



ALPHA & OMEGA
SEMICONDUCTOR

AOTF5B60D

600V, 5A AlphaIGBT™ with Diode

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.

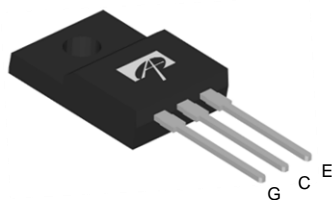
Product Summary

V_{CE}	600V
I_C ($T_C=100^\circ\text{C}$)	5A
$V_{CE(sat)}$ ($T_C=25^\circ\text{C}$)	1.55V

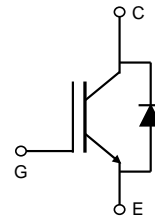


Top View

TO-220F



AOTF5B60D



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

Parameter	Symbol	AOTF5B60D	Units
Collector-Emitter Voltage	V_{CE}	600	V
Gate-Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current ^A	$T_C=25^\circ\text{C}$	14	A
	$T_C=100^\circ\text{C}$	5.8	
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	$T_C=25^\circ\text{C}$	10	A
	$T_C=100^\circ\text{C}$	5	
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	$T_C=25^\circ\text{C}$	31.2	W
	$T_C=100^\circ\text{C}$	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	AOTF5B60D	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: 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	$V_{GE}=15\text{V}$, $I_C=5\text{A}$	-	1.55	1.8	V
		$T_J=25^\circ\text{C}$	-	1.78	-	V
		$T_J=125^\circ\text{C}$	-	1.85	-	V
		$T_J=150^\circ\text{C}$	-	1.46	1.75	V
V_F	Diode Forward Voltage	$V_{GE}=0\text{V}$, $I_C=5\text{A}$	-	1.36	-	V
		$T_J=25^\circ\text{C}$	-	1.3	-	V
		$T_J=125^\circ\text{C}$	-	1.3	-	V
		$T_J=150^\circ\text{C}$	-	1.3	-	V
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=V_{GE}$, $I_C=1\text{mA}$	-	6	-	V
I_{CES}	Zero Gate Voltage Collector Current	$V_{CE}=600\text{V}$, $V_{GE}=0\text{V}$	-	-	10	μA
		$T_J=25^\circ\text{C}$	-	-	100	μA
		$T_J=125^\circ\text{C}$	-	-	500	μA
		$T_J=150^\circ\text{C}$	-	-	500	μA
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	$V_{GE}=0\text{V}$, $V_{CE}=25\text{V}$, $f=1\text{MHz}$	-	34	-	pF
C_{res}	Reverse Transfer Capacitance	$V_{GE}=0\text{V}$, $V_{CE}=25\text{V}$, $f=1\text{MHz}$	-	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	$V_{GE}=15\text{V}$, $V_{CE}=480\text{V}$, $I_C=5\text{A}$	-	3.15	-	nC
Q_{gc}	Gate to Collector Charge	$V_{GE}=15\text{V}$, $V_{CE}=480\text{V}$, $I_C=5\text{A}$	-	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 DelayTime	$T_J=25^\circ\text{C}$	-	12	-	ns
t_r	Turn-On Rise Time	$T_J=25^\circ\text{C}$	-	15	-	ns
$t_{D(off)}$	Turn-Off Delay Time	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	83	-	ns
t_f	Turn-Off Fall Time	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	12	-	ns
E_{on}	Turn-On Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.14	-	mJ
E_{off}	Turn-Off Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.04	-	mJ
E_{total}	Total Switching Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.18	-	mJ
t_{rr}	Diode Reverse Recovery Time	$T_J=25^\circ\text{C}$	-	98	-	ns
Q_{rr}	Diode Reverse Recovery Charge	$T_J=25^\circ\text{C}$	-	0.23	-	μC
I_{rm}	Diode Peak Reverse Recovery Current	$I_F=5\text{A}$, $dI/dt=200\text{A}/\mu\text{s}$, $V_{CE}=400\text{V}$	-	4.4	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)						
$t_{D(on)}$	Turn-On DelayTime	$T_J=150^\circ\text{C}$	-	10	-	ns
t_r	Turn-On Rise Time	$T_J=150^\circ\text{C}$	-	16	-	ns
$t_{D(off)}$	Turn-Off Delay Time	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	108	-	ns
t_f	Turn-Off Fall Time	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	16	-	ns
E_{on}	Turn-On Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.18	-	mJ
E_{off}	Turn-Off Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.09	-	mJ
E_{total}	Total Switching Energy	$V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_G=60\Omega$, Parasitic Inductance=100nH	-	0.27	-	mJ
t_{rr}	Diode Reverse Recovery Time	$T_J=150^\circ\text{C}$	-	166	-	ns
Q_{rr}	Diode Reverse Recovery Charge	$T_J=150^\circ\text{C}$	-	0.4	-	μC
I_{rm}	Diode Peak Reverse Recovery Current	$I_F=5\text{A}$, $dI/dt=200\text{A}/\mu\text{s}$, $V_{CE}=400\text{V}$	-	5.2	-	A

