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FAIRCHILD SEMICONDUCTOR®

# ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3 / ISL9V3040S3

## EcoSPARKÈ 300mJ, 400V, N-Channel Ignition IGBT

### General Description

The ISL9V3040D3S, ISL9V3040S3S, ISL9V3040P3, and ISL9V3040S3 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-262 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.

**EcoSPARKÈ** devices can be custom made to specific clamp voltages. Contact your nearest Fairchild sales office for more information.

Formerly Developmental Type 49362

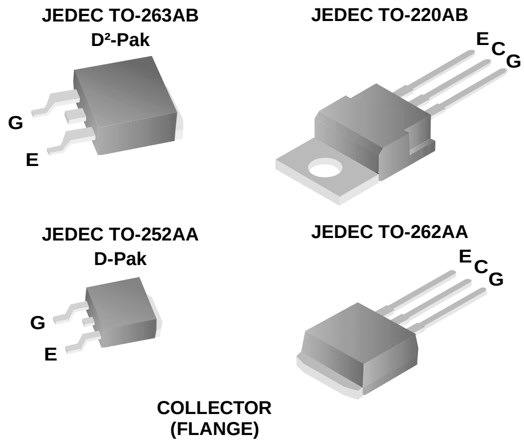
### Applications

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

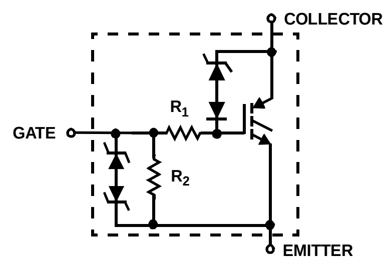
### Features

- Space saving D-Pak package availability
- SCIS Energy = 300mJ at $T_J$ = 25$^{o}$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 |
| V3040S | ISL9V3040S3ST | TO-263AB | 330mm | 24mm | 800 |
| V3040P | ISL9V3040P3 | TO-220AA | Tube | N/A | 50 |
| V3040S | ISL9V3040S3 | TO-262AA | Tube | N/A | 50 |
| V3040D | ISL9V3040D3S | TO-252AA | Tube | N/A | 75 |
| V3040S | ISL9V3040S3S | TO-263AB | Tube | N/A | 50 |

