

# Field Stop Trench IGBT With Soft Fast Recovery Diode

## 650 V, 120 A

### FGY120T65SPD-F085

#### Features

- Very Low Saturation Voltage :  $V_{CE(sat)} = 1.5 \text{ V(Typ.) @ } I_C = 120 \text{ A}$
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient
- Tight Parameter Distribution
- High Input Impedance
- 100% of the Parts are Dynamically Tested
- Short Circuit Ruggedness  $> 6 \mu\text{s @ } 25^\circ\text{C}$
- Copacked with Soft, Fast Recovery Extremefast Diode
- AEC-Q101 Qualified and PPAP Capable
- This is a Pb-Free Device

#### Benefits

- Very Low Conduction and Switching Losses for a High Efficiency Operation in Various Applications
- Rugged Transient Reliability
- Outstanding Parallel Operation Performance with Balance Current Sharing
- Low EMI

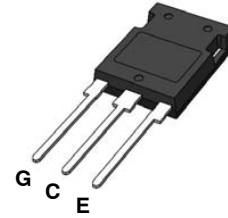
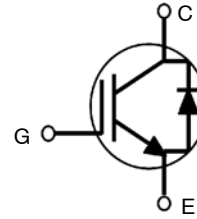
#### Applications

- Traction Inverter for HEV/EV
- Auxiliary DC/AC Converter
- Motor Drives
- Other Power-train Applications Requiring High Power Switch



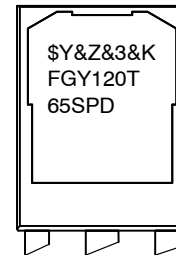
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TO-247-3LD  
CASE 340CU

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
&Z = Assembly Plant Code  
&3 = Data Code (Year & Week)  
&K = Lot  
FGY120T65SPD= Specific Device Code

#### ORDERING INFORMATION

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

## FGY120T65SPD-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 (Note 1) @ $T_C = 25^\circ\text{C}$	240	A
	Collector Current @ $T_C = 100^\circ\text{C}$	220	A
$I_{Nominal}$	Nominal Current	120	A
$I_{CM}$	Pulsed Collector Current	378	A
$I_F$	Diode Forward Current (Note 1) @ $T_C = 25^\circ\text{C}$	240	A
	Diode Forward Current @ $T_C = 100^\circ\text{C}$	188	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	882	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	441	W
SCWT	Short Circuit Withstand Time @ $T_C = 25^\circ\text{C}$	6	$\mu\text{s}$
dV/dt	Voltage Transient Ruggedness (Note 2)	10	V/ns
$T_J$	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 s	300	$^\circ\text{C}$

1. Limited by bondwire
2.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_{CE} = 378\text{ A}$ , Inductive Load

### THERMAL CHARACTERISTICS

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}(\text{IGBT})$	Thermal Resistance, Junction to Case	-	0.17	$^\circ\text{C/W}$
$R_{\theta JC}(\text{Diode})$	Thermal Resistance, Junction to Case	-	0.32	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	-	40	$^\circ\text{C/W}$

### PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Pacing Type	Qty per Tube
FGY120T65SPD	FGY120T65SPD-F085	TP-247	Tube	30ea

# FGY120T65SPD-F085

**ELECTRICAL CHARACTERISTICS OF THE IGBT**  $T_J = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
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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	-	V/ $^\circ\text{C}$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0\text{ V}$	-	-	40	$\mu\text{A}$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$	-	-	$\pm 250$	nA

**ON CHARACTERISTICS**

$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 120\text{ mA}, V_{CE} = V_{GE}$	4.2	5.4	6.2	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 120\text{ A}, V_{GE} = 15\text{ V}$	-	1.5	1.85	V
		$I_C = 120\text{ A}, V_{GE} = 15\text{ V}, T_J = 175^\circ\text{C}$	-	1.8	-	V

**DYNAMIC CHARACTERISTICS**

$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V},$ $f = 1\text{ MHz}$	-	6810	-	pF
$C_{oes}$	Output Capacitance		-	440	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	50	-	pF
$R_G$	Internal Gate Resistance	$f = 1\text{ MHz}$	-	3	-	$\Omega$

