

### General Description

- Latest AlphaIGBT (αIGBT) 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

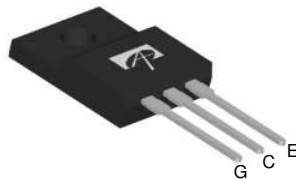
- Motor drives
- Sewing machines
- Home appliances
- Fan, pumps, vacuum cleaner
- Other hard switching applications

### Product Summary

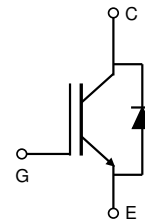
$V_{CE}$	650V
$I_C$ ( $T_C=100^\circ\text{C}$ )	15A
$V_{CE(sat)}$ ( $T_J=25^\circ\text{C}$ )	1.95V



TO-220F



AOTF15B65M3



Orderable Part Number	Package Type	Form	Minimum Order Quantity
AOTF15B65M3	TO220F	Tube	1000

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

Parameter	Symbol	AOTF15B65M3	Units
Collector-Emitter Voltage	$V_{CE}$	650	V
Gate-Emitter Voltage	$V_{GE}$	$\pm 30$	V
Continuous Collector Current	$I_C$	$T_C=25^\circ\text{C}$	30 <sup>(2)</sup>
		$T_C=100^\circ\text{C}$	15 <sup>(2)</sup>
Pulsed Collector Current, Limited by $T_{Jmax}$	$I_{CM}$	45	A
Turn off SOA, $V_{CE} \leq 650\text{V}$ , Limited by $T_{Jmax}$	$I_{LM}$	45	A
Continuous Diode Forward Current	$I_F$	$T_C=25^\circ\text{C}$	20 <sup>(2)</sup>
		$T_C=100^\circ\text{C}$	10 <sup>(2)</sup>
Diode Pulsed Current, Limited by $T_{Jmax}$	$I_{FM}$	30	A
Short circuit withstanding time $t_1$ $V_{GE}=15\text{V}$ , $V_{CC} \leq 400\text{V}$ , $T_J \leq 150^\circ\text{C}$	$t_{SC}$	5	$\mu\text{s}$
Power Dissipation	$P_D$	$T_C=25^\circ\text{C}$	30
		$T_C=100^\circ\text{C}$	12
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	AOTF15B65M3	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	4.2	$^\circ\text{C/W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	7	$^\circ\text{C/W}$

1) Allowed number of short circuits: &lt;1000; time between short circuits: &gt;1s.

 2) TO220F  $I_C$  follows TO220/TO263.

