ALPHA & OMEGA SEMICONDUCTOR

AOK20B65M1/AOT20B65M1/AOB20B65M1

650V, 20A Alpha IGBT™

With soft and fast recovery anti-parallel diode

General Description

- Latest Alpha IGBT (α IGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low $V_{CE(sat)}$ enables high efficiencies
- Low turn-off switching loss and softness
- Very good EMI behavior
- High short-circuit ruggedness

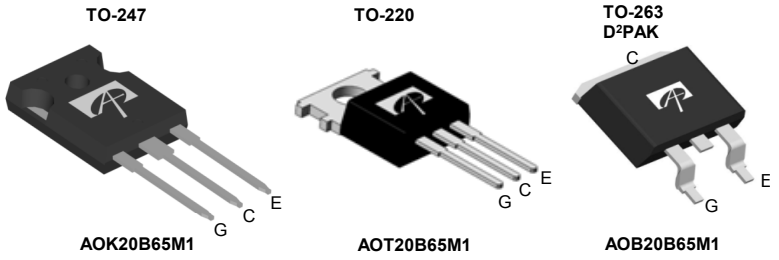
Applications

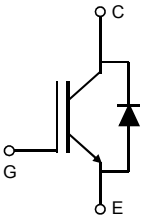
- Motor Drives
- Sewing Machines
- Home Appliances
- Fan, Pumps, Vacuum Cleaner
- Other Hard Switching Applications

Product Summary

V_{CE}	650V
I_C (T_C=100°C)	20A
$V_{CE(sat)}$ (T_J=25°C)	1.7V

RoHS Compliant





Orderable Part Number	Package Type	Form	Minimum Order Quantity
AOK20B65M1	TO247	Tube	240
AOT20B65M1	TO220	Tube	1000
AOB20B65M1	TO263	Tape & Reel	800

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	AOK20B65M1/AOT(B)20B65M1	Units
Collector-Emitter Voltage		V_{CE}	650	V
Gate-Emitter Voltage		V_{GE}	±30	V
Continuous Collector Current	T_C=25°C	I_C	40	A
	T_C=100°C		20	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	60	A
Turn off SOA, V_{CE}≤650V, Limited by T_{Jmax}		I_{LM}	60	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}	60	A
Short circuit withstanding time 1) V_{GE}=15V, V_{CC}≤400V, T_J≤175°C		t_{SC}	5	µs
Power Dissipation	T_C=25°C	P_D	227	W
	T_C=100°C		114	
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	AOK20B65M1	AOT(B)20B65M1	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	65	°C/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.66		°C/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	1.5		°C/W

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

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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=20A	T_J=25°C	-	1.7	2.15	V
			T_J=125°C	-	2.02	-	
			T_J=175°C	-	2.2	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_F=20A	T_J=25°C	-	1.66	2.1	V
			T_J=125°C	-	1.67	-	
			T_J=175°C	-	1.62	-	
$V_{GE(th)}$	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	-	-	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=20A		-	14	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CC}=25V, f=1MHz		-	1212	-	pF
C_{oes}	Output Capacitance			-	141	-	pF
C_{res}	Reverse Transfer Capacitance			-	50	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CC}=520V, I_C=20A		-	46	-	nC
Q_{ge}	Gate to Emitter Charge			-	12	-	nC
Q_{gc}	Gate to Collector Charge			-	21	-	nC
$I_{C(SC)}$	Short circuit collector current	V_{GE}=15V, V_{CC}=400V, t_{sc}≤5us, T_J≤175°C		-	115	-	A
R_g	Gate resistance	V_{GE}=0V, V_{CC}=0V, f=1MHz		-	13	-	Ω
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=25°C V_{GE}=15V, V_{CC}=400V, I_C=20A, R_G=15Ω		-	26	-	ns
t_r	Turn-On Rise Time			-	25	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	122	-	ns
t_f	Turn-Off Fall Time			-	13	-	ns
E_{on}	Turn-On Energy			-	0.47	-	mJ
E_{off}	Turn-Off Energy			-	0.27	-	mJ
E_{total}	Total Switching Energy			-	0.74	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=25°C I_F=20A, di/dt=200A/µs, V_{CC}=400V		-	322	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.8	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	5.2	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=175°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=175°C V_{GE}=15V, V_{CC}=400V, I_C=20A, R_G=15Ω		-	27	-	ns
t_r	Turn-On Rise Time			-	24	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	150	-	ns
t_f	Turn-Off Fall Time			-	28	-	ns
E_{on}	Turn-On Energy			-	0.52	-	mJ
E_{off}	Turn-Off Energy			-	0.49	-	mJ
E_{total}	Total Switching Energy			-	1.01	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=175°C I_F=20A, di/dt=200A/µs, V_{CC}=400V		-	494	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	1.6	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	7.1	-	A

