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SH7280 Group

12-Bit A/D Converter: Example of Settings for Conversion in Continuous Scan Mode

Introduction

This application note describes an example of settings for the 12-bit A/D converter in continuous scan mode as an example of application of the A/D converter of the SH7285.

Target Device

SH7285

Contents

1. Preface

1.1 Specifications

- A/D conversion in continuous scan mode by the 12-bit A/D converter
- Three rounds of A/D conversion are performed on analog input channels 0 to 3 (AN0 to AN3), and the converted data are stored in RAM.

1.2 Module Used

- 12-bit A/D converter (12-bit A/D)

1.3 Applicable Conditions

• MCU	SH7285/SH7286/SH7243
• Operating frequency	Internal clock: 100 MHz Bus clock: 50 MHz Peripheral clock: 50 MHz
• C compiler	SuperH RISC Engine Family C/C++ Compiler Package Ver.9.01 Release01 from Renesas Technology
• Compiler options	-cpu = sh2a -include = "$(WORKSPDIR)\inc" -object = "$(CONFIGDIR)\$(FILELEAF).obj" -debug -gbr = auto -chgincpath -errorpath -global_volatile = 0 -opt_range = all -infinite_loop = 0 -del_vacant_loop = 0 -struct_alloc = 1 -nologo

1.4 Related Application Note

None

2. Description of the Sample Application

The sample program employs the continuous scan mode of the 12-bit A/D converter to perform three rounds of A/D conversion on input channels 0 to 3 (AN0 to AN3), and then stores converted data in RAM.

2.1 Operational Overview of Module Used

The operating modes of the 12-bit A/D converter are single-cycle scan mode and continuous scan mode. In single-cycle scan mode, A/D conversion is performed once on each of one or more specified channels and then ends. The ADST bit is automatically cleared to 0. In continuous scan mode, A/D conversion is performed sequentially by software on one or more specified channels until the ADST bit is cleared to 0.

Additionally, channels 0 to 2 have dedicated sample-and-hold circuits, so multiple channels are capable of simultaneous sampling.

Table 1 gives an overview of the module used in this sample application (i.e. the A/D converter) and figure 1 is a block diagram of 12-bit A/D converter. For details on the 12-bit A/D converter, see the section on the A/D converter in the *SH7280 Group Hardware Manual*.

Table 1 Overview of the Module (A/D Converter) Used in the Sample Application

Item	Description
Resolution	12 bits
Minimum conversion time	1.0 µs per channel (Pϕ = 50 MHz)
Number of modules	2 (SH7285, SH7243), 3 (SH7286)
Input channels	8 (SH7285, SH7243), 12 (SH7286)
Operating modes	Single-cycle scan mode Continuous scan mode
Sample-and-hold function	Common to 0 to 3 channels: 1 circuit Common to 4 to 7 channels: 1 circuit Common to 8 to 11 channels: 1 circuit Dedicated for individual channels: 1 circuit each for ch0 to ch2 (3 in all)
Sources for activation of A/D conversion	Software: Setting of the ADST bit Timer: TRGAN, TRG0N, TRG4AN, and TRG4BN signals from the MTU2 module TRGAN, TRG4AN, and TRG4BN signals from the MTU2S module External trigger: $\overline{\text{ADTRG}}$

