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ALPHA & OMEGA
SEMICONDUCTOR

AOT10B60D

600V, 10A Alpha IGBT™ with Diode

General Description

The Alpha IGBT™ line of products offers best-in-class performance in conduction and switching losses, with robust short circuit capability. They are designed for ease of paralleling, minimal gate spike under high dV/dt conditions and resistance to oscillations. The soft co-package diode is targeted for minimal losses in motor control applications.

Product Summary

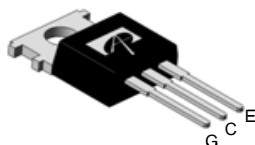
V_{CE}	600V
I_C ($T_C=100^\circ\text{C}$)	10A
$V_{CE(sat)}$ ($T_C=25^\circ\text{C}$)	1.53V

100% E_{on}/E_{off} Tested
 100% Q_{rr} Tested
 100% Short Circuit Current Tested*

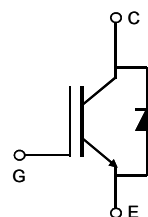


Top View

TO-220



AOT10B60D



Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

Parameter	Symbol	AOT10B60D	Units
Collector-Emitter Voltage	V_{CE}	600	V
Gate-Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current	I_C	$T_C=25^\circ\text{C}$	20
		$T_C=100^\circ\text{C}$	10
Pulsed Collector Current, Limited by T_{Jmax}	I_{CM}	40	A
Turn off SOA, $V_{CE} \leq 600\text{V}$, Limited by T_{Jmax}	I_{LM}	40	A
Continuous Diode Forward Current	I_F	$T_C=25^\circ\text{C}$	20
		$T_C=100^\circ\text{C}$	10
Diode Pulsed Current, Limited by T_{Jmax}	I_{FM}	40	A
Short circuit withstanding time $V_{GE} = 15\text{V}$, $V_{CE} \leq 400\text{V}$, Delay between short circuits $\geq 1.0\text{s}$, $T_C=25^\circ\text{C}$	t_{SC}	10	μs
Power Dissipation	P_D	$T_C=25^\circ\text{C}$	163
		$T_C=100^\circ\text{C}$	82
Junction and Storage Temperature Range	T_J, T_{STG}	-55 to 175	$^\circ\text{C}$
Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds	T_L	300	$^\circ\text{C}$

Thermal Characteristics

Parameter	Symbol	AOT10B60D	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.92	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	1.7	$^\circ\text{C/W}$

 * V_{CE} equal to 50V

Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
STATIC PARAMETERS							
BV_{CES}	Collector-Emitter Breakdown Voltage	$I_C=250\mu A, V_{GE}=0V, T_J=25^\circ C$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15V, I_C=10A$	$T_J=25^\circ C$	-	1.53	1.8	V
			$T_J=125^\circ C$	-	1.75	-	
			$T_J=175^\circ C$	-	1.88	-	
V_F	Diode Forward Voltage	$V_{GE}=0V, I_C=10A$	$T_J=25^\circ C$	-	1.52	1.85	V
			$T_J=125^\circ C$	-	1.48	-	
			$T_J=175^\circ C$	-	1.39	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=V_{GE}, I_C=250\mu A$	-	5.6	-	V	
I_{CES}	Zero Gate Voltage Collector Current	$V_{CE}=600V, V_{GE}=0V$	$T_J=25^\circ C$	-	-	10	μA
			$T_J=125^\circ C$	-	-	200	
			$T_J=175^\circ C$	-	-	2000	
I_{GES}	Gate-Emitter leakage current	$V_{CE}=0V, V_{GE}=\pm 20V$	-	-	± 100	nA	
g_{FS}	Forward Transconductance	$V_{CE}=20V, I_C=10A$	-	4.8	-	S	
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	$V_{GE}=0V, V_{CE}=25V, f=1MHz$	-	824	-	pF	
C_{oes}	Output Capacitance		-	68	-	pF	
C_{res}	Reverse Transfer Capacitance		-	2.7	-	pF	
Q_g	Total Gate Charge	$V_{GE}=15V, V_{CE}=480V, I_C=10A$	-	17.4	-	nC	
Q_{ge}	Gate to Emitter Charge		-	6.2	-	nC	
Q_{gc}	Gate to Collector Charge		-	6.3	-	nC	
$I_{C(SC)}$	Short circuit collector current, Max. 1000 short circuits, Delay between short circuits $\geq 1.0s$	$V_{GE}=15V, V_{CE}=400V, R_G=30\Omega$	-	43	-	A	
R_g	Gate resistance	$V_{GE}=0V, V_{CE}=0V, f=1MHz$	-	3.2	-	Ω	
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	$T_J=25^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=10A,$ $R_G=30\Omega,$ Parasitic Inductance=100nH	-	10	-	ns	
t_r	Turn-On Rise Time		-	15	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	72	-	ns	
t_f	Turn-Off Fall Time		-	8.8	-	ns	
E_{on}	Turn-On Energy		-	0.26	-	mJ	
E_{off}	Turn-Off Energy		-	0.07	-	mJ	
E_{total}	Total Switching Energy		-	0.33	-	mJ	
t_{rr}	Diode Reverse Recovery Time		$T_J=25^\circ C$	-	105	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=10A, di/dt=200A/\mu s, V_{CE}=400V$	-	0.25	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	5	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=175°C)							
$t_{D(on)}$	Turn-On DelayTime	$T_J=175^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=10A,$ $R_G=30\Omega,$ Parasitic Inductance=100nH	-	10.4	-	ns	
t_r	Turn-On Rise Time		-	15.6	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	95	-	ns	
t_f	Turn-Off Fall Time		-	11.2	-	ns	
E_{on}	Turn-On Energy		-	0.37	-	mJ	
E_{off}	Turn-Off Energy		-	0.17	-	mJ	
E_{total}	Total Switching Energy		-	0.54	-	mJ	
t_{rr}	Diode Reverse Recovery Time		$T_J=175^\circ C$	-	196	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=10A, di/dt=200A/\mu s, V_{CE}=400V$	-	0.63	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	6.8	-	A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

