


<p>General Description</p> <ul style="list-style-type: none"> • Latest AlphaIGBT (αIGBT) technology • 650V breakdown voltage • IGBT copacked with very fast and soft antiparallel diode • Very good EMI performance with lower turn-on switching losses • High short-circuit ruggedness • High HBM class <p>Applications</p> <ul style="list-style-type: none"> • Motor drives • Home appliance applications • Other hard switching applications 	<p>Product Summary</p> <table border="0"> <tr> <td>V_{CE}</td> <td>650V</td> </tr> <tr> <td>I_C ($T_C=100^\circ\text{C}$)</td> <td>5A</td> </tr> <tr> <td>$V_{CE(sat)}$ ($T_J=25^\circ\text{C}$)</td> <td>2.15V</td> </tr> </table> <p>Typical ESD protection HBM Class 2</p> <div style="text-align: right;">  </div>	V_{CE}	650V	I_C ($T_C=100^\circ\text{C}$)	5A	$V_{CE(sat)}$ ($T_J=25^\circ\text{C}$)	2.15V
V_{CE}	650V						
I_C ($T_C=100^\circ\text{C}$)	5A						
$V_{CE(sat)}$ ($T_J=25^\circ\text{C}$)	2.15V						



Orderable Part Number	Package Type	Form	Minimum Order Quantity
CQD5B65MQ1E	TO252	Tape & Reel	2500

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

Parameter	Symbol	CQD5B65MQ1E	Units
Collector-Emitter Voltage	V_{CE}	650	V
Gate-Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current	I_C	$T_C=25^\circ\text{C}$	10
		$T_C=100^\circ\text{C}$	5
Pulsed Collector Current, Limited by T_{Jmax}	I_{CM}	15	A
Turn-Off SOA, $V_{CE} \leq 650\text{V}$, Limited by T_{Jmax}	I_{LM}	15	A
Continuous Diode Forward Current	I_F	$T_C=25^\circ\text{C}$	10
		$T_C=100^\circ\text{C}$	4
Diode Pulsed Current, Limited by T_{Jmax}	I_{FM}	15	A
Short Circuit Withstanding Time ⁽¹⁾ $V_{GE}=15\text{V}$, $V_{CC} \leq 400\text{V}$, $T_J \leq 150^\circ\text{C}$	t_{SC}	5	μs
Power Dissipation	P_D	$T_C=25^\circ\text{C}$	52
		$T_C=100^\circ\text{C}$	21
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	CQD5B65MQ1E	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	55	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	2.4	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	6.8	$^\circ\text{C/W}$

(1) Allowed number of short circuits: <1000; time between short circuits: >1s.

