AOK40B65GQ1

650V, 40A AlphaIGBT™

With Soft and Fast Recovery Anti-Parallel Diode

ALPHA & OMEGA SEMICONDUCTOR

General Description

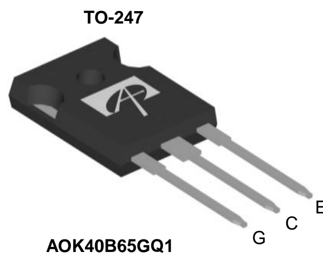
- Latest AlphaIGBT (αIGBT) technology
- 650V breakdown voltage
- Low $V_{CE(sat)}$
- Low switching losses and softness

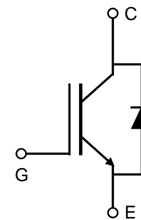
Product Summary

V_{CE}	650V
I_C (T_C=100°C)	40A
$V_{CE(sat)}$ (T_J=25°C)	1.85V

Applications

- Power factor correction
- High frequency resonant converters





Orderable Part Number	Package Type	Form	Minimum Order Quantity
AOK40B65GQ1	TO247	Tube	240

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	AOK40B65GQ1	Units
Collector-Emitter Voltage		V_{CE}	650	V
Gate-Emitter Voltage		V_{GE}	±30	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}	120	A
Turn-Off SOA, V_{CE} ≤ 650V, Limited by T_{Jmax}		I_{LM}	120	A
Continuous Diode Forward Current	T_C=25°C	I_F	20	A
	T_C=100°C		10	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	30	A
Power Dissipation	T_C=25°C	P_D	227	W
	T_C=100°C		113	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C
Maximum Lead Temperature for Soldering Purpose, 1/8" from case for 5 seconds		T_L	300	°C

Thermal Characteristics

Parameter	Symbol	Typical	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	°C/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.66	°C/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	2.78	°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		650	-	-	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE}=15V, I_C=40A	T_J=25°C	-	1.85	2.4	V
			T_J=125°C	-	2.11	-	
			T_J=175°C	-	2.28	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_F=10A	T_J=25°C	-	1.65	2.1	V
			T_J=125°C	-	1.76	-	
			T_J=175°C	-	1.7	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=5V, I_C=1mA		-	6	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE}=650V, V_{GE}=0V	T_J=25°C	-	-	10	μA
			T_J=125°C	-	-	500	
			T_J=175°C	-	-	5000	
I_{GES}	Gate-Emitter Leakage Current	V_{CE}=0V, V_{GE}=±30V		-	-	±100	nA
g_{FS}	Forward Transconductance	V_{CE}=20V, I_C=40A		-	29	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CC}=25V, f=1MHz		-	2565	-	pF
C_{oes}	Output Capacitance			-	65	-	pF
C_{res}	Reverse Transfer Capacitance			-	45	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CC}=520V, I_C=40A		-	86	-	nC
Q_{ge}	Gate to Emitter Charge			-	24	-	nC
Q_{gc}	Gate to Collector Charge			-	35	-	nC
R_g	Gate Resistance	V_{GE}=0V, V_{CC}=0V, f=1MHz		-	0.8	-	Ω
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On Delay Time	T_J=25°C V_{GE}=15V, V_{CC}=400V, I_C=20A, $R_{g(on)}$=7.5Ω, $R_{g(off)}$=47Ω		-	25.5	-	ns
t_r	Turn-On Rise Time			-	17	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	344	-	ns
t_f	Turn-Off Fall Time			-	28	-	ns
E_{on}	Turn-On Energy			-	0.44	-	mJ
E_{off}	Turn-Off Energy			-	0.43	-	mJ
E_{total}	Total Switching Energy			-	0.87	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=25°C I_F=10A, di/dt=200A/μs, V_{CC}=400V		-	106	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.24	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	3.7	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=175°C)							
$t_{D(on)}$	Turn-On Delay Time	T_J=175°C V_{GE}=15V, V_{CC}=400V, I_C=20A, $R_{g(on)}$=7.5Ω, $R_{g(off)}$=47Ω		-	24	-	ns
t_r	Turn-On Rise Time			-	19	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	391	-	ns
t_f	Turn-Off Fall Time			-	25	-	ns
E_{on}	Turn-On Energy			-	0.46	-	mJ
E_{off}	Turn-Off Energy			-	0.56	-	mJ
E_{total}	Total Switching Energy			-	1.02	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=175°C I_F=10A, di/dt=200A/μs, V_{CC}=400V		-	168	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.51	-	μC
I_{rm}	Diode Peak Reverse Recovery Current			-	5.0	-	A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

