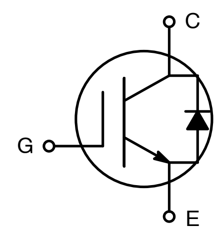
Field Stop Trench IGBT With Soft Fast Recovery Diode and V_{CESAT}, V_{TH} Binning

650 V, 120 A

ON Semiconductor®

www.onsemi.com

AFGY120T65SPD-B4



Features

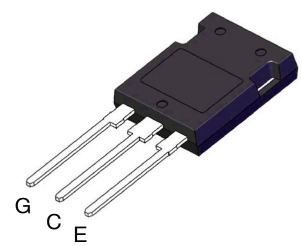
- AEC−Q101 Qualified and PPAP Capable
- Very Low Saturation Voltage: $V_{CE(sat)}$ = 1.5 V (Typ.) @ I_C = 120 A
- Maximum Junction Temperature: T_J = 175°C
- Positive Temperature Co−Efficient
- Tight Parameter Distribution
- High Input Impedance
- 100% of the Parts are Dynamically Tested
- Short Circuit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

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

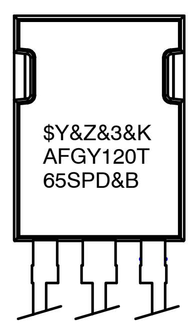
Applications

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



TO−247−3LD
CASE 340CU

MARKING DIAGRAM



$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Date Code (Year & Week)
&K	= Lot Traceability Code
AFGY120T65SPD	= Specific Device Code
&B	= BIN Designator

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Ratings	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 (Note 1)	240	A
	Collector Current @ T_C = 100°C	220	A
$I_{Nominal}$	Nominal Current	120	A
I_{CM}	Pulsed Collector Current	378	A
I_{FM}	Diode Forward Current @ T_C = 25°C (Note 1)	240	A
	Diode Forward Current @ T_C = 100°C	188	A
P_D	Maximum Power Dissipation @ T_C = 25°C	882	W
	Maximum Power Dissipation @ T_C = 100°C	441	W
SCWT	Short Circuit Withstand Time @ T_C = 25°C	6	μs
ΔV/Δt	Voltage Transient Ruggedness (Note 2)	10	V/ns
T_J	Operating Junction Temperature	−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 seconds	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. Limited to bondwire.
2. V_{CC} = 400 V, V_{GE} = 15 V, I_{CE} = 378 A, Inductive load.

THERMAL CHARACTERISTICS

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

PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Bin Designator	Packing Type	Qty per Tube/Reel*
AFGY120T65SPDA	AFGY120T65SPD−B4	A	Tube	30
AFGY120T65SPDB	AFGY120T65SPD−B4	B	Tube	30
AFGY120T65SPDC	AFGY120T65SPD−B4	C	Tube	30
AFGY120T65SPDD	AFGY120T65SPD−B4	D	Tube	30

*Generally all tubes in one box will belong to the same bin. In rare and unusual cases there may be tubes from more than one bin inside one box. Such mixing would not be considered a quality excursion.
The primary container quantity (MPQ) for these binning products is 30 units and therefore partial box shipment can be expected.

