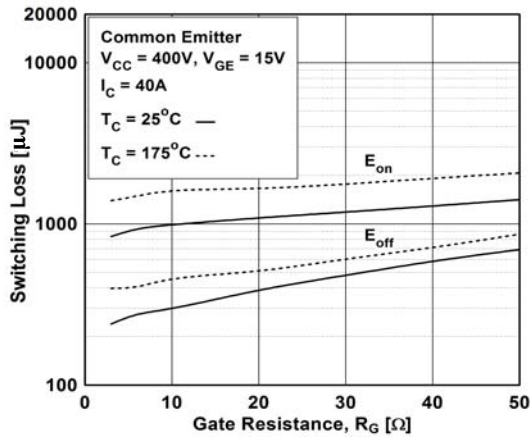


Figure 17. Switching Loss vs. Gate Resistance

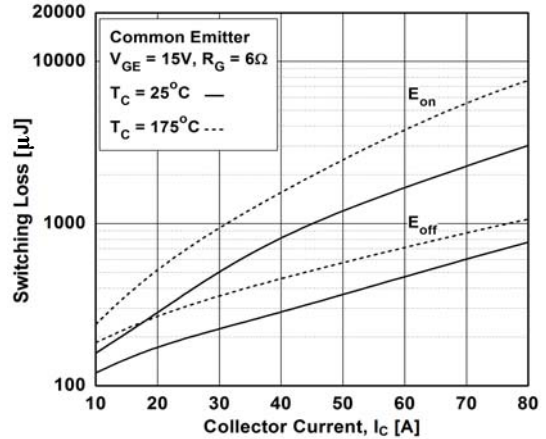


Figure 18. Switching Loss vs. Collector Current



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

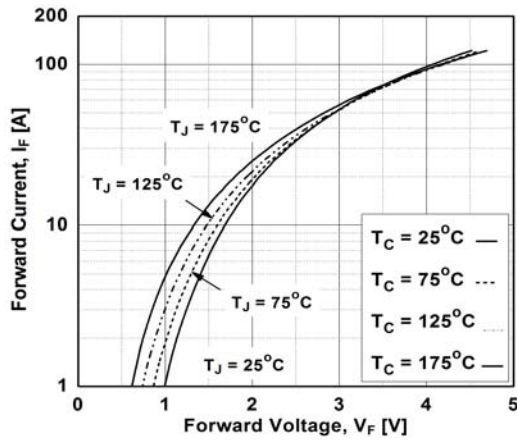


Figure 19. Forward Characteristics

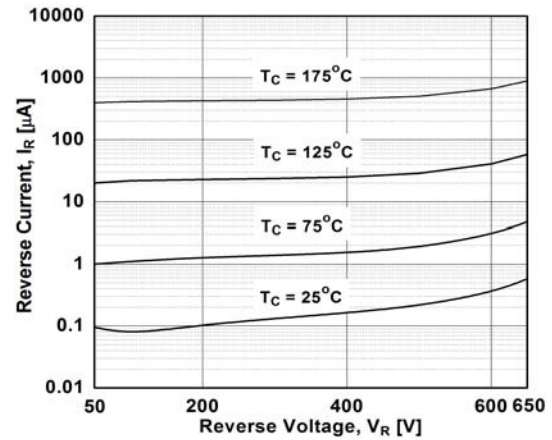


Figure 20. Reverse Current

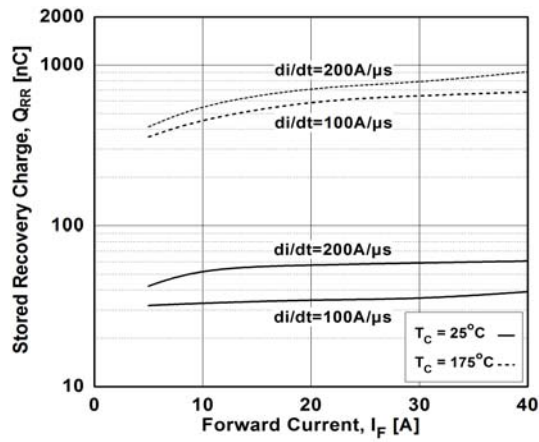


Figure 21. Stored Charge

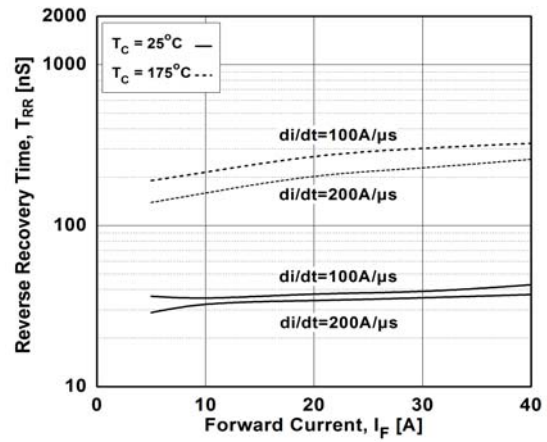


Figure 22. Reverse Recovery Time

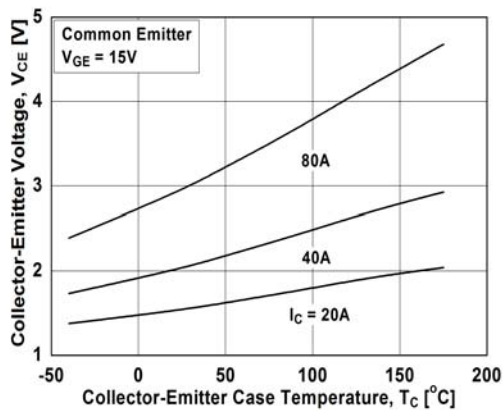


