AOK50B60D1

600V, 50A Alpha IGBT™ with Diode

ALPHA & OMEGA SEMICONDUCTOR

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-packaged diode is targeted for minimal losses in Welding machines, Solar Inverter and UPS applications.

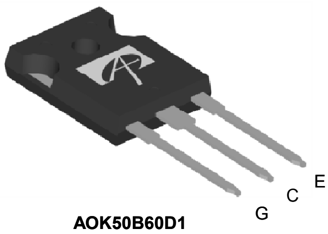
Product Summary

V_{CE}	600V
I_C (T_C=100°C)	50A
$V_{CE(sat)}$ (T_C=25°C)	1.85V

RoHS Compliant

Top View

TO-247



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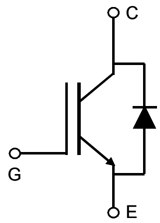

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		**Symbol**	**AOK50B60D1**	**Units**
Collector-Emitter Voltage		V_{CE}	600	V
Gate-Emitter Voltage		V_{GE}	±20	V
V_{GE} Spike	500ns	V_{SPIKE}	24	V
Continuous Collector Current	T_C=25°C	I_C	100	A
	T_C=100°C		50	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	168	A
Turn off SOA, $V_{CE} \leqslant$ 600V, Limited by T_{Jmax}		I_{LM}	168	A
Continuous Diode Forward Current	T_C=25°C	I_F	50	A
	T_C=100°C		25	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	168	A
Short circuit withstanding time V_{GE} = 15V, $V_{CE} \leqslant$ 400V, Delay between short circuits $\geqslant$ 1.0s, T_C=150°C		t_{SC}	10	µs
Power Dissipation	T_C=25°C	P_D	312	W
	T_C=100°C		125	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C
Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds		T_L	300	°C

Thermal Characteristics

Parameter	**Symbol**	**AOK50B60D1**	**Units**
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	°C/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.4	°C/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	1.2	°C/W

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=50A	T_J=25°C	-	1.85	2.4	V
			T_J=125°C	-	2.2	-	
			T_J=150°C	-	2.3	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_C=25A	T_J=25°C	-	1.4	1.9	V
			T_J=125°C	-	1.37	-	
			T_J=150°C	-	1.34	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=5V, I_C=1mA		-	5.6	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE}=600V, V_{GE}=0V	T_J=25°C	-	-	10	μA
			T_J=125°C	-	-	800	
			T_J=150°C	-	-	4000	
I_{GES}	Gate-Emitter leakage current	V_{CE}=0V, V_{GE}=±20V		-	-	±100	nA
g_{FS}	Forward Transconductance	V_{CE}=20V, I_C=50A		-	20	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CE}=25V, f=1MHz		-	2572	-	pF
C_{oes}	Output Capacitance			-	308	-	pF
C_{res}	Reverse Transfer Capacitance			-	10	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CE}=480V, I_C=50A		-	64	-	nC
Q_{ge}	Gate to Emitter Charge			-	27	-	nC
Q_{gc}	Gate to Collector Charge			-	19	-	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=25Ω		-	168	-	A
R_g	Gate resistance	f=1MHz		-	1.53	-	Ω
SWITCHING PARAMETERS, (Load Iductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=25°C V_{GE}=15V, V_{CE}=400V, I_C=50A, R_G=6Ω, Parasitic Inductance=150nH		-	26	-	ns
t_r	Turn-On Rise Time			-	70	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	68	-	ns
t_f	Turn-Off Fall Time			-	18	-	ns
E_{on}	Turn-On Energy			-	2.37	-	mJ
E_{off}	Turn-Off Energy			-	0.5	-	mJ
E_{total}	Total Switching Energy			-	2.87	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=25°C I_F=25A,dI/dt=200A/μs,V_{CE}=400V		-	132	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.77	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	9	-	A
SWITCHING PARAMETERS, (Load Iductive, T_J=150°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=150°C V_{GE}=15V, V_{CE}=400V, I_C=50A, R_G=6Ω, Parasitic Inductance=150nH		-	24	-	ns
t_r	Turn-On Rise Time			-	74	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	84	-	ns
t_f	Turn-Off Fall Time			-	20	-	ns
E_{on}	Turn-On Energy			-	2.7	-	mJ
E_{off}	Turn-Off Energy			-	0.9	-	mJ
E_{total}	Total Switching Energy			-	3.6	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=150°C I_F=25A,dI/dt=200A/μs,V_{CE}=400V		-	220	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	1.46	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	12.7	-	A