APPLICATIONS OR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS ARE NOT AUTHORIZED. AOS DOES NOT ASSUME ANY LIABILITY ARISING OUT OF SUCH APPLICATIONS OR USES OF ITS PRODUCTS. AOS RESERVES THE RIGHT TO IMPROVE PRODUCT DESIGN,FUNCTIONS AND RELIABILITY WITHOUT NOTICE.

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

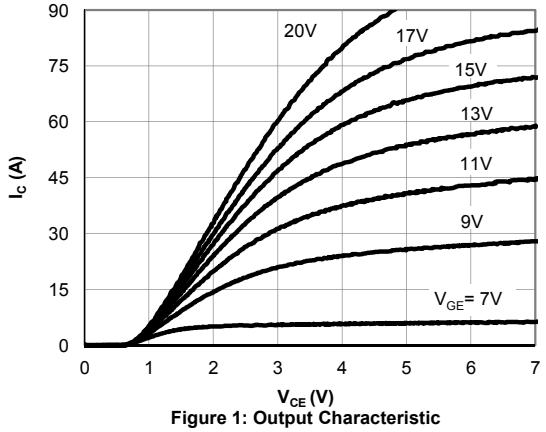

Figure 1: Output Characteristic (T_j=25°C)

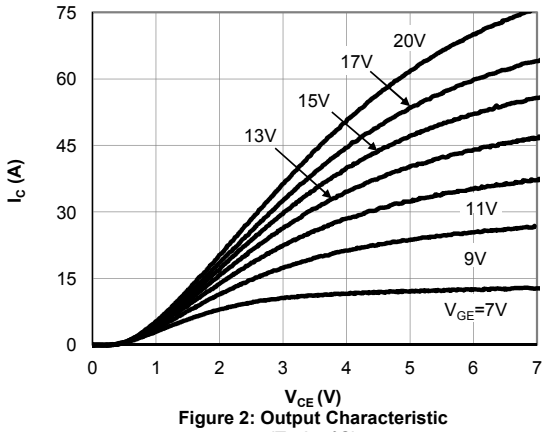

Figure 2: Output Characteristic (T_j=175°C)

