



**THE DATASHEET OF
AOK40B60D1**



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.

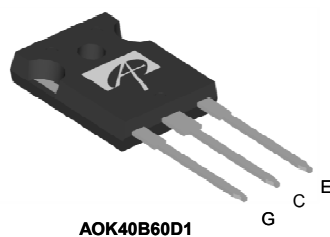
Product Summary

V_{CE}	600V
I_C ($T_C=100^\circ\text{C}$)	40A
$V_{CE(sat)}$ ($T_C=25^\circ\text{C}$)	1.85V

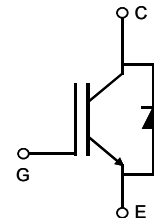


Top View

TO-247



AOK40B60D1



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

Parameter	Symbol	AOK40B60D1	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	I_C	$T_C=25^\circ\text{C}$	80	A
		$T_C=100^\circ\text{C}$	40	
Pulsed Collector Current, Limited by T_{Jmax}	I_{CM}	140	A	
Turn off SOA, $V_{CE} \leq 600\text{V}$, Limited by T_{Jmax}	I_{LM}	140	A	
Continuous Diode Forward Current	I_F	$T_C=25^\circ\text{C}$	40	A
		$T_C=100^\circ\text{C}$	20	
Diode Pulsed Current, Limited by T_{Jmax}	I_{FM}	140	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	$T_C=25^\circ\text{C}$	278	W
		$T_C=100^\circ\text{C}$	111	
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	AOK40B60D1	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.45	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
STATIC PARAMETERS							
BV_{CES}	Collector-Emitter Breakdown Voltage	$I_C=1mA, V_{GE}=0V, T_J=25^\circ C$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15V, I_C=40A$	$T_J=25^\circ C$	-	1.85	2.4	V
			$T_J=125^\circ C$	-	2.2	-	
			$T_J=150^\circ C$	-	2.3	-	
V_F	Diode Forward Voltage	$V_{GE}=0V, I_C=20A$	$T_J=25^\circ C$	-	1.42	1.95	V
			$T_J=125^\circ C$	-	1.4	-	
			$T_J=150^\circ C$	-	1.36	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=5V, I_C=1mA$	-	5.5	-	V	
I_{CES}	Zero Gate Voltage Collector Current	$V_{CE}=600V, V_{GE}=0V$	$T_J=25^\circ C$	-	-	10	μA
			$T_J=125^\circ C$	-	-	600	
			$T_J=150^\circ C$	-	-	3000	
I_{GES}	Gate-Emitter leakage current	$V_{CE}=0V, V_{GE}=\pm 20V$	-	-	±100	nA	
g_{FS}	Forward Transconductance	$V_{CE}=20V, I_C=40A$	-	16	-	S	
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	$V_{GE}=0V, V_{CE}=25V, f=1MHz$	-	1950	-	pF	
C_{oes}	Output Capacitance		-	250	-	pF	
C_{res}	Reverse Transfer Capacitance		-	9	-	pF	
Q_g	Total Gate Charge	$V_{GE}=15V, V_{CE}=480V, I_C=40A$	-	45	-	nC	
Q_{ge}	Gate to Emitter Charge		-	17	-	nC	
Q_{gc}	Gate to Collector Charge		-	15.6	-	nC	
$I_{C(SC)}$	Short circuit collector current, Max. 1000 short circuits, Delay between short circuits ≥ 1.0s	$V_{GE}=15V, V_{CE}=400V, R_G=25\Omega$	-	140	-	A	
R_g	Gate resistance	$f=1MHz$	-	1.45	-	Ω	
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	$T_J=25^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=40A,$ $R_G=7.5\Omega,$ Parasitic Inductance=150nH	-	29	-	ns	
t_r	Turn-On Rise Time		-	22	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	74	-	ns	
t_f	Turn-Off Fall Time		-	15	-	ns	
E_{on}	Turn-On Energy		-	1.55	-	mJ	
E_{off}	Turn-Off Energy		-	0.3	-	mJ	
E_{total}	Total Switching Energy		-	1.85	-	mJ	
t_{rr}	Diode Reverse Recovery Time		$T_J=25^\circ C$	-	127	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=20A, di/dt=200A/\mu s, V_{CE}=400V$	-	0.63	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	8	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)							
$t_{D(on)}$	Turn-On DelayTime	$T_J=150^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=40A,$ $R_G=7.5\Omega,$ Parasitic Inductance=150nH	-	29	-	ns	
t_r	Turn-On Rise Time		-	24	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	85	-	ns	
t_f	Turn-Off Fall Time		-	17	-	ns	
E_{on}	Turn-On Energy		-	1.7	-	mJ	
E_{off}	Turn-Off Energy		-	0.49	-	mJ	
E_{total}	Total Switching Energy		-	2.19	-	mJ	
t_{rr}	Diode Reverse Recovery Time		$T_J=150^\circ C$	-	204	-	ns
Q_{rr}	Diode Reverse Recovery Charge		$I_F=20A, di/dt=200A/\mu s, V_{CE}=400V$	-	1.2	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	11	-	A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