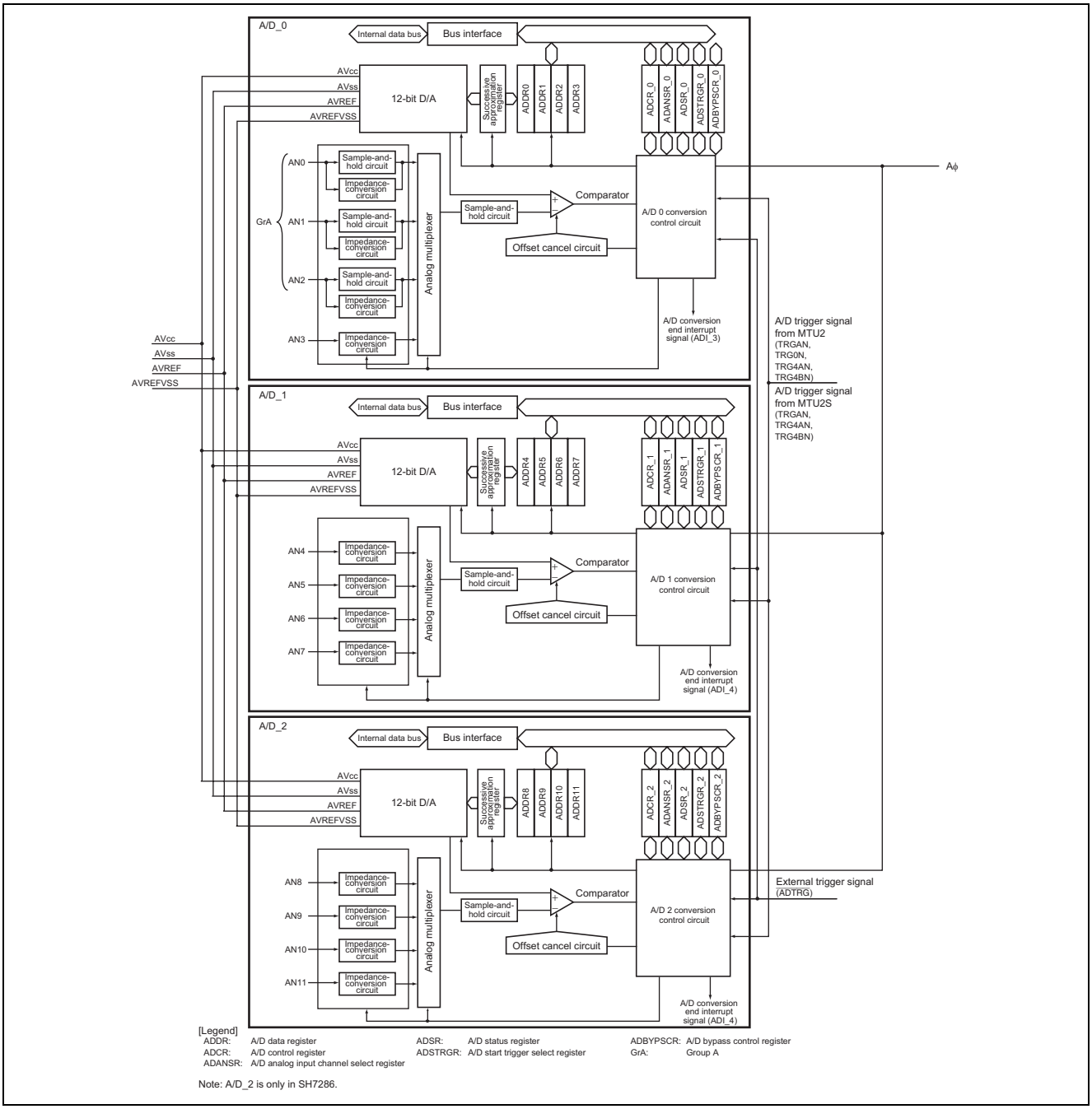

Figure 1 Block Diagram of the 12-Bit A/D Converter

2.2 Procedure for Setting Module Used

Figure 2 shows an example of the initialization sequence for A/D conversion in continuous scan mode. For details on the settings of individual registers, see the *SH7280 Group Hardware Manual*.

