ALPHA & OMEGA SEMICONDUCTOR

AOK40B60D

600V, 40A 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.

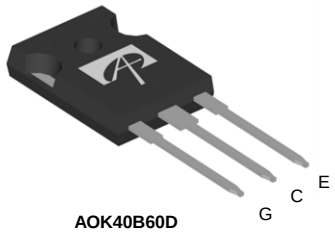
Product Summary

V_{CE}	600V
I_C (T_C=100°C)	40A
$V_{CE(sat)}$ (T_C=25°C)	1.6V

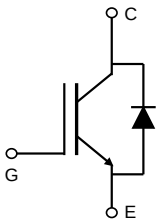
RoHS Compliant

Top View

TO-247



AOK40B60D



Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	AOK40B60D	Units
Collector-Emitter Voltage		V_{CE}	600	V
Gate-Emitter Voltage		V_{GE}	±20	V
Continuous Collector Current	T_C=25°C	I_C	80	A
	T_C=100°C		40	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	160	A
Turn off SOA, $V_{CE} \leqslant$ 600V, Limited by T_{Jmax}		I_{LM}	160	A
Continuous Diode Forward Current	T_C=25°C	I_F	40	A
	T_C=100°C		20	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	160	A
Short circuit withstanding time V_{GE} = 15V, $V_{CE} \leqslant$ 400V, Delay between short circuits $\geqslant$ 1.0s, T_C=25°C		t_{SC}	10	µs
Power Dissipation	T_C=25°C	P_D	312.5	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	AOK40B60D	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	$R_{\theta JC}$	0.65	°C/W

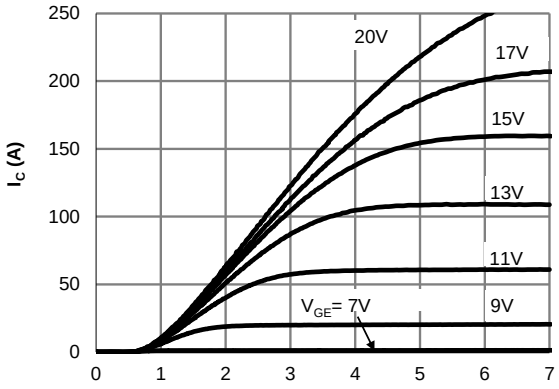
Electrical Characteristics (T_J=25°C unless otherwise noted)

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=40A	T_J=25°C	-	1.6	2.1	V
			T_J=125°C	-	1.88	-	
			T_J=150°C	-	1.96	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_C=40A	T_J=25°C	-	1.36	1.9	V
			T_J=125°C	-	1.34		
			T_J=150°C	-	1.31	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=5V, I_C=1mA		-	5.5	-	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=40A		-	21	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CE}=25V, f=1MHz		-	2584	-	pF
C_{oes}	Output Capacitance			-	303	-	pF
C_{res}	Reverse Transfer Capacitance			-	9.2	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CE}=480V, I_C=40A		-	63.5	-	nC
Q_{ge}	Gate to Emitter Charge			-	21.6	-	nC
Q_{gc}	Gate to Collector Charge			-	19.4	-	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		-	160	-	A
R_g	Gate resistance	V_{GE}=0V, V_{CE}=0V, f=1MHz		-	1.45	-	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=40A, R_G=7.5Ω, Parasitic Inductance=150nH		-	28	-	ns
t_r	Turn-On Rise Time			-	52	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	77	-	ns
t_f	Turn-Off Fall Time			-	12	-	ns
E_{on}	Turn-On Energy			-	1.72	-	mJ
E_{off}	Turn-Off Energy			-	0.3	-	mJ
E_{total}	Total Switching Energy			-	2	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=25°C I_F=40A,dI/dt=200A/µs,V_{CE}=400V		-	138	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.86	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	10	-	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=40A, R_G=7.5Ω, Parasitic Inductance=150nH		-	29	-	ns
t_r	Turn-On Rise Time			-	53	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	95	-	ns
t_f	Turn-Off Fall Time			-	12	-	ns
E_{on}	Turn-On Energy			-	2.1	-	mJ
E_{off}	Turn-Off Energy			-	0.6	-	mJ
E_{total}	Total Switching Energy			-	2.7	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=150°C I_F=40A,dI/dt=200A/µs,V_{CE}=400V		-	210	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	1.87	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	15	-	A