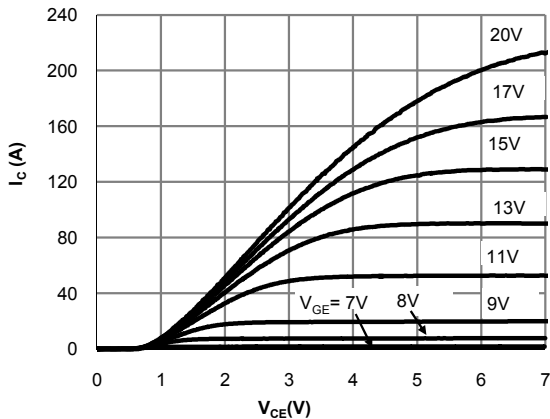


Fig 1: Output Characteristic
($T_J=25^\circ\text{C}$)

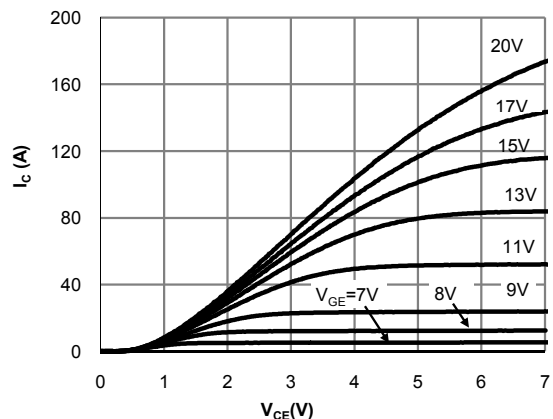


Fig 2: Output Characteristic
($T_J=150^\circ\text{C}$)

