FAIRCHILD SEMICONDUCTOR®

April 2002

ISL9V2040D3S / ISL9V2040S3S / ISL9V2040P3

EcoSPARK^{TM} 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 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 49444

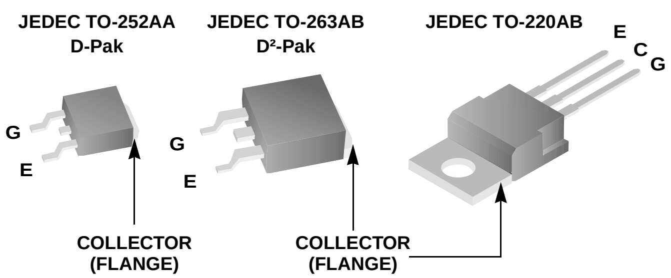
Applications

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

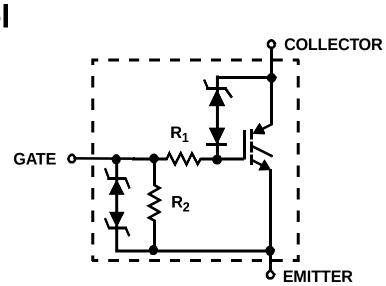
Features

- Space saving D - Pak package available
- SCIS Energy = 200mJ at $T_J = 25^oC$
- 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} = 11.5A, L = 3.0mHy	200	mJ
$E_{SCIS150}$	At Starting T_J = 150°C, I_{SCIS} = 8.9A, L = 3.0mHy	120	mJ
I_{C25}	Collector Current Continuous, At T_C = 25°C, See Fig 9	10	A
I_{C110}	Collector Current Continuous, At T_C = 110°C, See Fig 9	10	A
V_{GEM}	Gate to Emitter Voltage Continuous	±10	V
P_D	Power Dissipation Total T_C = 25°C	130	W
	Power Dissipation Derating T_C > 25°C	0.87	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	Tape Width	Quantity
V2040D	ISL9V2040D3S	TO-252AA	16mm	2500
V2040S	ISL9V2040S3S	TO-263AB	24mm	800
V2040P	ISL9V2040P3	TO-220AB	-	-

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	-	1.45	1.9	V
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	I_C = 10A, V_{GE} = 4.5V	T_C = 150°C See Fig. 4	-	1.95	2.3	V
Dynamic Characteristics							
$Q_{G(ON)}$	Gate Charge	I_C = 10A, V_{CE} = 12V, V_{GE} = 5V, See Fig. 14		-	12	-	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	-	2.3	V
			T_C = 150°C	0.75	-	1.8	V
V_{GEP}	Gate to Emitter Plateau Voltage	I_C = 10A, V_{CE} = 12V		-	3.4	-	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		-	0.61	-	µs
t_{riseR}	Current Rise Time-Resistive			-	2.17	-	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		-	3.64	-	µs
t_{fL}	Current Fall Time-Inductive			-	2.36	-	µs
SCIS	Self Clamped Inductive Switching	T_J = 25°C, L = 3.0mHy, R_G = 1KΩ, V_{GE} = 5V, See Fig. 1 & 2		-	-	200	mJ
Thermal Characteristics							
$R_{\theta JC}$	Thermal Resistance Junction-Case	TO-252, TO-263, TO-220		-	-	1.15	°C/W

Typical Performance Curves (Continued)