## 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 | All packages | | - | - | 1.0 | °C/W |

## Typical Performance Curves

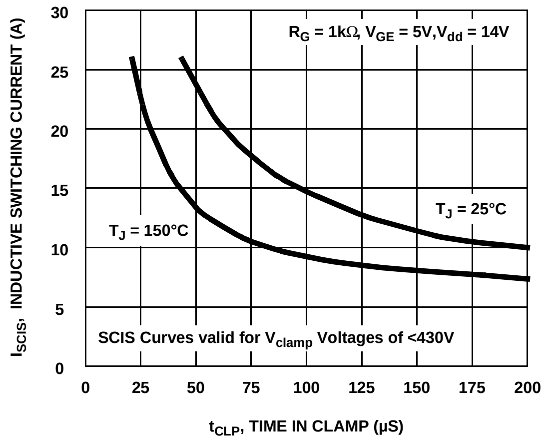



**Figure 1. Self Clamped Inductive Switching Current vs Time in Clamp**

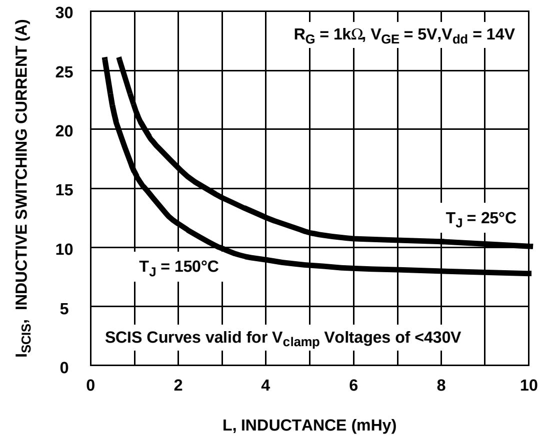



**Figure 2. Self Clamped Inductive Switching Current vs Inductance**

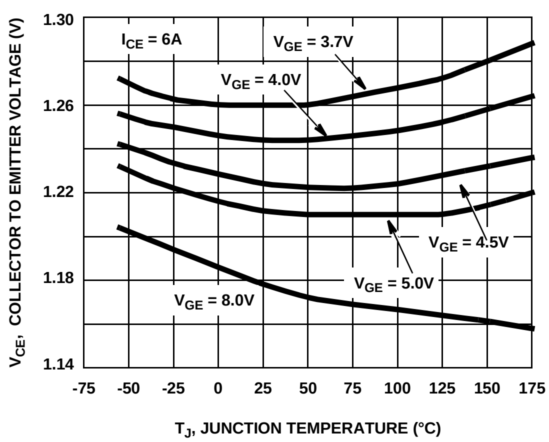



**Figure 3. Collector to Emitter On-State Voltage vs Junction Temperature**

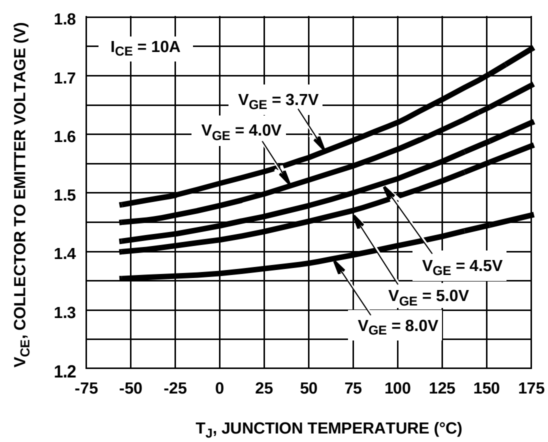



**Figure 4. Collector to Emitter On-State Voltage vs Junction Temperature**

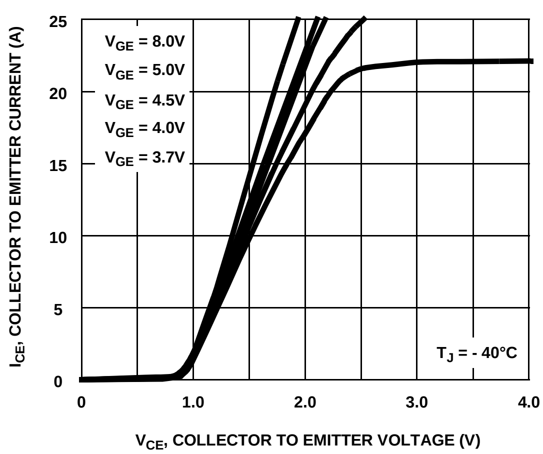



