

## 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-package diode is targeted for minimal losses in motor control applications.

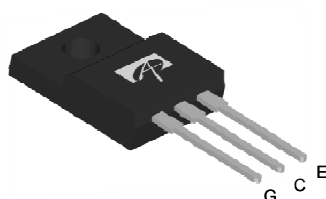
## Product Summary

$V_{CE}$	600V
$I_C$ ( $T_C=100^\circ\text{C}$ )	15A
$V_{CE(sat)}$ ( $T_J=25^\circ\text{C}$ )	1.53V

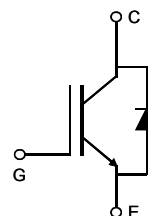


Top View

TO-220F



AOTF15B60D2



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

Parameter	Symbol	AOTF15B60D2	Units
Collector-Emitter Voltage	$V_{CE}$	600	V
Gate-Emitter Voltage	$V_{GE}$	$\pm 20$	V
Continuous Collector Current <sup>A</sup>	$I_C$	$T_C=25^\circ\text{C}$	23 <sup>B</sup>
		$T_C=100^\circ\text{C}$	15
Pulsed Collector Current, Limited by $T_{Jmax}$	$I_{CM}$	40	A
Turn off SOA, $V_{CE} \leq 600\text{V}$ , Limited by $T_{Jmax}$	$I_{LM}$	40	A
Continuous Diode Forward Current <sup>A</sup>	$I_F$	$T_C=25^\circ\text{C}$	23 <sup>B</sup>
		$T_C=100^\circ\text{C}$	15
Diode Pulsed Current, Limited by $T_{Jmax}$	$I_{FM}$	40	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	$\mu\text{s}$
Power Dissipation	$P_D$	$T_C=25^\circ\text{C}$	42
		$T_C=100^\circ\text{C}$	16.7
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	AOTF15B60D2	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	$^\circ\text{C}/\text{W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	3	$^\circ\text{C}/\text{W}$
Maximum Diode Junction-to-Case	$R_{\theta JC}$	4	$^\circ\text{C}/\text{W}$

Note A: With 50% duty cycle and 300 $\mu\text{s}$  pulse width

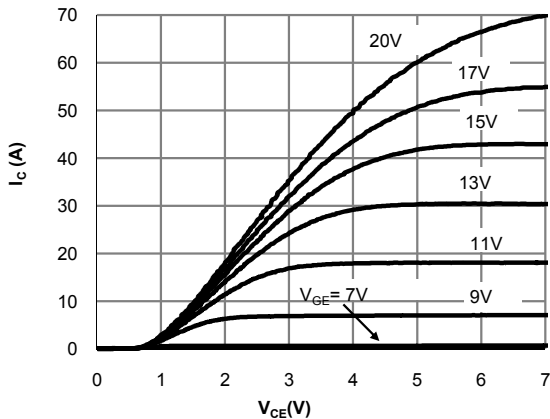
Note B:  $I_C$  limited by package limitation

