

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.

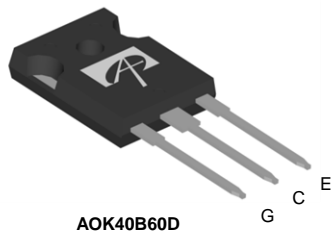
Product Summary

V_{CE}	600V
I_C ($T_C=100^\circ\text{C}$)	40A
$V_{CE(sat)}$ ($T_C=25^\circ\text{C}$)	1.6V

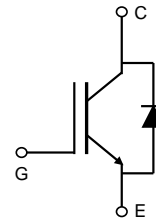


Top View

TO-247



AOK40B60D


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

Parameter	Symbol	AOK40B60D	Units
Collector-Emitter Voltage	V_{CE}	600	V
Gate-Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current	I_C	$T_C=25^\circ\text{C}$	80
		$T_C=100^\circ\text{C}$	40
Pulsed Collector Current, Limited by T_{Jmax}	I_{CM}	160	A
Turn off SOA, $V_{CE} \leq 600\text{V}$, Limited by T_{Jmax}	I_{LM}	160	A
Continuous Diode Forward Current	I_F	$T_C=25^\circ\text{C}$	40
		$T_C=100^\circ\text{C}$	20
Diode Pulsed Current, Limited by T_{Jmax}	I_{FM}	160	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	$T_C=25^\circ\text{C}$	312.5
		$T_C=100^\circ\text{C}$	125
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	AOK40B60D	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.4	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	0.65	$^\circ\text{C/W}$

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
STATIC PARAMETERS							
BV_{CES}	Collector-Emitter Breakdown Voltage	$I_C=1\text{mA}, V_{GE}=0\text{V}, T_J=25^\circ\text{C}$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15\text{V}, I_C=40\text{A}$	$T_J=25^\circ\text{C}$	-	1.6	2.1	V
			$T_J=125^\circ\text{C}$	-	1.88	-	
			$T_J=150^\circ\text{C}$	-	1.96	-	
V_F	Diode Forward Voltage	$V_{GE}=0\text{V}, I_C=40\text{A}$	$T_J=25^\circ\text{C}$	-	1.36	1.9	V
			$T_J=125^\circ\text{C}$	-	1.34	-	
			$T_J=150^\circ\text{C}$	-	1.31	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=5\text{V}, I_C=1\text{mA}$	-	5.5	-	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
			$T_J=125^\circ\text{C}$	-	-	800	
			$T_J=150^\circ\text{C}$	-	-	4000	
I_{GES}	Gate-Emitter leakage current	$V_{CE}=0\text{V}, V_{GE}=\pm 20\text{V}$	-	-	± 100	nA	
g_{FS}	Forward Transconductance	$V_{CE}=20\text{V}, I_C=40\text{A}$	-	21	-	S	
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	$V_{GE}=0\text{V}, V_{CE}=25\text{V}, f=1\text{MHz}$	-	2584	-	pF	
C_{oes}	Output Capacitance		-	303	-	pF	
C_{res}	Reverse Transfer Capacitance		-	9.2	-	pF	
Q_g	Total Gate Charge	$V_{GE}=15\text{V}, V_{CE}=480\text{V}, I_C=40\text{A}$	-	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 $\geq 1.0\text{s}$	$V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_G=25\Omega$	-	160	-	A	
R_g	Gate resistance	$V_{GE}=0\text{V}, V_{CE}=0\text{V}, f=1\text{MHz}$	-	1.45	-	Ω	
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On Delay Time	$T_J=25^\circ\text{C}$ $V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A},$ $R_G=7.5\Omega,$ 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		$T_J=25^\circ\text{C}$	-	138	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=40\text{A}, di/dt=200\text{A}/\mu\text{s}, V_{CE}=400\text{V}$	-	0.86	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	10	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)							
$t_{D(on)}$	Turn-On Delay Time	$T_J=150^\circ\text{C}$ $V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A},$ $R_G=7.5\Omega,$ 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		$T_J=150^\circ\text{C}$	-	210	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=40\text{A}, di/dt=200\text{A}/\mu\text{s}, V_{CE}=400\text{V}$	-	1.87	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	15	-	A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