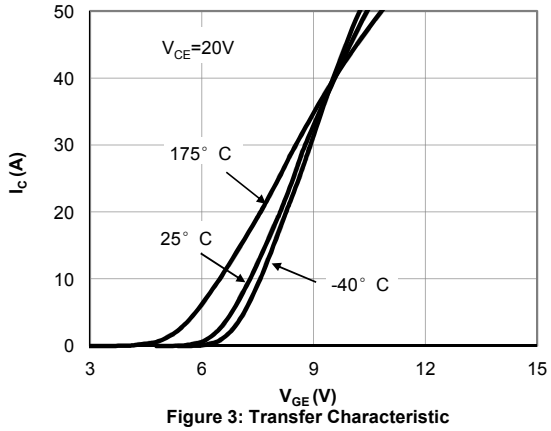

Figure 3: Transfer Characteristic

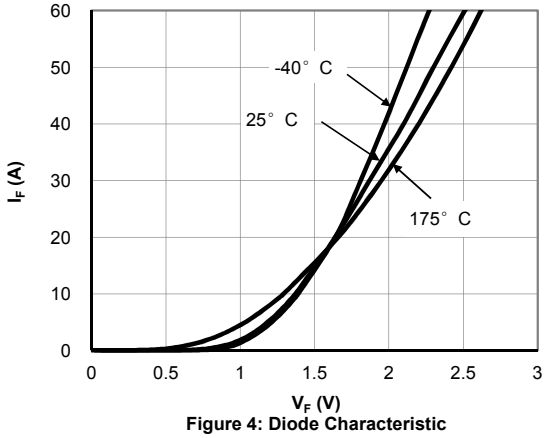

Figure 4: Diode Characteristic

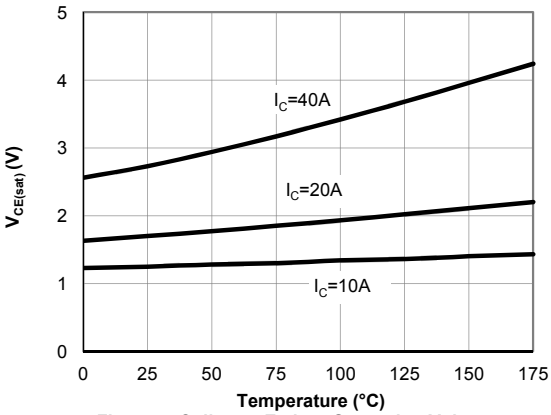

Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

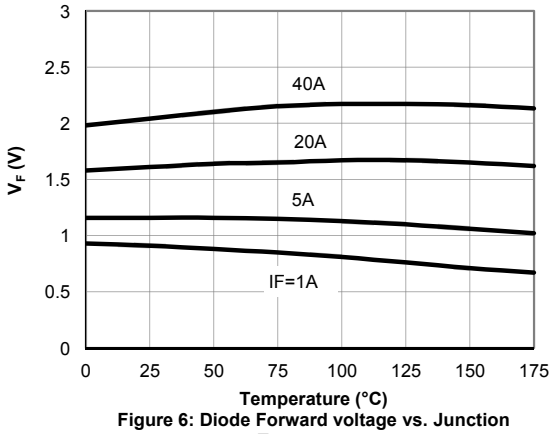

Figure 6: Diode Forward voltage vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

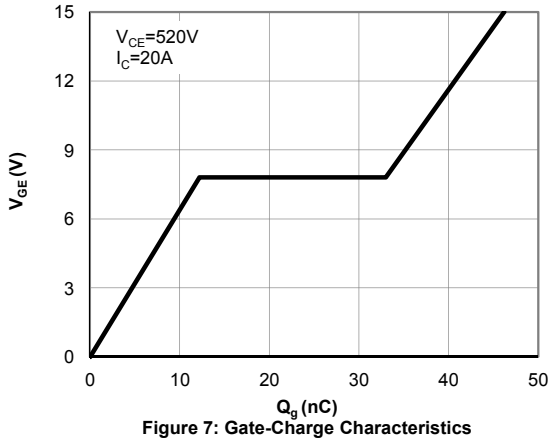

Figure 7: Gate-Charge Characteristics

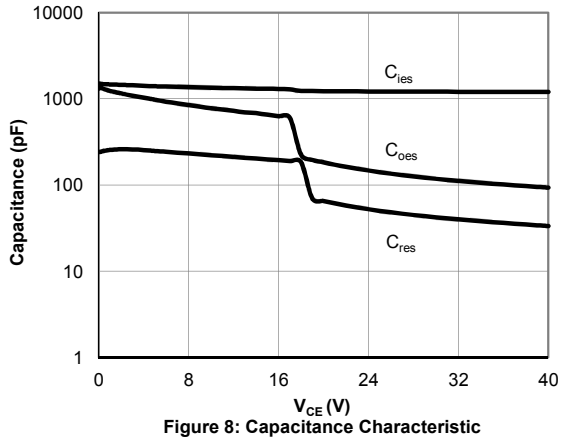

Figure 8: Capacitance Characteristic

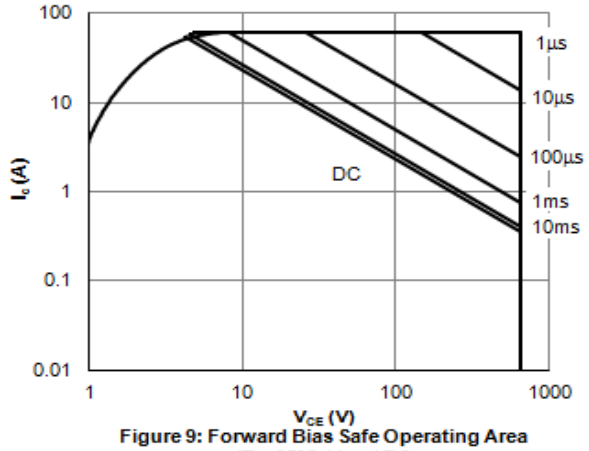

Figure 9: Forward Bias Safe Operating Area
(T_C=25°C, V_{GE}=15V)