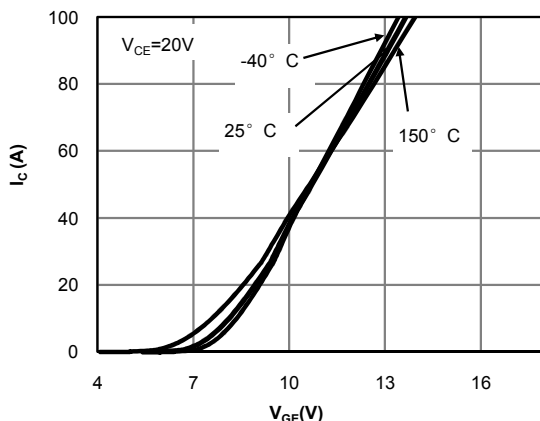


Fig 3: Transfer Characteristic

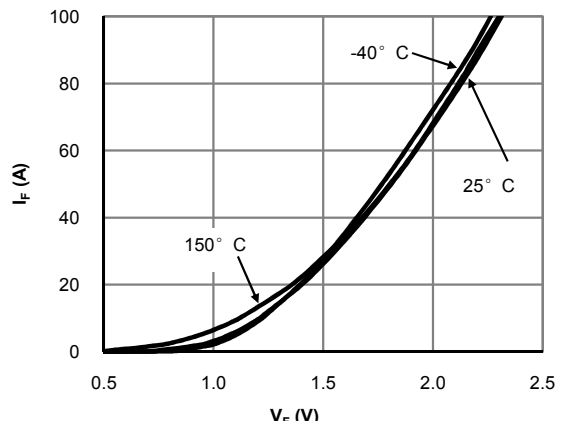


Fig 4: Diode Characteristic

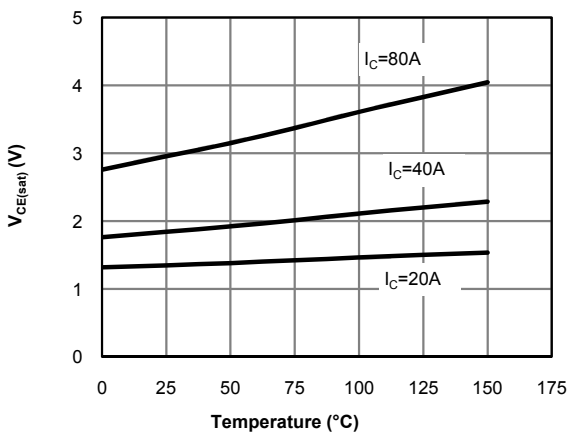


Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

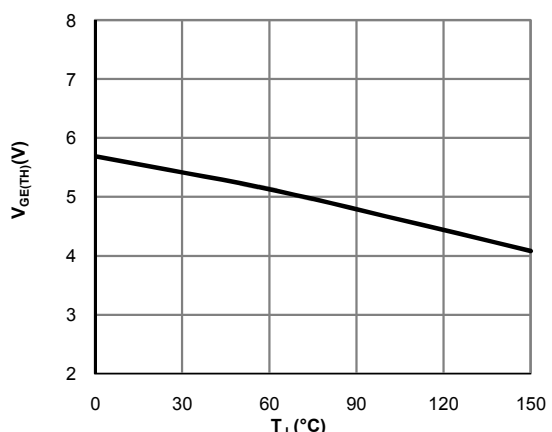


Figure 6: $V_{GE(TH)}$ vs. T_J

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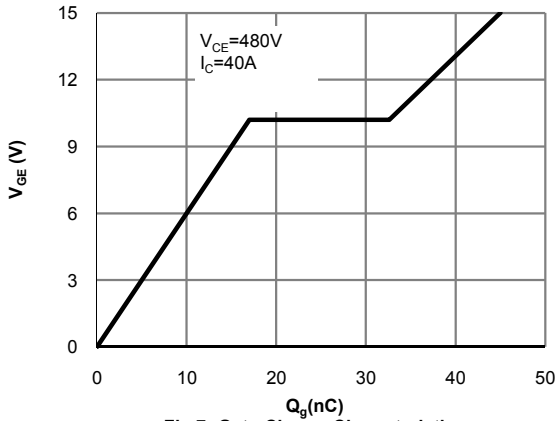


Fig 7: Gate-Charge Characteristics

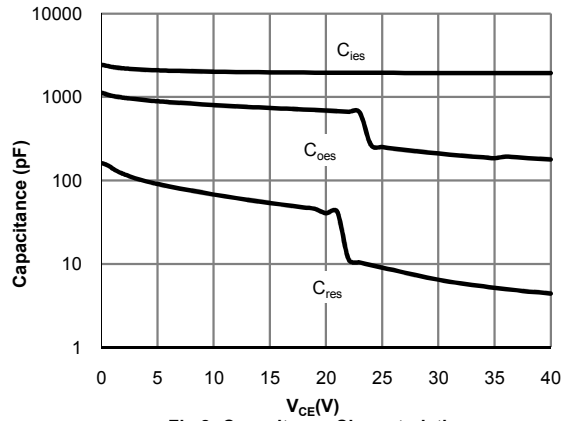


Fig 8: Capacitance Characteristic

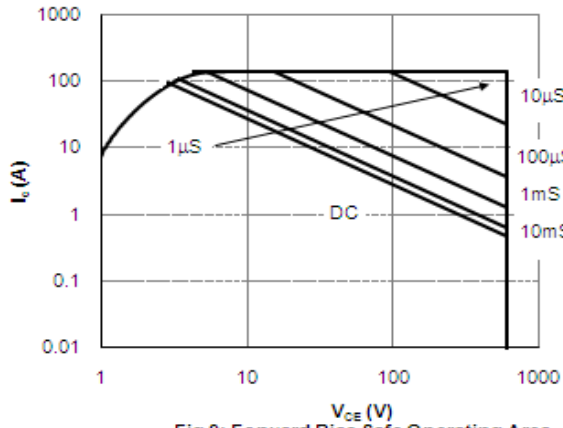


Fig 9: Forward Bias Safe Operating Area
($T_C=25^\circ\text{C}, V_{GE}=15\text{V}$)

