



General Description

The AlphaIGBT™ 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 co-packaged soft diode is optimized to minimize losses in motor control applications.

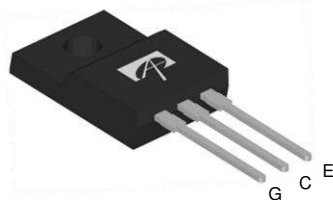
Product Summary

V_{CE}	600V
I_C ($T_C=100^\circ\text{C}$)	10A
$V_{CE(sat)}$ ($T_J=25^\circ\text{C}$)	1.55V

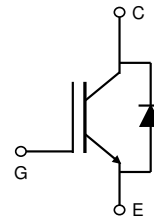


Top View

TO-220F



AOTF10B60D2



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

Parameter	Symbol	AOTF10B60D2	Units
Collector-Emitter Voltage	V_{CE}	600	V
Gate-Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current ^A	I_C	$T_C=25^\circ\text{C}$	23 ^B
		$T_C=100^\circ\text{C}$	10
Pulsed Collector Current, Limited by T_{Jmax}	I_{CM}	20	A
Turn off SOA, $V_{CE} \leq 600\text{V}$, Limited by T_{Jmax}	I_{LM}	20	A
Continuous Diode Forward Current ^A	I_F	$T_C=25^\circ\text{C}$	23 ^B
		$T_C=100^\circ\text{C}$	10
Diode Pulsed Current, Limited by T_{Jmax}	I_{FM}	20	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	$T_C=25^\circ\text{C}$	31.2
		$T_C=100^\circ\text{C}$	12.5
Junction and Storage Temperature Range	T_J, T_{STG}	-55 to 150	$^\circ\text{C}$
Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds	T_L	300	$^\circ\text{C}$

Thermal Characteristics

Parameter	Symbol	AOTF10B60D2	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	4	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	4	$^\circ\text{C/W}$

Note A: With 50% duty cycle and 200 μs pulse width

Note B: I_C limited by package limitation

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
STATIC PARAMETERS							
BV_{CES}	Collector-Emitter Breakdown Voltage	$I_C=1\text{mA}$, $V_{GE}=0\text{V}$, $T_J=25^\circ\text{C}$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15\text{V}$, $I_C=5\text{A}$	$T_J=25^\circ\text{C}$	-	1.55	1.8	V
			$T_J=125^\circ\text{C}$	-	1.78	-	
			$T_J=150^\circ\text{C}$	-	1.85	-	
V_F	Diode Forward Voltage	$V_{GE}=0\text{V}$, $I_C=5\text{A}$	$T_J=25^\circ\text{C}$	-	1.46	1.75	V
			$T_J=125^\circ\text{C}$	-	1.36	-	
			$T_J=150^\circ\text{C}$	-	1.3	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=V_{GE}$, $I_C=1\text{mA}$	-	6	-	V	
I_{CES}	Zero Gate Voltage Collector Current	$V_{CE}=600\text{V}$, $V_{GE}=0\text{V}$	$T_J=25^\circ\text{C}$	-	-	10	μA
			$T_J=125^\circ\text{C}$	-	-	100	
			$T_J=150^\circ\text{C}$	-	-	500	
I_{GES}	Gate-Emitter Leakage Current	$V_{CE}=0\text{V}$, $V_{GE}=\pm 20\text{V}$	-	-	± 100	nA	
g_{FS}	Forward Transconductance	$V_{CE}=20\text{V}$, $I_C=5\text{A}$	-	2.3	-	S	
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	$V_{GE}=0\text{V}$, $V_{CE}=25\text{V}$, $f=1\text{MHz}$	-	367	-	pF	
C_{oes}	Output Capacitance		-	34	-	pF	
C_{res}	Reverse Transfer Capacitance		-	1.47	-	pF	
Q_g	Total Gate Charge	$V_{GE}=15\text{V}$, $V_{CE}=480\text{V}$, $I_C=5\text{A}$	-	9.4	-	nC	
Q_{ge}	Gate to Emitter Charge		-	3.15	-	nC	
Q_{gc}	Gate to Collector Charge		-	3.6	-	nC	
$I_{C(SC)}$	Short circuit collector current, Max. 1000 short circuits, Delay between short circuits $\geq 1.0\text{s}$	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $R_G=60\Omega$	-	21	-	A	
R_g	Gate Resistance	$V_{GE}=0\text{V}$, $V_{CE}=0\text{V}$, $f=1\text{MHz}$	-	3	-	Ω	
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On Delay Time	$T_J=25^\circ\text{C}$ $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	12	-	ns	
t_r	Turn-On Rise Time		-	15	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	83	-	ns	
t_f	Turn-Off Fall Time		-	12	-	ns	
E_{on}	Turn-On Energy		-	0.14	-	mJ	
E_{off}	Turn-Off Energy		-	0.04	-	mJ	
E_{total}	Total Switching Energy		-	0.18	-	mJ	
t_{rr}	Diode Reverse Recovery Time		-	98	-	ns	
Q_{rr}	Diode Reverse Recovery Charge		$T_J=25^\circ\text{C}$ $I_F=5\text{A}$, $dI/dt=200\text{A}/\mu\text{s}$, $V_{CE}=400\text{V}$	-	0.23	-	μC
I_{rm}	Diode Peak Reverse Recovery Current		-	4.4	-	A	
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)							
$t_{D(on)}$	Turn-On Delay Time	$T_J=150^\circ\text{C}$ $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	10	-	ns	
t_r	Turn-On Rise Time		-	16	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	108	-	ns	
t_f	Turn-Off Fall Time		-	16	-	ns	
E_{on}	Turn-On Energy		-	0.18	-	mJ	
E_{off}	Turn-Off Energy		-	0.09	-	mJ	
E_{total}	Total Switching Energy		-	0.27	-	mJ	
t_{rr}	Diode Reverse Recovery Time		$T_J=150^\circ\text{C}$	-	166	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=5\text{A}$, $dI/dt=200\text{A}/\mu\text{s}$, $V_{CE}=400\text{V}$	-	0.4	-	μC
I_{rm}	Diode Peak Reverse Recovery Current		-	5.2	-	A	