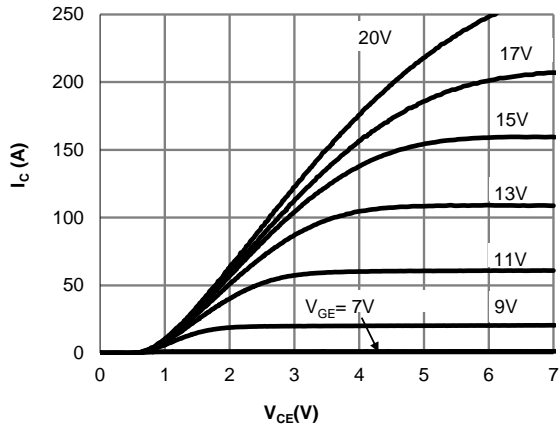


Fig 1: Output Characteristic
($T_j=25^{\circ}\text{C}$)

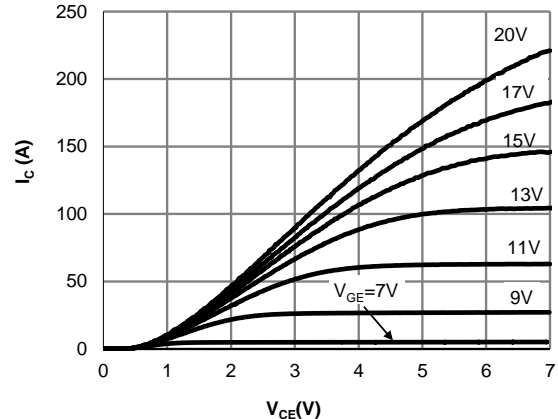


Fig 2: Output Characteristic
($T_j=150^{\circ}\text{C}$)