APPLICATIONS OR USES AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS ARE NOT AUTHORIZED. AOS DOES NOT ASSUME ANY LIABILITY ARISING OUT OF SUCH APPLICATIONS OR USES OF ITS PRODUCTS. AOS RESERVES THE RIGHT TO MAKE CHANGES TO PRODUCT SPECIFICATIONS WITHOUT NOTICE. IT IS THE RESPONSIBILITY OF THE CUSTOMER TO EVALUATE SUITABILITY OF THE PRODUCT FOR THEIR INTENDED APPLICATION. CUSTOMER SHALL COMPLY WITH APPLICABLE LEGAL REQUIREMENTS, INCLUDING ALL APPLICABLE EXPORT CONTROL RULES, REGULATIONS AND LIMITATIONS.

AOS' products are provided subject to AOS' terms and conditions of sale which are set forth at:
http://www.aosmd.com/terms_and_conditions_of_sale

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

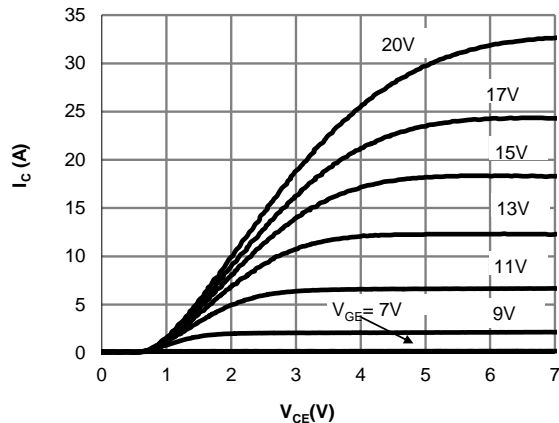


Figure 1: Output Characteristic
($T_j=25^{\circ}\text{C}$)

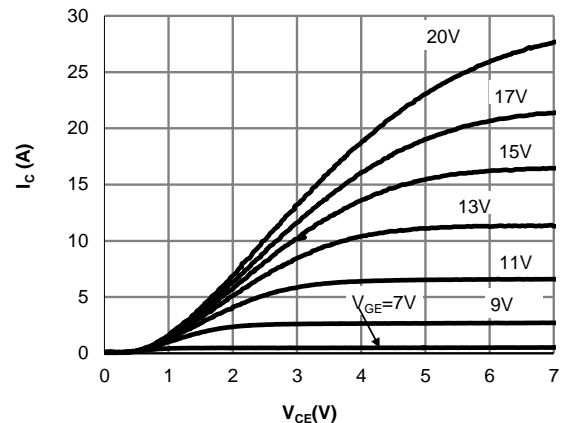


Figure 2: Output Characteristic
($T_j=150^{\circ}\text{C}$)