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

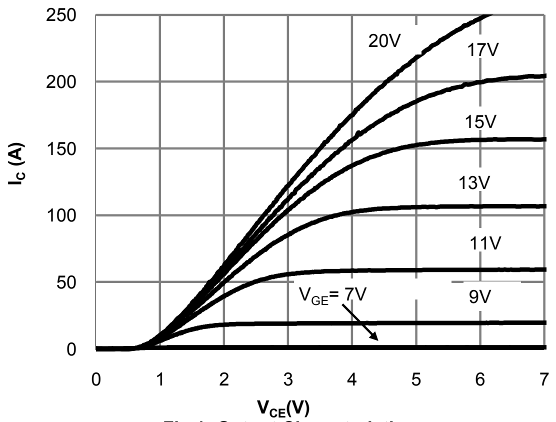

Fig 1: Output Characteristic (T_j=25°C)

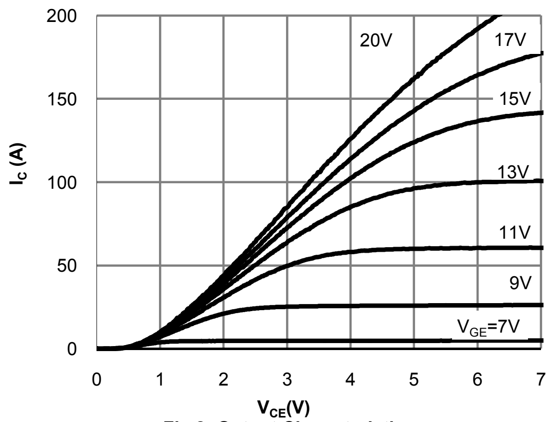

Fig 2: Output Characteristic (T_j=150°C)