ELECTRICAL CHARACTERISTICS OF THE IGBT (T_J = 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	–	0.6	–	V/°C
I_{CES}	Collector Cut-Off Current	$V_{CE} = V_{CES}$, V_{GE} = 0 V	–	–	40	μA
I_{GES}	G−E Leakage Current	$V_{GE} = V_{GES}$, V_{CE} = 0 V	–	–	±250	nA
ON CHARACTERISTICS						
$V_{GE(th)A}$	G−E Threshold (Bin A)	Ic = 120 mA; $V_{CE} = V_{GE}$	5.1	5.6	6.2	V
$V_{CE(sat)A}$	Collector to Emitter Saturation Voltage (Bin A)	Ic = 120 A; V_{GE} = 15 V	1.3	1.44	1.475	V
$V_{GE(th)B}$	G−E Threshold (Bin B)	Ic = 120 mA; $V_{CE} = V_{GE}$	5.1	5.6	6.2	V
$V_{CE(sat)B}$	Collector to Emitter Saturation Voltage (Bin B)	Ic = 120 A; V_{GE} = 15 V	1.41	1.46	1.85	V
$V_{GE(th)C}$	G−E Threshold (Bin C)	Ic = 120 mA; $V_{CE} = V_{GE}$	4.2	5.4	5.7	V
$V_{CE(sat)C}$	Collector to Emitter Saturation Voltage (Bin C)	Ic = 120 A; V_{GE} = 15 V	1.3	1.44	1.475	V
$V_{GE(th)D}$	G−E Threshold (Bin D)	Ic = 120 mA; $V_{CE} = V_{GE}$	4.2	5.4	5.7	V
$V_{CE(sat)D}$	Collector to Emitter Saturation Voltage (Bin D)	Ic = 120 A; V_{GE} = 15 V	1.41	1.46	1.85	V
$V_{GE(th)}$	G−E Threshold	Ic = 120 mA; $V_{CE} = V_{GE}$	4.2	5.4	6.2	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	Ic = 120 A; V_{GE} = 15 V	–	1.5	1.85	V
		Ic = 120 A; V_{GE} = 15 V; T_J = 175°C	–	1.8	–	V
DYNAMIC CHARACTERISTICS						
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	6810	–	pF
C_{oes}	Output Capacitance		–	440	–	pF
C_{res}	Reverse Transfer Capacitance		–	50	–	pF
R_G	Internal Gate Resistance	f = 1 MHz	–	3	–	Ω
SWITCHING CHARACTERISTICS						
$T_{d(on)}$	Turn-On Delay Time	V_{CC} = 400 V, I_C = 120 A, R_G = 5 Ω, V_{GE} = 15 V, Inductive Load, T_J = 25°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 V, I_C = 120 A, R_G = 5 Ω, V_{GE} = 15 V, Inductive Load, T_J = 175°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

ELECTRICAL CHARACTERISTICS OF THE IGBT (T_J = 25°C unless otherwise noted) (continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
SWITCHING CHARACTERISTICS						
Q_g	Total Gate Charge	V_{CE} = 400 V, I_C = 120 A, V_{GE} = 15 V	–	162	243	nC
Q_{ge}	Gate to Emitter Charge		–	49	–	nC
Q_{gc}	Gate to Collector Charge		–	47	–	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_J = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_{FM}	Diode Forward Voltage	I_F = 120 A	T_J = 25°C	–	1.3	1.6	V
			T_J = 175°C	–	1.2	–	
E_{rec}	Reverse Recovery Energy	V_{CE} = 400 V, I_F = 120 A, $\Delta I_F/\Delta t$ = 1000 A/μs	T_J = 25°C	–	450	–	μJ
			T_J = 175°C	–	3000	–	
T_{rr}	Diode Reverse Recovery Time		T_J = 25°C	–	123	–	ns
			T_J = 175°C	–	240	–	
Q_{rr}	Diode Reverse Recovery Charge		T_J = 25°C	–	2.8	–	μC
			T_J = 175°C	–	12.2	–	