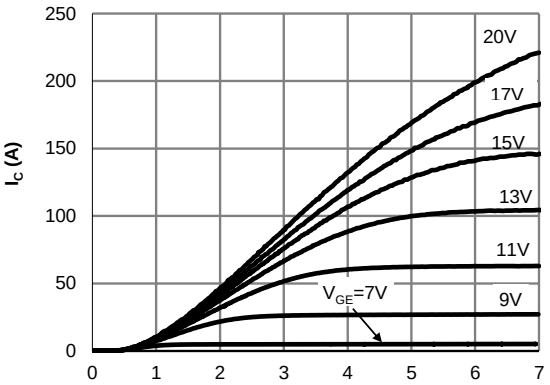
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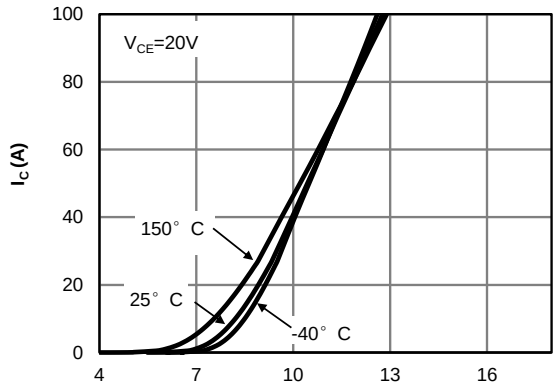
TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



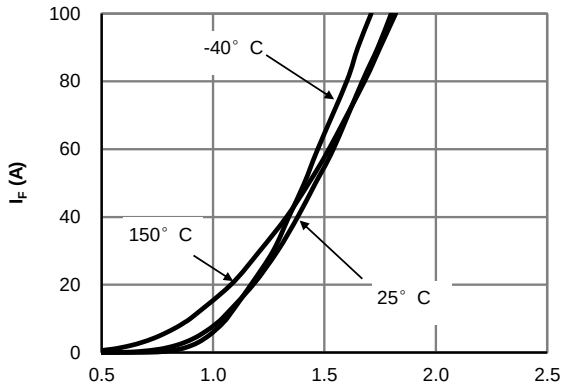
V_{CE}(V)
Fig 1: Output Characteristic (T_j=25°C)



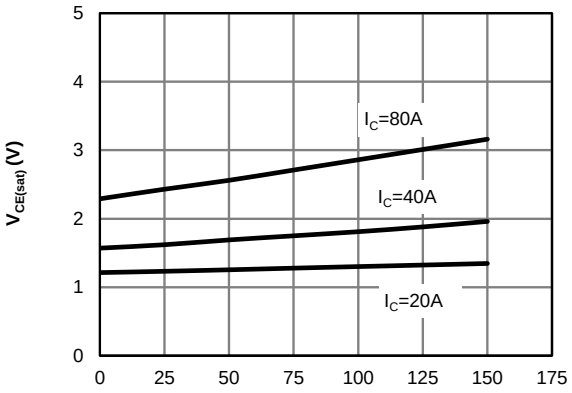
V_{CE}(V)
Fig 2: Output Characteristic (T_j=150°C)



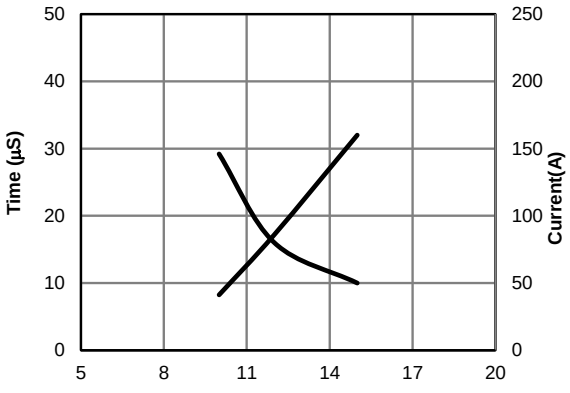
V_{GE}(V)
Fig 3: Transfer Characteristic