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 =5A	T _J =25°C	-	2.15	2.7	V
			T _J =125°C	-	2.74	-	
			T _J =150°C	-	2.89	-	
V _F	Diode Forward Voltage	V _{GE} =0V, I _F =5A	T _J =25°C	-	2.06	2.6	V
			T _J =125°C	-	2.17	-	
			T _J =150°C	-	2.13	-	
V _{GE(th)}	Gate-Emitter Threshold Voltage	V _{CE} =5V, I _C =1mA	-	5.1	-	V	
I _{CES}	Zero Gate Voltage Collector Current	V _{CE} =650V, V _{GE} =0V	T _J =25°C	-	-	10	μA
			T _J =125°C	-	-	100	
			T _J =150°C	-	-	500	
I _{GES}	Gate-Emitter Leakage Current	V _{CE} =0V, V _{GE} =±20V	-	-	±10	μA	
g _{FS}	Forward Transconductance	V _{CE} =20V, I _C =5A	-	2	-	S	
DYNAMIC PARAMETERS							
C _{ies}	Input Capacitance	V _{GE} =0V, V _{CC} =25V, f=1MHz	-	235	-	pF	
C _{oes}	Output Capacitance		-	22	-	pF	
C _{res}	Reverse Transfer Capacitance		-	5	-	pF	
Q _g	Total Gate Charge	V _{GE} =15V, V _{CC} =520V, I _C =5A	-	8.8	-	nC	
Q _{ge}	Gate to Emitter Charge		-	2.6	-	nC	
Q _{gc}	Gate to Collector Charge		-	3.4	-	nC	
I _{C(SC)}	Short Circuit Collector Current	V _{GE} =15V, V _{CC} =400V, t _{sc} ≤5us, T _J ≤150°C	-	20	-	A	
R _g	Gate Resistance	V _{GE} =0V, V _{CC} =0V, f=1MHz	-	20	-	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 =5A, R _G =60Ω	-	7	-	ns	
t _r	Turn-On Rise Time		-	13	-	ns	
t _{D(off)}	Turn-Off Delay Time		-	78	-	ns	
t _f	Turn-Off Fall Time		-	20	-	ns	
E _{on}	Turn-On Energy		-	0.09	-	mJ	
E _{off}	Turn-Off Energy		-	0.06	-	mJ	
E _{total}	Total Switching Energy		-	0.15	-	mJ	
t _{rr}	Diode Reverse Recovery Time		T _J =25°C	-	74	-	ns
Q _{rr}	Diode Reverse Recovery Charge		I _F =5A, di/dt=200A/μs, V _{CC} =400V	-	0.11	-	μC
I _{rm}	Diode Peak Reverse Recovery Current		-	-	2.46	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)							
t _{D(on)}	Turn-On Delay Time	T _J =150°C V _{GE} =15V, V _{CC} =400V, I _C =5A, R _G =60Ω	-	6.5	-	ns	
t _r	Turn-On Rise Time		-	14	-	ns	
t _{D(off)}	Turn-Off Delay Time		-	96	-	ns	
t _f	Turn-Off Fall Time		-	34	-	ns	
E _{on}	Turn-On Energy		-	0.10	-	mJ	
E _{off}	Turn-Off Energy		-	0.10	-	mJ	
E _{total}	Total Switching Energy		-	0.20	-	mJ	
t _{rr}	Diode Reverse Recovery Time		T _J =150°C	-	161	-	ns
Q _{rr}	Diode Reverse Recovery Charge		I _F =5A, di/dt=200A/μs, V _{CC} =400V	-	0.21	-	μC
I _{rm}	Diode Peak Reverse Recovery Current		-	-	2.83	-	A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

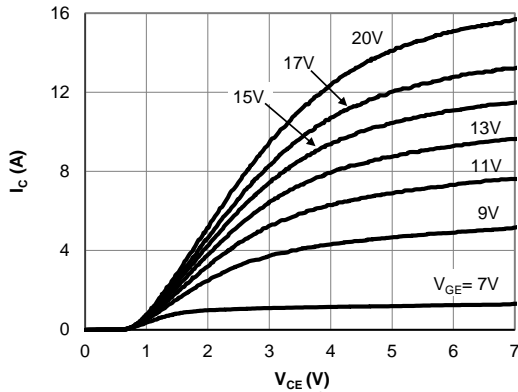


Figure 1: Output Characteristic (T_J=25°C)

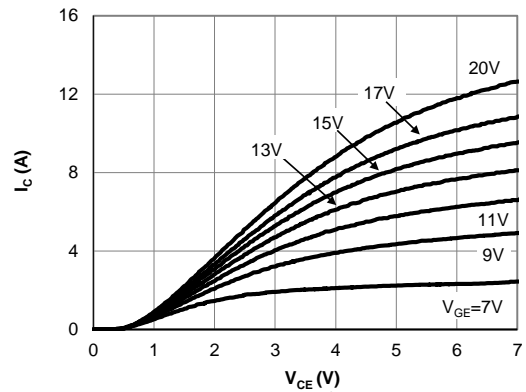


Figure 2: Output Characteristic (T_J=150°C)