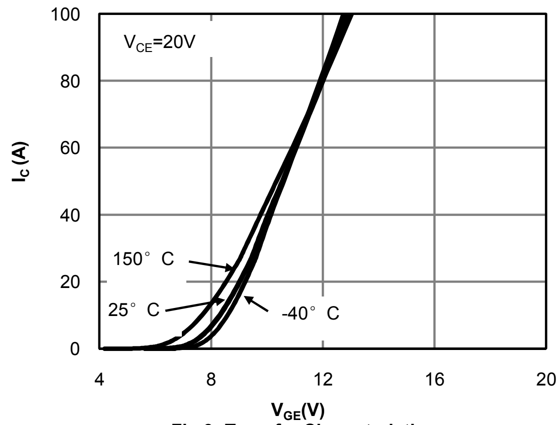

Fig 3: Transfer Characteristic

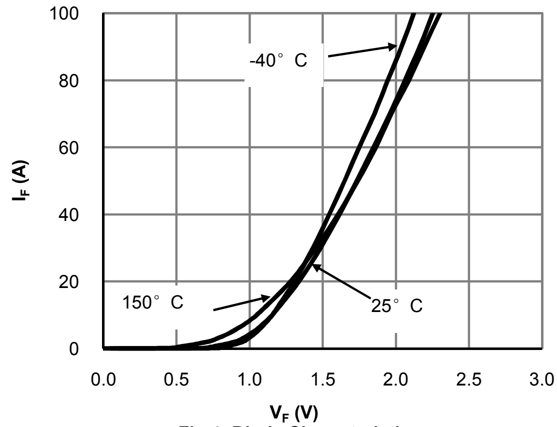

Fig 4: Diode Characteristic

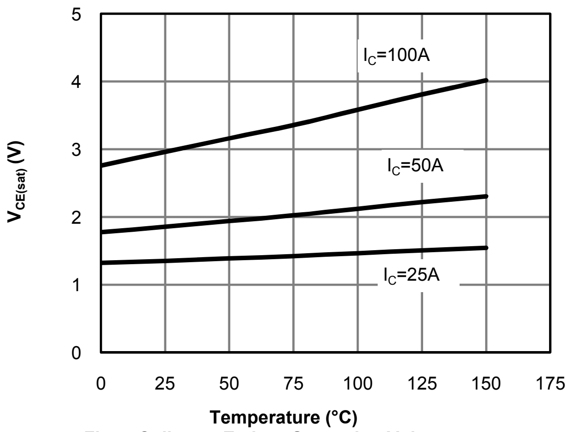

Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

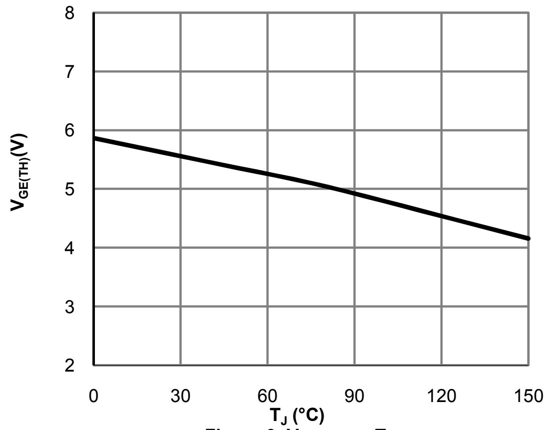

Figure 6: $V_{GE(TH)}$ vs. T_j

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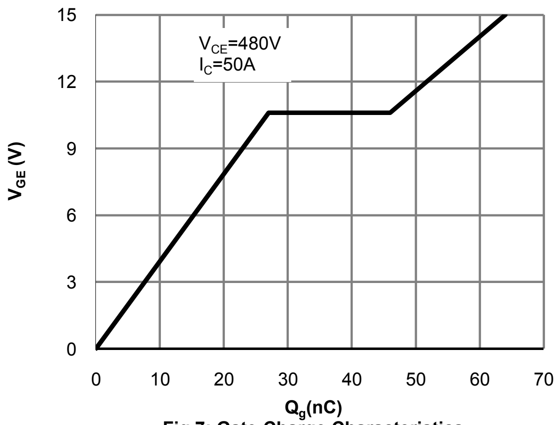