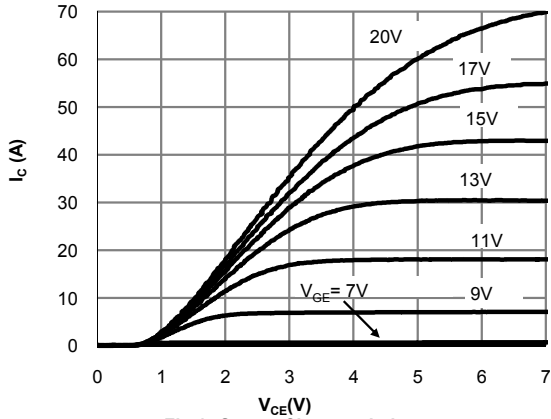


Fig 1: Output Characteristic
($T_j=25^\circ\text{C}$)

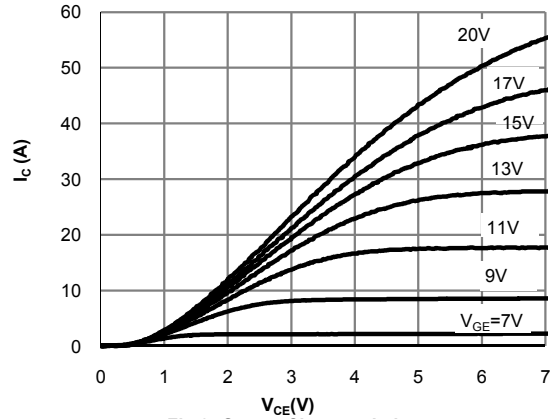


Fig 2: Output Characteristic
($T_j=175^\circ\text{C}$)