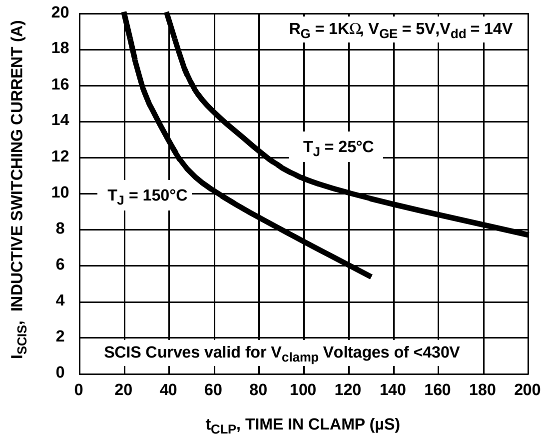


Figure 1. Self Clamped Inductive Switching Current vs Time in Clamp

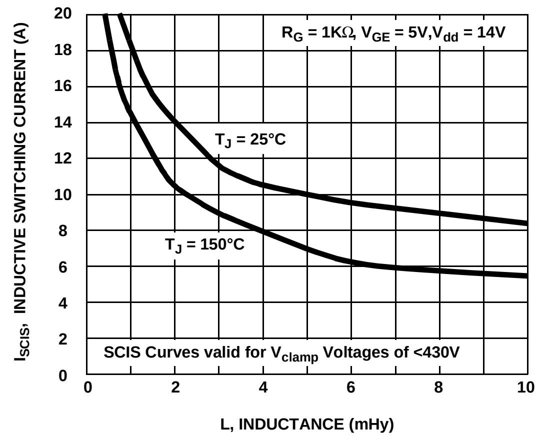


Figure 2. Self Clamped Inductive Switching Current vs Inductance

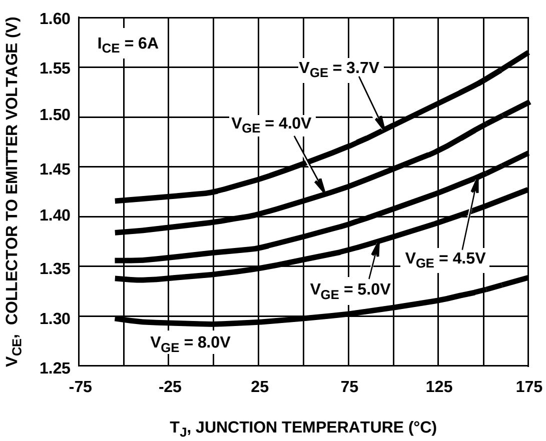


Figure 3. Collector to Emitter On-State Voltage vs Junction Temperature

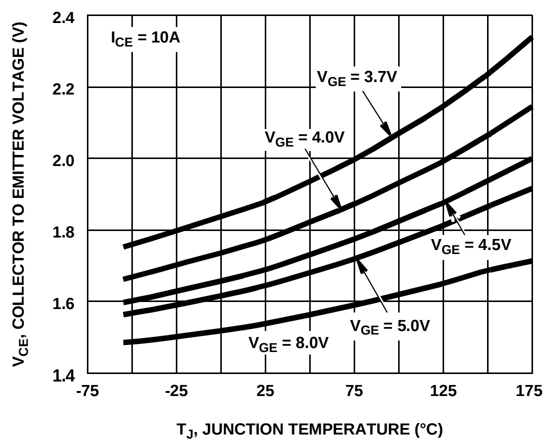


Figure 4. Collector to Emitter On-State Voltage vs Junction Temperature

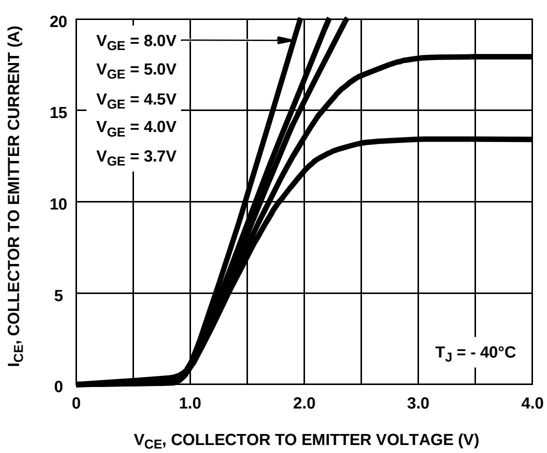


Figure 5. Collector to Emitter On-State Voltage vs Collector Current

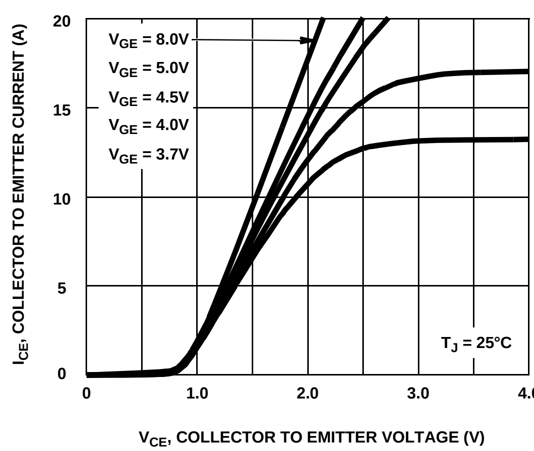


Figure 6. Collector to Emitter On-State Voltage vs Collector Current

Typical Performance Curves (Continued)