**SWITCHING CHARACTERISTICS**

$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 120\text{ A}, R_G = 5\ \Omega,$ $V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 25^\circ\text{C}$	-	53	-	ns
$T_r$	Rise Time		-	134	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	102	-	ns
$T_f$	Fall Time		-	115	-	ns
$E_{on}$	Turn-On Switching Loss		-	6.8	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	3.5	-	mJ
$E_{ts}$	Total Switching Loss		-	10.3	-	mJ
$T_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 120\text{ A}, R_G = 5\ \Omega,$ $V_{GE} = 15\text{ V},$ Inductive Load, $T_J = 175^\circ\text{C}$	-	50	-	ns
$T_r$	Rise Time		-	133	-	ns
$T_{d(off)}$	Turn-Off Delay Time		-	109	-	ns
$T_f$	Fall Time		-	138	-	ns
$E_{on}$	Turn-On Switching Loss		-	9.8	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	4.0	-	mJ
$E_{ts}$	Total Switching Loss		-	13.8	-	mJ
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}, I_C = 120\text{ A}, V_{GE} = 15\text{ V}$	-	162	243	nC
$Q_{ge}$	Gate to Emitter Charge		-	49	-	nC
$Q_{gc}$	Gate to Collector Charge		-	47	-	nC

## FGY120T65SPD-F085

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Units	
$V_{FM}$	Diode Forward Voltage	$I_F = 120\text{ A}$	$T_J = 25^\circ\text{C}$	-	1.3	1.6	V
			$T_J = 175^\circ\text{C}$	-	1.2	-	
$E_{rec}$	Reverse Recovery Energy	$V_{CE} = 400\text{V}$ , $I_F = 120\text{ A}$ , $di_F/dt = 1000\text{ A}/\mu\text{s}$	$T_J = 25^\circ\text{C}$	-	450	-	$\mu\text{J}$
			$T_J = 175^\circ\text{C}$	-	3000	-	
$T_{rr}$	Diode Reverse Recovery Time		$T_J = 25^\circ\text{C}$	-	123	-	ns
			$T_J = 175^\circ\text{C}$	-	240	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_J = 25^\circ\text{C}$	-	2.8	-	$\mu\text{C}$
			$T_J = 175^\circ\text{C}$	-	12.2	-	