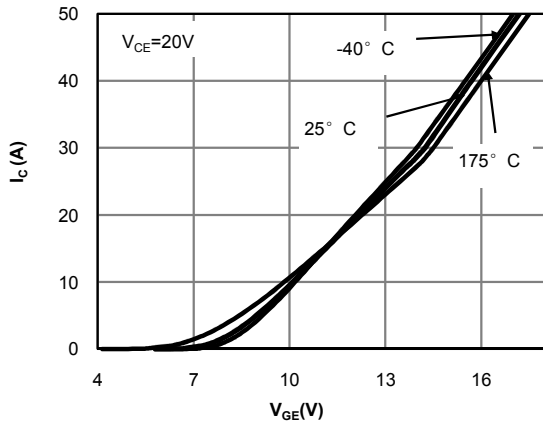


Fig 3: Transfer Characteristic

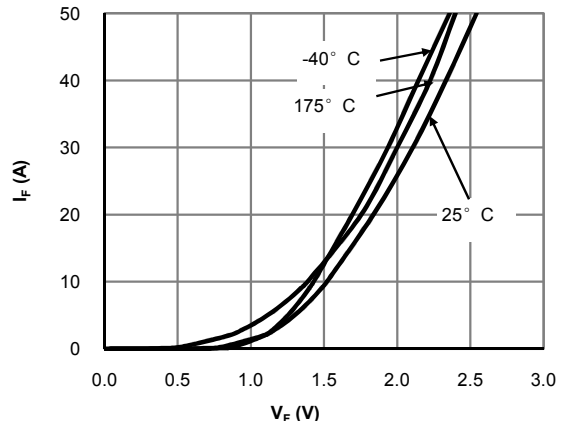


Fig 4: Diode Characteristic

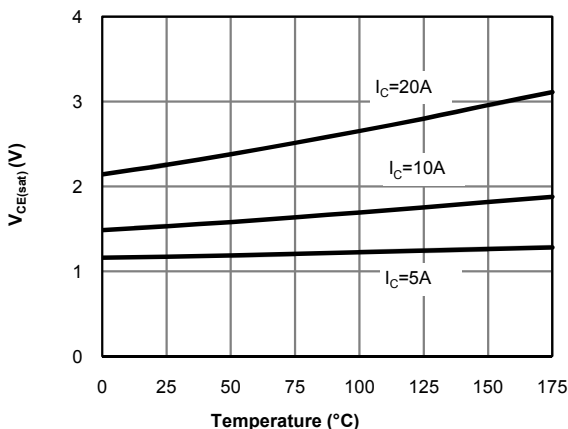


Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

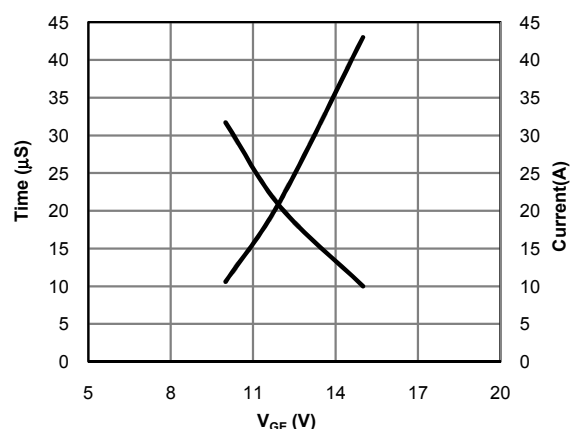


Fig 6: V_{GE} vs. Short Circuit Time
($V_{CE}=400V, T_C=25^\circ\text{C}$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