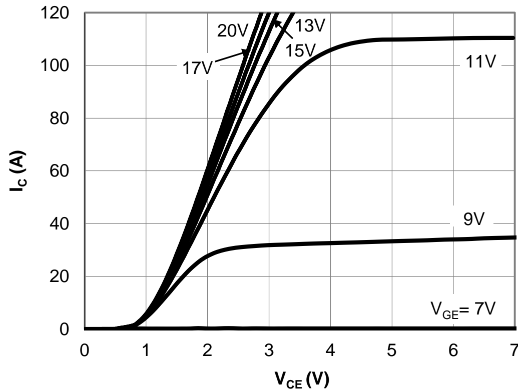

Figure 1: Output Characteristic (T_j=25°C)

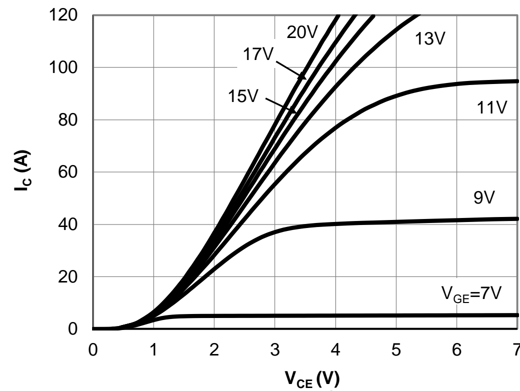

Figure 2: Output Characteristic (T_j=175°C)