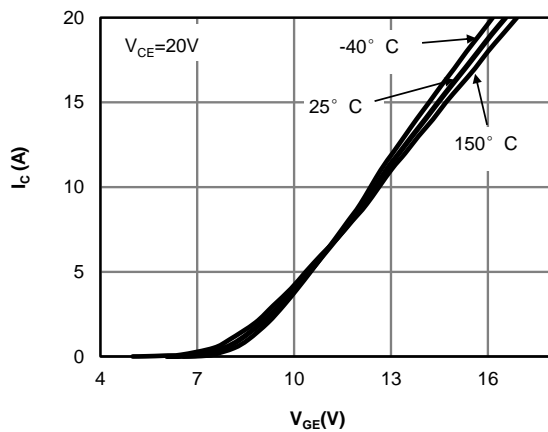


Figure 3: Transfer Characteristic

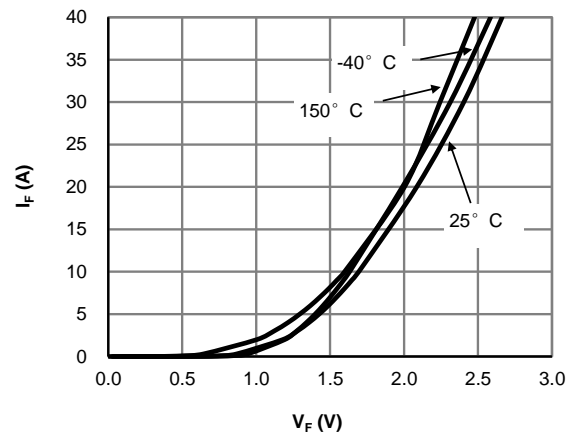


Figure 4: Diode Characteristic

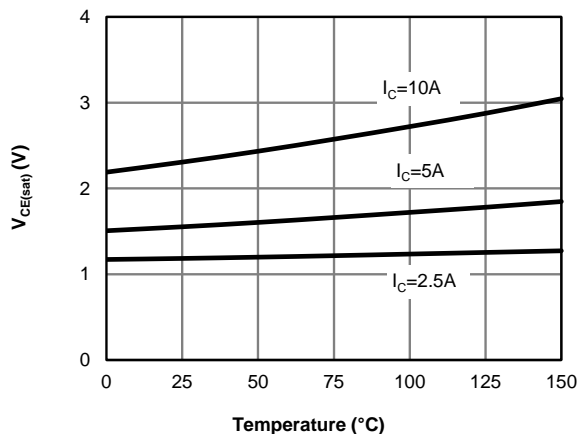


Figure 5: Collector-Emitter Saturation Voltage vs.
Junction Temperature

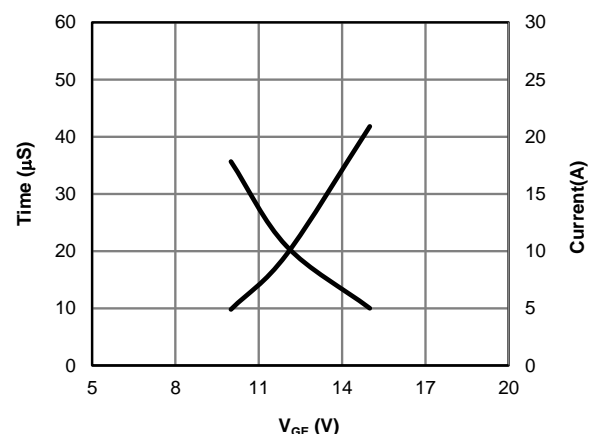


Figure 6: V_{GE} vs. Short Circuit Time
($V_{CE}=400\text{V}, T_C=25^{\circ}\text{C}$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