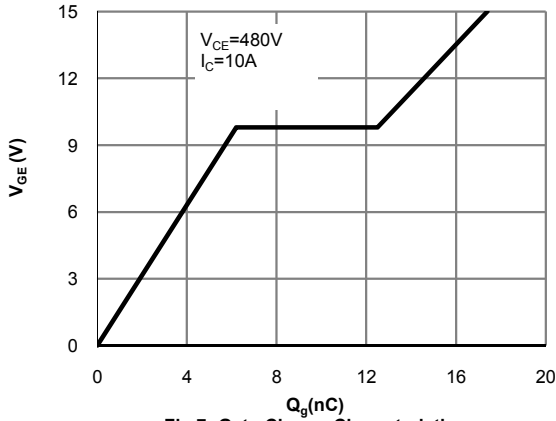


Fig 7: Gate-Charge Characteristics

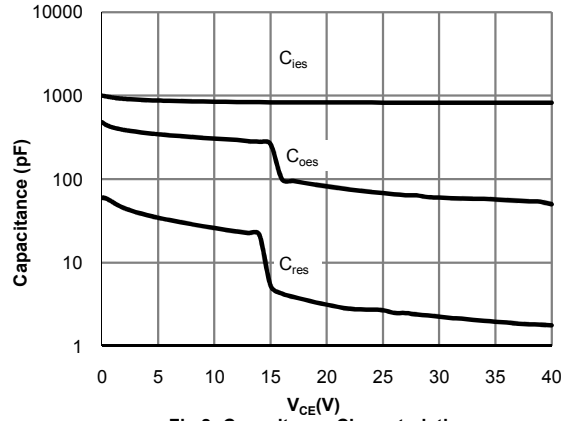


Fig 8: Capacitance Characteristic

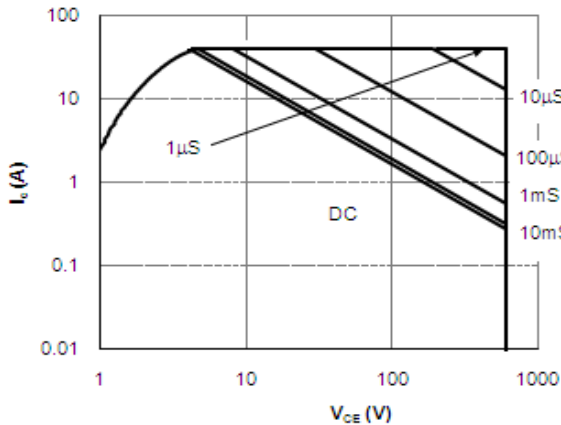


Fig 9: Forward Bias Safe Operating Area
($T_C=25^\circ\text{C}, V_{GE}=15\text{V}$)

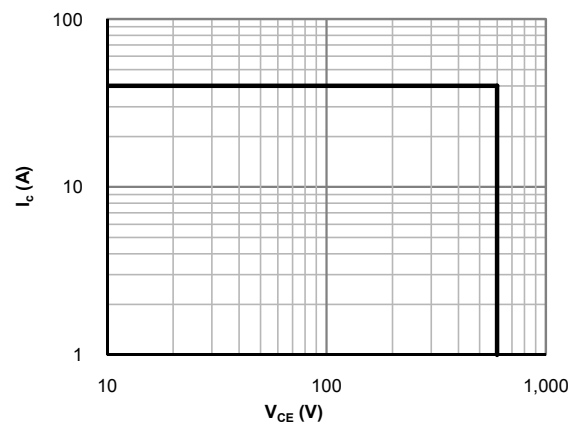


Fig 10: Reverse Bias SOA
($T_J=175^\circ\text{C}, V_{GE}=15\text{V}$)

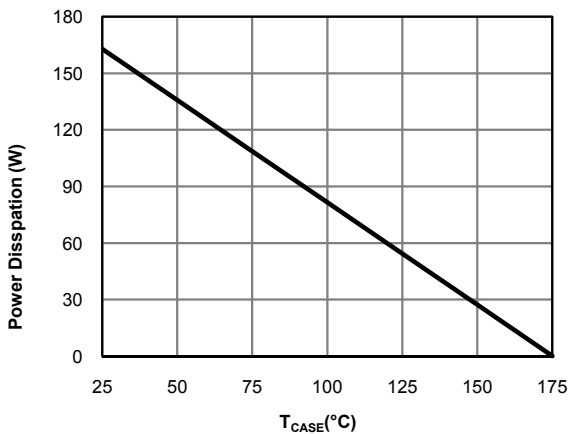


Fig 11: Power Dissipation as a Function of Case

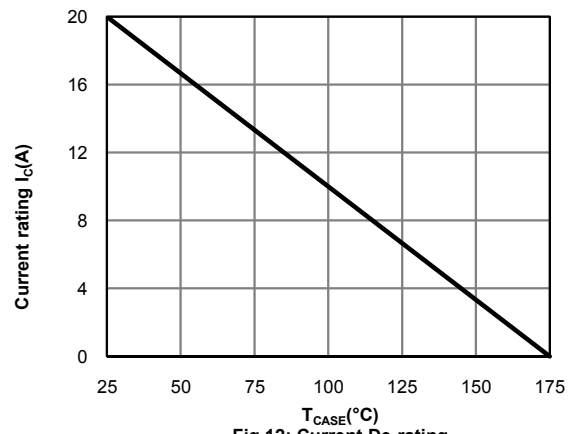


Fig 12: Current De-rating

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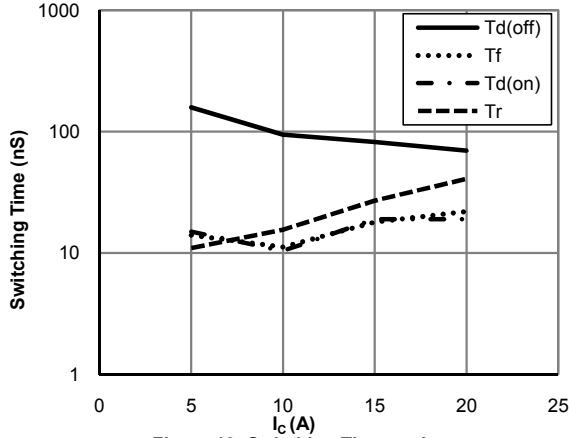