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

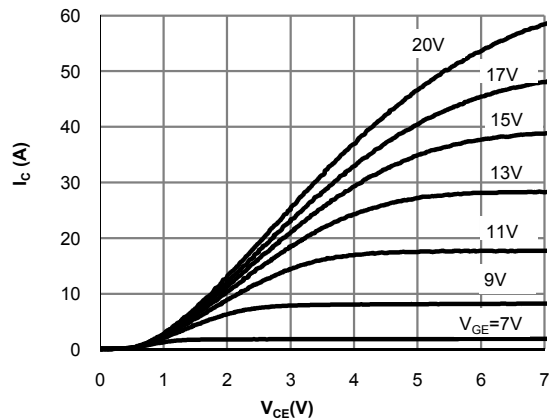
Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>STATIC PARAMETERS</b>							
$BV_{CES}$	Collector-Emitter Breakdown Voltage	$I_C=250\mu A, V_{GE}=0V, T_J=25^\circ C$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15V, I_C=10A$	$T_J=25^\circ C$	-	1.53	1.8	V
			$T_J=125^\circ C$	-	1.75	-	
			$T_J=150^\circ C$	-	1.81	-	
$V_F$	Diode Forward Voltage	$V_{GE}=0V, I_C=10A$	$T_J=25^\circ C$	-	1.52	1.85	V
			$T_J=125^\circ C$	-	1.48	-	
			$T_J=150^\circ C$	-	1.44	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=V_{GE}, I_C=250\mu A$	-	5.6	-	V	
$I_{CES}$	Zero Gate Voltage Collector Current	$V_{CE}=600V, V_{GE}=0V$	$T_J=25^\circ C$	-	-	10	$\mu A$
			$T_J=125^\circ C$	-	-	200	
			$T_J=150^\circ C$	-	-	1000	
$I_{GES}$	Gate-Emitter leakage current	$V_{CE}=0V, V_{GE}=\pm 20V$	-	-	$\pm 100$	nA	
$g_{FS}$	Forward Transconductance	$V_{CE}=20V, I_C=10A$	-	4.8	-	S	
<b>DYNAMIC PARAMETERS</b>							
$C_{ies}$	Input Capacitance	$V_{GE}=0V, V_{CE}=25V, f=1MHz$	-	824	-	pF	
$C_{oes}$	Output Capacitance		-	68	-	pF	
$C_{res}$	Reverse Transfer Capacitance		-	2.7	-	pF	
$Q_g$	Total Gate Charge	$V_{GE}=15V, V_{CE}=480V, I_C=10A$	-	17.4	-	nC	
$Q_{ge}$	Gate to Emitter Charge		-	6.2	-	nC	
$Q_{gc}$	Gate to Collector Charge		-	6.3	-	nC	
$I_{C(SC)}$	Short circuit collector current, Max. 1000 short circuits, Delay between short circuits $\geq 1.0s$	$V_{GE}=15V, V_{CE}=400V, R_G=30\Omega$	-	43	-	A	
$R_g$	Gate resistance	$V_{GE}=0V, V_{CE}=0V, f=1MHz$	-	3.2	-	$\Omega$	
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=25°C)</b>							
$t_{D(on)}$	Turn-On DelayTime	$T_J=25^\circ C, V_{GE}=15V, V_{CE}=400V, I_C=10A, R_G=30\Omega, \text{Parasitic Inductance}=100nH$	-	10	-	ns	
$t_r$	Turn-On Rise Time		-	15	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	72	-	ns	
$t_f$	Turn-Off Fall Time		-	8.8	-	ns	
$E_{on}$	Turn-On Energy		-	0.26	-	mJ	
$E_{off}$	Turn-Off Energy		-	0.07	-	mJ	
$E_{total}$	Total Switching Energy		-	0.33	-	mJ	
$t_{rr}$	Diode Reverse Recovery Time		$T_J=25^\circ C$	-	105	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		$I_F=10A, dl/dt=200A/\mu s, V_{CE}=400V$	-	0.25	-	$\mu C$
$I_{rm}$	Diode Peak Reverse Recovery Current			-	5	-	A
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=150°C)</b>							
$t_{D(on)}$	Turn-On DelayTime	$T_J=150^\circ C, V_{GE}=15V, V_{CE}=400V, I_C=10A, R_G=30\Omega, \text{Parasitic Inductance}=100nH$	-	10.4	-	ns	
$t_r$	Turn-On Rise Time		-	15.6	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	91	-	ns	
$t_f$	Turn-Off Fall Time		-	10.4	-	ns	
$E_{on}$	Turn-On Energy		-	0.35	-	mJ	
$E_{off}$	Turn-Off Energy		-	0.16	-	mJ	
$E_{total}$	Total Switching Energy		-	0.51	-	mJ	
$t_{rr}$	Diode Reverse Recovery Time		$T_J=150^\circ C$	-	194	-	ns
$Q_{rr}$	Diode Reverse Recovery Charge		$I_F=10A, dl/dt=200A/\mu s, V_{CE}=400V$	-	0.55	-	$\mu C$
$I_{rm}$	Diode Peak Reverse Recovery Current			-	6.3	-	A

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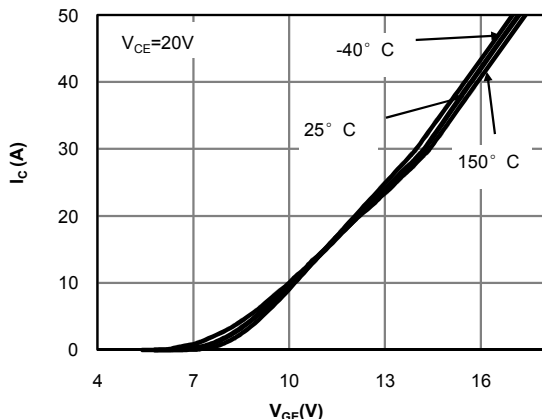
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