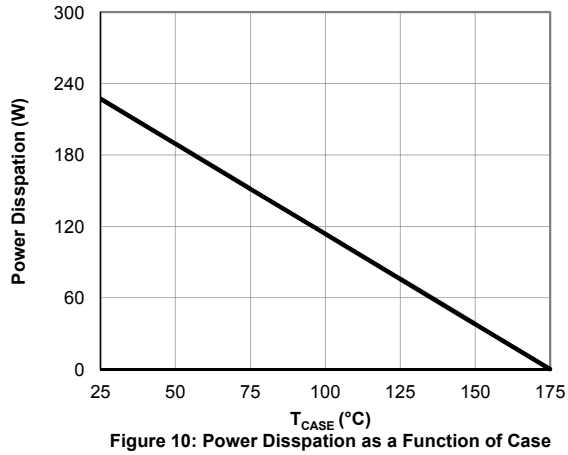

Figure 10: Power Disspation as a Function of Case

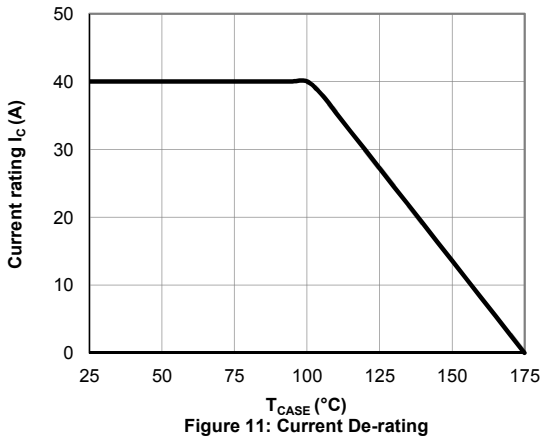

Figure 11: Current De-rating

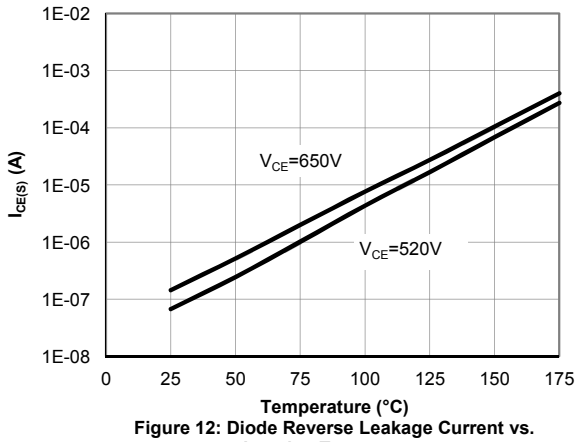

Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

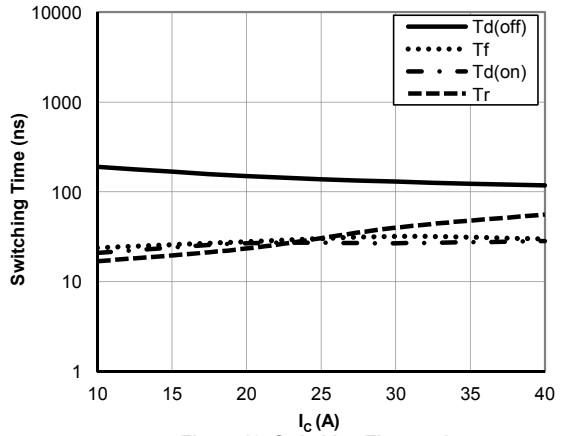

Figure 13: Switching Time vs. I_C
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, R_g=15Ω)

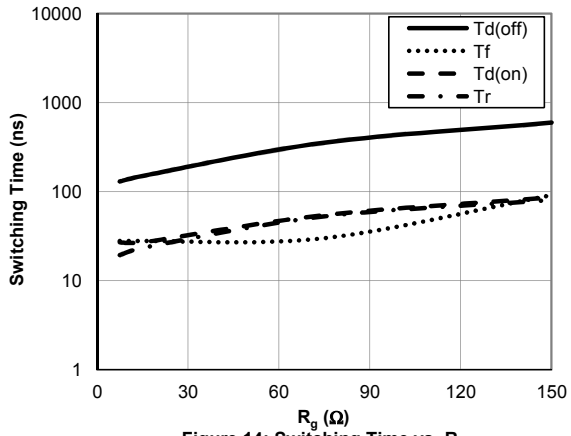

Figure 14: Switching Time vs. R_g
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