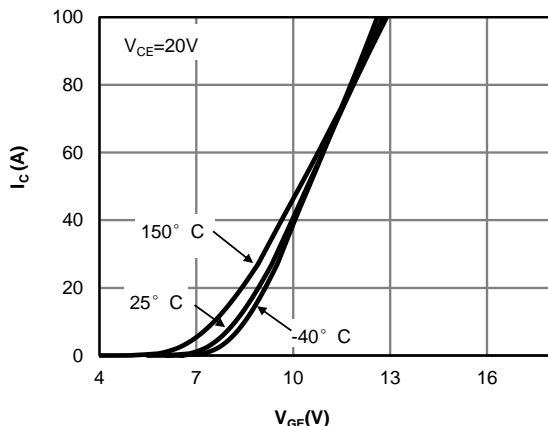


Fig 3: Transfer Characteristic

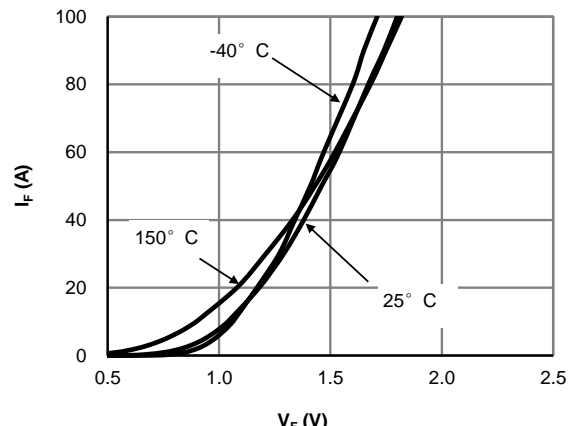


Fig 4: Diode Characteristic

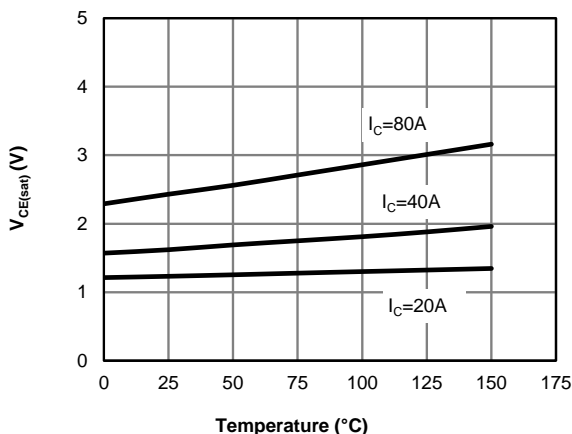


Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

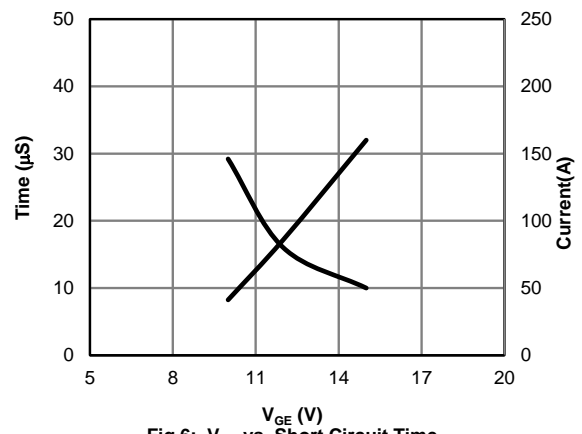


Fig 6: V_{GE} vs. Short Circuit Time
($V_{CE}=400\text{V}, T_C=25^{\circ}\text{C}$)

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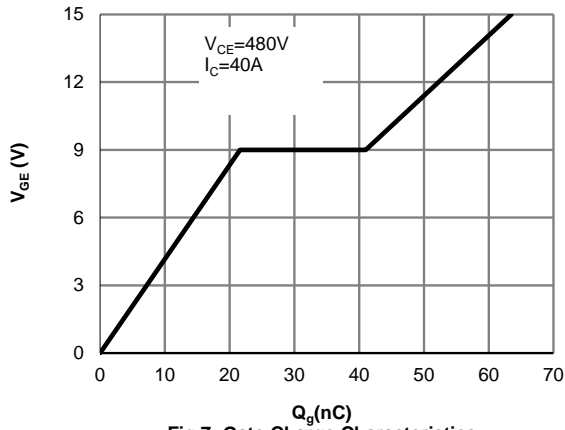


Fig 7: Gate-Charge Characteristics

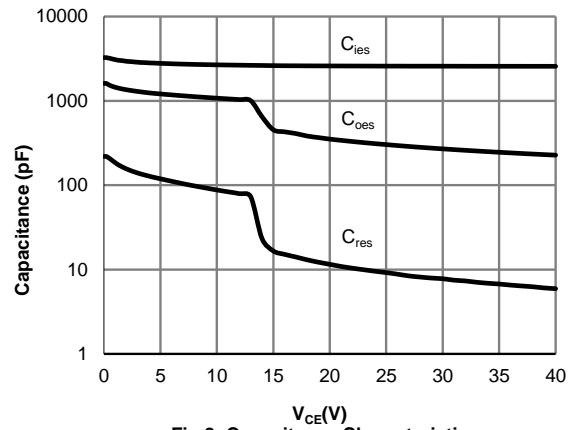


Fig 8: Capacitance Characteristic

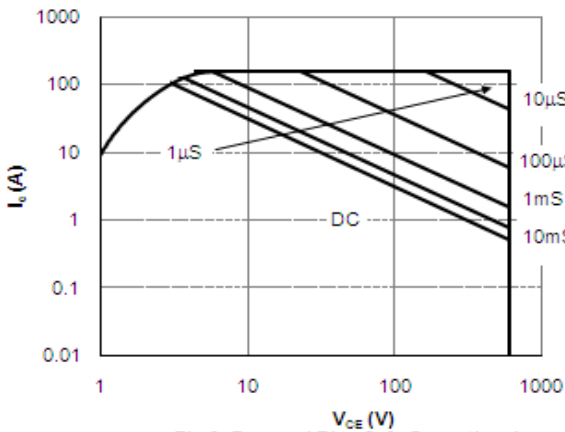


Fig 9: Forward Bias Safe Operating Area
($T_C=25^\circ\text{C}, V_{GE}=15\text{V}$)

