

### General Description

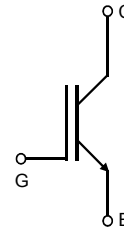
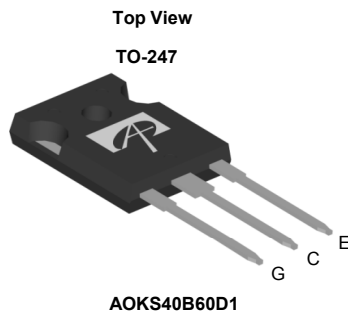
- Latest Alpha IGBT ( $\alpha$  IGBT) technology
- High efficient turn-on di/dt controllability
- Very high switching speed
- Low turn-off switching loss and softness
- Very good EMI behavior
- Short-circuit ruggedness

### Applications

- Power factor correction
- UPS & Solar Inverters
- Very High Switching Frequency Applications
- Welding Machines

### Product Summary

$V_{CE}$	600V
$I_C$ ( $T_C=100^\circ\text{C}$ )	40A
$V_{CE(sat)}$ ( $T_C=25^\circ\text{C}$ )	1.85V



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

Parameter	Symbol	AOKS40B60D1	Units
Collector-Emitter Voltage	$V_{CE}$	600	V
Gate-Emitter Voltage	$V_{GE}$	$\pm 20$	V
$V_{GE}$ Spike	500ns $V_{SPIKE}$	24	V
Continuous Collector Current	$I_C$	$T_C=25^\circ\text{C}$	80
		$T_C=100^\circ\text{C}$	40
Pulsed Collector Current, Limited by $T_{Jmax}$	$I_{CM}$	140	A
Turn off SOA, $V_{CE} \leq 600\text{V}$ , Limited by $T_{Jmax}$	$I_{LM}$	140	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	$P_D$	$T_C=25^\circ\text{C}$	278
		$T_C=100^\circ\text{C}$	111
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

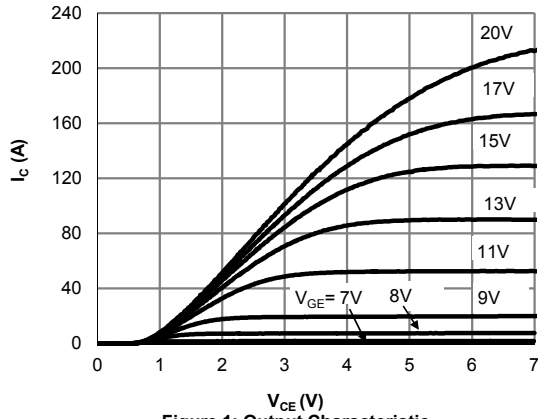
Parameter	Symbol	AOKS40B60D1	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	40	$^\circ\text{C/W}$
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	0.45	$^\circ\text{C/W}$

