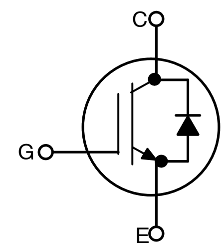
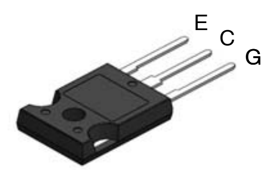
IGBT - Field Stop
600 V, 40 A

FGH40N60SMD-F085

ON Semiconductor®

www.onsemi.com





TO−247−3LD
CASE 340CK

Description

Using Novel Field Stop IGBT Technology, ON Semiconductor's new series of Field Stop IGBTs offer the optimum performance for Automotive Chargers, Inverter, and other applications where low conduction and switching losses are essential.

Features

- Maximum Junction Temperature: T_J = 175°C
- Positive Temperature Co−efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.9 V(Typ.) @ I_C = 40 A
- High Input Impedance
- Tightened Parameter Distribution
- AEC Qualified and PPAP Capable
  IGBT: AEC−Q101
- This Device is Pb−Free and is RoHS Compliant

Applications

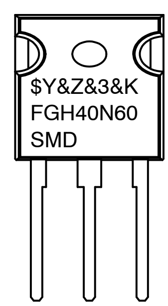
- Automotive Chargers, Converters, High Voltage Auxiliaries
- Inverters, SMPS, PFC, UPS

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Ratings	Unit
Collector to Emitter Voltage	V_{CES}	600	V
Gate to Emitter Voltage	V_{GES}	±20	V
Collector Current @ T_C = 25°C @ T_C = 100°C	I_C	 80 40	A
Pulsed Collector Current	I_{CM} (Note 1)	120	A
Diode Forward Current @ T_C = 25°C @ T_C = 100°C	I_F	 40 20	A
Pulsed Diode Maximum Forward Current	I_{FM} (Note 1)	120	A
Maximum Power Dissipation @ T_C = 25°C @ T_C = 100°C	P_D	 349 174	W
Operating Junction Temperature	T_J	−55 to +175	°C
Storage Temperature Range	T_{stg}	−55 to +175	°C
Maximum Lead Temperature for Soldering, 1/8″ from Case for 5 Seconds	T_L	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. Repetitive rating: Pulse width limited by max. junction temperature.

MARKING DIAGRAM



$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
FGH40N60SMD	= Specific Device Code

ORDERING INFORMATION

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

February, 2020 − Rev. 4
Publication Order Number:
FGH40N60SMD−F085/D

THERMAL CHARACTERISTICS

Parameter	Symbol	Ratings	Unit
Thermal Resistance Junction−to−Case, for IGBT	$R_{\theta JC}$ (Note 2)	0.43	°C/W
Thermal Resistance Junction−to−Case, for Diode	$R_{\theta JC}$	1.8	°C/W
Parameter	**Symbol**	**Typ.**	
Thermal Resistance Junction−to−Ambient (PCB Mount) (Note 2)	$R_{\theta JA}$	45	°C/W

2. $R_{\theta JC}$ for TO−247: according to Mil standard 883−1012 test method. $R_{\theta JA}$ for TO−247 : according to JESD51−2, test method environmental condition and JESD51−10, test boards for through hole perimeter leaded package thermal measurements. JESD51−3 : Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Package.

PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Package Type	Quantity
FGH40N60SMD	FGH40N60SMD−F085	TO−247−3	Tube	30 Units

