ALPHA & OMEGA SEMICONDUCTOR

AOT5B60D

600V, 5A Alpha IGBT^{TM} with Diode

General Description

The Alpha IGBT^{TM} 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.

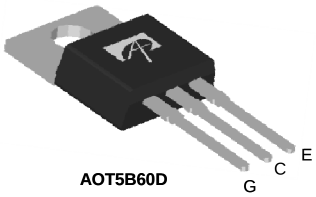
Product Summary

V_{CE}	600V
I_C (T_C=100℃)	5A
$V_{CE(sat)}$ (T_C=25℃)	1.55V

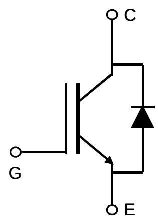
100% E_{on}/E_{off} Tested
100% Q_{rr} Tested
100% Short Circuit Current Tested*

Top View

TO-220



AOT5B60D



Absolute Maximum Ratings T_A=25℃ unless otherwise noted

Parameter		Symbol	AOT5B60D	Units
Collector-Emitter Voltage		V_{CE}	600	V
Gate-Emitter Voltage		V_{GE}	±20	V
Continuous Collector Current	T_C=25℃	I_C	10	A
	T_C=100℃		5	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	20	A
Turn off SOA, V_{CE} ≤ 600V, Limited by T_{Jmax}		I_{LM}	20	A
Continuous Diode Forward Current	T_C=25℃	I_F	10	A
	T_C=100℃		5	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	20	A
Short circuit withstanding time V_{GE} = 15V, V_{CE} ≤ 400V, Delay between short circuits ≥ 1.0s, T_C=150℃		t_{SC}	10	µs
Power Dissipation	T_C=25℃	P_D	82.4	W
	T_C=100℃		41.2	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	℃
Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds		T_L	300	℃

Thermal Characteristics

Parameter	Symbol	AOT5B60D	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	℃/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	1.82	℃/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	3	℃/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=1mA, V_{GE}=0V, T_J=25°C		600	-	-	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE}=15V, I_C=5A	T_J=25°C	-	1.55	1.8	V
			T_J=125°C	-	1.78	-	
			T_J=175°C	-	1.91	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_C=5A	T_J=25°C	-	1.46	1.75	V
			T_J=125°C	-	1.36	-	
			T_J=175°C	-	1.25	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=V_{GE}, I_C=1mA		-	6	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE}=600V, V_{GE}=0V	T_J=25°C	-	-	10	µA
			T_J=125°C	-	-	100	
			T_J=175°C	-	-	1000	
I_{GES}	Gate-Emitter Leakage Current	V_{CE}=0V, V_{GE}=±20V		-	-	±100	nA
g_{FS}	Forward Transconductance	V_{CE}=20V, I_C=5A		-	2.3	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CE}=25V, f=1MHz		-	367	-	pF
C_{oes}	Output Capacitance			-	34	-	pF
C_{res}	Reverse Transfer Capacitance			-	1.47	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CE}=480V, I_C=5A		-	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 ⩾ 1.0s	V_{GE}=15V, V_{CE}=400V, R_G=60Ω		-	21	-	A
R_g	Gate Resistance	V_{GE}=0V, V_{CE}=0V, f=1MHz		-	3	-	Ω
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=25°C V_{GE}=15V, V_{CE}=400V, I_C=5A, R_G=60Ω, 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	T_J=25°C I_F=5A,dI/dt=200A/µs,V_{CE}=400V		-	98	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.23	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	4.4	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=175°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=175°C V_{GE}=15V, V_{CE}=400V, I_C=5A, R_G=60Ω, Parasitic Inductance=100nH		-	10	-	ns
t_r	Turn-On Rise Time			-	16	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	113	-	ns
t_f	Turn-Off Fall Time			-	14	-	ns
E_{on}	Turn-On Energy			-	0.19	-	mJ
E_{off}	Turn-Off Energy			-	0.09	-	mJ
E_{total}	Total Switching Energy			-	0.28	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=175°C I_F=5A,dI/dt=200A/µs,V_{CE}=400V		-	195	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.48	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	5.6	-	A