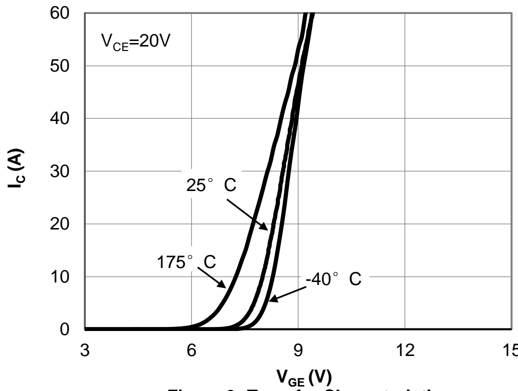

Figure 3: Transfer Characteristic

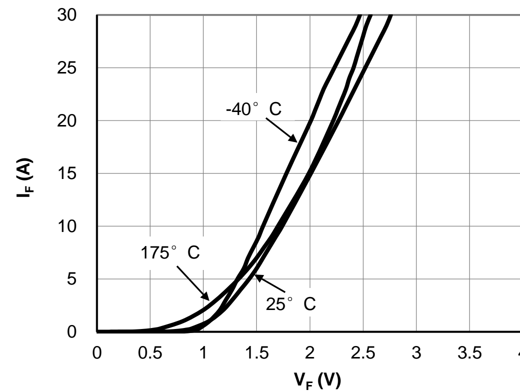

Figure 4: Diode Characteristic

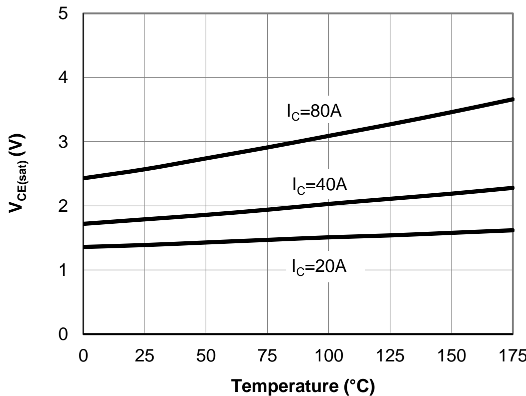

Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

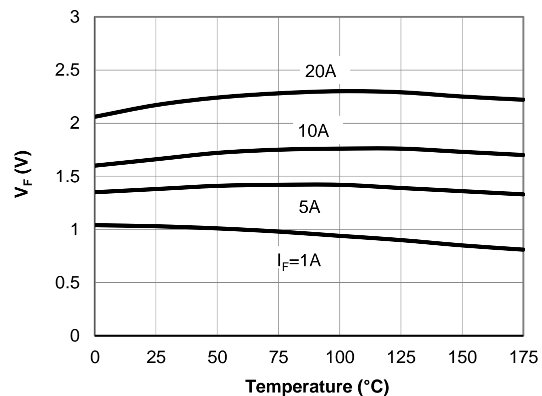

Figure 6: Diode Forward voltage vs. Junction Temperature

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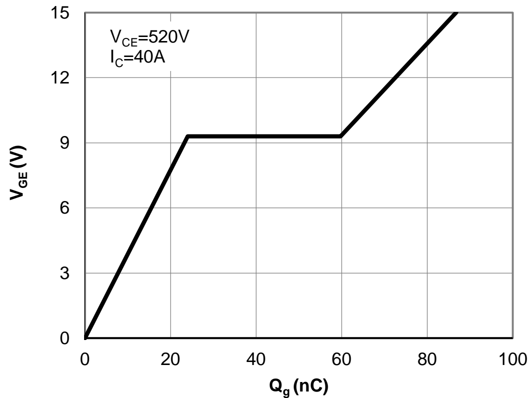

Figure 7: Gate-Charge Characteristics

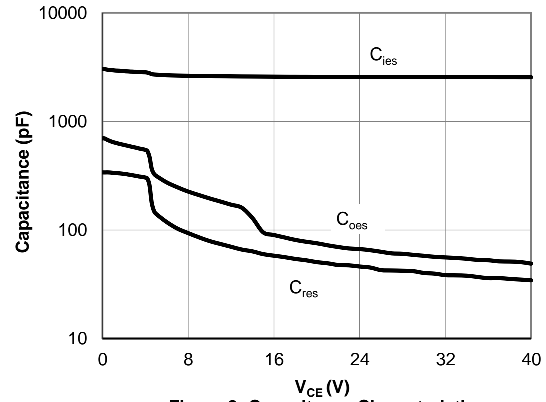

Figure 8: Capacitance Characteristic

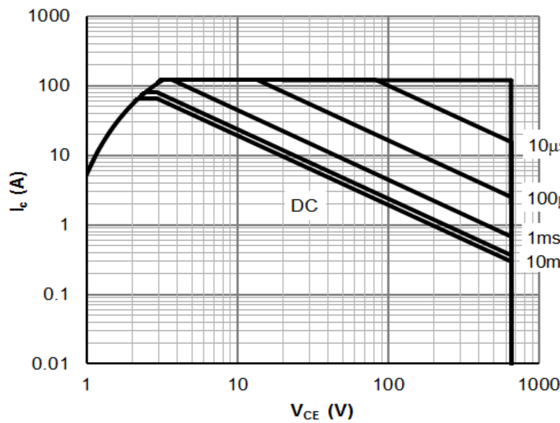

Figure 9: Forward Bias Safe Operating Area (T_C=25°C, V_{GE}=15V)