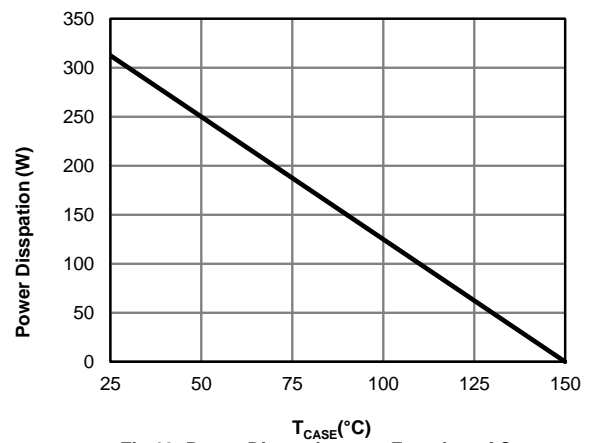


Fig 10: Power Dissipation as a Function of Case

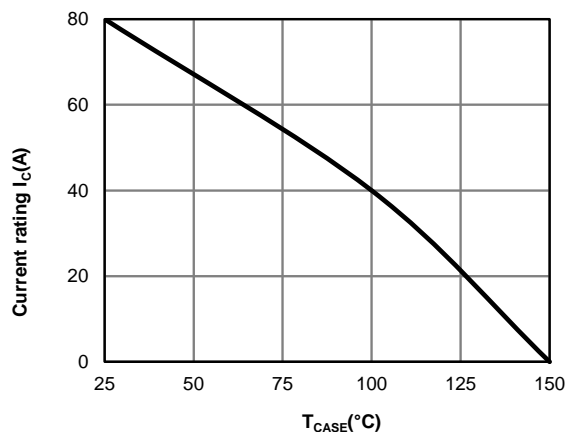
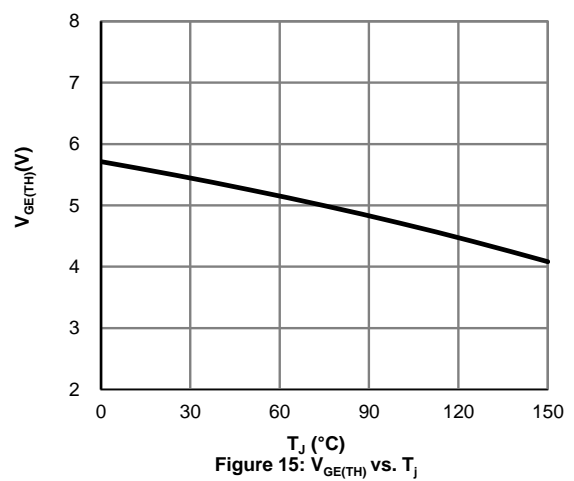
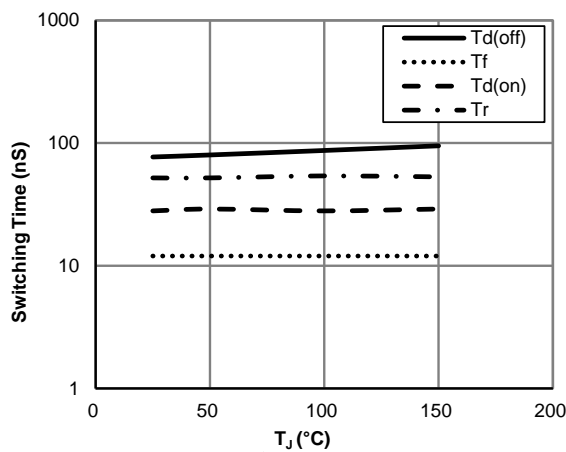
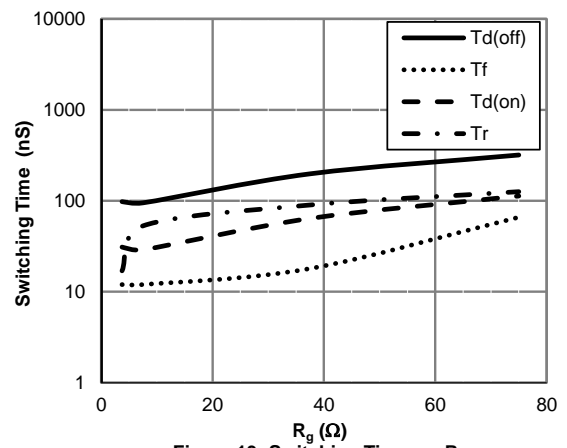
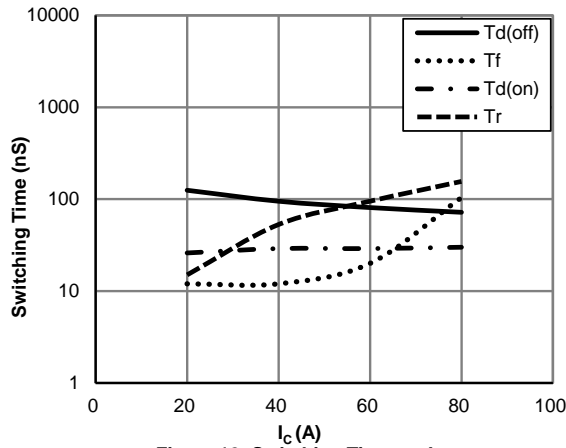


