IGBT for Automotive Application

1200 V, 40 A

AFGHL40T120RLD

ON Semiconductor®

www.onsemi.com

Description

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Field Stop II Trench construction. Provides superior performance in demanding switching applications, offering both low on state voltage and minimal switching loss, which is AEC Q101 qualified offer the optimum performance for both hard and soft switching topology in automotive application.

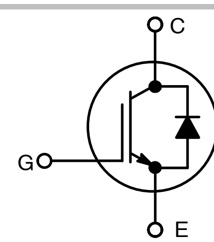
Features

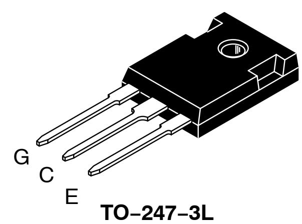
- Extremely Efficient Trench with Field Stop Technology
- Maximum Junction Temperature: T_J = 175°C
- Short Circuit Withstand Time 9 μs
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.75 V (Typ.) @ I_C = 40 A
- 100% of the Parts Tested for I_{LM} (Note 2)
- Fast Switching
- Tighten Parameter Distribution
- AEC−Q101 Qualified and PPAP Capable
- This Device is Pb−Free, Halogen Free/BFR Free and is RoHS Compliant

Typical Applications

- Automotive HEV−EV E−Compressor
- Automotive HEV−EV PTC Heater
- Automotive HEV−EV Onboard Chargers
- Automotive HEV−EV DC−DC Converters

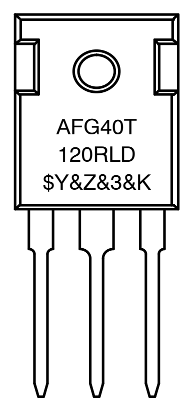
V_{CES}	I_C	$V_{CE(Sat)}$
1200 V	40 A	1.75 V (Typ.)





TO−247−3L
CASE 340CX

MARKING DIAGRAM



AFG40T120RLD	= Specific Device Code
$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= 3−Digit Date Code
&K	= 2−Digit Lot Traceability Code

ORDERING INFORMATION

Device	Package	Shipping
AFGHL40T120RLD	TO−247−3L	30 Units / Rail

MAXIMUM RATINGS

Description	Symbol	Value	Units
Collector to Emitter Voltage	V_{CES}	1200	V
Gate to Emitter Voltage	V_{GES}	±20	V
Transient Gate to Emitter Voltage		±30	
Collector Current @ T_C = 25°C (Note 1)	I_C	48	A
Collector Current @ T_C = 100°C		40	
Pulsed Collector Current (Note 2)	I_{LM}	160	A
Pulsed Collector Current (Note 3)	I_{CM}	160	A
Diode Forward Current @ T_C = 25°C (Note 1)	I_F	48	A
Diode Forward Current @ T_C = 100°C		40	
Pulsed Diode Maximum Forward Current	I_{FM}	160	A
Maximum Power Dissipation @ T_C = 25°C	P_D	529	W
Maximum Power Dissipation @ T_C = 100°C		264	
Short Circuit Withstand Time V_{GE} = 15 V, V_{CE} = 600 V, T_J = 150°C	SCWT	9	μs
Operating Junction Temperature / Storage Temperature Range	T_J, T_{STG}	−55 to +175	°C
Maximum Lead Temp. For Soldering Purposes, ⅛” from case for 5 seconds	T_L	260	°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. Value limited by bond wire.
2. V_{CC} = 600 V, V_{GE} = 15 V, I_C = 160 A, R_G = 15 Ω, Inductive Load, 100% Tested
3. Repetitive rating: pulse width limited by max. Junction temperature.

THERMAL CHARACTERISTICS

Rating	Symbol	Max.	Units
Thermal Resistance, Junction to Case, for IGBT	$R_{\theta JC}$	0.28	°C/W
Thermal Resistance, Junction to Case, Max for Diode	$R_{\theta JC}$	0.47	°C/W
Thermal Resistance, Junction to Ambient, Max	$R_{\theta JA}$	40	°C/W

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS						
Collector−emitter Breakdown Voltage, Gate−emitter Short−circuited	V_{GE} = 0 V, I_C = 1mA	BVCES	1250	–	–	V
Temperature Coefficient of Breakdown Voltage	V_{GE} = 0 V, I_C = 1mA	$\Delta BV_{CES}/\Delta T_J$	–	1.4	–	V/°C
Collector−emitter Cut−off Current, Gate−emitter Short−circuited	V_{GE} = 0 V, V_{CE} = V_{CES}	ICES	–	–	40	μA
Gate Leakage Current, Collector−emitter Short−circuited	V_{GE} = V_{GES}, V_{CE} = 0 V	IGES	–	–	±400	nA
ON CHARACTERISTICS						
Gate−emitter Threshold Voltage	V_{GE} = V_{CE}, I_C = 40 mA	VGE(th)	5.3	6.3	7.3	V
Collector−emitter Saturation Voltage	V_{GE} = 15 V, I_C = 40 A V_{GE} = 15 V, I_C = 40 A, T_J = 175°C	VCE(sat)	– –	1.75 2.09	2.1 –	V