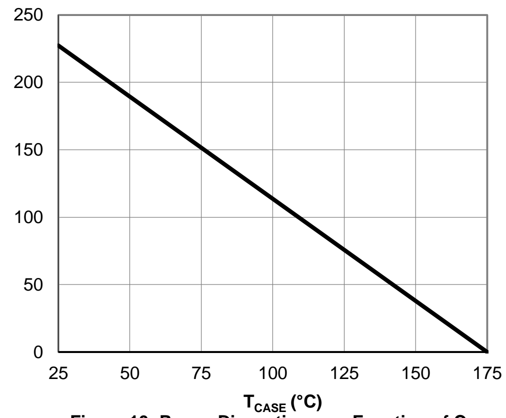

Figure 10: Power Disspation as a Function of Case

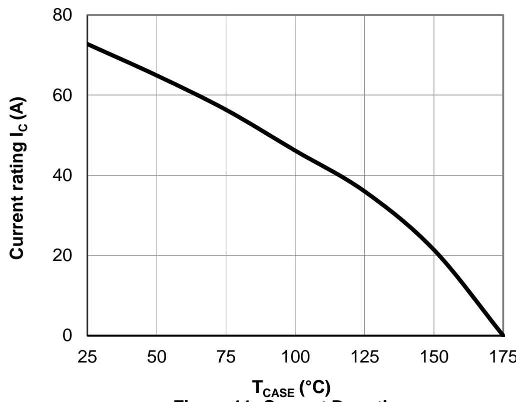

Figure 11: Current De-rating

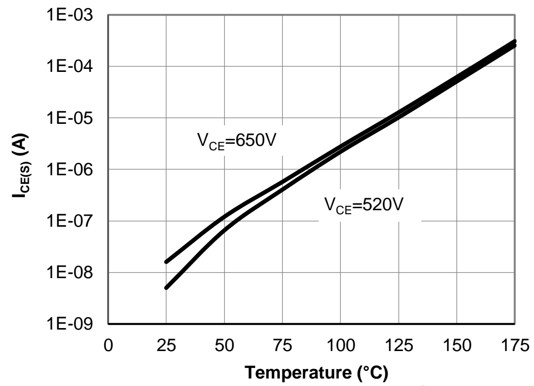

Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

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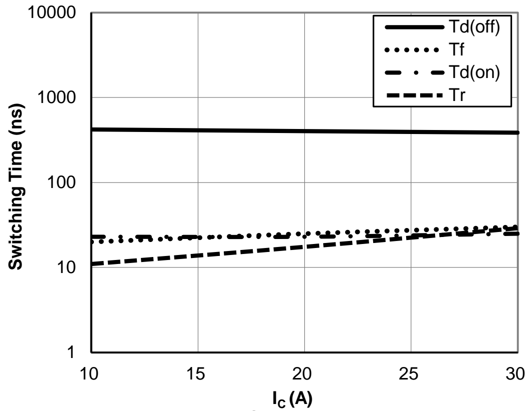

Figure 13: Switching Time vs. I_C
(T_j=175°C,V_{GE}=15V,V_{CE}=400V,R_{gon}=7.5Ω,R_{goff}=47Ω)

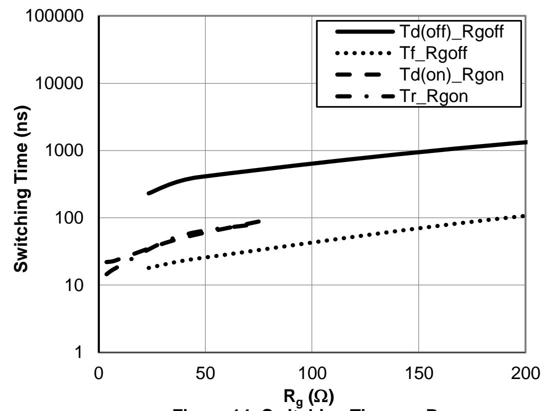

Figure 14: Switching Time vs. R_g
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

