SH7216 Series

Digital Power Control: Battery Charger

RET05B0012-0100
Rev.1.00
Sep 30, 2010

Introduction

This application note describes the design of a battery charger based on the Renesas SH7216 microcontrollers.

This battery charger provide a reference design using Renesas SH7216 MCU, which has the fast processing core and I/O port for the controller needs. It has a fast charging system, which can shorten charging time for large capacity battery.

Target Device

SuperH RISC engine Family SH7216 Series

Contents

1. System Architecture

The Battery Charger consists of three main sections. These are:

- CPU Board
- Three Batteries in series
- Battery Charger Board

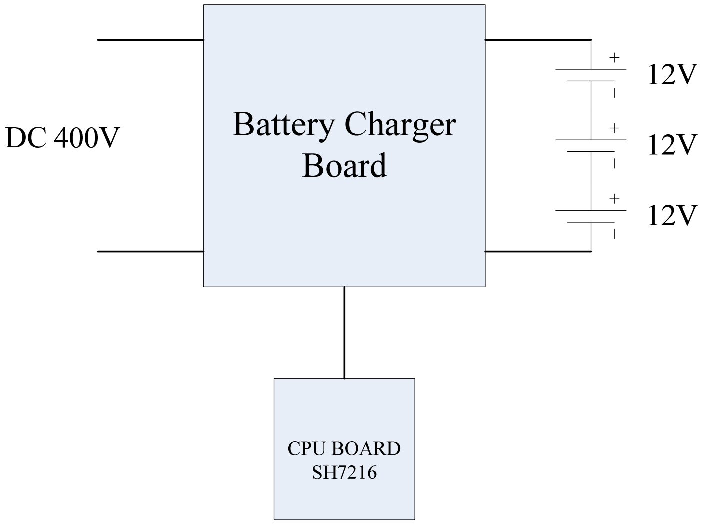

Figure 1 Block diagram

2. Specifications

Battery Charger Board:

The detail designed specifications of the battery charger are shown in Table 1.

Table 1 Specifications

	Charger
Input Voltage	DC 400 V
Output Voltage	DC 31.5~40.5V
Output Waveform	DC
Type/Topology	Flyback
Max. Output Current	DC 1.7 A
Max. Output Power	68.85 W
Battery	12V * 3

CPU Board:
- Renesas Microcontroller: SH7216

Battery:
- Three 12V 7.2Ah Batteries in series

NOTE:
The use of high voltage power supplies is extremely dangerous. Only authorized personnel working in a controlled environment are allowed to change the system configuration, at their own risk.
The voltage supply in the standard configuration is 400Vdc.
Renesas does not assume any responsibility for any voluntary modification of the standard demonstration hardware as well as over any misuse of the proposed system.

2.1 CPU Board

The CPU board can be used to control the battery charger. The microcontroller responsible for the following tasks:

1) Battery charging

2) Regulation PI algorithm

3) MOSFETs management.