Fig 7: Gate-Charge Characteristics

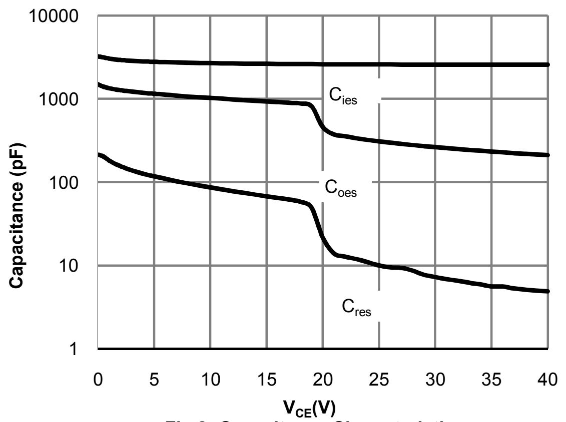


Fig 8: Capacitance Characteristic

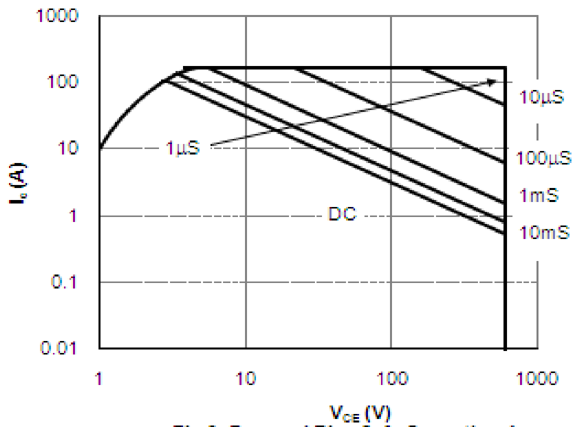


Fig 9: Forward Bias Safe Operating Area (T_c=25C,V_{GE}=15V)

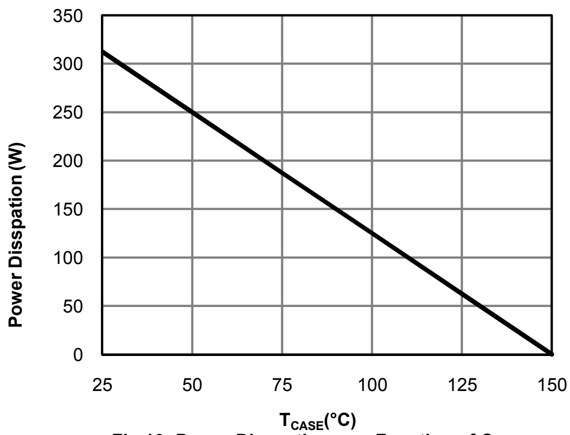


Fig 10: Power Disspation as a Function of Case

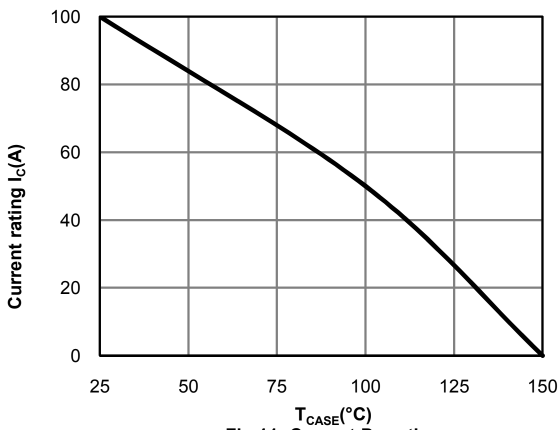


Fig 11: Current De-rating

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

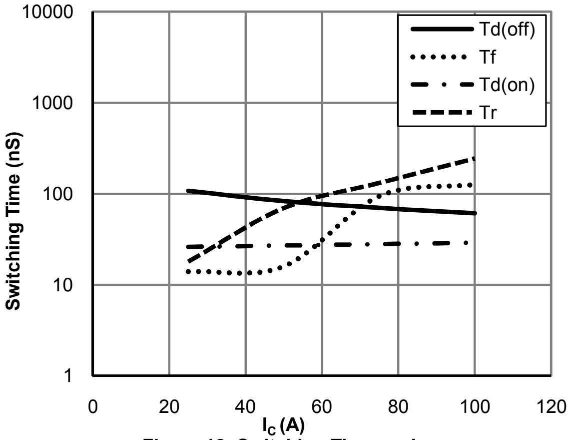


Figure 12: Switching Time vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=6Ω)

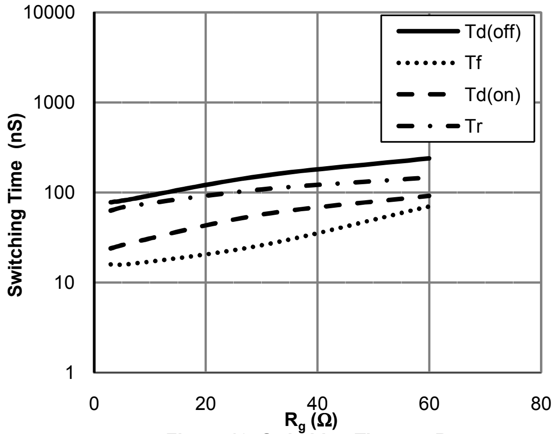


Figure 13: Switching Time vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=50A)