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector to Emitter Breakdown Voltage	BV_{CES}	V_{GE} = 0 V, I_C = 250 μA	600	–	–	V
Temperature Coefficient of Breakdown Voltage	$\Delta BV_{CES}/\Delta T_J$	V_{GE} = 0 V, I_C = 250 μA	–	0.6	–	V/°C
Collector Cut−Off Current	I_{CES}	V_{CE} = V_{CES}, V_{GE} = 0 V	–	–	250	μA
		I_{CES} at 80% * B_{VCES}, 175°C	–	–	800	
G−E Leakage Current	I_{GES}	V_{GE} = V_{GES}, V_{CE} = 0 V	–	–	±400	nA
ON CHARACTERISTICs						
G−E Threshold Voltage	$V_{GE(th)}$	I_C = 250 μA, V_{CE} = V_{GE}	3.5	4.5	6.0	V
Collector to Emitter Saturation Voltage	$V_{CE(sat)}$	I_C = 40 A, V_{GE} = 15 V	–	1.9	2.5	V
		I_C = 40 A, V_{GE} = 15 V, T_C = 175°C	–	2.1	–	V
DYNAMIC CHARACTERISTICS						
Input Capacitance	C_{ies}	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	1880	2500	pF
Output Capacitance	C_{oes}		–	180	240	pF
Reverse Transfer Capacitance	C_{res}		–	50	65	pF
SWITCHING CHARACTERISTICS						
Turn−On Delay Time	$t_{d(on)}$	V_{CC} = 400 V, I_C = 40 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 25°C	–	18	24	ns
Rise Time	t_r		–	28	36.4	ns
Turn−Off Delay Time	$t_{d(off)}$		–	110	143	ns
Fall Time	t_f		–	13.2	18.5	ns
Turn−On Switching Loss	E_{on}		–	0.92	1.2	mJ
Turn−Off Switching Loss	E_{off}		–	0.3	0.39	mJ
Total Switching Loss	E_{ts}		–	1.22	1.59	mJ
Turn−On Delay Time	$t_{d(on)}$	V_{CC} = 400 V, I_C = 40 A, R_G = 6 Ω, V_{GE} = 15 V, Inductive Load, T_C = 175°C	–	16.7	23.8	ns
Rise Time	t_r		–	27	35.1	ns
Turn−Off Delay Time	$t_{d(off)}$		–	116	151	ns
Fall Time	t_f		–	56.5	81	ns
Turn−On Switching Loss	E_{on}		–	1.47	1.91	mJ
Turn−Off Switching Loss	E_{off}		–	0.73	0.95	mJ
Total Switching Loss	E_{ts}		–	2.20	2.86	mJ

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Total Gate Charge	Q_g	V_{CE} = 400 V, I_C = 40 A, V_{GE} = 15 V	–	119	180	nC
Gate to Emitter Charge	Q_{ge}		–	13	20	nC
Gate to Collector Charge	Q_{gc}		–	58	90	nC

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

Parametr	Symbol	Test Conditions		Min	Typ	Max	Unit
Diode Forward Voltage	V_{FM}	I_F = 20 A	T_C = 25°C	–	2.3	2.8	V
			T_C = 175°C	–	1.67	–	
Reverse Recovery Energy	E_{rec}	I_F = 20 A, di_F/dt = 200 A/μs	T_C = 175°C	–	48.9	–	μJ
Diode Reverse Recovery Time	t_{rr}		T_C = 25°C	–	36	47	ns
			T_C = 175°C	–	110	–	
Diode Reverse Recovery Charge	Q_{rr}		T_C = 25°C	–	46.8	61	nC
			T_C = 175°C	–	470	–	