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

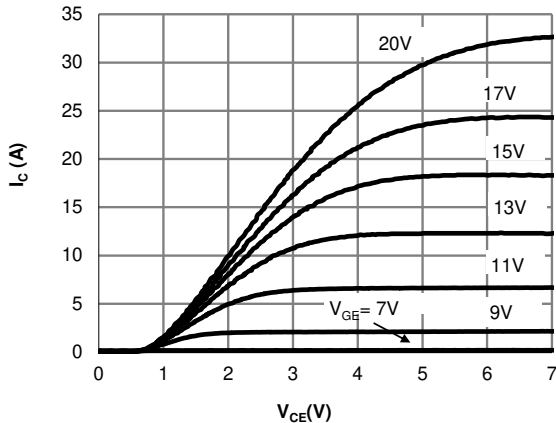


Figure 1: Output Characteristic
($T_j=25^\circ\text{C}$)

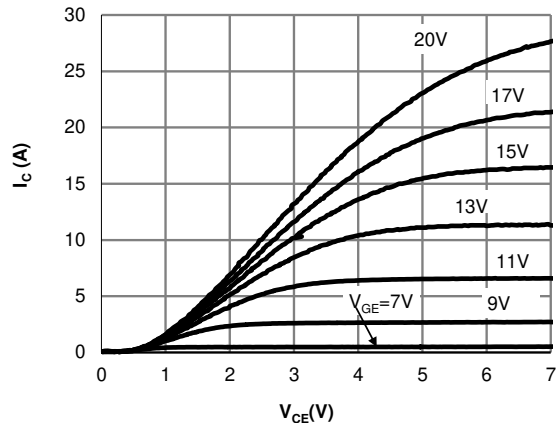


Figure 2: Output Characteristic
($T_j=150^\circ\text{C}$)