Figure 23. Saturation Voltage vs. Case Temperature at Variant Current Level

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

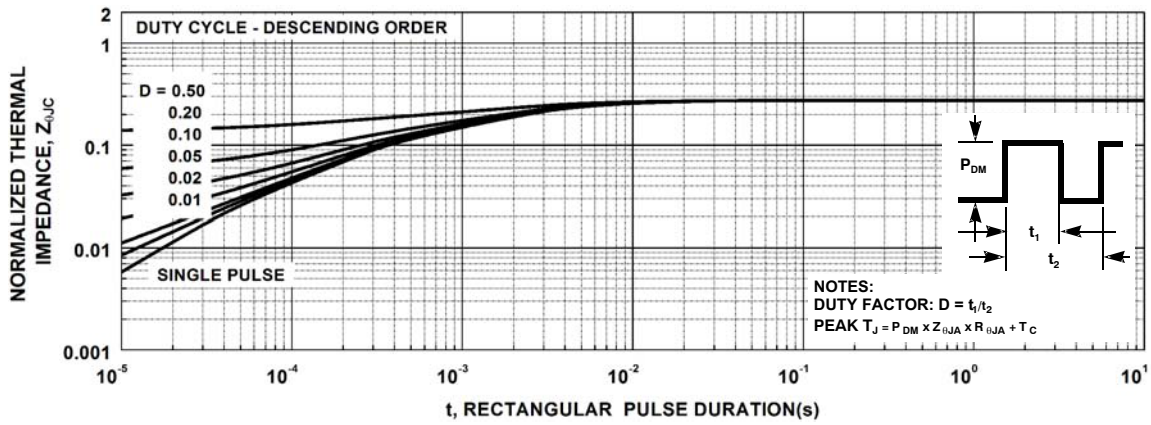


Figure 24. Transient Thermal Impedance of IGBT

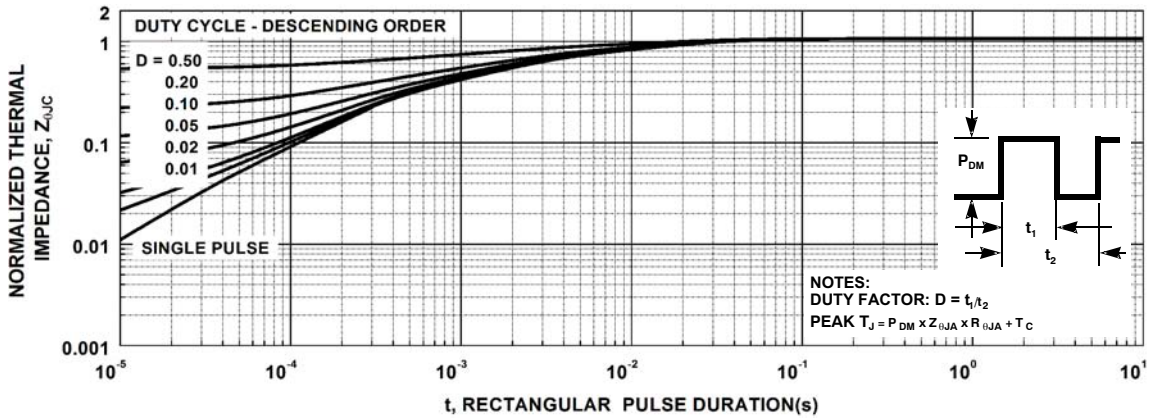


Figure 25. Transient Thermal Impedance of Diode

PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Reel Size	Tape Width	Shipping†
FGB40T65SPD	FGB40T65SPD-F085	D <sup>2</sup> PAK-3 (TO-263, 3-LEAD) (Pb-Free)	—	—	800 / Tape & Reel

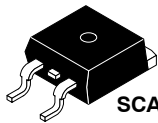
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