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

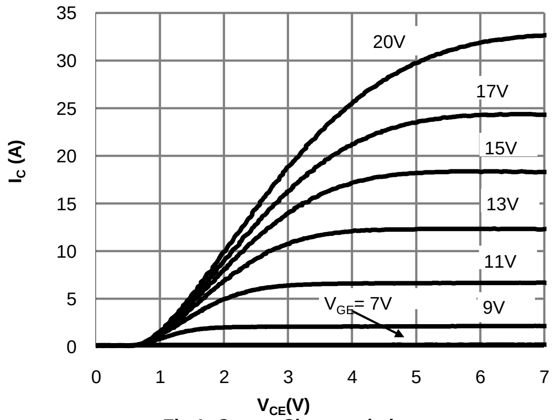


Fig 1: Output Characteristic (T_j=25°C)

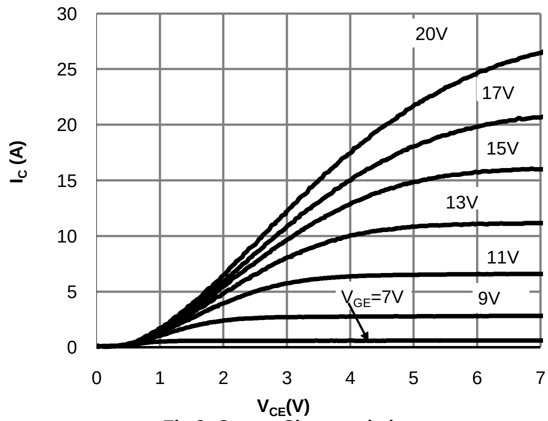


Fig 2: Output Characteristic (T_j=175°C)

