

# IGBT - Field Stop, Trench

## 650 V, 40 A

### FGH40T65SPD-F085

#### Description

Using the novel field stop 3<sup>rd</sup> generation IGBT technology, FGH40T65SPD-F085 offers the optimum performance with both low conduction loss and switching loss for a high efficiency operation in various applications, which 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:  $V_{CE(Sat)} = 1.85 \text{ V (Typ.) @ } I_C = 40 \text{ A}$
- 100% Of The Part Are Dynamically Tested (Note 1)
- 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 Co-efficient for Easy Parallel Operating
- Co-Packed With Soft And Fast Recovery Diode
- AEC-Q101 Qualified and PPAP Capable
- This Device is Pb-Free and is RoHS Compliant

#### Applications

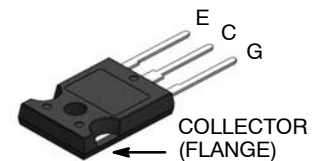
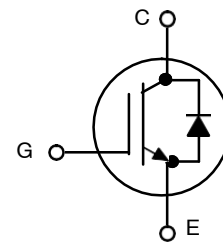
- On-board Charger
- Air Conditioner Compressor
- PTC Heater
- Motor Drivers
- Other Automotive Power-Train Applications



**ON Semiconductor®**

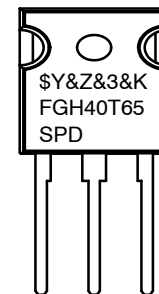
[www.onsemi.com](http://www.onsemi.com)

$V_{CES}$	$E_{on}$	$V_{CE(Sat)}$
650 V	1.16 mJ	1.85 V



TO-247-3LD  
CASE 340CK

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = 3-Digit Data code  
 &K = 2-Digit Lot Traceability code  
 FGH40T65SPD = Specific Device Code

#### ORDERING INFORMATION

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

# FGH40T65SPD-F085

## 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 @ $T_C = 25^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100^\circ\text{C}$	40	
$I_{CM}$	Pulsed Collector Current (Note 2)	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	
$I_{FM}$	Pulsed Diode Maximum Forward Current (Note 2)	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	
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, $\frac{1}{8}$ " 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.

- $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 120\text{ A}$ ,  $R_G = 20\ \Omega$ , Inductive Load.
- Repetitive rating: pulse width limited by max. Junction temperature.

## THERMAL CHARACTERISTICS

Symbol	Rating	Max.	Units
$R_{\theta JC}$	Thermal Resistance Junction to Case, for IGBT	0.56	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance Junction to Case, for Diode	1.71	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	40	$^\circ\text{C}/\text{W}$

## PACKING MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Pacing Type	Quantity
FGH40T65SPD	FGH40T65SPD-F085	TO-247-3LD	Tube	30

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

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
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### OFF CHARACTERISTICS

Collector to Emitter Breakdown Voltage	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	$BV_{CES}$	650	-	-	V
Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	$\frac{\Delta BV_{CES}}{\Delta T_J}$	-	0.6	-	$\text{V}/^\circ\text{C}$
Collector Cut-off Current	$V_{GE} = 0\text{ V}$ , $V_{CE} = V_{CES}$	$I_{CES}$	-	-	250	$\mu\text{A}$
G-E Leakage Current	$V_{GE} = V_{GES}$ , $V_{CE} = 0\text{ V}$	$I_{GES}$	-	-	$\pm 400$	nA

### ON CHARACTERISTICS

G-E Threshold Voltage	$V_{GE} = V_{CE}$ , $I_C = 40\text{ mA}$	$V_{GE(th)}$	4.0	5.5	7.5	V
Collector to Emitter Saturation Voltage	$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ , $T_J = 175^\circ\text{C}$	$V_{CE(sat)}$	-	1.85 2.51	2.4 -	V

### DYNAMIC CHARACTERISTICS

## FGH40T65SPD-F085

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

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
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#### DYNAMIC CHARACTERISTICS