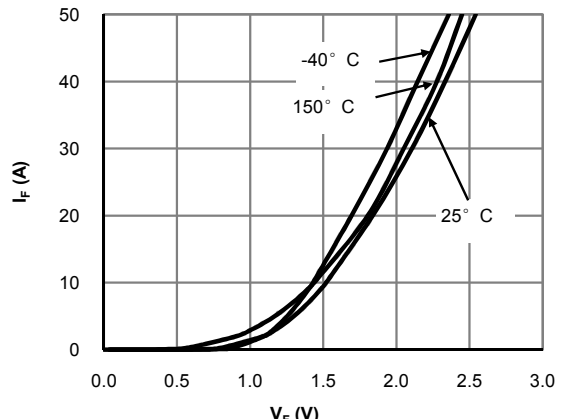
**Fig 1: Output Characteristic**  
( $T_j=25^\circ\text{C}$ )



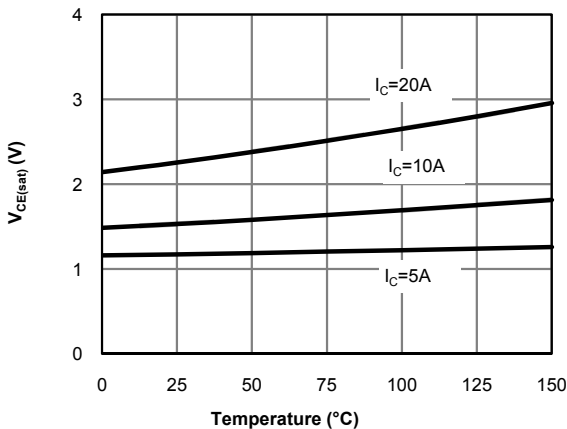
**Fig 2: Output Characteristic**  
( $T_j=150^\circ\text{C}$ )



