To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)
Send any inquiries to http://www.renesas.com/inquiry.
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 depend 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 sheet or data book.

“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.
Introduction

As well as having an architecture that is upward-compatible with each CPU of the H8/300, H8/300H, and H8S series, so as to inherit a full complement of peripheral functions, the H8SX microcomputer series has a maximum operating frequency of 50 MHz and uses a 32-bit H8SX core CPU as well as an on-chip multiplier/divider to improve performance.

This H8SX series Application Note provides information you may need during software and hardware design. This is a basic edition that provides operation examples that each use a single H8SX series on-chip peripheral function.

Although the operation of each program, circuit, and other aspects covered by this application note has been checked, make sure that you conduct your own operation checks before actually using the H8SX series.

Contents

1. Overview ..................................................................................................................... 2
2. Configuration ............................................................................................................... 2
3. Sample Program ....................................................................................................... 5
1. Overview

Four-channel voltage data is input to the H8SX series as shown in Figure 1. The A/D conversion result is then stored into RAM. The A/D converter is started by an external trigger.

![Figure 1 Block Diagram of Voltage Measurement Using the H8SX Series](image)

2. Configuration

Figure 2 is a block diagram of four-channel A/D conversion.

![Figure 2 Block Diagram of A/D Converter](image)
Table 1 lists the function allocations for this sample task. The H8SX series functions are allocated and A/D conversion is performed.

Table 1  Function Allocation for H8SX Series

<table>
<thead>
<tr>
<th>H8SX series function</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADCSR</td>
<td>Selects A/D conversion channels (group) and displays the status.</td>
</tr>
<tr>
<td>ADCR</td>
<td>Selects the start trigger signal and sets the operating mode (scan).</td>
</tr>
<tr>
<td>ADDRA to ADDRG</td>
<td>Stores the A/D conversion result.</td>
</tr>
<tr>
<td>ADTRG</td>
<td>A/D external trigger input pin</td>
</tr>
</tbody>
</table>

Figure 3 shows the description of operation. As shown in Figure 3, external trigger ADTRG starts the A/D converter which repeats A/D conversion for channels AN0 and AN4 to AN6 (four channels). The ADST bit is set to 1 until it is cleared to 0 by software. While this bit remains set to 1, A/D conversion of the selected input channels is repeated. In this task, buffer operation (consisting of four stages) is used. The A/D conversion result in ADDRA to ADDRG is stored in 140 bytes of RAM between SCN0 and SCN6.
H8SX Series
A/D Conversion Using Scan Mode

Figure 3 Description of A/D Conversion Using Scan Mode

Hardware processing
(a) Starts A/D conversion for external trigger pin (ADTRG).

Software processing - None

Hardware processing
(a) Sets A/D converter.
- Sets conversion mode to group scan mode.
- Sets analog input channels to AN0 to AN6.
- Sets four-stage buffer operation.
- Sets conversion time to 20 states.
- Enables A/D interrupt.
(b) Clears A/D interrupt counter.
(c) Clears A/D conversion end flag.

Hardware processing
(a) Executes A/D conversion of AN0 and AN4 to AN6.
(b) Stores conversion result in ADDRA to ADDRG one after another.

Software processing - None

Hardware processing
(a) Sets ADF.
(b) Generates A/D interrupt (ADI).

Software processing A/DI processing
(a) Clears ADF.
(b) Increments A/D interrupt counter.
(c) Stores A/D conversion result of AN0 and AN4 to AN6 in RAM.
(d) Sets A/D conversion end flag.
(e) Stops A/D conversion.
3. Sample Program

3.1 Function
This program performs an A/D conversion of analog voltage captured in four-channel scan mode.
The program uses external trigger pin to turn A/D conversion on or off. It generates an interrupt at the end of A/D conversion and obtains the A/D-converted value. This sample program obtains each channel ten times.

3.2 Function Specifications

```c
void ad_scan(void);
```

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>—</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Return value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>—</td>
</tr>
</tbody>
</table>

Example)

```c
extern void ad_scan(void);
void main(void) // Main routine
{
    ad_scan(); // Starts A/D conversion.
    while(1);
}
```
3.3 Flowchart

Start

Cancel A/D conversion module stop mode

Set A/D conversion time to 68 states

Clear flag indicating end of four-channel A/D conversion

Clear A/D interrupt counter

Set A/D conversion mode to four-channel scan mode, buffer operation, and analog input channels to AN0 and AN4 to AN6 and enable A/D interrupt

Clear I flag and enable interrupt

Have all four channels ended?

Enable A/D interrupt

End

Start

Clear A/D interrupt request flag

Increment A/D interrupt counter

Is A/D interrupt count <10?

Set flag indicating end of four-channel A/D conversion

Stop A/D conversion

Set ADDRA to ADDRG in RAM

End
3.4 Program Listing

/***************************************************************/
/* Include File */
/***************************************************************/
#include <machine.h>
#include "iodefine.h"

/***************************************************************/
/* Function Prototype */
/***************************************************************/
void ad_scan(void);

/***************************************************************/
/* RAM Allocation */
/***************************************************************/
static unsigned short scn[7];   // Result Of A/D Conversion
static unsigned char scn_cnt;  // Work
static unsigned char scn_endf; // A/D Conversion End Flag
static unsigned char adi_cnt;

/***************************************************************/
/* Function Definition(Main Program) */
/***************************************************************/
void ad_scan(void)
{
    P_MSTPCR.BIT.ADF = 0;    // disable module stop mode
    scn_endf = 0;            // A/D Conversion End Flag Clear
    scn_cnt = 0;            // Work Clear
    adi_cnt  = 0;
P_P1.DDR    = 0;
P_P1.ICR.BIT.B3 = 1;
P_AD.CR.BYTE = 0xF0;       // Initialize CR
P_AD.CSR.BYTE = 0x46;     // Initialize CSR
set_imask_ccr(0);           // Enable Interrupt
while(scn_endf==0);         // Check Conversion End
}

/***************************************************************/
/* Function Definition(Interrupt Handler) */
/***************************************************************/
#pragma interrupt (inthdr_adscan)
void inthdr_adscan(void)        // Conversion Interrupt Handler
{
P_AD.CSR.BIT.ADF = 0;        // Clear ADF
if(adi_cnt < 10)            // 10 Count
{
    scn[scn_cnt++]=P_AD.DRA.BYTE;
    scn[scn_cnt++]=P_AD.DRB.BYTE;
    scn[scn_cnt++]=P_AD.DRC.BYTE;
    scn[scn_cnt++]=P_AD.DRD.BYTE;
    scn[scn_cnt++]=P_AD.DRE.BYTE;
    scn[scn_cnt++]=P_AD.DRF.BYTE;
}
scn[scn_cnt++]=P_AD.DRG.BYTE;
    adi_cnt += 1;  // Counter Up
}
else                        // Under 10 Count
{
    scn_endf = 1;       // Set Conversion End Flag
    P_AD.CSR.BIT.ADST = 0; // ADST Clear
## Revision Record

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
<th>Page</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Sept.19.03</td>
<td>—</td>
<td>—</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>

---
Keep safety first in your circuit designs!

1. Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.

2. Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.

3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein. The information described here may contain technical inaccuracies or typographical errors. Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors. Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).

4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.

5. Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.

6. The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.

7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination. Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.

8. Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.