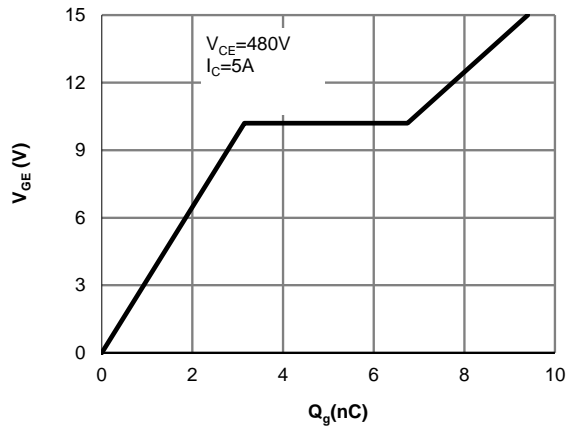


Figure 7: Gate-Charge Characteristics

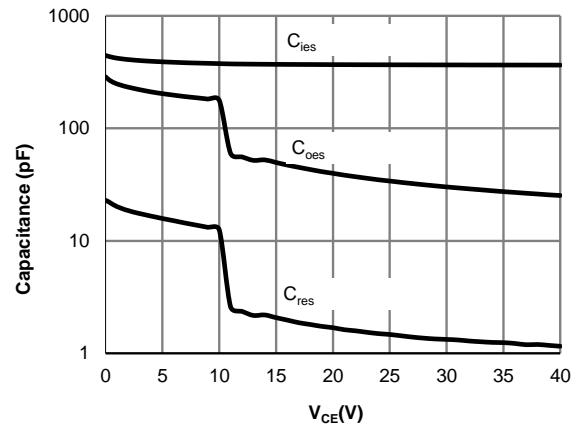


Figure 8: Capacitance Characteristic

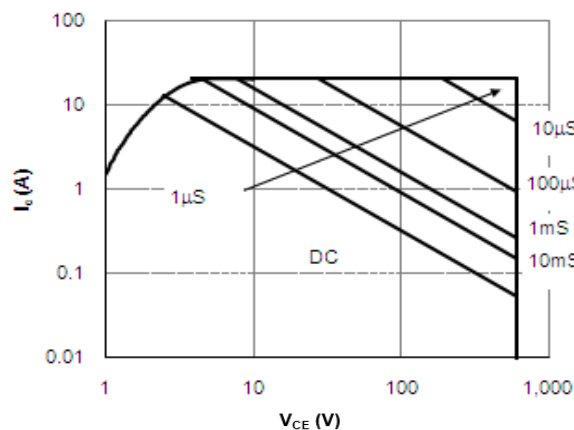


Figure 9: Forward Bias Safe Operating Area
($T_C=25^{\circ}\text{C}$, $V_{GE}=15\text{V}$)

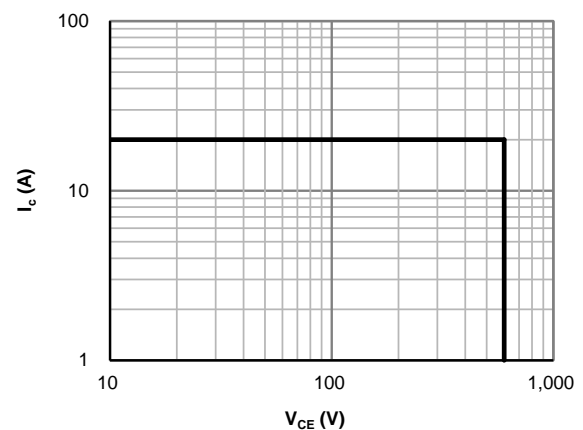


Figure 10: Reverse Bias SOA
($T_J=150^{\circ}\text{C}$, $V_{GE}=15\text{V}$)