Figure 13: Switching Time vs. I_c
 ($T_J=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=30\Omega$)

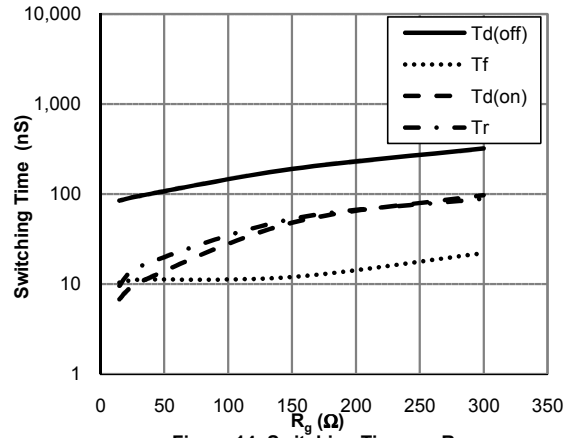


Figure 14: Switching Time vs. R_g
 ($T_J=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}$)

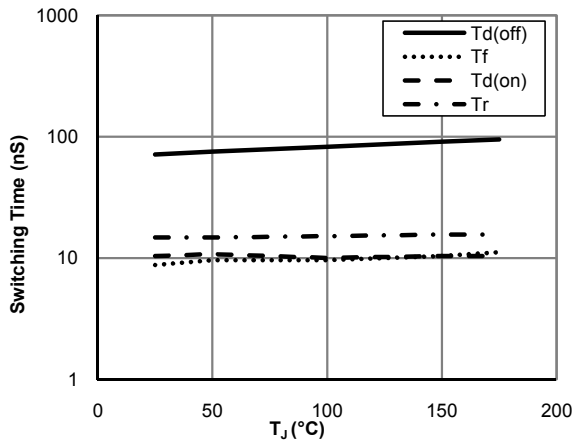


Figure 15: Switching Time vs. T_J
 ($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}, R_g=30\Omega$)

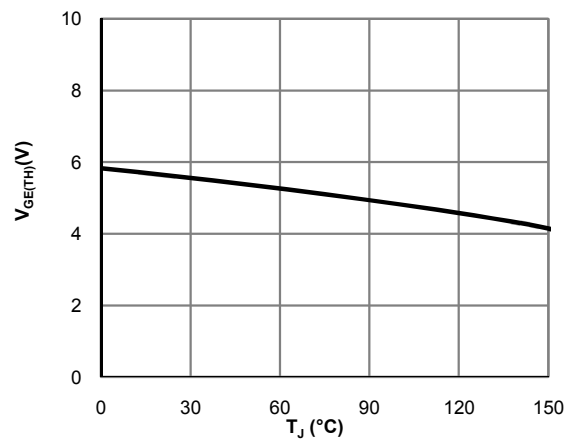


Figure 16: $V_{GE(\text{TH})}$ vs. T_J

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

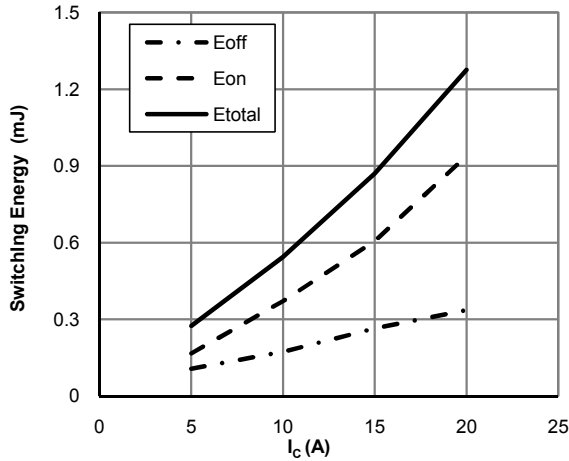


Figure 17: Switching Loss vs. I_c
($T_j=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=30\Omega$)

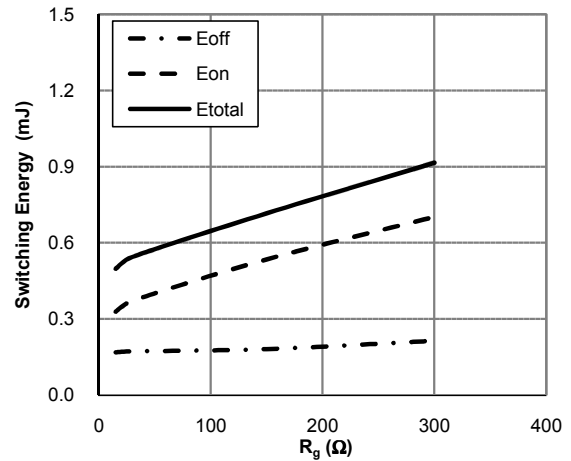


Figure 18: Switching Loss vs. R_g
($T_j=175^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}$)