V_F (V)
Fig 4: Diode Characteristic



Temperature (°C)
Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature



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

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

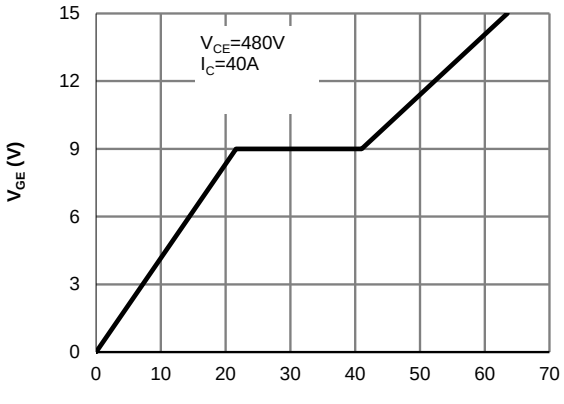


Fig 7: Gate-Charge Characteristics

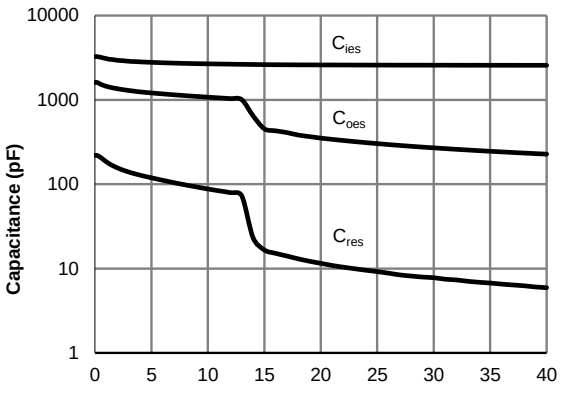


Fig 8: Capacitance Characteristic

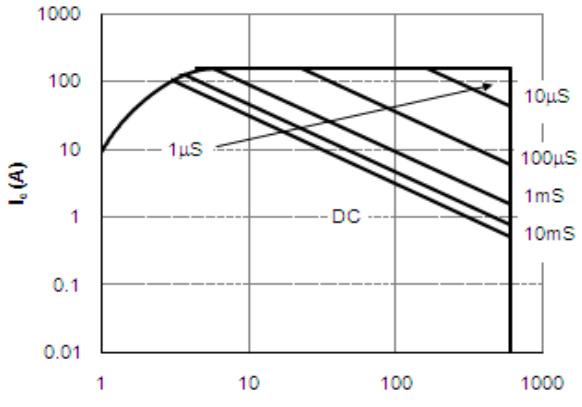


Fig 9: Forward Bias Safe Operating Area
(T_C=25C,V_{GE}=15V)