Fig 11: Current De-rating

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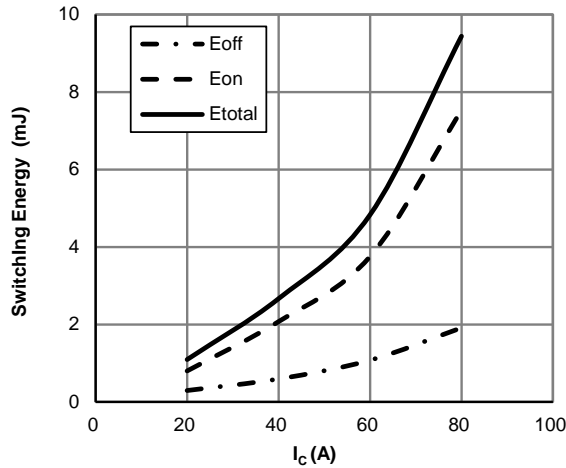


Figure 16: Switching Loss vs. I_C
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=7.5\Omega$)

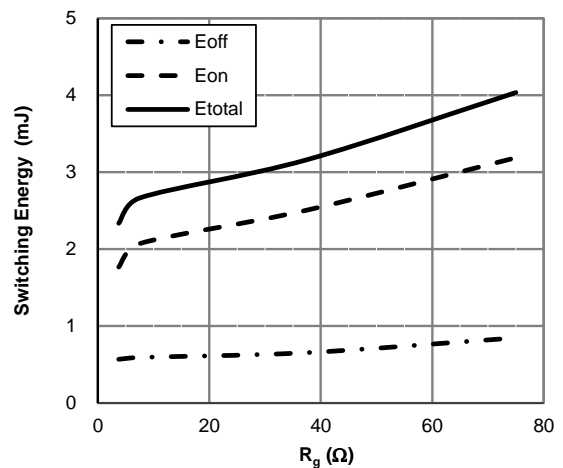


Figure 17: Switching Loss vs. R_g
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A}$)

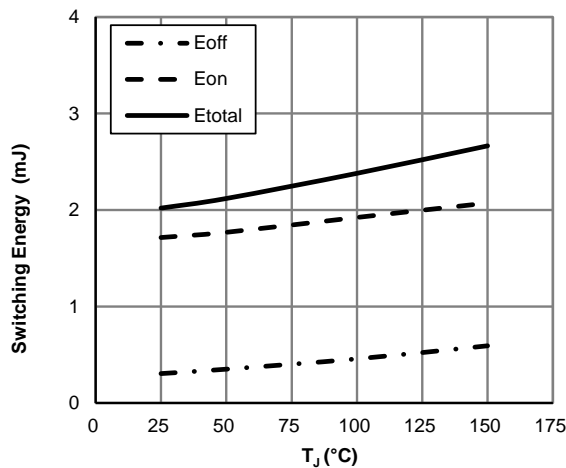


Figure 18: Switching Loss vs. T_J
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A}, R_g=7.5\Omega$)