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

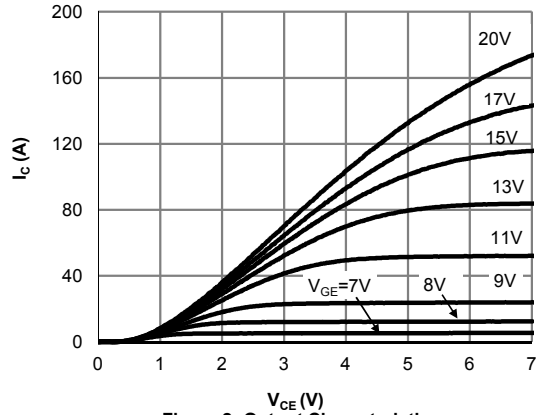
Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>STATIC PARAMETERS</b>							
$BV_{CES}$	Collector-Emitter Breakdown Voltage	$I_C=1mA, V_{GE}=0V, T_J=25^\circ C$	600	-	-	V	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE}=15V, I_C=40A$	$T_J=25^\circ C$	-	1.85	2.4	V
			$T_J=125^\circ C$	-	2.2	-	
			$T_J=150^\circ C$	-	2.3	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$V_{CE}=5V, I_C=1mA$	-	5.5	-	V	
$I_{CES}$	Zero Gate Voltage Collector Current	$V_{CE}=600V, V_{GE}=0V$	$T_J=25^\circ C$	-	-	10	$\mu A$
			$T_J=125^\circ C$	-	-	600	
			$T_J=150^\circ C$	-	-	3000	
$I_{GES}$	Gate-Emitter leakage current	$V_{CE}=0V, V_{GE}=\pm 20V$	-	-	$\pm 100$	nA	
$g_{FS}$	Forward Transconductance	$V_{CE}=20V, I_C=40A$	-	16	-	S	
<b>DYNAMIC PARAMETERS</b>							
$C_{ies}$	Input Capacitance	$V_{GE}=0V, V_{CE}=25V, f=1MHz$	-	1950	-	pF	
$C_{oes}$	Output Capacitance		-	200	-	pF	
$C_{res}$	Reverse Transfer Capacitance		-	9	-	pF	
$Q_g$	Total Gate Charge	$V_{GE}=15V, V_{CE}=480V, I_C=40A$	-	45	-	nC	
$Q_{ge}$	Gate to Emitter Charge		-	17	-	nC	
$Q_{gc}$	Gate to Collector Charge		-	15.6	-	nC	
$I_{C(SC)}$	Short circuit collector current, Max. 1000 short circuits, Delay between short circuits $\geq 1.0s$	$V_{GE}=15V, V_{CE}=400V, R_G=25\Omega$	-	140	-	A	
$R_g$	Gate resistance	$f=1MHz$	-	1.45	-	$\Omega$	
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=25°C)</b>							
$t_{D(on)}$	Turn-On DelayTime	$T_J=25^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=40A,$ $R_G=7.5\Omega,$ Parasitic Inductance=150nH Eon and Etotal include diode (AOK40B60D1) reverse recovery	-	29	-	ns	
$t_r$	Turn-On Rise Time		-	22	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	74	-	ns	
$t_f$	Turn-Off Fall Time		-	15	-	ns	
$E_{on}$	Turn-On Energy		-	1.55	-	mJ	
$E_{off}$	Turn-Off Energy		-	0.3	-	mJ	
$E_{total}$	Total Switching Energy		-	1.85	-	mJ	
<b>SWITCHING PARAMETERS, (Load Inductive, T<sub>J</sub>=150°C)</b>							
$t_{D(on)}$	Turn-On DelayTime	$T_J=150^\circ C$ $V_{GE}=15V, V_{CE}=400V, I_C=40A,$ $R_G=7.5\Omega,$ Parasitic Inductance=150nH Eon and Etotal include diode (AOK40B60D1) reverse recovery	-	29	-	ns	
$t_r$	Turn-On Rise Time		-	24	-	ns	
$t_{D(off)}$	Turn-Off Delay Time		-	85	-	ns	
$t_f$	Turn-Off Fall Time		-	17	-	ns	
$E_{on}$	Turn-On Energy		-	1.7	-	mJ	
$E_{off}$	Turn-Off Energy		-	0.49	-	mJ	
$E_{total}$	Total Switching Energy		-	2.19	-	mJ	

THIS PRODUCT HAS BEEN DESIGNED AND QUALIFIED FOR THE CONSUMER MARKET. APPLICATIONS OR USES 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.

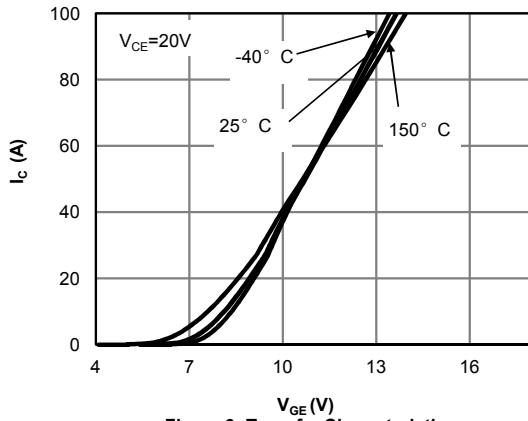
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



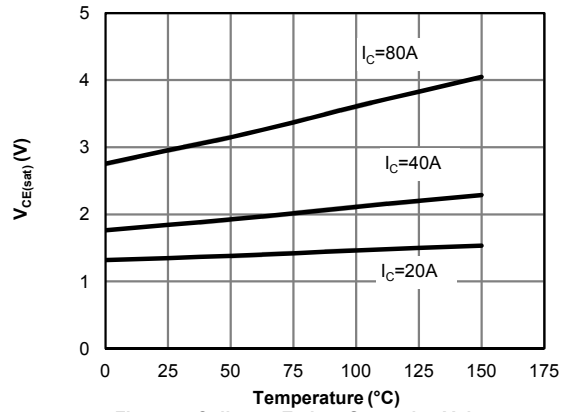
**Figure 1: Output Characteristic**  
( $T_j=25^\circ\text{C}$ )



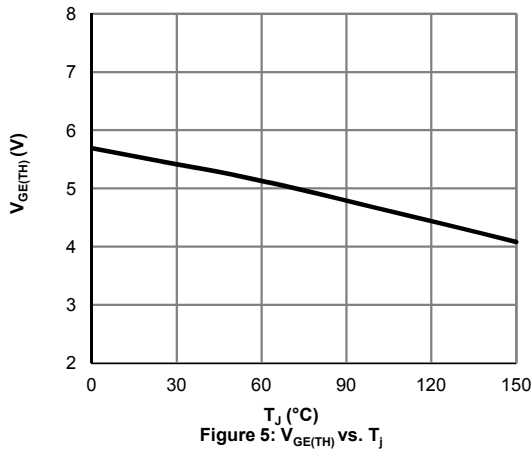
**Figure 2: Output Characteristic**  
( $T_j=150^\circ\text{C}$ )



**Figure 3: Transfer Characteristic**



**Figure 4: Collector-Emitter Saturation Voltage vs. Junction Temperature**



**Figure 5:  $V_{GE(TH)}$  vs.  $T_j$**

**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

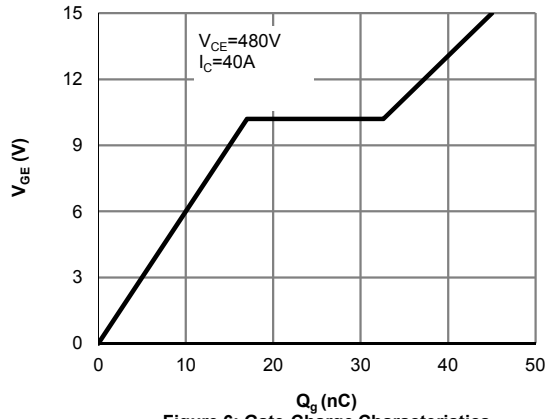


Figure 6: Gate-Charge Characteristics

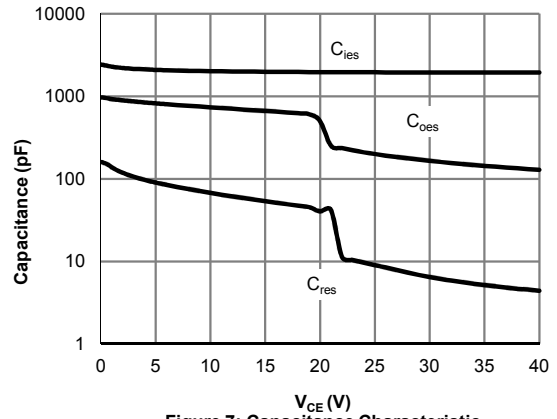


Figure 7: Capacitance Characteristic

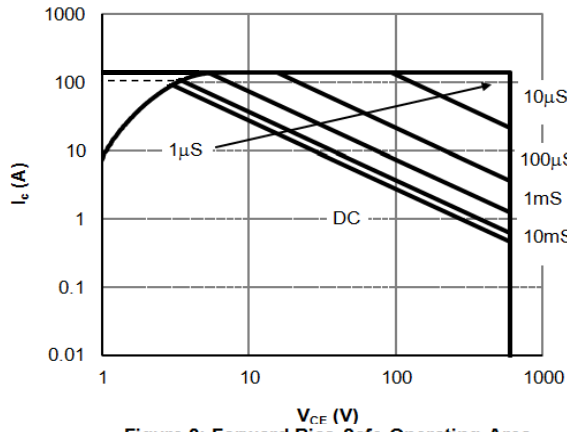


Figure 8: Forward Bias Safe Operating Area  
( $T_C=25^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ )

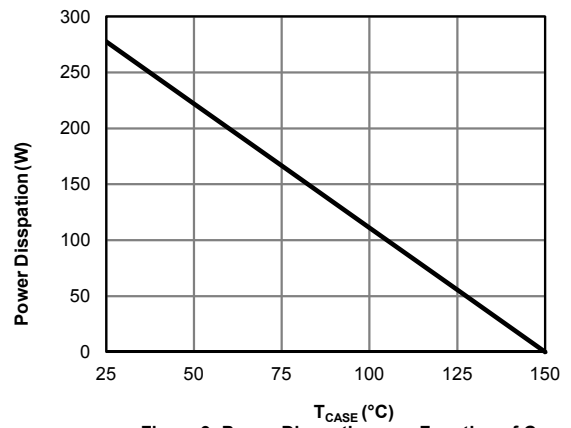


Figure 9: Power Dissipation as a Function of Case

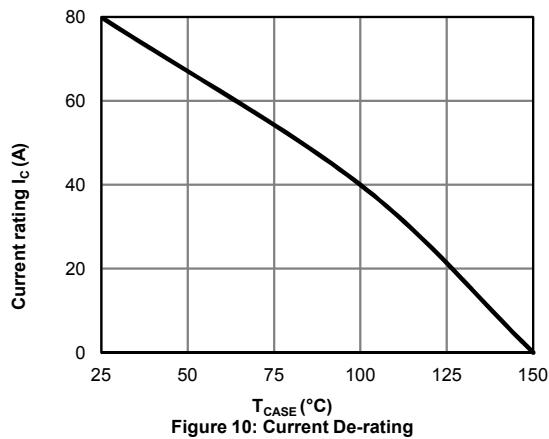
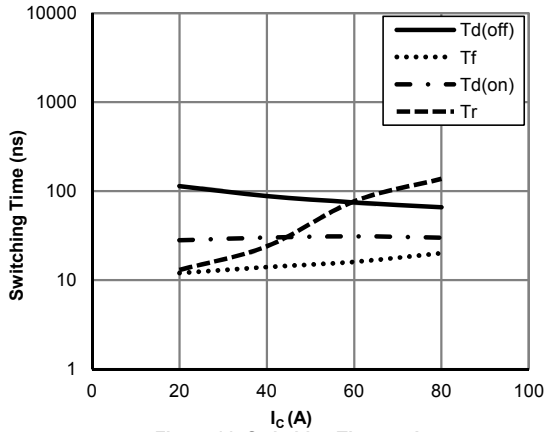
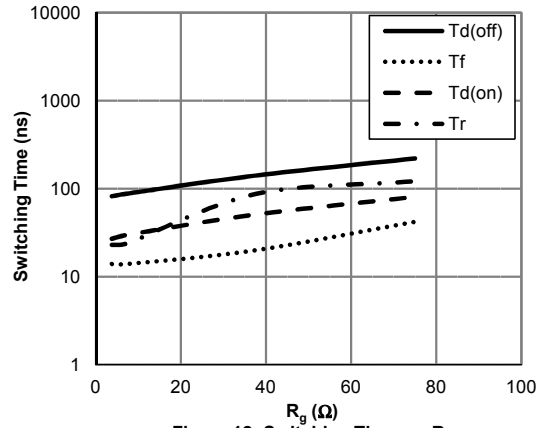


Figure 10: Current De-rating

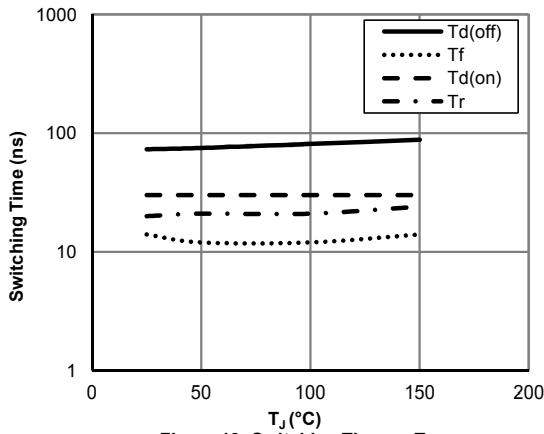
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**



**Figure 11: Switching Time vs.  $I_c$**   
( $T_j=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $R_g=7.5\Omega$ )

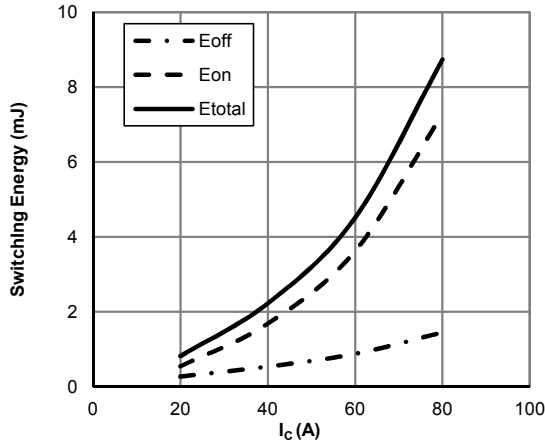


**Figure 12: Switching Time vs.  $R_g$**   
( $T_j=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_c=40\text{A}$ )

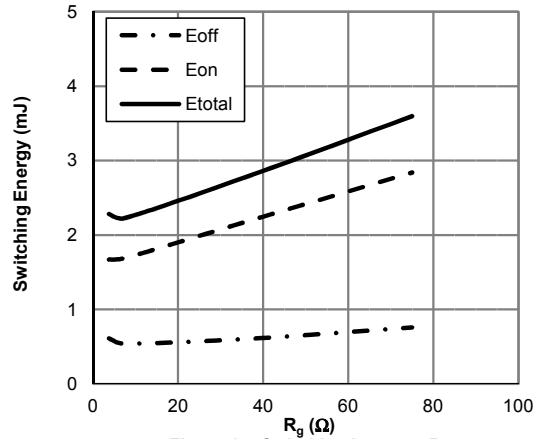


**Figure 13: Switching Time vs.  $T_j$**   
( $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_c=40\text{A}$ ,  $R_g=7.5\Omega$ )

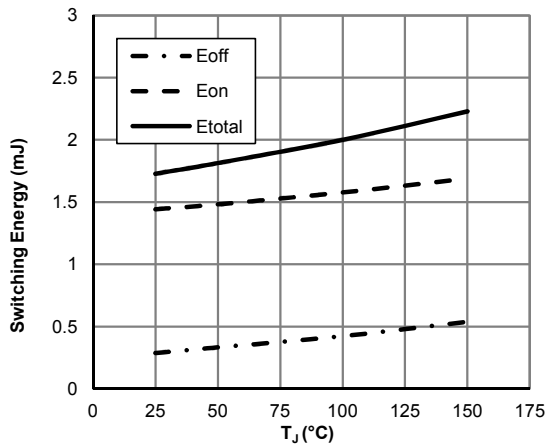
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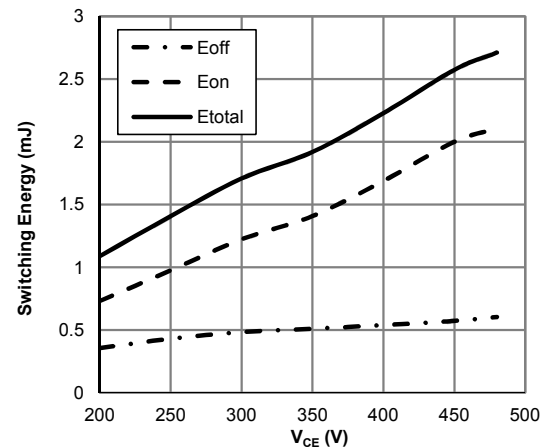
**Figure 14: Switching Loss vs.  $I_C$**   
( $T_J=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $R_g=7.5\Omega$ )



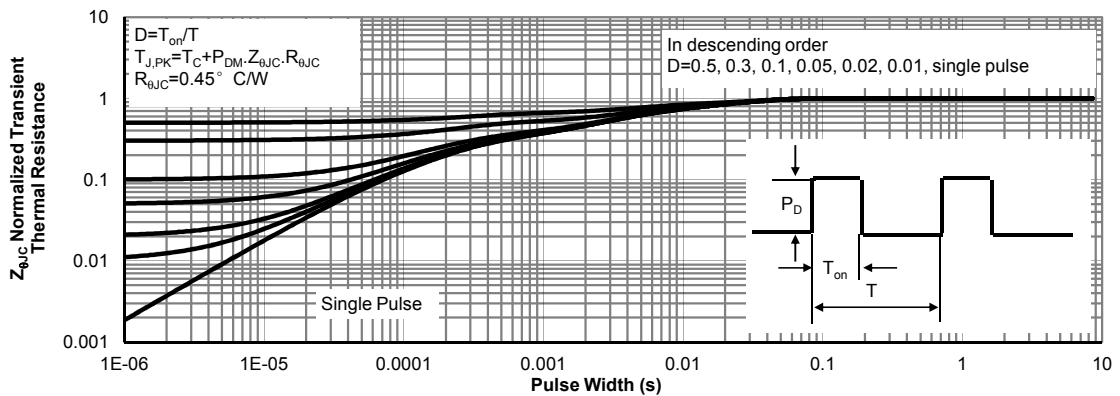
**Figure 15: Switching Loss vs.  $R_g$**   
( $T_J=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_C=40\text{A}$ )



**Figure 16: Switching Loss vs.  $T_J$**   
( $V_{GE}=15\text{V}$ ,  $V_{CE}=400\text{V}$ ,  $I_C=40\text{A}$ ,  $R_g=7.5\Omega$ )



**Figure 17: Switching Loss vs.  $V_{CE}$**   
( $T_J=150^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_g=7.5\Omega$ )



**Figure 18: Normalized Maximum Transient Thermal Impedance for IGBT**

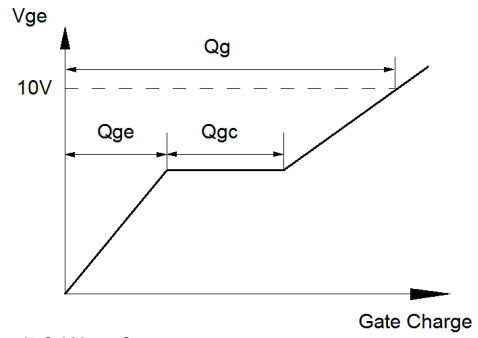
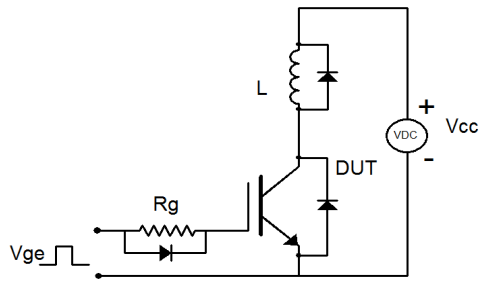


Figure A: Gate Charge Test Circuit & Waveforms

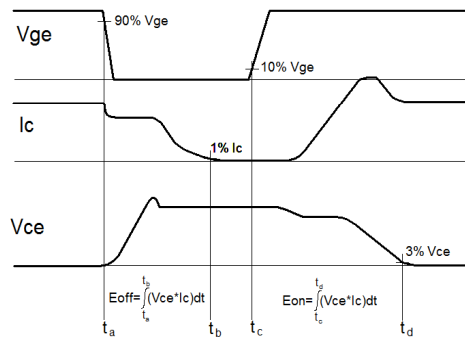
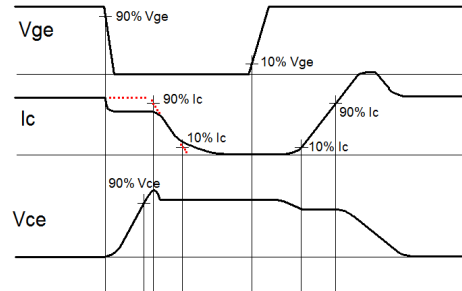
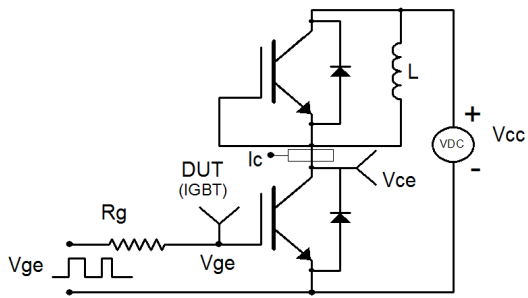


Figure B: Inductive Switching Test Circuit & Waveforms

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