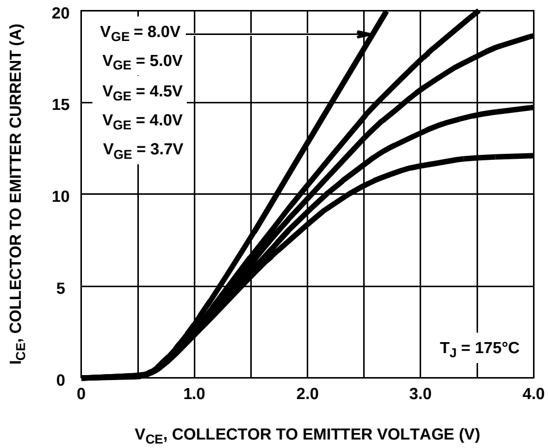


Figure 7. Collector to Emitter On-State Voltage vs Collector Current

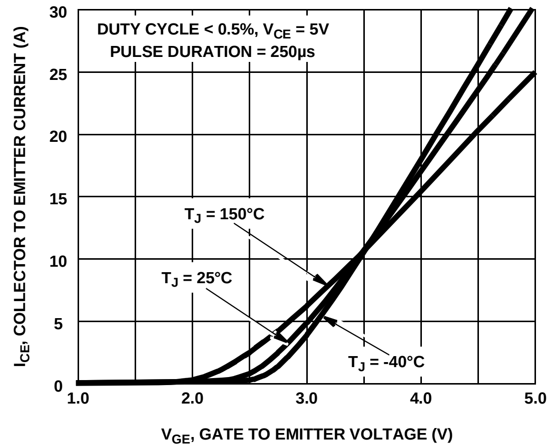


Figure 8. Transfer Characteristics

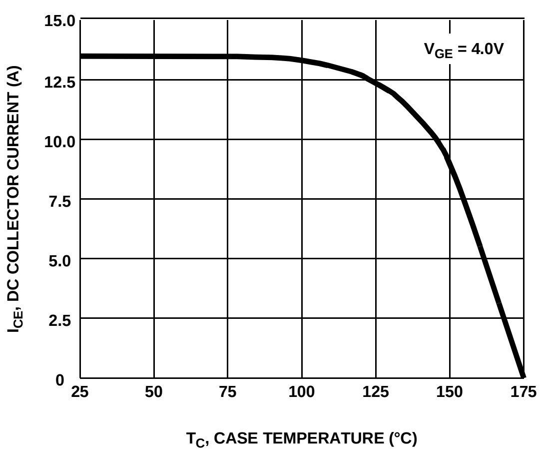


Figure 9. DC Collector Current vs Case Temperature

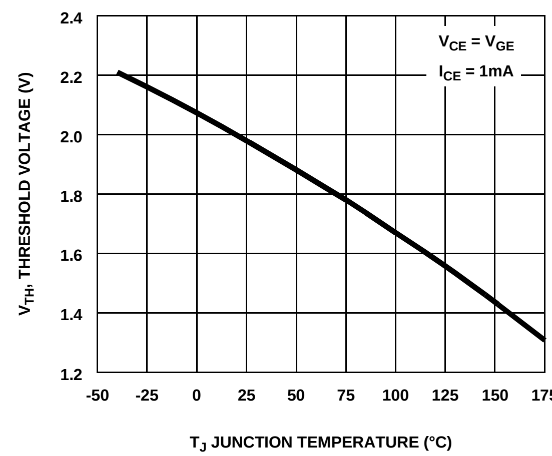


Figure 10. Threshold Voltage vs Junction Temperature

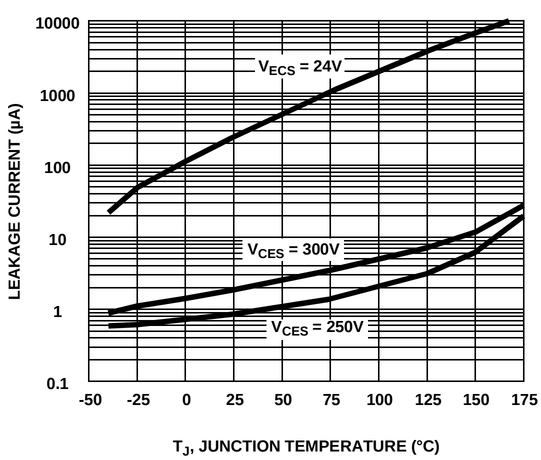


Figure 11. Leakage Current vs Junction Temperature

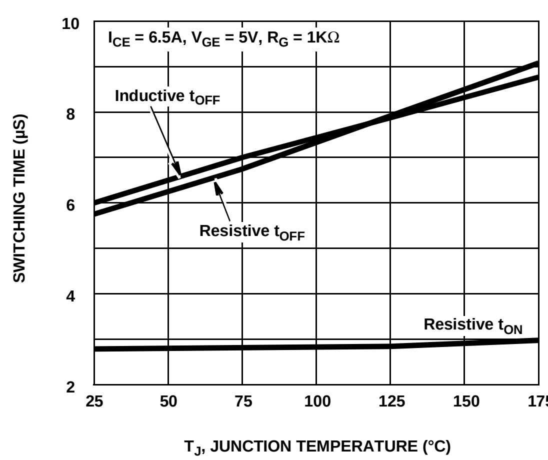


Figure 12. Switching Time vs Junction Temperature

Typical Performance Curves (Continued)