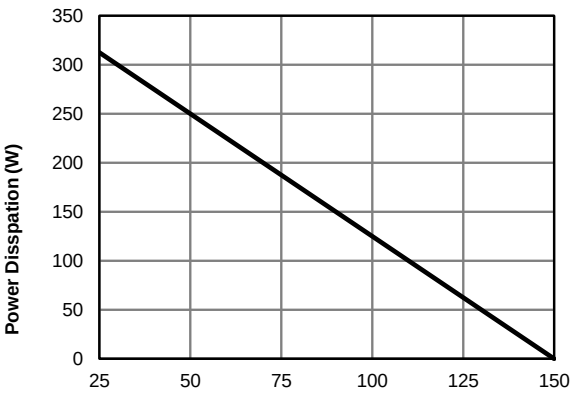


Fig 10: Power Disspation as a Function of Case

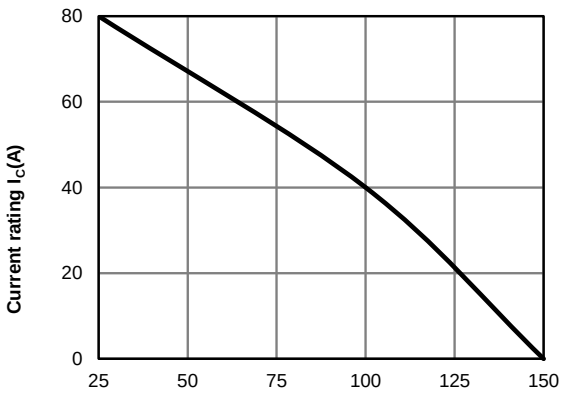


Fig 11: Current De-rating

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

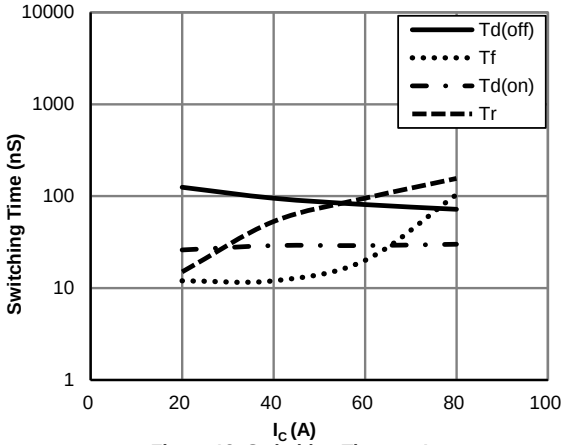


Figure 12: Switching Time vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=7.5Ω)

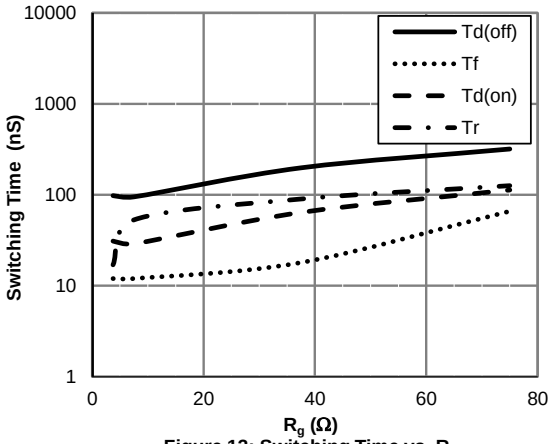


Figure 13: Switching Time vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=40A)

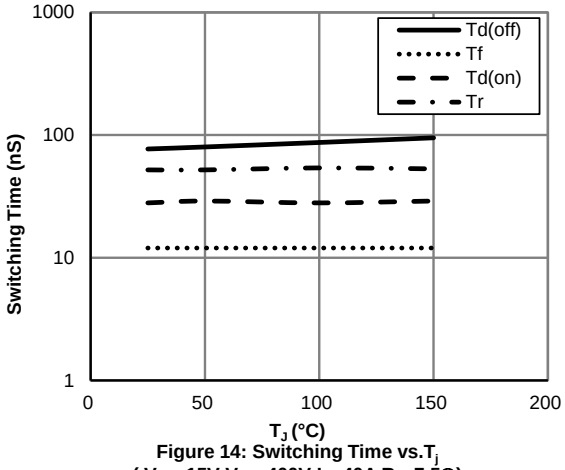


Figure 14: Switching Time vs.T_j
(V_{GE}=15V,V_{CE}=400V,I_C=40A,R_g=7.5Ω)