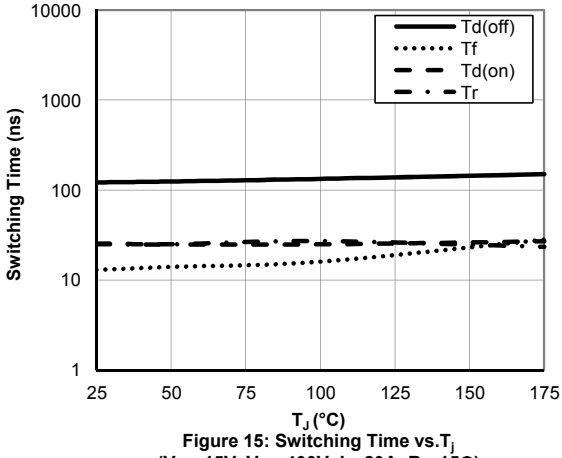

Figure 15: Switching Time vs.T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A, R_g=15Ω)

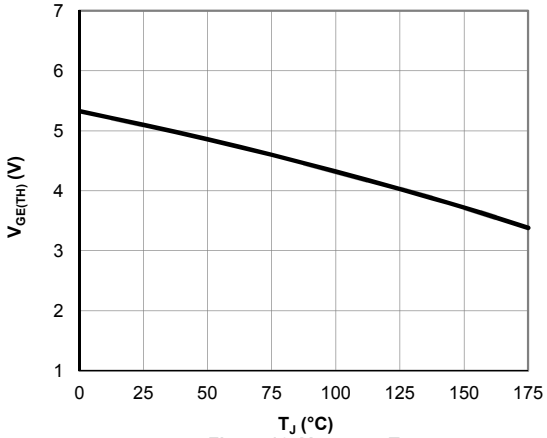

Figure 16: $V_{GE(TH)}$ vs. T_j

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

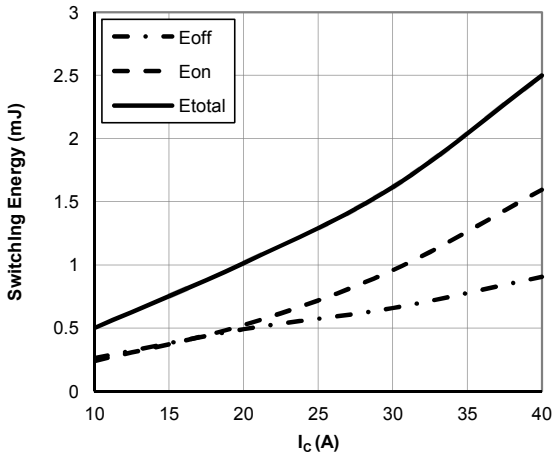

Figure 17: Switching Loss vs. I_C
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, R_g=15Ω)

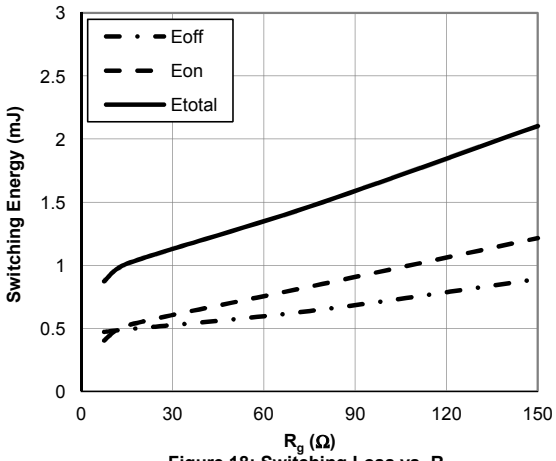

Figure 18: Switching Loss vs. R_g
(T_j=175°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

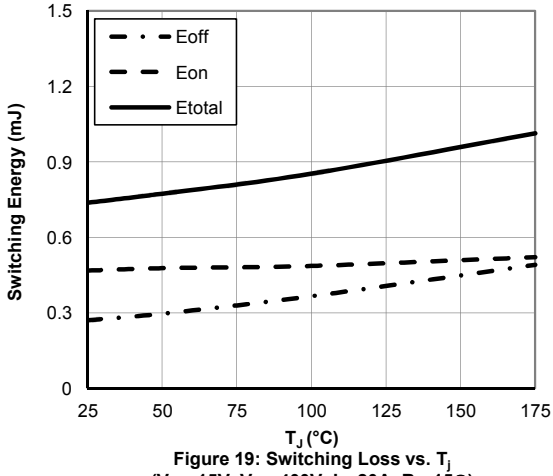

Figure 19: Switching Loss vs. T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A, R_g=15Ω)