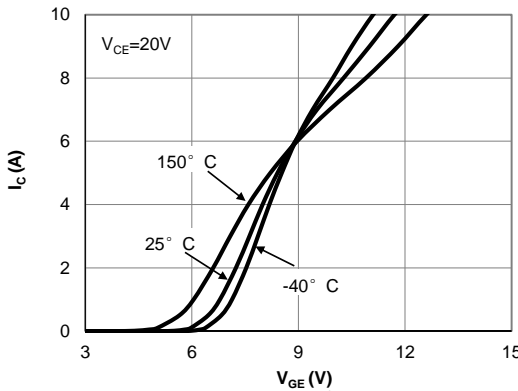


Figure 3: Transfer Characteristic

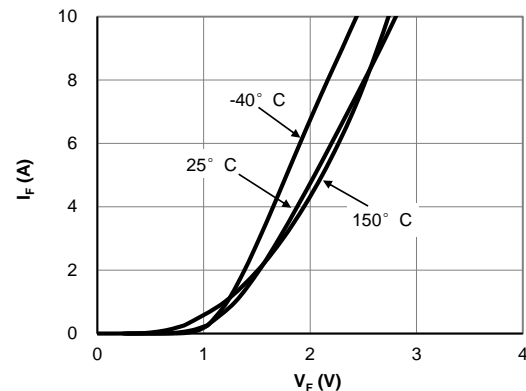


Figure 4: Diode Characteristic

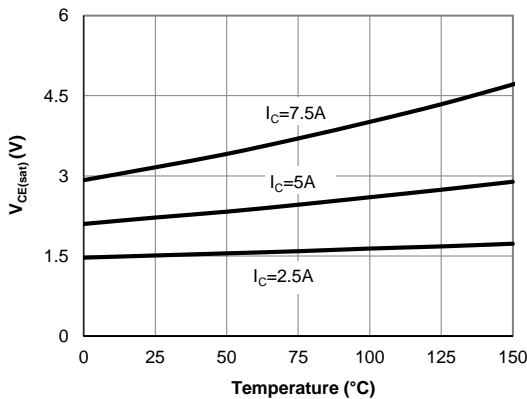


Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

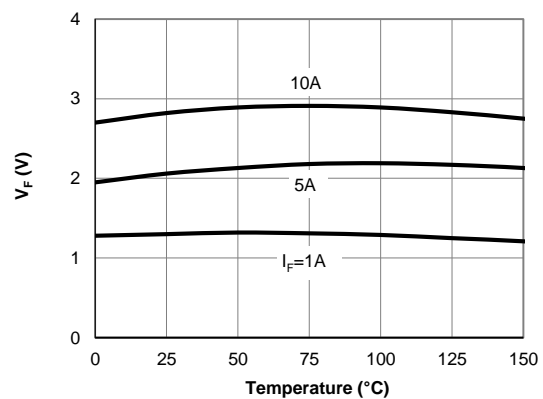


Figure 6: Diode Forward voltage vs. Junction Temperature

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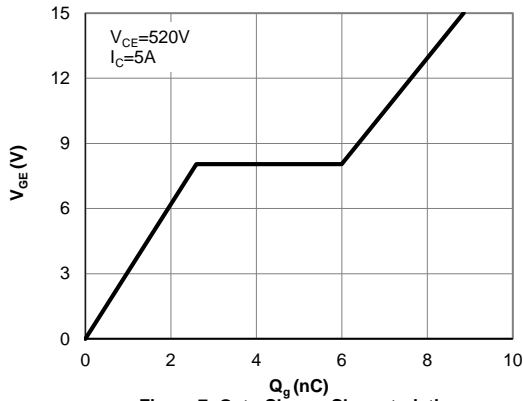