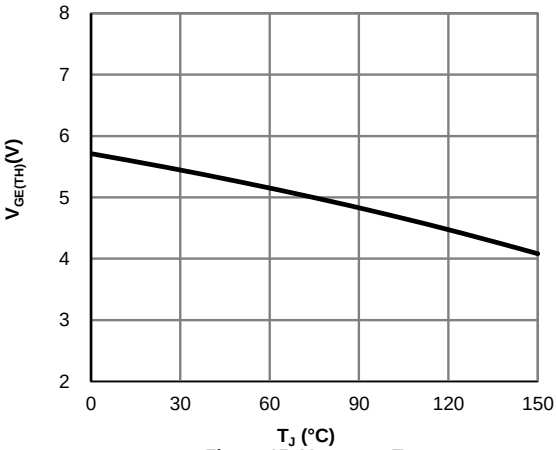


Figure 15: $V_{GE(TH)}$ vs. T_j

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

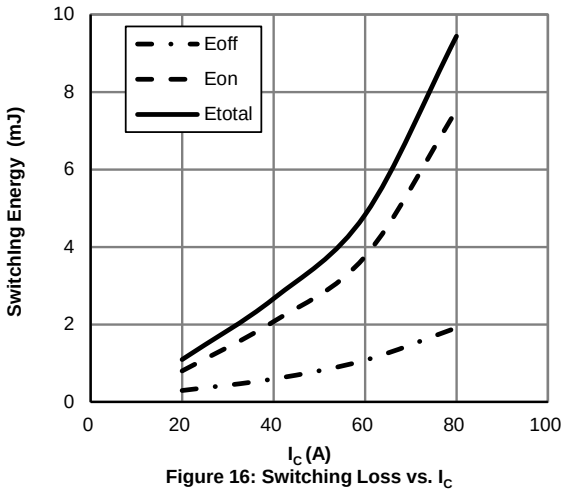


Figure 16: Switching Loss vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=7.5Ω)

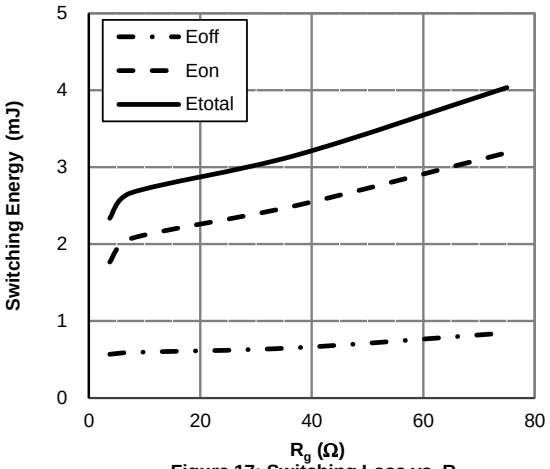


Figure 17: Switching Loss vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=40A)

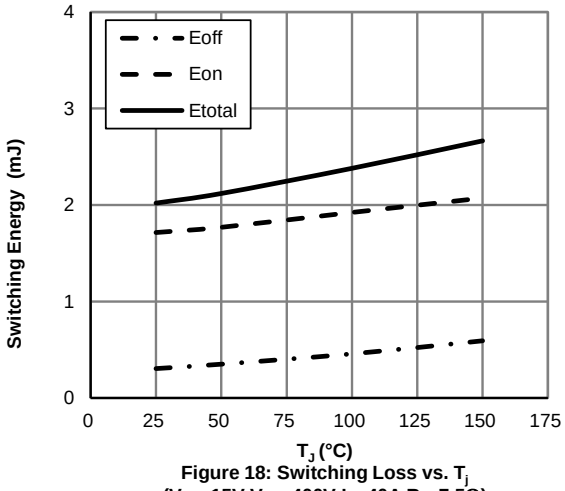


Figure 18: Switching Loss vs. T_j
(V_{GE}=15V,V_{CE}=400V,I_C=40A,R_g=7.5Ω)

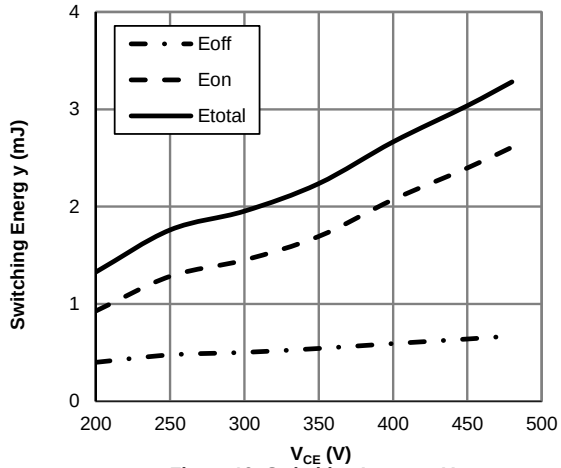


Figure 19: Switching Loss vs. V_{CE}
(T_j=150°C,V_{GE}=15V,I_C=40A,R_g=7.5Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

