

Introduction

Power supply sequencing is a method of staging two or more power supply output voltages. Sequencing makes the timing between power supplies turning on and off very deterministic. This document describes the application of the ZL2005 in an Autonomous Sequencing application.

Autonomous Sequencing technology is a feature of the ZL2005 where the relationship between each output is configured by pin-strap settings. An Autonomous Sequencing group is defined as a set of ZL2005 devices that are configured to sequence relative to each other without the intervention of a host controller. A common two wire bus provides the means for all devices to communicate their requirement to turn on or turn off relative to each other within the group. This type of sequencing that includes inter-device communication allows for a very robust, easy to implement and intelligent sequencing method.

Each ZL2005 device is pin-strap configured for its own output voltage, softstart ramp, power-up delay, clock configuration, and bus address. A device's group position is determined by the pin-strap setting of its address. The first ZL2005 device in an Autonomous Sequencing group is defined by being set to the lowest address within the group and the setting of the CFG pin. The last ZL2005 device in an Autonomous Sequencing group is defined by the highest consecutive address within the group and the setting of the CFG pin. All of the ZL2005 ENABLE pins are connected together and driven by a single logic source. The first device initiates the power up of the sequencing group following assertion of ENABLE. The last device initiates the power down of the sequencing group following de-

assertion of ENABLE. In the event of a fault within the group, shut down will be communicated within the group and an immediate power down of all devices within the group will begin. Each sequencing communication in the group is the result of an event within the group. The ability to communicate faults within the group is termed "fault spreading."

Autonomous Sequencing Example

This section describes an example of Autonomous Sequencing technology using two ZL2005 devices mounted on two ZL2005EV1 evaluation boards. The sequencing scenario will include a 3.3V rail and a 1.5V rail that are configured to sequence in a preset manner.

A ZL2005 device that is used for Autonomous Sequencing capabilities is expected to be pin-strap configured from the factory default state with no parameters stored in either USER_STORE or DEFAULT_STORE. Stored configurations should be erased from all devices. A new ZL2005EV1 EVB will have a configuration stored in the DEFAULT_STORE. To erase all stored configurations perform the following steps:

1. Invoke the ZL2005 Evaluation Software
2. Select the "PMBus: Advanced" page.
3. Click "RESTORE_FACTORY"
4. Click "STORE_DEFAULT_ALL"
5. Click "OK"
6. Click "STORE_USER_ALL"
7. Click "OK".

Then select the address for the next board (0x21) and repeat the configuration erase for that board's device. This procedure will erase all stored configurations and place each device in the factory default state.

The configuration pin (CFG) is used to set the relative position of a ZL2005 device within an Autonomous Sequencing group. A resistor from ground applied to this pin sets the device to be either first, in the middle or last in the group. The lowest addressed device in the group must be set as the first device of the group. The consecutively addressed devices must be set as middle devices. The highest consecutively addressed device must be set as the last device.

The ZL2005 address pins set the absolute position of the device within an Autonomous Sequencing

group. The addresses must be set in conjunction with the CFG pin setting and must be set in a consecutive order. The ZL2005 pin-strap addressing is settable from address 0x20 to 0x27 with combinations of high, open and low on pins SA1 and SA0. Refer to the data sheet for the address settings. Other address ranges can be selected through resistor settings on the SA1 and SA0 pins, but the addresses must be limited to groups of eight such as 0x40 through 0x47, or 0x58 through 0x5F, or 0x60 through 0x67, for example.

Table 1. ZL2005 Device Settings

| Pin | Device on EVB #1 | Device on EVB #2 |
|--------------|---|---|
| SA1, SA0 | low, low (address x20) | low, open (address x21) |
| V1, V0 | high, low (2.5V) | open, low (1.2V) |
| SYNC | open (auto detect) | open (auto detect) |
| CFG | low (SYNC pin is input) | low (SYNC pin is input) |
| DLY1, DLY0 | open, open (10 ms delay) | open, open (10 ms delay) |
| SS1, SS0 | open, high (20 ms ramp time & PG delay) | open, open (10 ms ramp time & PG delay) |
| ILIM1, ILIM0 | open, high (70 mV/2.7 mΩ = 25.9A) | open, high (70 mV/2.7 mΩ = 25.9A) |
| FC1, FC0 | open, high (stable for power train) | open, high (stable for power train) |
| UVLO | open (4.5V min) | open (4.5V min) |

ZL2005 Device Settings

Table 1 describes the pin-strap values applied to each ZL2005EV1 to prepare the device on each EVB for autonomous sequencing activities.