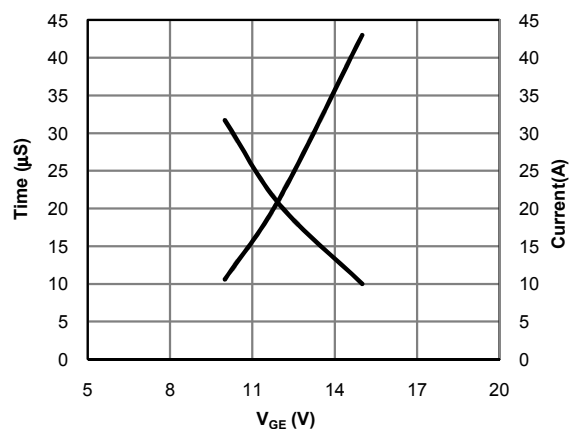
**Fig 3: Transfer Characteristic**



**Fig 4: Diode Characteristic**

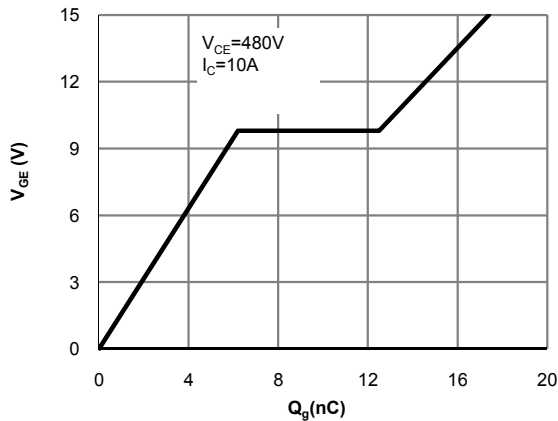


**Fig 5: Collector-Emitter Saturation Voltage vs. Junction Temperature**

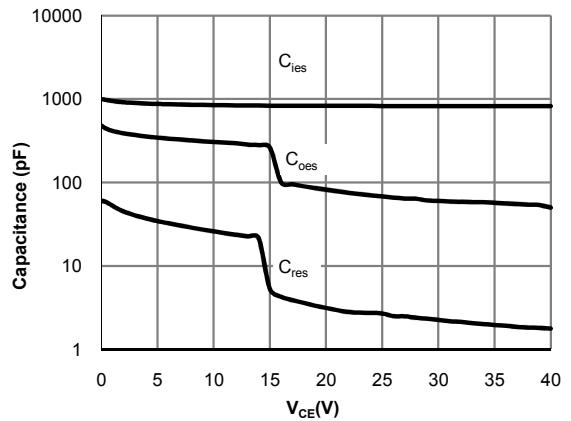


**Fig 6:  $V_{GE}$  vs. Short Circuit Time**  
( $V_{CE}=400V, T_C=25^\circ\text{C}$ )

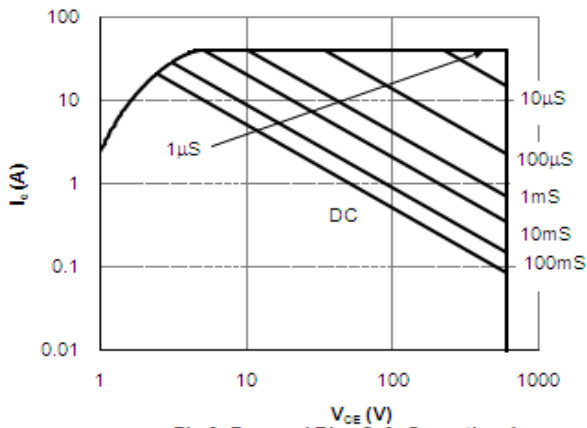
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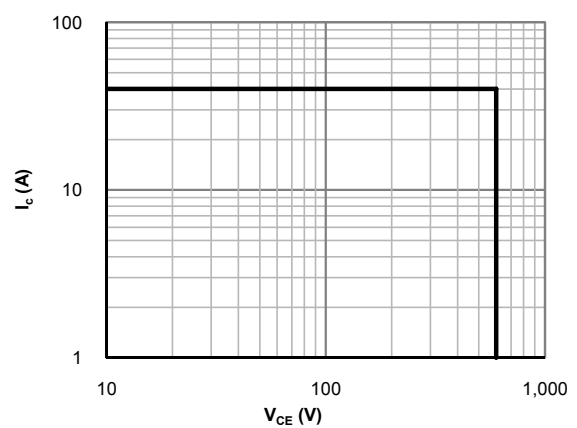
**Fig 7: Gate-Charge Characteristics**