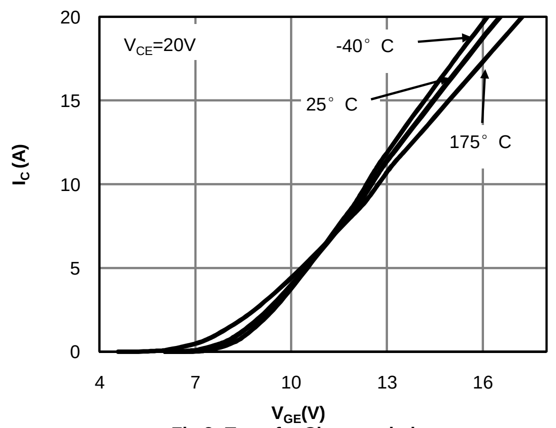


Fig 3: Transfer Characteristic

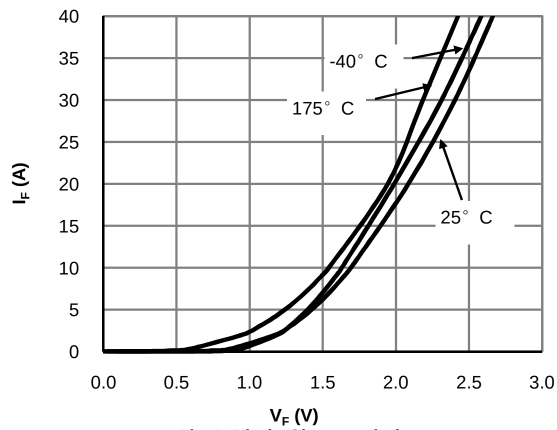


Fig 4: Diode Characteristic

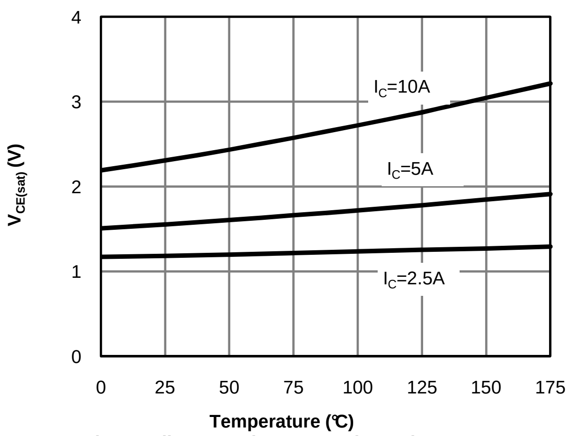


Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

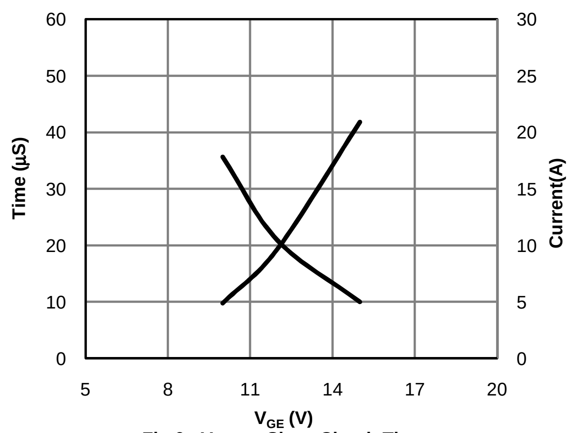


Fig 6: V_{GE} vs. Short Circuit Time (V_{CE}=400V,T_C=25°C)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