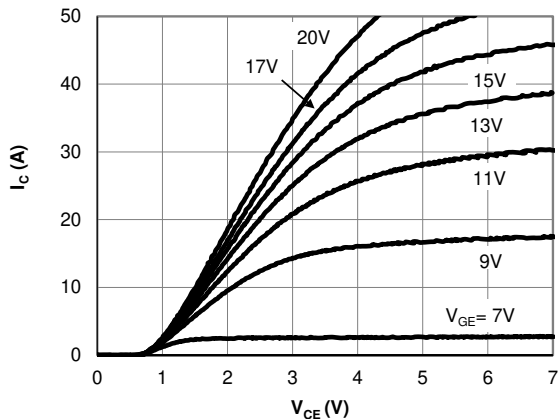
**Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>STATIC PARAMETERS</b>							
BV <sub>CES</sub>	Collector-Emitter Breakdown Voltage	I <sub>C</sub> =1mA, V <sub>GE</sub> =0V, T <sub>J</sub> =25°C	650	-	-	V	
V <sub>CE(sat)</sub>	Collector-Emitter Saturation Voltage	V <sub>GE</sub> =15V, I <sub>C</sub> =15A	T <sub>J</sub> =25°C	-	1.95	2.5	V
			T <sub>J</sub> =125°C	-	2.46	-	
			T <sub>J</sub> =150°C	-	2.61	-	
V <sub>F</sub>	Diode Forward Voltage	V <sub>GE</sub> =0V, I <sub>F</sub> =10A	T <sub>J</sub> =25°C	-	1.9	2.4	V
			T <sub>J</sub> =125°C	-	1.96	-	
			T <sub>J</sub> =150°C	-	1.95	-	
V <sub>GE(th)</sub>	Gate-Emitter Threshold Voltage	V <sub>CE</sub> =5V, I <sub>C</sub> =1mA	-	5.1	-	V	
I <sub>CES</sub>	Zero Gate Voltage Collector Current	V <sub>CE</sub> =650V, V <sub>GE</sub> =0V	T <sub>J</sub> =25°C	-	-	10	μA
			T <sub>J</sub> =125°C	-	-	100	
			T <sub>J</sub> =150°C	-	-	500	
I <sub>GES</sub>	Gate-Emitter leakage current	V <sub>CE</sub> =0V, V <sub>GE</sub> =±30V	-	-	±100	nA	
g <sub>FS</sub>	Forward Transconductance	V <sub>CE</sub> =20V, I <sub>C</sub> =15A	-	9	-	S	
<b>DYNAMIC PARAMETERS</b>							
C <sub>ies</sub>	Input Capacitance	V <sub>GE</sub> =0V, V <sub>CC</sub> =25V, f=1MHz	-	655	-	pF	
C <sub>oes</sub>	Output Capacitance		-	68	-	pF	
C <sub>res</sub>	Reverse Transfer Capacitance		-	25	-	pF	
Q <sub>g</sub>	Total Gate Charge	V <sub>GE</sub> =15V, V <sub>CC</sub> =520V, I <sub>C</sub> =15A	-	25.4	-	nC	
Q <sub>ge</sub>	Gate to Emitter Charge		-	7.5	-	nC	
Q <sub>gc</sub>	Gate to Collector Charge		-	11	-	nC	
I <sub>C(SC)</sub>	Short circuit collector current	V <sub>GE</sub> =15V, V <sub>CC</sub> =400V, t <sub>sc</sub> ≤5μs, T <sub>J</sub> ≤150°C	-	70	-	A	
R <sub>g</sub>	Gate resistance	V <sub>GE</sub> =0V, V <sub>CC</sub> =0V, f=1MHz	-	5.8	-	Ω	
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=25°C)</b>							
t <sub>D(on)</sub>	Turn-On Delay Time	T <sub>J</sub> =25°C V <sub>GE</sub> =15V, V <sub>CC</sub> =400V, I <sub>C</sub> =15A, R <sub>G</sub> =20Ω	-	10	-	ns	
t <sub>r</sub>	Turn-On Rise Time		-	17	-	ns	
t <sub>D(off)</sub>	Turn-Off Delay Time		-	68	-	ns	
t <sub>f</sub>	Turn-Off Fall Time		-	16	-	ns	
E <sub>on</sub>	Turn-On Energy		-	0.28	-	mJ	
E <sub>off</sub>	Turn-Off Energy		-	0.19	-	mJ	
E <sub>total</sub>	Total Switching Energy		-	0.47	-	mJ	
t <sub>rr</sub>	Diode Reverse Recovery Time		T <sub>J</sub> =25°C	-	263	-	ns
Q <sub>rr</sub>	Diode Reverse Recovery Charge		I <sub>F</sub> =10A, di/dt=200A/μs, V <sub>CC</sub> =400V	-	0.4	-	μC
I <sub>rm</sub>	Diode Peak Reverse Recovery Current		-	-	3.8	-	A
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=150°C)</b>							
t <sub>D(on)</sub>	Turn-On Delay Time	T <sub>J</sub> =150°C V <sub>GE</sub> =15V, V <sub>CC</sub> =400V, I <sub>C</sub> =15A, R <sub>G</sub> =20Ω	-	9	-	ns	
t <sub>r</sub>	Turn-On Rise Time		-	18	-	ns	
t <sub>D(off)</sub>	Turn-Off Delay Time		-	80	-	ns	
t <sub>f</sub>	Turn-Off Fall Time		-	28	-	ns	
E <sub>on</sub>	Turn-On Energy		-	0.3	-	mJ	
E <sub>off</sub>	Turn-Off Energy		-	0.31	-	mJ	
E <sub>total</sub>	Total Switching Energy		-	0.61	-	mJ	
t <sub>rr</sub>	Diode Reverse Recovery Time		T <sub>J</sub> =150°C	-	262	-	ns
Q <sub>rr</sub>	Diode Reverse Recovery Charge		I <sub>F</sub> =10A, di/dt=200A/μs, V <sub>CC</sub> =400V	-	0.6	-	μC
I <sub>rm</sub>	Diode Peak Reverse Recovery Current		-	-	4.5	-	A

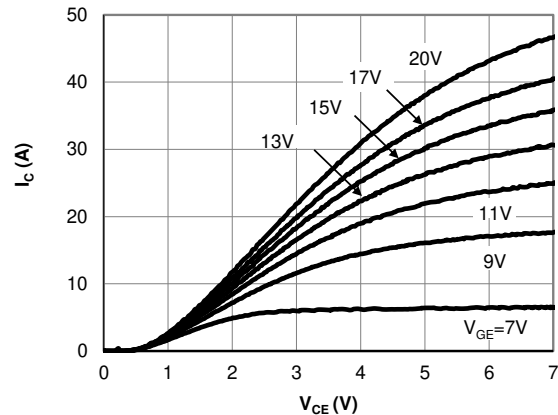
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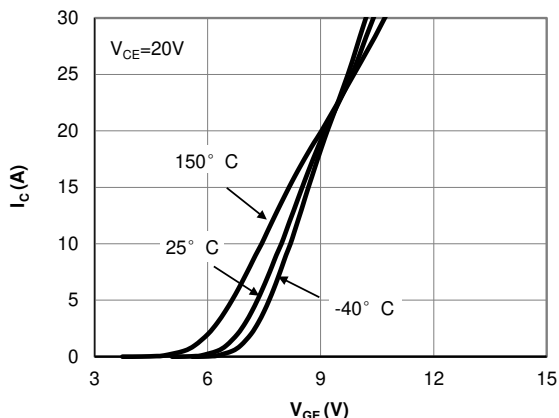
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