Input Capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V},$ $f = 1\text{ MHz}$	$C_{ies}$	-	1518	-	pF
Output Capacitance		$C_{oes}$	-	91	-	
Reverse Transfer Capacitance		$C_{res}$	-	15	-	

#### SWITCHING CHARACTERISTICS

Turn-on Delay Time	$T_C = 25^\circ\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A}$ $R_g = 6\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$T_{d(on)}$	-	18	-	ns	
Rise Time		$T_r$	-	42	-		
Turn-off Delay Time		$T_{d(off)}$	-	35	-		
Fall Time		$T_f$	-	10	-		
Turn-on Switching Loss		$E_{on}$	-	1.16	-	mJ	
Turn-off Switching Loss		$E_{off}$	-	0.27	-		
Total Switching Loss		$E_{ts}$	-	1.43	-		
Turn-on Delay Time		$T_C = 175^\circ\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A}$ $R_g = 6\ \Omega$ $V_{GE} = 15\text{ V}$ Inductive Load	$T_{d(on)}$	-	16	-	ns
Rise Time			$T_r$	-	40	-	
Turn-off Delay Time	$T_{d(off)}$		-	37	-		
Fall Time	$T_f$		-	11	-		
Turn-on Switching Loss	$E_{on}$		-	1.59	-	mJ	
Turn-off Switching Loss	$E_{off}$		-	0.42	-		
Total Switching Loss	$E_{ts}$		-	2.01	-		
Gate Charge Total	$V_{CE} = 400\text{ V}, I_C = 40\text{ V},$ $V_{GE} = 15\text{ V}$		$Q_g$	-	36	-	nC
Gate to Emitter Charge			$Q_{ge}$	-	11	-	
Gate to Collector Charge		$Q_{gc}$	-	12	-		

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

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Diode Forward Voltage	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	2.2	2.7	V
		$T_C = 175^\circ\text{C}$	-	1.9	-	
Reverse Recovery Energy	$I_F = 20\text{ A},$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 175^\circ\text{C}$	-	51	-	$\mu\text{J}$
Diode Reverse Recovery Time		$T_C = 25^\circ\text{C}$	-	35	-	ns
		$T_C = 175^\circ\text{C}$	-	214	-	
Diode Reverse Recovery Charge		$T_C = 25^\circ\text{C}$	-	58	-	$\mu\text{C}$
	$T_C = 175^\circ\text{C}$	-	776	-		

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 PERFORMANCE CHARACTERISTICS