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

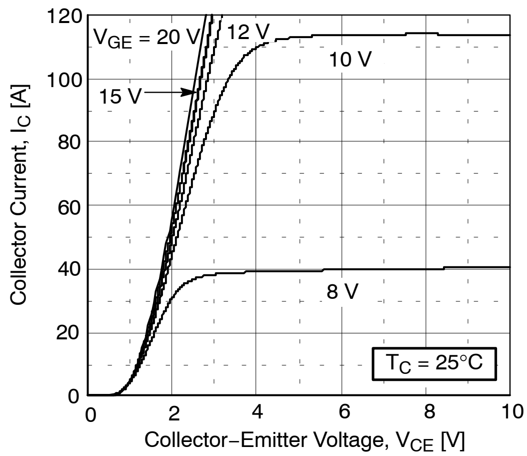


Figure 1. Typical Output Characteristics

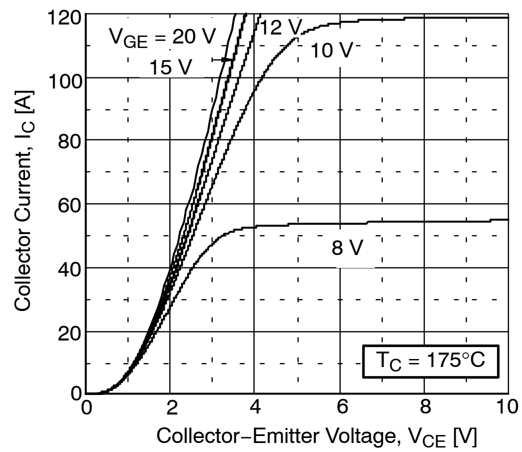


Figure 2. Typical Output Characteristics

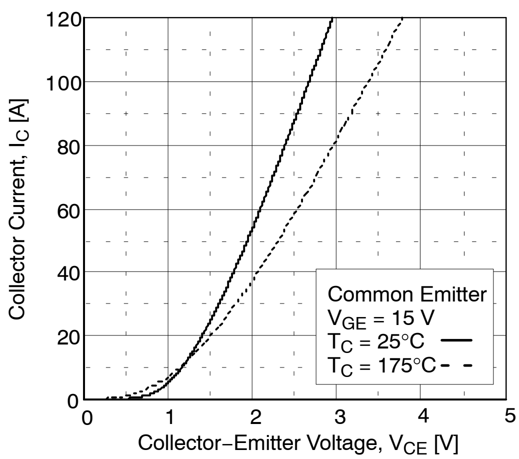


Figure 3. Typical Saturation Voltage Characteristics

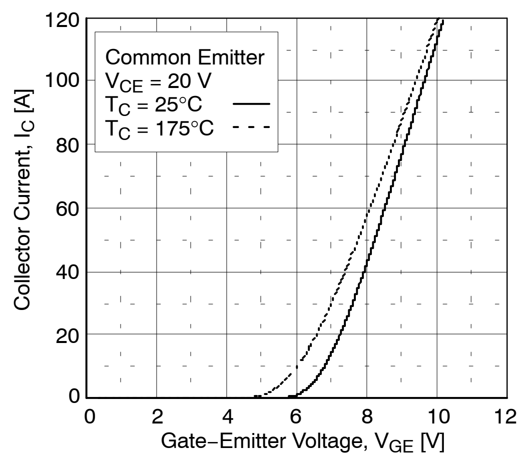


Figure 4. Transfer Characteristics

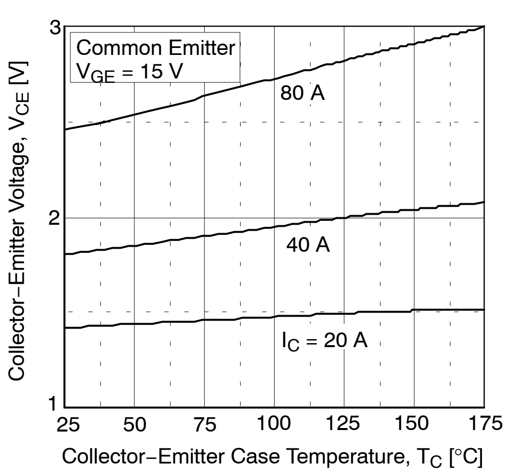


Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level