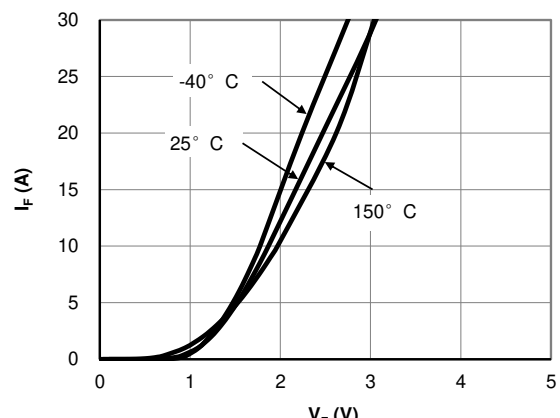
**Figure 1: Output Characteristic**  
( $T_j=25^\circ\text{C}$ )



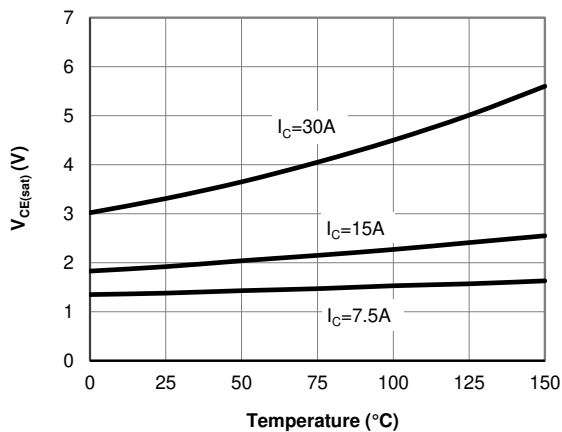
**Figure 2: Output Characteristic**  
( $T_j=150^\circ\text{C}$ )