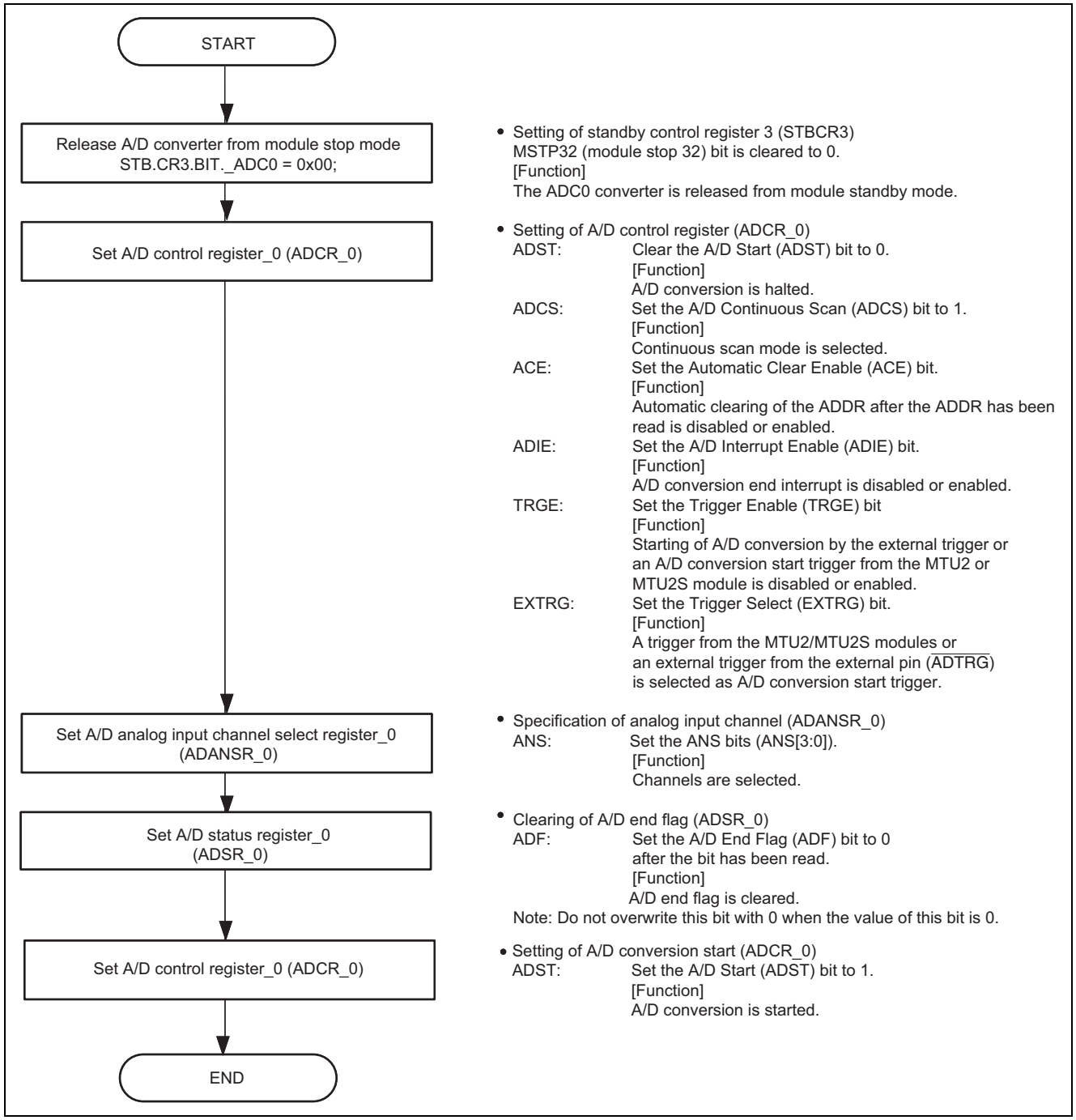

Figure 2 Initialization Sequence for 12-Bit A/D Conversion

2.3 Operation of the Sample Program

In this sample program, A/D conversion in continuous scan mode is performed on channels 0 to 3 (AN0 to AN3). The A/D converter is activated by software and converted data are stored in RAM. This processing is repeated three times.

Table 2 gives a description of RAM usage in this sample program.

Table 2 Variables Used in the Sample Program

Variable Name	Description	Area	Name of Employing Module
unsigned short Ad_data[AD][CH]	Array for storing A/D-converted data (2 bytes/datum)	On-chip RAM	io_ad_continuous_scan (unsigned short*ad_buf)

2.4 Sequence of Processing by the Sample Program

Table 3 gives settings for registers used in the sample program and figure 3 shows the flow of handling the sample program.

Table 3 Register Settings Used in Sample Program

Register Name	Address	Setting	Description	
A/D control register_0 (ADCR_0)	H'FFFF E800	H'40	ADST = 0:	Halts A/D conversion
			ADCS = 1:	Continuous scan mode
			ACE = 0:	Disables automatic clearing of the ADDR
			ADIE = 0:	Disables A/D conversion end interrupt
			TRGE = 0:	Disables starting of A/D conversion by an external trigger or by the MTU2 and MTU2S modules
		H'C0	ADST = 1:	Starts A/D conversion