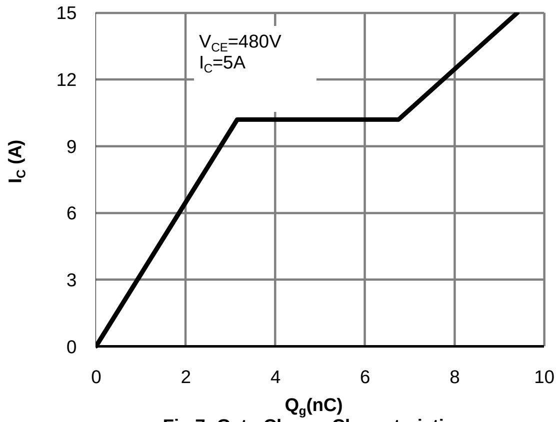


Fig 7: Gate-Charge Characteristics

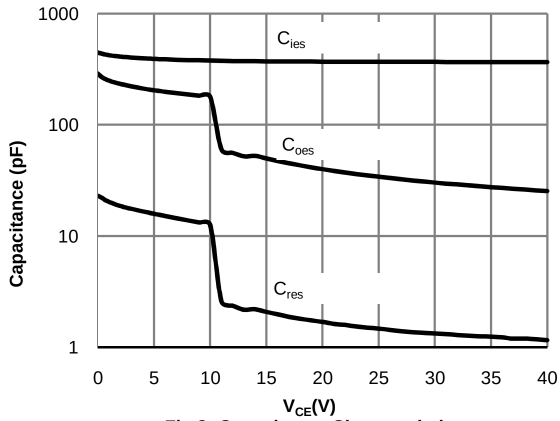


Fig 8: Capacitance Characteristic

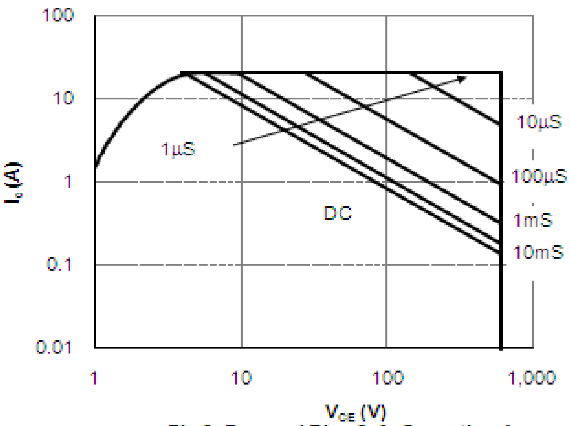


Fig 9: Forward Bias Safe Operating Area
(T_c=25°C,V_{GE}=15V)

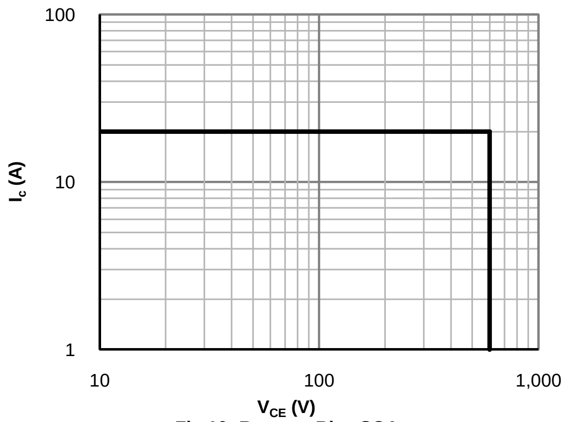


Fig 10: Reverse Bias SOA
(T_j=175℃,V_{GE}=15V)