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified) (continued)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
DYNAMIC CHARACTERISTICS						
Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	C_{ies}	–	8755	–	pF
Output Capacitance		C_{oes}	–	302	–	
Reverse Transfer Capacitance		C_{res}	–	162	–	
SWITCHING CHARACTERISTICS, INDUCTIVE LOAD						
Turn−on Delay Time	T_J = 25°C V_{CC} = 600 V, I_C = 20 A Rg = 5 Ω V_{GE} = 15 V Inductive Load	$t_{d(on)}$	–	43	–	ns
Rise Time		t_r	–	18	–	
Turn−off Delay Time		$t_{d(off)}$	–	222	–	
Fall Time		t_f	–	53	–	
Turn−on Switching Loss		E_{on}	–	1.6	–	mJ
Turn−off Switching Loss		E_{off}	–	0.45	–	
Total Switching Loss		E_{ts}	–	2.05	–	
Turn−on Delay Time	T_J = 25°C V_{CC} = 600 V, I_C = 40 A Rg = 5 Ω V_{GE} = 15 V Inductive Load	$t_{d(on)}$	–	48	–	ns
Rise Time		t_r	–	32	–	
Turn−off Delay Time		$t_{d(off)}$	–	208	–	
Fall Time		t_f	–	68	–	
Turn−on Switching Loss		E_{on}	–	3.4	–	mJ
Turn−off Switching Loss		E_{off}	–	1.2	–	
Total Switching Loss		E_{ts}	–	4.6	–	
Turn−on Delay Time	T_J = 175°C V_{CC} = 600 V, I_C = 20 A Rg = 5 Ω V_{GE} = 15 V Inductive Load	$t_{d(on)}$	–	40	–	ns
Rise Time		t_r	–	20	–	
Turn−off Delay Time		$t_{d(off)}$	–	252	–	
Fall Time		t_f	–	156	–	
Turn−on Switching Loss		E_{on}	–	2.5	–	mJ
Turn−off Switching Loss		E_{off}	–	1.08	–	
Total Switching Loss		E_{ts}	–	3.58	–	
Turn−on Delay Time	T_J = 175°C V_{CC} = 600 V, I_C = 40 A Rg = 5 Ω V_{GE} = 15 V Inductive Load	$t_{d(on)}$	–	44	–	ns
Rise Time		t_r	–	32	–	
Turn−off Delay Time		$t_{d(off)}$	–	236	–	
Fall Time		t_f	–	164	–	
Turn−on Switching Loss		E_{on}	–	4.9	–	mJ
Turn−off Switching Loss		E_{off}	–	2.5	–	
Total Switching Loss		E_{ts}	–	7.4	–	
Total Gate Charge	V_{CE} = 600 V, I_C = 40 A, V_{GE} = 15 V	Q_g	–	395	–	nC
Gate to Emitter Charge		Q_{ge}	–	72	–	
Gate to collector Charge		Q_{gc}	–	198	–	
DIODE CHARACTERISTICS						
Forward Voltage	I_F = 40 A, T_J = 25°C I_F = 40 A, T_J = 175°C	V_F	– –	1.51 1.54	2.0	V
Reverse Recovery Energy	T_J = 25°C V_R = 600 V, I_F = 20 A dI_F/dt = 1000 A/μs	E_{rec}	–	0.74	–	mJ
Diode Reverse Recovery Time		T_{rr}	–	143	–	ns
Diode Reverse Recovery Charge		Q_{rr}	–	2546	–	nC

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified) (continued)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
DIODE CHARACTERISTICS						
Reverse Recovery Energy	T_J = 25°C V_R = 600 V, I_F = 40 A dI_F/dt = 1000 A/μs	E_{rec}	–	1.14	–	mJ
Diode Reverse Recovery Time		T_{rr}	–	195	–	ns
Diode Reverse Recovery Charge		Q_{rr}	–	3761	–	nC
Reverse Recovery Energy	T_J = 175°C V_R = 600 V, I_F = 20 A dI_F/dt = 1000 A/μs	E_{rec}	–	1.92	–	mJ
Diode Reverse Recovery Time		T_{rr}	–	212	–	ns
Diode Reverse Recovery Charge		Q_{rr}	–	5242	–	nC
Reverse Recovery Energy	T_J = 175°C V_R = 600 V, I_F = 40 A dI_F/dt = 1000 A/μs	E_{rec}	–	2.768	–	mJ
Diode Reverse Recovery Time		T_{rr}	–	286	–	ns
Diode Reverse Recovery Charge		Q_{rr}	–	7321	–	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.