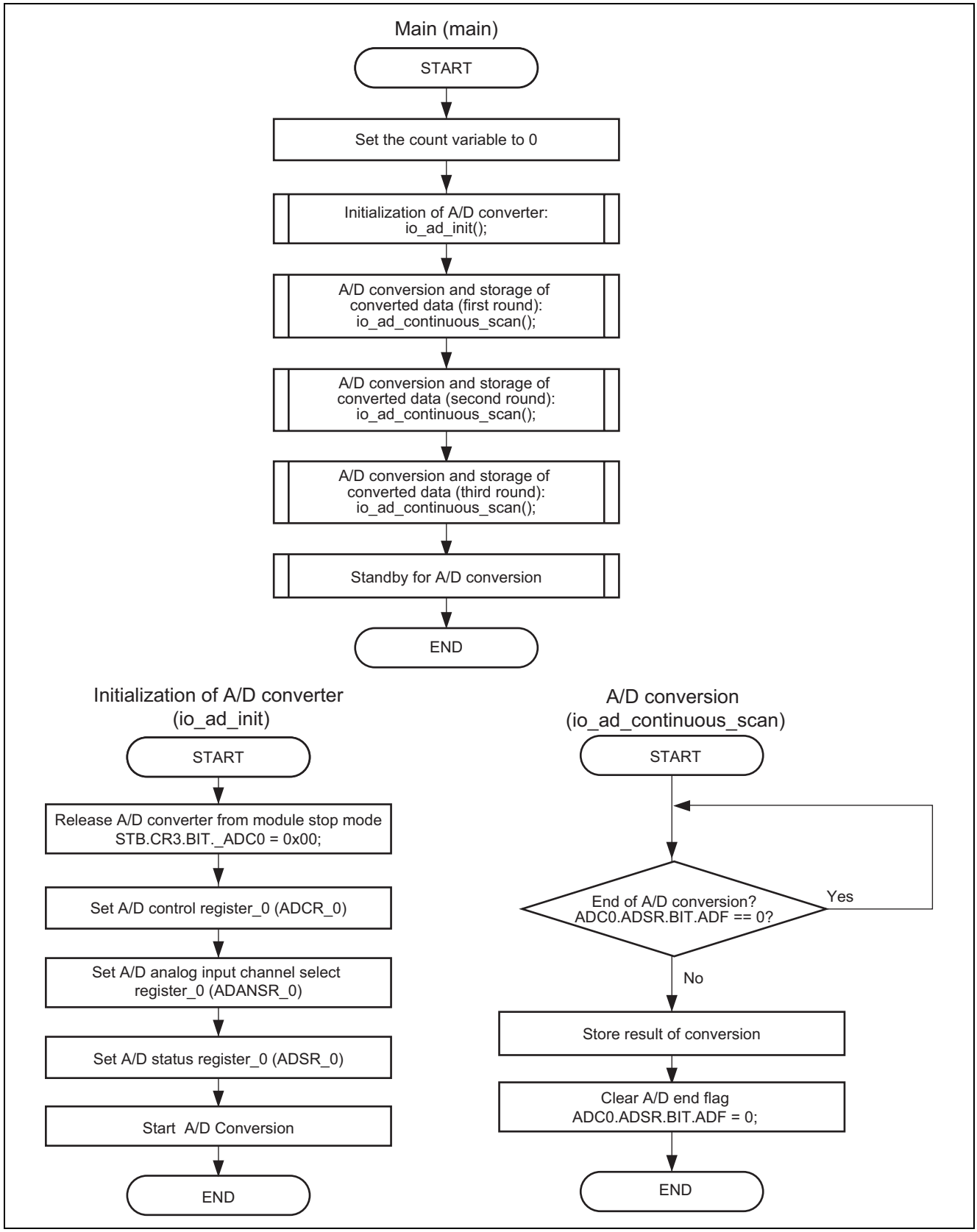

Figure 3 Flow of Handling the Sample Program

3. Listing of the Sample Program

1. Sample Program Listing: main.c (1)

```
1       /*""FILE COMMENT""*****************************************************************
2       *
3       *       System Name : SH7285 Sample Program
4       *       File Name   : main.c
5       *       Contents    : Sample program for A/D conversion in continuous scan mode
6       *       Version     : 1.00.00
7       *       Model       : M3A-HS85
8       *       CPU         : SH7285
9       *       Compiler    : SHC9.1.1.0
10      *       note        : A/D conversion in continuous scan mode is performed by the A/D
11      *                     converter. Three rounds of A/D conversion on analog input channels
12      *                     0 to 3 (AN0 to AN3) proceed, and the converted data are stored in RAM.
13      *
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21      *
22      *       history   : 2008.02.26 ver.1.00.00
23      *""FILE COMMENT END""*************************************************************/
24      #include <machine.h>
25      #include "iodefine.h"       /* SH7285 iodefine  */
26
27      /* ==== prototype declaration ==== */
28      void main(void);
29      void io_ad_init(void);
30      void io_ad_continuous_scan(unsigned short *ad_buf);
31
32      /* ==== symbol definition ==== */
33      #define AD 3
34      #define CH 4
35
36      /* ==== RAM allocation variable declaration ==== */
37      unsigned short Ad_data[AD][CH];
38
```

