Introduction

Due to its flexibility in design, FPGA based systems have become increasingly common in space applications. One of the most commonly used IC’s in the space industry are the radiation tolerant low power FPGA’s. This application note discusses the ISL_LOWPWRMEZ_EV1ZA board, Intersil’s reference power design for low power radiation hardened FPGA’s. This particular board is optimized to power an Actel RTAX FPGA and features the ISL70003SEH and ISL75051SEH as the POL regulators for the core, auxiliary, and I/O voltages needed in the FPGA.

FPGA Power Solution

The core voltage for the RTAX is 1.5V and is regulated by the ISL70003SEH directly from the 12V intermediate bus. A secondary ISL70003SEH is used to create a 5V rail, which will be in the inputs to the LDO’s. This is done to reduce the overall system noise. Two ISL75051SEH IC’s regulate the necessary 1.8V and 3.3V for the auxiliary and I/O supplies, respectively (see Figure 1).

Circuit Description

An AC/DC adapter provides the input source through the 2.1mm barrel-jack connector. Once the board is enabled, both ISL70003SEH parts start up at the same time. To ensure proper sequence during power-up is maintained, the PGOOD line of both ISL70003SEH’s are OR’ed together and connected to the ENABLE pin of the ISL75051SEH’s. This ensures that the core voltage is up first, followed by simultaneous start up of the auxiliary and I/O voltage once both the core voltage and 5V are at their proper levels.

The output capacitors for each device have been chosen to minimize ESR in an effort to maintain output ripple <1% of the regulated voltage and to optimize the stability of the systems. KEMET’s T530 series of tantalum capacitors offer ultra low ESR <15mΩ and are DLA certified.

Provisions for stability measurements are included by replacing R4, R19, R38 and R45 with 10Ω resistors and injecting the AC signal across the test points on either side of those resistors.

Radiation Tolerance

Total Ionizing Dose

These circuits are fabricated on a 0.6μm BiCMOS junction isolated process optimized for power management applications. They were hardened by design to achieve a Total Ionizing Dose (TID) rating of at least 100krads(Si) at the standard 50 to 300rad(Si)/s high dose rate as well as the standard <10mrad(Si)/s low dose rate. Well known TID hardening methods were employed such as closed geometry NMOS devices to reduce leakage and optimized bias levels for bipolar devices to compensate for gain reduction. These products are wafer-by-wafer acceptance tested to 50krad(Si) at the standard low dose rate of <10mrad(Si)/s.

Single Event Effects

Both IC’s are also hardened by design for Single Event Effects (SEE) to a Linear Energy Transfer (LET) of 86.4MeV·cm²/mg by employing various SEE hardening techniques such as proper device sizing, filtering and special layout constraints. The ISL75051SEH and the ISL70003SEH exhibit no single event latch-up or burnout up to their respective input voltage at an LET of 86.4MeV·cm²/mg.

These circuits also offer class leading Single Event Transient (SET) performance. The ISL70003SEH is designed to offer a single LX pulse deviation due to an SET at an LET of 86.4MeV·cm²/mg. The ISL75051SEH also guarantees a <5% output voltage deviation without the need of additional external filtering. This is important as modern processors and FPGAs can only tolerate a 5% window for the supply voltage and in many cases, the 5% tolerance includes DC voltage tolerance and transients due to load step or release and transients due to SETs.

FIGURE 1. BLOCK DIAGRAM OF POWER DISTRIBUTION

The ISL70003SEH is a radiation hardened and SEE hardened high efficiency, monolithic synchronous buck regulator with integrated MOSFETs. This single chip power solution operates over an input voltage range of 3V to 13.2V and provides a tightly regulated output voltage that is externally adjustable from 0.8V to ~85% of the input voltage. The ISL70003SEH uses voltage mode architecture with feed-forward and switches at a fixed frequency of 500kHz or 300kHz. Loop compensation is externally adjustable to allow for an optimum balance between stability and output dynamic performance. The ISL70003SEH can provide up to 3A of continuous output current at a TJ = +150°C and 6A at TJ = +125°C.

The ISL75051SEH is a radiation hardened, low voltage, high current, single output LDO specified for up to 3A of continuous output current. It can operate over an input voltage range of 2.2V to 6V and is capable of providing output voltages of 0.8V to 5V with an external resistor divider. Typical dropout voltages seen with the ISL75051SEH are 65mV at 1A load current and 225mV at 3A.

The ISL75051SEH and the ISL70003SEH exhibit no single event latch-up or burnout up to their respective input voltage at an LET of 86.4MeV·cm²/mg.
For further information on radiation performance and a complete listing of Applications, Related Documentation and Related Parts scan this QR code with your smart phone or visit us at www.intersil.com/space.
Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.

2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.

3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.

5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality.” The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.

   “Standard”: Computers, office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots, etc.

   “High Quality”: Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations, etc.), or may cause serious property damage (space systems; underwater repellers; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.

6. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to minimum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failures or accidents arising out of the use of Renesas Electronics products outside of such specified ranges.

7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to, redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.

8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.

10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.

11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Rev.4.0-1  November 2017)