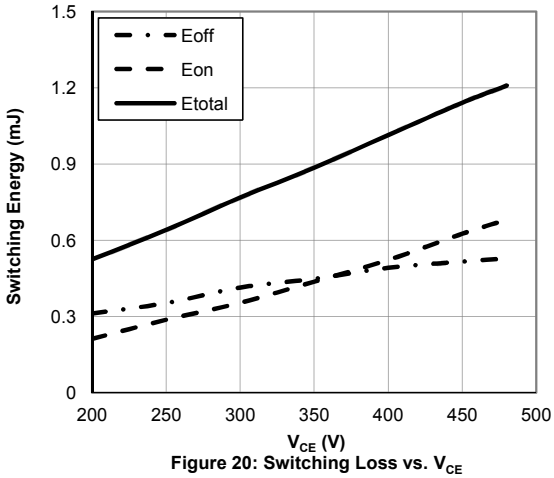

Figure 20: Switching Loss vs. V_{CE}
(T_j=175°C, V_{GE}=15V, I_C=20A, R_g=15Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

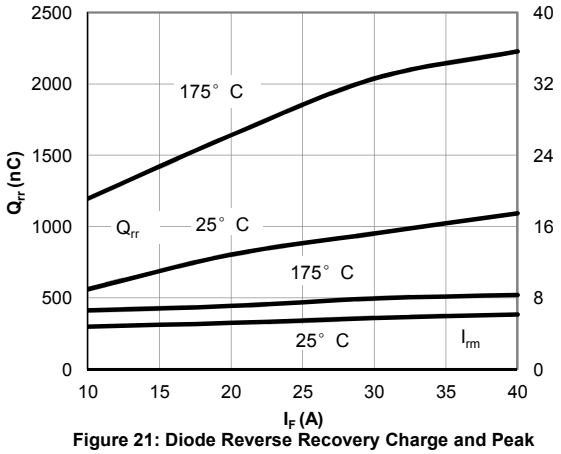

Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

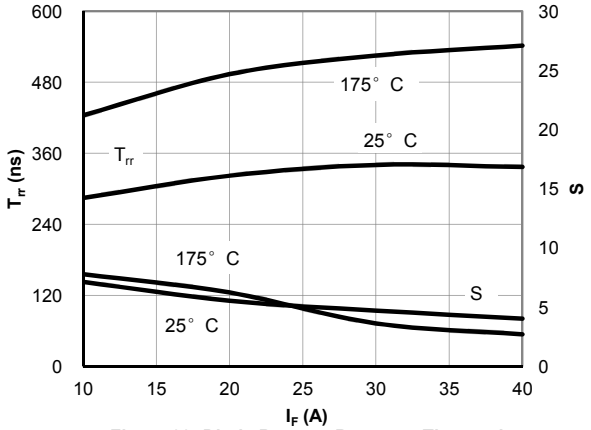

Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

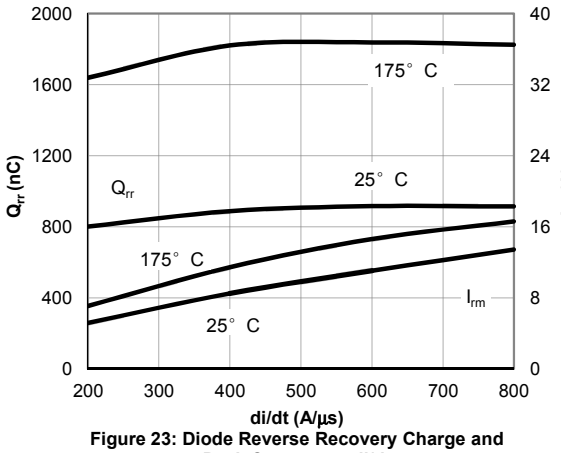

Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=20A)

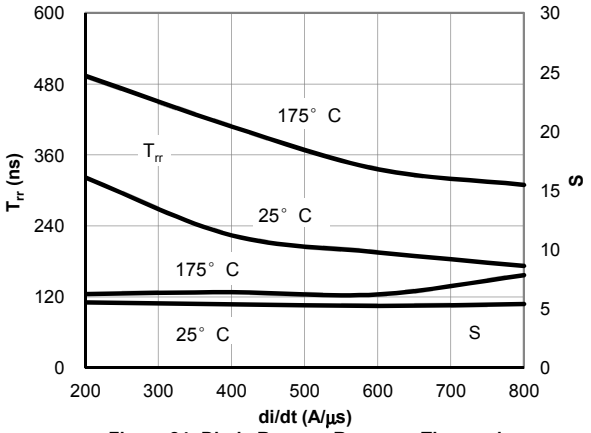

Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=20A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