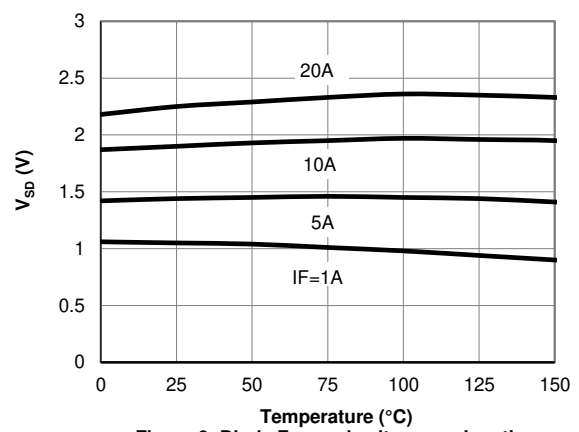
**Figure 3: Transfer Characteristic**



**Figure 4: Diode Characteristic**

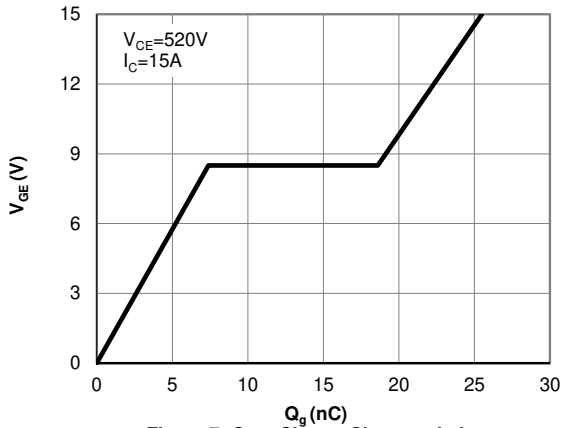


**Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature**

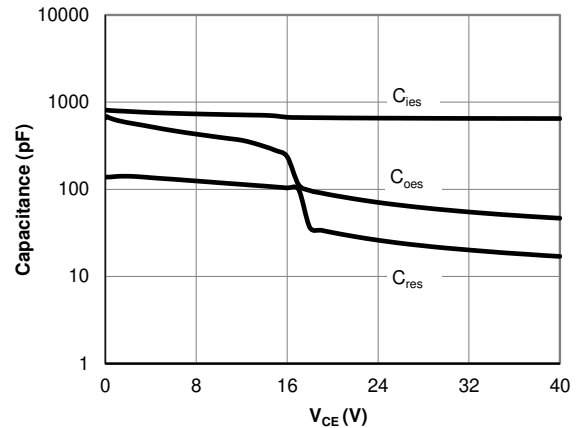


**Figure 6: Diode Forward voltage vs. Junction Temperature**

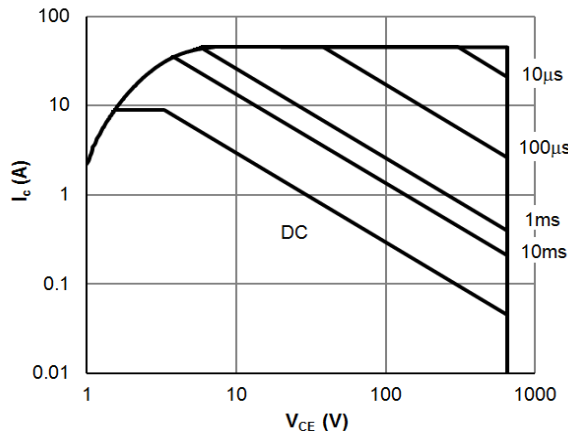
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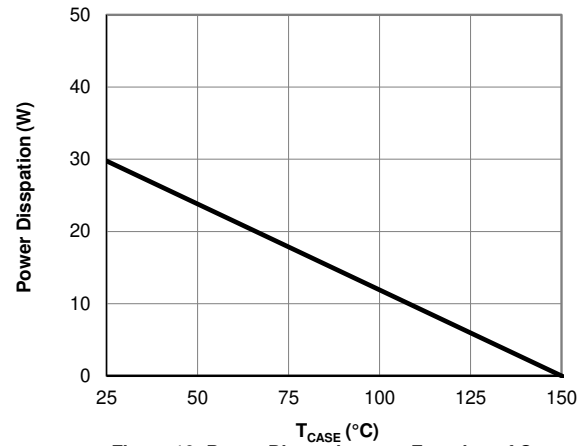
**Figure 7: Gate-Charge Characteristics**



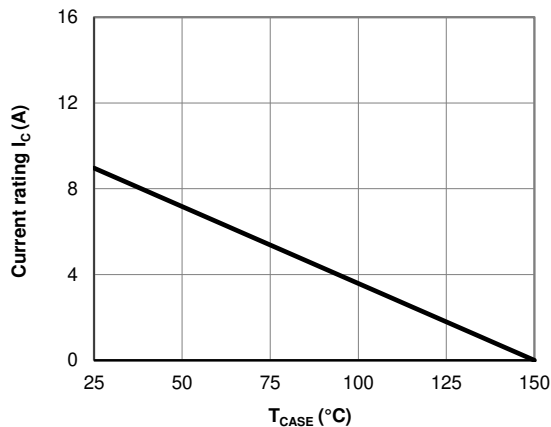
**Figure 8: Capacitance Characteristic**



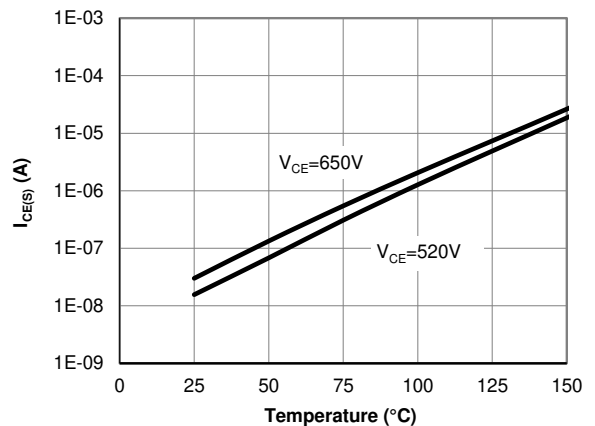
**Figure 9: Forward Bias Safe Operating Area**  
( $T_C=25^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ )



**Figure 10: Power Dissipation as a Function of Case**

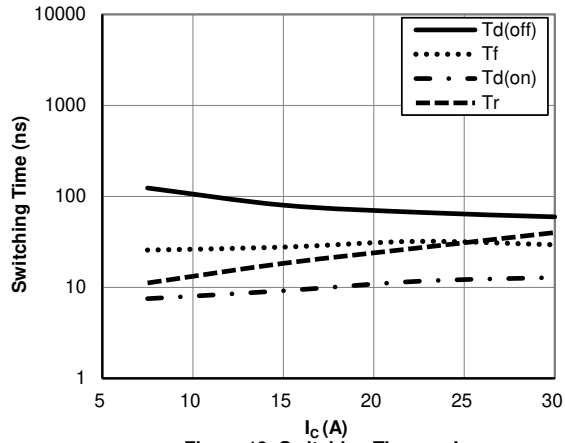


**Figure 11: Current De-rating**

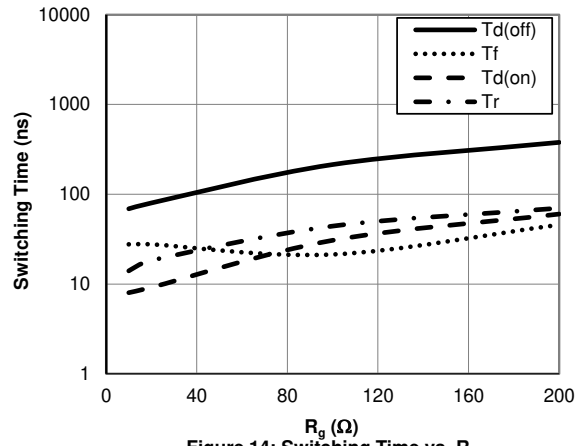


**Figure 12: Diode Reverse Leakage Current vs. Junction Temperature**

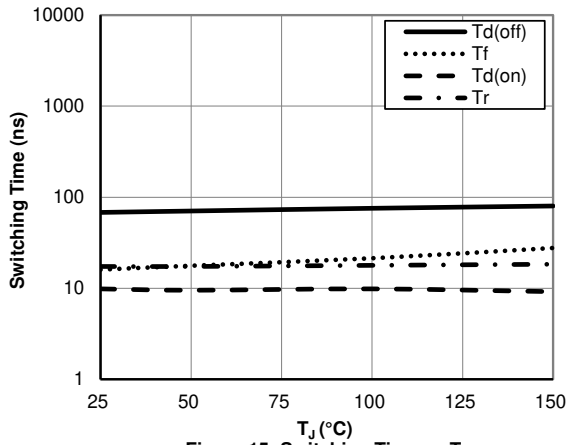
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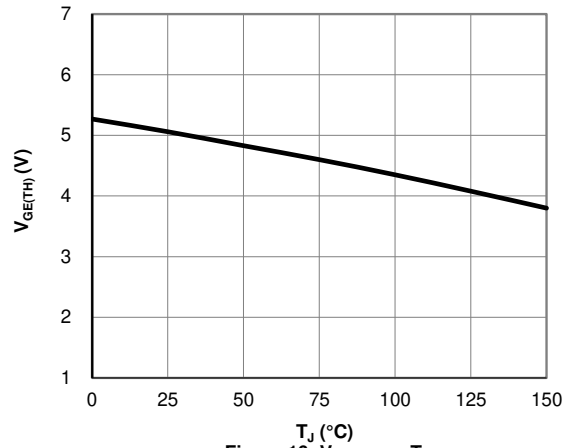
**Figure 13: Switching Time vs.  $I_C$**   
( $T_J=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $R_g=20\Omega$ )



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

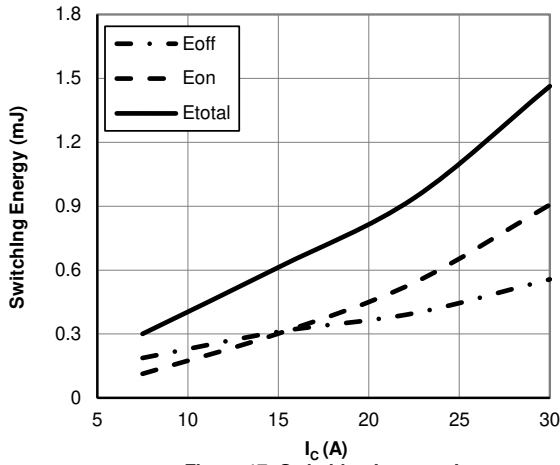


**Figure 15: Switching Time vs.  $T_J$**   
( $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_C=15\text{A}$ ,  $R_g=20\Omega$ )

