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Renesas Electronics Corporation

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M16C/Tiny Series

Operation of A/D Converter (Single Sweep Mode)

1. Abstract

In single sweep mode of A/D converter, choose functions from those listed in Table 1. Operations of the checked items are described below.

Table 1. Choosed Functions

Item	Set-up		Item	Set-up	
Operating Clock ϕ_{AD}	Yes	fAD, divided-by-2 of fAD, divided-by-3 of fAD, divided-by-4 of fAD, divided-by-6 of fAD, divided-by-12 of fAD	A/D Conversion Start Condition	Yes	Software trigger
					$\overline{ADTRG}$ trigger
Resolution		8-bit	Sample and hold function		Without sample and hold
	Yes	10-bit		Yes	With sample and hold
Analog Input Pins	Yes	Select from AN_0 to AN_1 (2 pins), AN_0 to AN_3 (4 pins), AN_0 to AN_5 (6 pins), AN_0 to AN_7 (8 pins) (Note 1)			

Note 1: Conditions for the M16C/26

For the M16C/26A, AN_{30} to AN_{32}, and AN_{24} can be used in the same way as AN_0 to AN_7. However, all input pins need to belong to the same group.

For the M16C/28, AN_{00} to AN_{07}, AN_{20} to AN_{27} can be used in the same way as AN_0 to AN_7. However, all input pins need to belong to the same group.

For the M16C/29, AN_{00} to AN_{07}, AN_{20} to AN_{27}, and AN_{30} to AN_{32} can be used in the same way as AN_0 to AN_7. However, all input pins need to belong to the same group.

2. Introduction

The explanation of this issue is applied to the following condition:
Applicable MCU: M16C/26, M16C/26A, M16C/28, M16C/29 Group

This program can be used for the other M16C Families which have the same SFR (Special Function Register) as the one in the M16C/26, M16C/26A, M16C/28, M16C/29 However, since some functions may be modified such as added functions, check it in a manual. Execute sufficient evaluation when using this application note.

3. Operation of A/D Converter

(1) Setting the A/D conversion start flag to “1” causes the A/D converter to start the conversion on voltage input to the AN0 pin.

(2) After the A/D conversion of voltage input to the AN0 pin is completed, the content of the successive comparison register (conversion result) is transmitted to A/D register 0. The A/D converter converts all analog input pins selected by the user. The conversion result is transmitted to A/D register i corresponding to each pin, every time conversion on one pin is completed.

(3) When the A/D conversion on all the analog input pins selected is completed, the A/D conversion interrupt request bit goes to “1”. At this time, the A/D conversion start flag goes to “0”. The A/D converter stops operating.