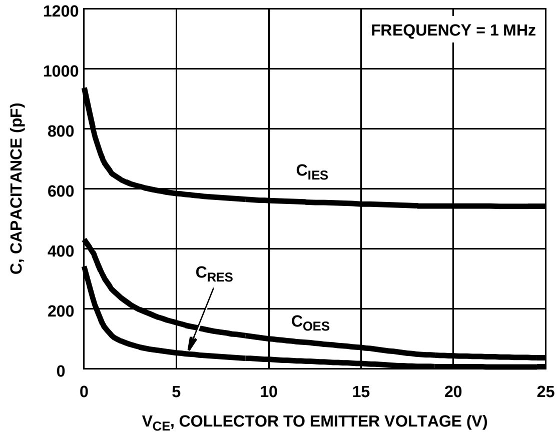


Figure 13. Capacitance vs Collector to Emitter Voltage

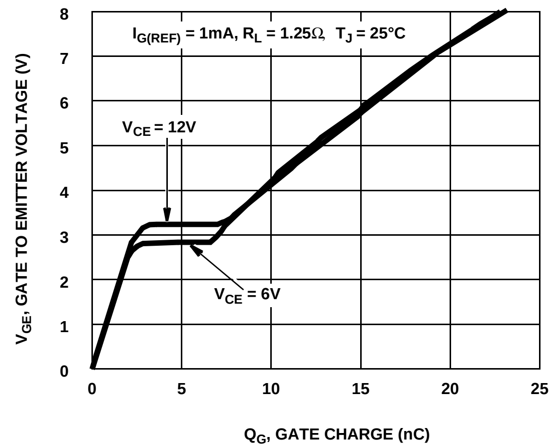


Figure 14. Gate Charge

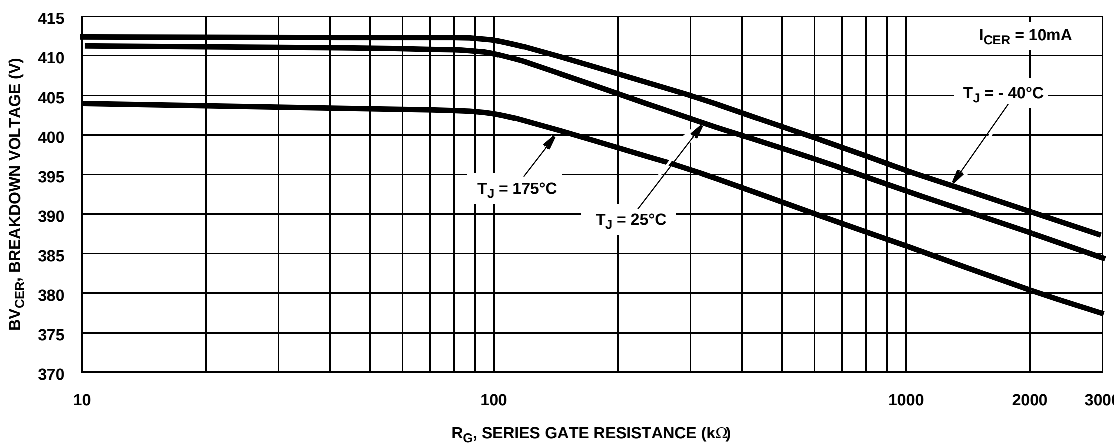


Figure 15. Breakdown Voltage vs Series Gate Resistance

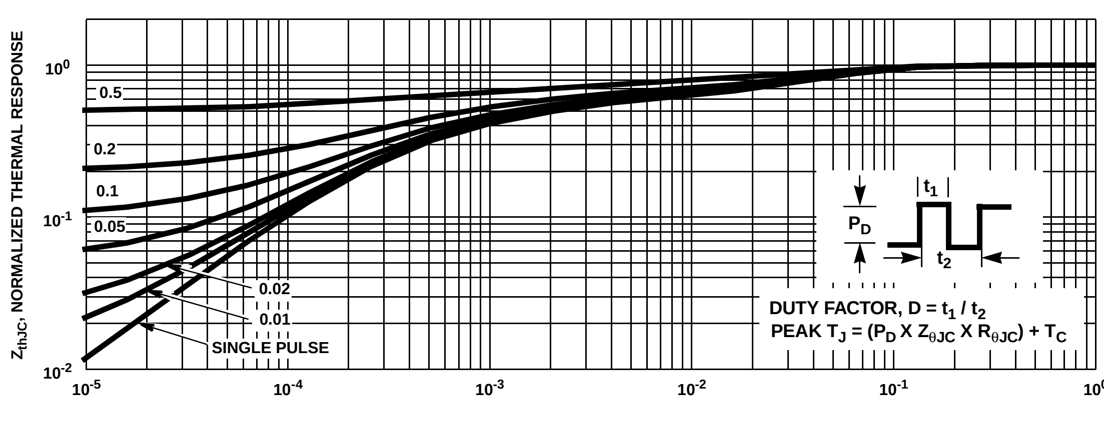


Figure 16. IGBT Normalized Transient Thermal Impedance, Junction to Case

Test Circuit and Waveforms

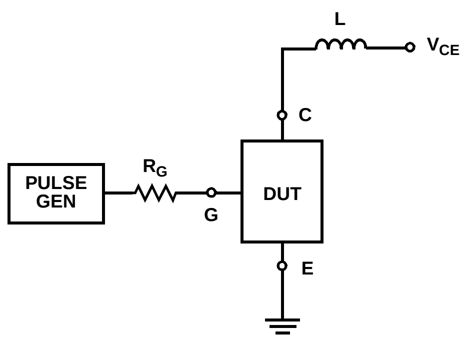


Figure 17. Inductive Switching Test Circuit

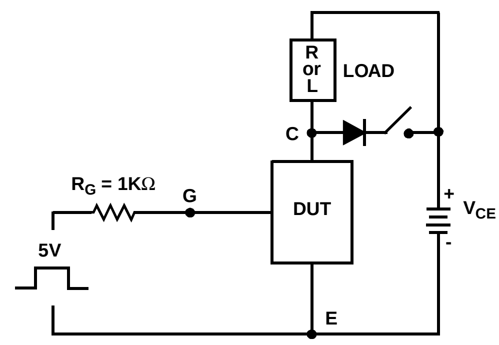


Figure 18. t_{ON} and t_{OFF} Switching Test Circuit

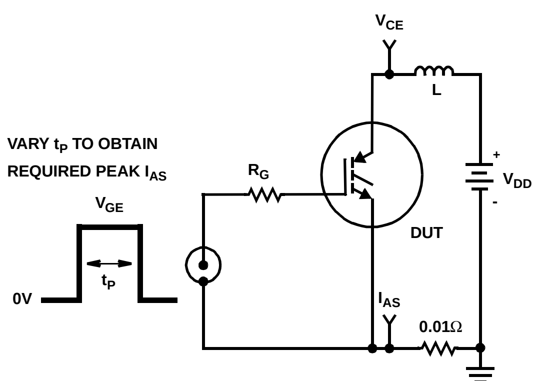


Figure 19. Unclamped Energy Test Circuit

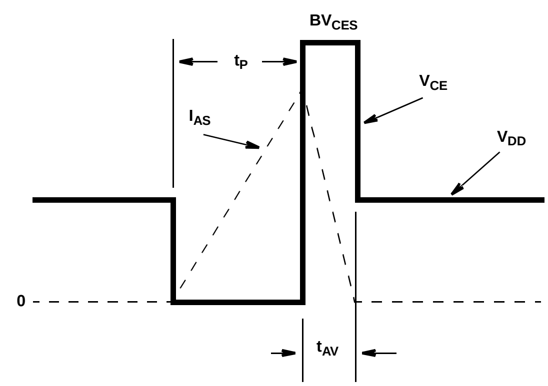


Figure 20. Unclamped Energy Waveforms

SPICE Thermal Model

REV 25 April 2002

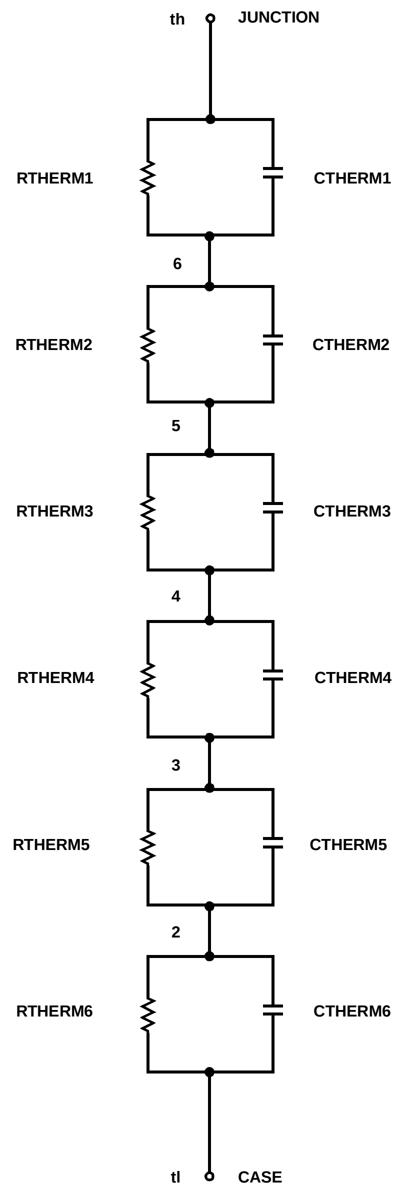
ISL9V2040D3S, ISL9V2040S3S, ISL9V2040P3

```
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
}
```



TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™	FAST ®	MICROWIRE™	SILENT SWITCHER ®	UHC™
Bottomless™	FASTr™	OPTOLOGIC ®	SMART START™	UltraFET ®
CoolFET™	FRFET™	OPTOPLANAR™	SPM™	VCX™
CROSSVOLT™	GlobalOptoisolator™	PACMAN™	STAR*POWER™	
DenseTrench™	GTO™	POP™	Stealth™	
DOME™	HiSeC™	Power247™	SuperSOT™-3	
EcoSPARK™	I^{2}C™	PowerTrench ®	SuperSOT™-6	
E^{2}CMOS™	ISOPLANAR™	QFET™	SuperSOT™-8	
EnSigna™	LittleFET™	QS™	SyncFET™	
FACT™	MicroFET™	QT Optoelectronics™	TinyLogic™	
FACT Quiet Series™	MicroPak™	Quiet Series™	TruTranslation™	

STAR*POWER is used under license

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

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

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Rev. H5