TYPICAL CHARACTERISTICS

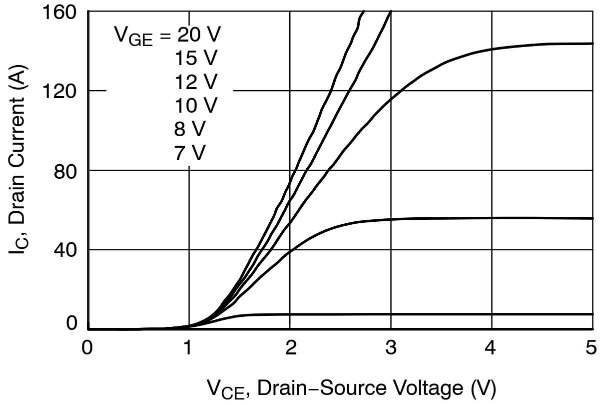


Figure 1. Typical Output Characteristics (25°C)

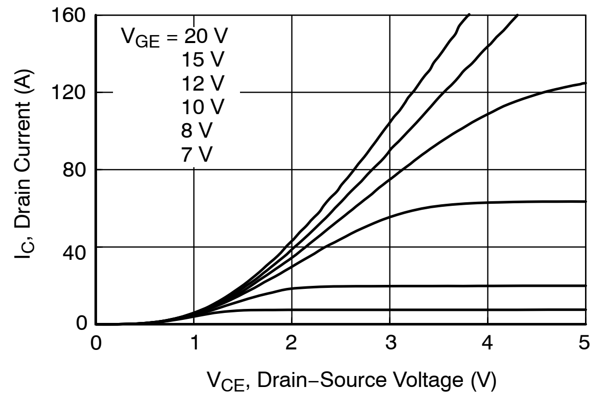


Figure 2. Typical Output Characteristics (175°C)

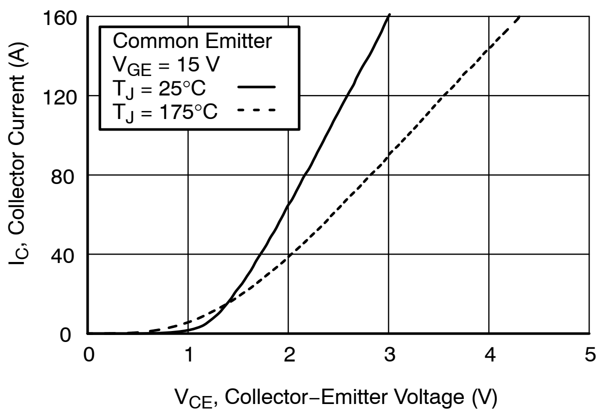


Figure 3. Typical Saturation Voltage Characteristics

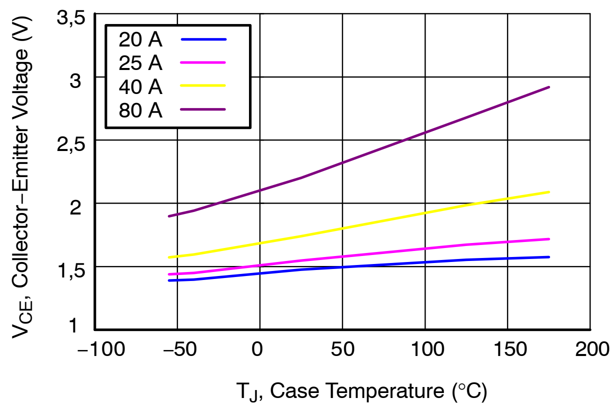


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

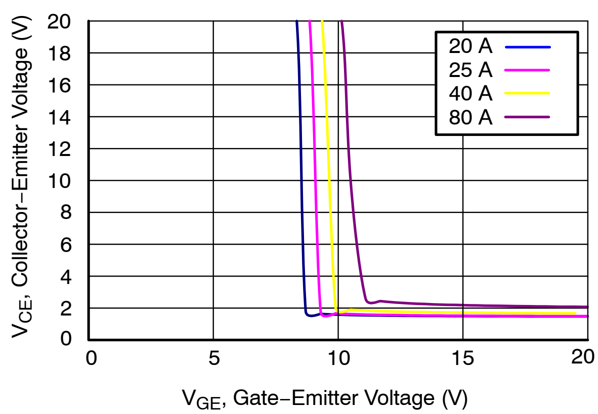


Figure 5. Saturation Voltage vs. V_{GE} (25°C)

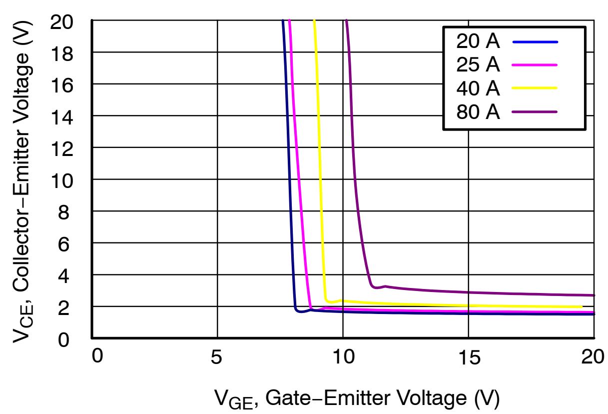


Figure 6. Saturation Voltage vs. V_{GE} (175°C)

TYPICAL CHARACTERISTICS (continued)