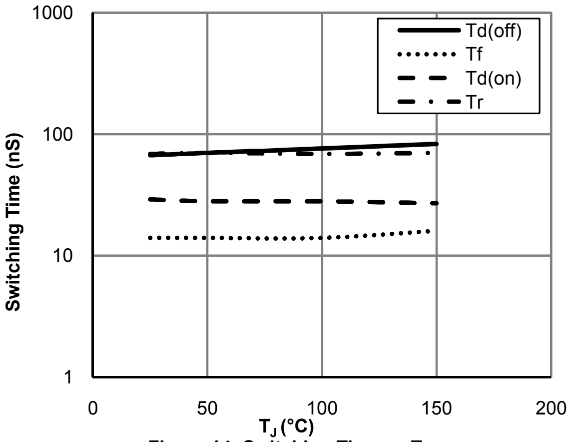


Figure 14: Switching Time vs.T_j
(V_{GE}=15V,V_{CE}=400V,I_C=50A,R_g=6Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

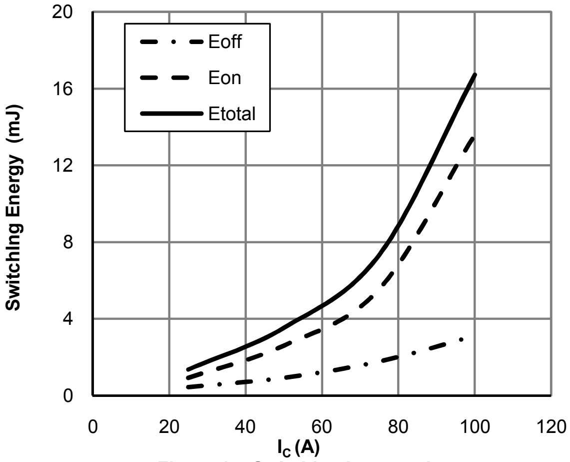


Figure 15: Switching Loss vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=6Ω)

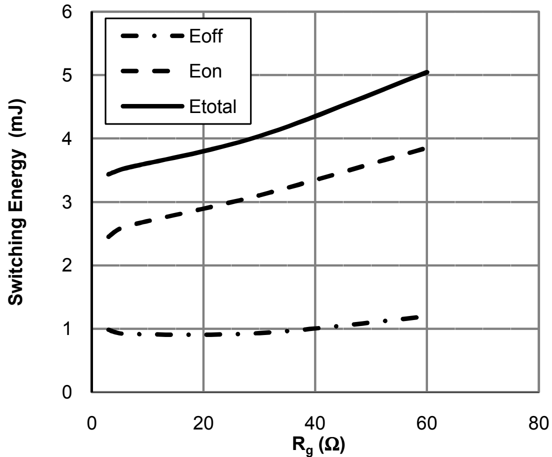


Figure 16: Switching Loss vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=50A)

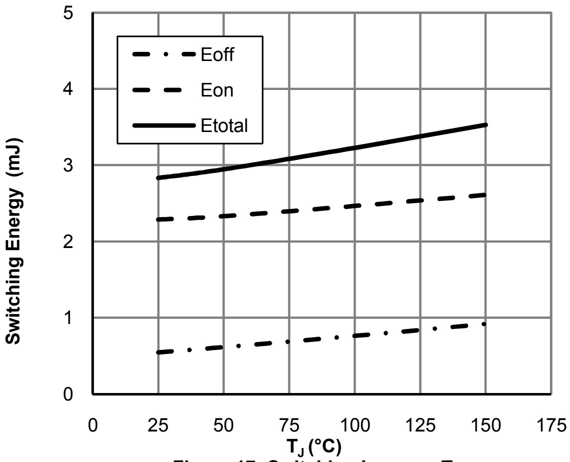


Figure 17: Switching Loss vs. T_j
(V_{GE}=15V,V_{CE}=400V,I_C=50A,R_g=6Ω)