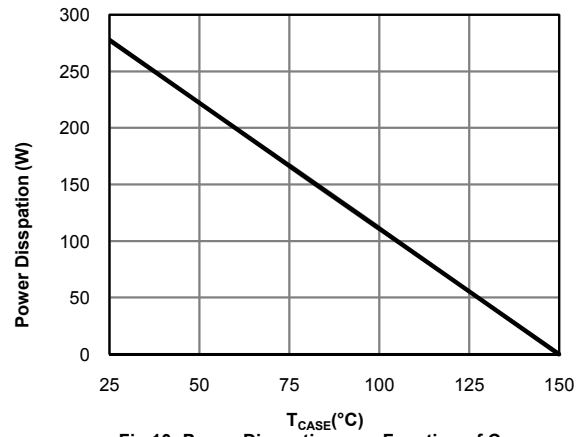


Fig 10: Power Dissipation as a Function of Case

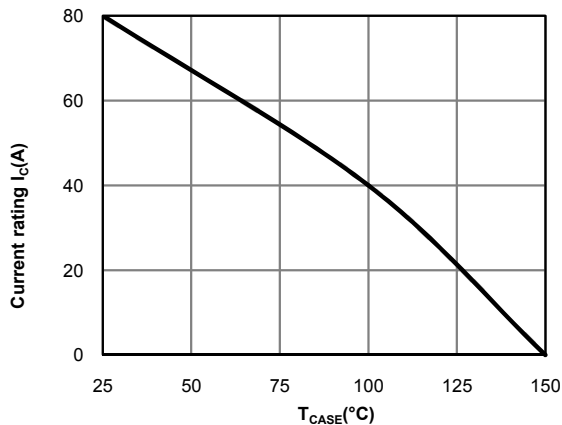


Fig 11: Current De-rating

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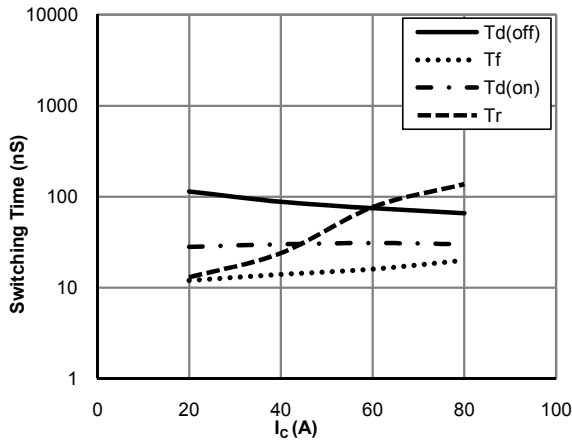


Figure 12: Switching Time vs. I_c
($T_j=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=7.5\Omega$)

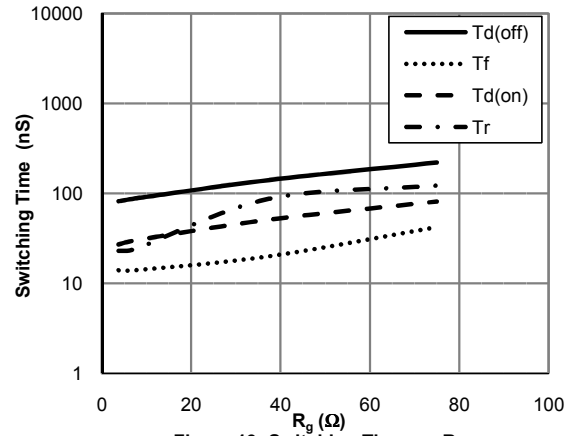


Figure 13: Switching Time vs. R_g
($T_j=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}$)