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

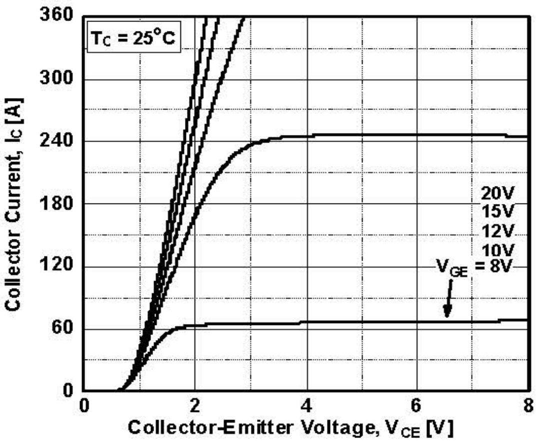


Figure 1. Typical Output Characteristics

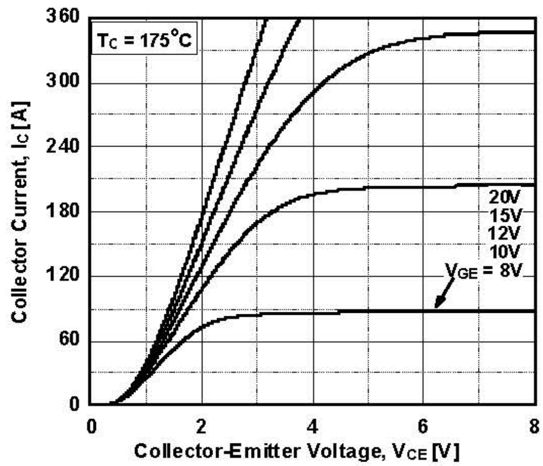


Figure 2. Typical Output Characteristics

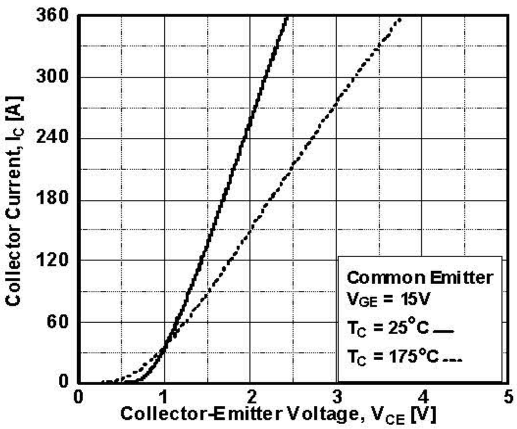


Figure 3. Typical Saturation Voltage Characteristics

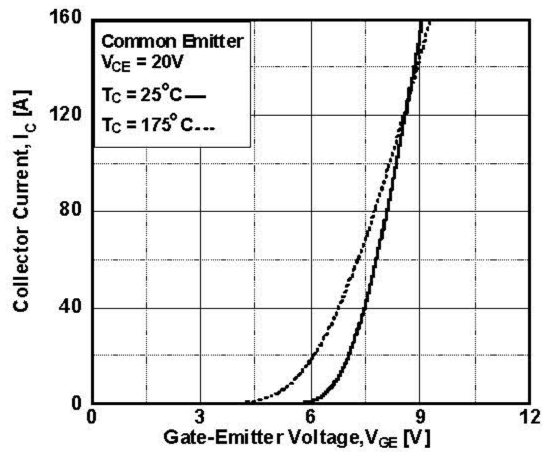


Figure 4. Transfer Characteristics

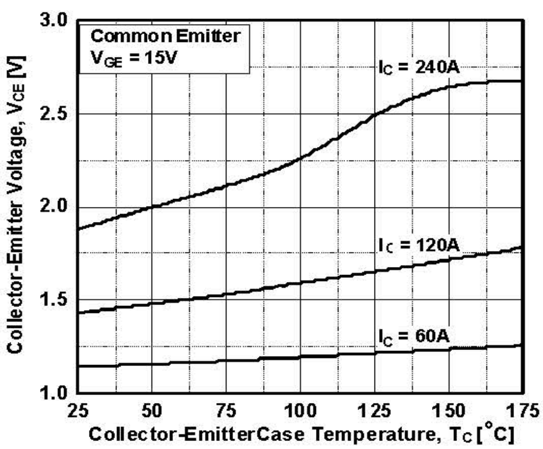


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

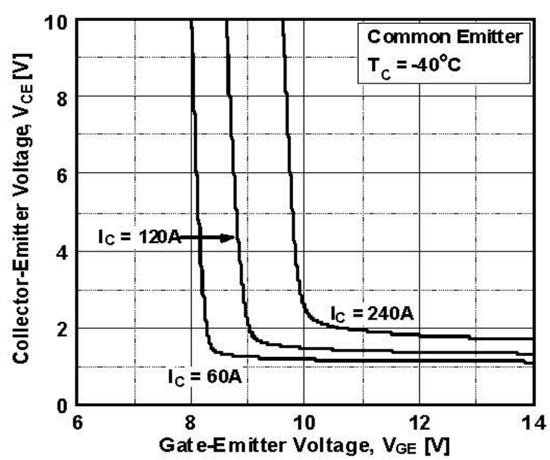


Figure 6. Saturation Voltage vs. V_{GE}