Figure 1 shows the operation timing

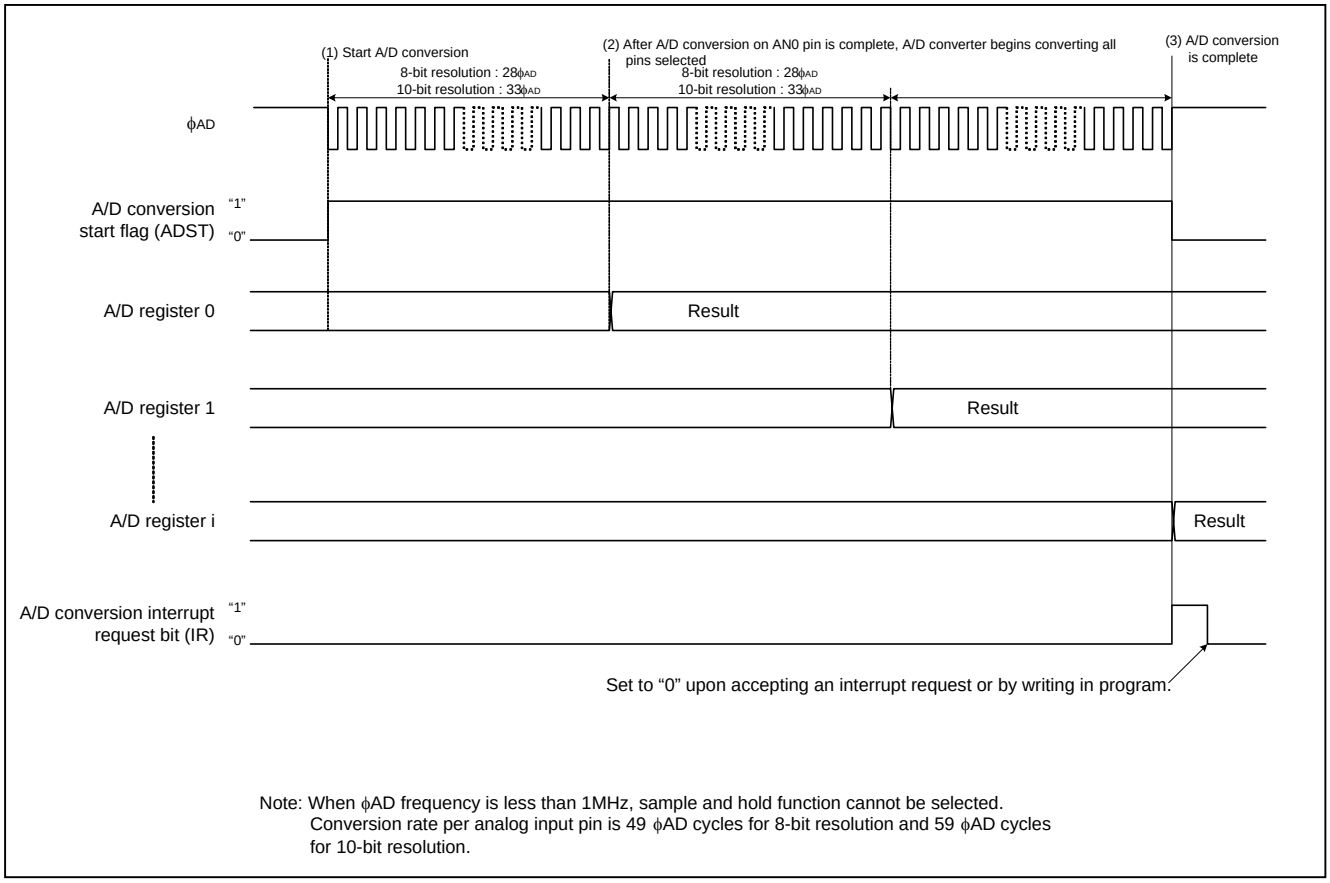


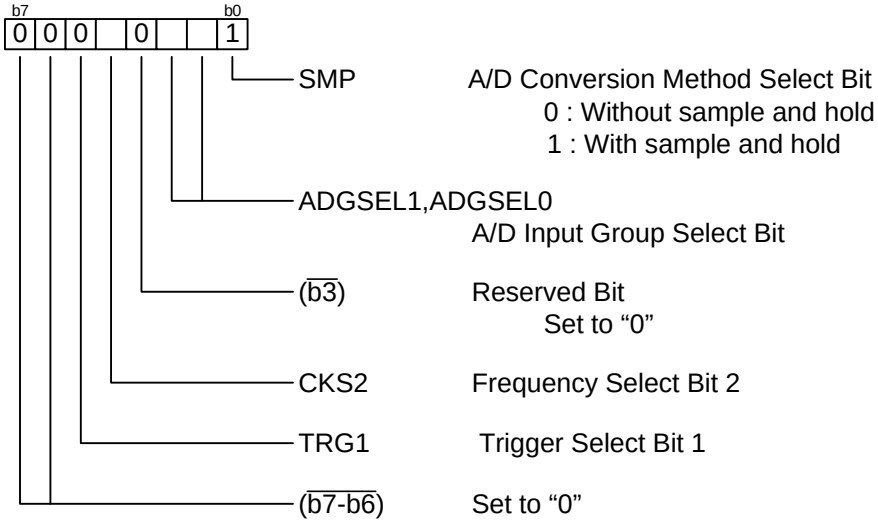
Figure 1. Operation Timing of Single Sweep Mode

