ISL70002SEH SPICE Average Model

AN1970
Rev 0.00
Dec 15, 2015

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.

Table of Contents

List of Figures

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

License Statement

The information in this SPICE model is protected under the United States copyright laws. Intersil Corporation hereby grants users of this macro-model hereto referred to as "Licensee", a nonexclusive, nontransferable license to use this model as long as the Licensee abides by the terms of this agreement. Before using this macro-model, the Licensee should read this license. If the Licensee does not accept these terms, permission to use the model is not granted.

The Licensee may not sell, loan, rent, or license the macro-model, in whole, in part, or in modified form, to anyone outside the Licensee's company. The Licensee may modify the macro-model to suit his/her specific applications, and the Licensee may make copies of this macro-model for use within their company only.

This macro-model is provided "AS IS, WHERE IS, AND WITH NO WARRANTY OF ANY KIND EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE."

In no event will Intersil be liable for special, collateral, incidental, or consequential damages in connection with or arising out of the use of this macro-model. Intersil reserves the right to make changes to the product and the macro-model without prior notice.

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.

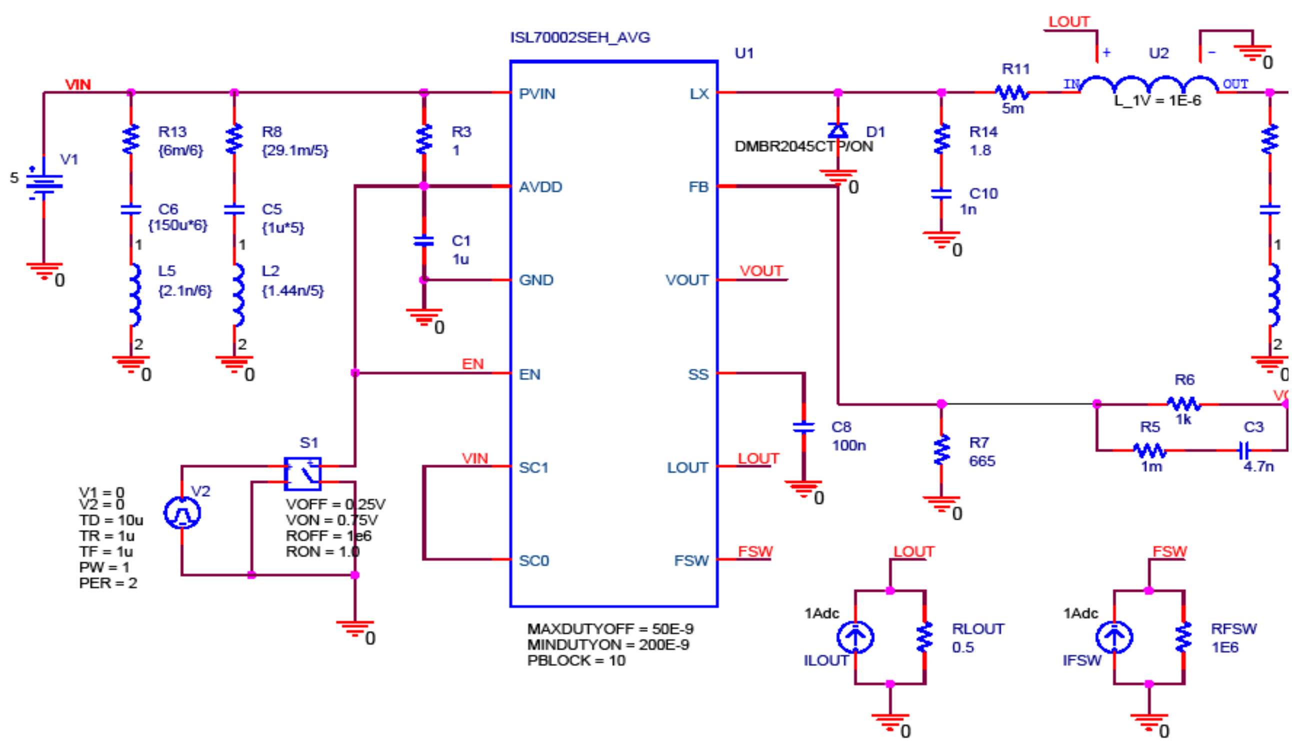

FIGURE 1. BASIC NONINVERTING GAIN CONFIGURATION IN ORCAD SPICE FOR AC ANALYSIS

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 = 1µH, for every volt on LOUT the inductor value is 1µH. For example, to change the inductor value to 500nH, one must change R_{LOUT} to 0.5Ω.

V_{OUT} 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 500kΩ.

Simulated Performance Curves

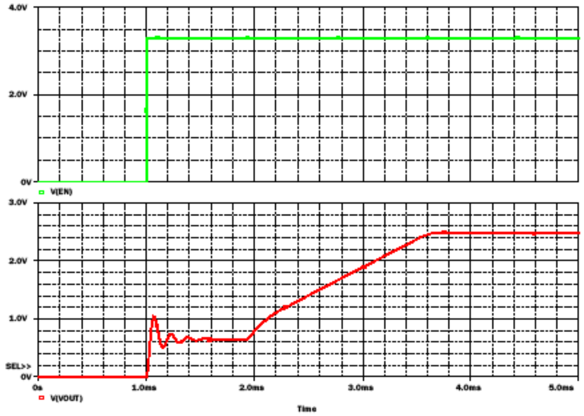

FIGURE 2. SIMULATED START-UP

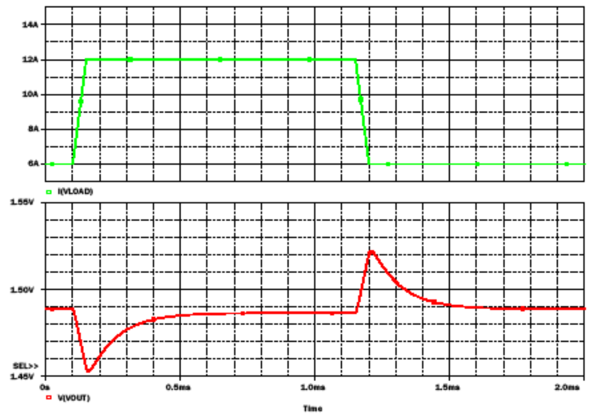

FIGURE 3. SIMULATED 6A TRANSIENT RESPONSE

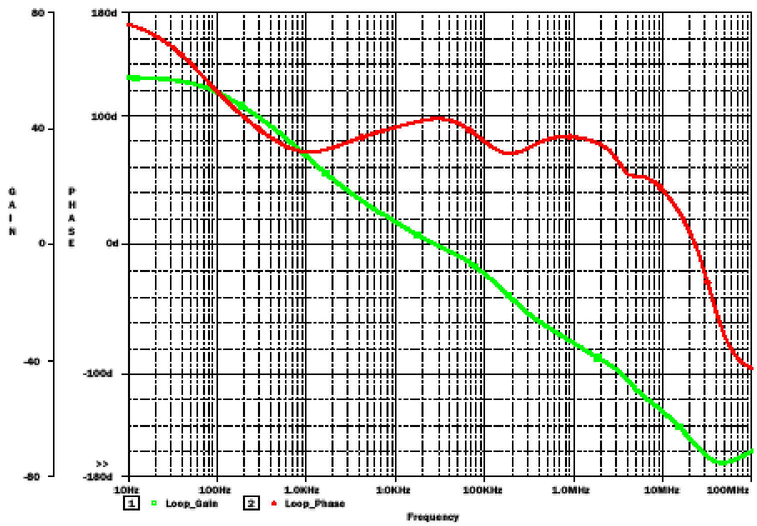

FIGURE 4. SIMULATED LOOP RESPONSE

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Colophon 7.0