TYPICAL PERFORMANCE CHARACTERISTICS

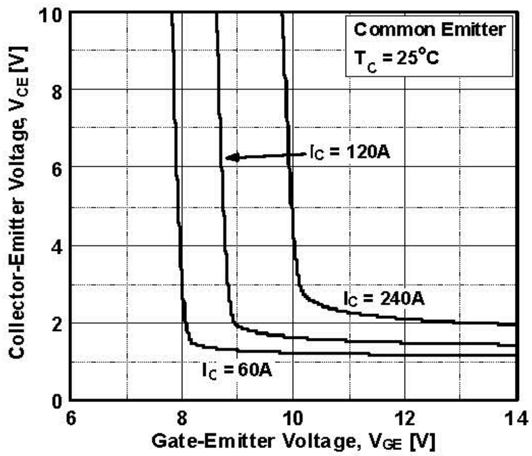


Figure 7. Saturation Voltage vs. V_{GE}

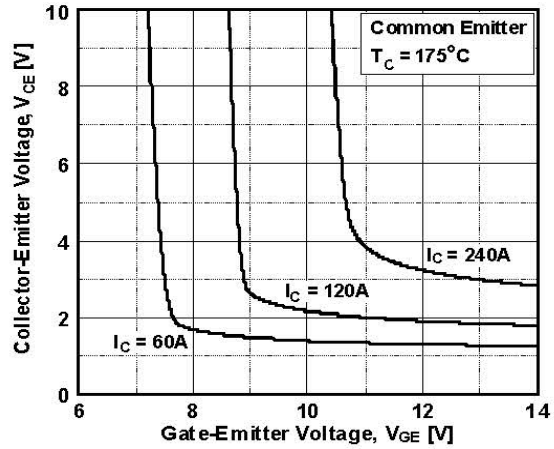


Figure 8. Saturation Voltage vs. V_{GE}

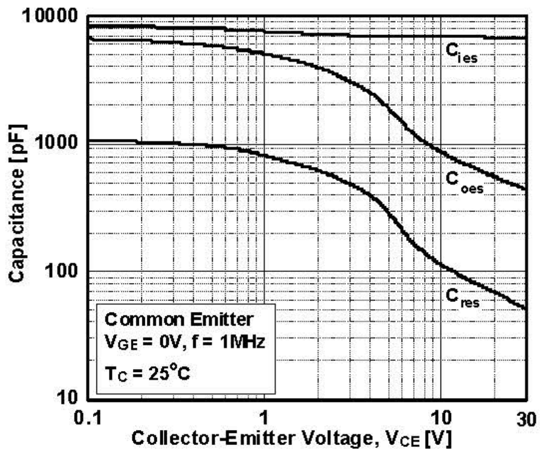


Figure 9. Capacitance Characteristics

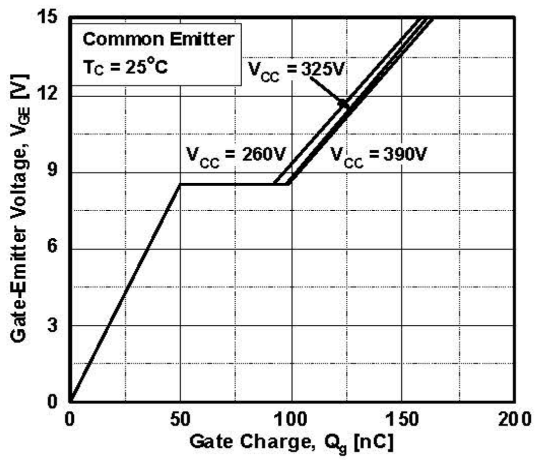


Figure 10. Gate Charge Characteristics

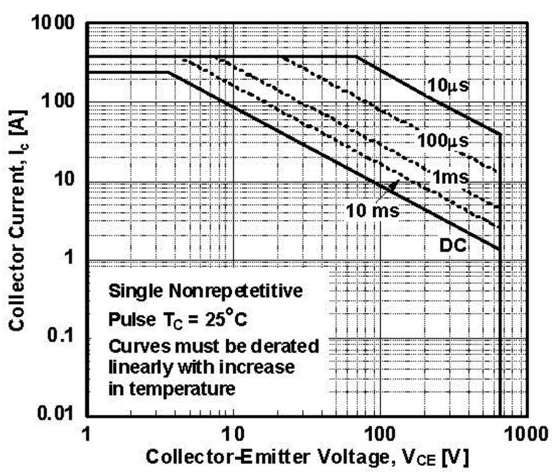


Figure 11. SOA Characteristics

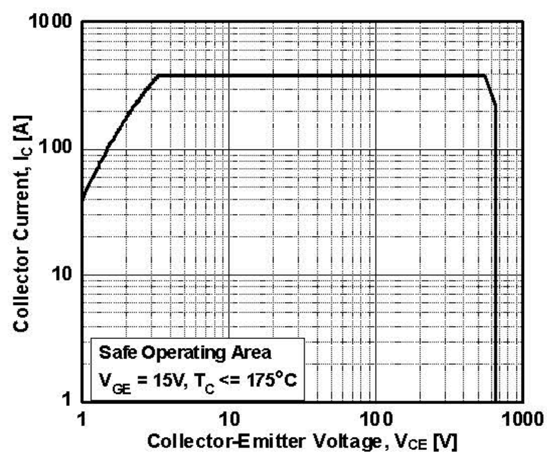


Figure 12. Turn Off Switching SOA Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS

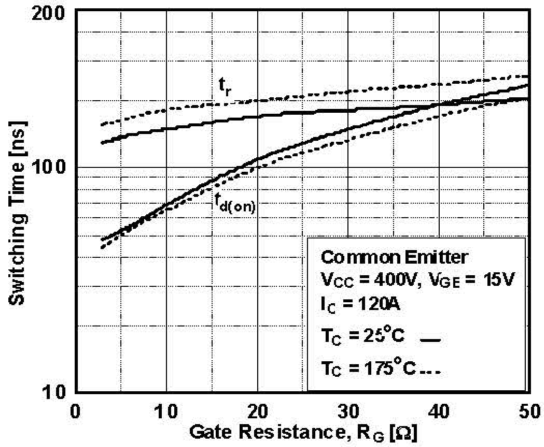


Figure 13. Turn−on Characteristics vs. Gate Resistance

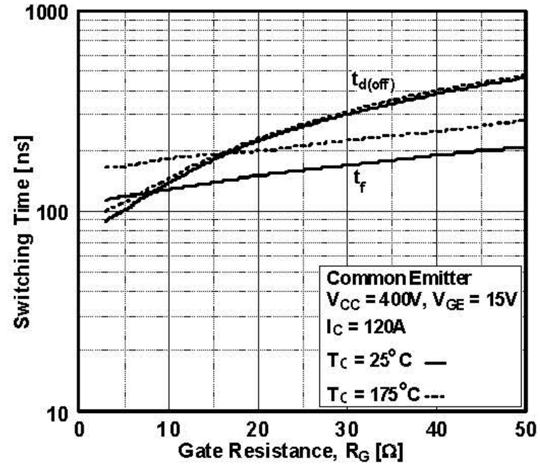


Figure 14. Turn−off Characteristics vs. Gate Resistance

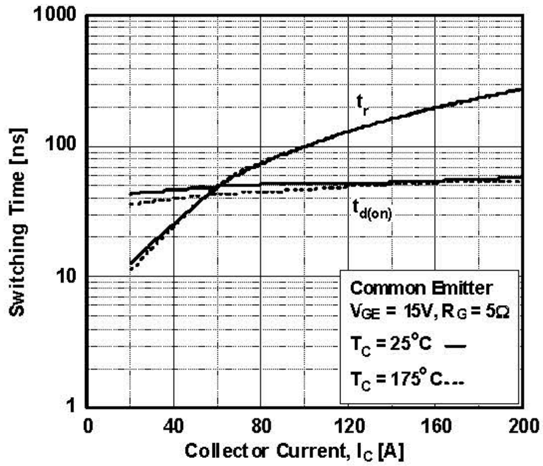


Figure 15. Turn−on Characteristics vs. Collector Current

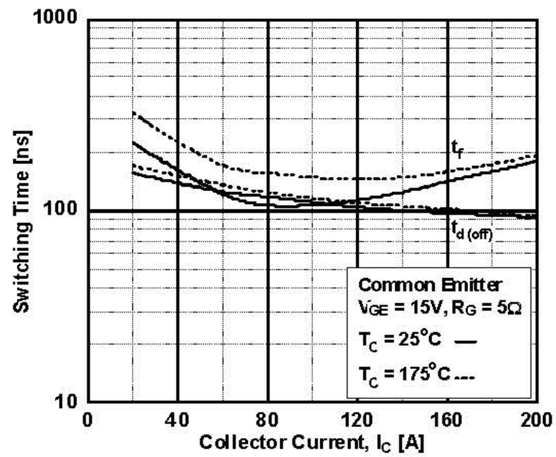


Figure 16. Turn−off Characteristics vs. Collector Current

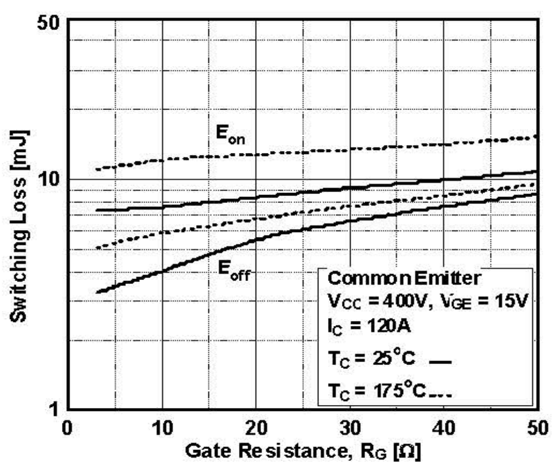


Figure 17. Switching Loss vs. Gate Resistance

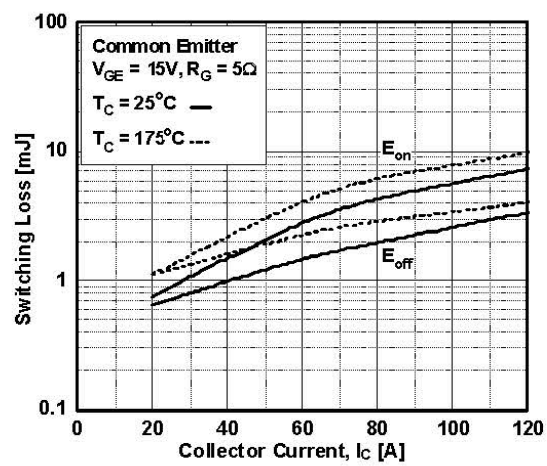


Figure 18. Switching Loss vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS

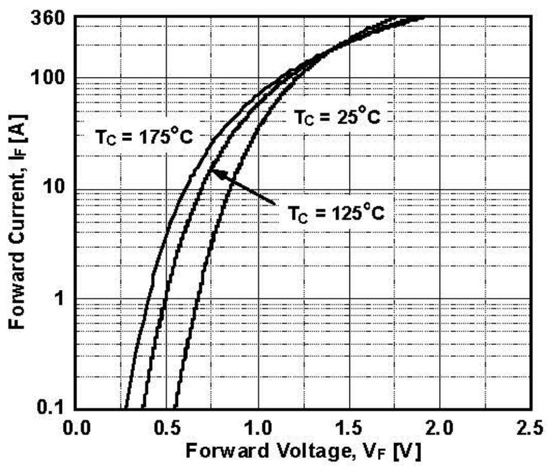


Figure 19. Forward Characteristics

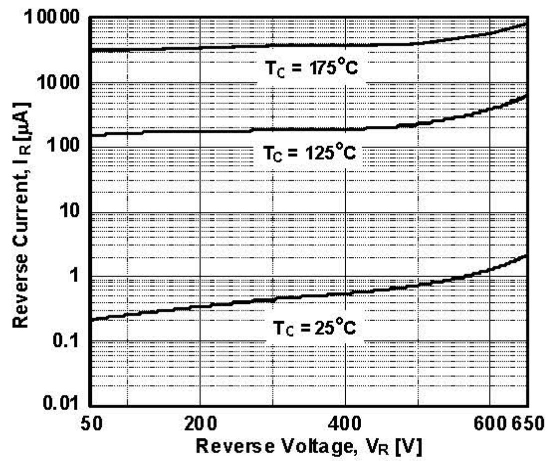


Figure 20. Reverse Current

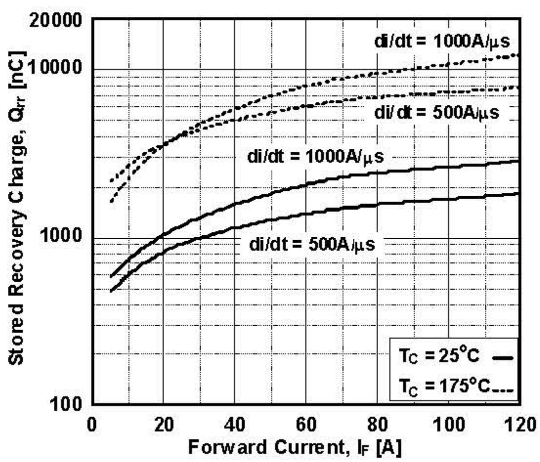


Figure 21. Stored Charge

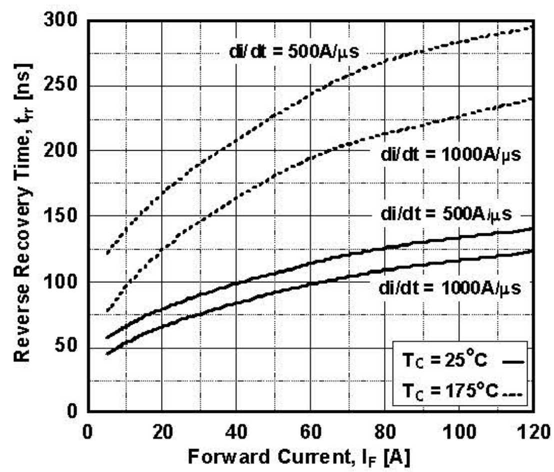


Figure 22. Reverse Recovery Time

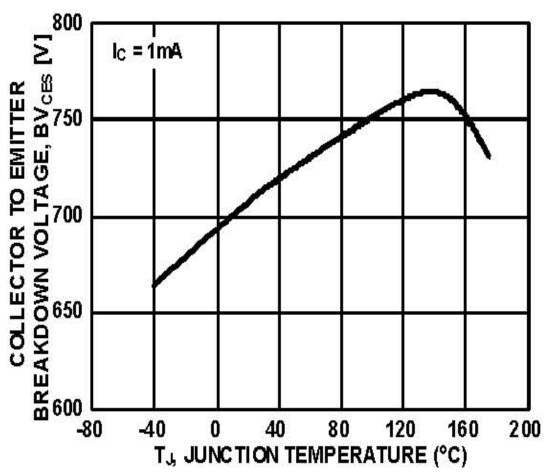


Figure 23. Collector to Emitter Breakdown Voltage vs. Junction Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