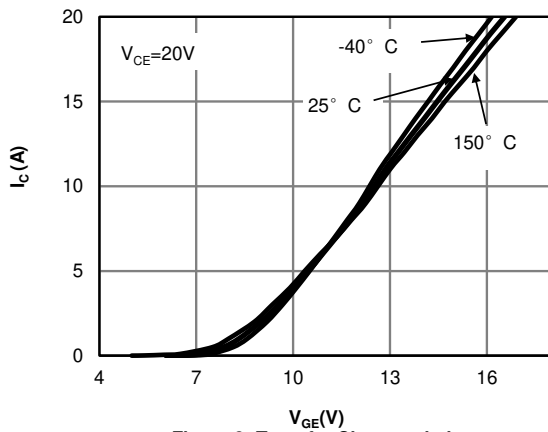


Figure 3: Transfer Characteristic

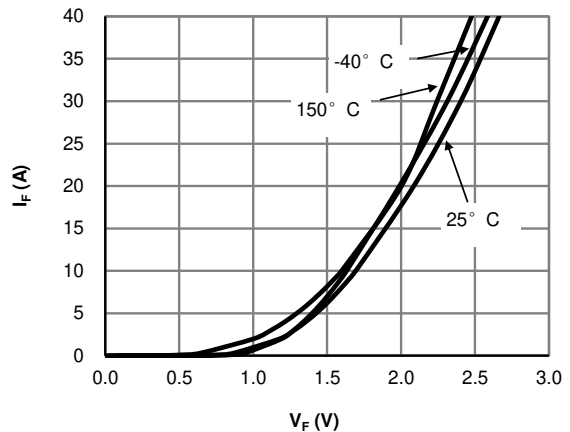


Figure 4: Diode Characteristic

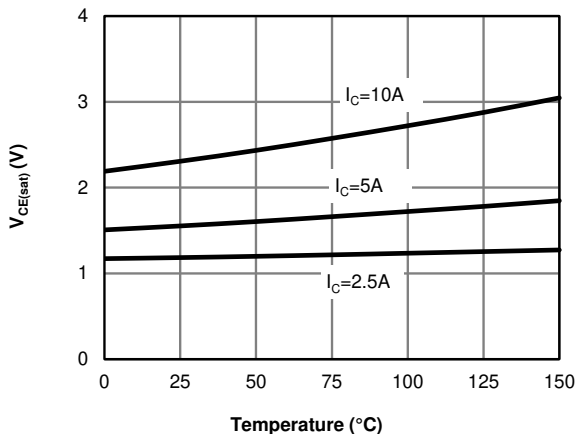


Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

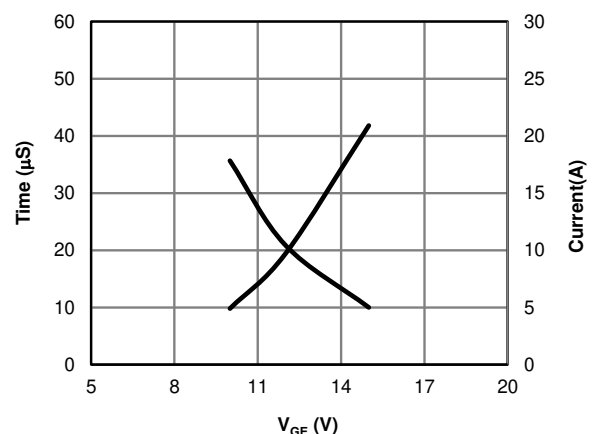


Figure 6: V_{GE} vs. Short Circuit Time
($V_{CE}=400\text{V}, T_C=25^\circ\text{C}$)

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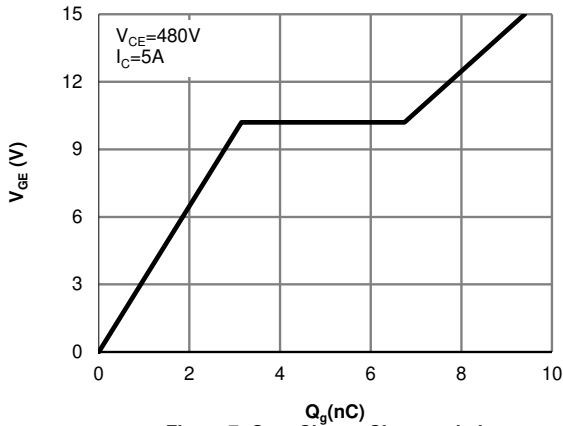