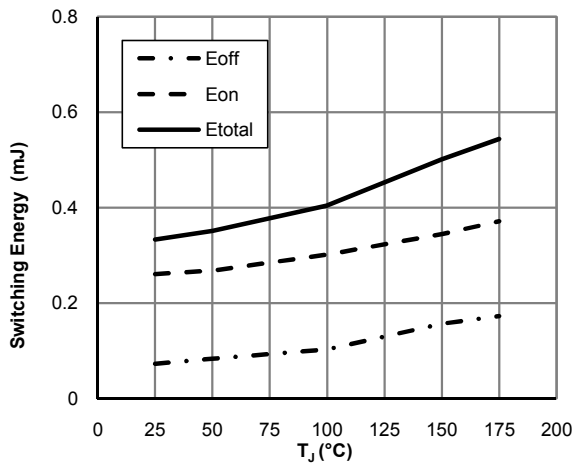


Figure 19: Switching Loss vs. T_j
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}, R_g=30\Omega$)

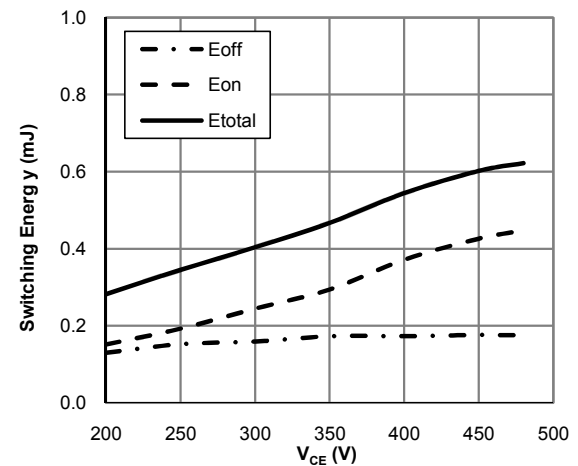


Figure 20: Switching Loss vs. V_{CE}
($T_j=175^\circ\text{C}, V_{GE}=15\text{V}, I_c=10\text{A}, R_g=30\Omega$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