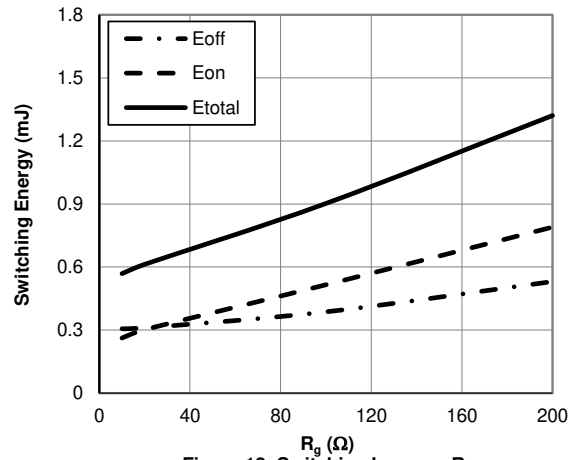


**Figure 16:  $V_{GE(TH)}$  vs.  $T_J$**

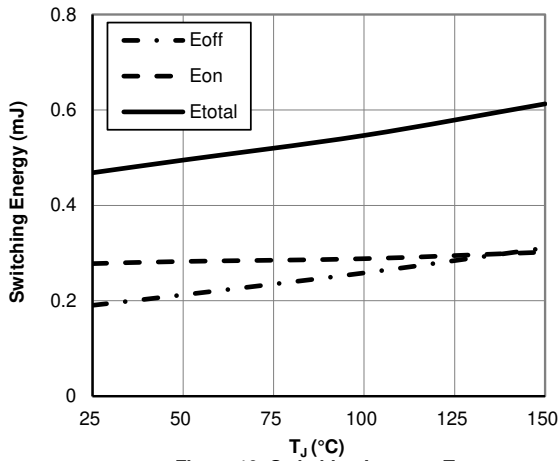
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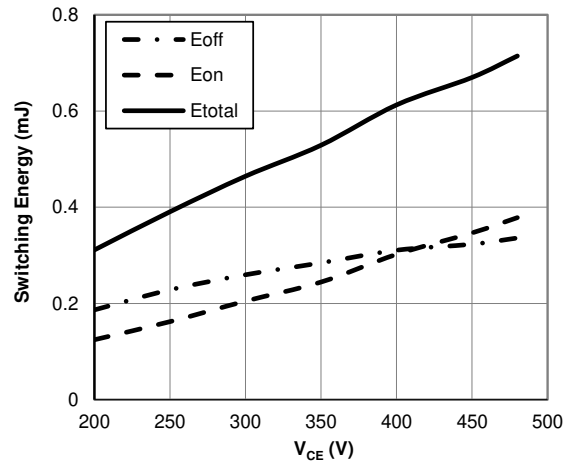
**Figure 17: Switching Loss vs.  $I_C$**   
( $T_j=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $R_g=20\Omega$ )



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

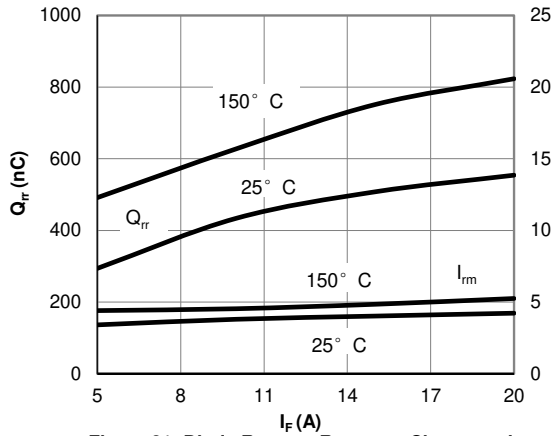


**Figure 19: Switching Loss vs.  $T_j$**   
( $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_C=15\text{A}$ ,  $R_g=20\Omega$ )

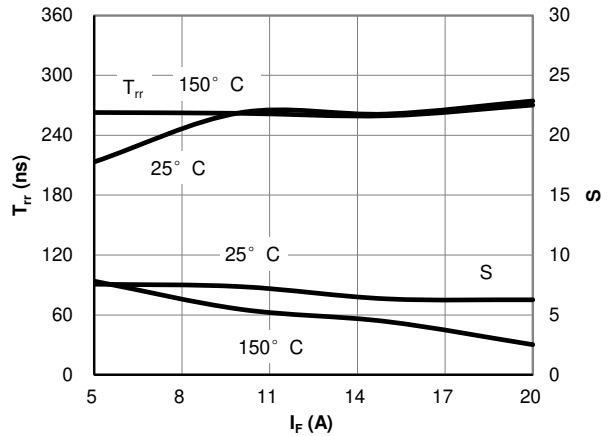


**Figure 20: Switching Loss vs.  $V_{CE}$**   
( $T_j=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=15\text{A}$ ,  $R_g=20\Omega$ )

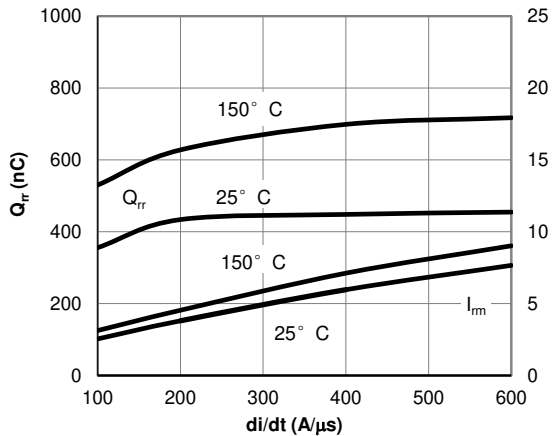
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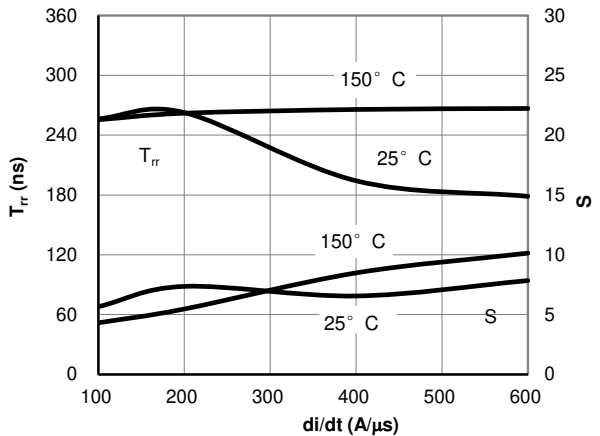
**Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current**  
( $V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$ )