Figure 7: Gate-Charge Characteristics

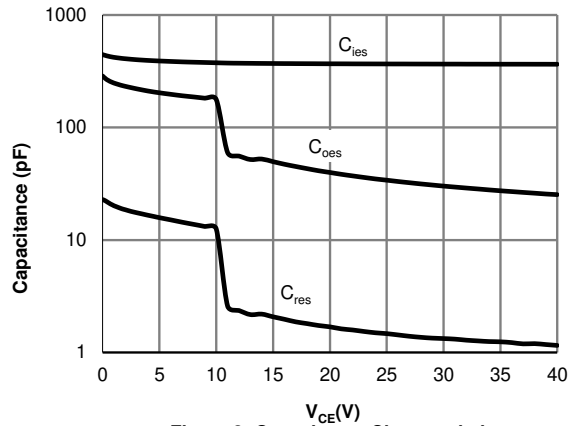


Figure 8: Capacitance Characteristic

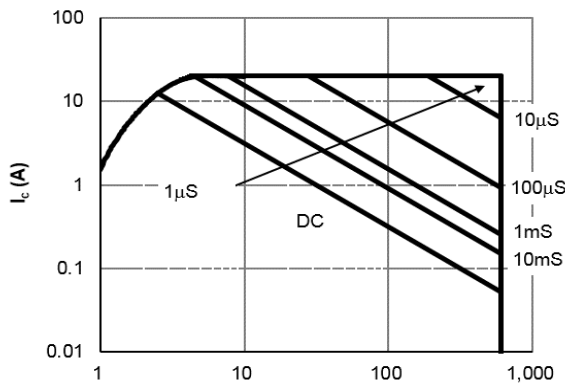


Figure 9: Forward Bias Safe Operating Area
($T_C=25^\circ\text{C}, V_{GE}=15\text{V}$)

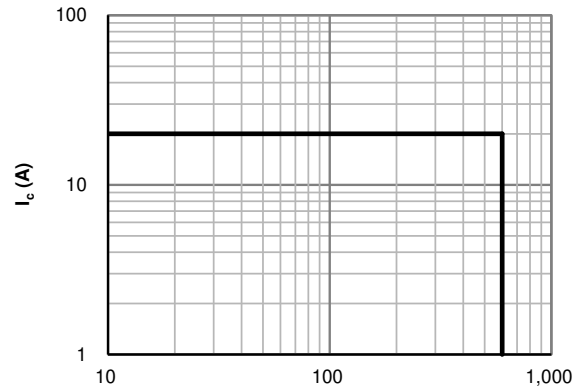


Figure 10: Reverse Bias SOA
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}$)

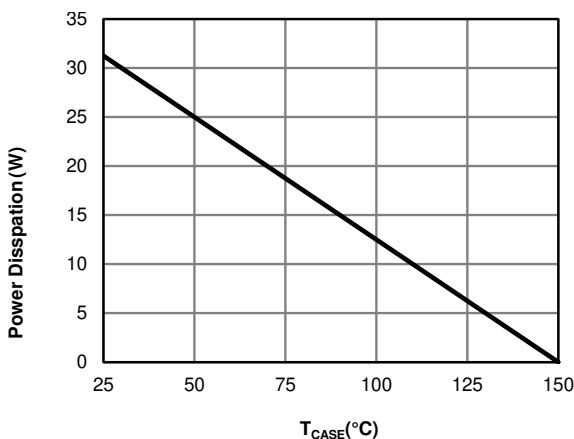


Figure 11: Power Dissipation as a Function of Case

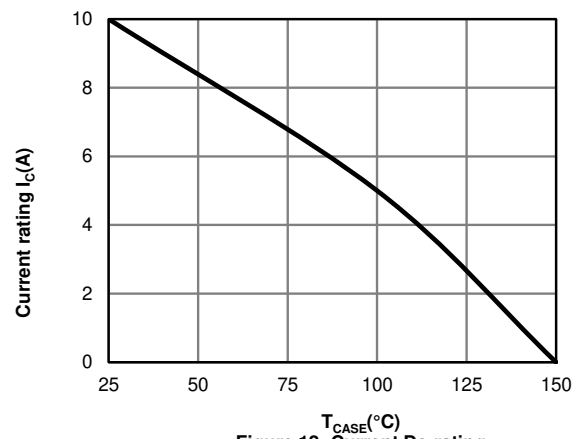


Figure 12: Current De-rating

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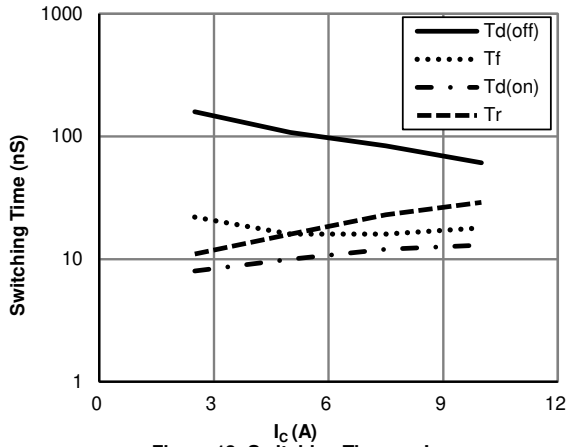


Figure 13: Switching Time vs. I_C
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=60\Omega$)