3.1 Register Setting

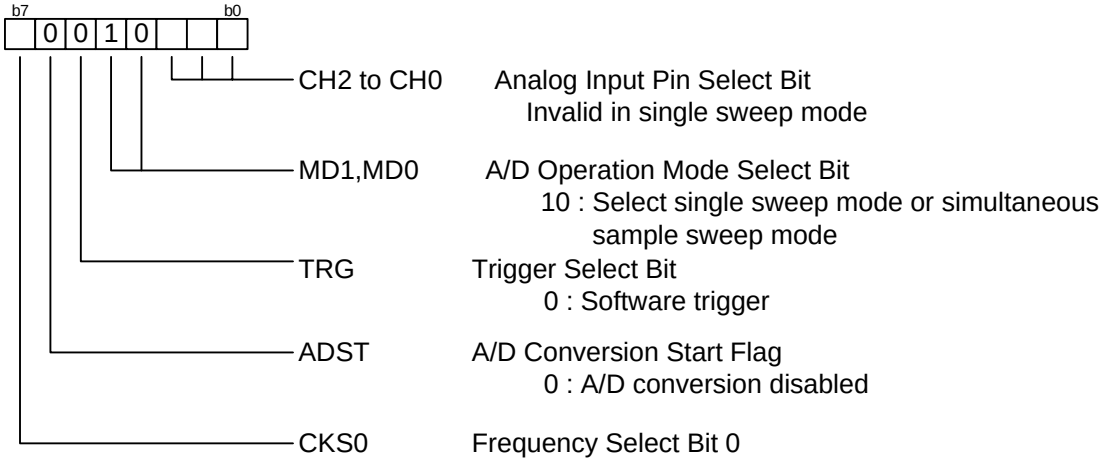
To enable the operation defined in “Section 3. Operation of A/D Converter”, the following register settings must be taken place step by step. For detail configuration of each register, please refer to M16C/26 Group hardware manual, M16C/26A Group hardware manual, M16C/28 Group hardware manual, M16C/29 Group hardware manual.