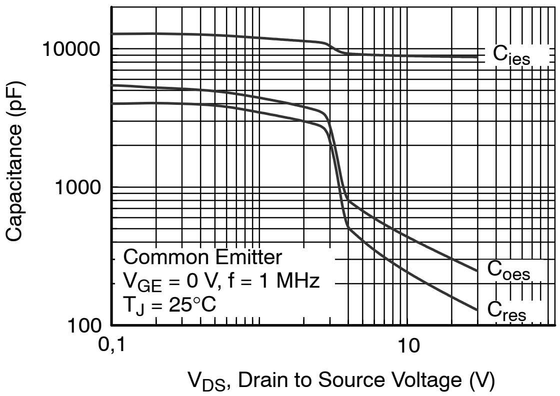


Figure 7. Capacitance Characteristics

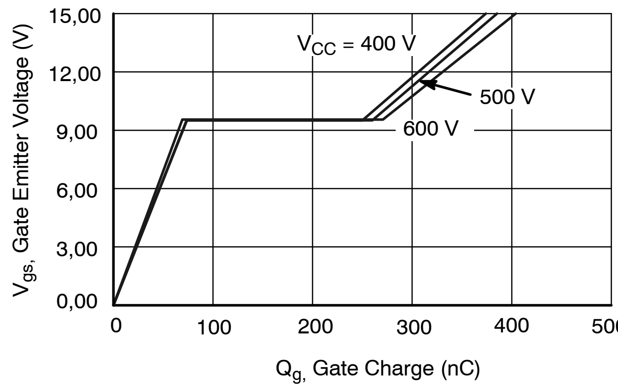


Figure 8. Gate Charge Characteristics

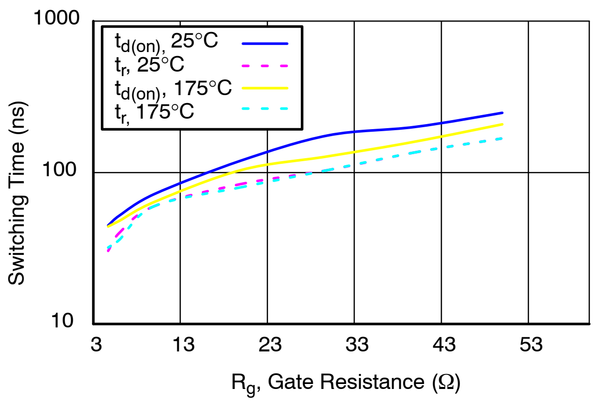


Figure 9. Turn−on Characteristics vs. Gate Resistance

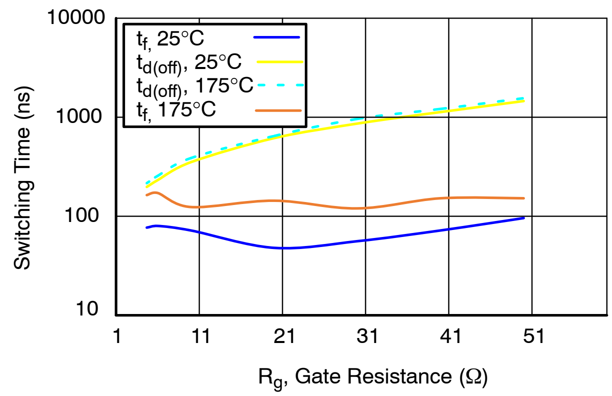


Figure 10. Turn−off Characteristics vs. Gate Resistance

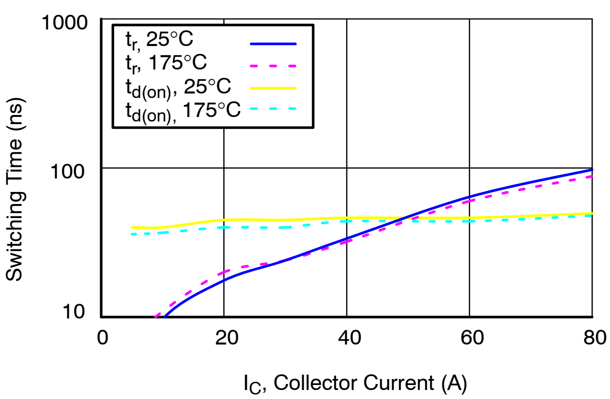


Figure 11. Turn−on Characteristics vs. Collector Current

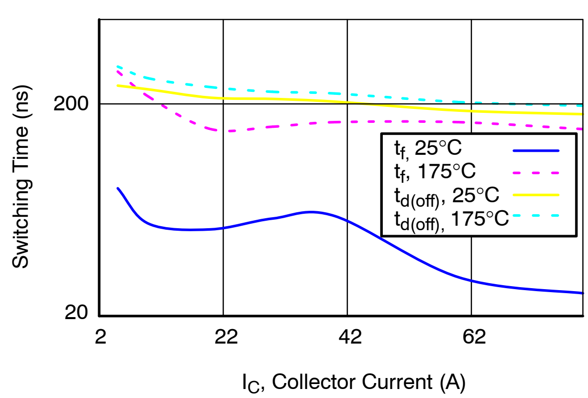


Figure 12. Turn−off Characteristics vs. Collector Current

TYPICAL CHARACTERISTICS (continued)