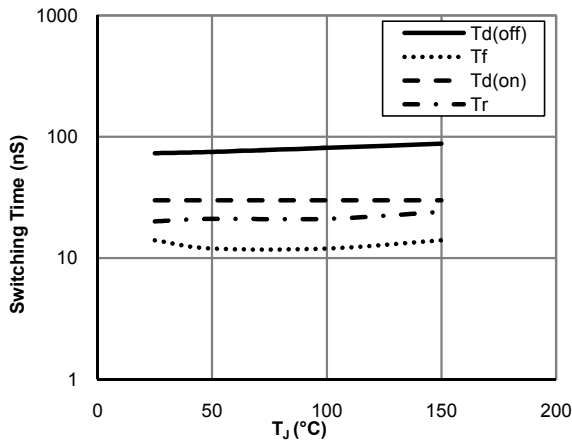


Figure 14: Switching Time vs. T_j
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=40\text{A}, R_g=7.5\Omega$)

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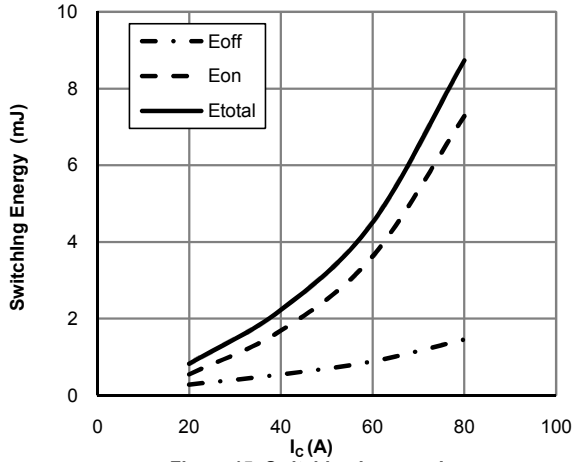


Figure 15: Switching Loss vs. I_C
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=7.5\Omega$)

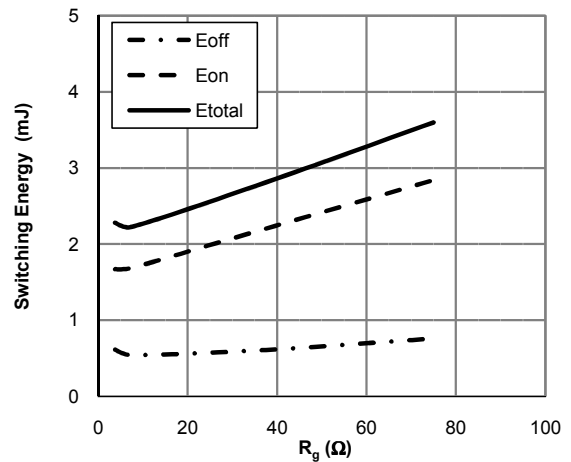


Figure 16: Switching Loss vs. R_g
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A}$)

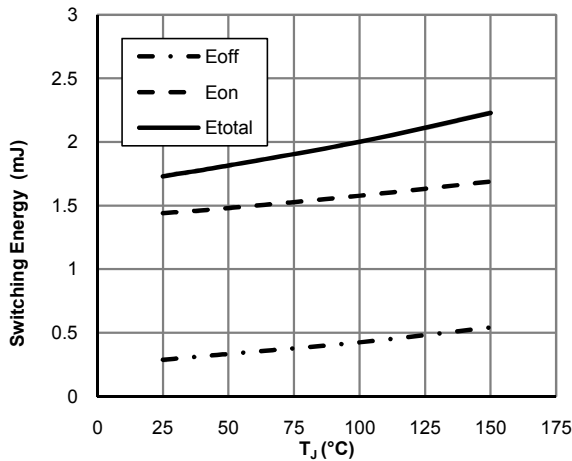


Figure 17: Switching Loss vs. T_J
($V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=40\text{A}, R_g=7.5\Omega$)