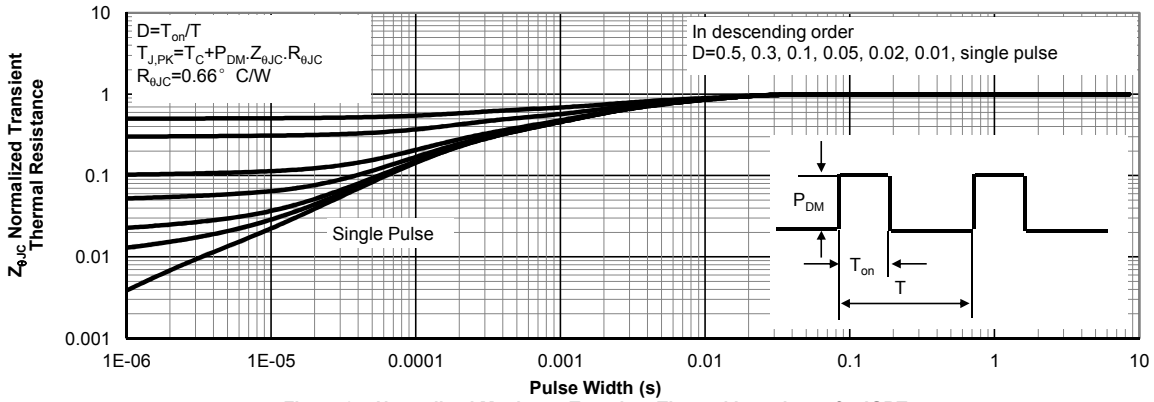

Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

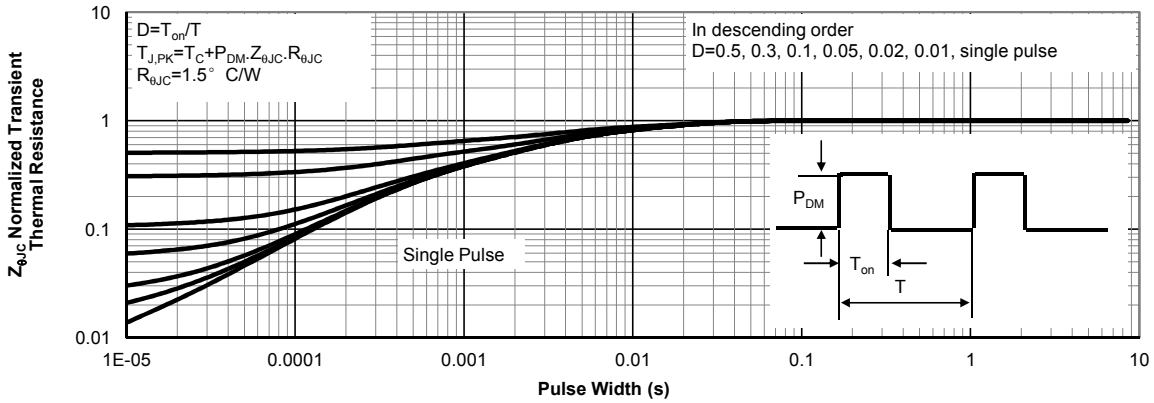

Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

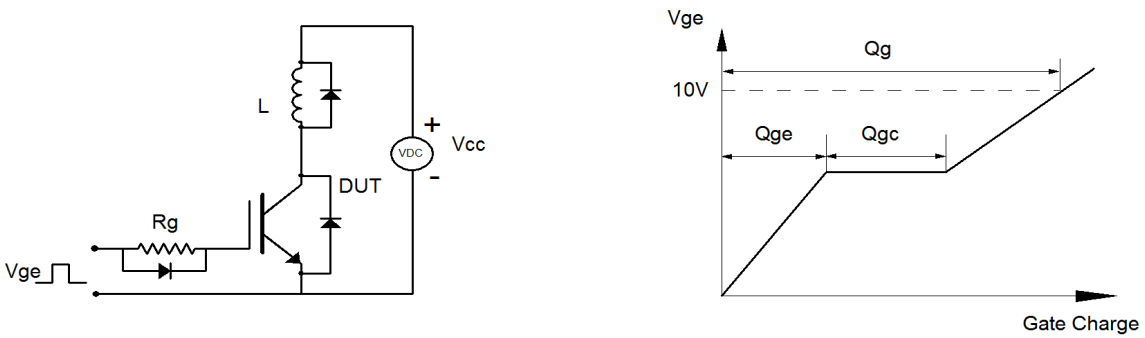

