



ON Semiconductor®

## ISL9V2040D3S / ISL9V2040S3S / ISL9V2040P3

### EcoSPARK<sup>™</sup> 200mJ, 400V, N-Channel Ignition IGBT

#### General Description

The ISL9V2040D3S, ISL9V2040S3S, and ISL9V2040P3 are the next generation ignition IGBTs that offer outstanding SCIS capability in the space saving D-Pak (TO-252), as well as the industry standard D<sup>2</sup>-Pak (TO-263) and TO-220 plastic packages. This device is intended for use in automotive ignition circuits, specifically as a coil driver. Internal diodes provide voltage clamping without the need for external components.

EcoSPARK<sup>™</sup> devices can be custom made to specific clamp voltages. Contact your nearest ON Semiconductor sales office for more information.

Formerly Developmental Type 49444

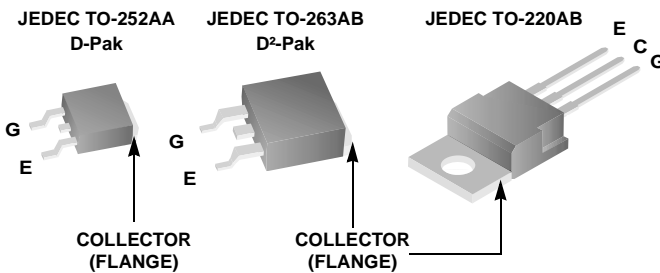
#### Applications

- Automotive Ignition Coil Driver Circuits
- Coil- On Plug Applications

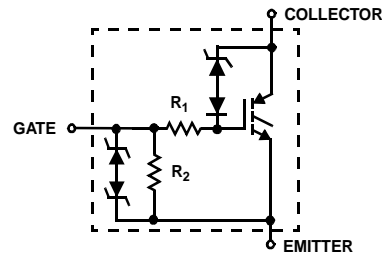
#### Features

- Space saving D - Pak package available
- SCIS Energy = 200mJ at T<sub>J</sub> = 25°C
- Logic Level Gate Drive

#### Package



#### Symbol



#### Device Maximum Ratings T<sub>A</sub> = 25°C unless otherwise noted

Symbol	Parameter	Ratings	Units
BV <sub>CER</sub>	Collector to Emitter Breakdown Voltage (I <sub>C</sub> = 1 mA)	430	V
BV <sub>ECS</sub>	Emitter to Collector Voltage - Reverse Battery Condition (I <sub>C</sub> = 10 mA)	24	V
E <sub>SCIS25</sub>	At Starting T <sub>J</sub> = 25°C, I <sub>SCIS</sub> = 11.5A, L = 3.0mH	200	mJ
E <sub>SCIS150</sub>	At Starting T <sub>J</sub> = 150°C, I <sub>SCIS</sub> = 8.9A, L = 3.0mH	120	mJ
I <sub>C25</sub>	Collector Current Continuous, At T <sub>C</sub> = 25°C, See Fig 9	10	A
I <sub>C110</sub>	Collector Current Continuous, At T <sub>C</sub> = 110°C, See Fig 9	10	A
V <sub>GEM</sub>	Gate to Emitter Voltage Continuous	±10	V
P <sub>D</sub>	Power Dissipation Total T <sub>C</sub> = 25°C	130	W
	Power Dissipation Derating T <sub>C</sub> > 25°C	0.87	W/°C
T <sub>J</sub>	Operating Junction Temperature Range	-40 to 175	°C
T <sub>STG</sub>	Storage Junction Temperature Range	-40 to 175	°C
T <sub>L</sub>	Max Lead Temp for Soldering (Leads at 1.6mm from Case for 10s)	300	°C
T <sub>pkg</sub>	Max Lead Temp for Soldering (Package Body for 10s)	260	°C
ESD	Electrostatic Discharge Voltage at 100pF, 1500Ω	4	kV

**Package Marking and Ordering Information**

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
V2040D	ISL9V2040D3ST	TO-252AA	330mm	16mm	2500
V2040S	ISL9V2040S3ST	TO-263AB	330mm	24mm	800
V2040P	ISL9V2040P3	TO-220AB	Tube	N/A	50
V2040D	ISL9V2040D3S	TO-252AA	Tube	N/A	75
V2040S	ISL9V2040S3S	TO-263AB	Tube	N/A	50

**Electrical Characteristics**  $T_A = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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**Off State Characteristics**

$BV_{CER}$	Collector to Emitter Breakdown Voltage	$I_C = 2\text{mA}$ , $V_{GE} = 0$ , $R_G = 1\text{K}\Omega$ , See Fig. 15 $T_J = -40$ to $150^\circ\text{C}$	370	400	430	V	
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$I_C = 10\text{mA}$ , $V_{GE} = 0$ , $R_G = 0$ , See Fig. 15 $T_J = -40$ to $150^\circ\text{C}$	390	420	450	V	
$BV_{ECS}$	Emitter to Collector Breakdown Voltage	$I_C = -75\text{mA}$ , $V_{GE} = 0\text{V}$ , $T_C = 25^\circ\text{C}$	30	-	-	V	
$BV_{GES}$	Gate to Emitter Breakdown Voltage	$I_{GES} = \pm 2\text{mA}$	$\pm 12$	$\pm 14$	-	V	
$I_{CER}$	Collector to Emitter Leakage Current	$V_{CER} = 250\text{V}$ , $R_G = 1\text{K}\Omega$ , See Fig. 11	$T_C = 25^\circ\text{C}$	-	-	25	$\mu\text{A}$
			$T_C = 150^\circ\text{C}$	-	-	1	$\text{mA}$
$I_{ECS}$	Emitter to Collector Leakage Current	$V_{EC} = 24\text{V}$ , See Fig. 11	$T_C = 25^\circ\text{C}$	-	-	1	$\text{mA}$
			$T_C = 150^\circ\text{C}$	-	-	40	$\text{mA}$
$R_1$	Series Gate Resistance		-	70	-	$\Omega$	
$R_2$	Gate to Emitter Resistance		10K	-	26K	$\Omega$	

**On State Characteristics**

$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_C = 6\text{A}$ , $V_{GE} = 4\text{V}$	$T_C = 25^\circ\text{C}$ , See Fig. 3	-	1.45	1.9	V
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_C = 10\text{A}$ , $V_{GE} = 4.5\text{V}$	$T_C = 150^\circ\text{C}$ See Fig. 4	-	1.95	2.3	V

**Dynamic Characteristics**

$Q_{G(ON)}$	Gate Charge	$I_C = 10\text{A}$ , $V_{CE} = 12\text{V}$ , $V_{GE} = 5\text{V}$ , See Fig. 14	-	12	-	$\text{nC}$	
$V_{GE(TH)}$	Gate to Emitter Threshold Voltage	$I_C = 1.0\text{mA}$ , $V_{CE} = V_{GE}$ , See Fig. 10	$T_C = 25^\circ\text{C}$	1.3	-	2.2	V
			$T_C = 150^\circ\text{C}$	0.75	-	1.8	V
$V_{GEP}$	Gate to Emitter Plateau Voltage	$I_C = 10\text{A}$ , $V_{CE} = 12\text{V}$	-	3.4	-	V	

**Switching Characteristics**

$t_{d(ON)R}$	Current Turn-On Delay Time-Resistive	$V_{CE} = 14\text{V}$ , $R_L = 1\Omega$ , $V_{GE} = 5\text{V}$ , $R_G = 1\text{K}\Omega$ , $T_J = 25^\circ\text{C}$	-	0.61	-	$\mu\text{s}$
$t_{riseR}$	Current Rise Time-Resistive		-	2.17	-	$\mu\text{s}$
$t_{d(OFF)L}$	Current Turn-Off Delay Time-Inductive	$V_{CE} = 300\text{V}$ , $L = 500\mu\text{H}$ , $V_{GE} = 5\text{V}$ , $R_G = 1\text{K}\Omega$ , $T_J = 25^\circ\text{C}$ , See Fig. 12	-	3.64	-	$\mu\text{s}$
$t_{fL}$	Current Fall Time-Inductive		-	2.36	-	$\mu\text{s}$
SCIS	Self Clamped Inductive Switching	$T_J = 25^\circ\text{C}$ , $L = 3.0\text{mH}$ , $R_G = 1\text{K}\Omega$ , $V_{GE} = 5\text{V}$ , See Fig. 1 & 2	-	-	200	$\text{mJ}$

**Thermal Characteristics**

$R_{\theta JC}$	Thermal Resistance Junction-Case	TO-252, TO-263, TO-220	-	-	1.15	$^\circ\text{C/W}$
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Typical Performance Curves

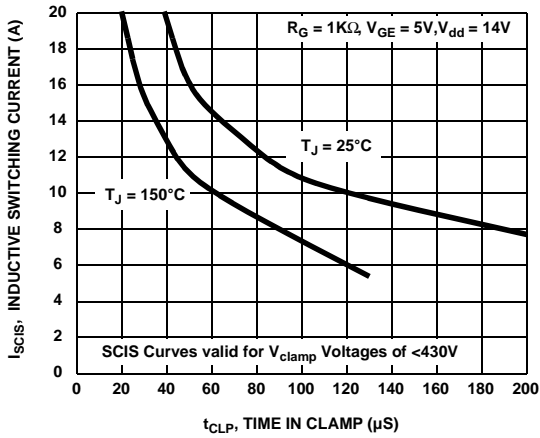


Figure 1. Self Clamped Inductive Switching Current vs Time in Clamp

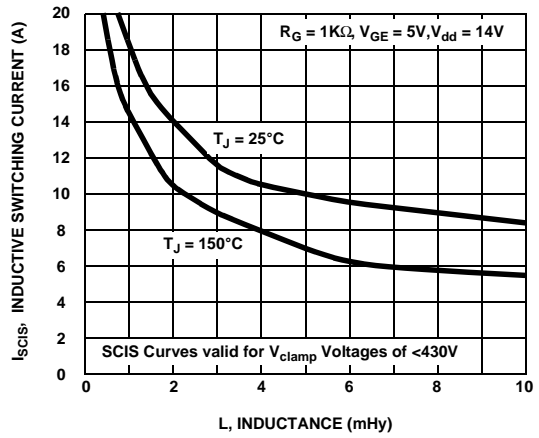


Figure 2. Self Clamped Inductive Switching Current vs Inductance

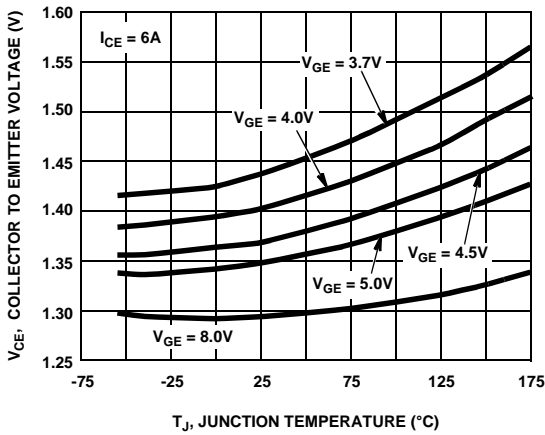


Figure 3. Collector to Emitter On-State Voltage vs Junction Temperature

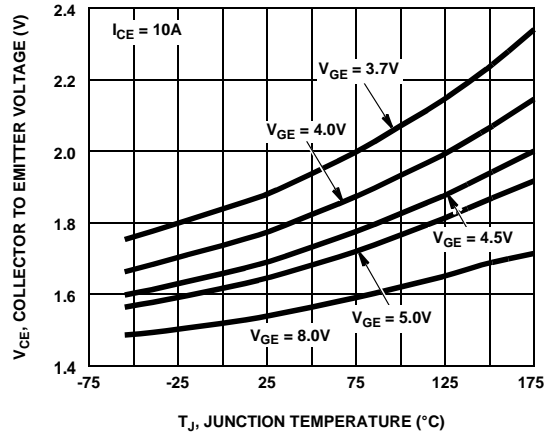


Figure 4. Collector to Emitter On-State Voltage vs Junction Temperature

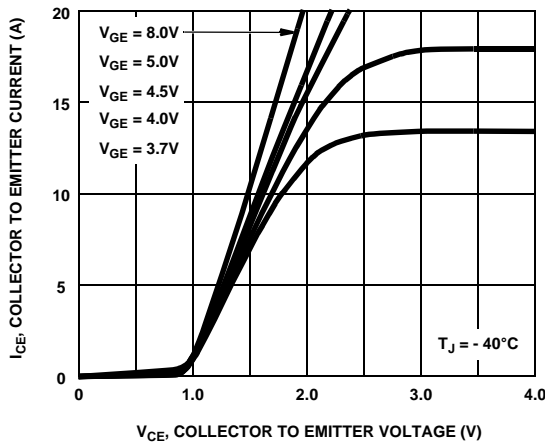


Figure 5. Collector to Emitter On-State Voltage vs Collector Current

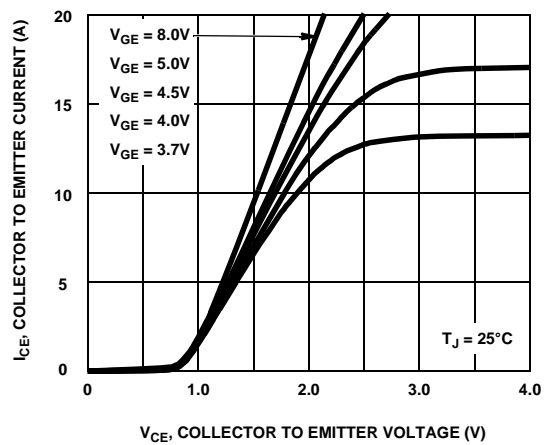


Figure 6. Collector to Emitter On-State Voltage vs Collector Current

Typical Performance Curves (Continued)

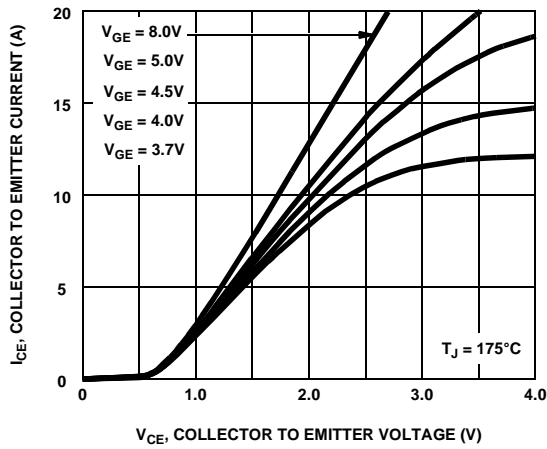


Figure 7. Collector to Emitter On-State Voltage vs Collector Current

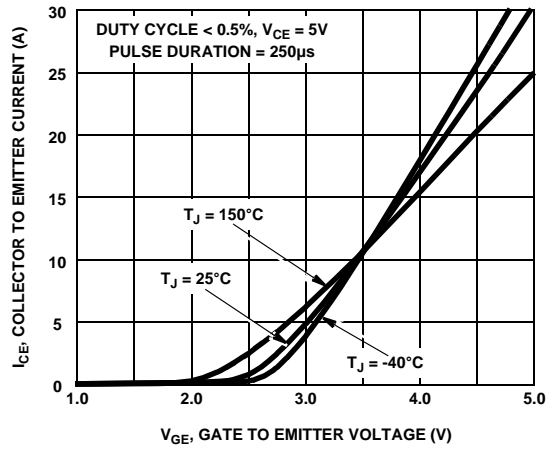


Figure 8. Transfer Characteristics

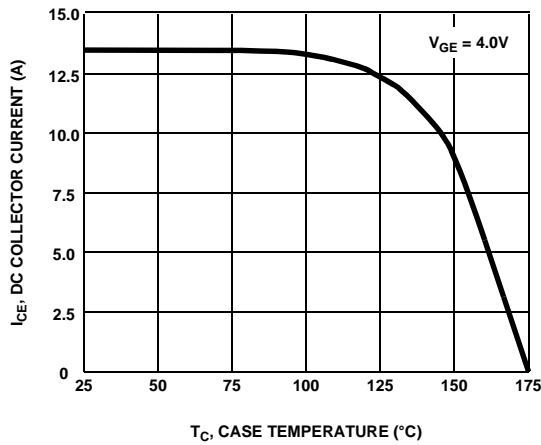


Figure 9. DC Collector Current vs Case Temperature

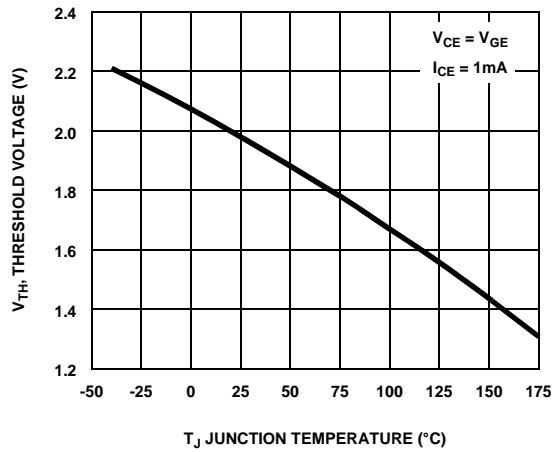


Figure 10. Threshold Voltage vs Junction Temperature

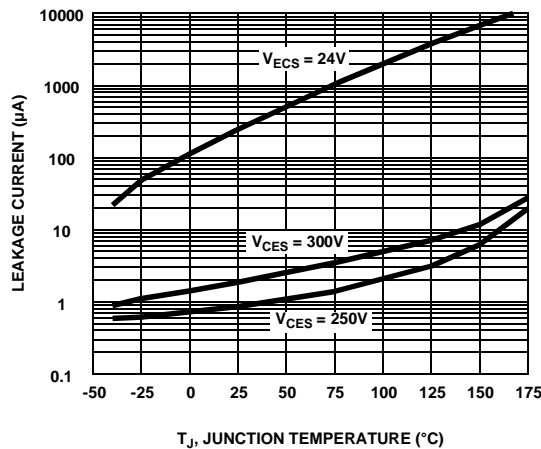


Figure 11. Leakage Current vs Junction Temperature

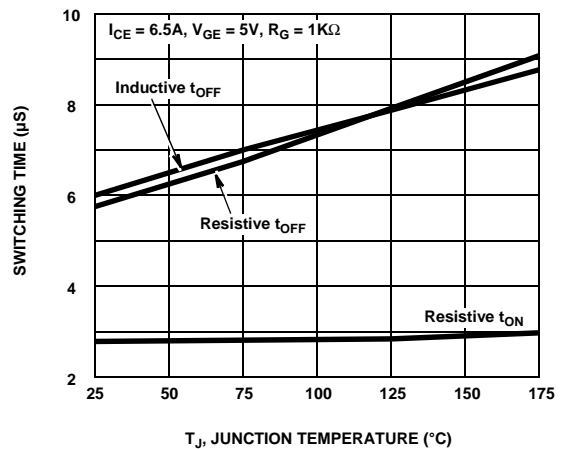


Figure 12. Switching Time vs Junction Temperature

Typical Performance Curves (Continued)

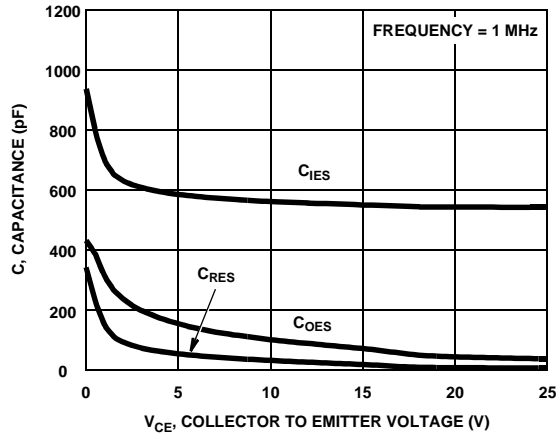


Figure 13. Capacitance vs Collector to Emitter Voltage

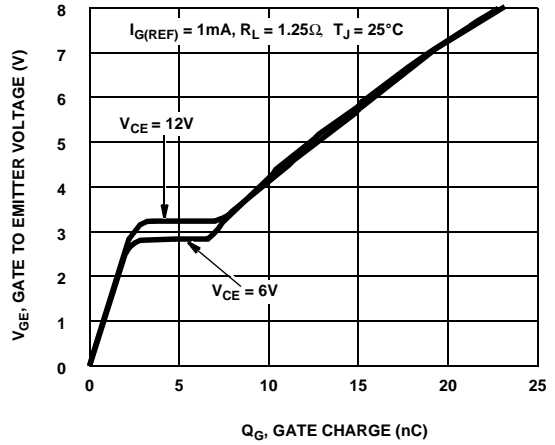


Figure 14. Gate Charge

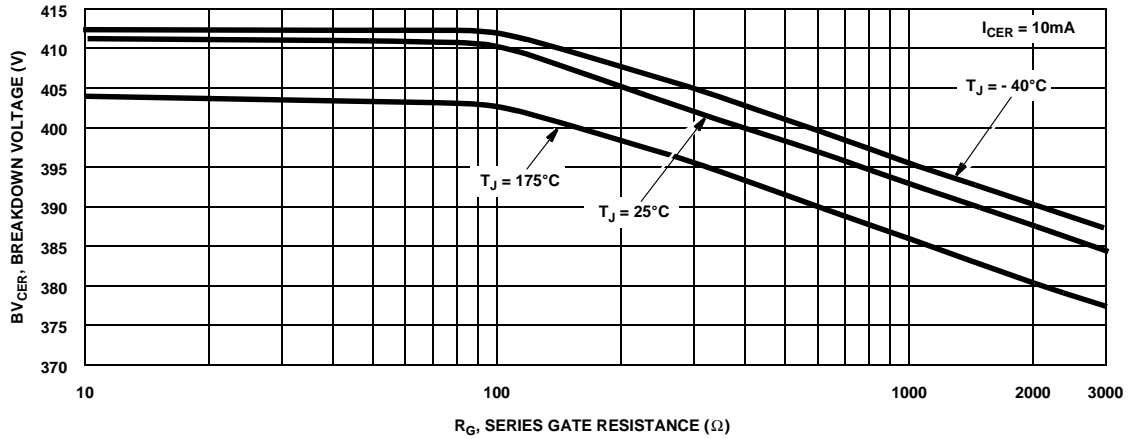


Figure 15. Breakdown Voltage vs Series Gate Resistance

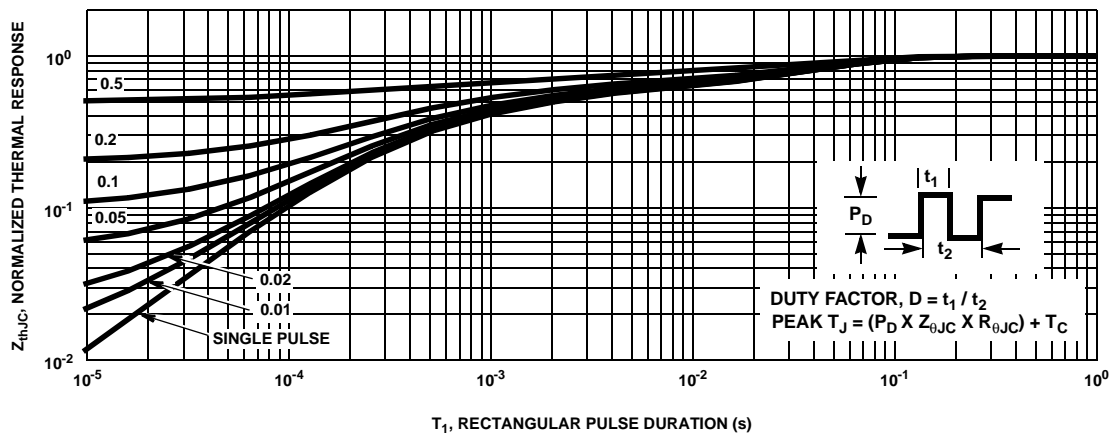


Figure 16. IGBT Normalized Transient Thermal Impedance, Junction to Case

Test Circuit and Waveforms

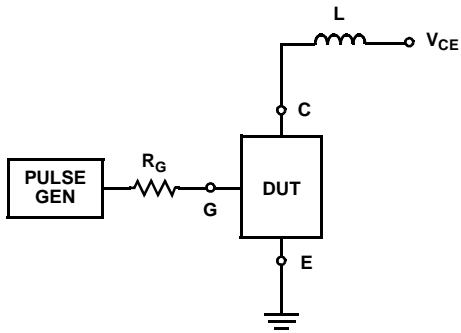


Figure 17. Inductive Switching Test Circuit

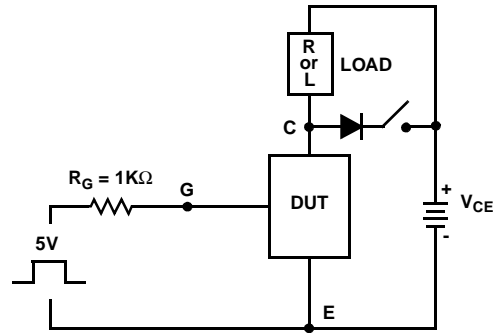


Figure 18.  $t_{ON}$  and  $t_{OFF}$  Switching Test Circuit

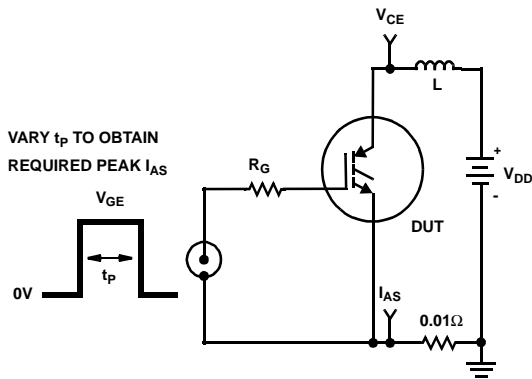


Figure 19. Unclamped Energy Test Circuit

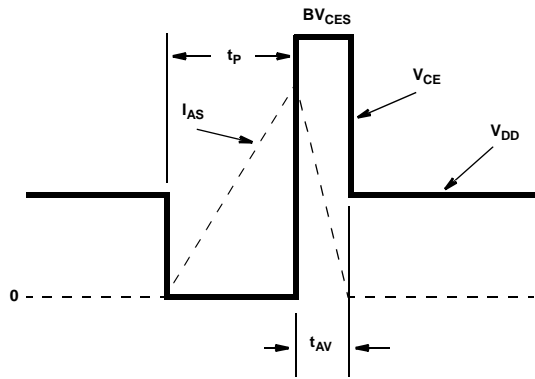


Figure 20. Unclamped Energy Waveforms

### SPICE Thermal Model

REV 25 April 2002

ISL9V2040D3S, ISL9V2040S3S, ISL9V2040P3

CTHERM1 th 6 1.3e -2  
 CTHERM2 6 5 8.8e -4  
 CTHERM3 5 4 8.8e -3  
 CTHERM4 4 3 3.9e -1  
 CTHERM5 3 2 3.6e -1  
 CTHERM6 2 tl 1.9e -1

RTHERM1 th 6 1.2e -1  
 RTHERM2 6 5 3.2e -1  
 RTHERM3 5 4 1.7e -1  
 RTHERM4 4 3 1.2e -1  
 RTHERM5 3 2 1.3e -1  
 RTHERM6 2 tl 2.5e -1

### SABER Thermal Model

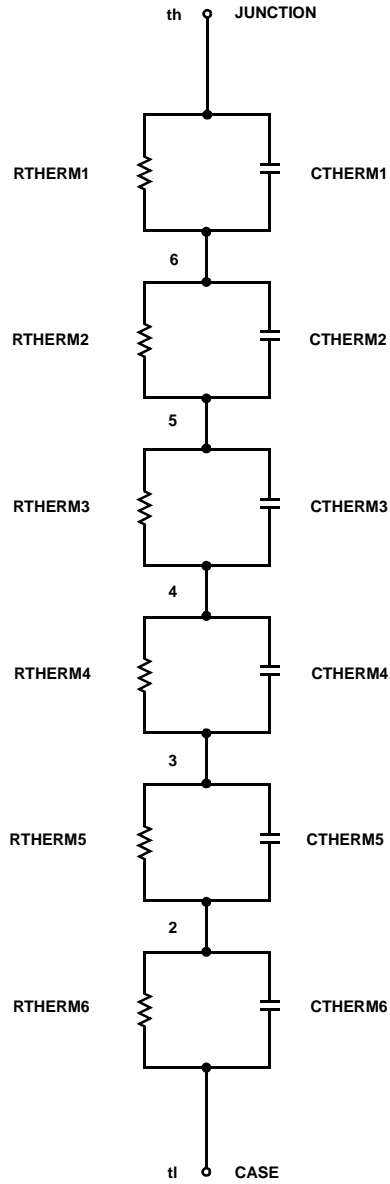
SABER thermal model

ISL9V2040D3S, ISL9V2040S3S, ISL9V2040P3

template thermal\_model th tl  
 thermal\_c th, tl

```
{
    ctherm.ctherm1 th 6 = 1.3e -3
    ctherm.ctherm2 6 5 = 8.8e -4
    ctherm.ctherm3 5 4 = 8.8e -3
    ctherm.ctherm4 4 3 = 3.9e -1
    ctherm.ctherm5 3 2 = 3.6e -1
    ctherm.ctherm6 2 tl = 1.9e -1
```

```
rtherm.rtherm1 th 6 = 1.2e -1
rtherm.rtherm2 6 5 = 3.2e -1
rtherm.rtherm3 5 4 = 1.7e -1
rtherm.rtherm4 4 3 = 1.2e -1
rtherm.rtherm5 3 2 = 1.3e -1
rtherm.rtherm6 2 tl = 2.5e -1
}
```



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