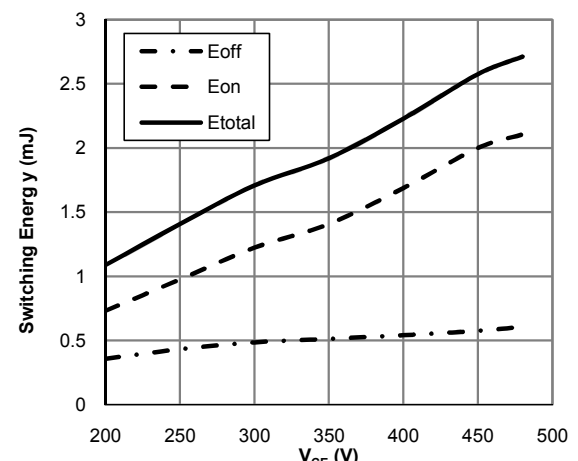


Figure 18: Switching Loss vs. V_{CE}
($T_J=150^\circ\text{C}, V_{GE}=15\text{V}, I_C=40\text{A}, R_g=7.5\Omega$)

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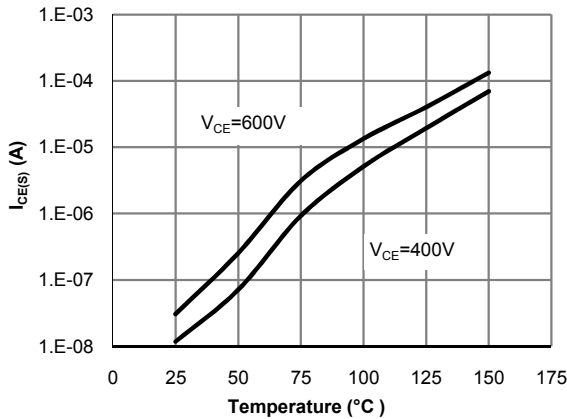