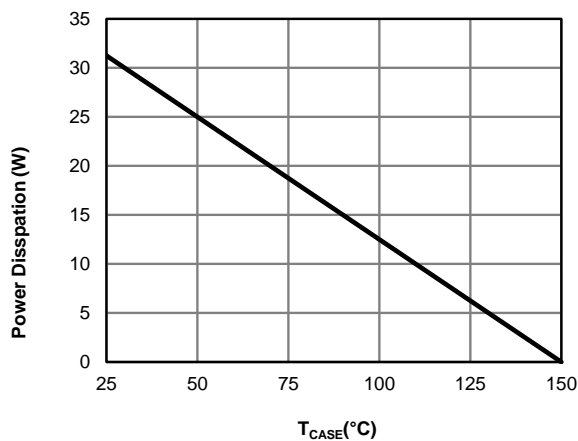


Figure 11: Power Dissipation as a Function of Case

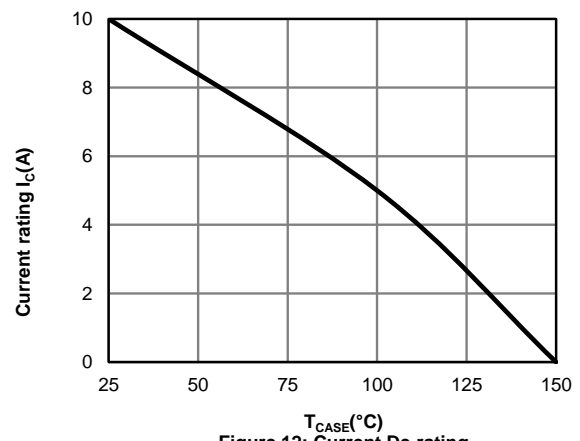
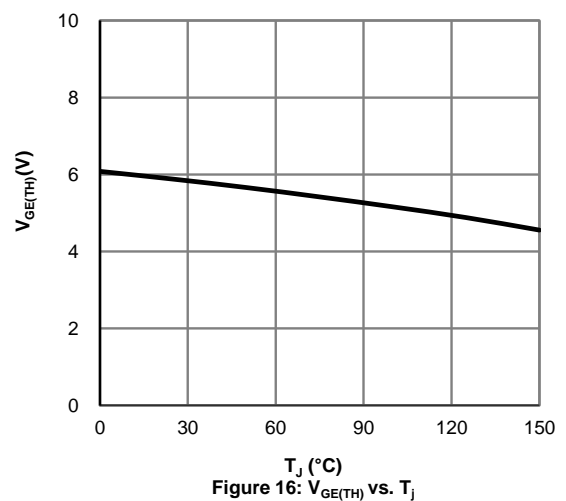
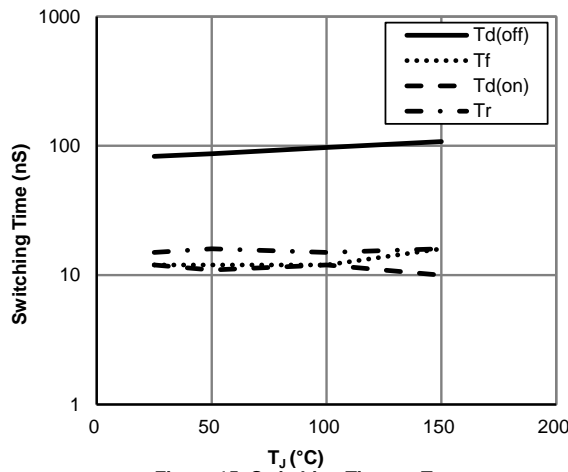