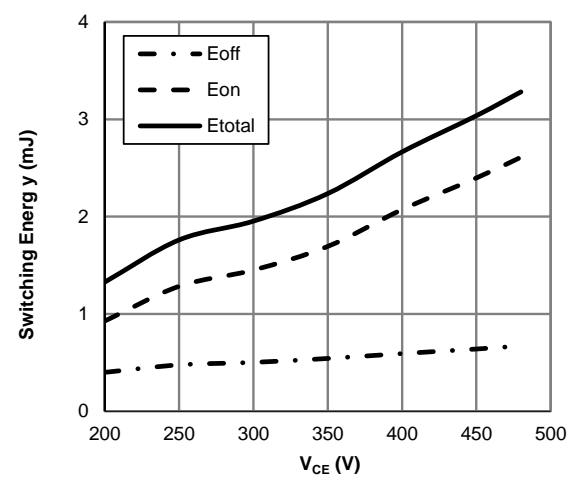


Figure 19: Switching Loss vs. V_{CE}
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, I_C=40\text{A}, R_g=7.5\Omega$)

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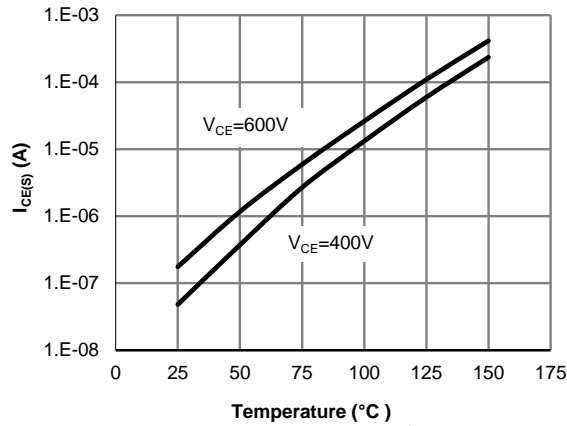