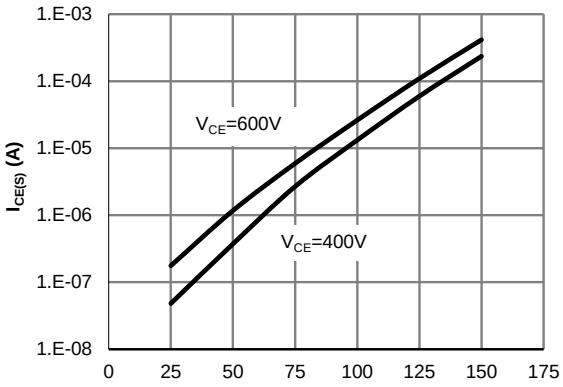


Fig 20: Diode Reverse Leakage Current vs. Junction Temperature

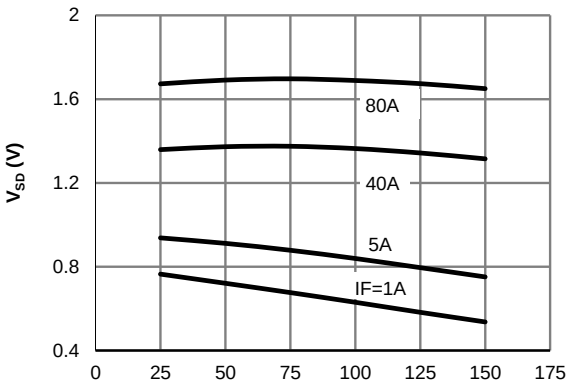


Fig 21: Diode Forward voltage vs. Junction Temperature

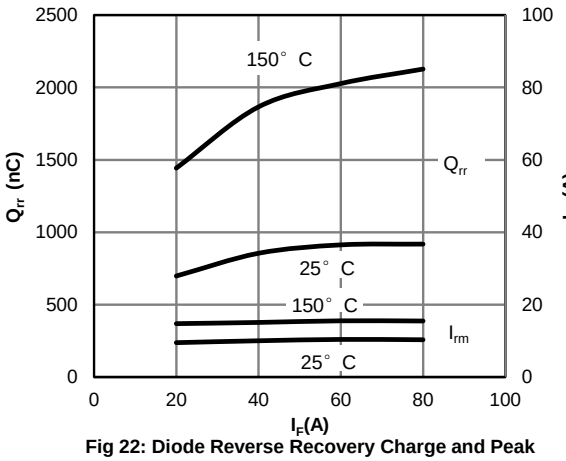


Fig 22: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

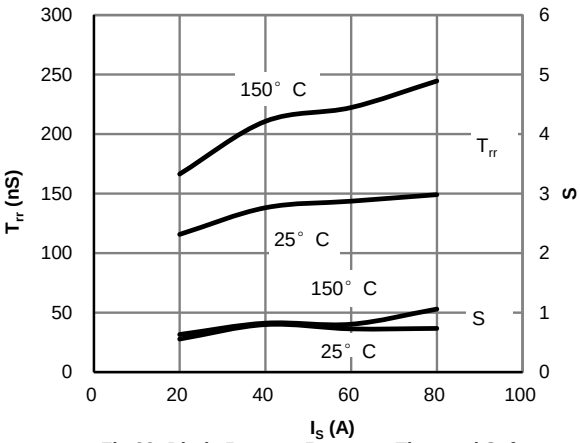


Fig 23: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V,V_{CE}=400V, di/dt=200A/µs)

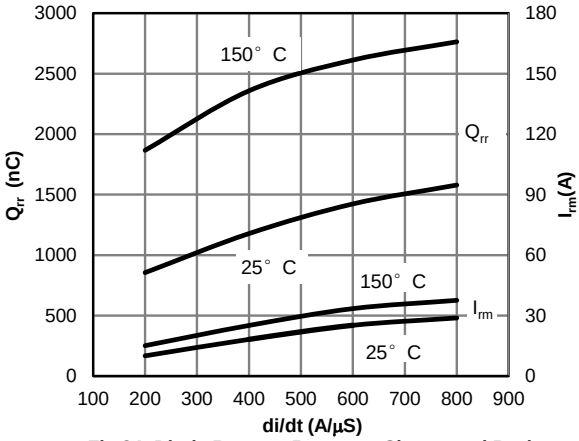


Fig 24: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=40A)