3.1.1 M16C/26A, M16C/28, M16C/29

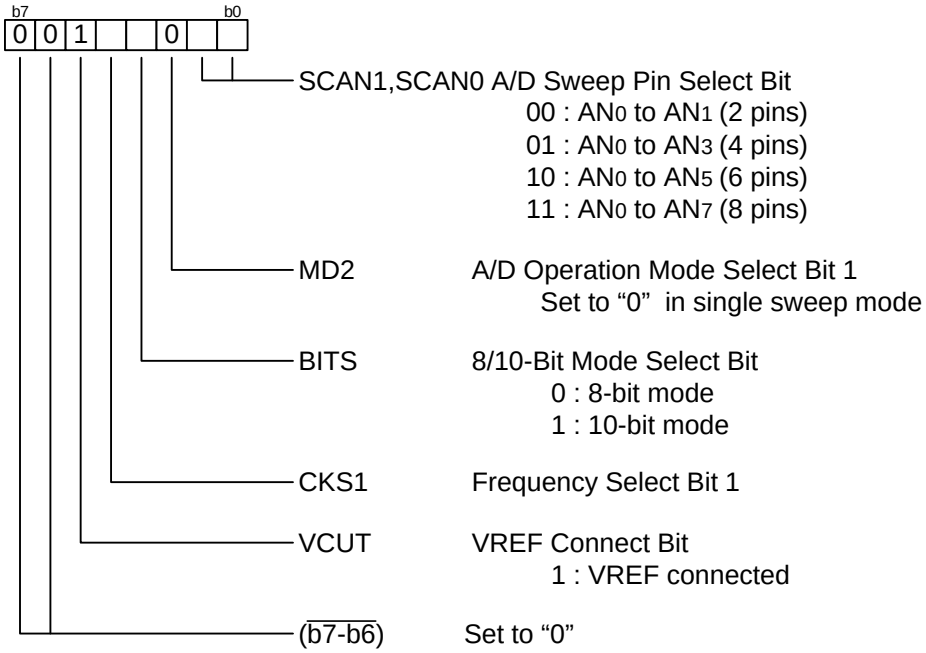
(1) Setting A/D control register 2



(2) Setting A/D control register 0



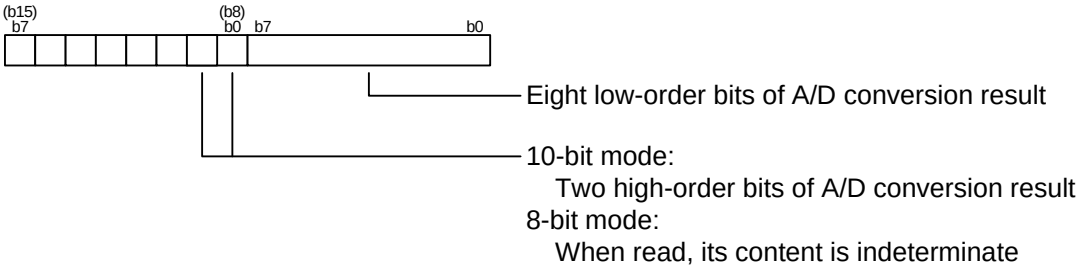
(3) Setting A/D control register 1



(4) A/D conversion start (setting A/D control register 0)

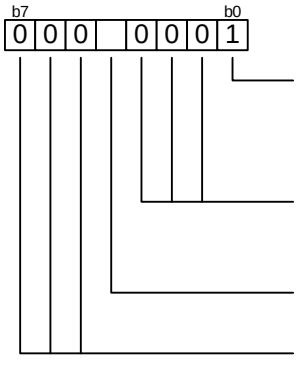
(5) Wait until the A/D converter stops.

(6) Reading conversion result (read ADi register)



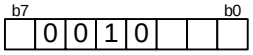
3.1.2 M16C/26

(1) Setting A/D control register 2



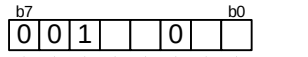
SMP	A/D Conversion Method Select Bit 0 : Without sample and hold 1 : With sample and hold
(b3-b1)	Reserved Bit Set to “0”
CKS2	Frequency Select Bit 2
(b7-b5)	Set to “0”

(2) Setting A/D control register 0



CH2 to CH0	Analog Input Pin Select Bit Invalid in single sweep mode
MD1,MD0	A/D Operation Mode Select Bit 10 : Select single sweep mode
TRG	Trigger Select Bit 0 : Software trigger
ADST	A/D Conversion Start Flag 0 : A/D conversion disabled
CKS0	Frequency Select Bit 0

(3) Setting A/D control register 1



SCAN1,SCAN0 A/D Sweep Pin Select Bit
00 : AN0 to AN1 (2 pins)
01 : AN0 to AN3 (4 pins)
10 : AN0 to AN5 (6 pins)
11 : AN0 to AN7 (8 pins)

MD2 — A/D Operation Mode Select Bit 1
Set to “0” in single sweep mode

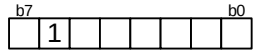
BITS — 8/10-Bit Mode Select Bit
0 : 8-bit mode
1 : 10-bit mode

CKS1 — Frequency Select Bit 1

VCUT — VREF Connect Bit
1 : VREF connected

($\overline{b7}$-$\overline{b6}$) — Set to “0”

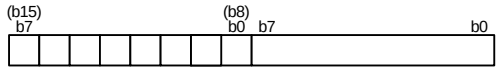
(4) A/D conversion start (setting A/D control register 0)



ADST — A/D Conversion Start Flag
1 : A/D conversion started

(5) Wait until the A/D converter stops.