Figure 7: Gate-Charge Characteristics

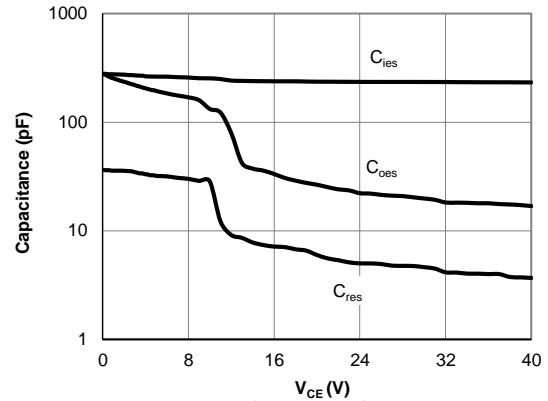


Figure 8: Capacitance Characteristic

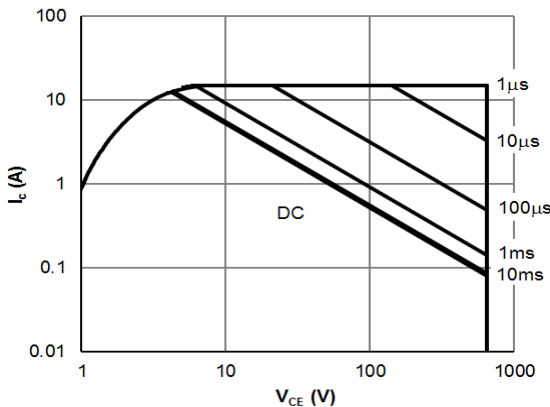


Figure 9: Forward Bias Safe Operating Area
($T_c=25^\circ\text{C}$, $V_{GE}=15\text{V}$)

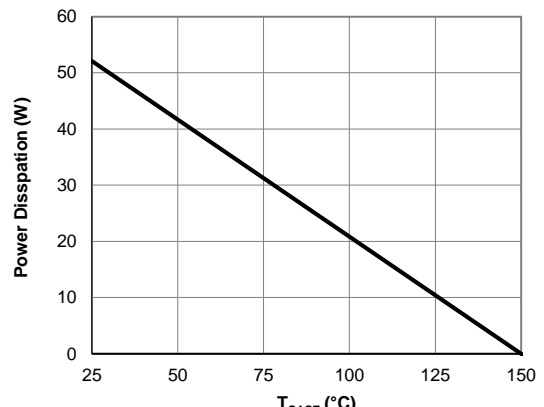


Figure 10: Power Dissipation as a Function of Case

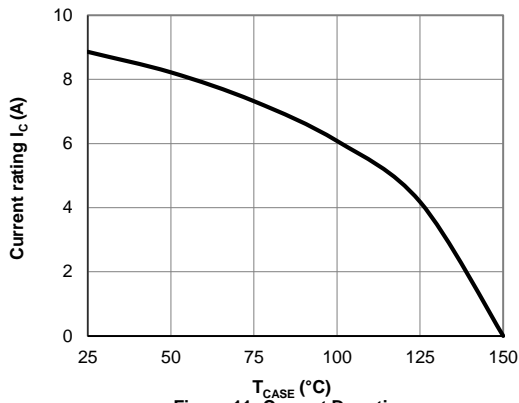


Figure 11: Current De-rating

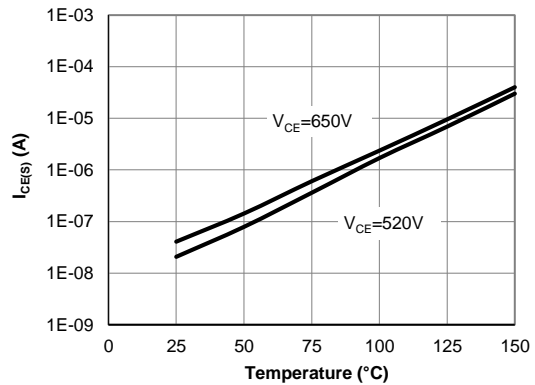


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

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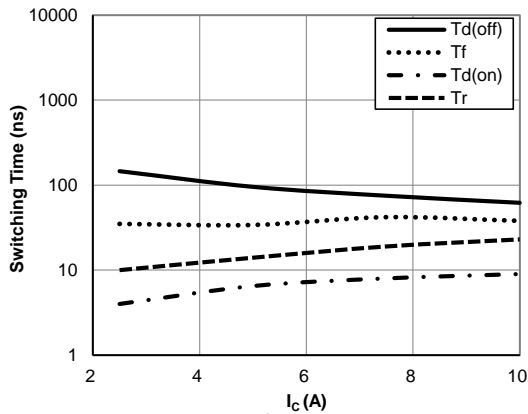


Figure 13: Switching Time vs. I_C
($T_J=150^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $R_g=60\Omega$)