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

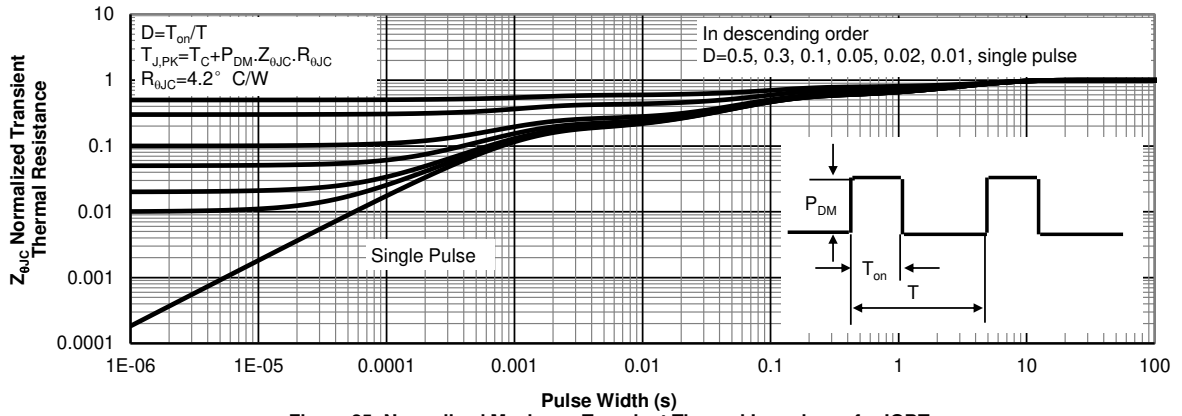


**Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt**  
( $V_{GE}=15V, V_{CE}=400V, I_F=10A$ )

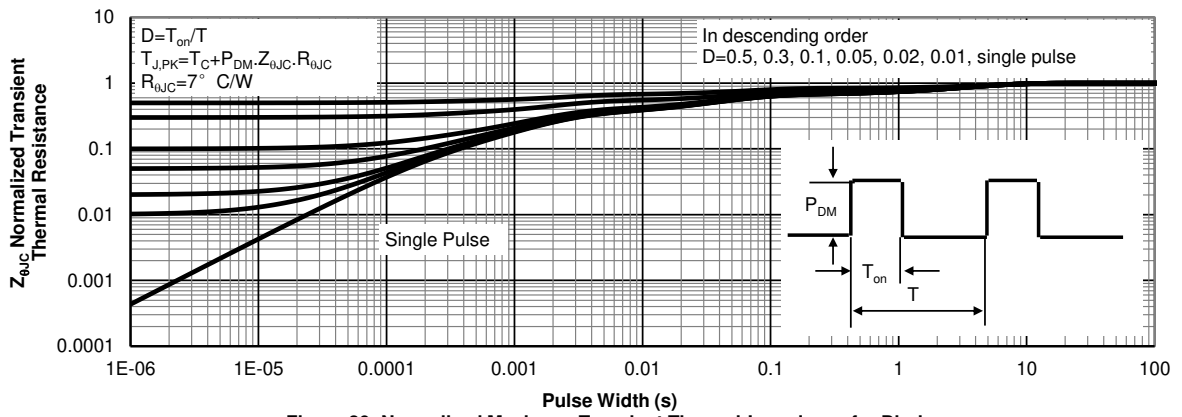


**Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt**  
( $V_{GE}=15V, V_{CE}=400V, I_F=10A$ )

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



**Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT**



**Figure 26: Normalized Maximum Transient Thermal Impedance for Diode**



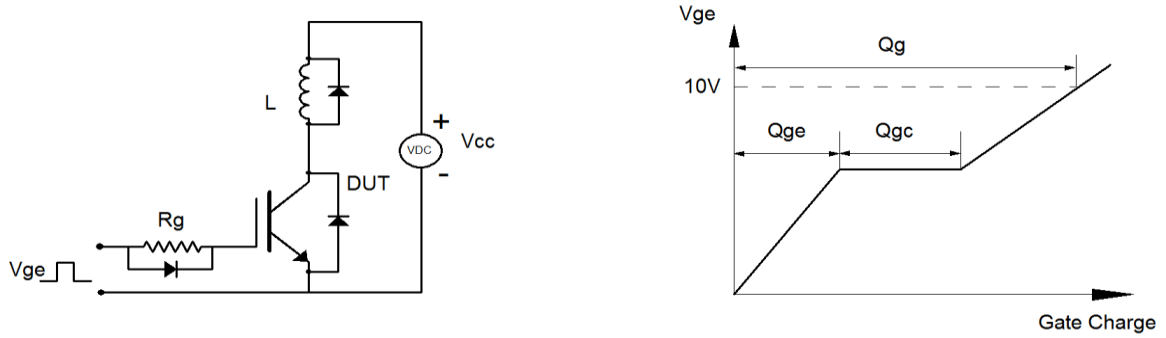


Figure A: Gate Charge Test Circuit & Waveforms

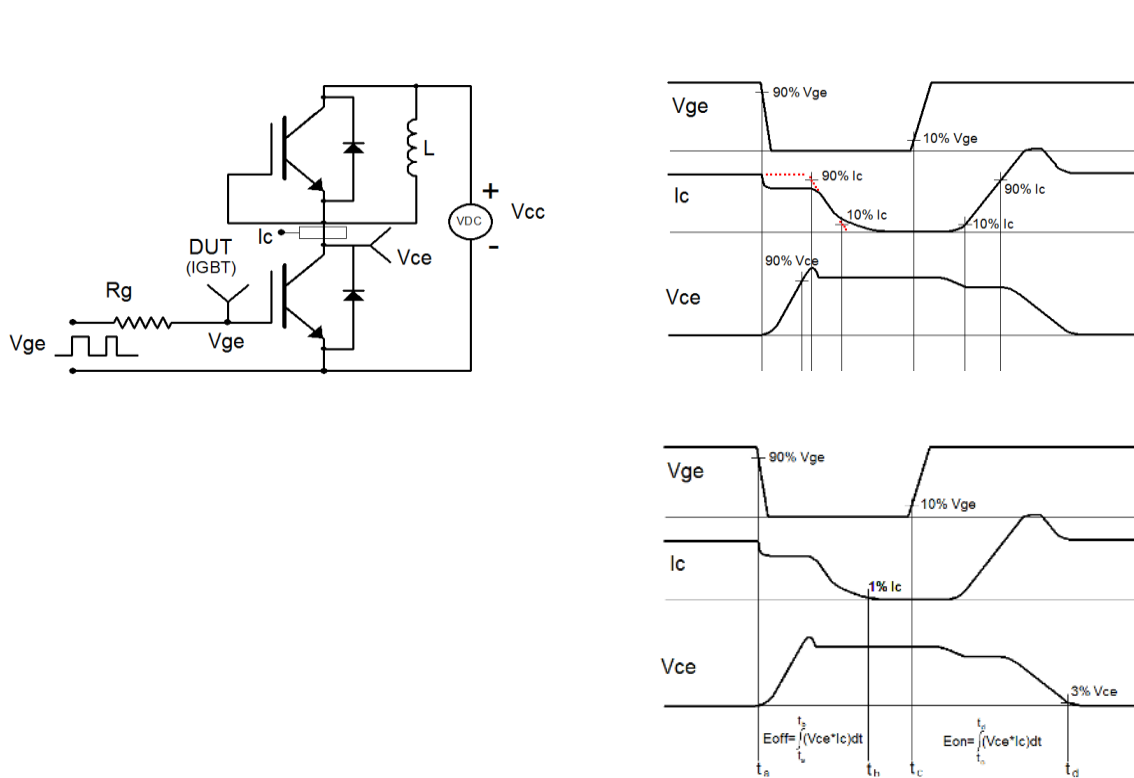


Figure B: Inductive Switching Test Circuit & Waveforms

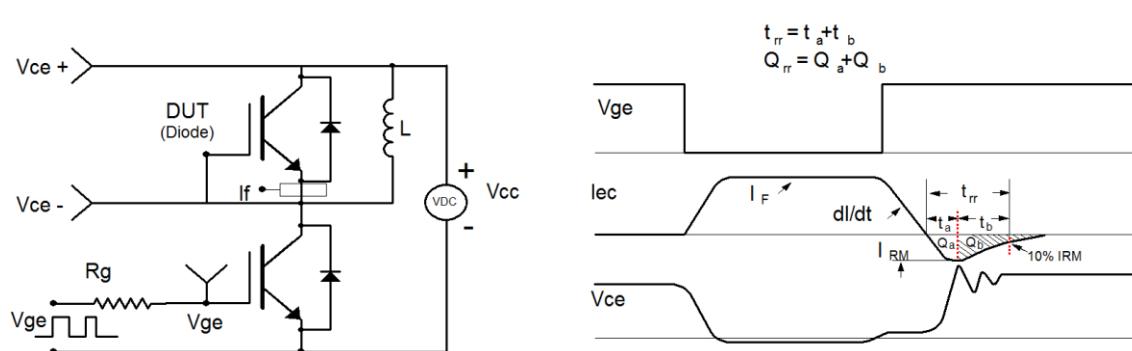


Figure C: Diode Recovery Test Circuit & Waveforms