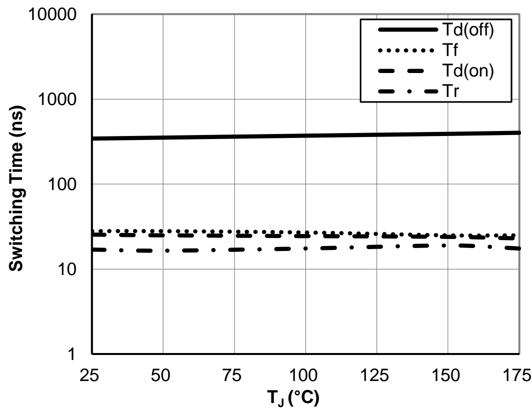

Figure 15: Switching Time vs.T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A,R_{gon}=7.5Ω,R_{goff}=47Ω)

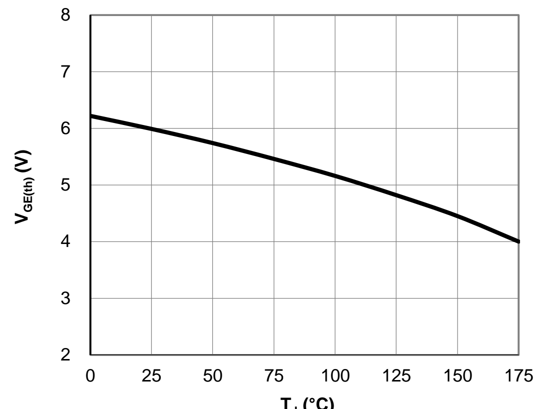

Figure 16: $V_{GE(th)}$ vs. T_j

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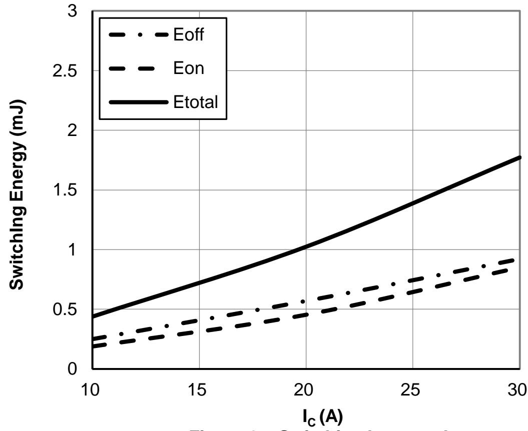

Figure 17: Switching Loss vs. I_C
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, R_{gon}=7.5Ω,R_{goff}=47Ω)

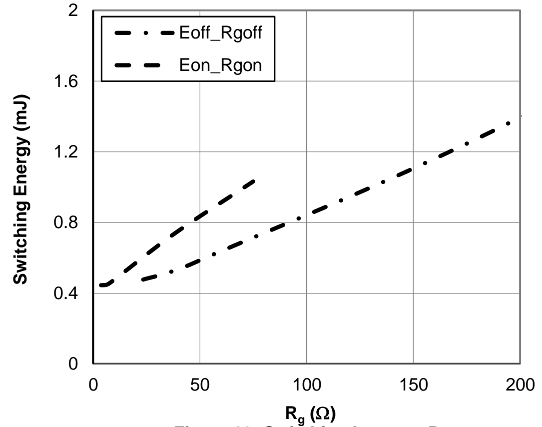

Figure 18: Switching Loss vs. R_g
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

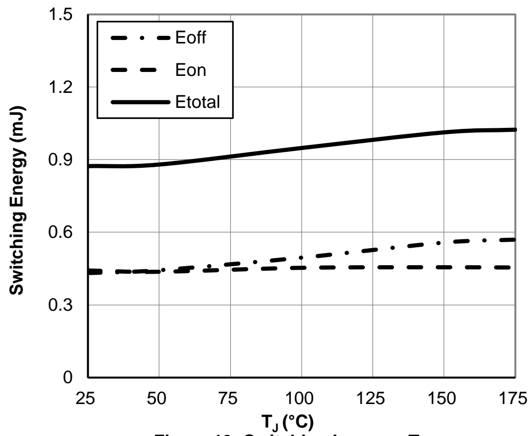

Figure 19: Switching Loss vs. T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A,R_{gon}=7.5Ω,R_{goff}=47Ω)