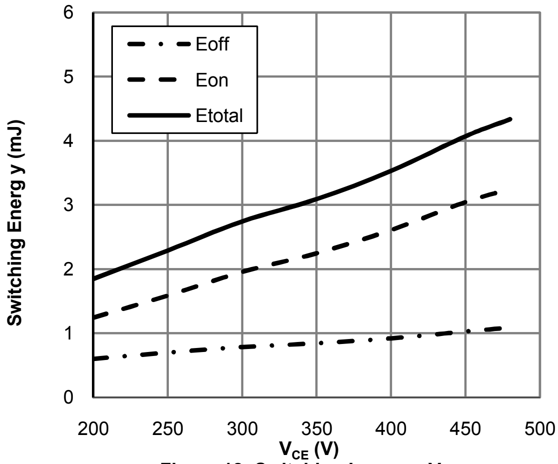


Figure 18: Switching Loss vs. V_{CE}
(T_j=150°C,V_{GE}=15V,I_C=50A,R_g=6Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

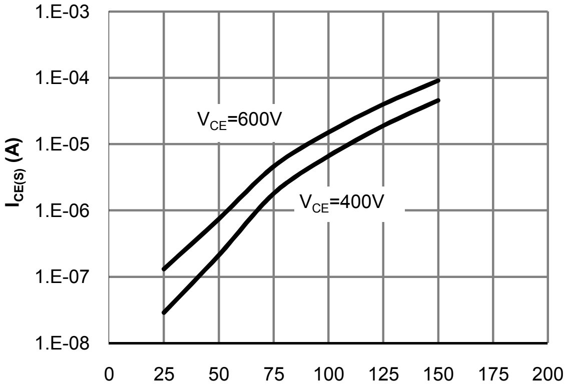


Fig 19: Diode Reverse Leakage Current vs. Junction Temperature

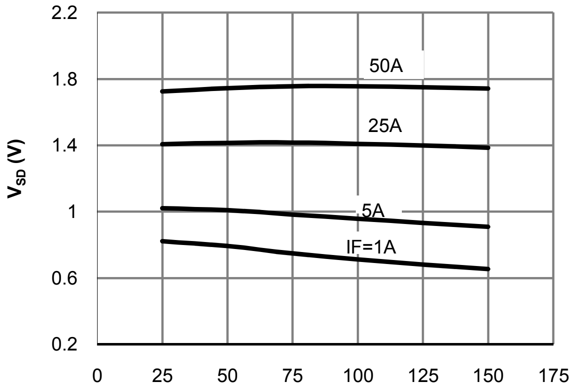


Fig 20: Diode Forward voltage vs. Junction Temperature

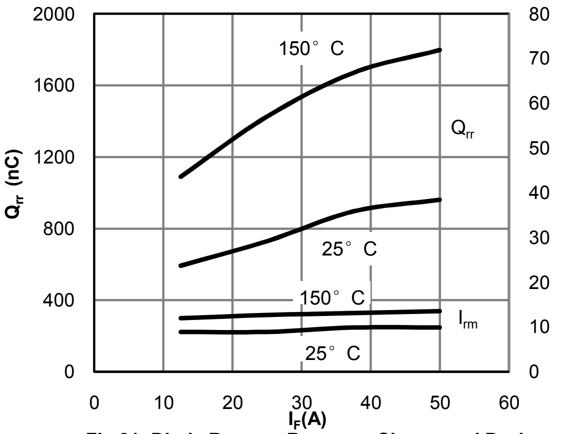