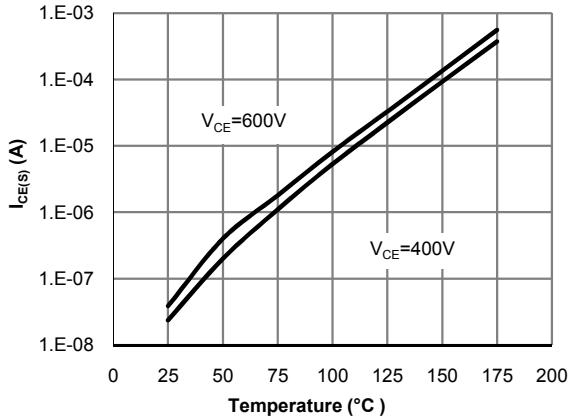


Fig 21: Diode Reverse Leakage Current vs. Junction Temperature

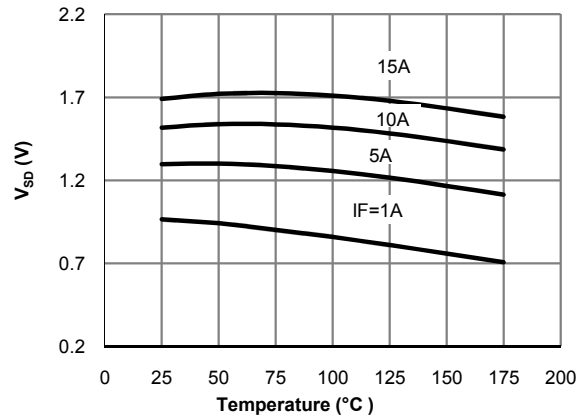


Fig 22: Diode Forward voltage vs. Junction Temperature

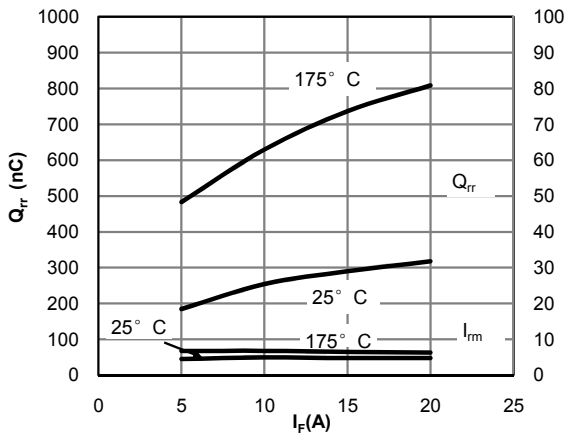


Fig 23: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

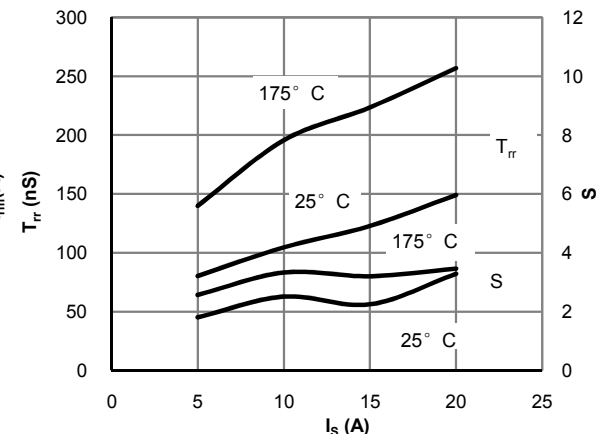


Fig 24: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

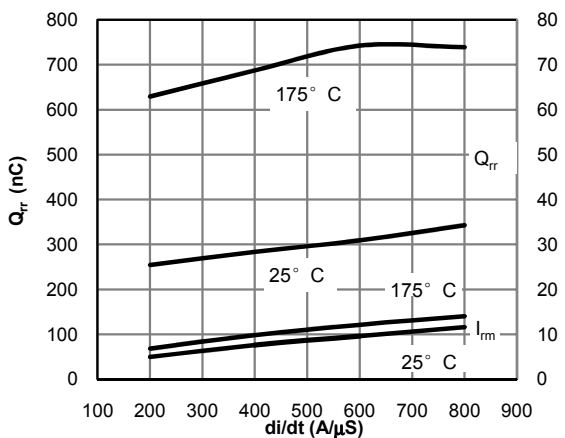


Fig 25: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=10A$)

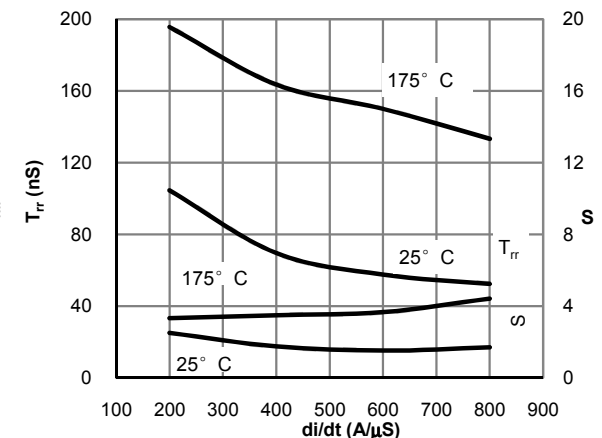


Fig 26: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=10A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