TYPICAL PERFORMANCE CHARACTERISTICS

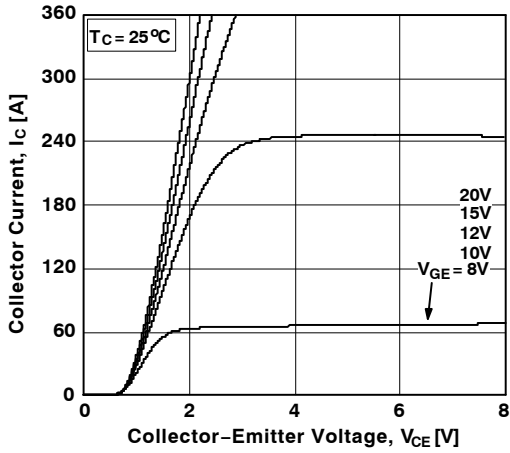


Figure 1. Typical Output Characteristics

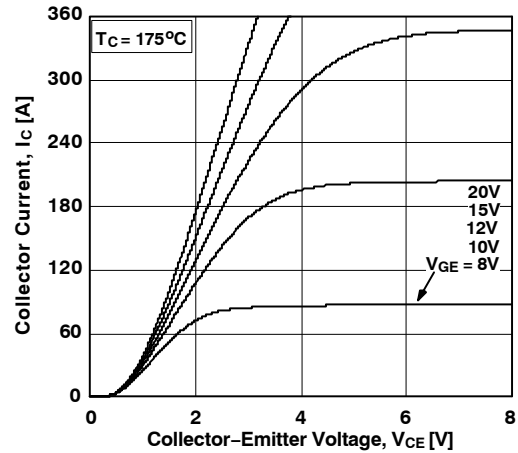


Figure 2. Typical Output Characteristics

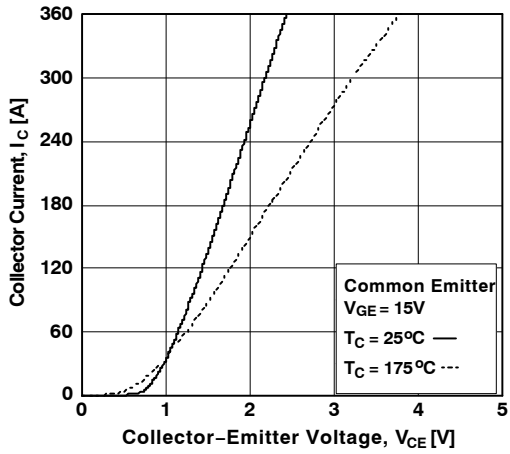


Figure 3. Typical Saturation Voltage Characteristics

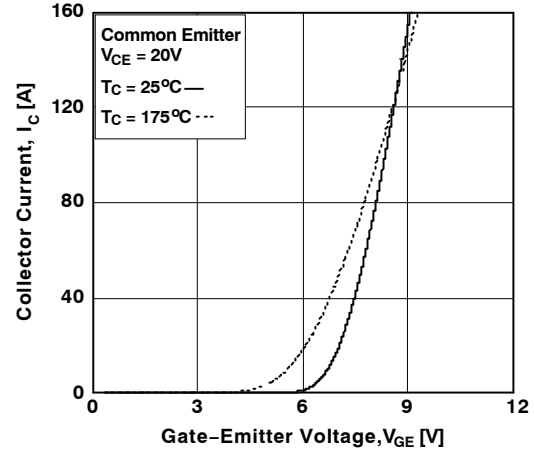


Figure 4. Transfer Characteristics

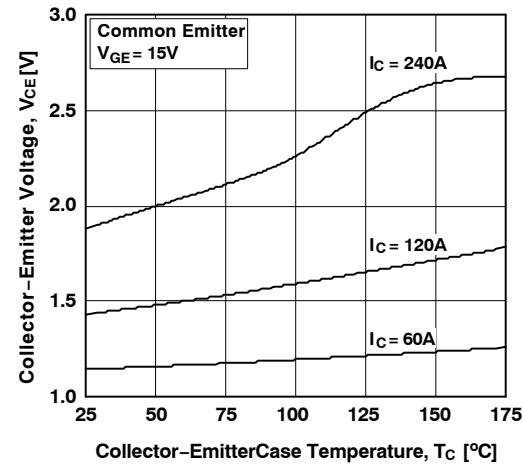


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

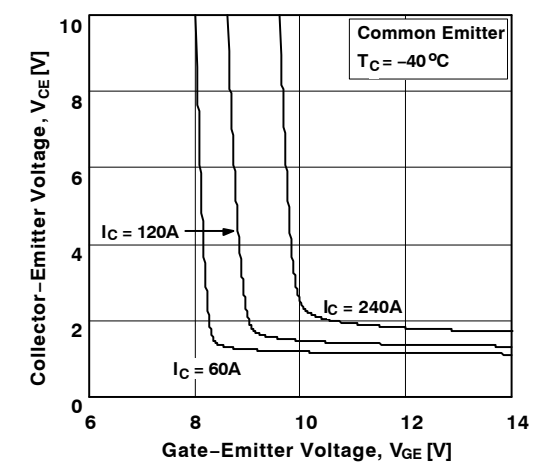