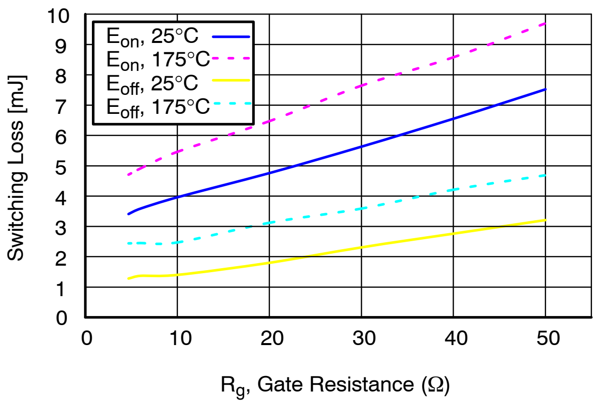


Figure 13. Switching Loss vs. Gate Resistance

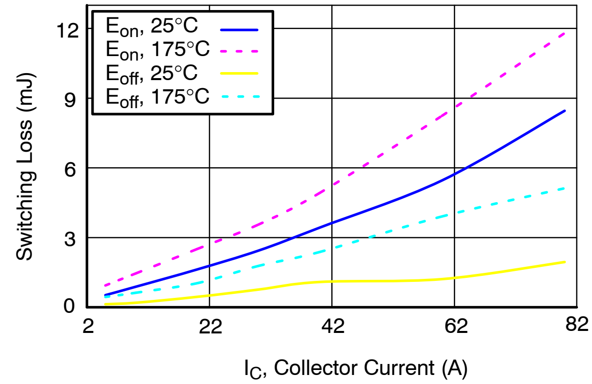


Figure 14. Switching Loss vs. Collector Current

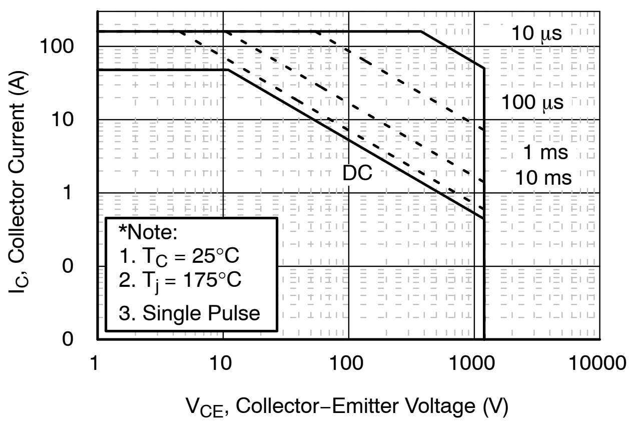


Figure 15. SOA Characteristics

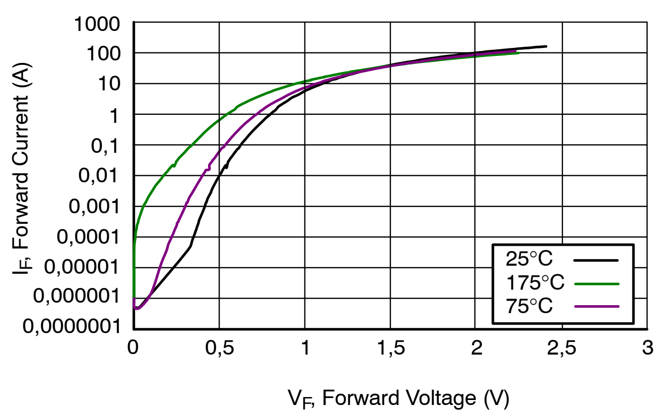


Figure 16. Forward Characteristics

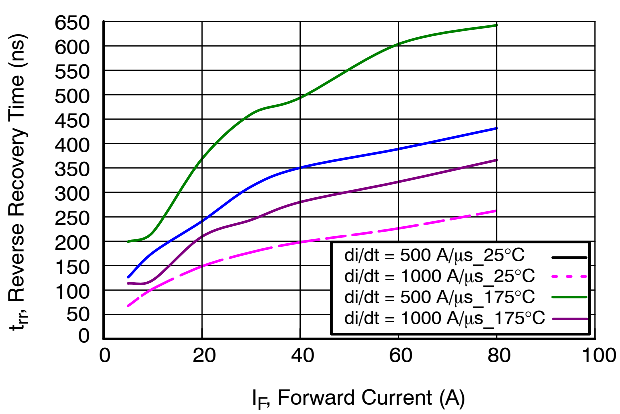


Figure 17. Reverse Recovery Time

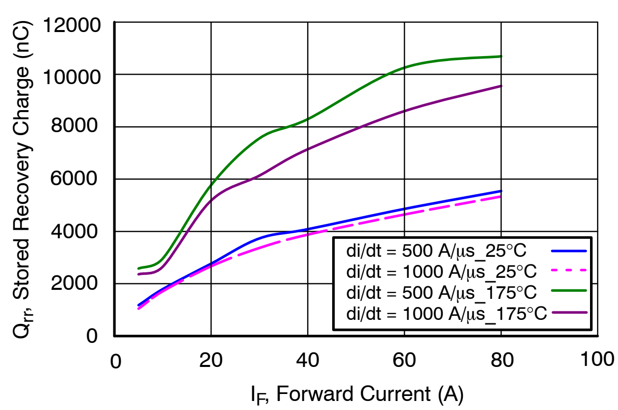


Figure 18. Stored Charge

TYPICAL CHARACTERISTICS (continued)