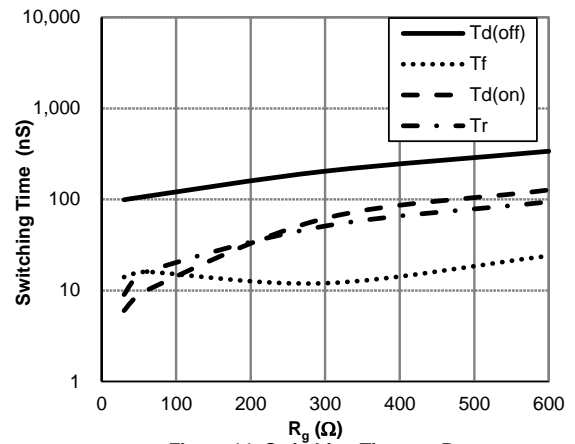
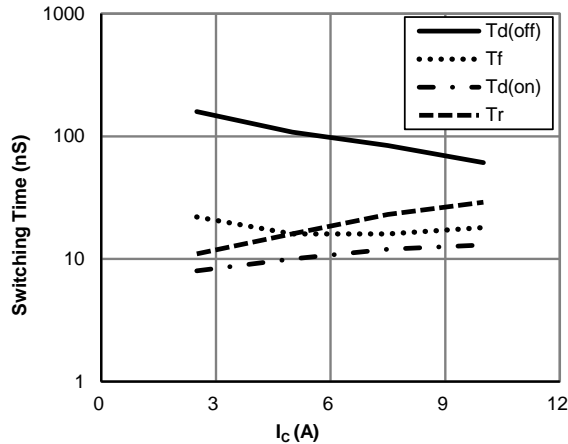
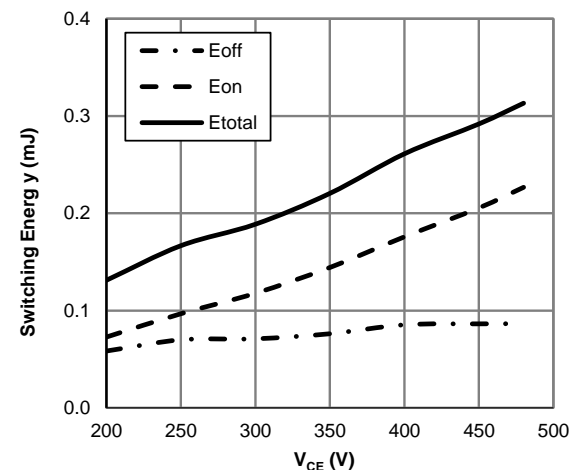
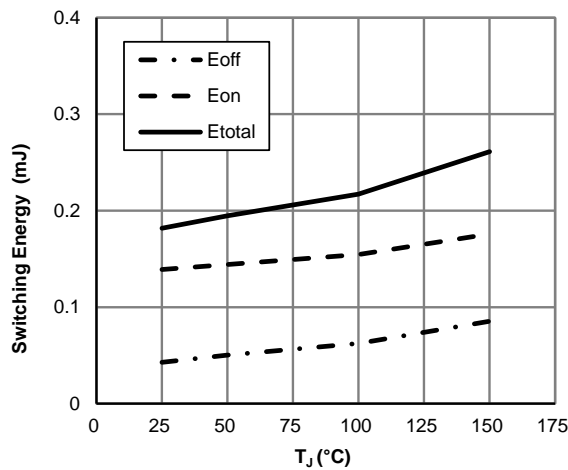
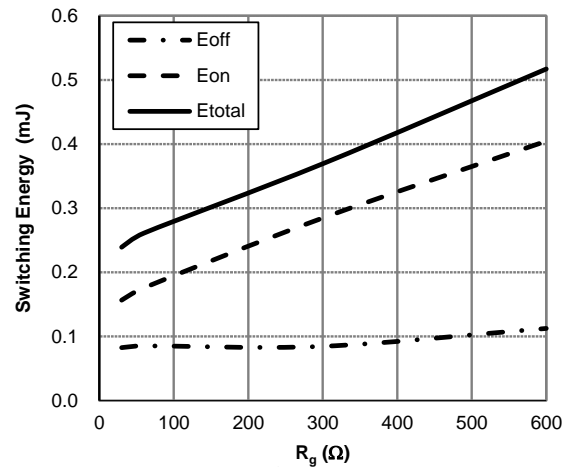
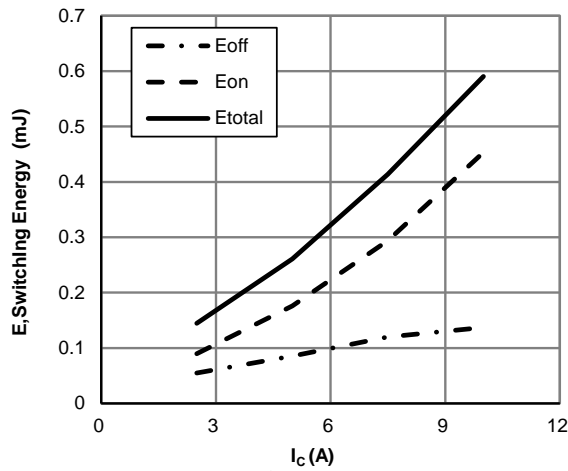