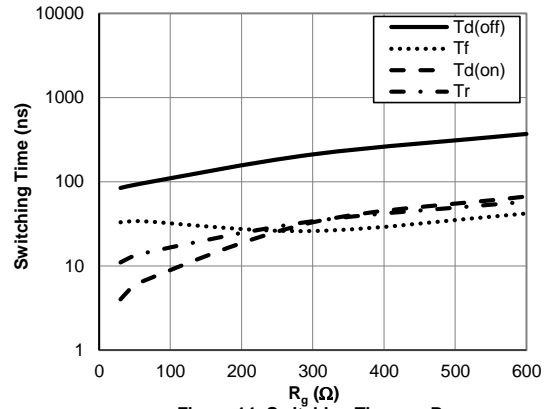


Figure 14: Switching Time vs. R_g
($T_J=150^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$)

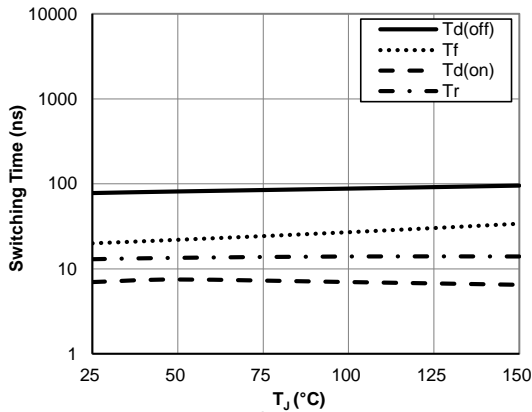


Figure 15: Switching Time vs. T_J
($V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_g=60\Omega$)

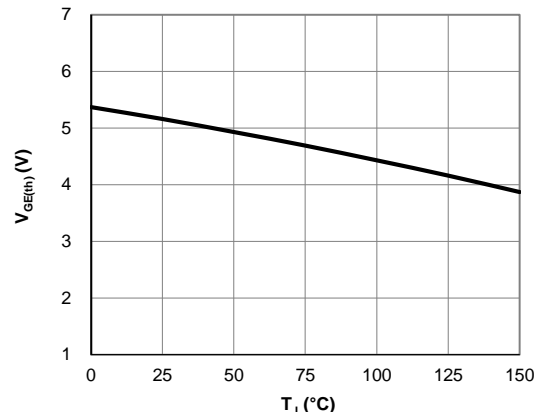


Figure 16: $V_{GE(th)}$ vs. T_J

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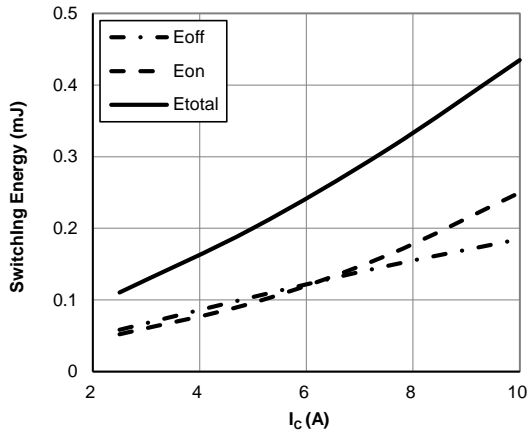


Figure 17: Switching Loss vs. I_C
($T_J=150^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $R_g=60\Omega$)

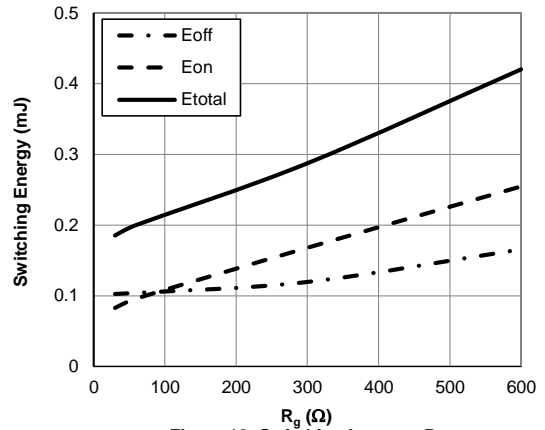


Figure 18: Switching Loss vs. R_g
($T_J=150^\circ\text{C}$, $V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$)