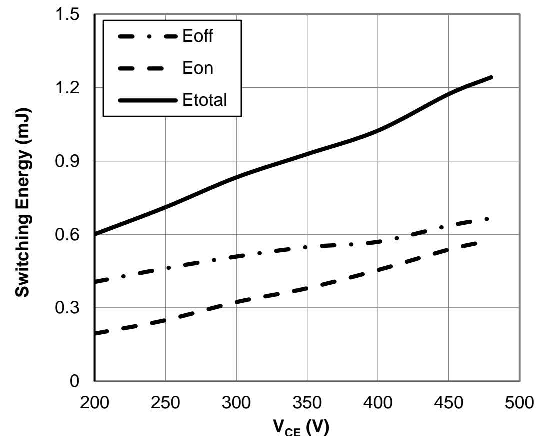

Figure 20: Switching Loss vs. V_{CE}
(T_j=175°C, V_{GE}=15V, I_C=20A, R_{gon}=7.5Ω,R_{goff}=47Ω)

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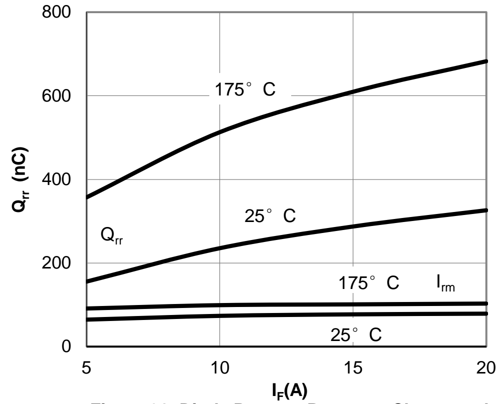

Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

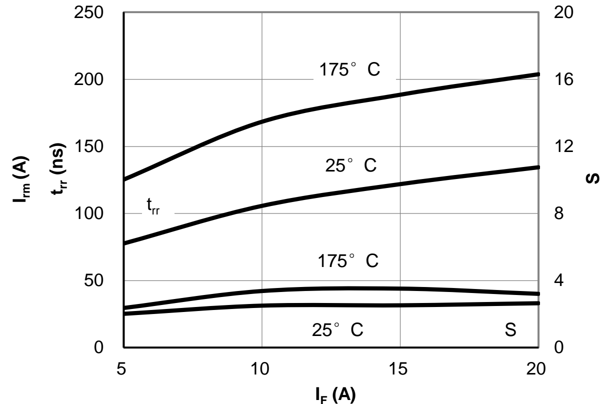

Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

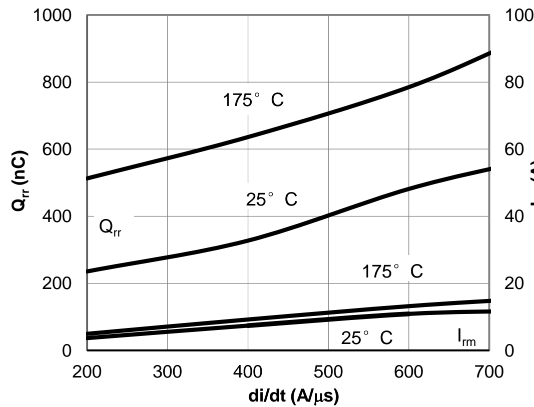

Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=10A)

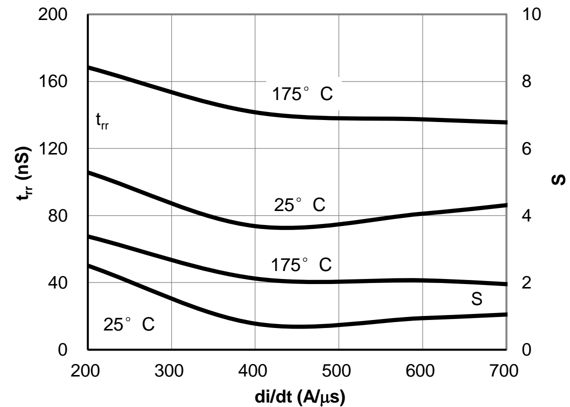

Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=10A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