Figure 12: Current De-rating

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

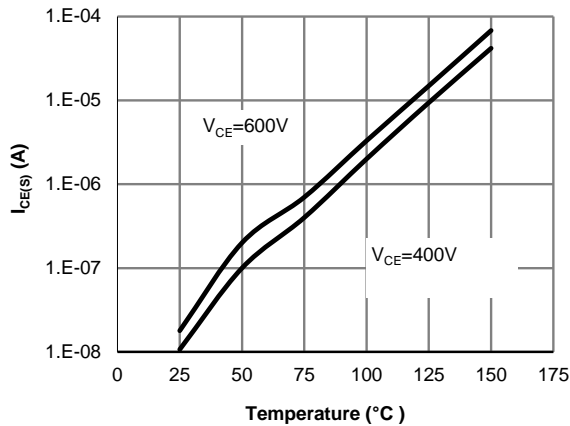


Figure 21: Diode Reverse Leakage Current vs. Junction Temperature

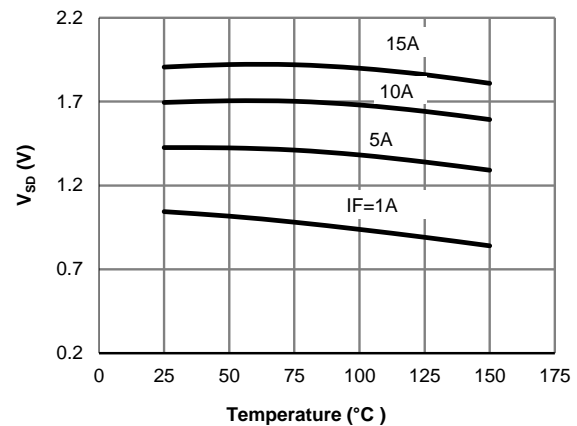


Figure 22: Diode Forward voltage vs. Junction Temperature

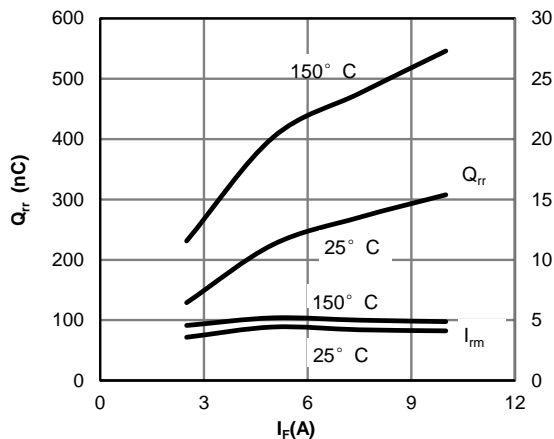


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

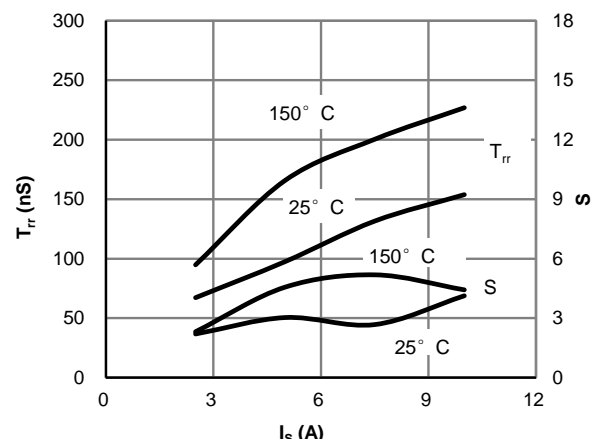


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

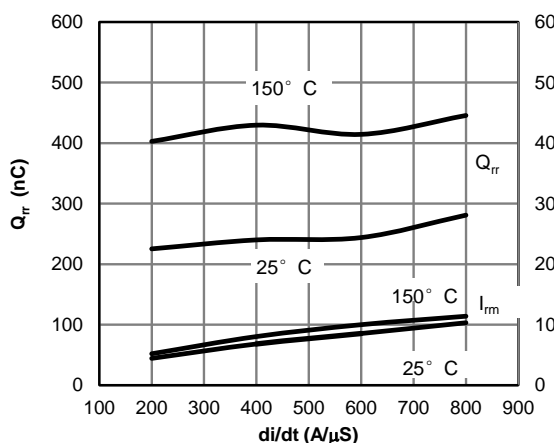