2. Sample Program Listing: main.c (2)

```
39      /*""FUNC COMMENT""*****************************************************
40       * Outline     : main
41       *---------------------------------------------------------------------
42       * Include     : #include "iodefine.h"
43       *---------------------------------------------------------------------
44       * Declaration : void main(void);
45       *---------------------------------------------------------------------
46       * Function    : AD translation with 1 cycle scan mode
47       *---------------------------------------------------------------------
48       * Argument    : void
49       *---------------------------------------------------------------------
50       * Return Value: void
51       *---------------------------------------------------------------------
52       * Notice      : non
53       *""FUNC COMMENT END""*************************************************/
54      void main(void)
55      {
56          unsigned char count;
57          count = 0;
58
59          /* ==== Initial Setting of ADC ==== */
60          io_ad_init();
61
62          /* ==== A/D convert ==== */
63          io_ad_continuous_scan(&Ad_data[count][0]);
64          count++;
65          io_ad_continuous_scan(&Ad_data[count][0]);
66          count++;
67          io_ad_continuous_scan(&Ad_data[count][0]);
68
69          ADC0.ADCR.BIT.ADST = 0;          /* A/D conversion stop */
70
71          while(1){
72              /* loop */
73          }
74      }
75
76      /*""FUNC COMMENT""*****************************************************
77       * Outline     : Initial setting of ADC
78       *---------------------------------------------------------------------
79       * Include     : #include "iodefine.h"
80       *---------------------------------------------------------------------
81       * Declaration : void io_ad_init(void);
82       *---------------------------------------------------------------------
83       * Function    : Initial setting of ADC
84       *---------------------------------------------------------------------
85       * Argument    : void
86       *---------------------------------------------------------------------
87       * Return Value: void
88       *---------------------------------------------------------------------
89       * Notice      : non
90       *""FUNC COMMENT END""*************************************************/
91
```

3. Sample Program Listing: main.c (3)

```
92      void io_ad_init(void)
93      {
94          /* ==== Release of module standby(ADC0) ==== */
95          STB.CR3.BIT._ADC0 = 0x00;
96
97          /* ==== Setting of ADC ==== */
98          /* ---- A/D Control Register(ADCR) ---- */
99          ADC0.ADCR.BYTE = 0x40;
100             /* 7   = b'0   : A/D End Flag                                  */
101             /* 6   = b'1   : Continuous scan                               */
102             /* 5   = b'0   : Automatic clearing of the ADDR
103                              after being read is disabled                  */
104             /* 4   = b'0   : Generation of A/D conversion end
105                              interrupt is disabled                         */
106             /* 3-2 = b'0   : reserve                                       */
107             /* 1   = b'0   : A/D conversion start by the external trigger
108                              or an A/D conversion start trigger from
109                              the MTU or MTU2S is disabled                  */
110             /* 0   = b'0   : A/D converter is started by the A/D conversion
111                              start trigger from the MTU2 or MTU2S          */
112
113         /* ---- A/D Analog Input Channel Select Register(ADANSR) ---- */
114         ADC0.ADANSR.BYTE = 0x0f;          /* AN0-AN3 */
115
116         /* ---- A/D Status Register(ADSR) ---- */
117         if(ADC0.ADSR.BIT.ADF == 0x01){
118             ADC0.ADSR.BIT.ADF = 0x00;     /* ADF clear */
119         }
120
121         ADC0.ADCR.BIT.ADST = 1;           /* A/D conversion start */
122
123     }
124
125     /*""FUNC COMMENT""*****************************************************
126      * Outline     : A/D convert
127      *-------------------------------------------------------------------
128      * Include     : #include "iodefine.h"
129      *-------------------------------------------------------------------
130      * Declaration : void io_ad_continuous_scan(unsigned short *ad_buf);
131      *-------------------------------------------------------------------
132      * Function    : The clearance of an ADF flag, storing of conversion data
133      *-------------------------------------------------------------------
134      * Argument    : void
135      *-------------------------------------------------------------------
136      * Return Value: void
137      *-------------------------------------------------------------------
138      * Notice      : non
139      *""FUNC COMMENT END""*************************************************/
140     void io_ad_continuous_scan(unsigned short *ad_buf)
141     {
142         while(ADC0.ADSR.BIT.ADF == 0){
143             /* A/D conversion completion waiting */
144         }
145         *ad_buf++ = ADC0.ADDR0;           /* AN0 */
146         *ad_buf++ = ADC0.ADDR1;           /* AN1 */
147         *ad_buf++ = ADC0.ADDR2;           /* AN2 */
148         *ad_buf++ = ADC0.ADDR3;           /* AN3 */
149         ADC0.ADSR.BIT.ADF = 0;            /* ADF clear */
150     }
151     /* End of File */
```

4. Documents for Reference

- Software Manual
  SH-2A, SH2A-FPU Software Manual
  The most up-to-date version of this document is available on the Renesas Technology Website.
- Hardware Manual
  SH7280 Group Hardware Manual
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