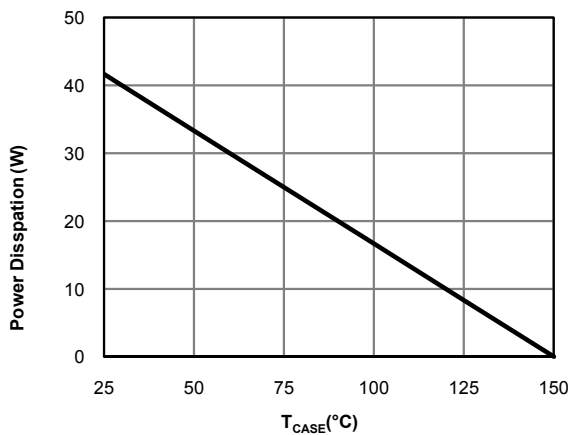
**Fig 8: Capacitance Characteristic**



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

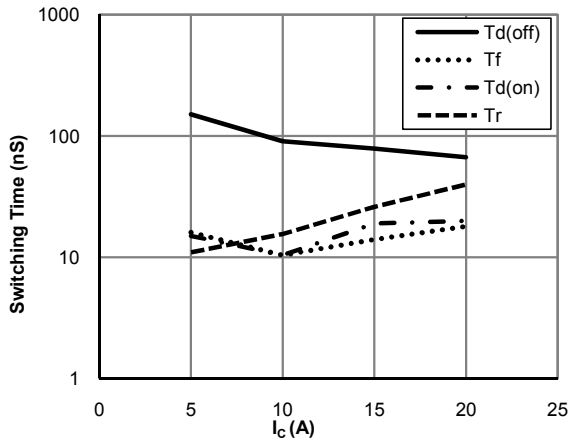


**Fig 10: Reverse Bias SOA**  
( $T_J = 150^\circ\text{C}, V_{GE} = 15\text{V}$ )

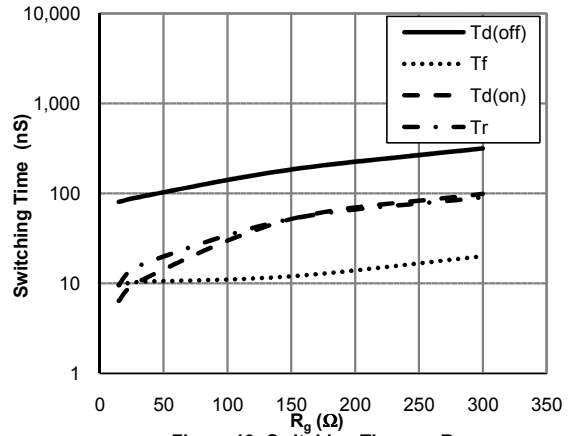


**Fig 11: Power Dissipation as a Function of Case**

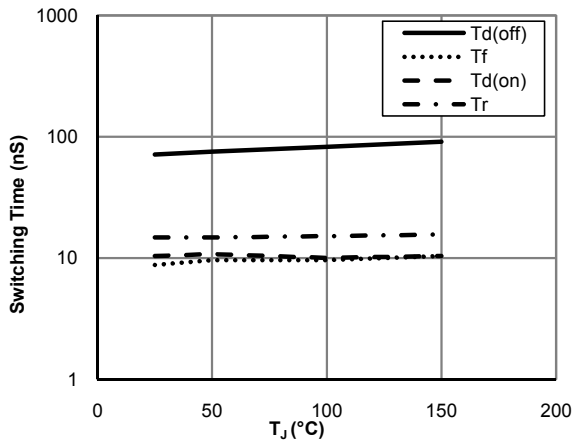
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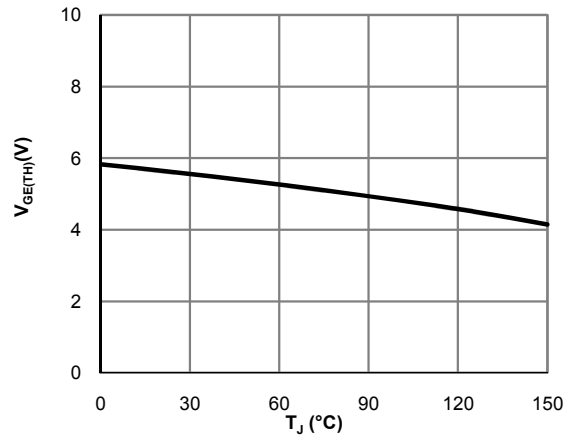
**Figure 12: Switching Time vs.  $I_c$**   
( $T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=30\Omega$ )



**Figure 13: Switching Time vs.  $R_g$**   
( $T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}$ )

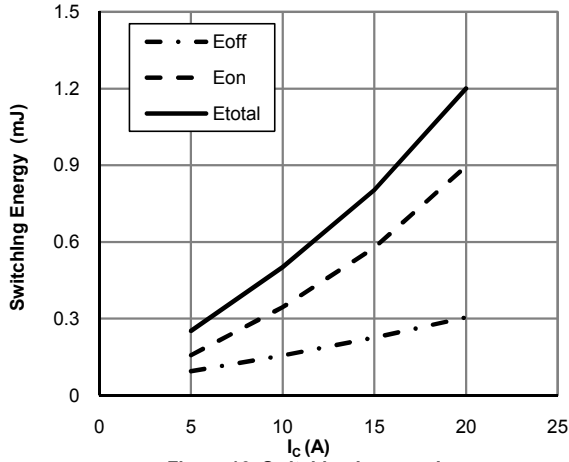


**Figure 14: Switching Time vs.  $T_J$**   
( $V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_c=10\text{A}, R_g=30\Omega$ )