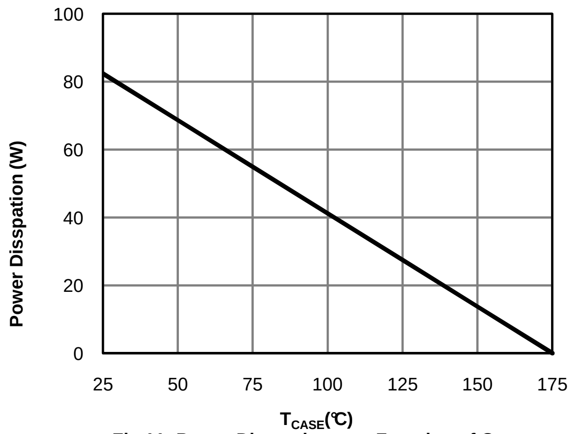


Fig 11: Power Disspation as a Function of Case

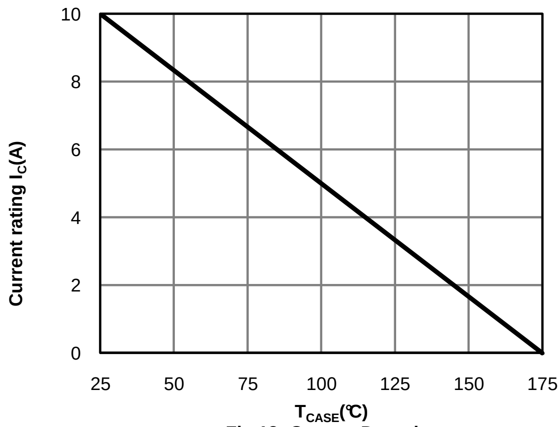
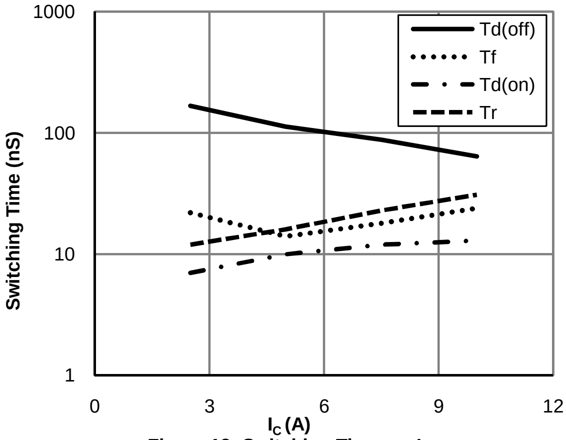


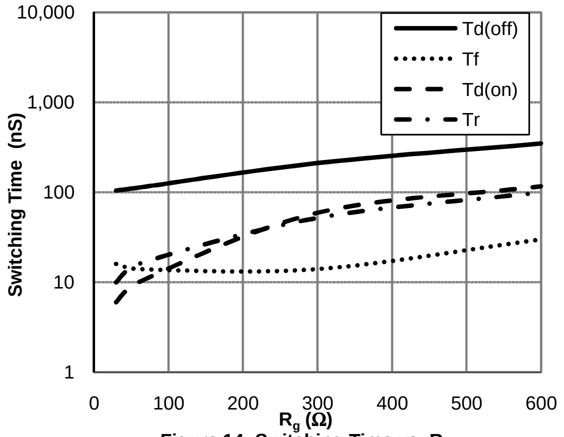
Fig 12: Current De-rating

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



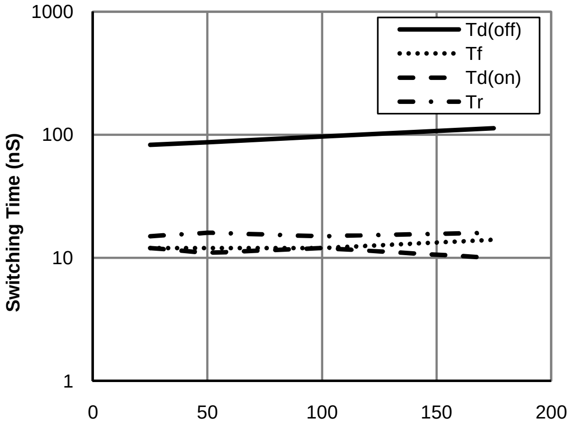
I_C (A)