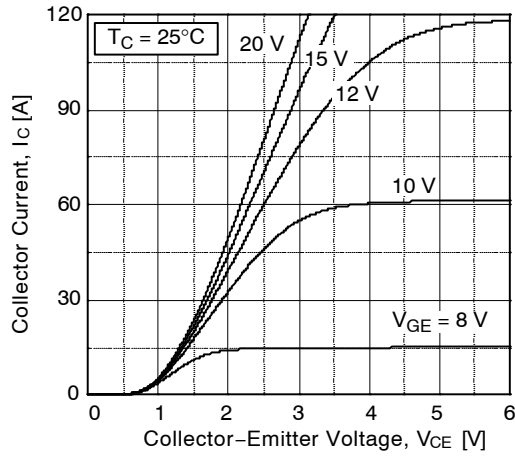


Figure 1. Typical Output Characteristics

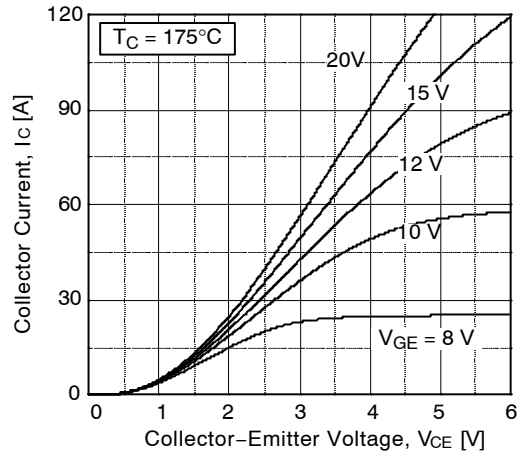


Figure 2. Typical Output Characteristics

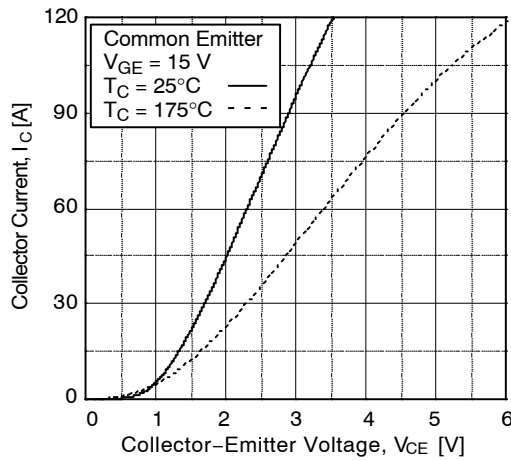


Figure 3. Typical Saturation Voltage Characteristics

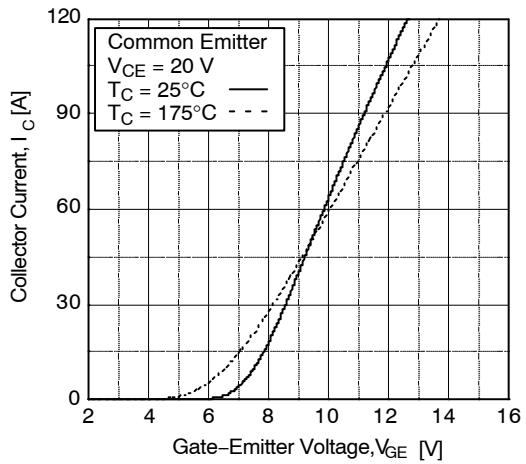


Figure 4. Transfer Characteristics

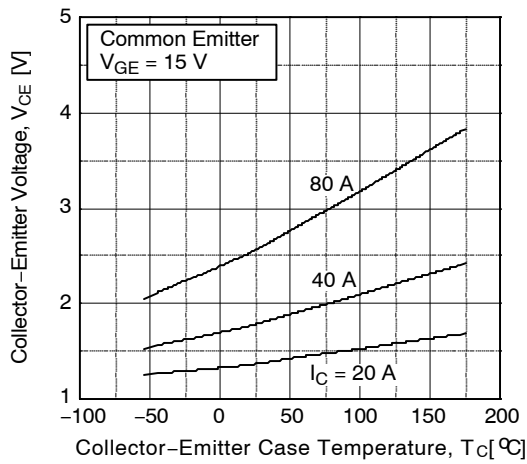


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