**Figure 5. Collector to Emitter On-State Voltage vs Collector Current**

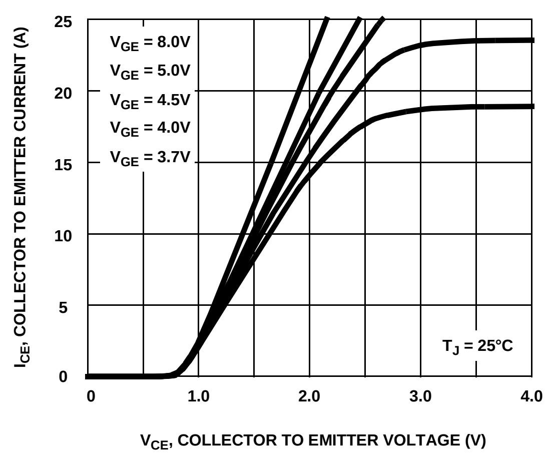



**Figure 6. Collector to Emitter On-State Voltage vs Collector Current**

## Typical Performance Curves (Continued)

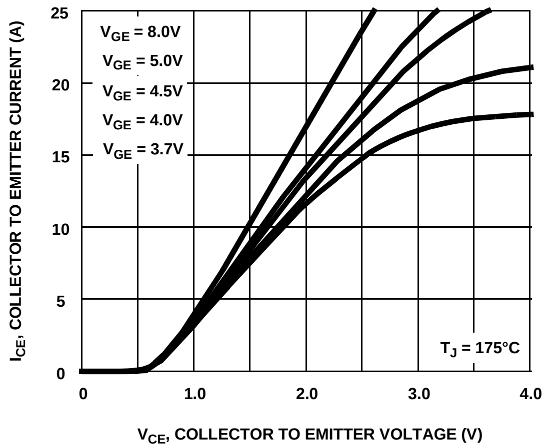



**Figure 7. Collector to Emitter On-State Voltage vs Collector Current**

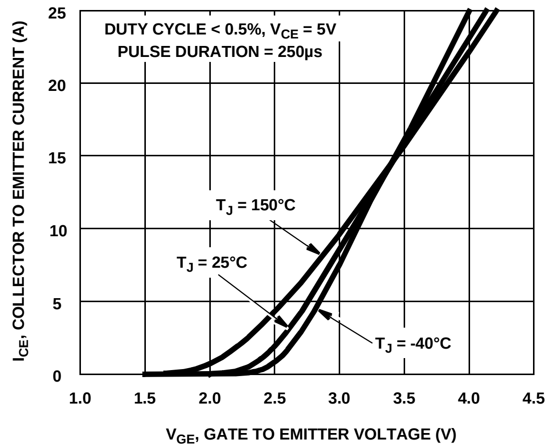



**Figure 8. Transfer Characteristics**

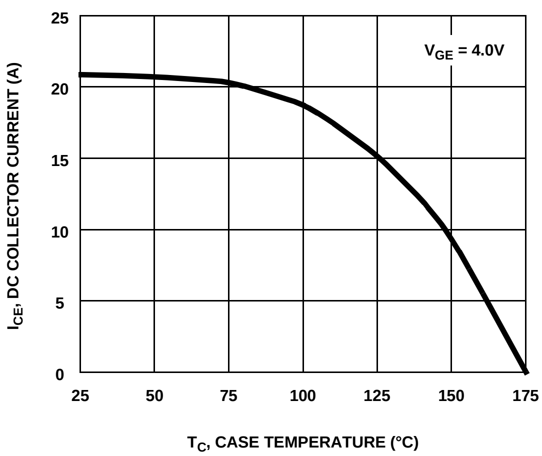



**Figure 9. DC Collector Current vs Case Temperature**

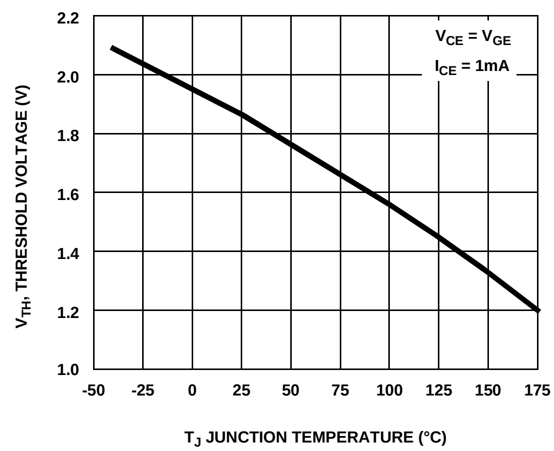



**Figure 10. Threshold Voltage vs Junction Temperature**

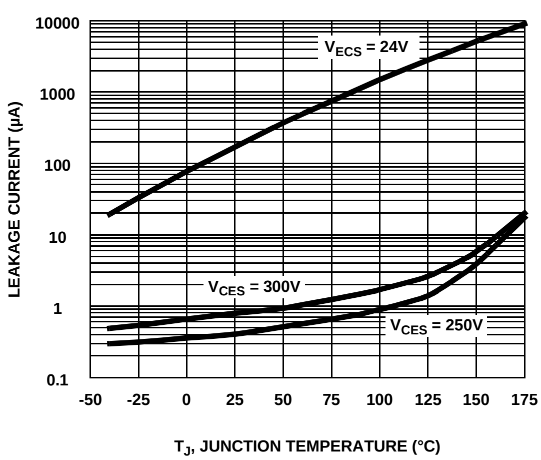



**Figure 11. Leakage Current vs Junction Temperature**

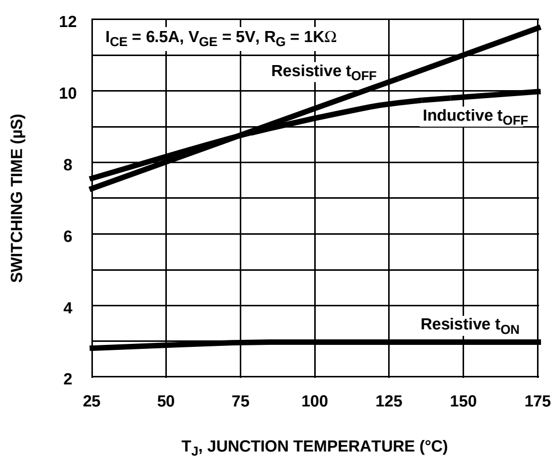



**Figure 12. Switching Time vs Junction Temperature**

## Typical Performance Curves (Continued)

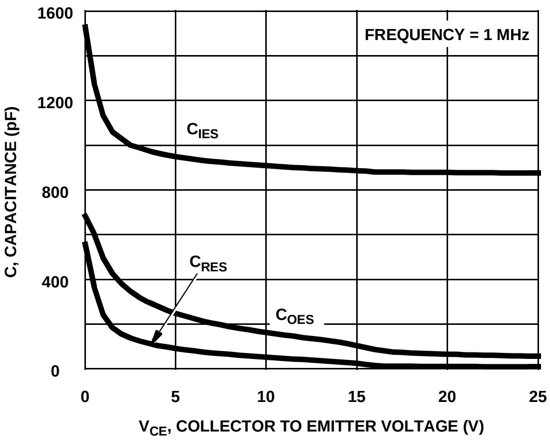



**Figure 13. Capacitance vs Collector to Emitter Voltage**

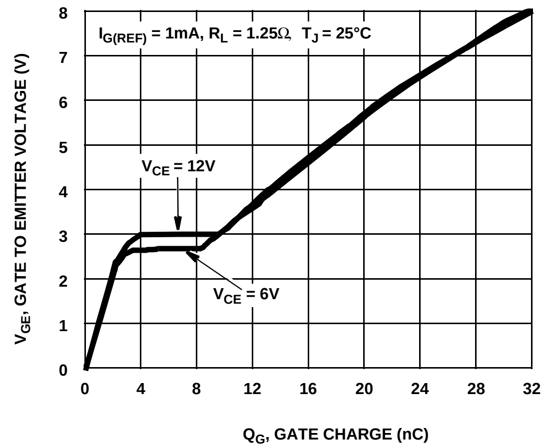



**Figure 14. Gate Charge**

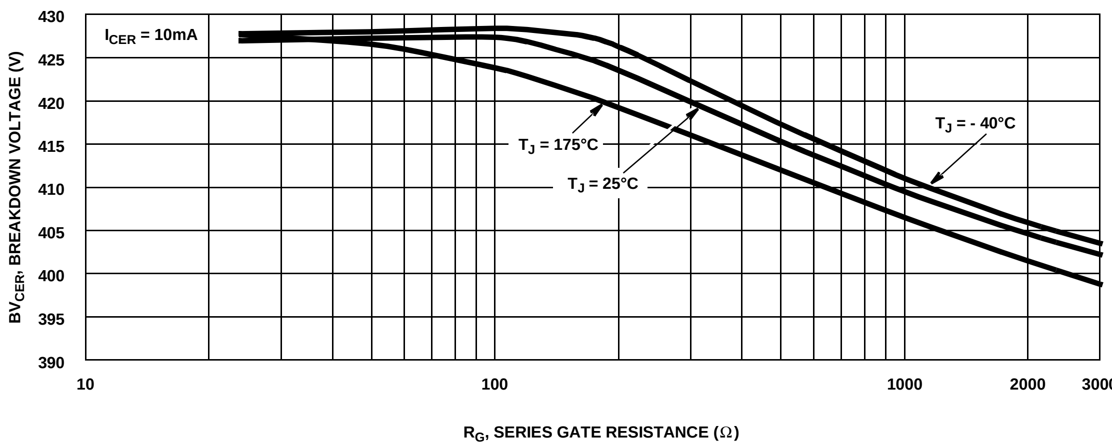



**Figure 15. Breakdown Voltage vs Series Gate Resistance**

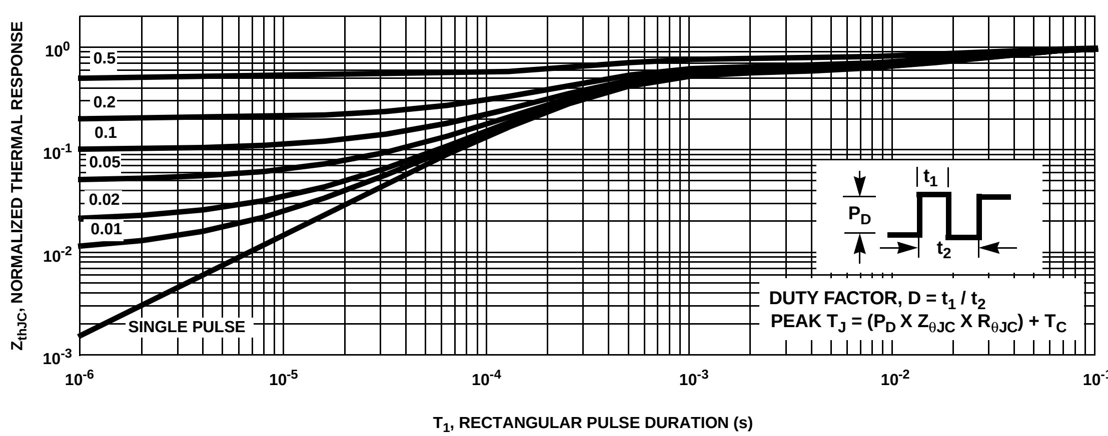



**Figure 16. IGBT Normalized Transient Thermal Impedance, Junction to Case**

## Test Circuit and Waveforms

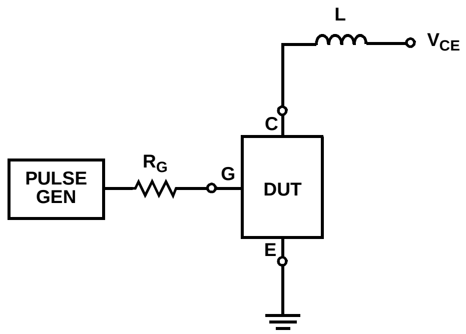



Figure 17. Inductive Switching Test Circuit

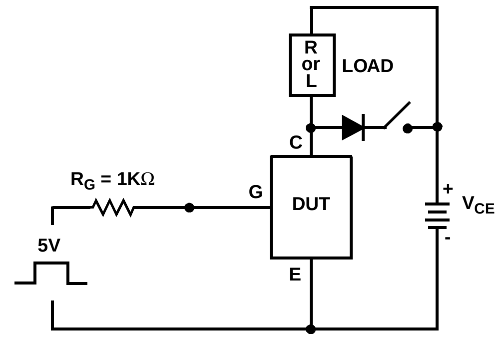



Figure 18. $t_{ON}$ and $t_{OFF}$ Switching Test Circuit

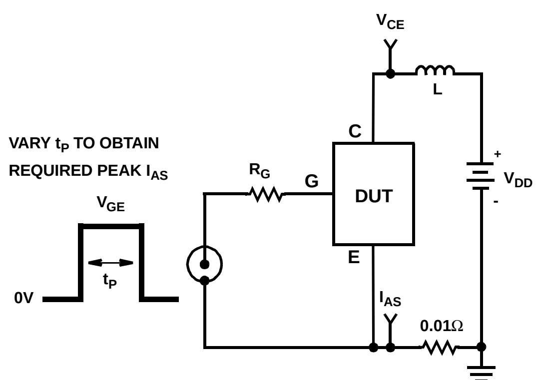



Figure 19. Energy Test Circuit

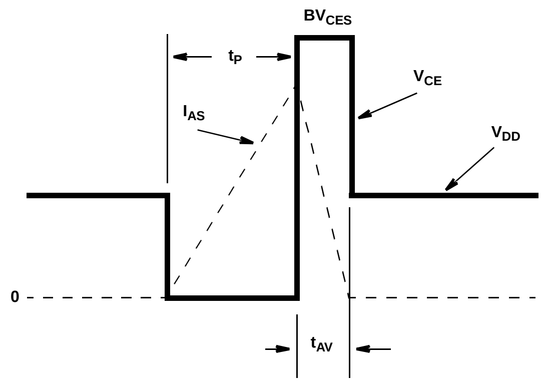



Figure 20. Energy Waveforms

## SPICE Thermal Model

REV 7 March 2002

ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3 /
ISL9V3040S3

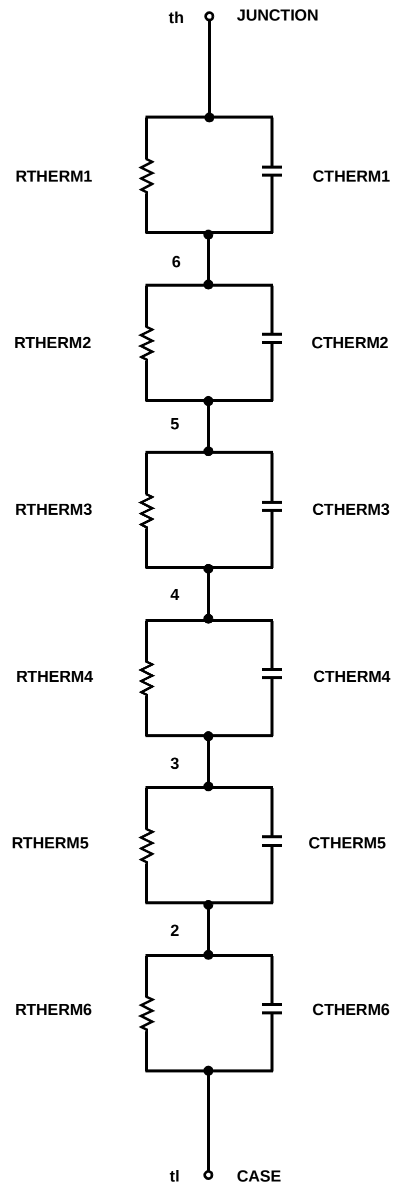
CTHERM1 th 6 2.1e -3
CTHERM2 6 5 1.4e -1
CTHERM3 5 4 7.3e -3
CTHERM4 4 3 2.1e -1
CTHERM5 3 2 1.1e -1
CTHERM6 2 tl 6.2e +6

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 -3

## SABER Thermal Model

SABER thermal model
ISL9V3040D3S / ISL9V3040S3S / ISL9V3040P3 /
ISL9V3040S3
template thermal_model th tl
thermal_c th, tl
{
ctherm.ctherm1 th 6 = 2.1e -3
ctherm.ctherm2 6 5 = 1.4e -1
ctherm.ctherm3 5 4 = 7.3e -3
ctherm.ctherm4 4 3 = 2.2e -1
ctherm.ctherm5 3 2 =1.1e -1
ctherm.ctherm6 2 tl = 6.2e +6

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 -3
}



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| Datasheet Identification | Product Status | Definition |
|---|---|---|
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| Preliminary | First Production | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production | Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design. |
| Obsolete | Not In Production | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only. |

Rev. I66

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