Fig 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

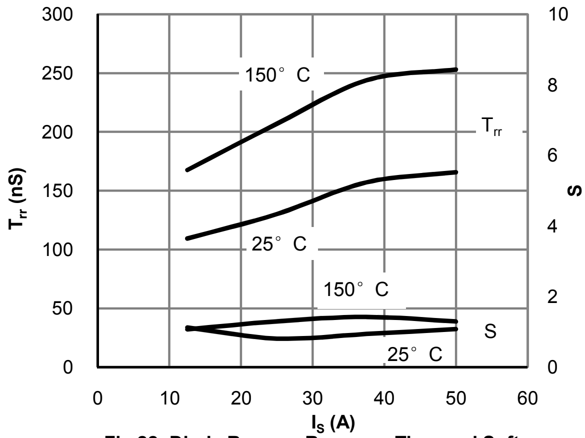


Fig 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

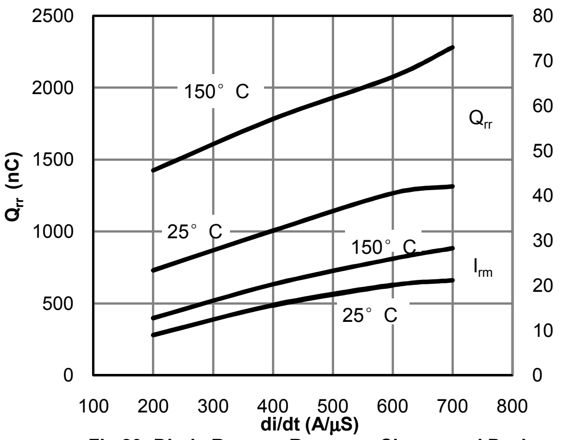


Fig 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=25A)

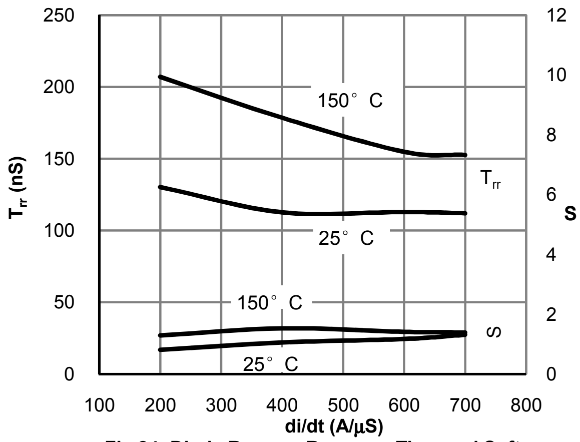


Fig 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=25A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