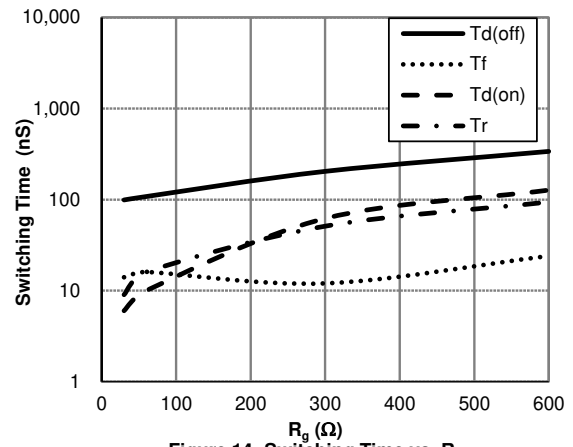


Figure 14: Switching Time vs. R_g
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=5\text{A}$)

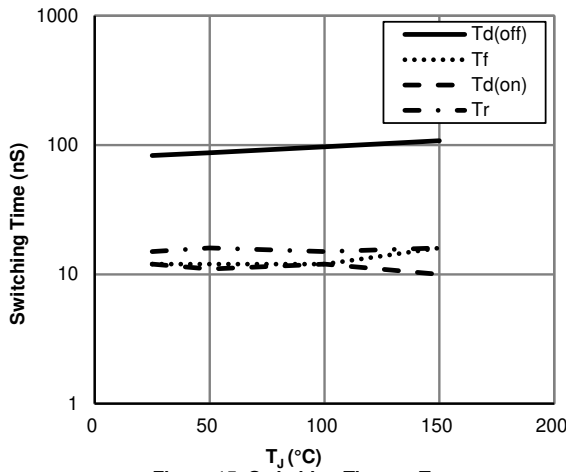


Figure 15: Switching Time vs. T_J
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=5\text{A}, R_g=60\Omega$)

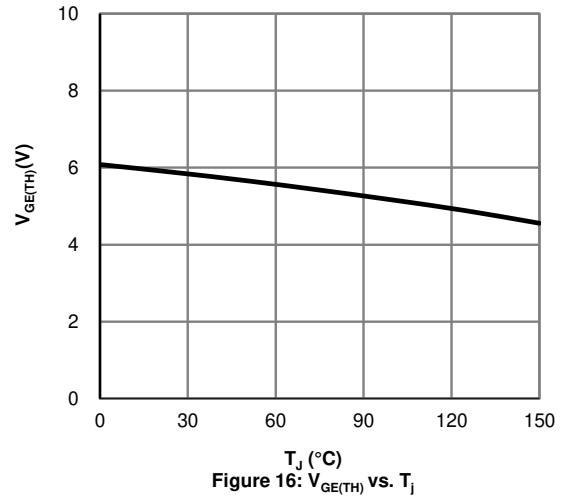


Figure 16: $V_{GE(TH)}$ vs. T_J

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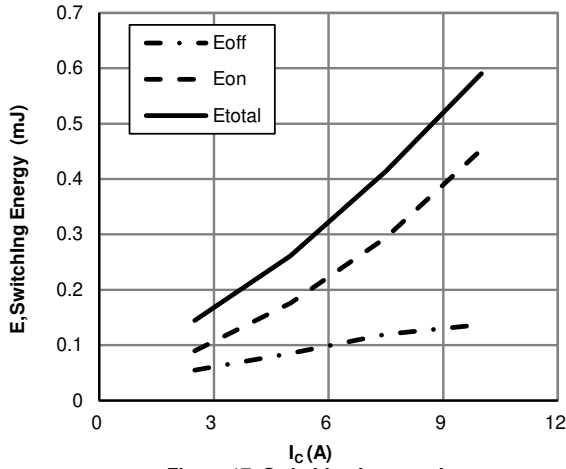


Figure 17: Switching Loss vs. I_C
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=60\Omega$)

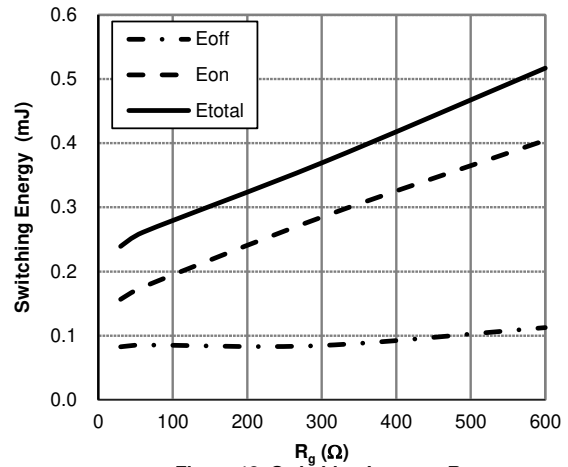


Figure 18: Switching Loss vs. R_g
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=5\text{A}$)

