

## Abstract

This application note describes how to use the SPICE model for the [ISL70002SEH](#) radiation hardened and SEE hardened 12A synchronous buck regulator. This SPICE model was developed to help system designers evaluate the operation of this IC prior or in conjunction with prototyping a system design. This model accurately simulates typical performance characteristics at room temperature (+25 °C) such as loop analysis, transient analysis and start-up. Functionality has been tested on CADENCE ORCAD 16.3. Other SPICE simulators may be used, however, the model may require translation.

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## Introduction

The ISL70002SEH is a radiation hardened and SEE hardened high efficiency monolithic synchronous buck regulator with integrated MOSFETs, which operate over an input voltage range of 3V to 5.5V. Utilizing peak current-mode control with integrated compensation and a switching frequency of 1MHz or 500kHz, this Point-of-Load (POL) provides excellent dynamic response in a small form factor. High integration and class leading radiation tolerance makes the ISL70002SEH the ideal POL solution for many space applications.

## Reference Documents

- [ISL70002SEH](#) datasheet
- SMD [5962-12202](#)

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## Project Files

The zip file: [isl70002seh-pspice-average-model.zip](#) contains the project file ISL70002SEH.opj to be used in an ORCAD simulator. The project file has the model definition file (.lib), symbol file (.olb) and the schematic page as shown in [Figure 1](#). Three simulation profiles are included in the project to simulate start-up, loop analysis and transient response. [Figures 2](#) through [4](#) show the results of the three preset simulation profiles.

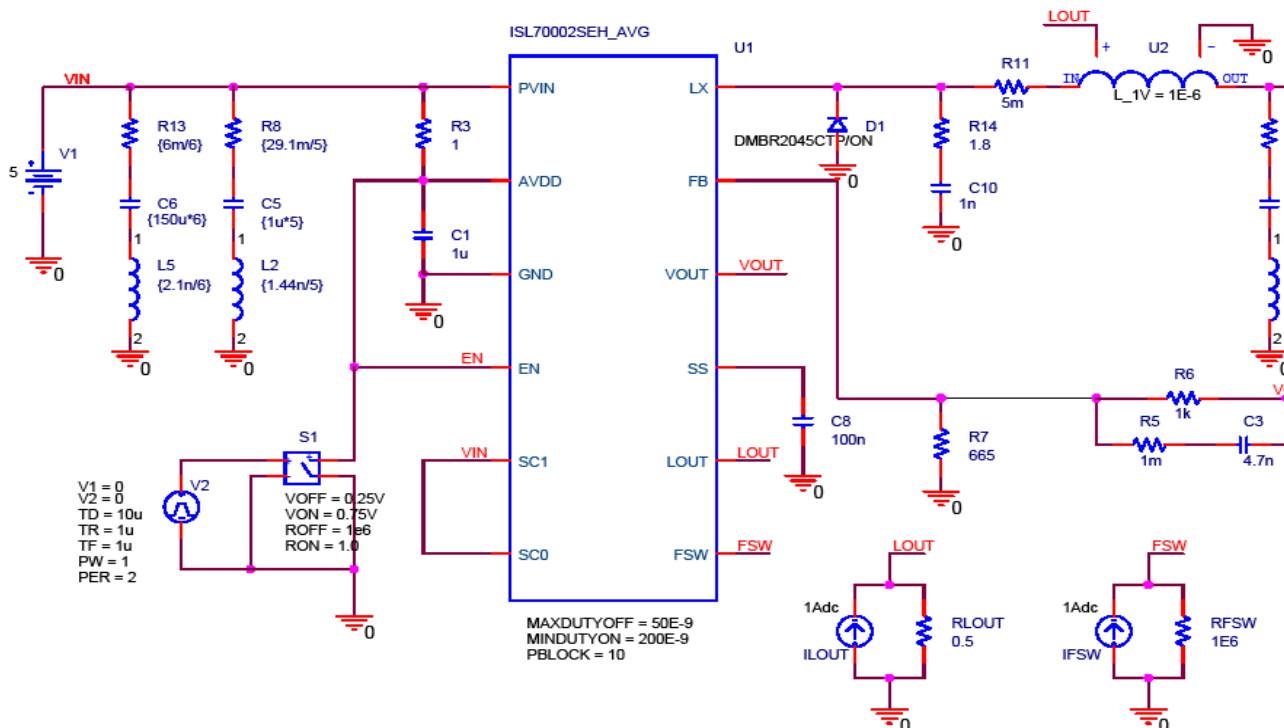


FIGURE 1. BASIC NONINVERTING GAIN CONFIGURATION IN ORCAD SPICE FOR AC ANALYSIS

## Power Blocks

The model has a parameter named PBLOCK, which is equivalent to the number of LX nodes connected on the ISL70002SEH in a given application. By double clicking the text, you can modify the number of blocks to match the prototype board.

## Maximum/Minimum Duty Cycle

The model has two parameters, named MAXDUTYOFF and MINDUTYON, which control the maximum LX off-time and minimum LX on-time, respectively. These parameters allow you to choose the proper on and off times based on your application and electrical specification limits of the datasheet or SMD. For example, the model is programmed with a 200ns minimum LX on-time based on the typical limit at 5.5V operation. If the application were for 3.3V rails the user should change this parameter to 225ns based on the datasheet electrical specifications for 3V operation.

## Inductor Value

The average model is based on a mathematical representation of the ISL70002SEH. The value of the inductor is needed for the model to accurately simulate the regulator. The model has an added pin, LOUT, which is connected to a current source  $I_{LOUT}$  and resistor  $R_{LOUT}$ . These create a voltage that is fed into the pin and into inductor U2. U2 translates the voltage into inductance by the equation  $L_{1V} = 1\mu H$ , for every volt on LOUT the inductor value is  $1\mu H$ . For example, to change the inductor value to 500nH, one must change  $R_{LOUT}$  to  $0.5\Omega$ .

## V<sub>OUT</sub> Value

The output voltage must also be known for the average model to work correctly. The VOUT pin is added to read the output voltage and feed into the internal equations within the ISL70002SEH model. For proper simulation of the model VOUT must be connected to the output voltage of the ISL70002SEH application schematic.

## Switching Frequency Value

Like the inductor, the value of the switching frequency is needed for the model to accurately simulate the regulator. The model has a pin, FSW, which functions differently than the FSEL pin on the physical device. The model requires a voltage to represent the value of the switching frequency. This voltage is set up and fed into the regulator using a current source,  $I_{FSW}$ , in parallel with a resistor,  $R_{FSW}$ . U1 translate, the voltage into frequency by the equation  $1V = 1Hz$ ; where for every volt on the FSW pin, the switching frequency value is 1Hz. For example, to change the switching frequency value to 500kHz, one must change  $R_{FSW}$  to 500k $\Omega$ .

## Simulated Performance Curves

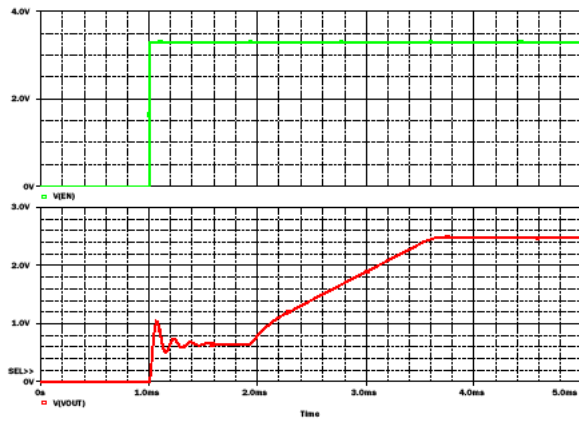


FIGURE 2. SIMULATED START-UP

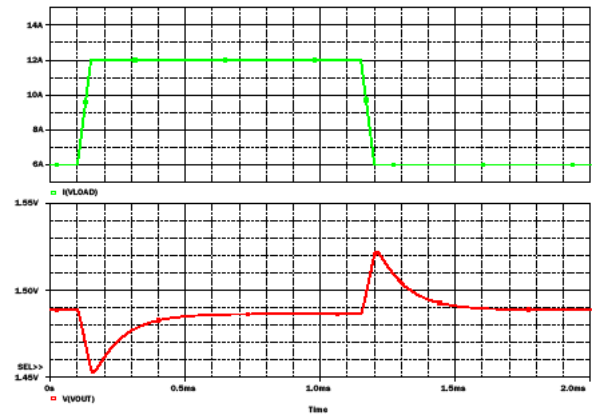


FIGURE 3. SIMULATED 6A TRANSIENT RESPONSE

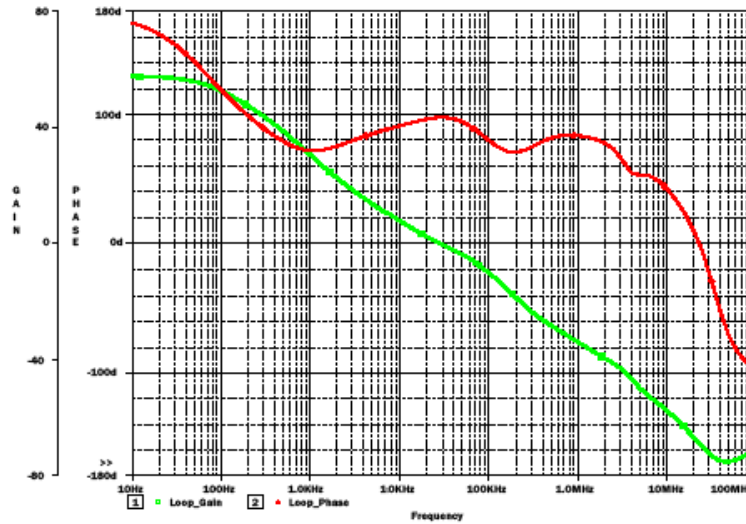


FIGURE 4. SIMULATED LOOP RESPONSE

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