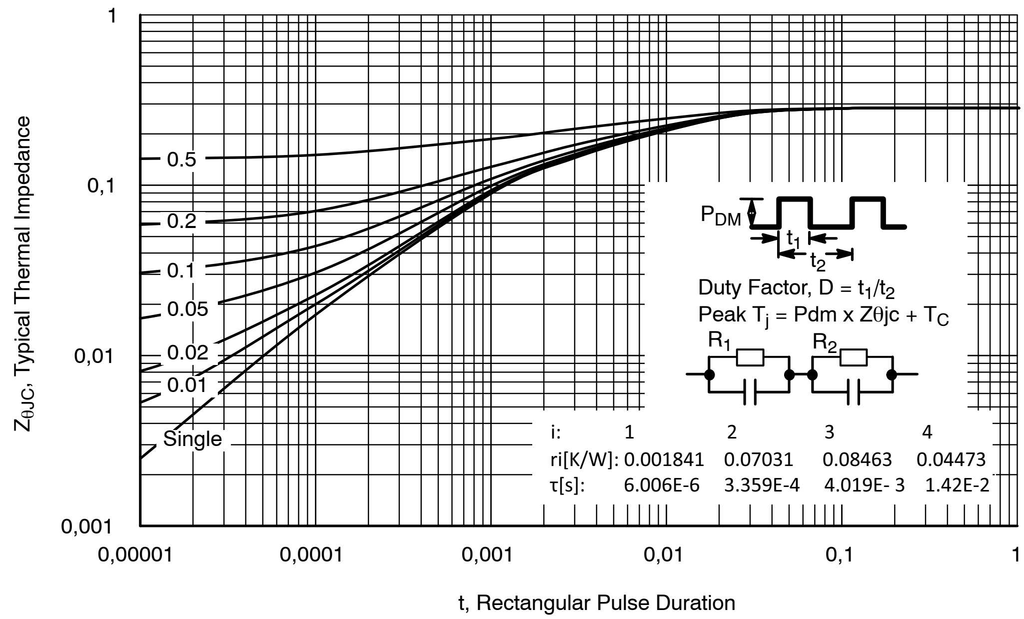


Figure 19. Transient Thermal Impedance of IGBT

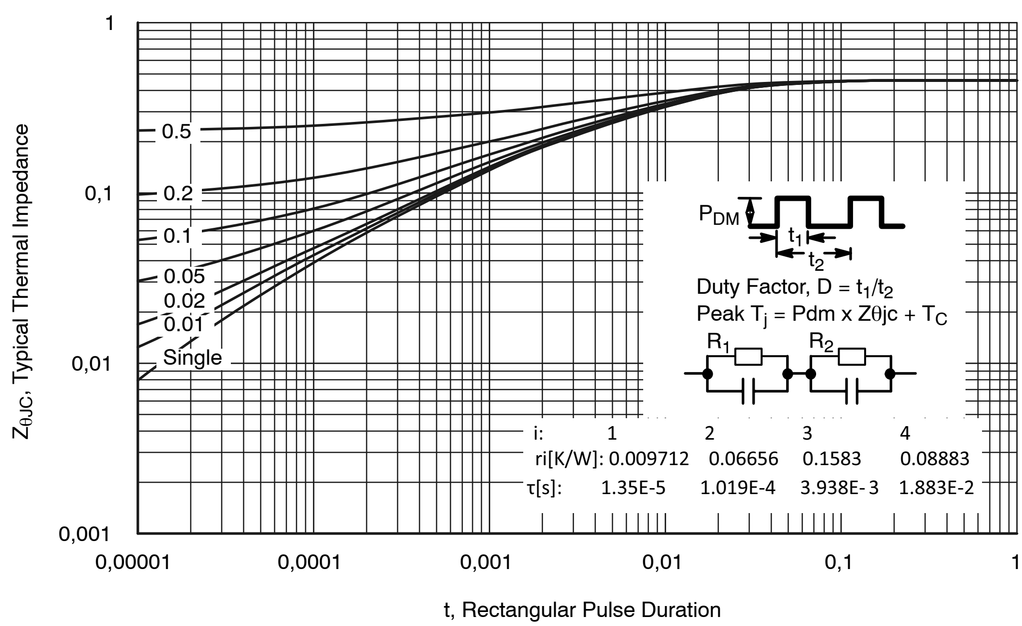


Figure 20. Transient Thermal Impedance of Diode

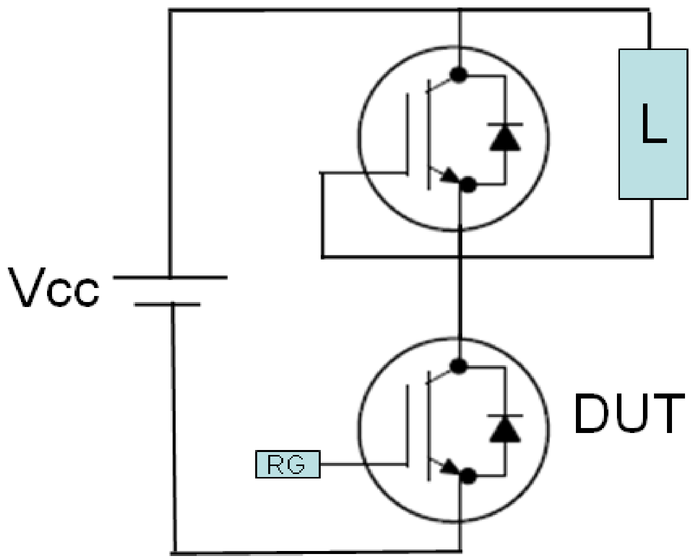


Figure 21. Test Circuit for Switching Characteristics

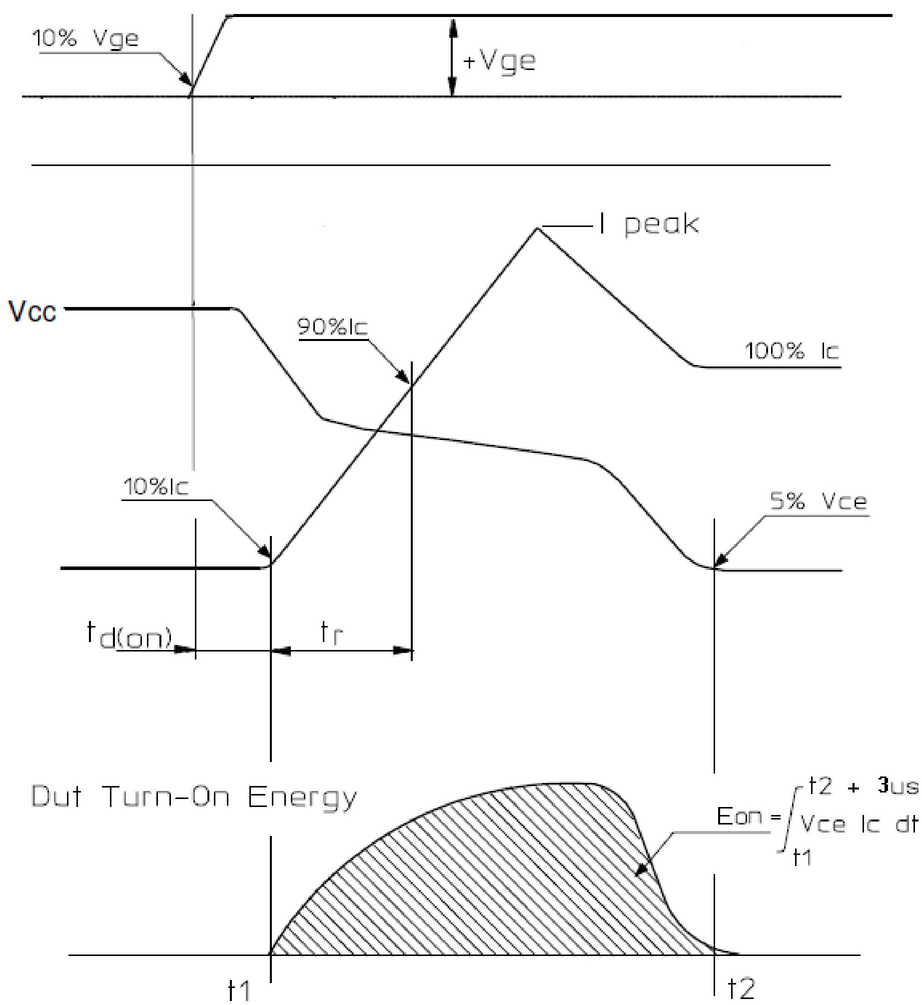


Figure 22. Definition of Turn On Waveform

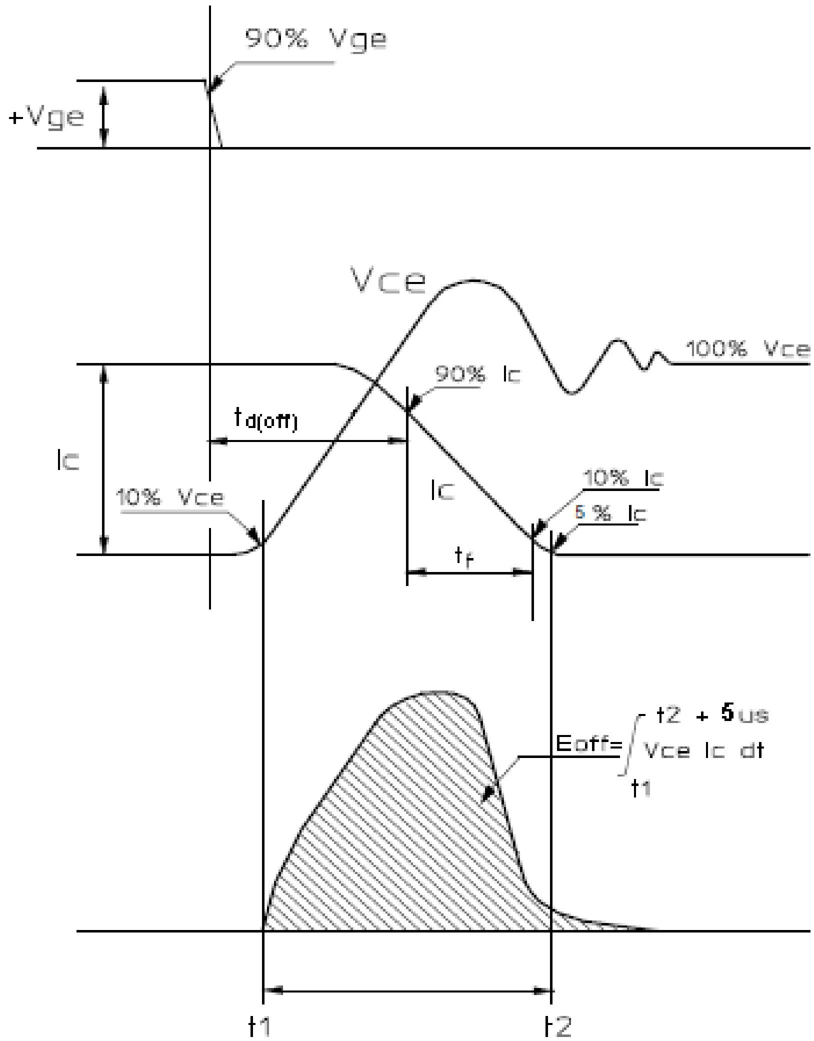