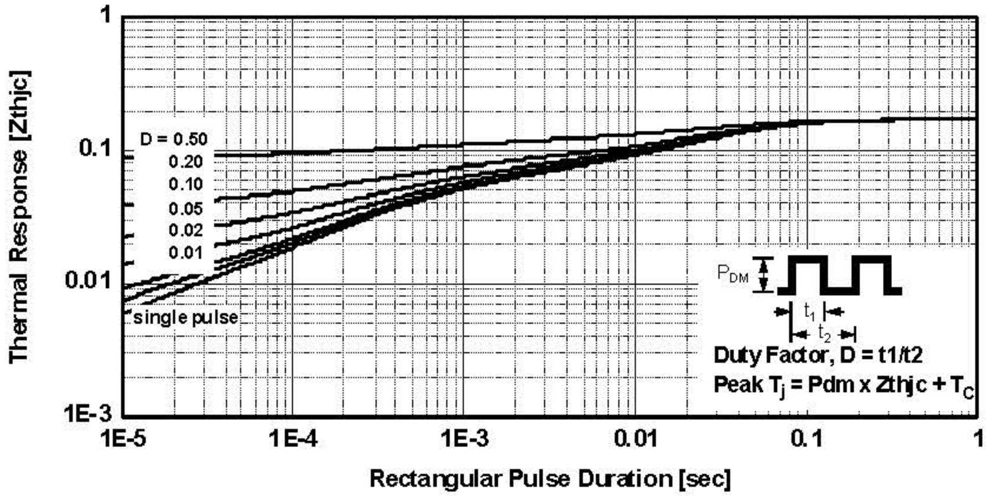


Figure 24. Transient Thermal Impedance of IGBT

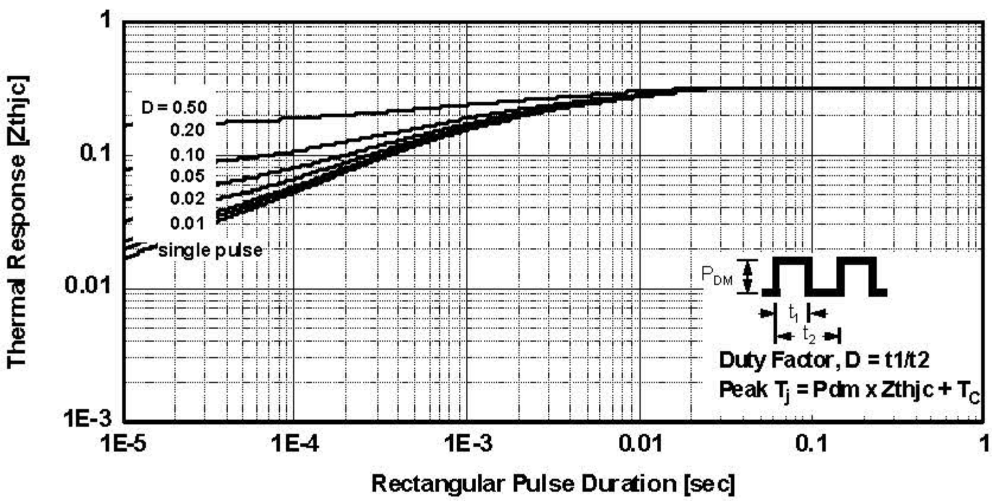
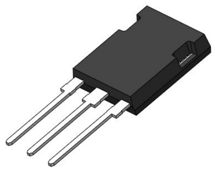
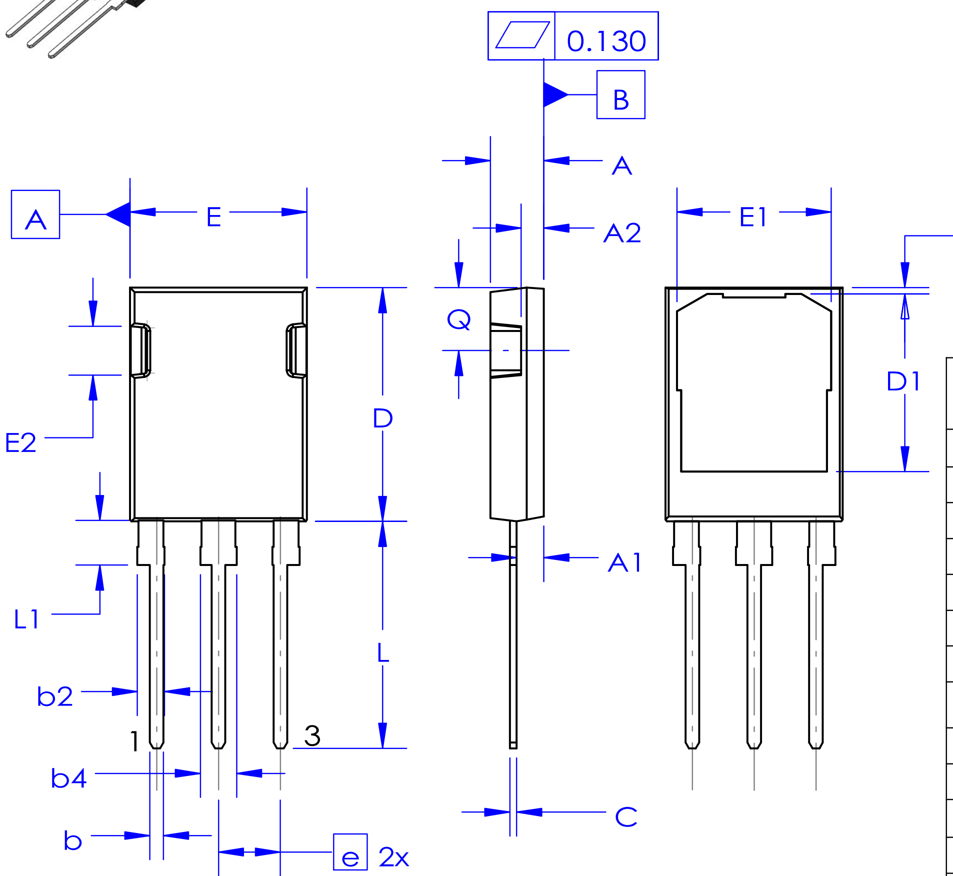


Figure 25. Transient Thermal Impedance of Diode



TO−247−3LD
CASE 340CU
ISSUE B

DATE 28 OCT 2021



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.60	4.70	4.80
A1	2.10	2.40	2.70
A2	1.70	2.00	2.30
b	1.16	1.20	1.26
b2	2.20	2.40	2.60
b4	3.00	3.20	3.40
c	0.59	0.60	0.66
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 STANDARS 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.

GENERIC MARKING DIAGRAM*

AYWWZZ
XXXXXXXXX
XXXXXXXXX

XXXX = Specific Device Code
A = Assembly Site Code
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.

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