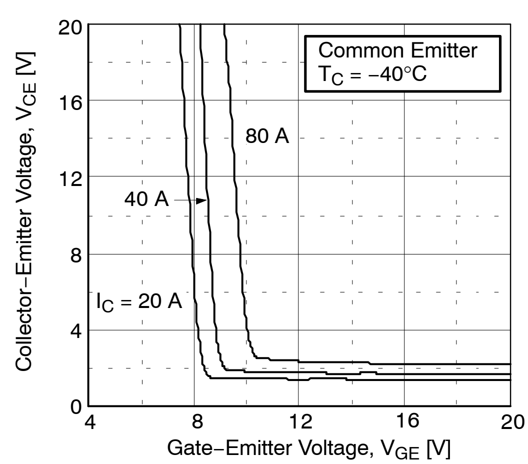


Figure 6. Saturation Voltage vs. V_{GE}

TYPICAL CHARACTERISTICS

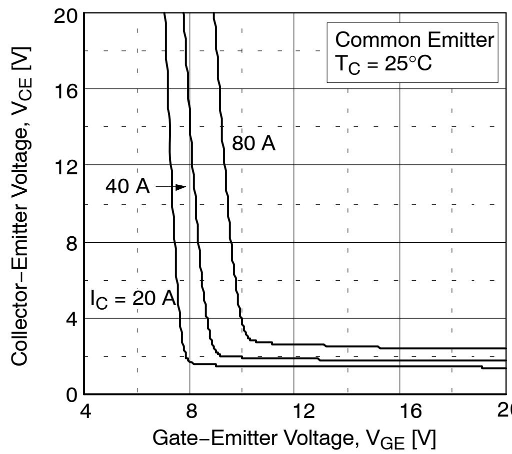


Figure 7. Saturation Voltage vs. V_{GE}

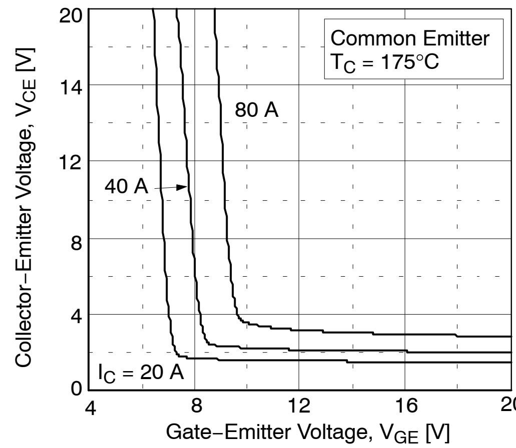


Figure 8. Saturation Voltage vs. V_{GE}

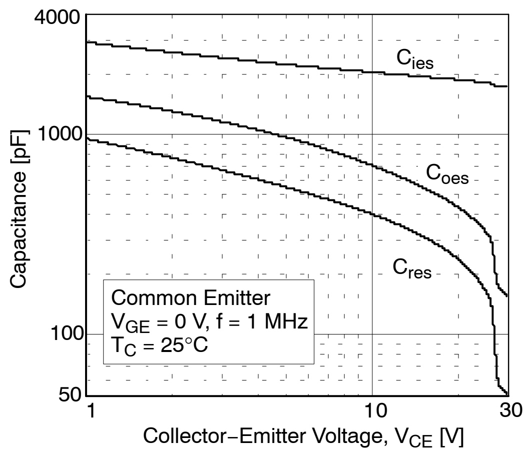


Figure 9. Capacitance Characteristics

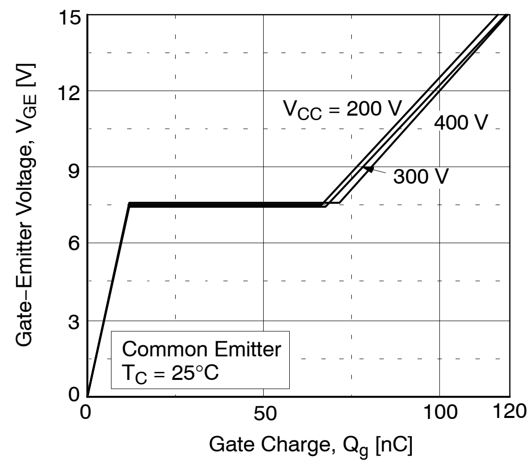


Figure 10. Gate Charge Characteristics

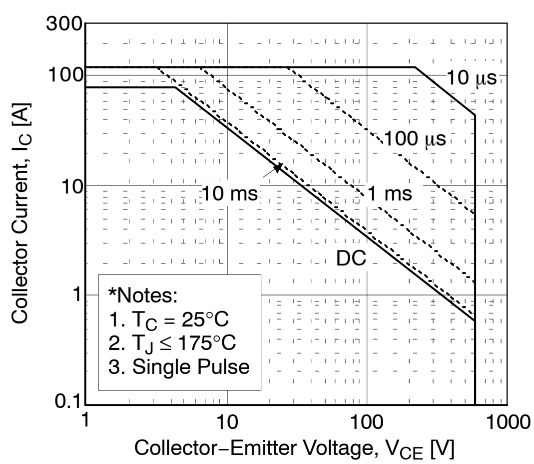


Figure 11. SOA Characteristics