Fig 19: Diode Reverse Leakage Current vs. Junction Temperature

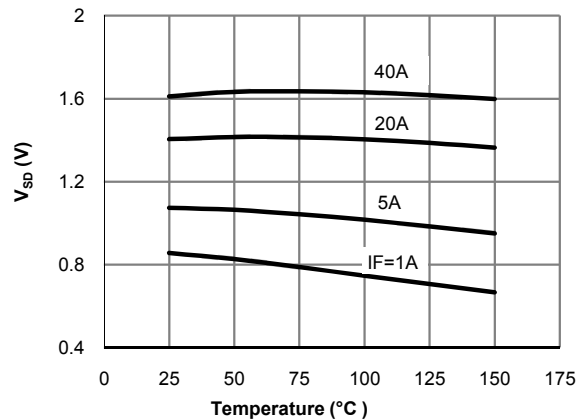


Fig 20: Diode Forward Voltage vs. Junction Temperature

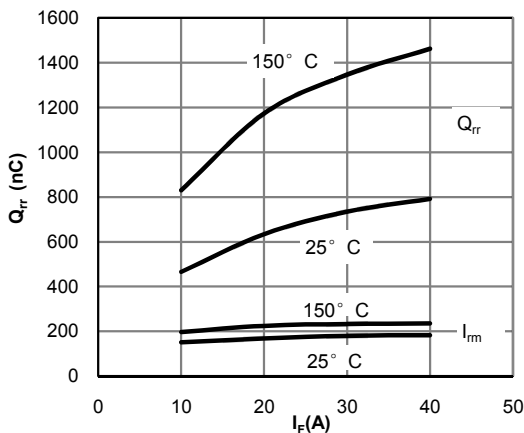


Fig 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

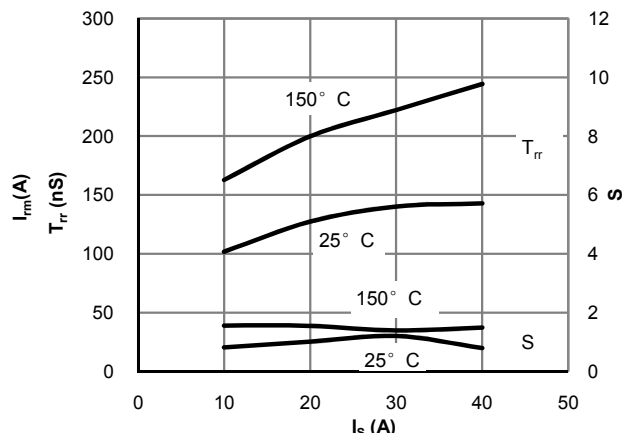


Fig 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

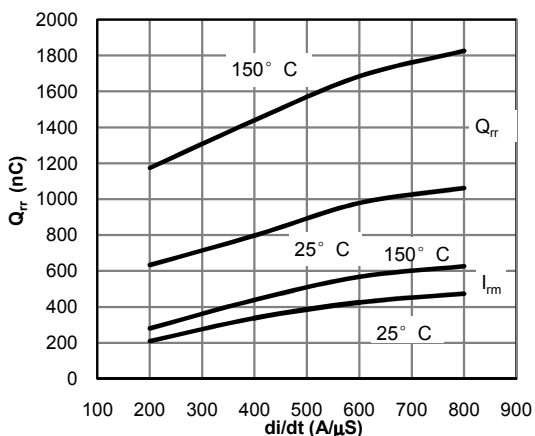


Fig 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=20A$)

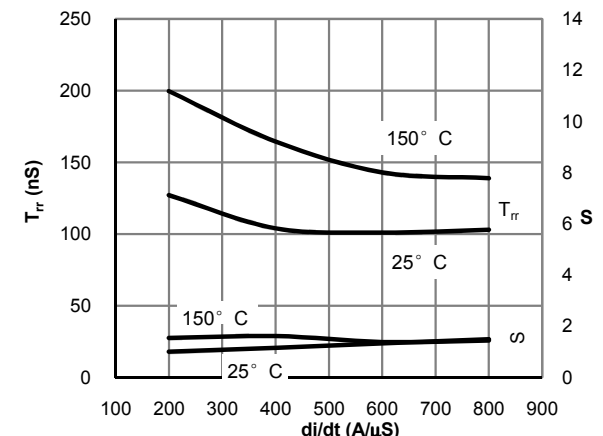


Fig 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=20A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