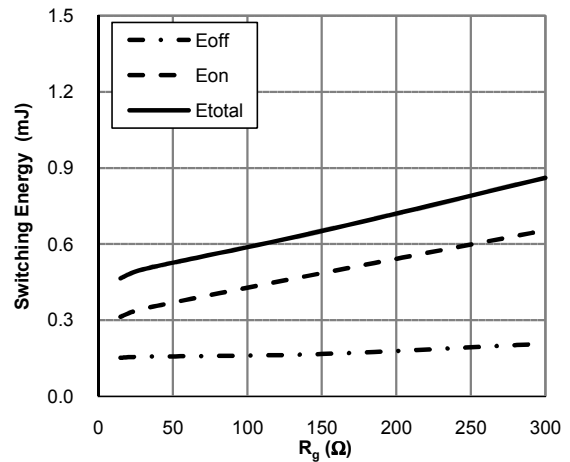


**Figure 15:  $V_{GE(TH)}$  vs.  $T_J$**

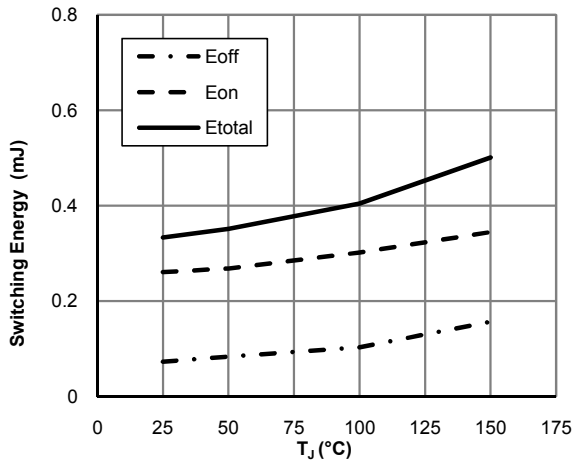
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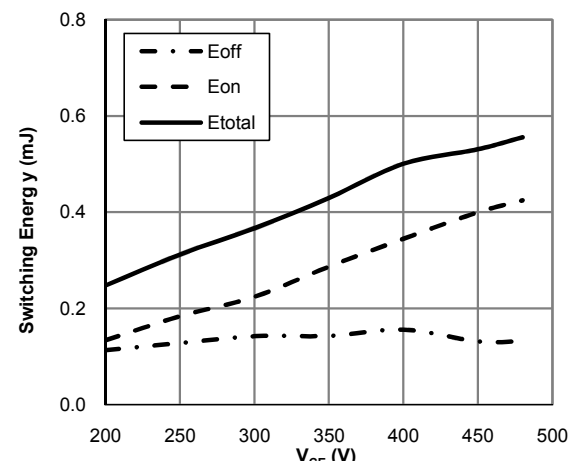
**Figure 16: Switching Loss vs.  $I_C$**   
( $T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, R_g=30\Omega$ )



**Figure 17: Switching Loss vs.  $R_g$**   
( $T_J=150^\circ\text{C}, V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=10\text{A}$ )

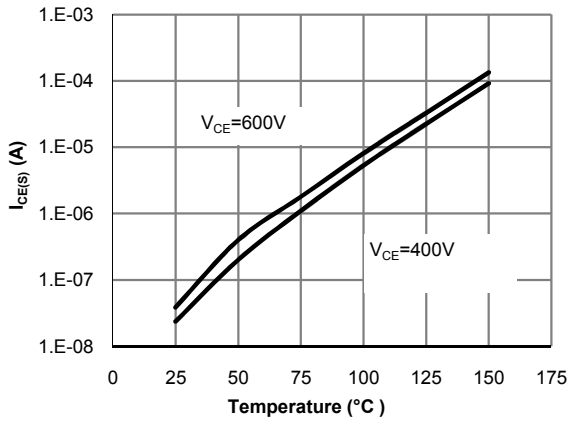


**Figure 18: Switching Loss vs.  $T_J$**   
( $V_{GE}=15\text{V}, V_{CE}=400\text{V}, I_C=10\text{A}, R_g=30\Omega$ )

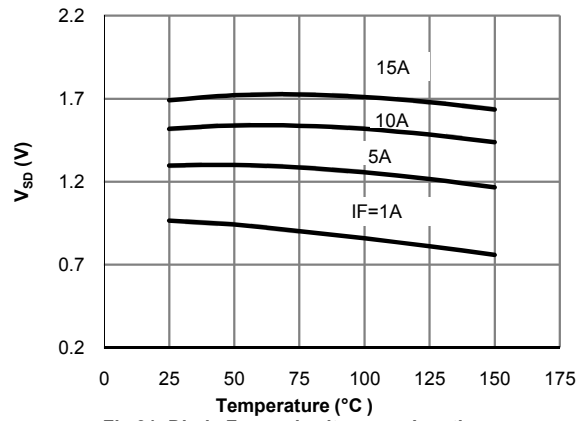


**Figure 19: Switching Loss vs.  $V_{CE}$**   
( $T_J=150^\circ\text{C}, V_{GE}=15\text{V}, I_C=10\text{A}, R_g=30\Omega$ )