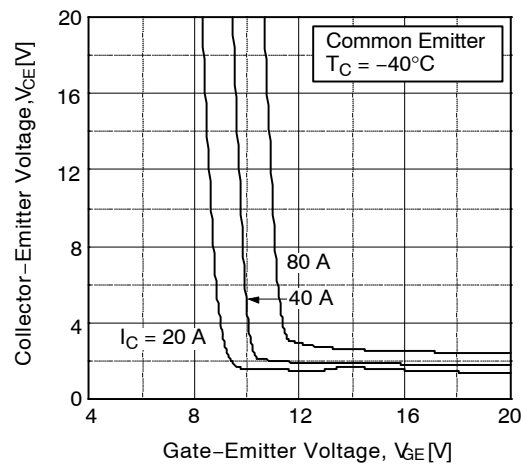


Figure 6. Saturation Voltage vs.  $V_{GE}$

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

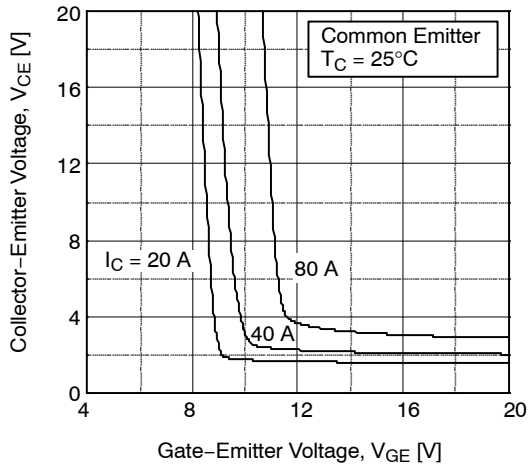


Figure 7. Saturation Voltage vs.  $V_{GE}$

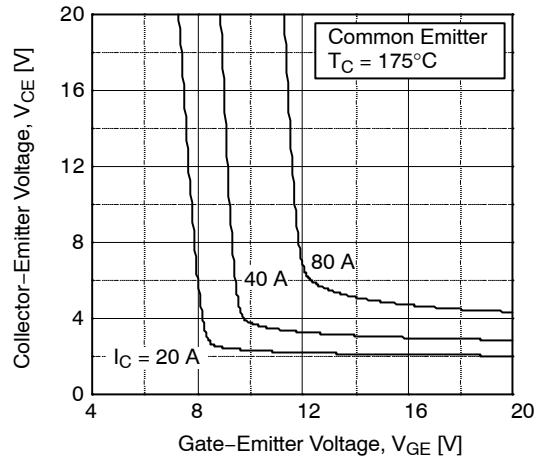


Figure 8. Saturation Voltage vs.  $V_{GE}$

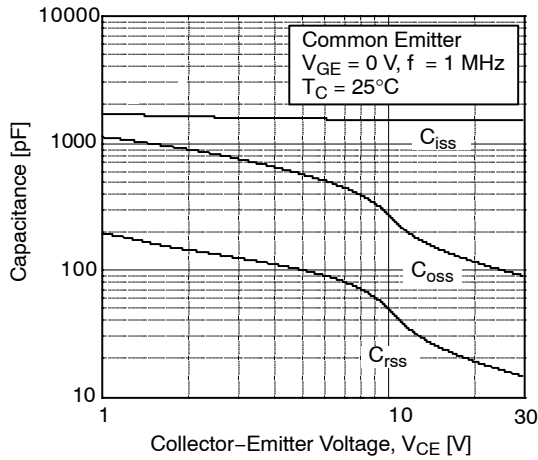


Figure 9. Capacitance Characteristics

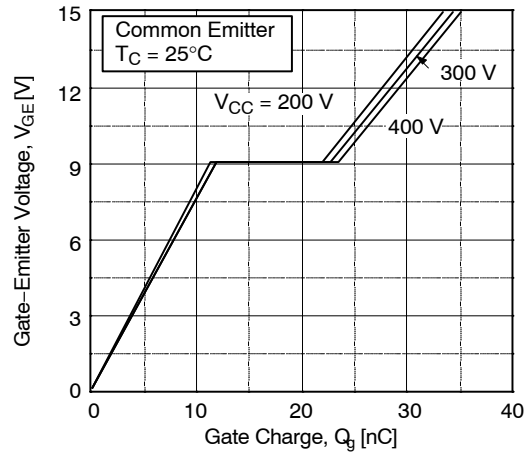