Figure 13: Switching Time vs. I_C
(T_j=175℃,V_{GE}=15V,V_{CE}=400V,R_g=60Ω)



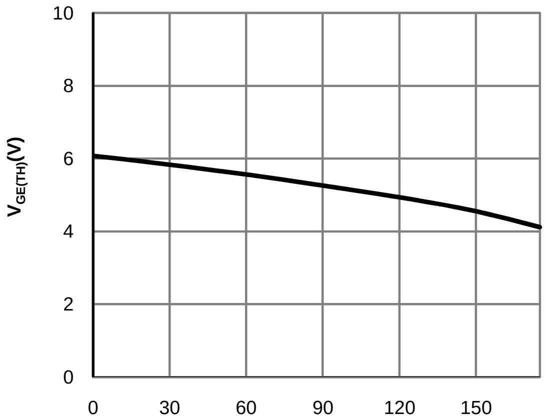
R_g (Ω)

Figure 14: Switching Time vs. R_g
(T_j=175℃,V_{GE}=15V,V_{CE}=400V,I_C=5A)



T_J (℃)

Figure 15: Switching Time vs.T_j
(V_{GE}=15V,V_{CE}=400V,I_C=5A,R_g=60Ω)



T_J (℃)

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

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

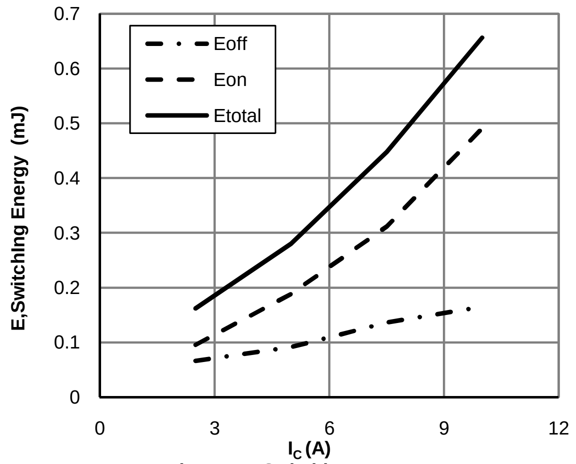


Figure 17: Switching Loss vs. I_C
(T_j=175℃,V_{GE}=15V,V_{CE}=400V,R_g=60Ω)

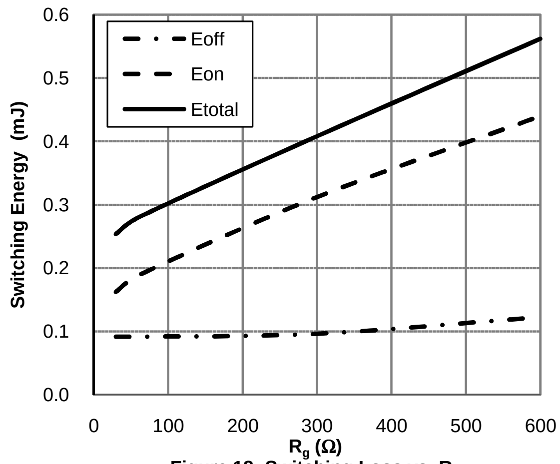


Figure 18: Switching Loss vs. R_g
(T_j=175℃,V_{GE}=15V,V_{CE}=400V,I_C=5A)

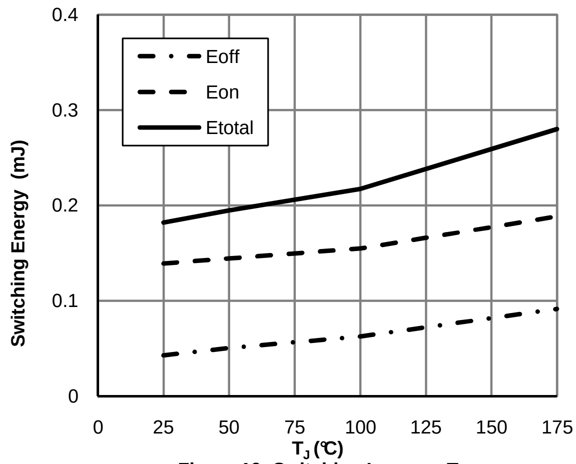


Figure 19: Switching Loss vs. T_j
(V_{GE}=15V,V_{CE}=400V,I_C=5A,R_g=60Ω)