Figure 6. Saturation Voltage vs.  $V_{GE}$

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

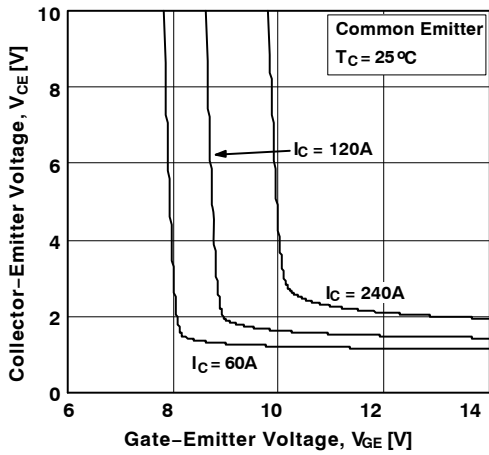


Figure 7. Saturation Voltage vs.  $V_{GE}$

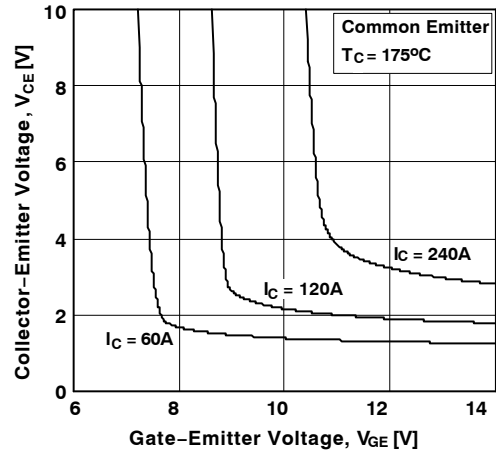


Figure 8. Saturation Voltage vs.  $V_{GE}$

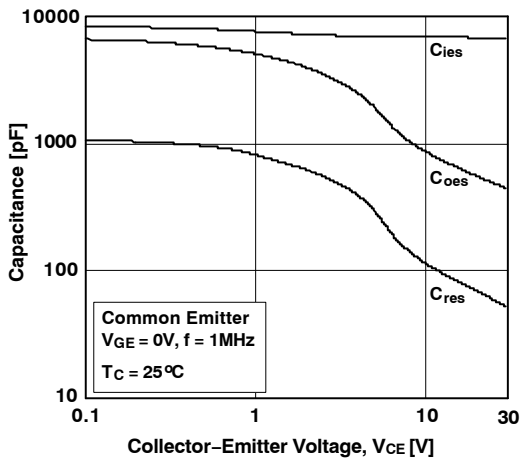


Figure 9. Capacitance Characteristics

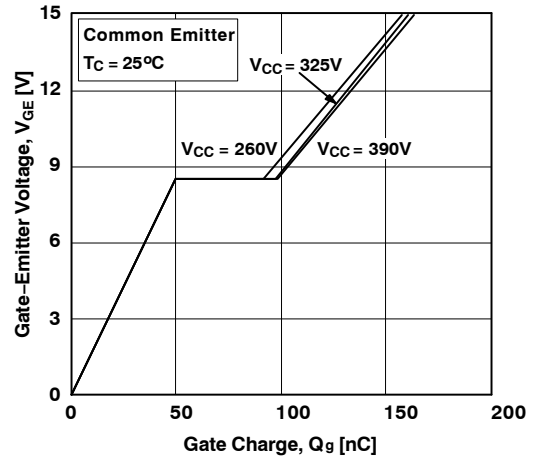


Figure 10. Gate charge Characteristics

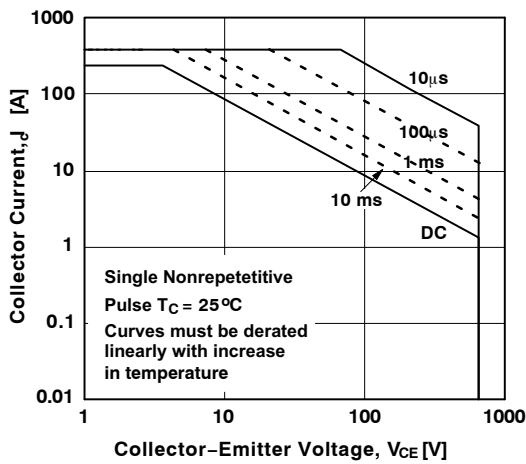


Figure 11. SOA Characteristics

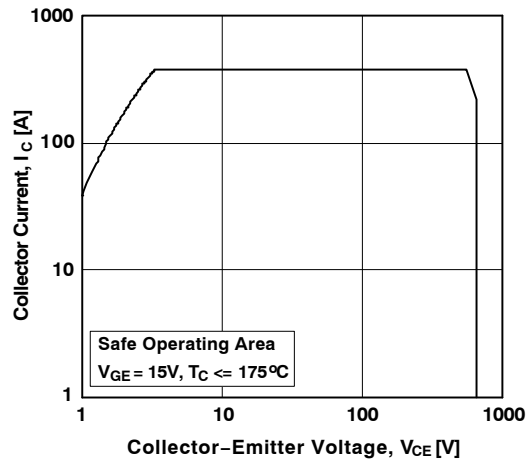