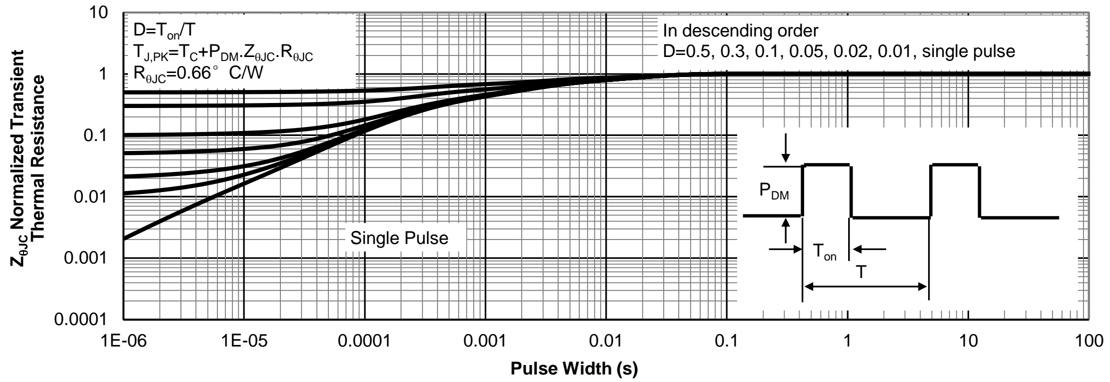

Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

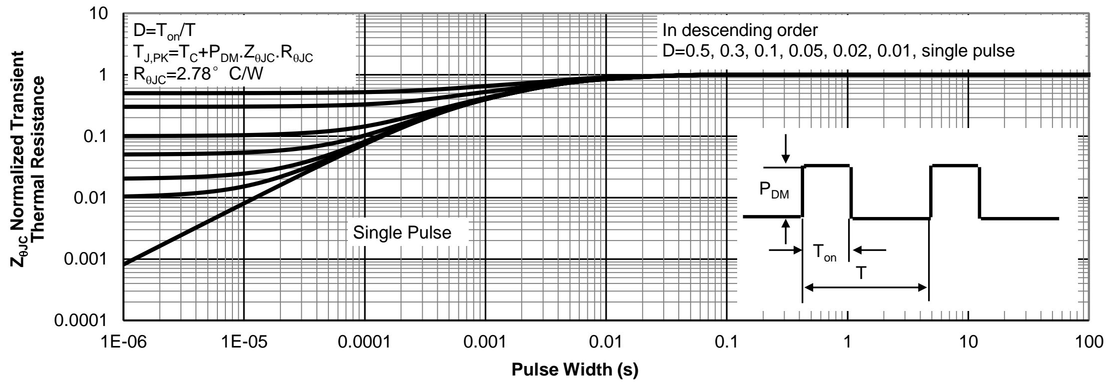

Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

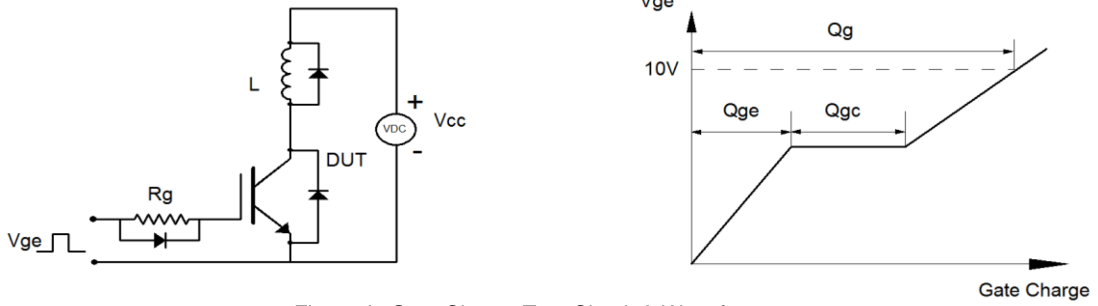