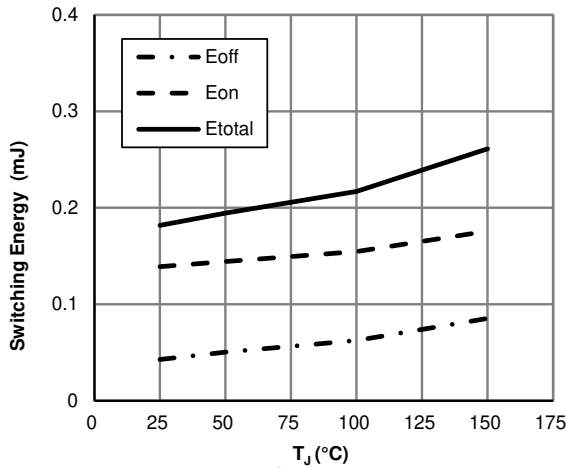


Figure 19: Switching Loss vs. T_J
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=5\text{A}, R_g=60\Omega$)

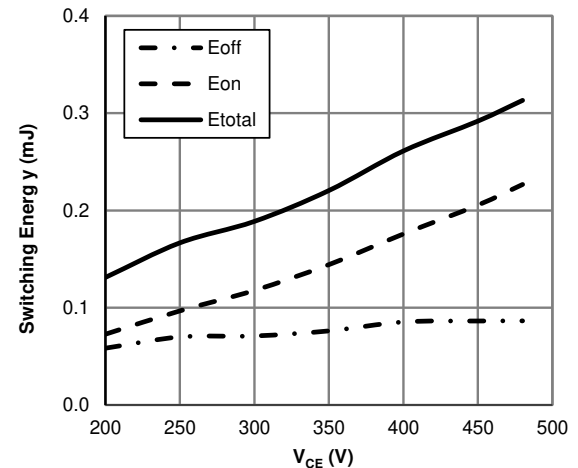


Figure 20: Switching Loss vs. V_{CE}
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, I_C=5\text{A}, R_g=60\Omega$)

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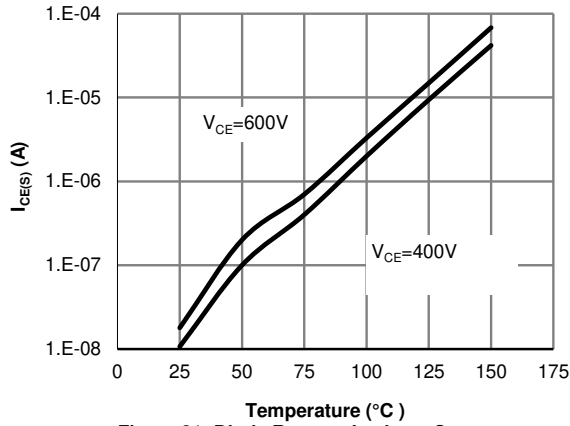