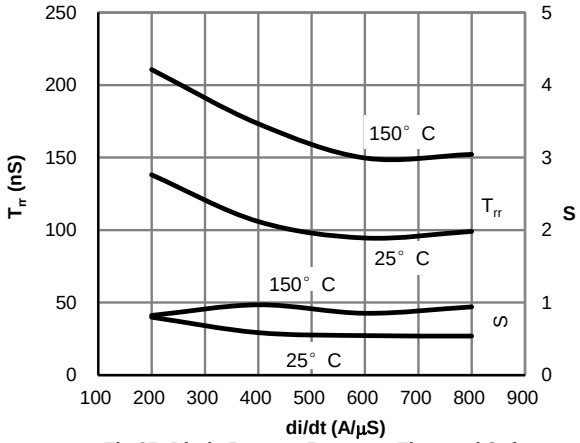


Fig 25: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=40A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

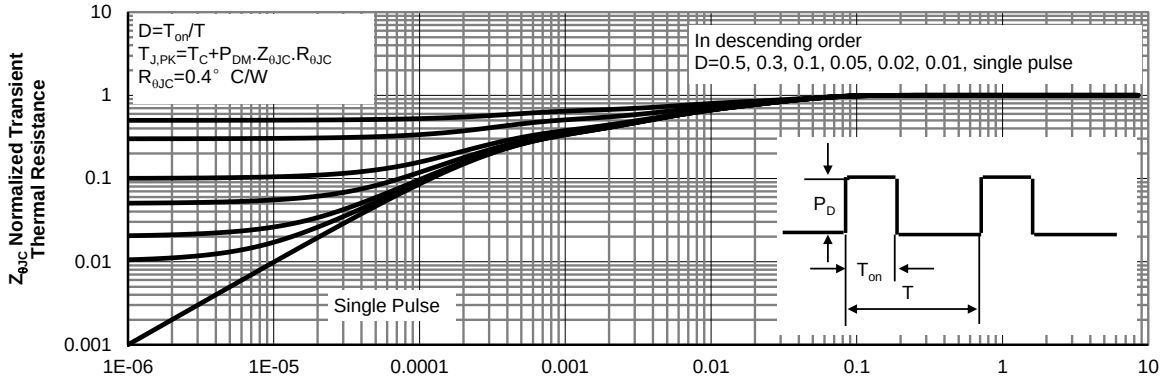


Figure 26: Normalized Maximum Transient Thermal Impedance for IGBT

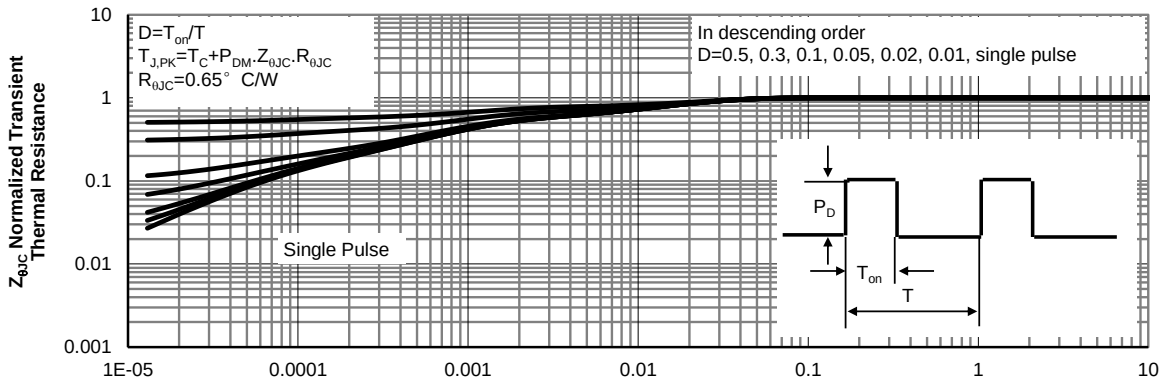