Figure 10. Gate Charge Characteristics

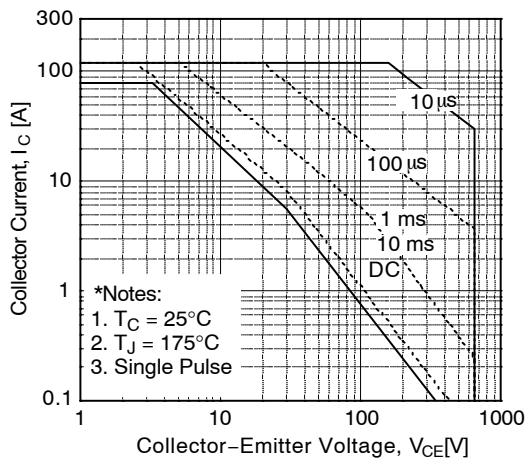


Figure 11. SOA Characteristics

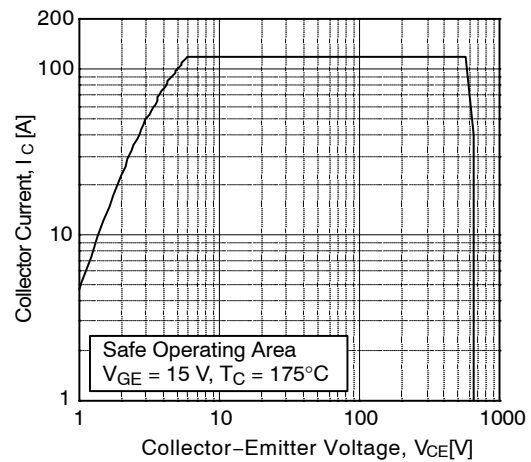


Figure 12. Turn off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

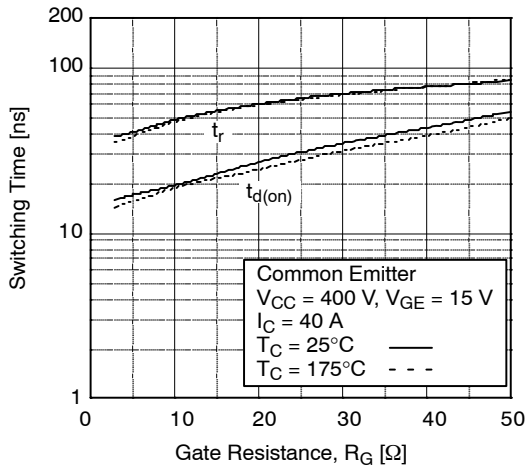


Figure 13. Turn-on Characteristics vs. Gate Resistance

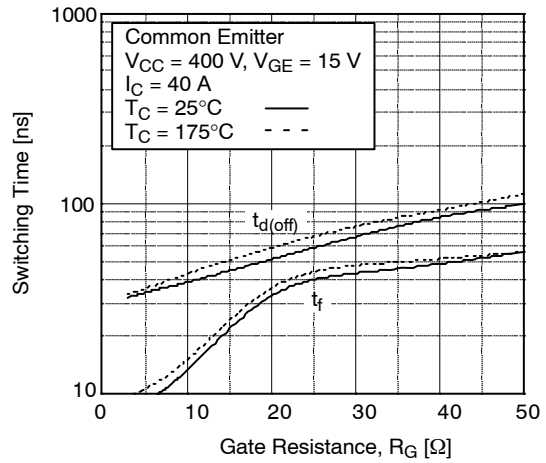


Figure 14. Turn-off Characteristics vs. Gate Resistance