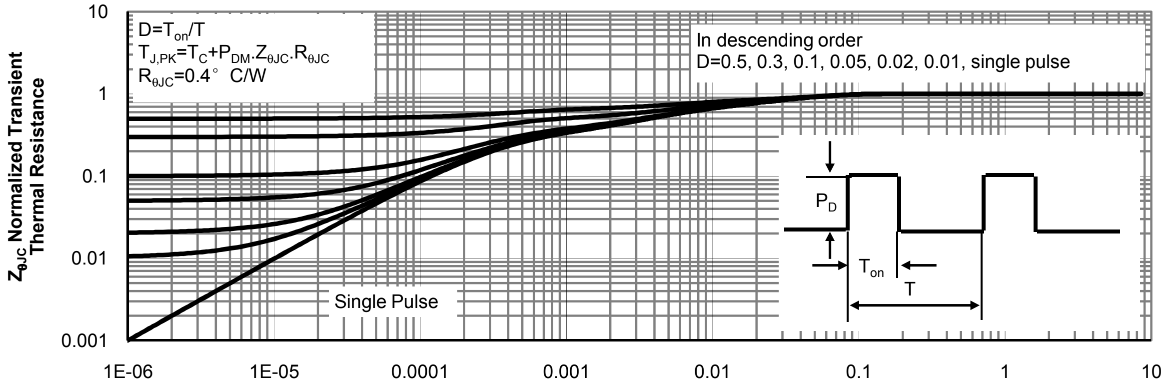


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

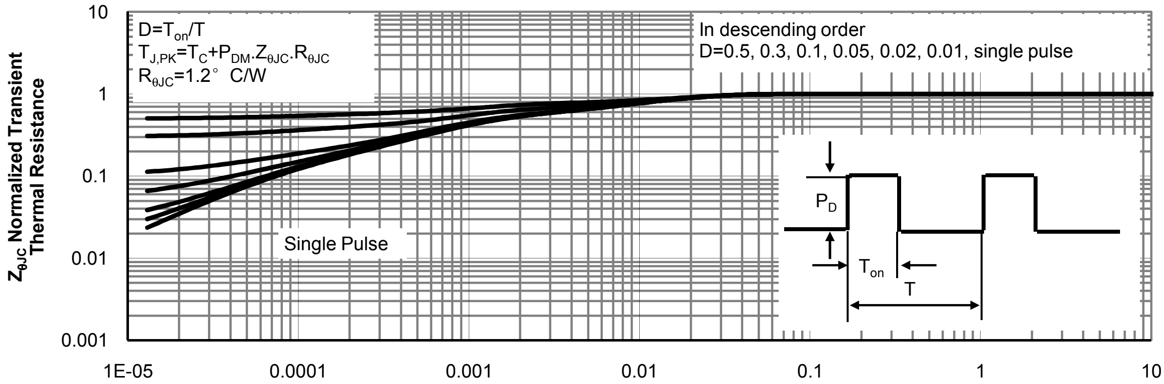
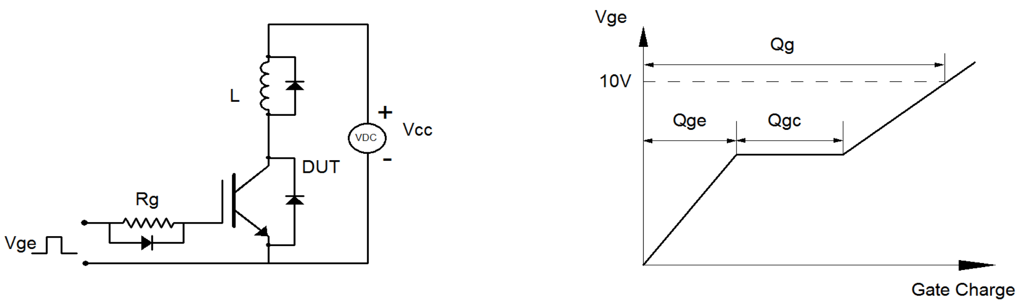
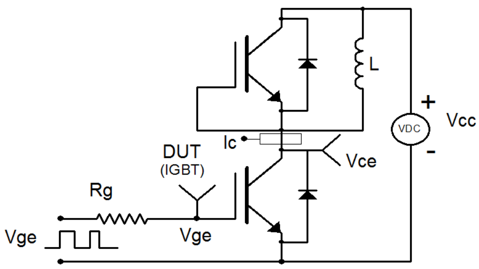


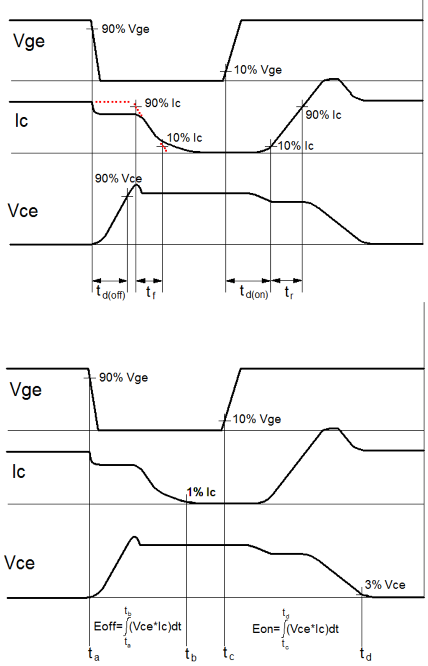
Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms





Diode Recovery Test Circuit & Waveforms