Fig 20: Diode Reverse Leakage Current vs. Junction Temperature

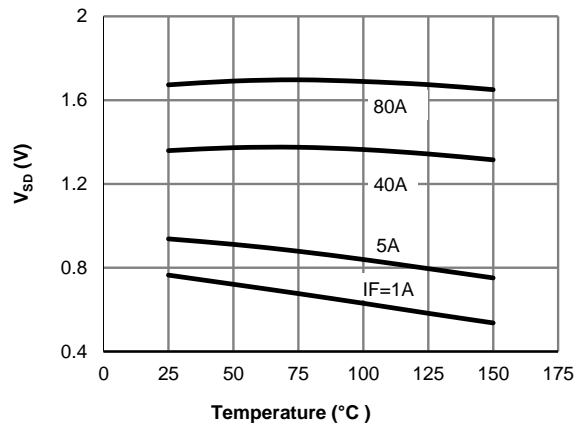


Fig 21: Diode Forward voltage vs. Junction Temperature

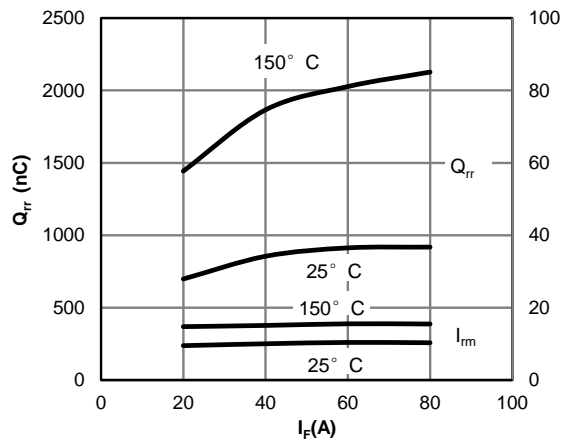


Fig 22: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

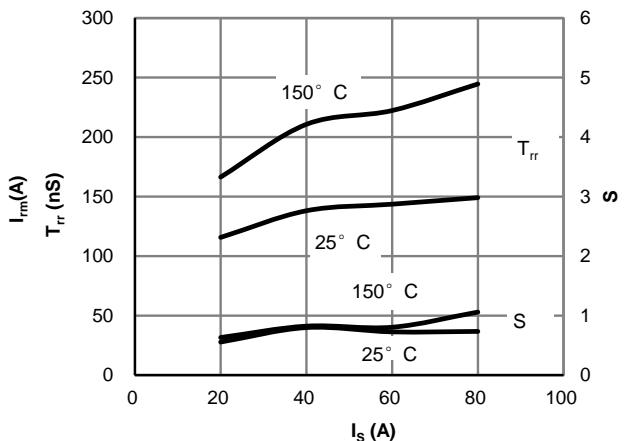


Fig 23: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

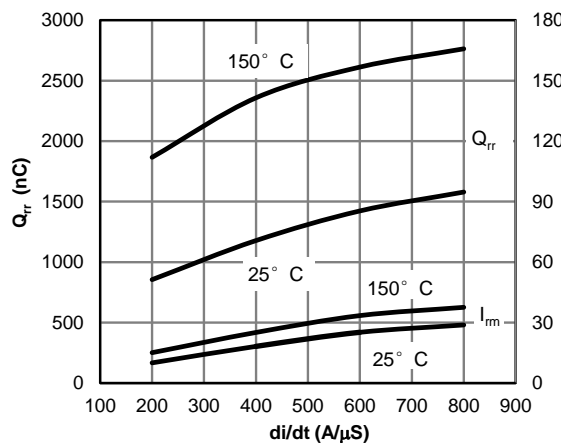


Fig 24: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=40A$)

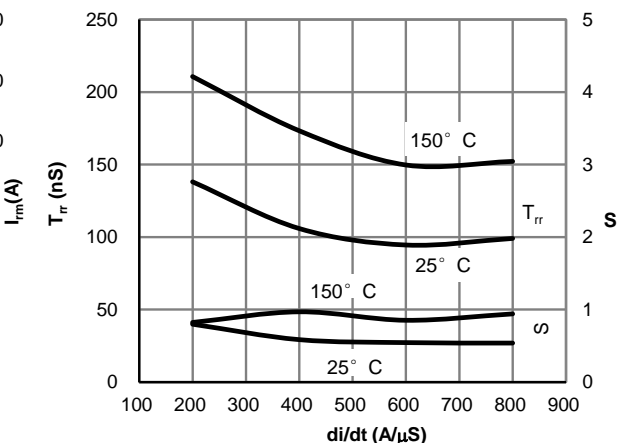


Fig 25: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=40A$)

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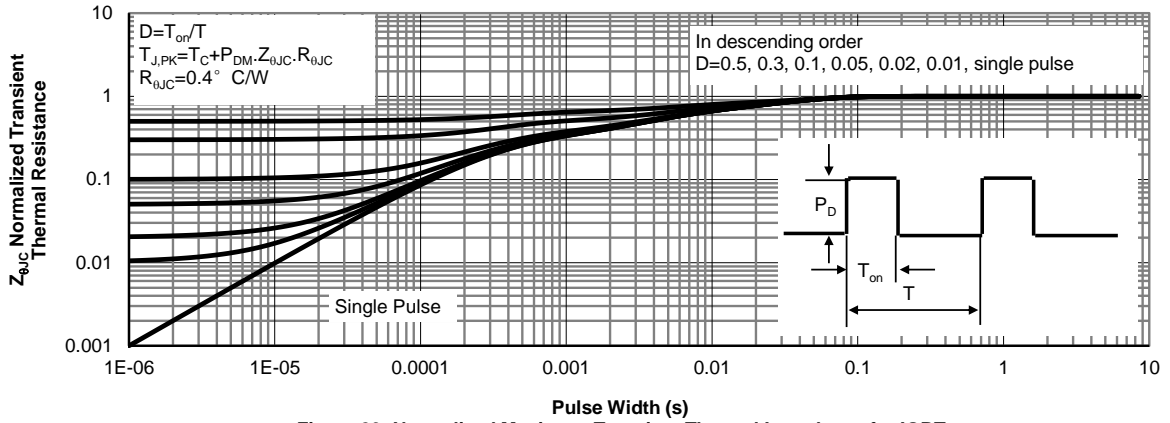