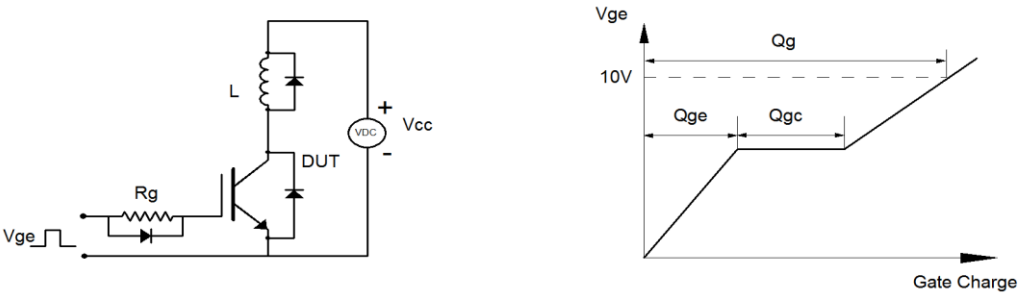
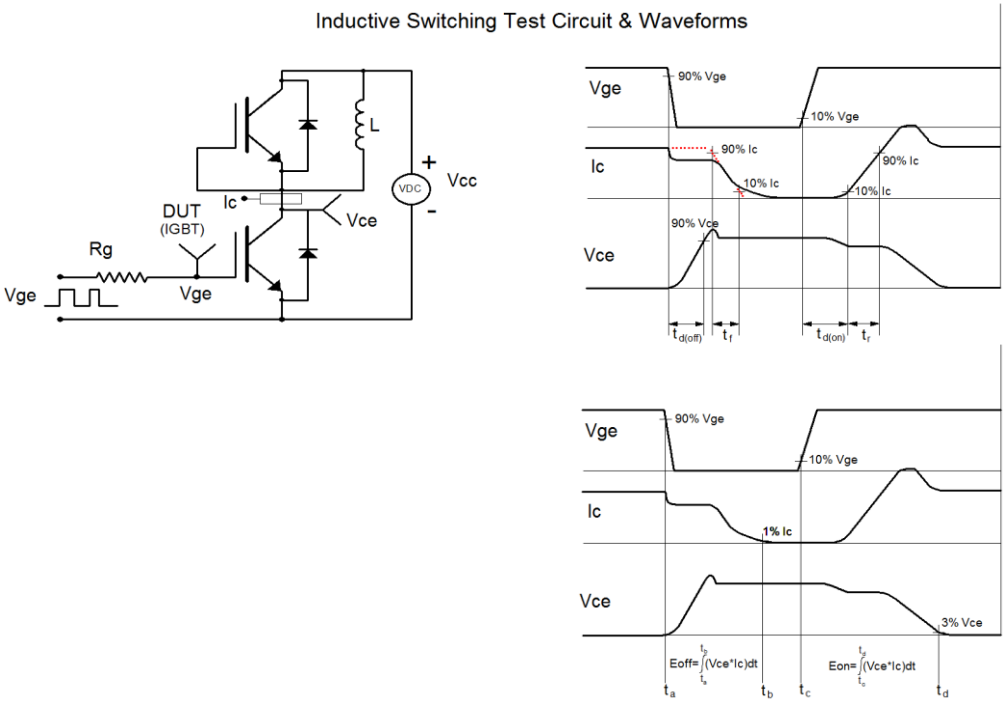


Figure 27: Normalized Maximum Transient Thermal Impedance for Diode

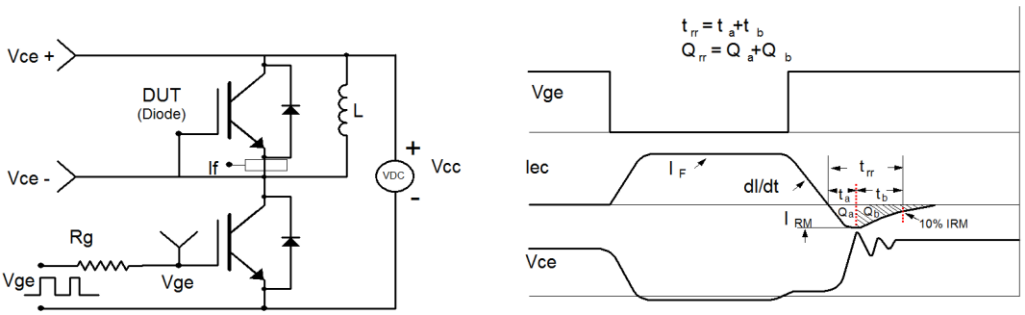
Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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