Figure A: Gate Charge Test Circuit & Waveforms

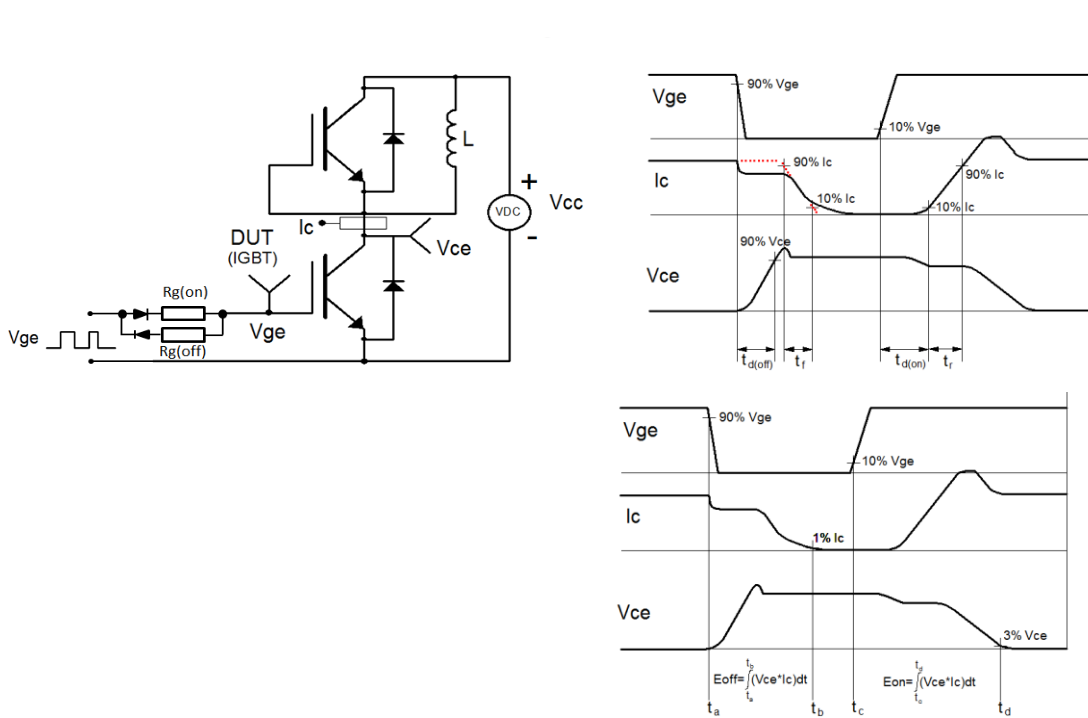

Figure B: Inductive Switching Test Circuit & Waveforms

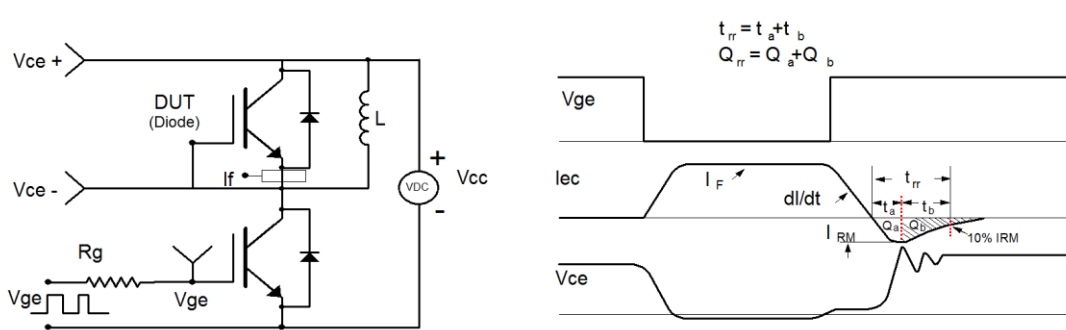

Figure C: Diode Recovery Test Circuit & Waveforms