ZL2005EV1 EVB Connections

1. Connect the evaluation boards together using J13 of board #1 (address x20) and J12 of board #2 (address x21). The inter-device bus, ENABLE and SYNC pins are connected together via these connectors.
2. Place the ENABLE jumper to the “MSTR EN” position on both boards.
3. Set the ENABLE switch of board #2 to the middle position (MONITOR).
4. Connect USB cable from PC to USB jack¹
5. Connect RTN of EVB#1 to RTN of EVB#2.
6. Connect VIN of EVB#1 to VIN of EVB#2.
7. Connect the power source GND to RTN and V+ to VIN.
8. Turn the input power supply on.
9. Enable outputs by the ENABLE switch on board #1

NOTE 1: These EVBs are configured to work in a group mode with inter-device communication. The USB from a PC must be connected to the USB jack in order to power the onboard microcontrollers. If the onboard microcontrollers are not powered they apply an improper load to the inter-device bus which disables the communication between ZL2005s.

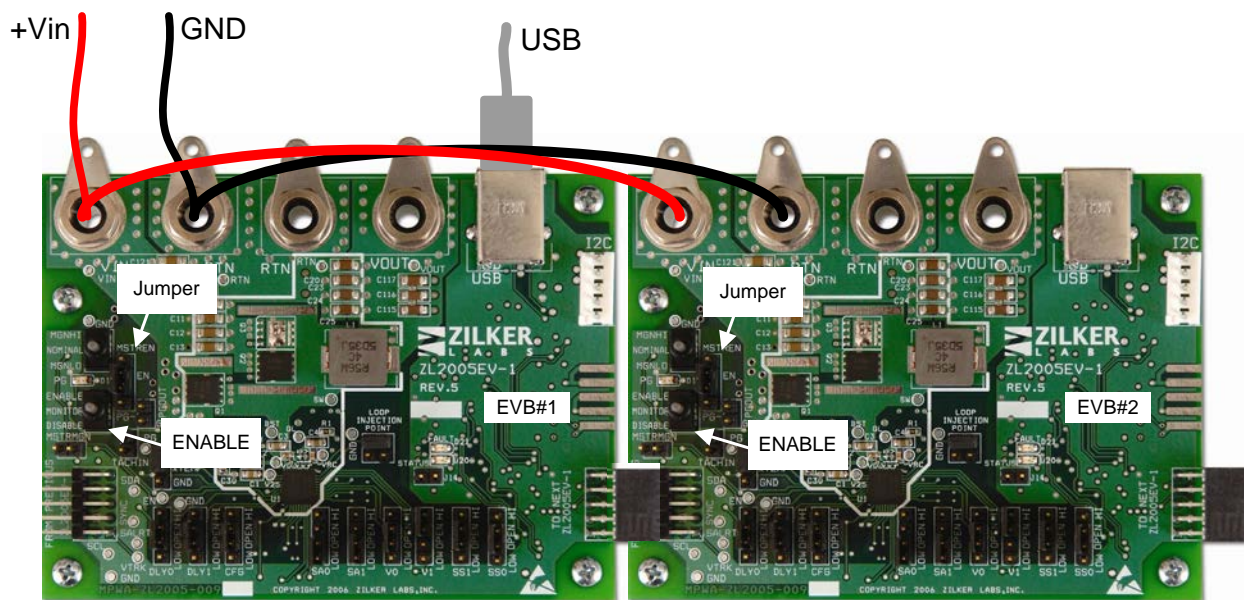


Figure 1. EVB Connections for Autonomous Sequencing

Autonomous Sequencing Example: Enable Sequence

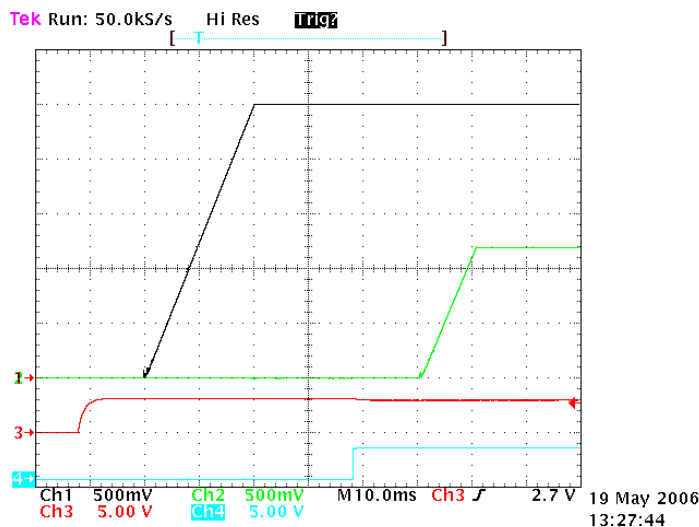


Figure 2. Enable Sequence

Channel 1 = VOUT1, board #1
 Channel 2 = VOUT2, board #2
 Channel 3 = ENABLE
 Channel 4 = Power Good, board #1