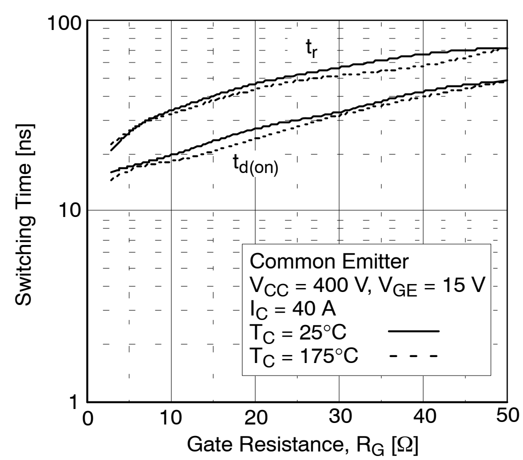


Figure 12. Turn−on Characteristics vs. Gate Resistance

TYPICAL CHARACTERISTICS

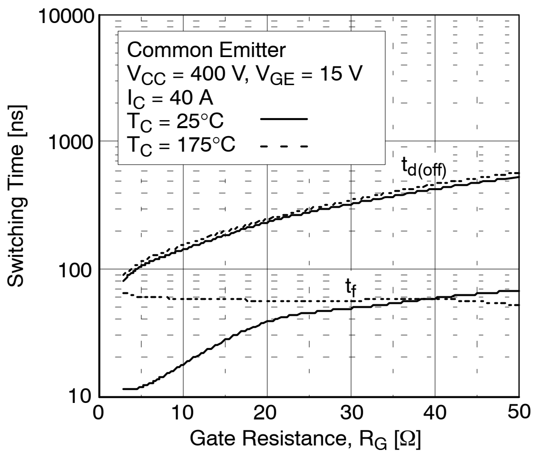


Figure 13. Turn−off Characteristics vs. Gate Resistance

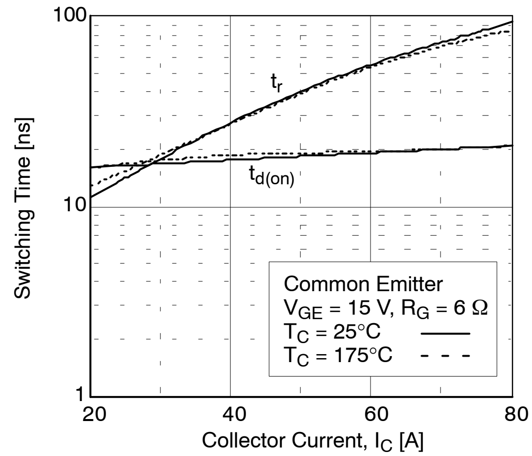


Figure 14. Turn−on Characteristics vs. Collector Current

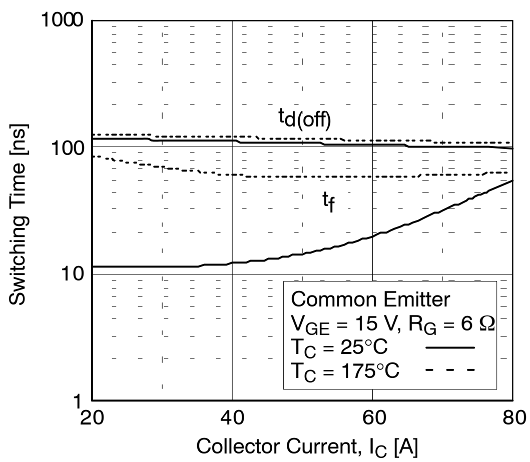


Figure 15. Turn−off Characteristics vs. Collector Current

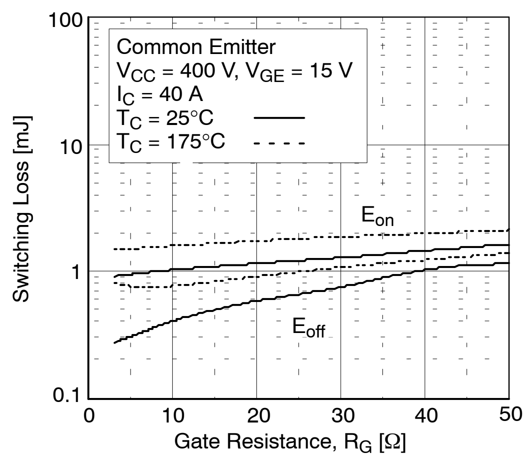


Figure 16. Switching Loss vs. Gate Resistance