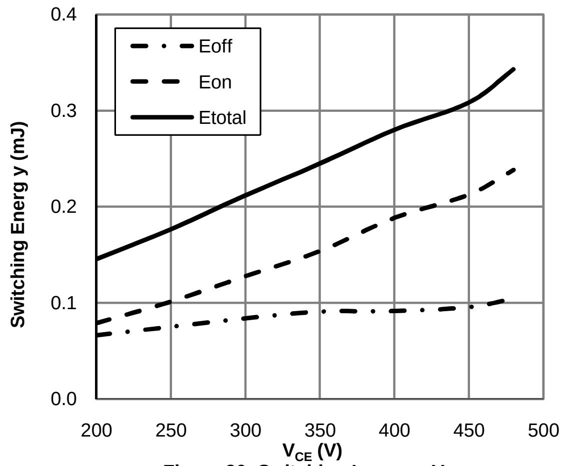


Figure 20: Switching Loss vs. V_{CE}
(T_j=175℃,V_{GE}=15V,I_C=5A,R_g=60Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

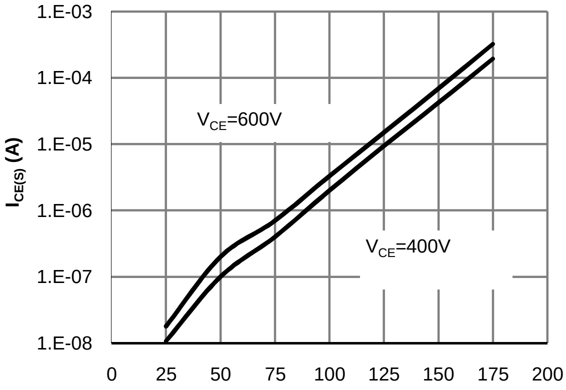


Fig 21: Diode Reverse Leakage Current vs. Junction Temperature

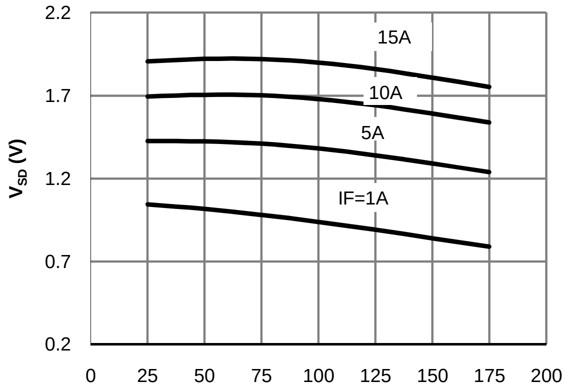


Fig 22: Diode Forward voltage vs. Junction Temperature

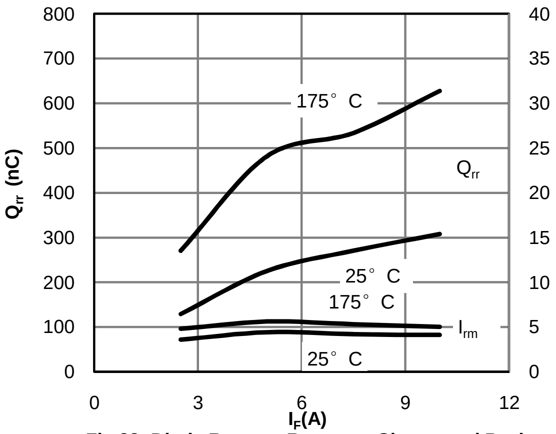


Fig 23: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

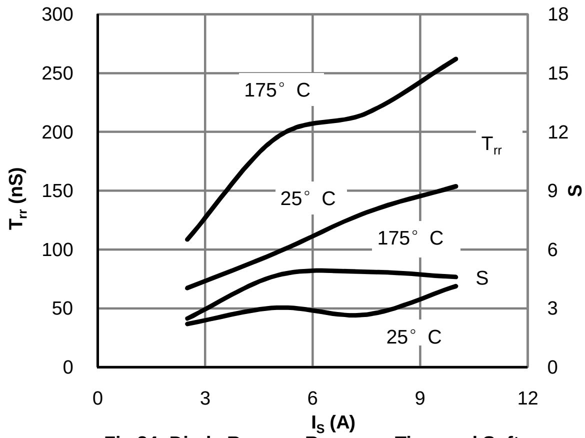


Fig 24: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

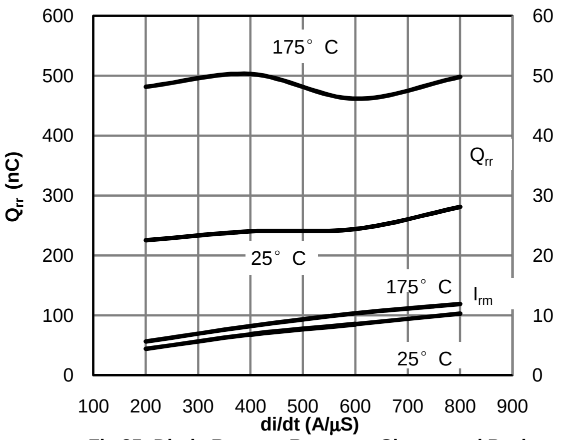


Fig 25: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=5A)

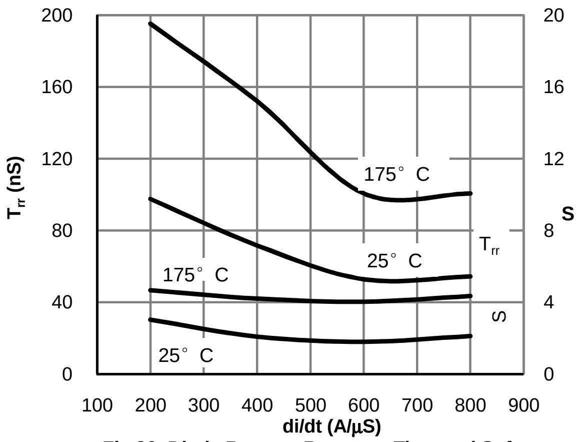


Fig 26: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=5A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