Figure 12. Turn off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

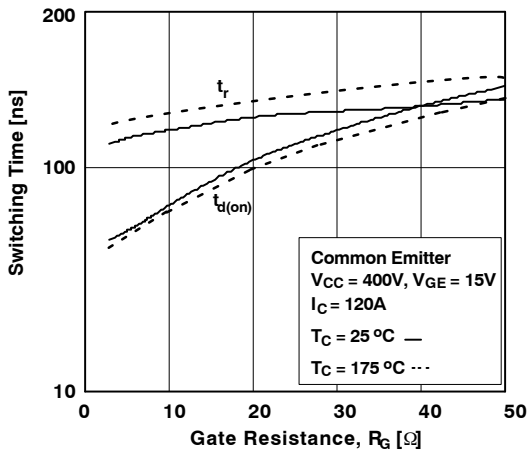


Figure 13. Turn-on Characteristics vs. Gate Resistance

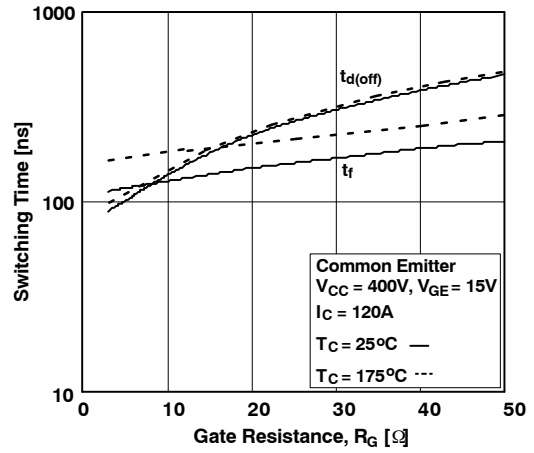


Figure 14. Turn-off Characteristics vs. Gate Resistance

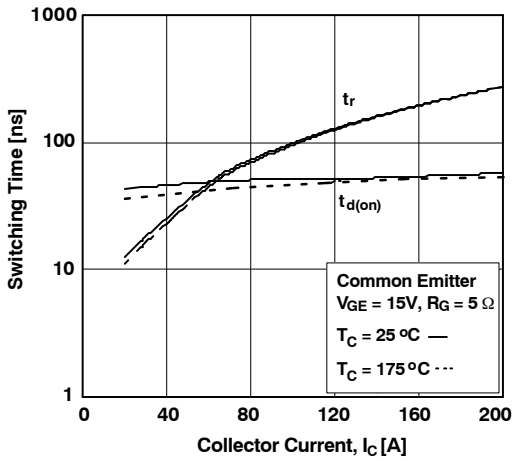


Figure 15. Turn-on Characteristics vs. Collector Current

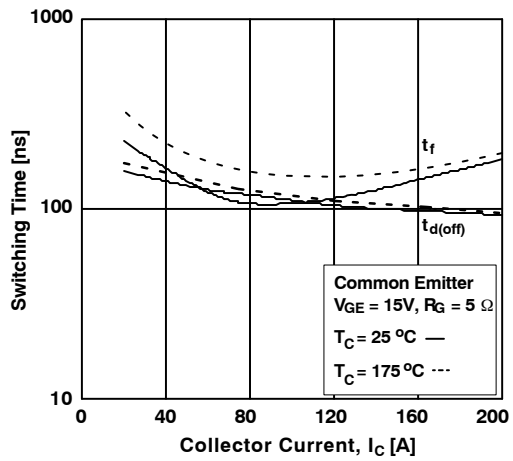


Figure 16. Turn-off Characteristics vs. Collector Current

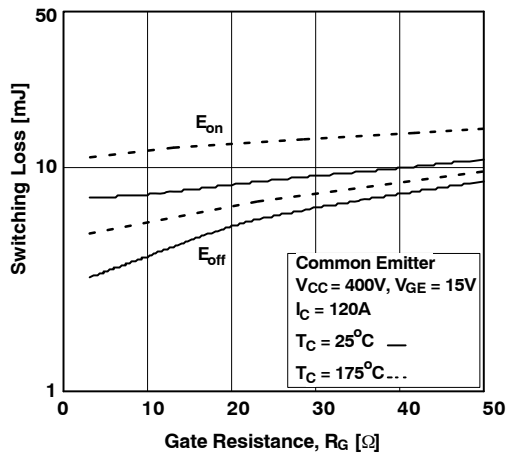