Figure 21: Diode Reverse Leakage Current vs. Junction Temperature

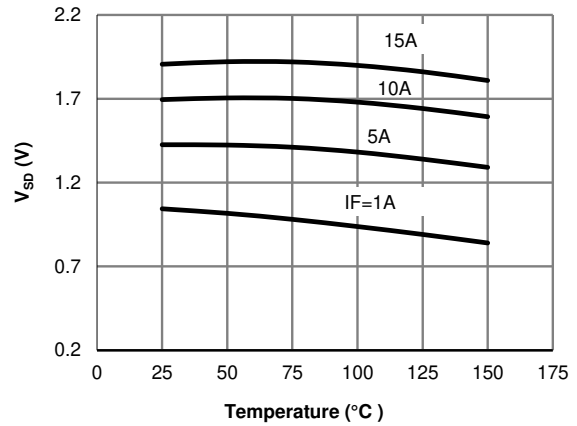


Figure 22: Diode Forward Voltage vs. Junction Temperature

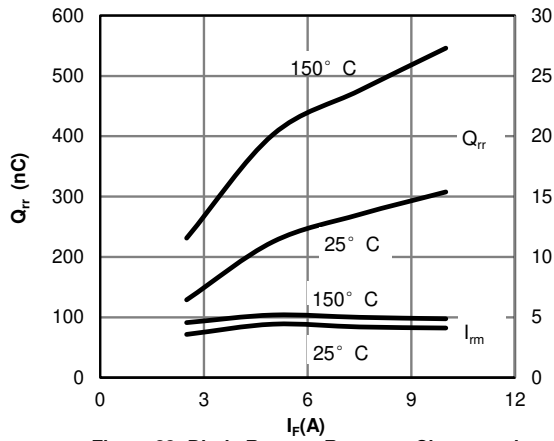


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

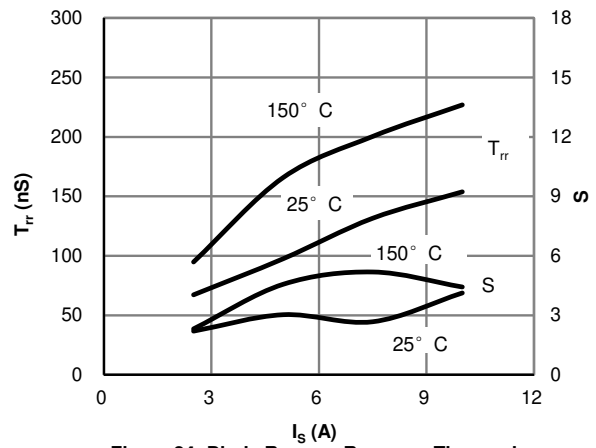


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

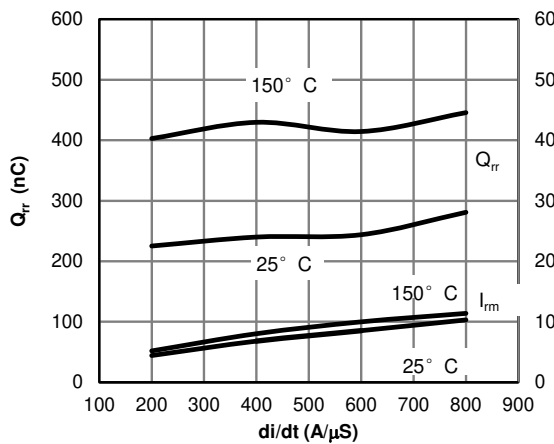


Figure 25: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

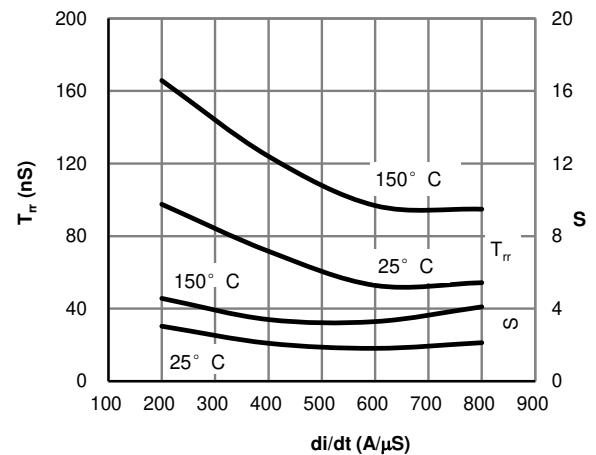