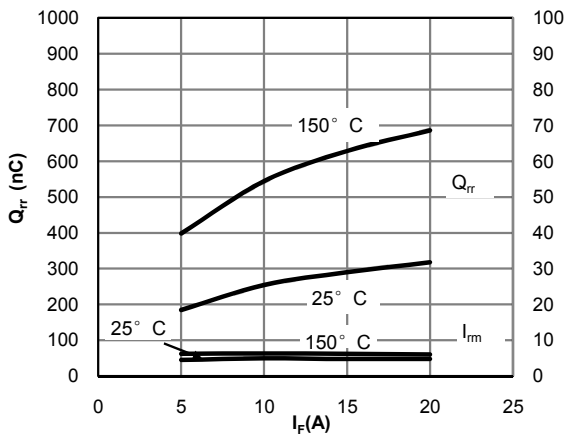
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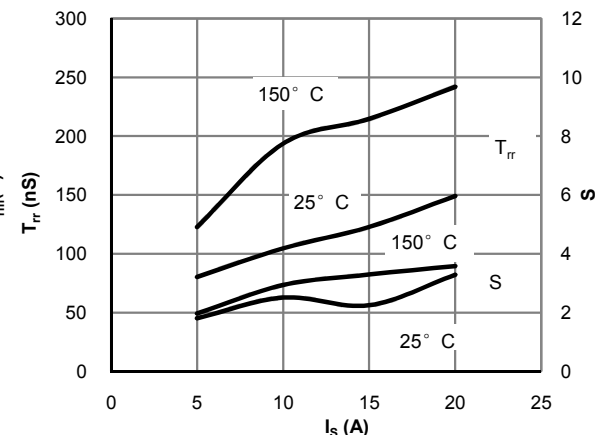
**Fig 20: Diode Reverse Leakage Current vs. Junction Temperature**



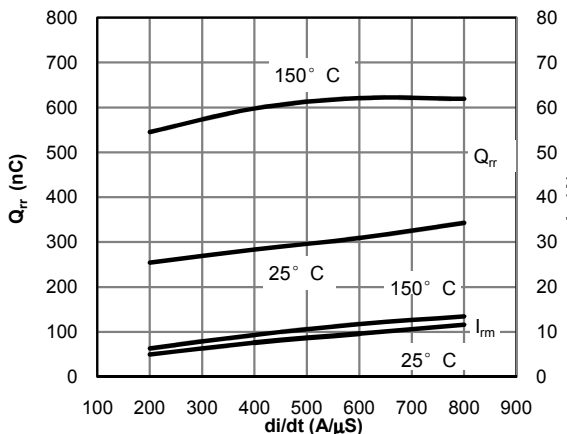
**Fig 21: Diode Forward Voltage vs. Junction Temperature**



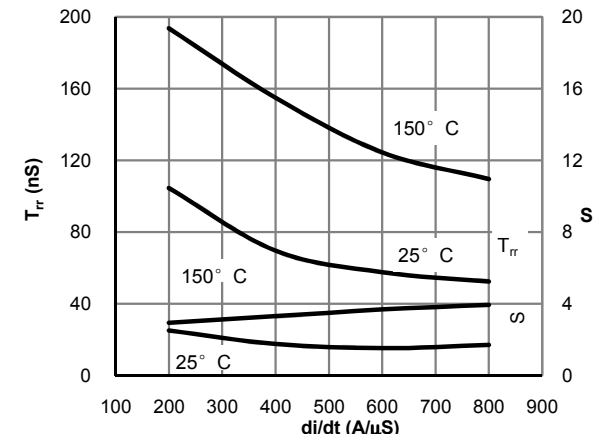
**Fig 22: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current**  
( $V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$ )



**Fig 23: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current**  
( $V_{GE}=15V, V_{CE}=400V, di/dt=200A/\mu s$ )

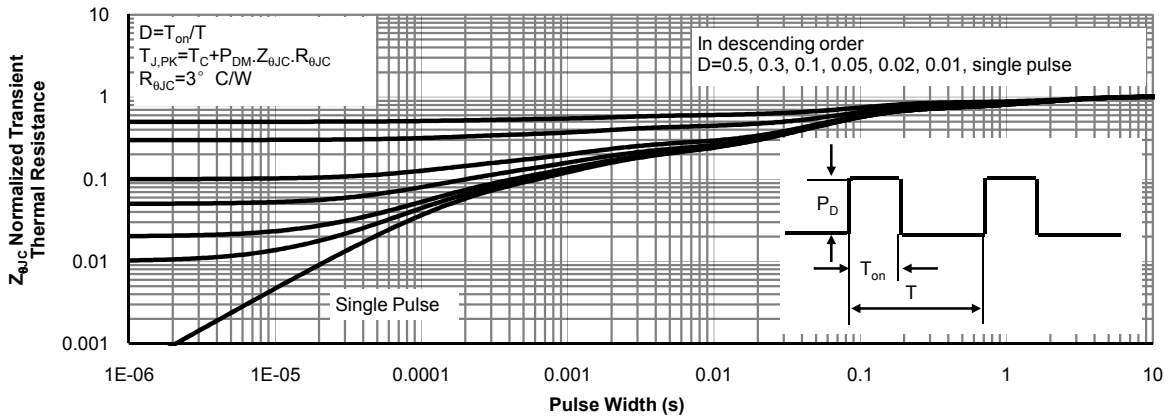


**Fig 24: Diode Reverse Recovery Charge and Peak Current vs. di/dt**  
( $V_{GE}=15V, V_{CE}=400V, I_F=10A$ )

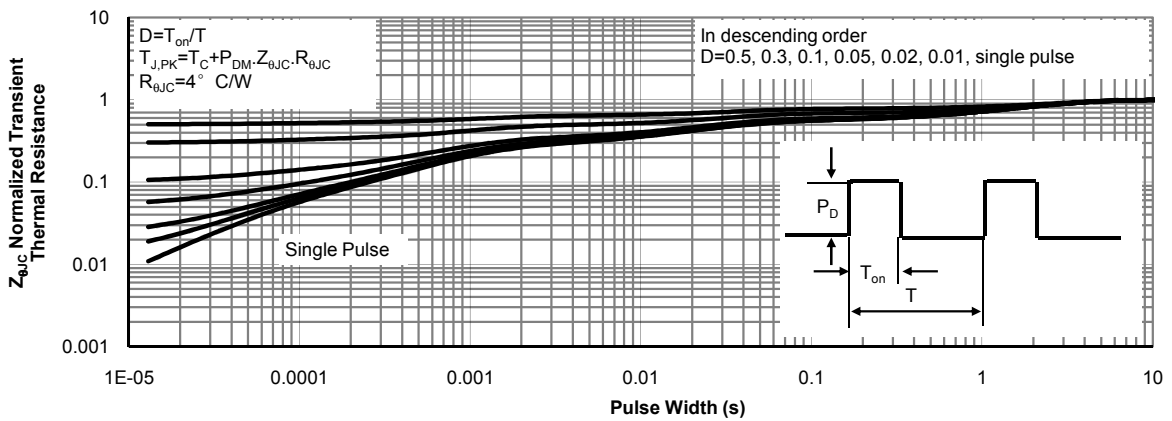


**Fig 25: Diode Reverse Recovery Time and Softness Factor vs. di/dt**  
( $V_{GE}=15V, V_{CE}=400V, I_F=10A$ )

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



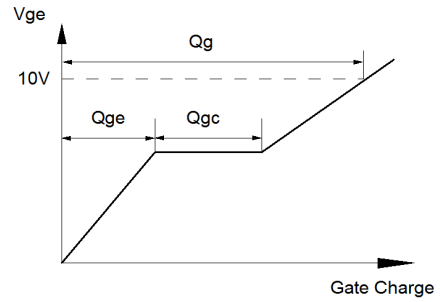
**Figure 26: Normalized Maximum Transient Thermal Impedance for IGBT**



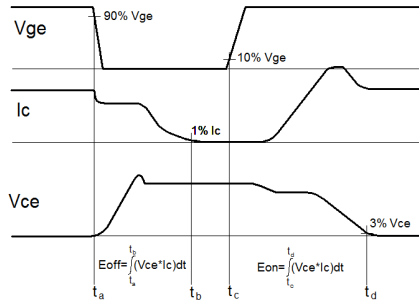
**Figure 27: Normalized Maximum Transient Thermal Impedance for Diode**



**Gate Charge Test Circuit & Waveform**



**Inductive Switching Test Circuit & Waveforms**



**Diode Recovery Test Circuit & Waveforms**