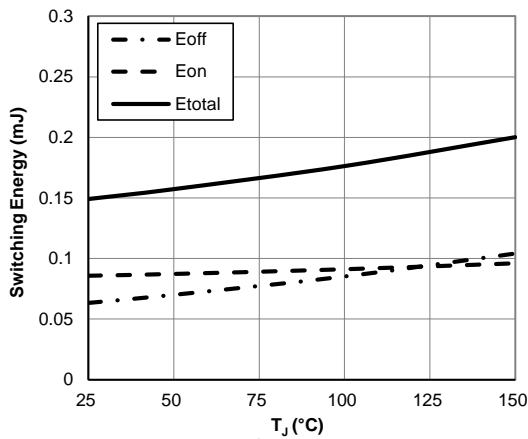


Figure 19: Switching Loss vs. T_J
($V_{GE}=15\text{V}$, $V_{CE}=400\text{V}$, $I_C=5\text{A}$, $R_g=60\Omega$)

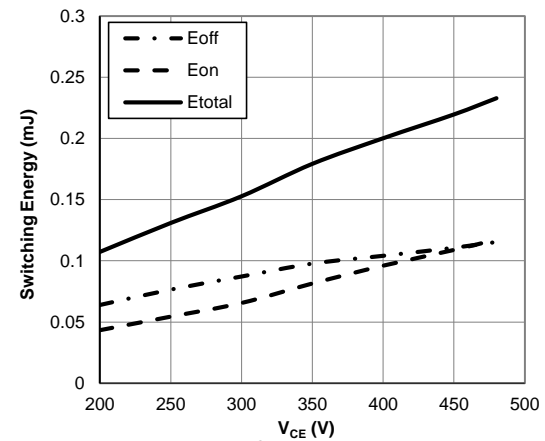


Figure 20: Switching Loss vs. V_{CE}
($T_J=150^\circ\text{C}$, $V_{GE}=15\text{V}$, $I_C=5\text{A}$, $R_g=60\Omega$)

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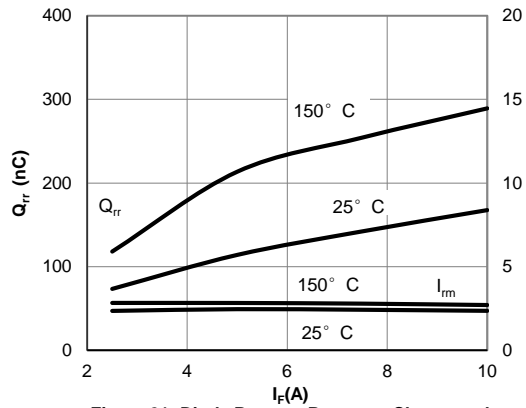


Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

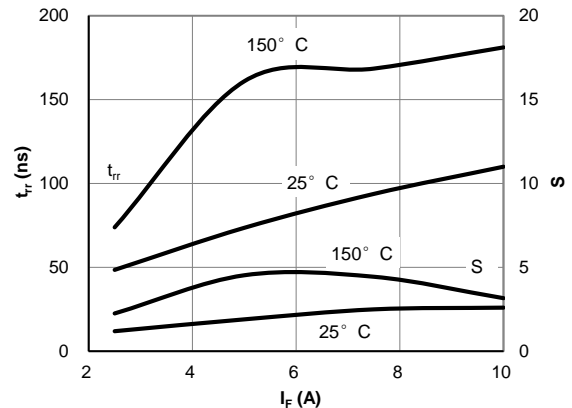


Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current
($V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$)