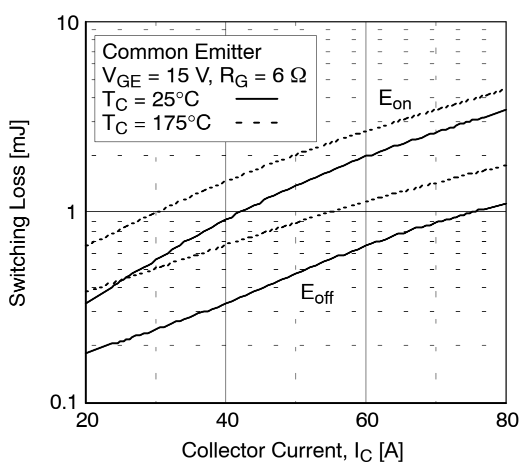


Figure 17. Switching Loss vs. Collector Current

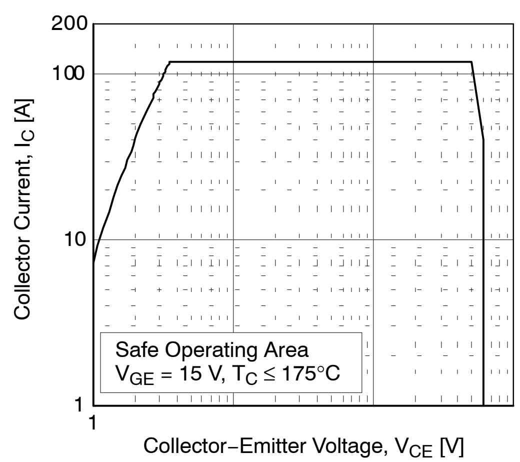


Figure 18. Turn−off Switching SOA Characteristics

TYPICAL CHARACTERISTICS

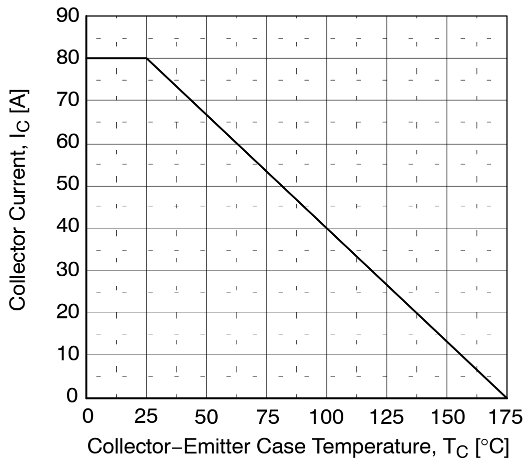


Figure 19. Current Derating

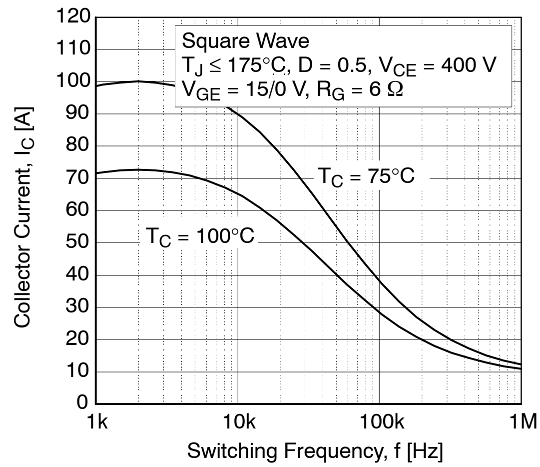


Figure 20. Load Current vs. Frequency

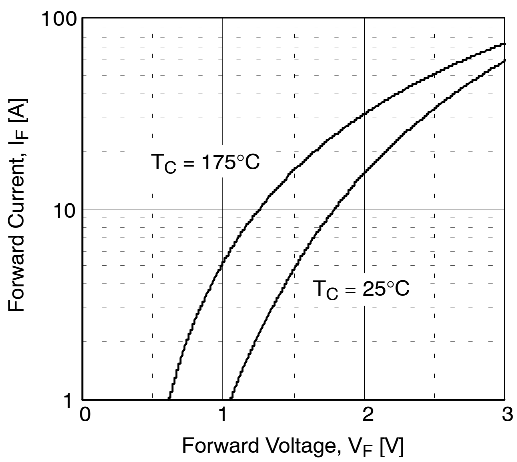


Figure 21. Forward Characteristics

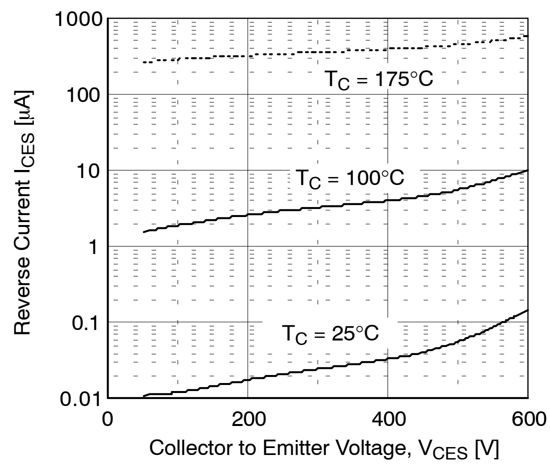


