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M16C/62

Using the M16C/62 Analog to Digital Converter in Repeat Sweep Mode 0

1.0 Abstract

The following article outlines the steps necessary to set up, perform, and read multiple conversions on multiple channels using the onboard analog to digital converter (ADC) of the M16C. The ADC is useful in measuring output voltages of sensors such as accelerometers or other analog instrumentation and converting them to digital values.

2.0 Introduction

The M16C line of devices features an onboard analog to digital converter (ADC). The ADC consists of one 10-bit successive approximation circuit with a capacitive coupled amplifier. There are eight analog input pins, selectable conversion clock speeds, sample and hold function, and several conversion modes. Figure 1 is an overview of the internal circuitry for the ADC block.

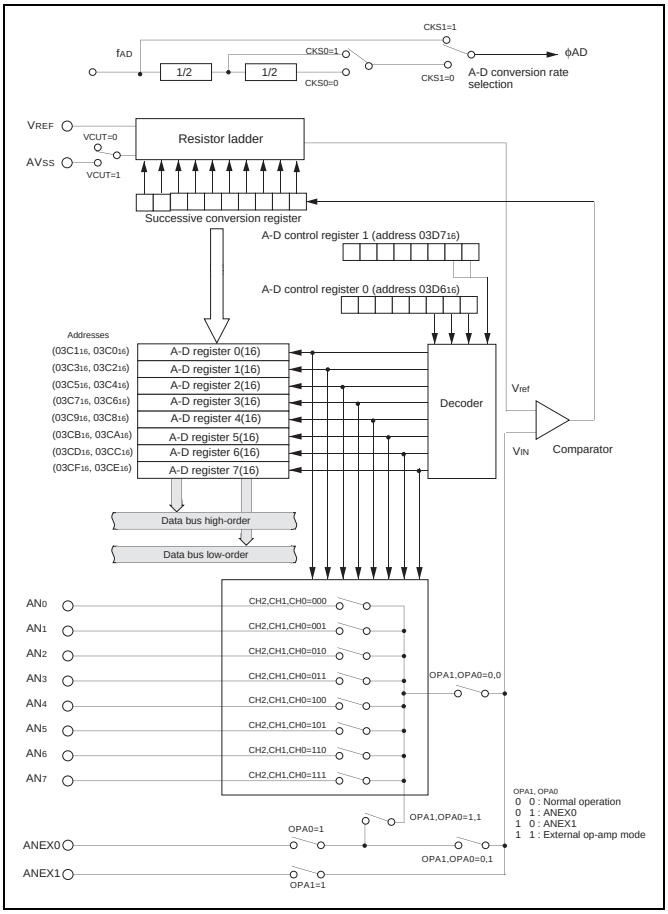

Figure 1 Internal Circuitry for ADC Block—Overview

3.0 Repeat Sweep Mode 0 Description

In repeat sweep mode 0, groups of pins of the ADC can be selected as input sources. Once triggered, a conversion takes place on the selected pins and the results are stored in the ADC result registers corresponding to the selected channels. This is repeated until the ADC conversion start flag is disabled. No interrupt is generated on the completed conversions, but rather the ADC output registers can be read anytime to determine the converted values. Figure 2 and Figure 3 re overviews of the registers that will be used in this example. These registers are detailed in the included sample code. For specific details, consult the MCU specification for the device in question.

A-D control register 0 (Note 1)

b7	b6	b5	b4	b3	b2	b1	b0

Symbol: ADCON0 — Address: $03D6_{16}$ — When reset: $00000XXX_2$

Bit symbol	Bit name	Function	R	W
CH0	Analog input pin select bit	b2 b1 b0 0 0 0 : AN_0 is selected 0 0 1 : AN_1 is selected 0 1 0 : AN_2 is selected 0 1 1 : AN_3 is selected 1 0 0 : AN_4 is selected 1 0 1 : AN_5 is selected 1 1 0 : AN_6 is selected 1 1 1 : AN_7 is selected (Note 2)	○	○
CH1			○	○
CH2			○	○
MD0	A-D operation mode select bit 0	b4 b3 0 0 : One-shot mode 0 1 : Repeat mode 1 0 : Single sweep mode 1 1 : Repeat sweep mode 0 Repeat sweep mode 1 (Note 2)	○	○
MD1			○	○
TRG	Trigger select bit	0 : Software trigger 1 : AD_{TRG} trigger	○	○
ADST	A-D conversion start flag	0 : A-D conversion disabled 1 : A-D conversion started	○	○
CKS0	Frequency select bit 0	0 : $f_{AD}/4$ is selected 1 : $f_{AD}/2$ is selected	○	○

Note 1: If the A-D control register is rewritten during A-D conversion, the conversion result is indeterminate.
Note 2: When changing A-D operation mode, set analog input pin again.