Figure 26: Normalized Maximum Transient Thermal Impedance for IGBT

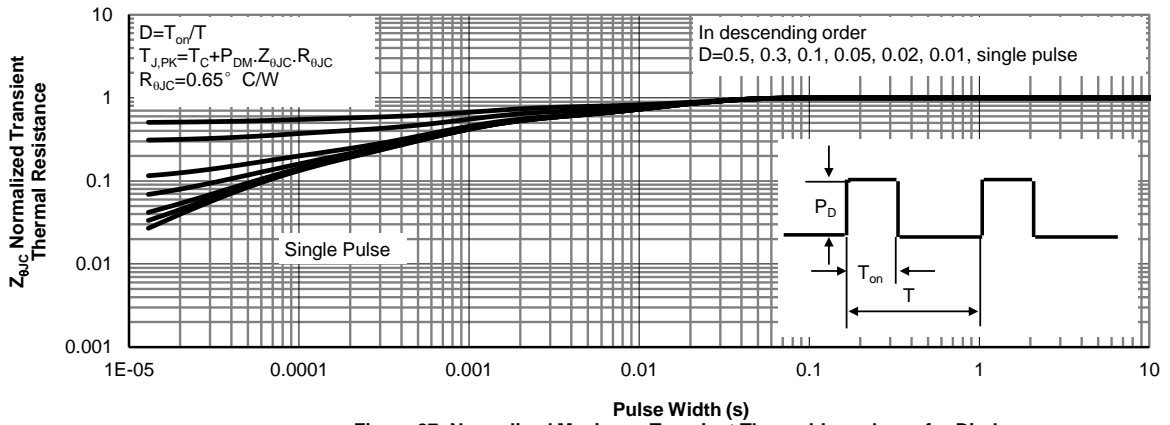
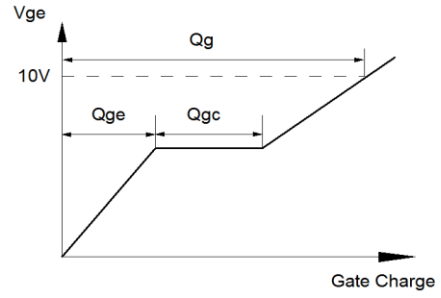
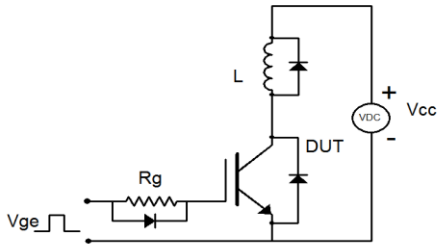
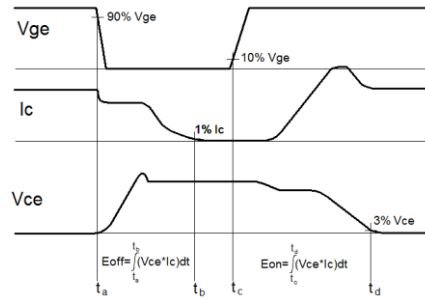
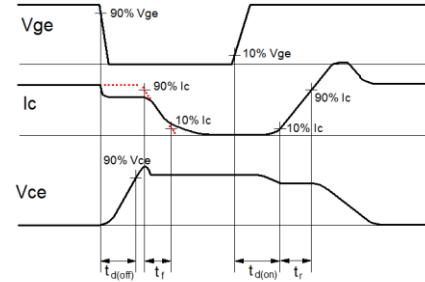
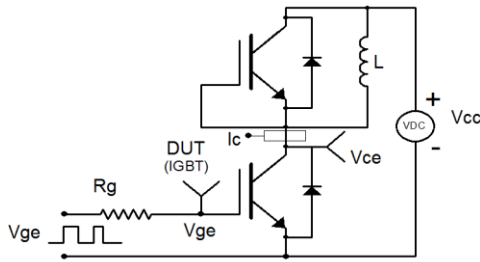


Figure 27: Normalized Maximum Transient Thermal Impedance for Diode

Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms