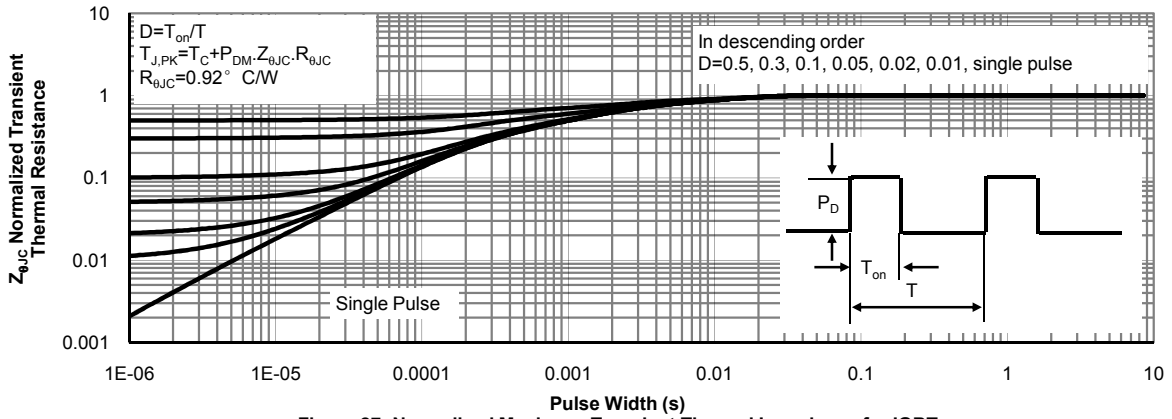


Figure 27: Normalized Maximum Transient Thermal Impedance for IGBT

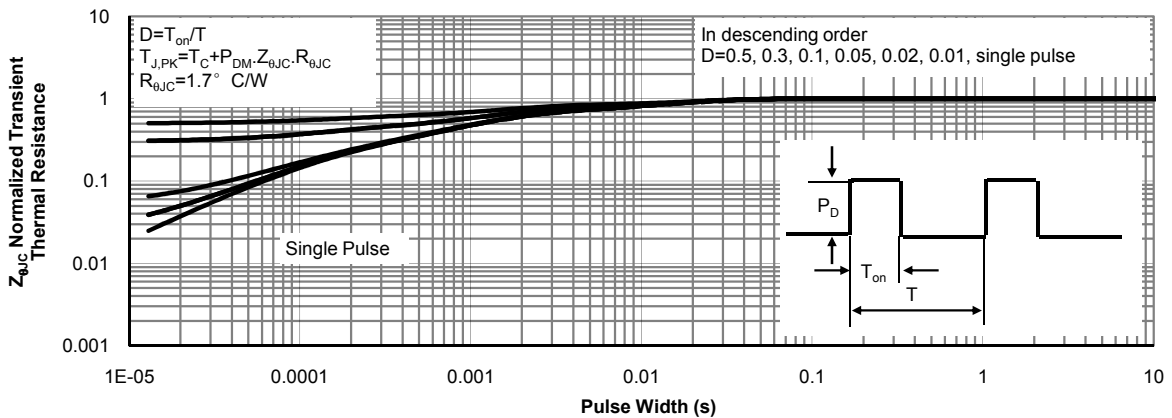
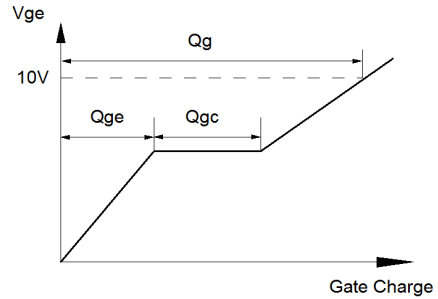
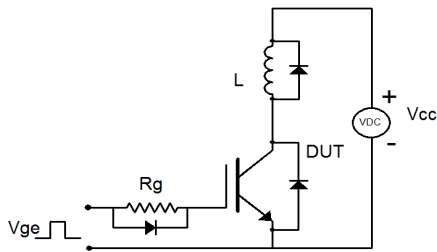
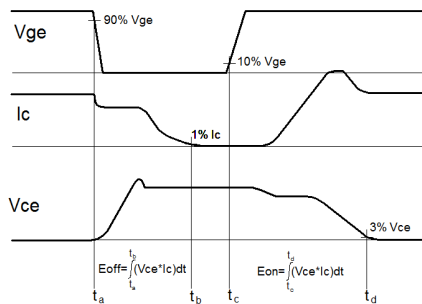
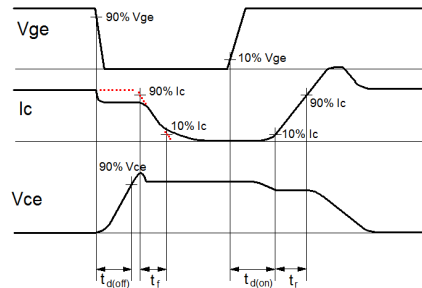
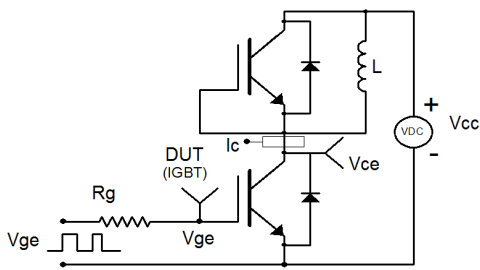


Figure 28: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