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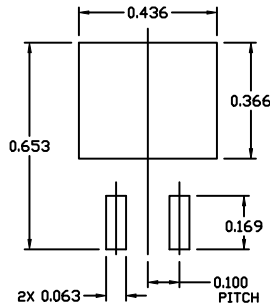
ON



SCALE 1:1

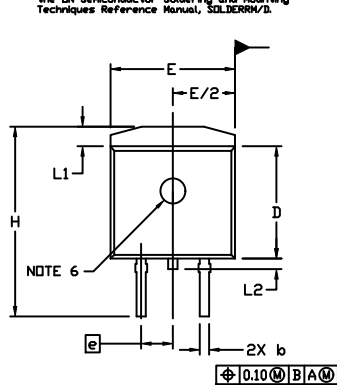
## D<sup>2</sup>PAK-3 (TO-263, 3-LEAD) CASE 418AJ ISSUE F

DATE 11 MAR 2021



### RECOMMENDED MOUNTING FOOTPRINT

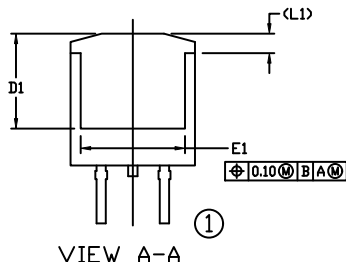
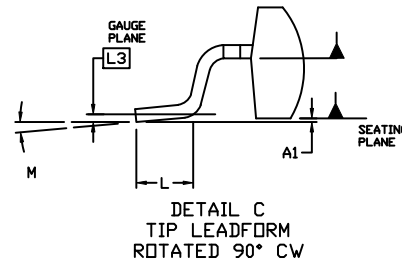
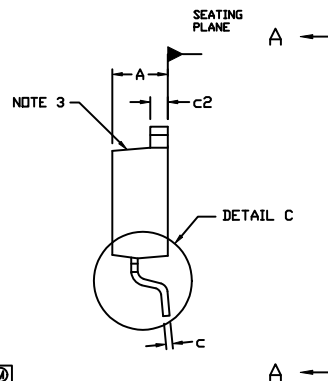
■ For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



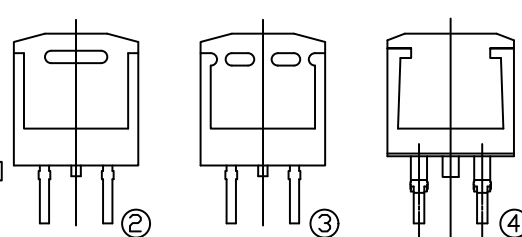
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. CHAMFER OPTIONAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
5. THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1.
6. OPTIONAL MOLD FEATURE.
7. Ⓢ, Ⓣ ... OPTIONAL CONSTRUCTION FEATURE CALL OUTS.

DIM	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.160	0.190	4.06	4.83
A1	0.000	0.010	0.00	0.25
b	0.020	0.039	0.51	0.99
c	0.012	0.029	0.30	0.74
c2	0.045	0.065	1.14	1.65
D	0.330	0.380	8.38	9.65
D1	0.260	---	6.60	---
E	0.380	0.420	9.65	10.67
E1	0.245	---	6.22	---
e	0.100	BSC	2.54	BSC
H	0.575	0.625	14.60	15.88
L	0.070	0.110	1.78	2.79
L1	---	0.066	---	1.68
L2	---	0.070	---	1.78
L3	0.010	BSC	0.25	BSC
M	0*	8*	0*	8*

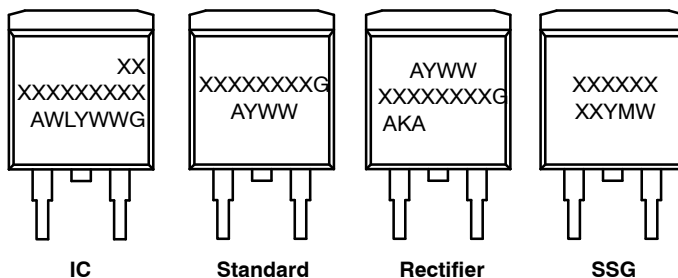


VIEW A-A



VIEW A-A  
OPTIONAL CONSTRUCTIONS

### GENERIC MARKING DIAGRAMS\*



IC

Standard

Rectifier

SSG

XXXXXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
W = Week Code (SSG)  
M = Month Code (SSG)  
G = Pb-Free Package  
AKA = Polarity Indicator

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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DESCRIPTION:	D <sup>2</sup> PAK-3 (TO-263, 3-LEAD)	PAGE 1 OF 1

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### TECHNICAL PUBLICATIONS:

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onsemi Website: [www.onsemi.com](http://www.onsemi.com)

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