(6) Reading conversion result (read ADi register)



Eight low-order bits of A/D conversion result

10-bit mode:
Two high-order bits of A/D conversion result
8-bit mode:
When read, its content is indeterminate

4. Sample Program

4.1 M16C/26A, M16C/28, M16C/29

```
/************************************************************
 *                                                          *
 *   FILE NAME :                                            *
 *   CPU       : M16C/Tiny series                           *
 *   Function  : Operation of A/D Converter                 *
 *               (sinle sweep mode)                         *
 *   Version   : 1.00                                       *
 *                                                          *
 *   Copyright (C)2004, Renesas Technology Corp.            *
 *   Copyright (C)2004, Renesas Solutions Corp.             *
 *                                                          *
 ************************************************************/
/***************************
 *   include file          *
 ***************************/
#include "sfr28.h"

/***************************
 *   Function Definition   *
 ***************************/

/***************************
 *   main                  *
 ***************************/
    unsigned short  ad_data0;
    unsigned short  ad_data1;

void main(void) {

    adic = 0;

    adcon2 = 0x01;   /*  Setting A/D control register 2
                         Enabled sample and hold
                         Port 10 group selected
                         Frequency is selected to fAD/4
                     */

    adcon0 = 0x10;   /*  Setting A/D control register 0
                         Single sweep mode is selected
                         Software trigger is selected
                     */

    adcon1 = 0x28;   /*  Setting A/D control register 1
                         A/D sweep pin is selected 00(AN0,AN1 (2 pins))
                         10-bit mode is selected
                         Vref is connected
                     */

    while (1) {

        adst = 1;        /* A/D convert start */

        while (!ir_adic) {   /* Check & wait until complete of A/D convert */
        }
        ir_adic = 0;

        ad_data0 = 0x03ff & ad0; /* Read conversion result AN0 */
        ad_data1 = 0x03ff & ad1; /* Read conversion result AN1 */

    }
}
```

4.2 M16C/26

```
/************************************************************
 *                                                          *
 *   FILE NAME :                                            *
 *   CPU       : M16C/Tiny series                           *
 *   Function  : Operation of A/D Converter                 *
 *               (sinle sweep mode)                         *
 *   Version   : 1.00                                       *
 *                                                          *
 *   Copyright (C)2004, Renesas Technology Corp.            *
 *   Copyright (C)2004, Renesas Solutions Corp.             *
 *                                                          *
 ************************************************************/
/***************************
 *   include file          *
 ***************************/
#include "sfr262.h"

/***************************
 *   Function Definition   *
 ***************************/

/***************************
 *   main                  *
 ***************************/
   unsigned short  ad_data0;
   unsigned short  ad_data1;

void main(void) {

    adic = 0;

    adcon2 = 0x01;   /*  Setting A/D control register 2
                         Enabled sample and hold
                         Frequency is selected to fAD/4
            */

    adcon0 = 0x10;   /*  Setting A/D control register 0
                         Single sweep mode is selected
                         Software trigger is selected
            */

    adcon1 = 0x28;   /*  Setting A/D control register 1
                         A/D sweep pin is selected 00(AN0,AN1 (2 pins))
                         10-bit mode is selected
                         Vref is connected
                    */

    while (1) {

        adst = 1;        /* A/D convert start */

        while (!ir_adic) {   /* Check & wait until complete of A/D convert */
        }
        ir_adic = 0;

        ad_data0 = 0x03ff & ad0; /* Read conversion result AN0 */
        ad_data1 = 0x03ff & ad1; /* Read conversion result AN1 */

    }
}
```

5. Reference

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Hardware Manual

M16C/26, M16C/26A, M16C/28, M16C/29 Group Hardware Manual
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		Page	Summary
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