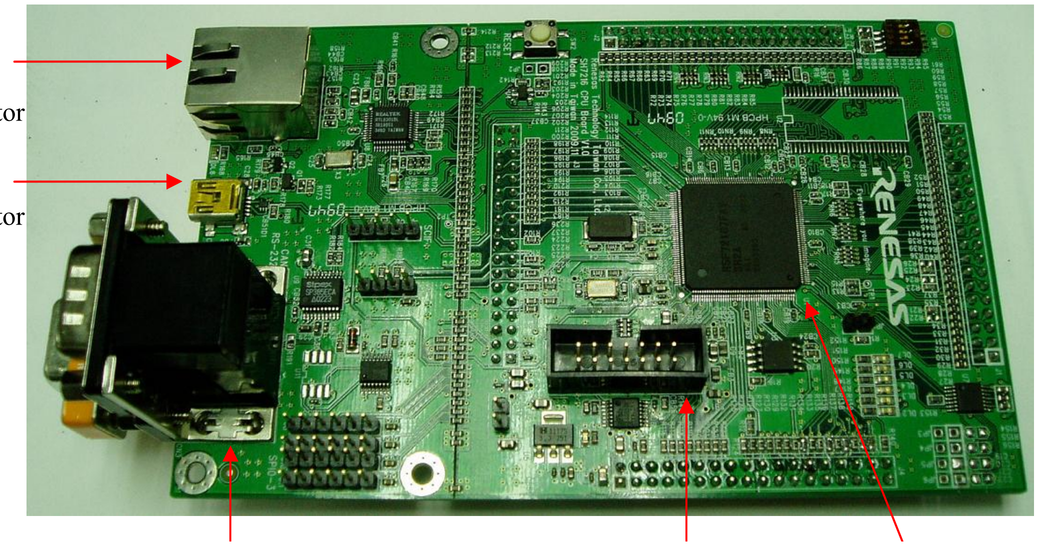

Figure 5 CPU Board

3. Control Block Diagram

The PI algorithm method is shown in Figure 9. The output voltage of charger is regulated at 36 V with 1.7 A current limit to prevent damaging of battery.

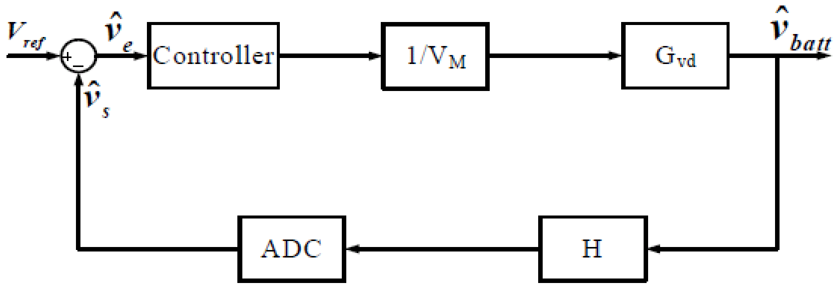

Figure 9 PI algorithm for charger

4. Hardware Block Diagram Analysis

The charger circuit is shown in figure 12. The type of charger circuit is flyback. Since the output power is quite low, the basic topology is a flyback converter with input bridge rectifier.

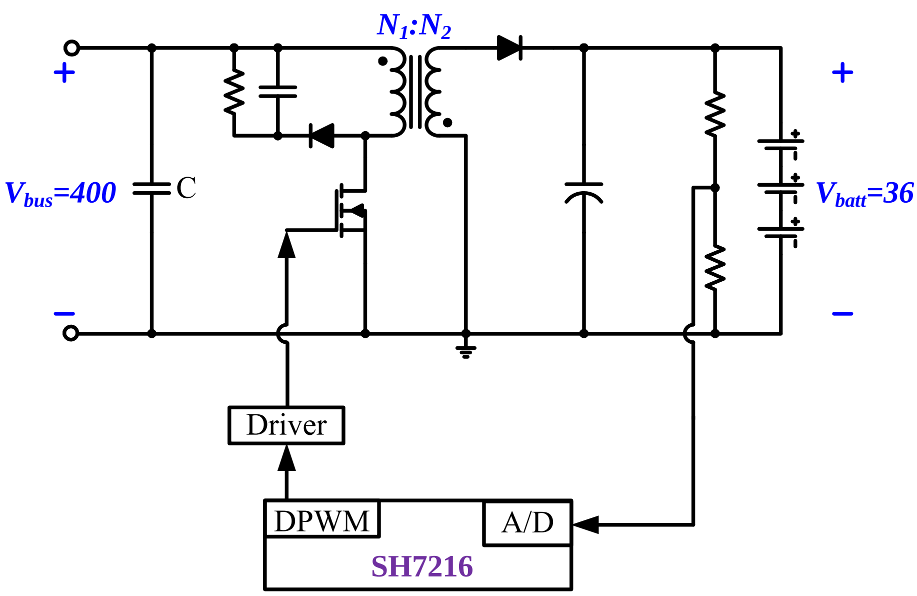

Figure 12 charger circuit

5. Software description

List and description of the battery charger software modules and functions

The main settings are:

io_set_cpg: performs the PLL initialization

```
WDT.WRITE.WTCSR = 0xa51e;          => WDT stop, WDT count clock setting
                                   => 1/4096 x P-clock (50MHz; 20.97msec)
WDT.WRITE.WTCNT = 0x5a85;          => Counter initial setting 10msec
CPG.FRQCR.WORD  = 0x0303;          => Clockin = 12.5MHz
                                   => I Clock = 200MHz, B Clock = 50MHz
                                   => P Clock = 50MHz
CPG.MCLKCR.BIT.MSDIVS = 1;         => MTU2S = 100MHz
CPG.ACLKCR.BIT.ASDIVS = 3;         => AD   =  50MHz
STB.CR3.BYTE = 0x02;               => Module Standby Clear
                                   => HIZ,MTU2S,MTU2,POE2,IIC3,ADC0,Reserve(1),FLASH
STB.CR4.BYTE = 0xE2;               => Module Standby Clear
                                   => SCIF3,Reserve(0),CMT,Reserve(1),EtherC
STB.CR5.BYTE = 0x12;               => Module Standby Clear
                                   => SCI0,SCI1,SCI2,SCI4,ADC1
```

charger_init: performs the MTU2 initialization

```
MTU2S3.TCR.BYTE = 0x20;            => CCLR = 0x1;
                                   => TCNT cleared by TGRA compare match/input capture
                                   => CKEG = 0x0;  Count at rising edge
                                   => TPSC = 0x0;  Internal clock: counts on Pφ/1

MTU2S3.TMDR.BIT.MD = 0x2;          => Operate as PWM mode 1
MTU2S3.TMDR.BIT.BFB = 1;
MTU2S3.TMDR.BIT.BFA = 1;

MTU2S3.TIOR.BIT.IOA = 0x02;
MTU2S3.TIOR.BIT.IOB = 0x01;        => Initial output is 1. 0 output at compare match

MTU2S3.TGRA = 0x3E8;
MTU2S3.TGRB = 0x001;
MTU2S3.TGRC = 0x3E8;
MTU2S3.TGRD = 0X001;

MTU2S3.TBTM.BIT.TTSB = 1;
MTU2S3.TBTM.BIT.TTSA = 1;
MTU2S3.TCNT = 0x0000;

ADC0.ADCR.BIT.ADCS=0x0;            => 0: Single-cycle scan
ADC0.ADANSR.BIT.ANS3=0x1;          => AD3 is used as analog input channel
ADC0.ADBYPSCR.BIT.SH=0x1;          => Turn on the sample and hold function

INTC.IPR12.WORD = 0xE000;
MTU2S3.TIER.BIT.TGIEA = 0x01;

PFC.PDCRL3.BIT.PD9MD = 0x4;
PFC.PDCRL3.BIT.PD8MD = 0x4;
```

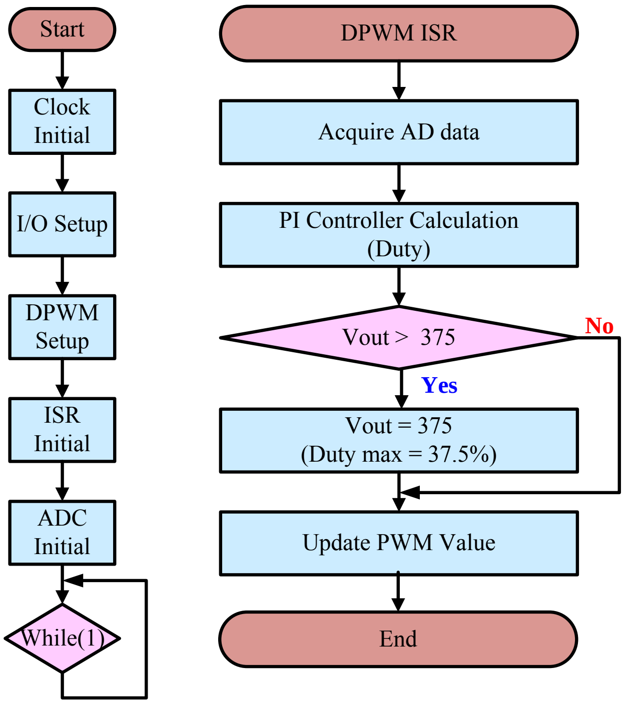

Figure 15 Flow chart for charger

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Sep.30.10	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of 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. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. 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 of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may 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.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.
   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, 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, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be 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, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

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.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

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

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
7F, No. 363 Fu Shing North Road Taipei, Taiwan, R.O.C.
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, 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 Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 1.0