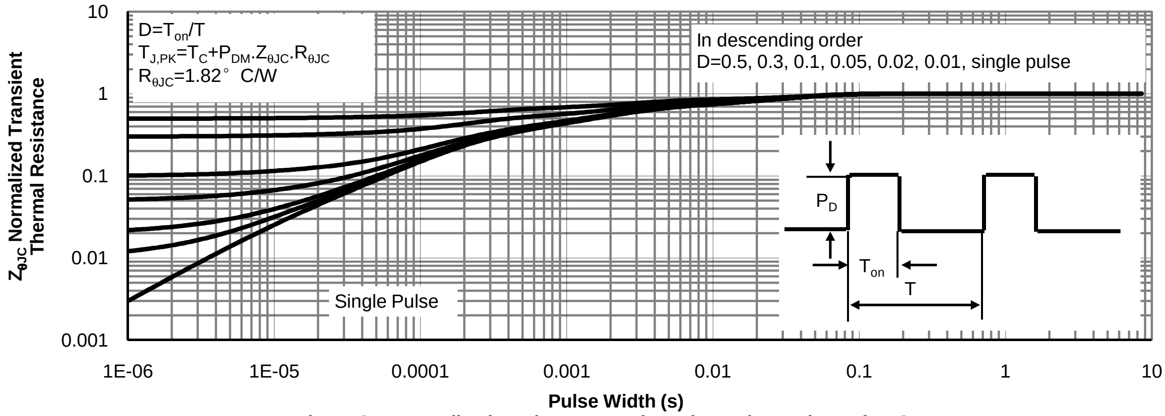


Figure 27: Normalized Maximum Transient Thermal Impedance for IGBT

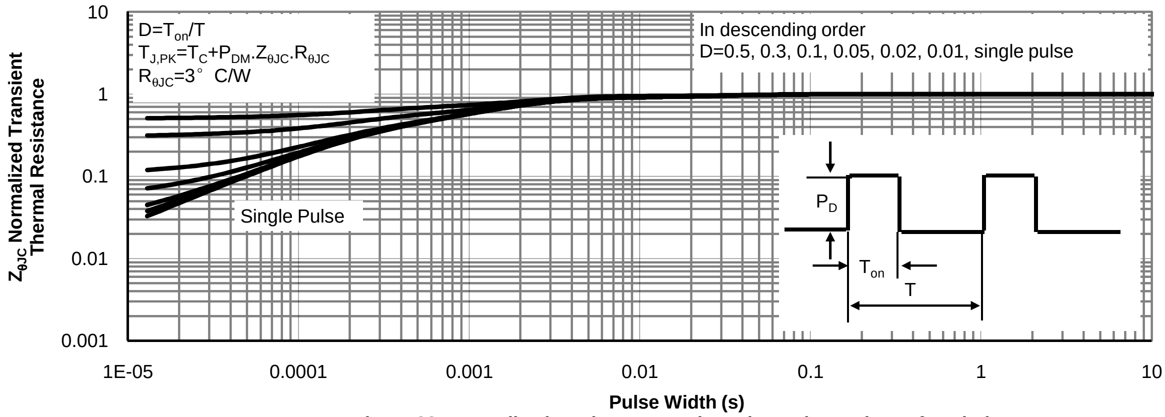
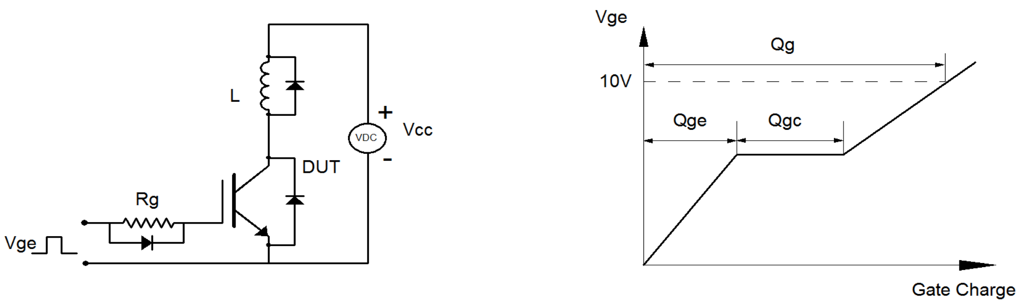
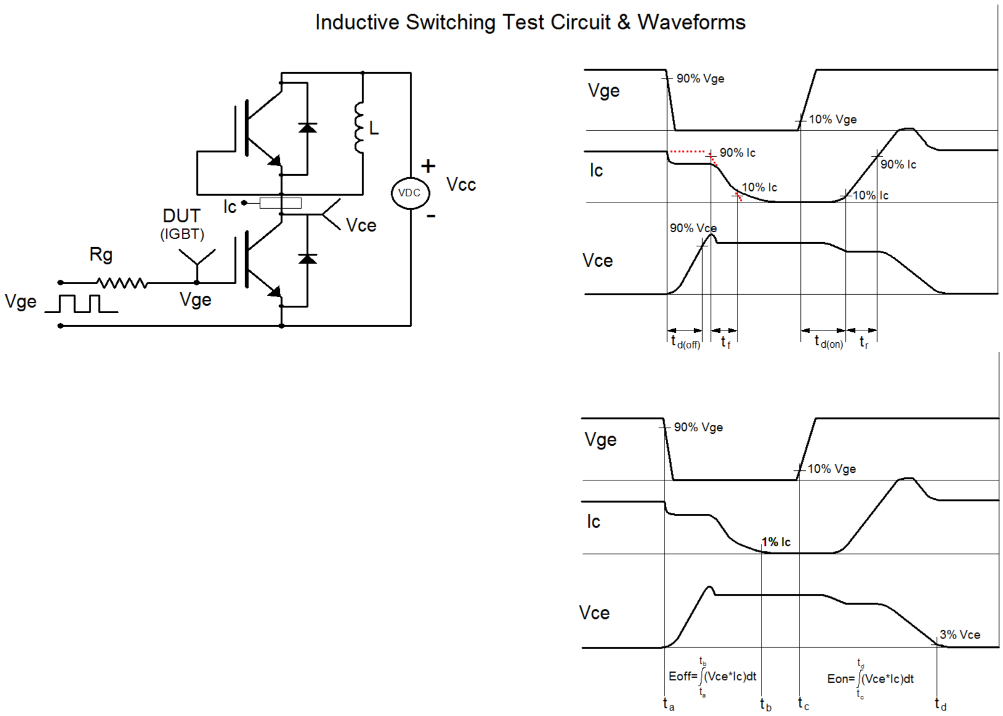


Figure 28: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms