January 2002

# ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3

## EcoSPARK™ 300mJ, 400V, N-Channel Ignition IGBT

### General Description

The ISL9V3040D3S, ISL9V3040S3S, and ISL9V3040P3 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 D²-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™** devices can be custom made to specific clamp voltages. Contact your nearest Fairchild sales office for more information.

Formerly Developmental Type 49362

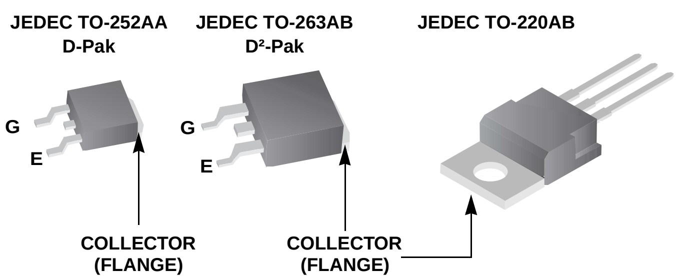
### Applications

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

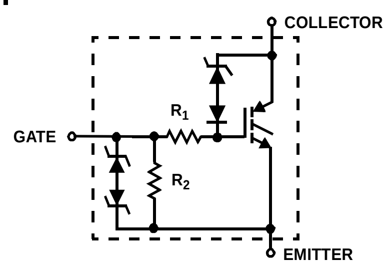
### Features

- Space saving D-Pak package availability
- SCIS Energy = 300mJ at $T_J$ = 25°C
- Logic Level Gate Drive

## Package




## Symbol




## Device Maximum Ratings $T_A$ = 25°C unless otherwise noted

| Symbol | Parameter | Ratings | Units |
|---|---|---|---|
| $BV_{CER}$ | Collector to Emitter Breakdown Voltage ($I_C$ = 1 mA) | 430 | V |
| $BV_{ECS}$ | Emitter to Collector Voltage - Reverse Battery Condition ($I_C$ = 10 mA) | 24 | V |
| $E_{SCIS25}$ | At Starting $T_J$ = 25°C, $I_{SCIS}$ = 14.2A, L = 3.0 mHy | 300 | mJ |
| $E_{SCIS150}$ | At Starting $T_J$ = 150°C, $I_{SCIS}$ = 10.6A, L = 3.0 mHy | 170 | mJ |
| $I_{C25}$ | Collector Current Continuous, At $T_C$ = 25°C, See Fig 9 | 21 | A |
| $I_{C110}$ | Collector Current Continuous, At $T_C$ = 110°C, See Fig 9 | 17 | A |
| $V_{GEM}$ | Gate to Emitter Voltage Continuous | ±10 | V |
| $P_D$ | Power Dissipation Total $T_C$ = 25°C | 150 | W |
| | Power Dissipation Derating $T_C$ > 25°C | 1.0 | W/°C |
| $T_J$ | Operating Junction Temperature Range | -40 to 175 | °C |
| $T_{STG}$ | Storage Junction Temperature Range | -40 to 175 | °C |
| $T_L$ | Max Lead Temp for Soldering (Leads at 1.6mm from Case for 10s) | 300 | °C |
| $T_{pkg}$ | 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 |
|---|---|---|---|---|---|
| V3040D | ISL9V3040D3ST | TO-252AA | 330mm | 16mm | 2500 units |
| V3040S | ISL9V3040S3ST | TO-263AB | 330mm | 24mm | 800 units |
| V3040D | ISL9V3040D3S | TO-252AA | Tube | N/A | 75 units |
| V3040S | ISL9V3040S3S | TO-263AB | Tube | N/A | 50 units |
| V3040P | ISL9V3040P3 | TO-220AB | Tube | N/A | 50 units |

## Electrical Characteristics $T_A$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **Off State Characteristics** | | | | | | | |
| $BV_{CER}$ | Collector to Emitter Breakdown Voltage | $I_C$ = 2mA, $V_{GE}$ = 0, $R_G$ = 1KΩ, See Fig. 15 $T_J$ = -40 to 150°C | | 370 | 400 | 430 | V |
| $BV_{CES}$ | Collector to Emitter Breakdown Voltage | $I_C$ = 10mA, $V_{GE}$ = 0, $R_G$ = 0, See Fig. 15 $T_J$ = -40 to 150°C | | 390 | 420 | 450 | V |
| $BV_{ECS}$ | Emitter to Collector Breakdown Voltage | $I_C$ = -75mA, $V_{GE}$ = 0V, $T_C$ = 25°C | | 30 | - | - | V |
| $BV_{GES}$ | Gate to Emitter Breakdown Voltage | $I_{GES}$ = ± 2mA | | ±12 | ±14 | - | V |
| $I_{CER}$ | Collector to Emitter Leakage Current | $V_{CER}$ = 250V, $R_G$ = 1KΩ, See Fig. 11 | $T_C$ = 25°C | - | - | 25 | µA |
| | | | $T_C$ = 150°C | - | - | 1 | mA |
| $I_{ECS}$ | Emitter to Collector Leakage Current | $V_{EC}$ = 24V, See Fig. 11 | $T_C$ = 25°C | - | - | 1 | mA |
| | | | $T_C$ = 150°C | - | - | 40 | mA |
| $R_1$ | Series Gate Resistance | | | - | 70 | - | Ω |
| $R_2$ | Gate to Emitter Resistance | | | 10K | - | 26K | Ω |
| **On State Characteristics** | | | | | | | |
| $V_{CE(SAT)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 6A, $V_{GE}$ = 4V | $T_C$ = 25°C, See Fig. 3 | - | 1.25 | 1.60 | V |
| $V_{CE(SAT)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 10A, $V_{GE}$ = 4.5V | $T_C$ = 150°C, See Fig. 4 | - | 1.58 | 1.80 | V |
| $V_{CE(SAT)}$ | Collector to Emitter Saturation Voltage | $I_C$ = 15A, $V_{GE}$ = 4.5V | $T_C$ = 150°C | - | 1.90 | 2.20 | V |
| **Dynamic Characteristics** | | | | | | | |
| $Q_{G(ON)}$ | Gate Charge | $I_C$ = 10A, $V_{CE}$ = 12V, $V_{GE}$ = 5V, See Fig. 14 | | - | 17 | - | nC |
| $V_{GE(TH)}$ | Gate to Emitter Threshold Voltage | $I_C$ = 1.0mA, $V_{CE}$ = $V_{GE}$, See Fig. 10 | $T_C$ = 25°C | 1.3 | - | 2.2 | V |
| | | | $T_C$ = 150°C | 0.75 | - | 1.8 | V |
| $V_{GEP}$ | Gate to Emitter Plateau Voltage | $I_C$ = 10A, $V_{CE}$ = 12V | | - | 3.0 | - | V |
| **Switching Characteristics** | | | | | | | |
| $t_{d(ON)R}$ | Current Turn-On Delay Time-Resistive | $V_{CE}$ = 14V, $R_L$ = 1Ω, $V_{GE}$ = 5V, $R_G$ = 1KΩ $T_J$ = 25°C, See Fig. 12 | | - | 0.7 | 4 | µs |
| $t_{rR}$ | Current Rise Time-Resistive | | | - | 2.1 | 7 | µs |
| $t_{d(OFF)L}$ | Current Turn-Off Delay Time-Inductive | $V_{CE}$ = 300V, L = 500µHy, $V_{GE}$ = 5V, $R_G$ = 1KΩ $T_J$ = 25°C, See Fig. 12 | | - | 4.8 | 15 | µs |
| $t_{fL}$ | Current Fall Time-Inductive | | | - | 2.8 | 15 | µs |
| SCIS | Self Clamped Inductive Switching | $T_J$ = 25°C, L = 3.0 mHy, $R_G$ = 1KΩ, $V_{GE}$ = 5V, See Fig. 1 & 2 | | - | - | 300 | mJ |
| **Thermal Characteristics** | | | | | | | |
| $R_{\theta JC}$ | Thermal Resistance Junction-Case | TO-252, TO-263, TO-220 | | - | - | 1.0 | °C/W |

## Typical Performance Curves (Continued)

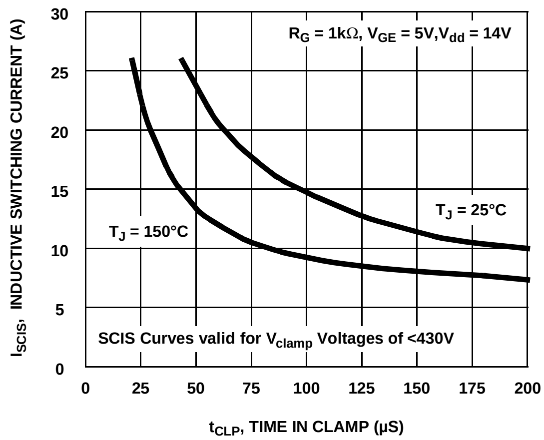



**Figure 1. Self Clamped Inductive Switching Current vs Time in Clamp**

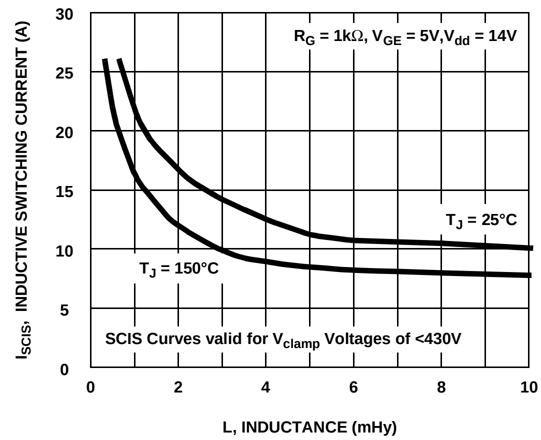



**Figure 2. Self Clamped Inductive Switching Current vs Inductance**

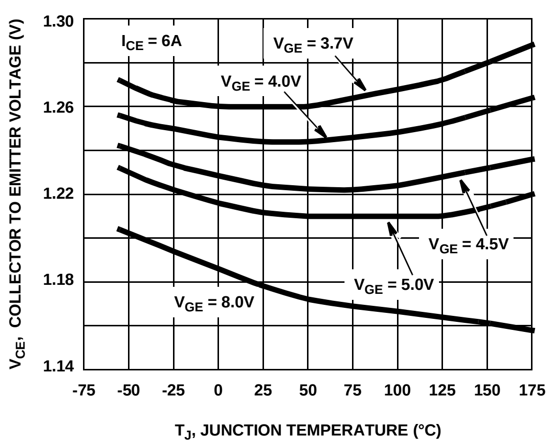



**Figure 3. Collector to Emitter On-State Voltage vs Junction Temperature**

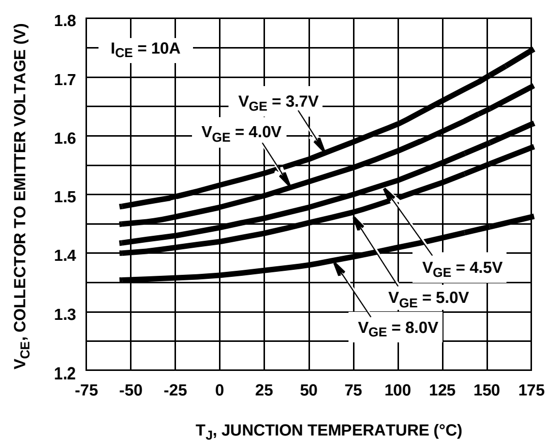



**Figure 4. Collector to Emitter On-State Voltage vs Junction Temperature**

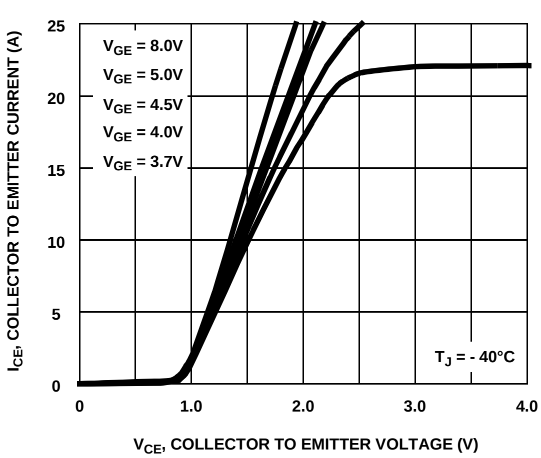



**Figure 5. Collector to Emitter On-State Voltage vs Collector Current**

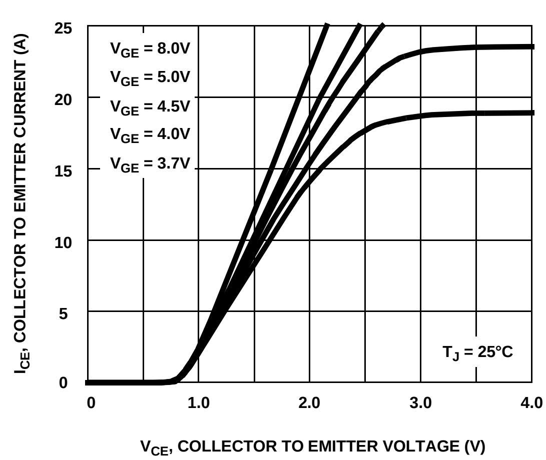



**Figure 6. Collector to Emitter On-State Voltage vs Collector Current**

## Typical Performance Curves (Continued)

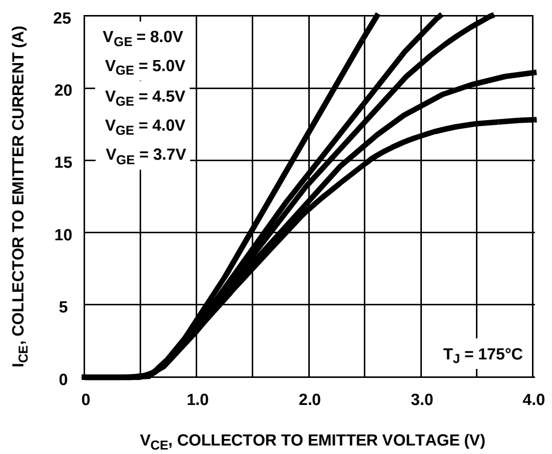



**Figure 7. Collector to Emitter On-State Voltage vs Collector Current**

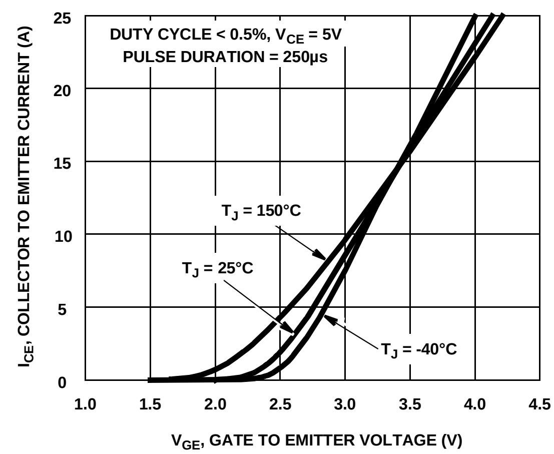



**Figure 8. Transfer Characteristics**

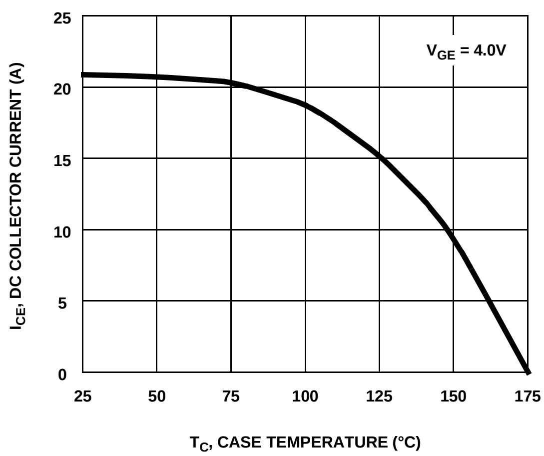



**Figure 9. DC Collector Current vs Case Temperature**

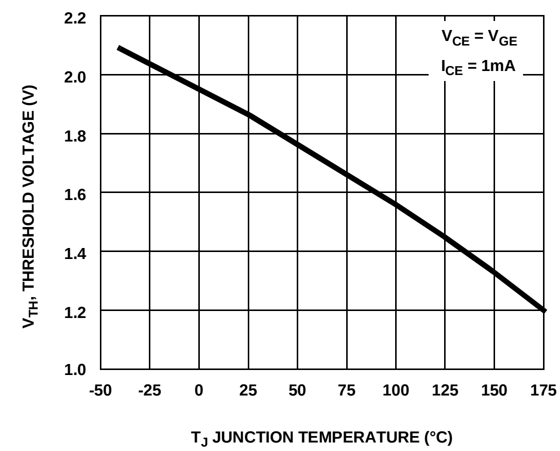



**Figure 10. Threshold Voltage vs Junction Temperature**

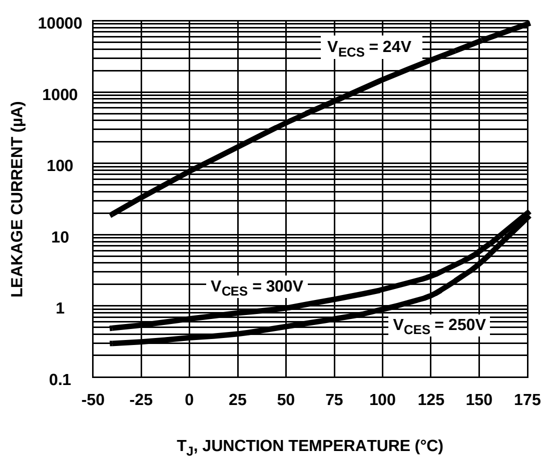



**Figure 11. Leakage Current vs Junction Temperature**

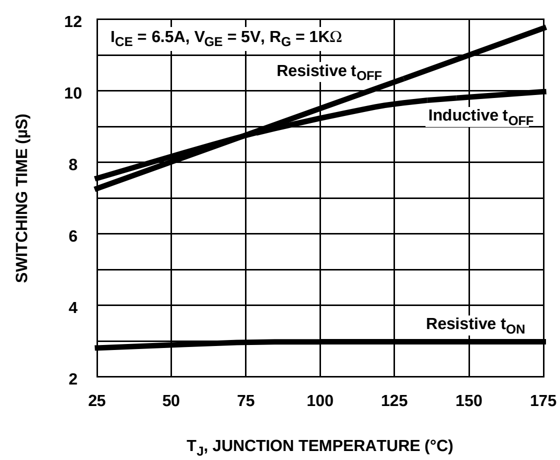



**Figure 12. Switching Time vs Junction Temperature**

## Typical Performance Curves (Continued)

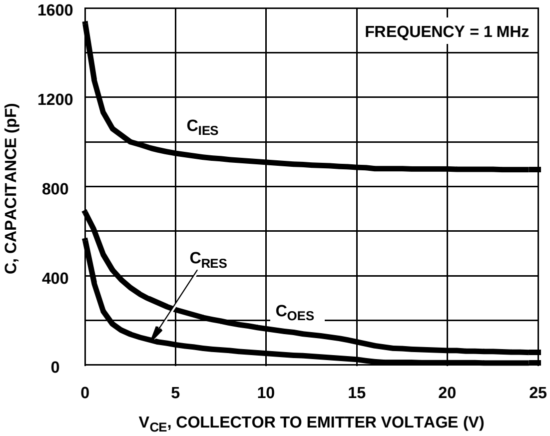



**Figure 13. Capacitance vs Collector to Emitter Voltage**

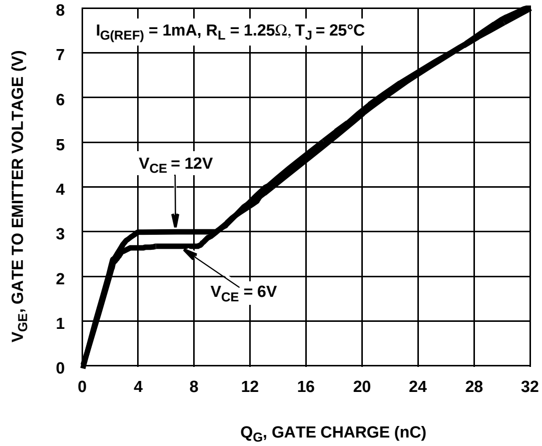



**Figure 14. Gate Charge**

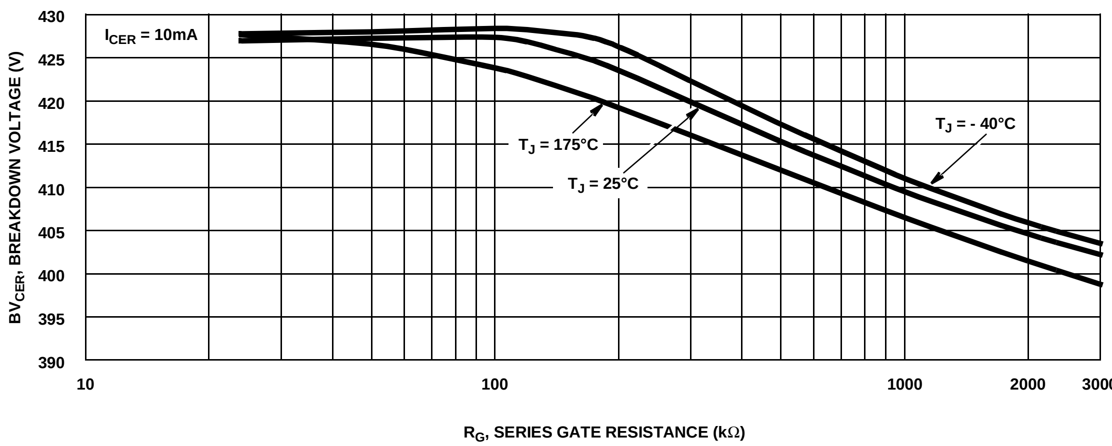



**Figure 15. Breakdown Voltage vs Series Gate Resistance**

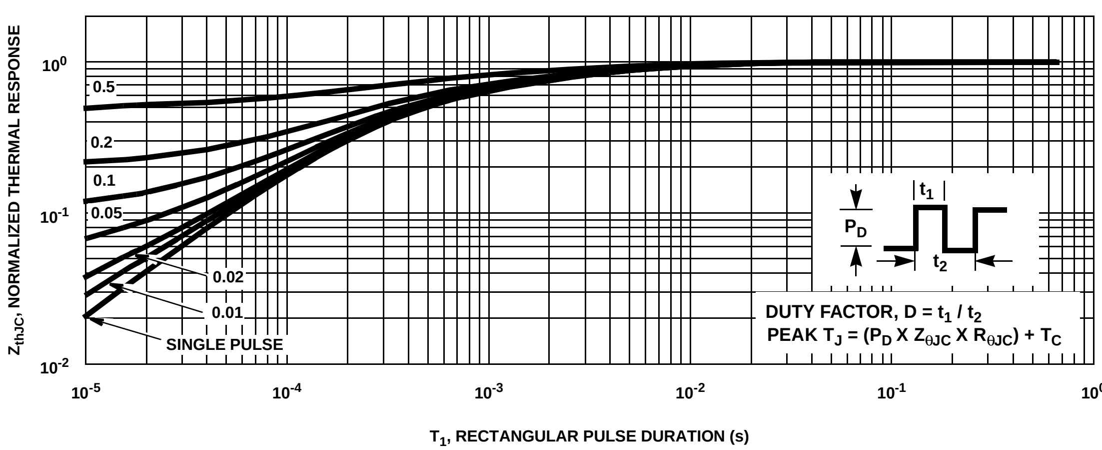



**Figure 16. IGBT Normalized Transient Thermal Impedance, Junction to Case**

## Test Circuit and Waveforms

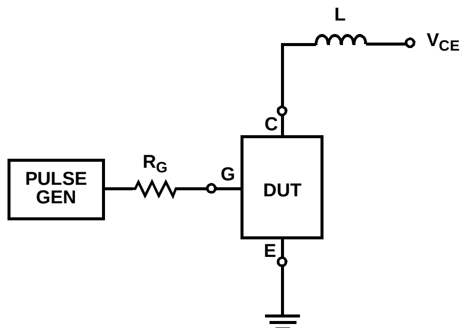



Figure 17. Inductive Switching Test Circuit

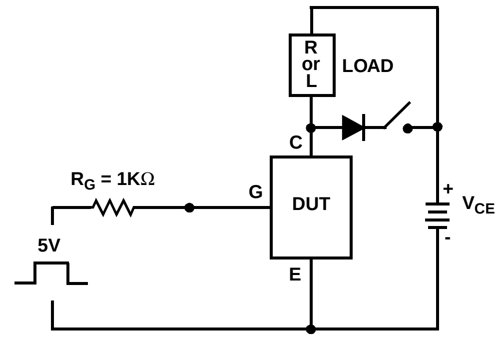



Figure 18. $t_{ON}$ and $t_{OFF}$ Switching Test Circuit

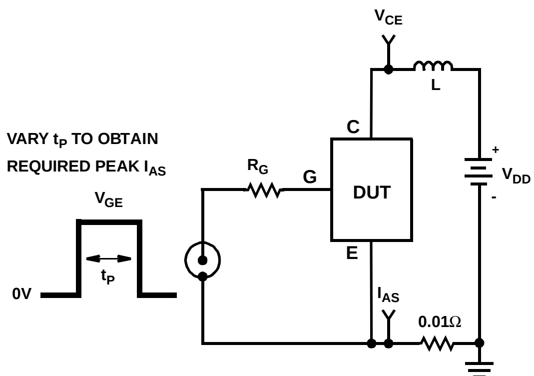



Figure 19. Unclamped Energy Test Circuit

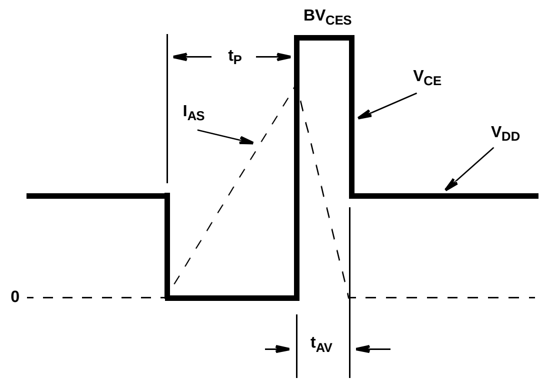



Figure 20. Unclamped Energy Waveforms

## SPICE Thermal Model

REV 25 May 2001

ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3

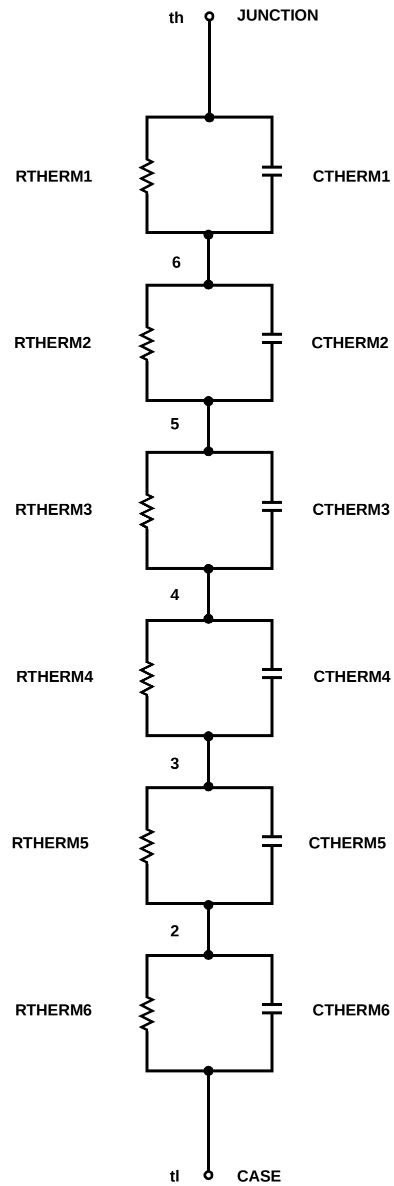
```
CTHERM1 th 6 2.5e -4
CTHERM2 6 5 2.5e -3
CTHERM3 5 4 1.6e -3
CTHERM4 4 3 1.3e -2
CTHERM5 3 2 6.1e -3
CTHERM6 2 tl 9.9e +2

RTHERM1 th 6 1.2e -1
RTHERM2 6 5 1.9e -1
RTHERM3 5 4 2.2e -1
RTHERM4 4 3 6.0e -2
RTHERM5 3 2 5.8e -2
RTHERM6 2 tl 1.6e -4
```

## SABER Thermal Model

```
SABER thermal model
ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3
template thermal_model th tl
thermal_c th, tl
{
ctherm.ctherm1 th 6 = 2.5e -4
ctherm.ctherm2 6 5 = 2.5e -3
ctherm.ctherm3 5 4 = 1.6e -3
ctherm.ctherm4 4 3 = 1.3e -2
ctherm.ctherm5 3 2 =6.1e -3
ctherm.ctherm6 2 tl = 9.9e +2

rtherm.rtherm1 th 6 = 1.2e -1
rtherm.rtherm2 6 5 = 1.9e -1
rtherm.rtherm3 5 4 = 2.2e -1
rtherm.rtherm4 4 3 = 6.0e -2
rtherm.rtherm5 3 2 = 5.8e -2
rtherm.rtherm6 2 tl = 1.6e -4
}
```



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| Bottomless™ | FASTr™ | OPTOPLANAR™ | STAR*POWER™ | |
| CoolFET™ | FRFET™ | PACMAN™ | Stealth™ | |
| *CROSSVOLT*™ | GlobalOptoisolator™ | POP™ | SuperSOT™-3 | |
| DenseTrench™ | GTO™ | Power247™ | SuperSOT™-6 | |
| DOME™ | HiSeC™ | PowerTrench® | SuperSOT™-8 | |
| EcoSPARK™ | ISOPLANAR™ | QFET™ | SyncFET™ | |
| $E^2$CMOS™ | LittleFET™ | QS™ | TinyLogic™ | |
| EnSigna™ | MicroFET™ | QT Optoelectronics™ | TruTranslation™ | |
| FACT™ | MicroPak™ | Quiet Series™ | UHC™ | |
| FACT Quiet Series™ | MICROWIRE™ | SILENT SWITCHER® | UltraFET® | |

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

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|---|---|---|
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