Figure 22. Reverse Current

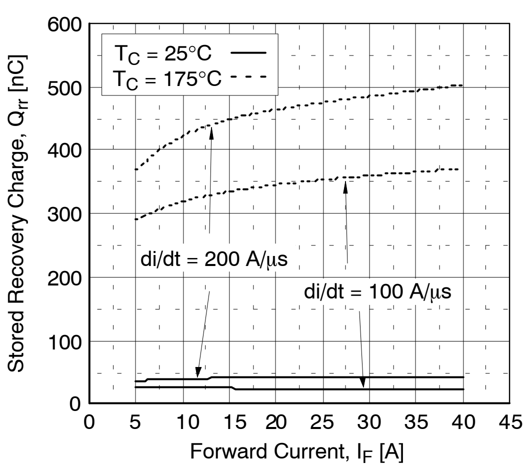


Figure 23. Stored Charge

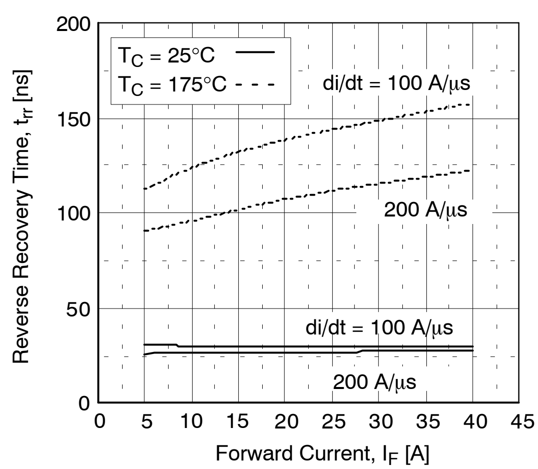


Figure 24. Reverse Recovery Time

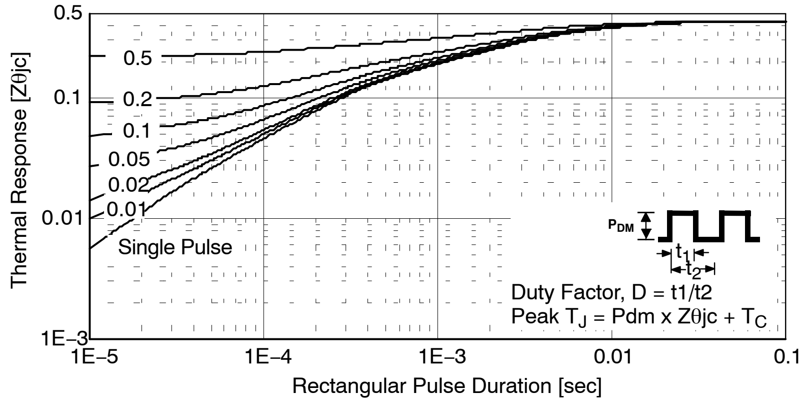


Figure 25. Transient Thermal Impedance of IGBT

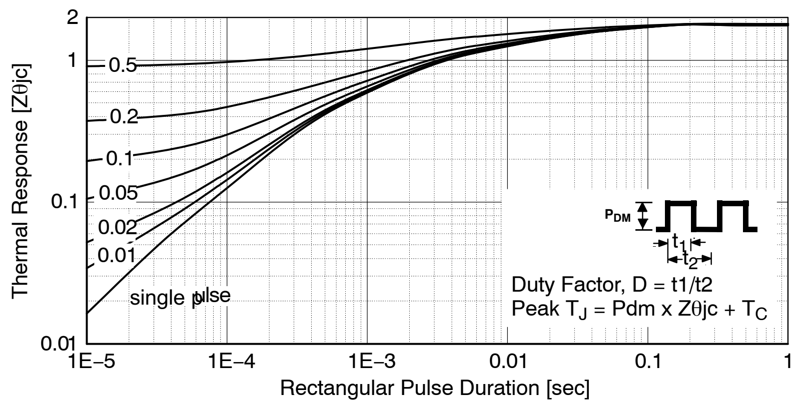


Figure 26. Transient Thermal Impedance of Diode

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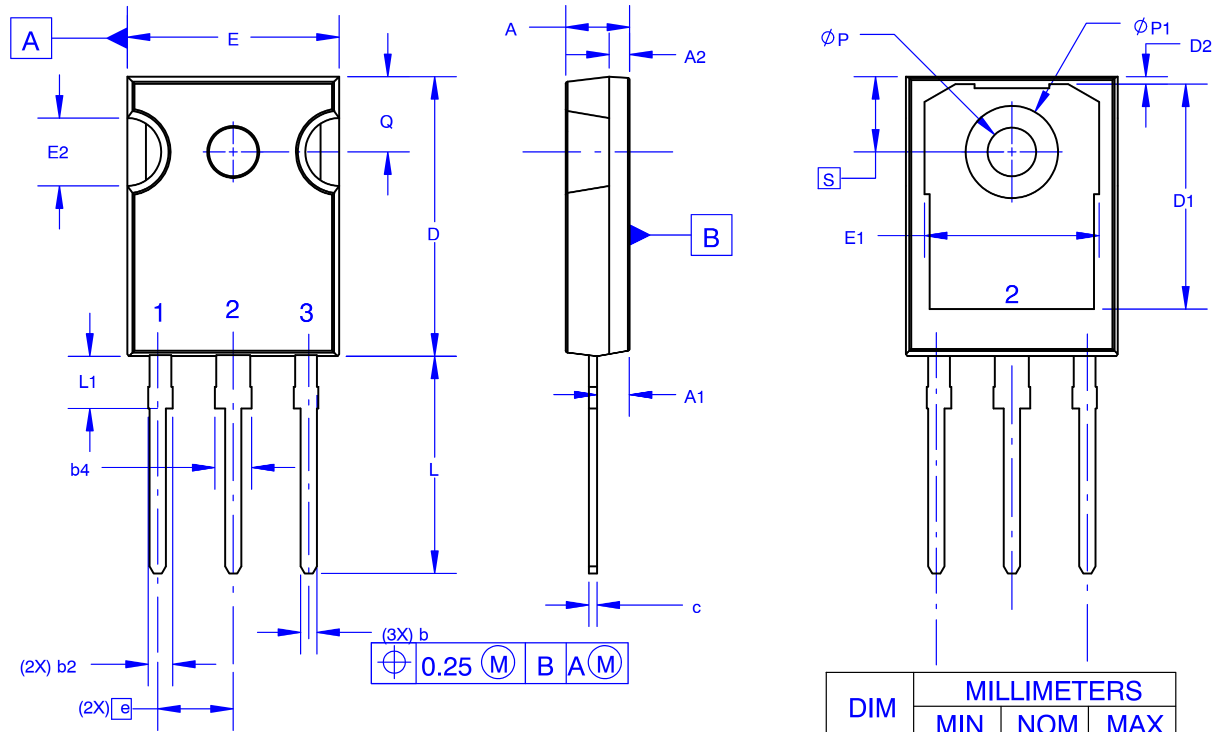
TO−247−3LD SHORT LEAD
CASE 340CK
ISSUE A

DATE 31 JAN 2019

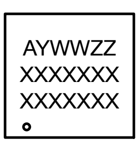


NOTES: UNLESS OTHERWISE SPECIFIED.

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.

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
ØP	3.51	3.58	3.65
ØP1	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

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.

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DESCRIPTION:	**TO−247−3LD SHORT LEAD**	**PAGE 1 OF 1**

ADDITIONAL INFORMATION

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