Figure 25: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

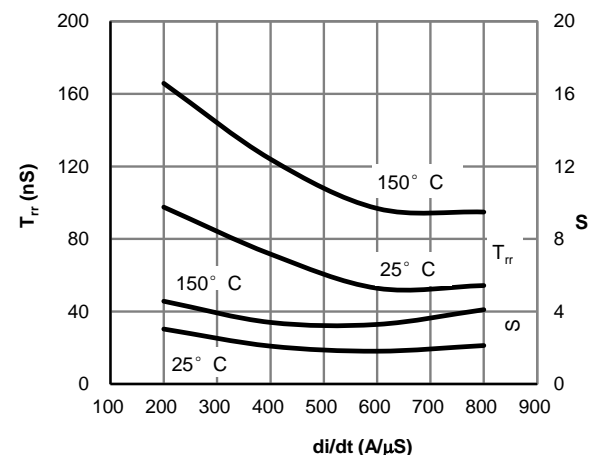


Figure 26: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

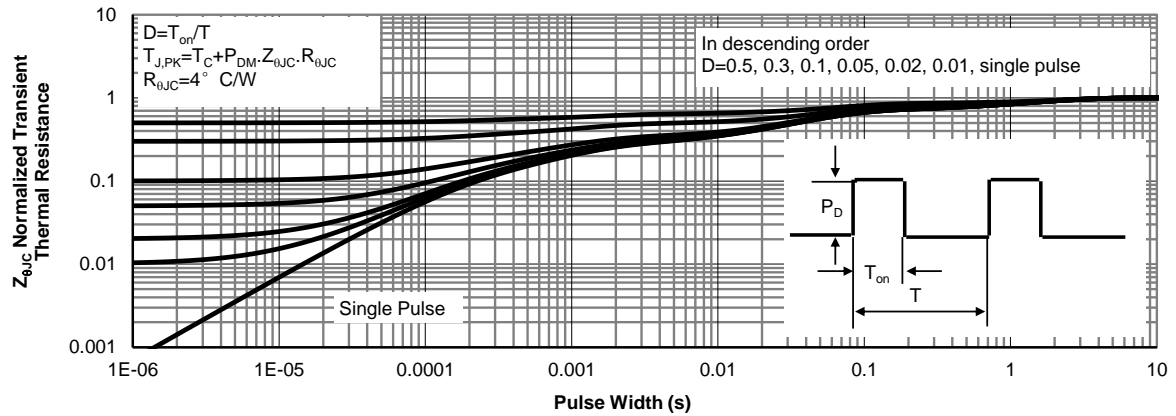


Figure 27: Normalized Maximum Transient Thermal Impedance for IGBT

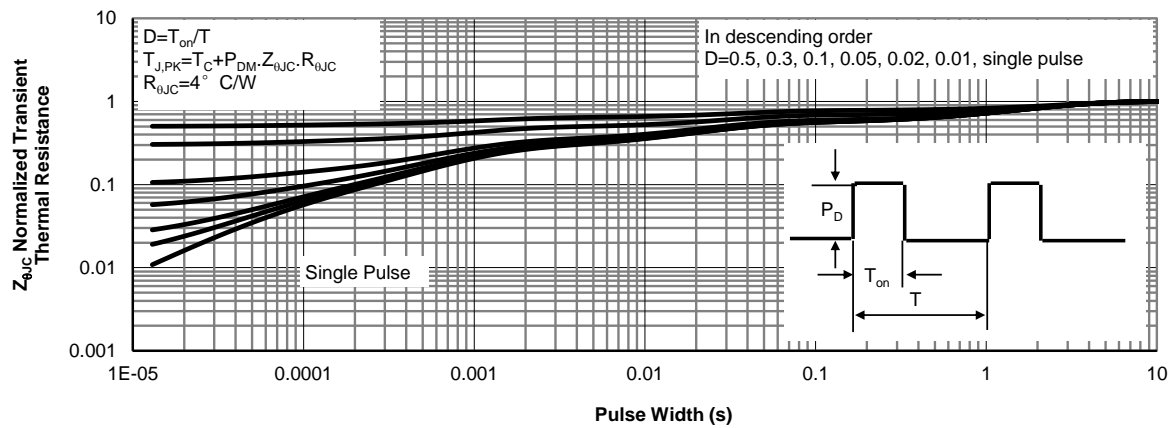
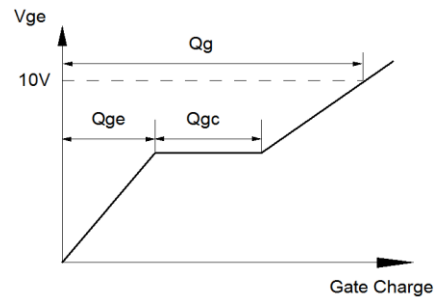
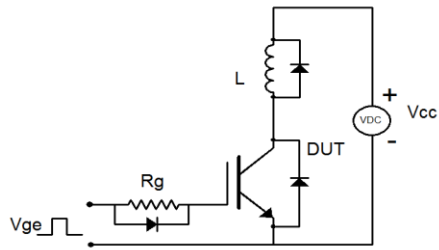
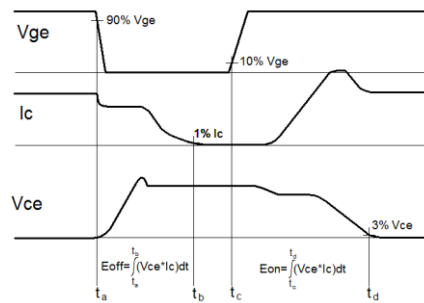
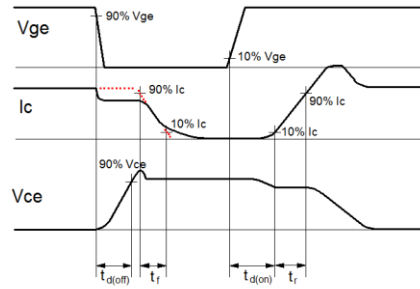
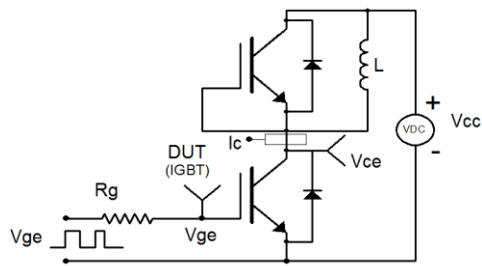


Figure 28: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