Figure A: Gate Charge Test Circuit & Waveforms

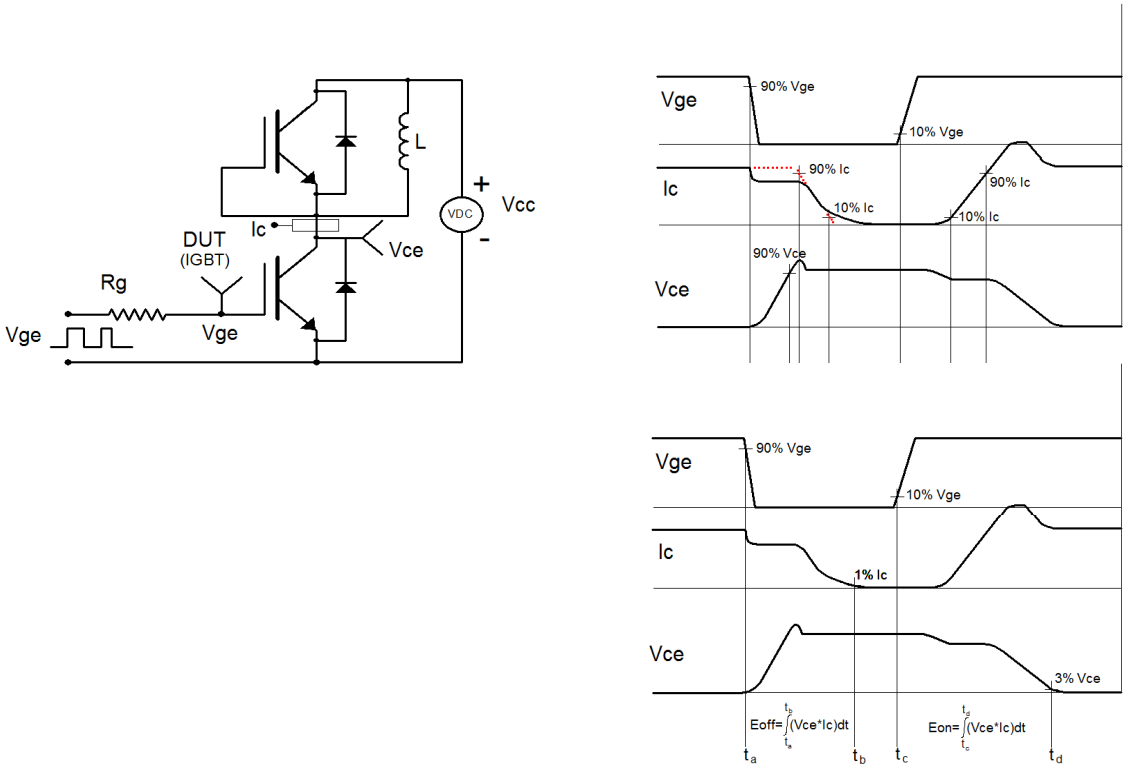

Figure B: Inductive Switching Test Circuit & Waveforms

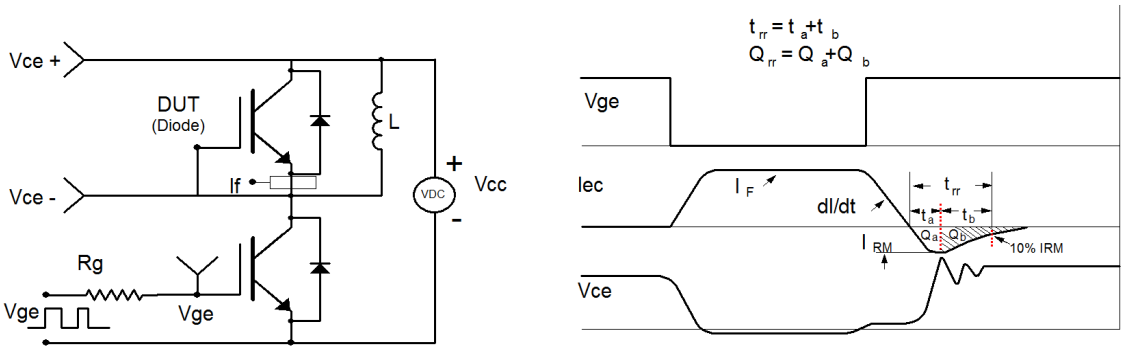

Figure C: Diode Recovery Test Circuit & Waveforms