Figure 26: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

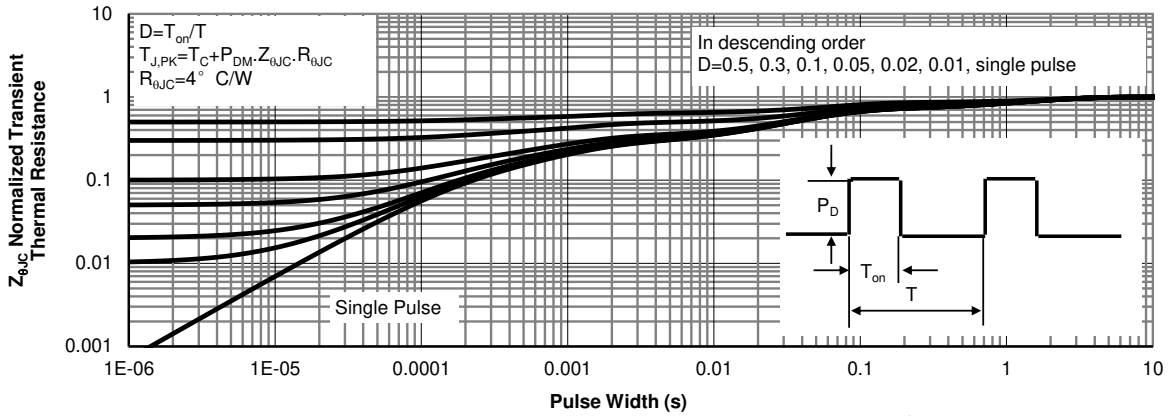


Figure 27: Normalized Maximum Transient Thermal Impedance for IGBT

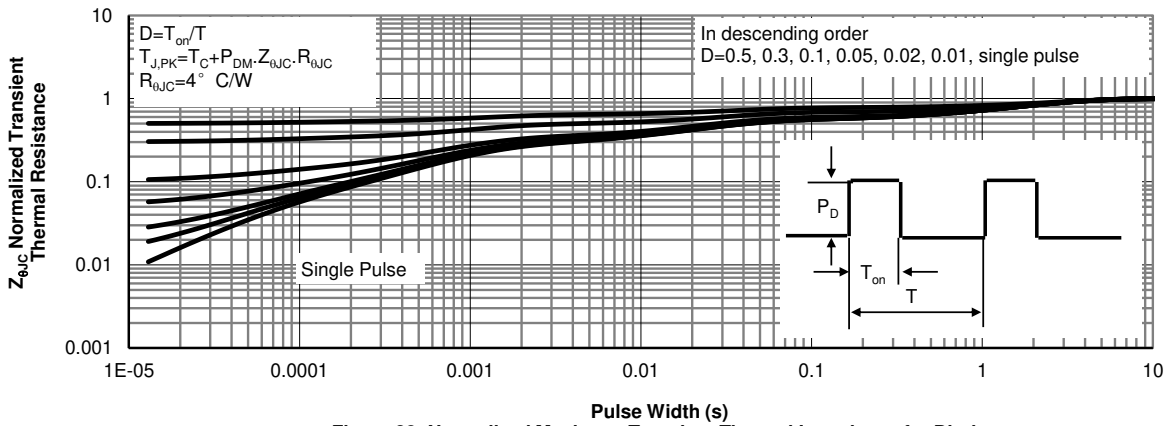
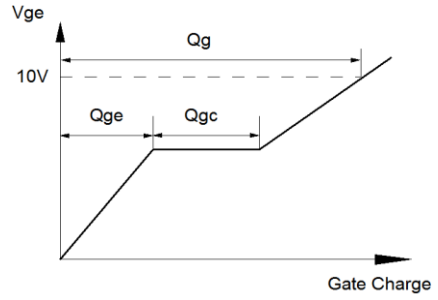
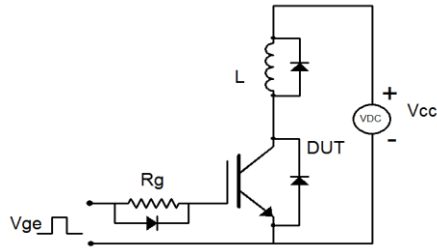
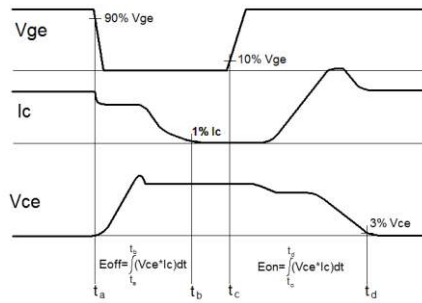
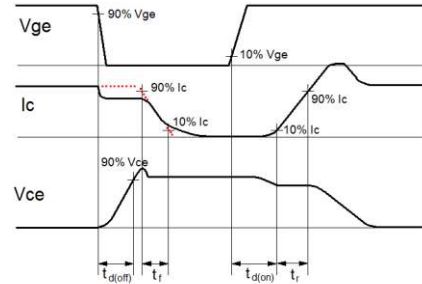
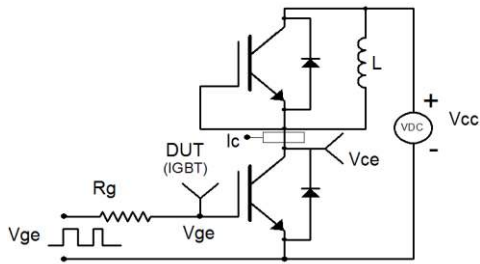


Figure 28: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