In Figure 2, the scope is set to trigger on the ENABLE event. The ENABLE signal is the first to go high. The next signal to change is the turn-on ramp of VOUT1 since it has been configured to be the first device in the group. It occurs 10 ms after ENABLE (DLY1:DLY0 set to 10 ms). The time of the VOUT1 ramp is 20 ms (SS1:SS0 set to 20ms). Power Good 1 then goes high 20 ms after VOUT1 is above power good threshold (power good delay = softstart = 20 ms). At the time of Power Good 1 going high, device #1 communicates over the inter-device bus that the next device in the group can begin its enable procedure (not shown). The delay for VOUT2 to begin its turn on is set to 10ms. The ramp time for VOUT2 is 10 ms (SS1:SS0 set to 10 ms).

Autonomous Sequencing Example: Disable Sequence

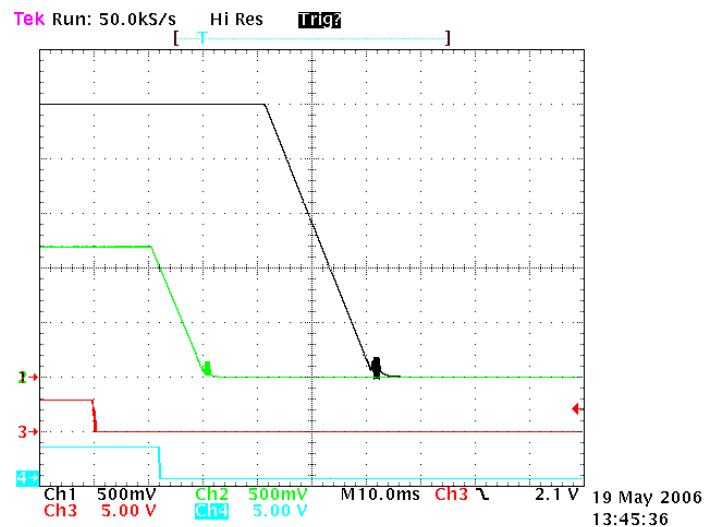


Figure 3. Disable Sequence

Channel 1 = VOUT1, board #1
 Channel 2 = VOUT2, board #2
 Channel 3 = ENABLE
 Channel 4 = Power Good, board #2

In Figure 3, the scope is set to trigger on the ENABLE event. The ENABLE signal is the first to go low. The next signal to change is the VOUT2 turn off ramp since it has been configured to be the last device in the group. It occurs 10 ms after ENABLE going low (DLY1:DLY0 set to 10 ms). The time of the VOUT2 ramp is 10 ms (SS1:SS0 set to 10ms). The next signal to change is the Power Good 2 which goes low after VOUT2 drops below the power good threshold. At the time VOUT2 ramps to zero volts, device #2 communicates over the inter-device bus that the next device in the group can begin its disable procedure (not shown). The delay for VOUT1 to begin its turn off is set to 10 ms. The ramp time for VOUT1 is 20 ms (SS1:SS0 to 20 ms).

References

- [1] *ZL2005 Data Sheet*, Zilker Labs, Inc., 2006.
- [2] AN2013 – *ZL2005 and PMBus™*, Zilker Labs, Inc., 2006.

Revision History

| Date | Rev. # | |
|-----------------|----------|---|
| July 10, 2006 | 1.0 | Initial Release |
| October 3, 2006 | 2.2 | Updated EVB picture on Page 3 |
| May 4, 2009 | AN2022.0 | Assigned file number AN2022 to app note as this will be the first release with an Intersil file number. Replaced header and footer with Intersil header and footer. Updated disclaimer information to read "Intersil and it's subsidiaries including Zilker Labs, Inc." No changes to app note content. |
| | | |

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 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 system; undersea repeaters; 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 maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident 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.
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)



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