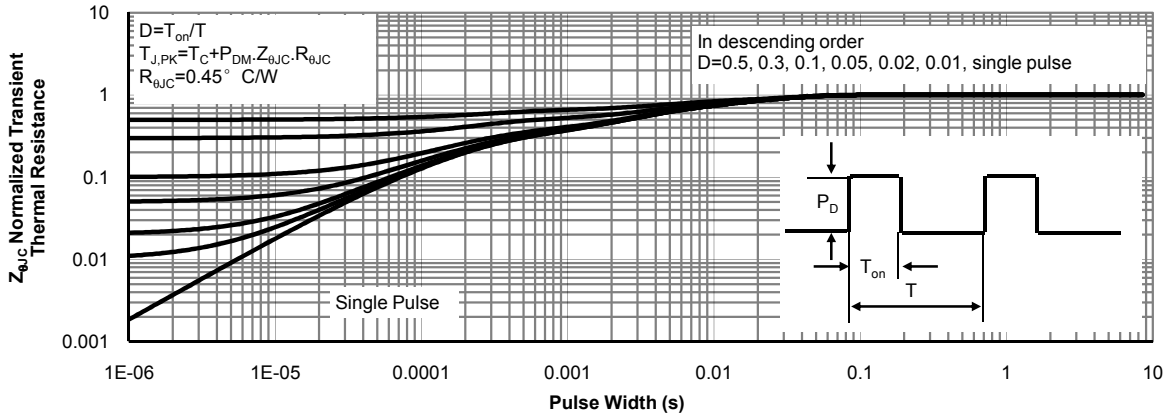


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

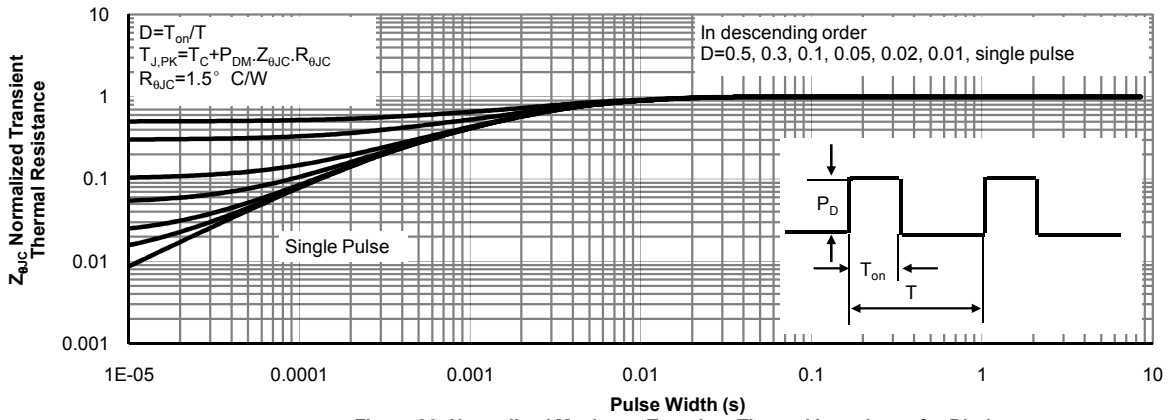
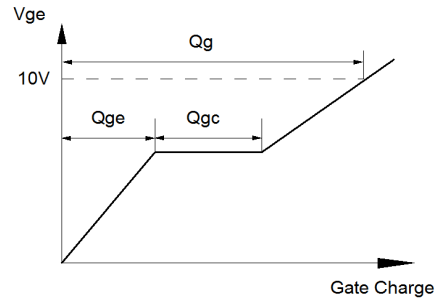
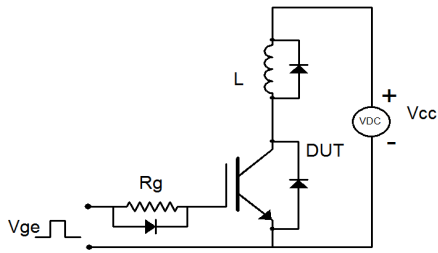
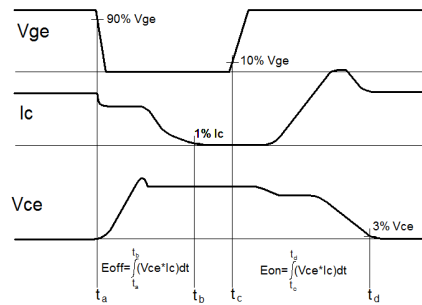
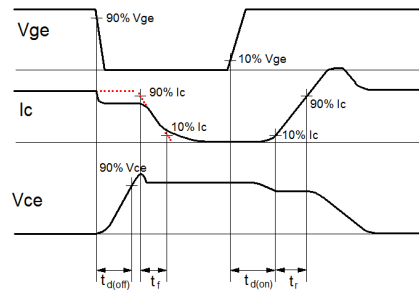
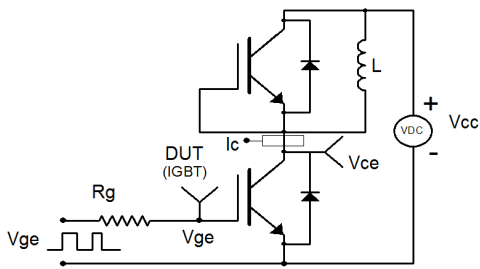


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

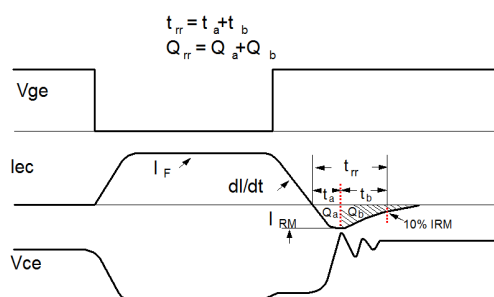
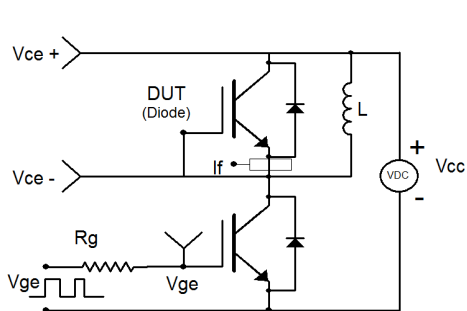
Gate Charge Test Circuit & Waveform



Inductive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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