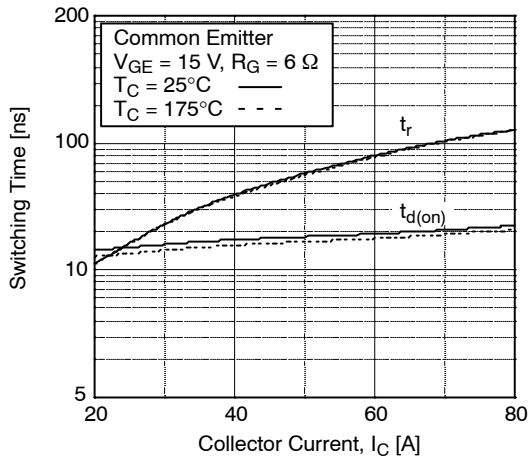


Figure 15. Turn-on Characteristics vs. Collector Current

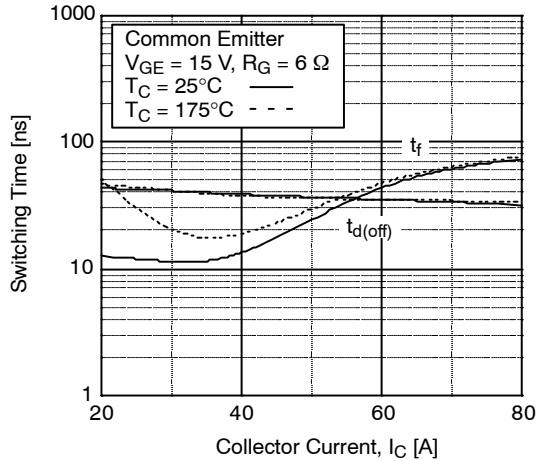


Figure 16. Turn-off Characteristics vs. Collector Current

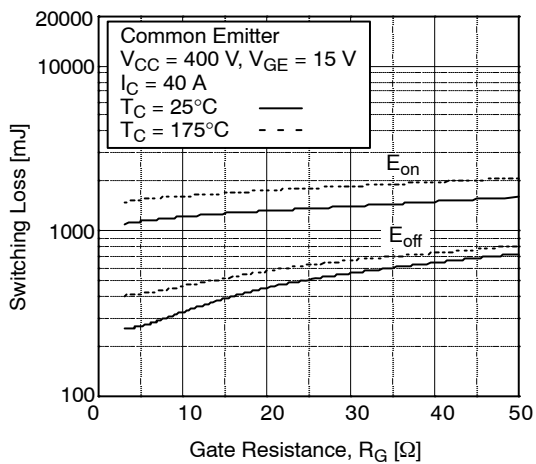


Figure 17. Switching Loss vs Gate Resistance

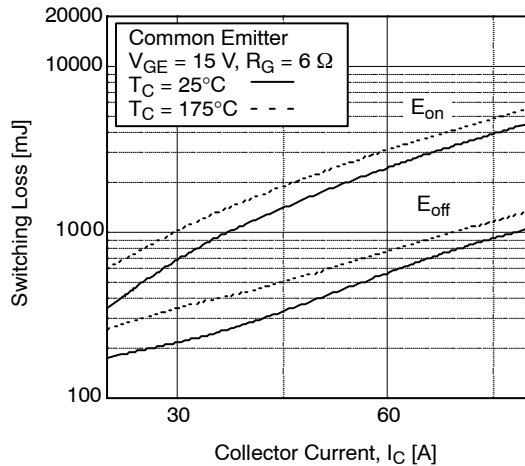


Figure 18. Switching Loss vs Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