Figure 17. Switching Loss vs. Gate Resistance

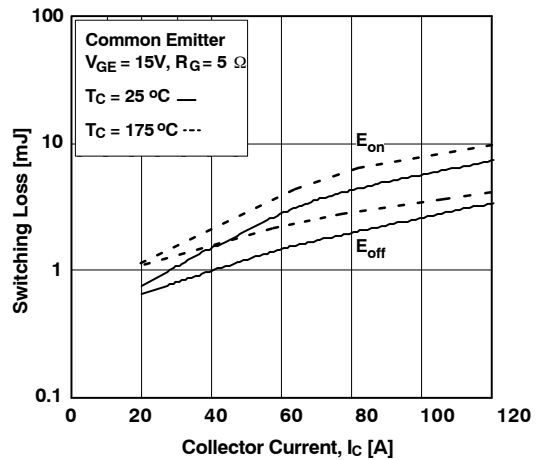


Figure 18. Switching Loss vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

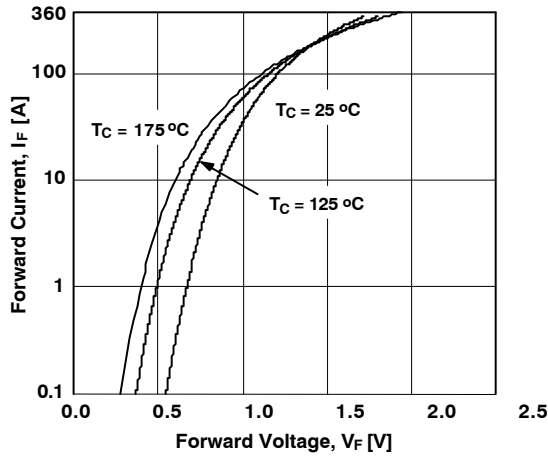


Figure 19. Forward Characteristics

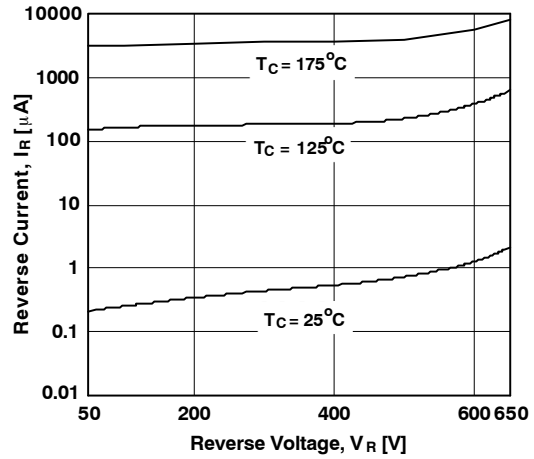


Figure 20. Reverse Current

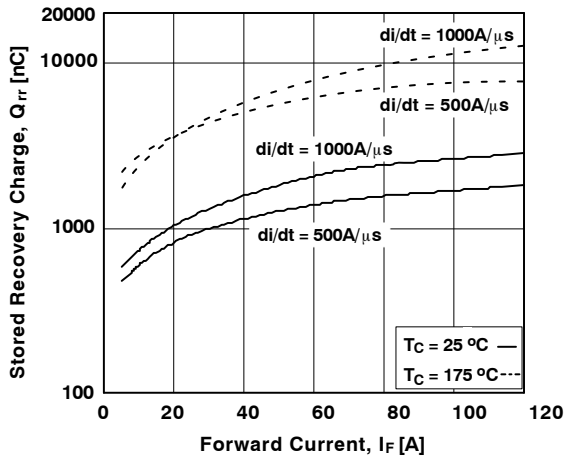


Figure 21. Stored Charge

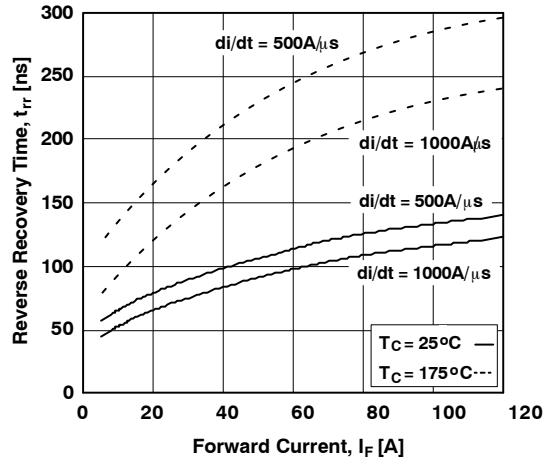


Figure 22. Reverse Recovery Time

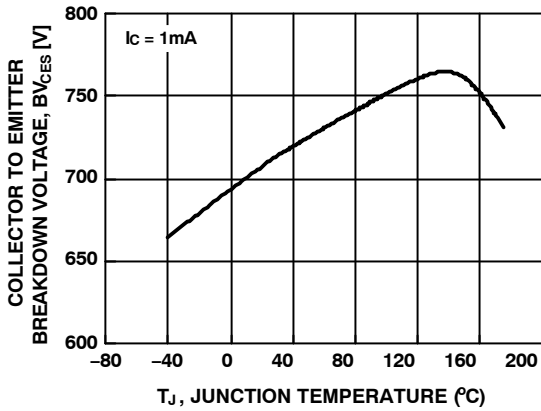