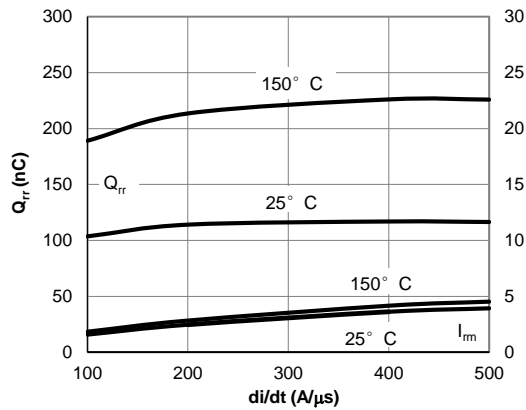


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

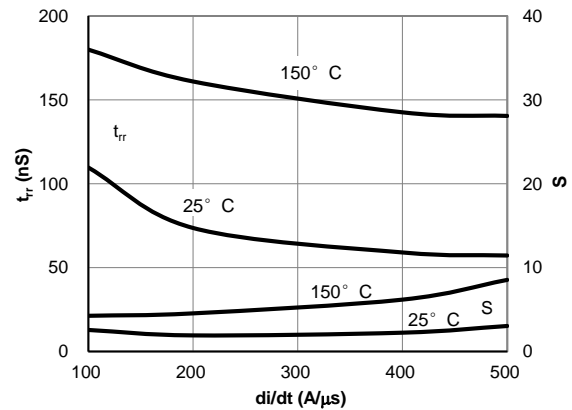


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt
($V_{GE}=15V, V_{CE}=400V, I_F=5A$)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