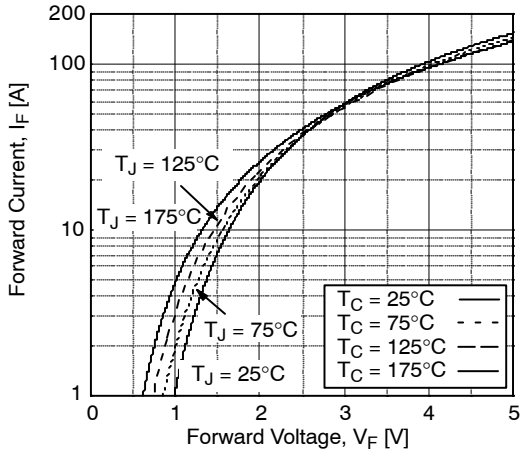


Figure 19. Forward Characteristics

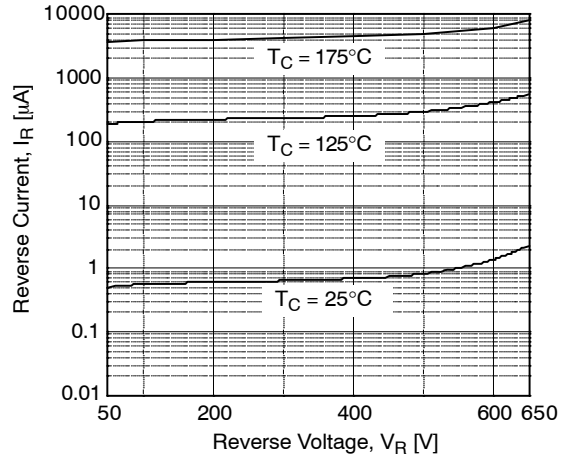


Figure 20. Reverse Current

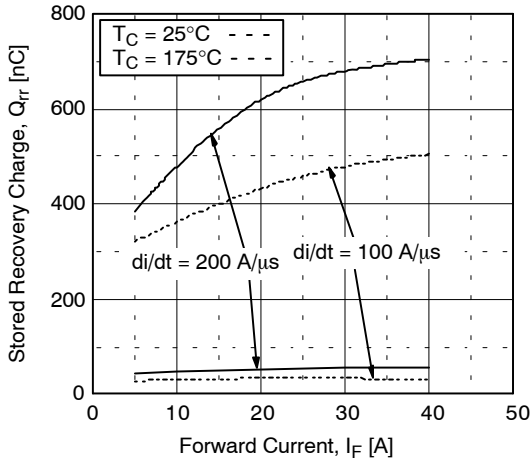


Figure 21. Stored Charge

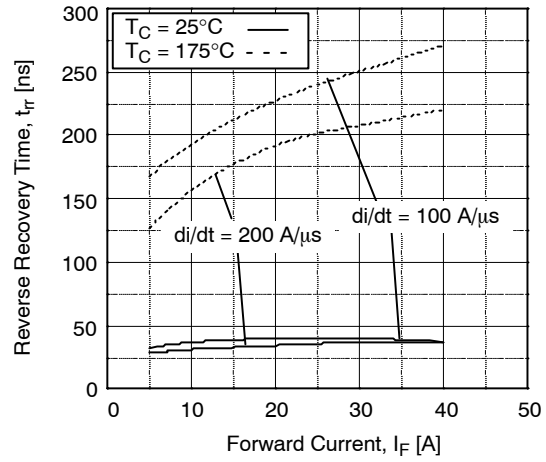


Figure 22. Reverse Recovery Time

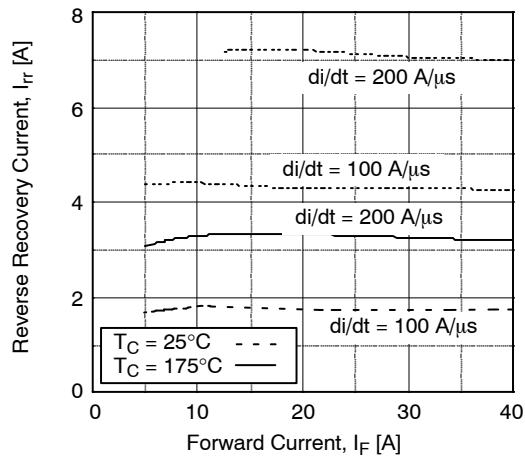


Figure 23. Reverse Recovery Current

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

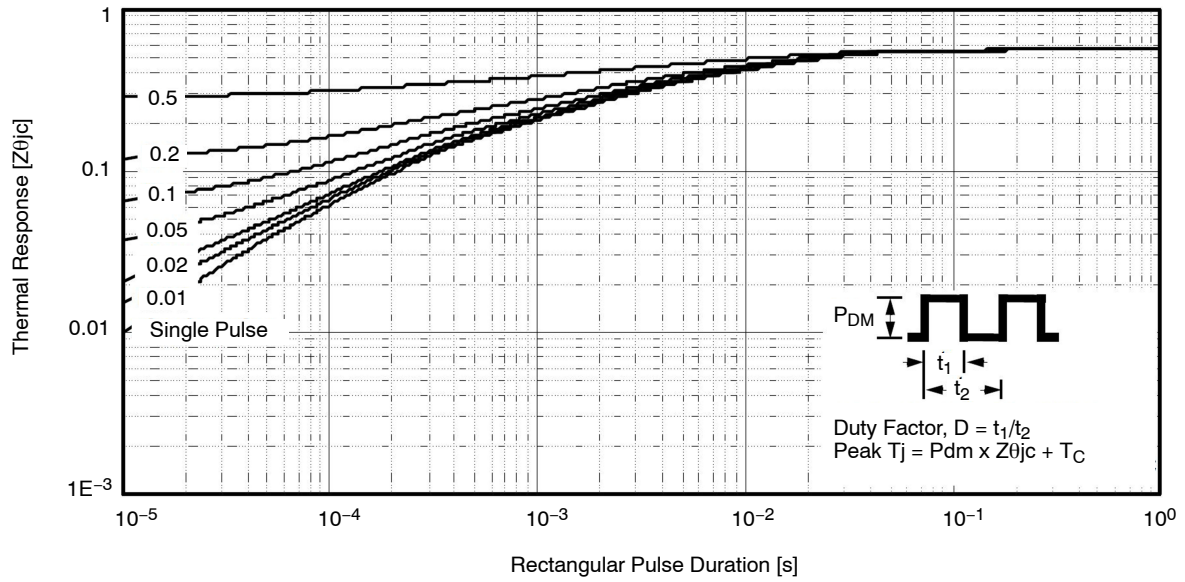


Figure 24. Transient Thermal Impedance of IGBT

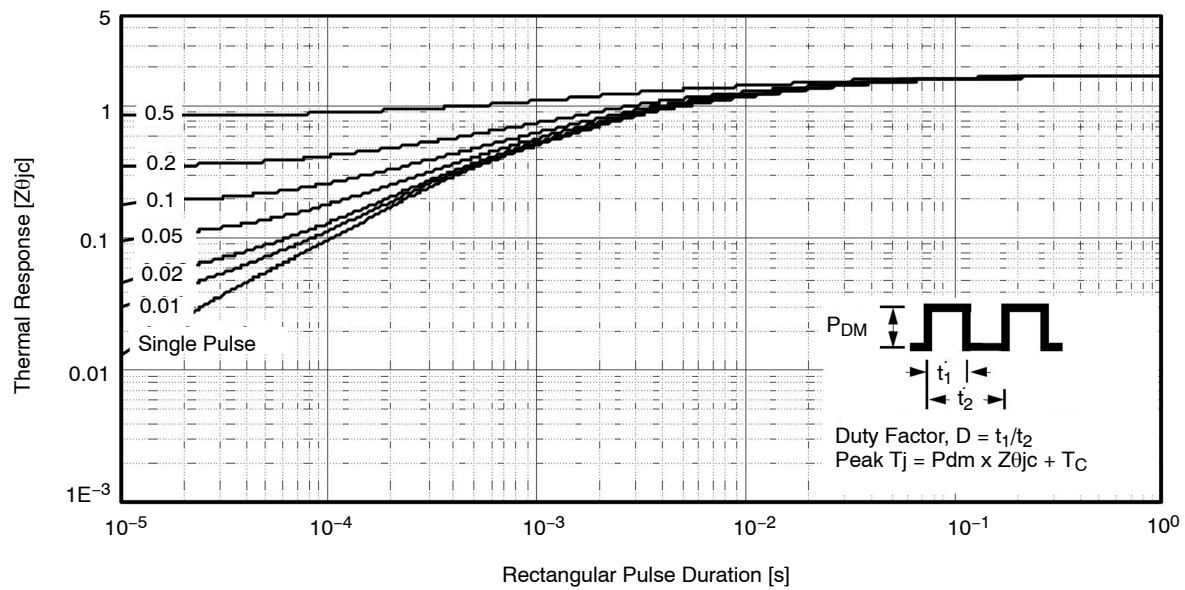


Figure 25. Transient Thermal Impedance of Diode



TO-247-3LD SHORT LEAD  
CASE 340CK  
ISSUE A

DATE 31 JAN 2019



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

GENERIC  
MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- ZZ = Assembly Lot Code

\*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.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.40	1.50	1.60
b	1.17	1.26	1.35
b2	1.53	1.65	1.77
b4	2.42	2.54	2.66
c	0.51	0.61	0.71
D	20.32	20.57	20.82
D1	13.08	~	~
D2	0.51	0.93	1.35
E	15.37	15.62	15.87
E1	12.81	~	~
E2	4.96	5.08	5.20
e	~	5.56	~
L	15.75	16.00	16.25
L1	3.69	3.81	3.93
∅P	3.51	3.58	3.65
∅P1	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

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DESCRIPTION:	TO-247-3LD SHORT LEAD	PAGE 1 OF 1

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