Figure 23. Collector to Emitter Breakdown Voltage vs. Junction Temperature



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

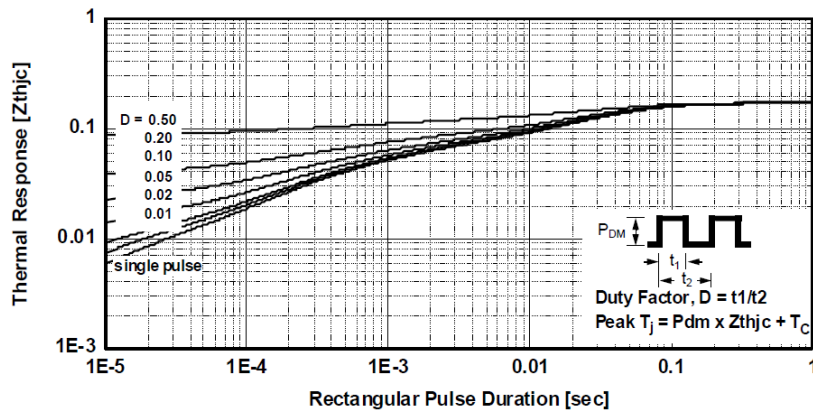


Figure 24. Transient Thermal Impedance of IGBT

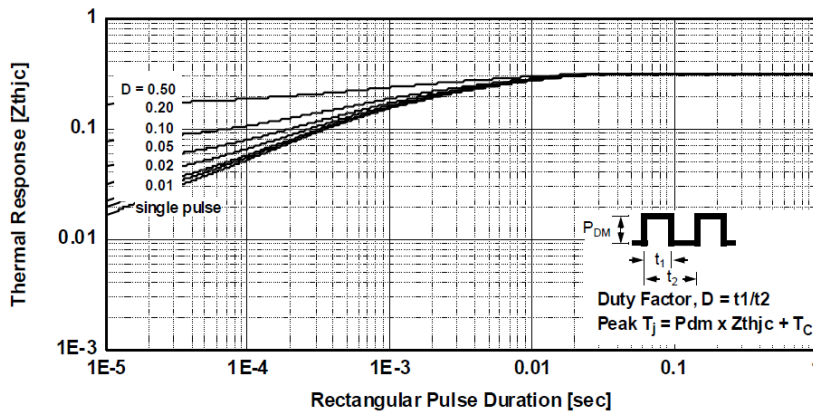


Figure 25. Transient Thermal Impedance of Diode

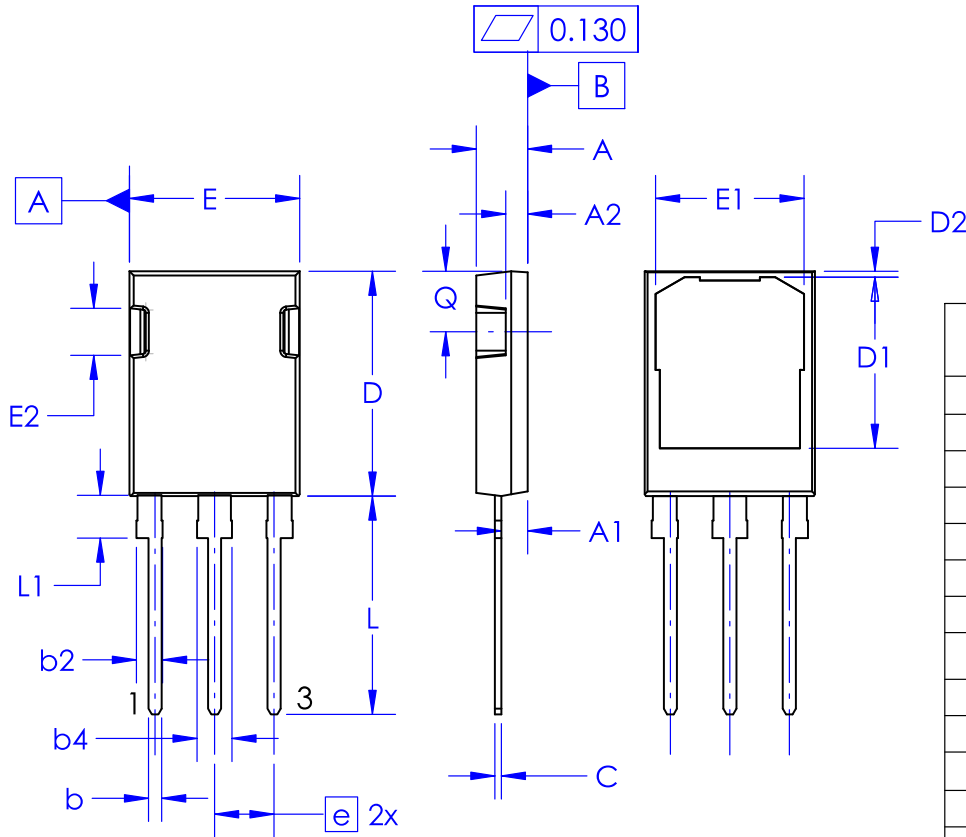
**MECHANICAL CASE OUTLINE**  
**PACKAGE DIMENSIONS**

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TO-247-3LD  
CASE 340CU  
ISSUE A

DATE 16 SEP 2019



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.50	4.70	4.90
A1	2.10	2.40	2.70
A2	1.70	2.00	2.30
b	1.00	1.20	1.400
b2	2.20	2.40	2.60
b4	3.00	3.20	3.40
c	0.40	0.60	0.80
D	20.40	20.60	20.80
D1	15.47	15.67	15.87
D2	0.25	0.55	0.85
e	5.45 BSC		
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	4.12	4.30	4.52
L	19.70	20.00	20.30
L1	3.65	3.85	4.05
Q	5.35	5.55	5.75

NOTES:

- A. NO INDUSTRY STANDARDS APPLIES TO THIS PACKAGE.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- D. DRAWING CONFORMS TO ASME Y14.5-2009.

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