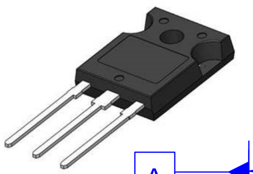
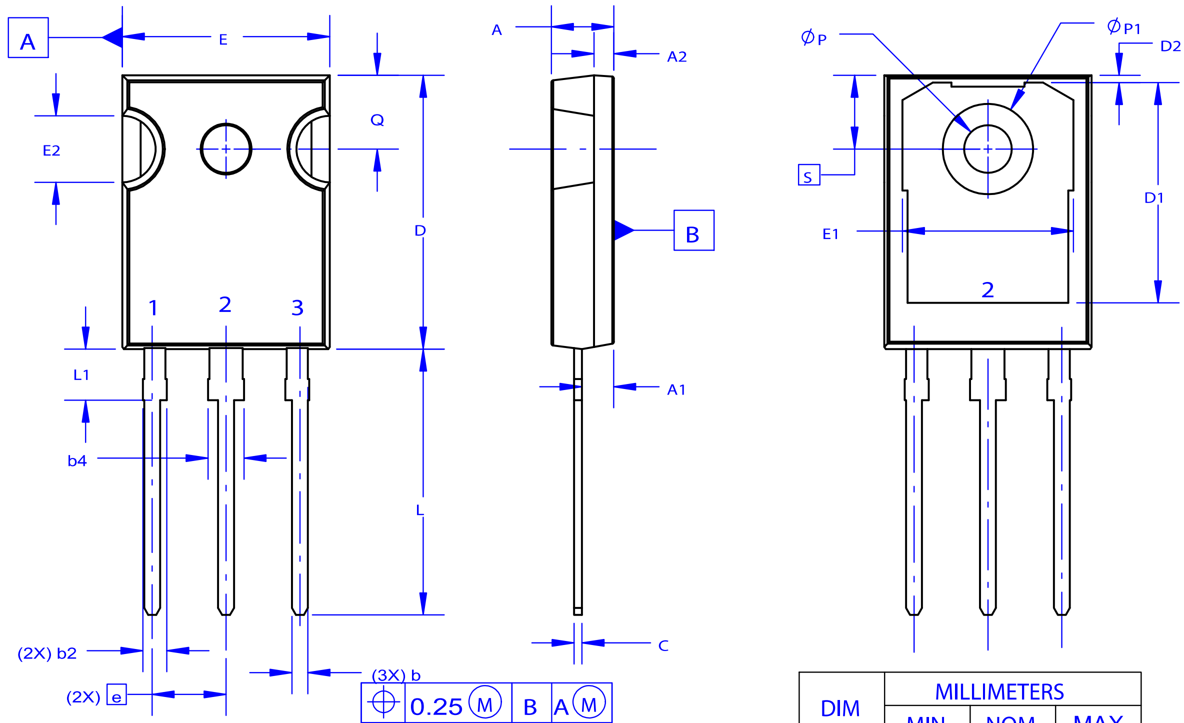


Figure 23. Definition of Turn Off Waveform



TO−247−3LD
CASE 340CX
ISSUE A

DATE 06 JUL 2020

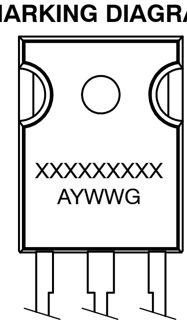


NOTES: UNLESS OTHERWISE SPECIFIED.

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
D	20.32	20.57	20.82
E	15.37	15.62	15.87
E2	4.96	5.08	5.20
e	~	5.56	~
L	19.75	20.00	20.25
L1	3.69	3.81	3.93
ØP	3.51	3.58	3.65
Q	5.34	5.46	5.58
S	5.34	5.46	5.58
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
D1	13.08	~	~
D2	0.51	0.93	1.35
E1	12.81	~	~
ØP1	6.60	6.80	7.00

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

*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	PAGE 1 OF 1

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