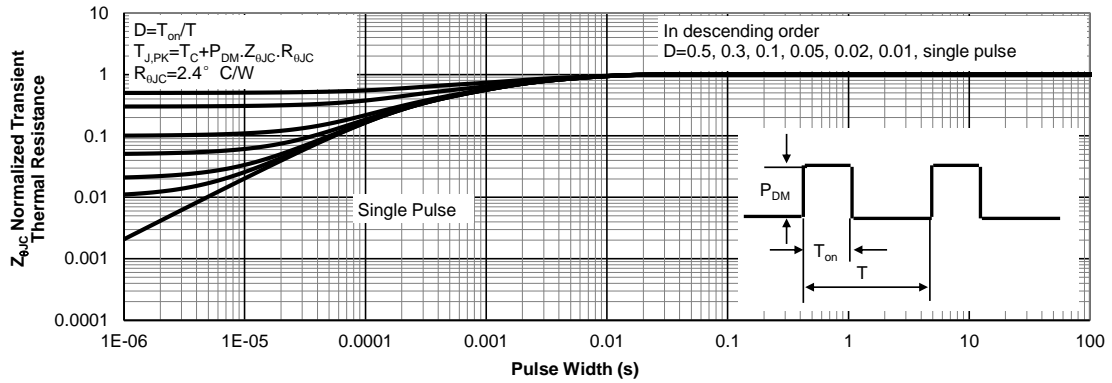


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

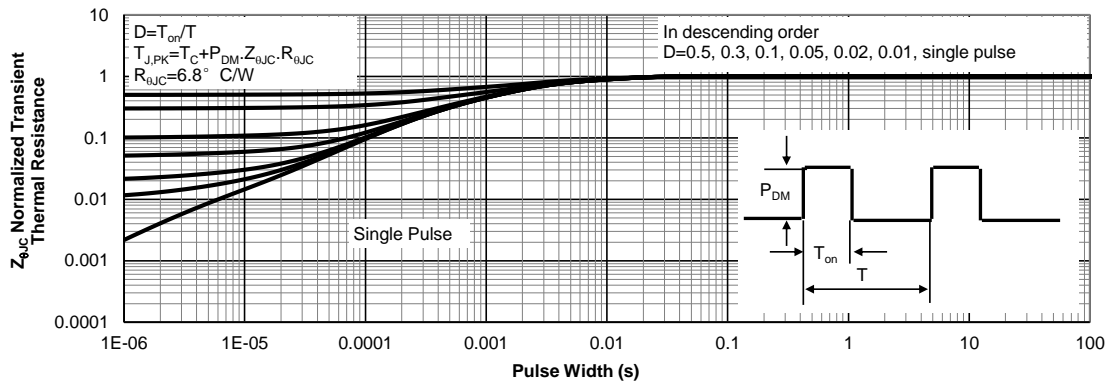


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

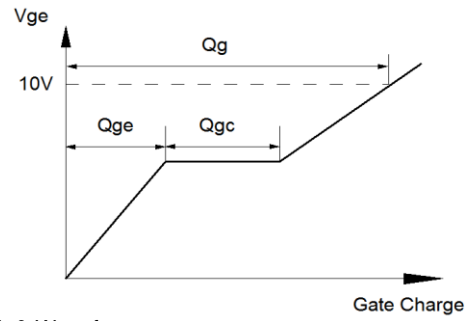
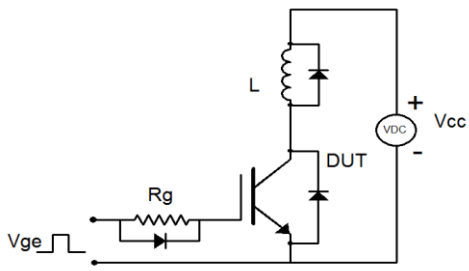


Figure A: Gate Charge Test Circuit & Waveforms

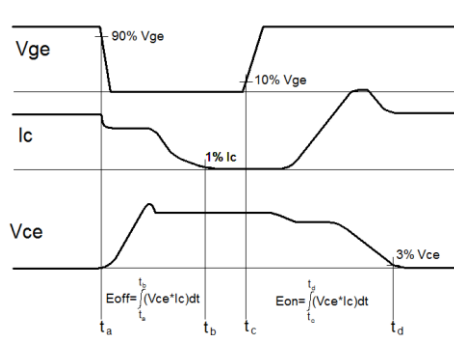
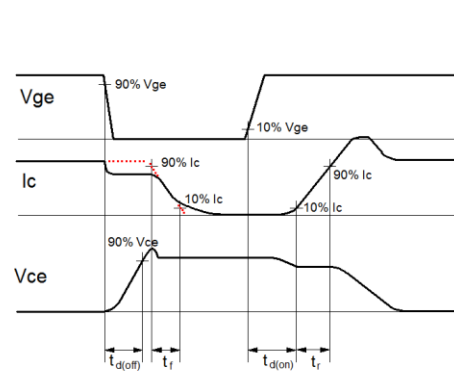
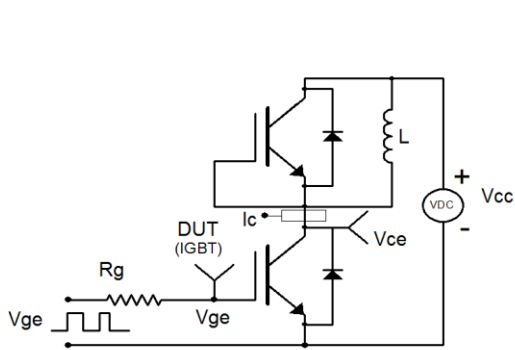


Figure B: Inductive Switching Test Circuit & Waveforms

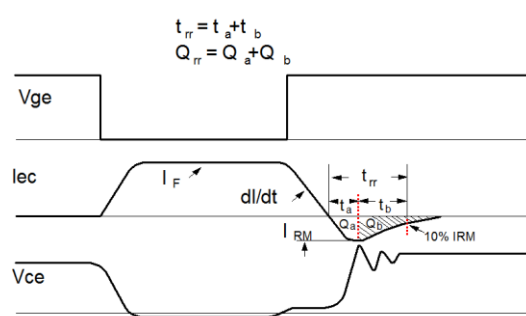
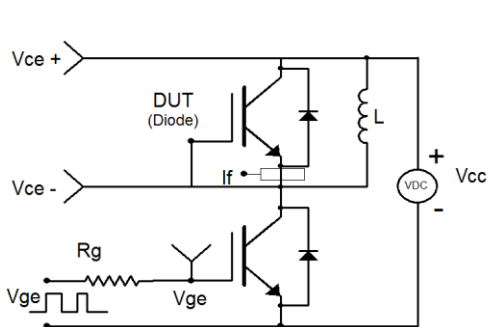


Figure C: Diode Recovery Test Circuit & Waveforms