A-D control register 1 (Note)

b7	b6	b5	b4	b3	b2	b1	b0

Symbol: ADCON1 — Address: $03D7_{16}$ — When reset: 00_{16}

Bit symbol	Bit name	Function	R	W
SCAN0	A-D sweep pin select bit	When single sweep and repeat sweep mode 0 are selected b1 b0 0 0 : AN_0, AN_1 (2 pins) 0 1 : AN_0 to AN_3 (4 pins) 1 0 : AN_0 to AN_5 (6 pins) 1 1 : AN_0 to AN_7 (8 pins)	○	○
SCAN1		When repeat sweep mode 1 is selected b1 b0 0 0 : AN_0 (1 pin) 0 1 : AN_0, AN_1 (2 pins) 1 0 : AN_0 to AN_2 (3 pins) 1 1 : AN_0 to AN_3 (4 pins)	○	○
MD2	A-D operation mode select bit 1	0 : Any mode other than repeat sweep mode 1 1 : Repeat sweep mode 1	○	○
BITS	8/10-bit mode select bit	0 : 8-bit mode 1 : 10-bit mode	○	○
CKS1	Frequency select bit 1	0 : $f_{AD}/2$ or $f_{AD}/4$ is selected 1 : f_{AD} is selected	○	○
VCUT	Vref connect bit	0 : Vref not connected 1 : Vref connected	○	○
OPA0	External op-amp connection mode bit	b7 b6 0 0 : ANEX0 and ANEX1 are not used 0 1 : ANEX0 input is A-D converted 1 0 : ANEX1 input is A-D converted 1 1 : External op-amp connection mode	○	○
OPA1			○	○

Note: If the A-D control register is rewritten during A-D conversion, the conversion result is indeterminate.

Figure 2 A-D Converter Related Registers

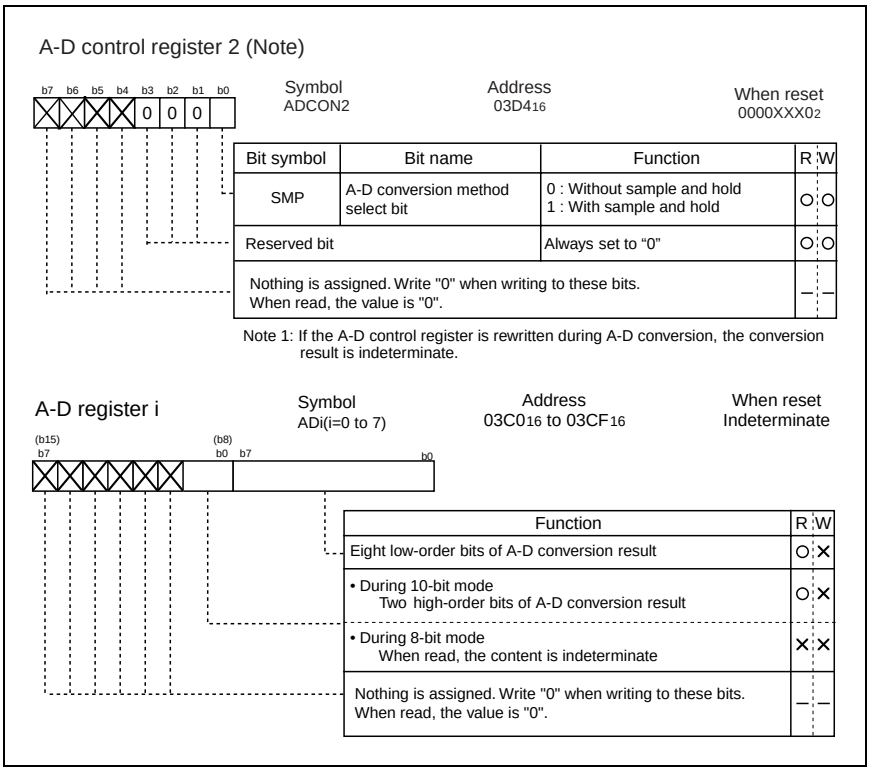

Figure 3 A-D Converter Related Register

4.0 Example Program

This example program demonstrates how to perform a conversion using the ADC in the following environment:

Environment Setup

- Repeat sweep mode 0 conversions
- 10-bit mode
- Analog inputs 0–3 used
- Sample and hold enabled
- Vref connected
- Conversion clock used will be $f_{AD}/2$ (when f(Xin) is greater than 10 MHz, f_{AD} must be divided)
- Software conversion start

ADC Software Setup

- Set the ADCON0 register for f_{AD} /2 and repeat sweep mode 0 operation (0x98)
- Set the ADCON1 register for 10-bit mode, f_{AD} divided, AN0-3 sweep, and connect Vref (0x29)
- Set the ADCON2 register for sample and hold (0x01)
- Enable the A/D converter by setting the ADST bit to 1
- Read current A/D channel values in the variables ‘TempStore(x)’

5.0 Reference

Renesas Technology Corporation Semiconductor Home Page

http://www.renesas.com

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support_apl@renesas.com

Data Sheets

- M16C/62 datasheets, 62aeds.pdf

User's Manual

- M16C/62 User's Manual, 62eum.pdf
- M16C/60 and M16C/20 C Language Programming Manual, 6020EC.pdf
- NC30 Ver. 4.0 User's Manual, NC30UE.pdf

6.0 Software Code

The sample software provided was written using the NC30 compiler. The program starts the conversion process on reset.

```
/*****************************************************************
 *
 *    DESCRIPTION: repeat_sweep_mode_0.c
 *
 *    AUTHOR: Renesas Technology Corporation, Inc. (June 2003)
 *
 *
 *    PURPOSE: Outlines how to use the M16C/62 ADC in repeat sweep
 *             mode 0. On reset, program repeatedly stores the result
 *             of the conversion in a variable that can be examined
 *             using KD30 and the MSV1632-62 Starter Kit
 *
 *****************************************************************/

#include "sfr62.h"

unsigned int TempStore0 = 0x0000;         // Location where AN0 result is stored
unsigned int TempStore1 = 0x0000;         // Location where AN1 result is stored
unsigned int TempStore2 = 0x0000;         // Location where AN2 result is stored
unsigned int TempStore3 = 0x0000;         // Location where AN3 result is stored
```

```
/*
 ** main
 *
 *  PARAMETERS: None
 *
 *  DESCRIPTION: Main function. Where program execution starts. Sets
 *                           up the ADC then reads conversion results.
 *
 *  RETURNS: Nothing
 */
void main (void){

       adcon0 = 0x98;  /*  10011000 AN0 input, repeat sweep mode 0, software trigger;
fAD/2
                           ||||||||_______analog input select bit 0
                           |||||||________analog input select bit 1
                           ||||||_________analog input select bit 2
                           |||||__________A/D operation mode select bit 0
                           ||||___________A/D operation mode select bit 1
                           |||____________trigger select bit
                           ||_____________A/D conversion start flag
                           |______________frequency select bit */

       adcon1 = 0x29;  /*00011001;  10 bit mode, fAD divided, Vref connected;AN0-AN3
converted
                         ||||||||_______A/D sweep pin select bit 0
                         |||||||________A/D sweep pin select bit 1
                         ||||||_________A/D operation mode select bit 1
                         |||||__________8/10 bit mode select bit
                         ||||___________frequency select bit 1
                         |||____________Vref connect bit
                         ||_____________external op-amp connection bit 0
                         |______________external op-amp connection bit 1 */

       adcon2 =  0x01;  /*00000001 Sample and hold enabled
                          ||||||||_______sample and hold select bit
                          |||||||________reserved
                          ||||||_________reserved
                          |||||__________reserved
                          ||||___________reserved
                          |||____________reserved
                          ||_____________reserved
                          |______________reserved */

       adst = 1;                   // Start AD conversions
```

```
while (1){
       TempStore0 = ad0 & 0x03ff;  // Mask off the upper 6 bits of the
                                          // variable leaving only the result
                                          // in the variable itself

       TempStore1 = ad1 & 0x03ff;  // Mask off the upper 6 bits of the
                                          // variable leaving only the result
                                          // in the variable itself

       TempStore2 = ad2 & 0x03ff;  // Mask off the upper 6 bits of the
                                          // variable leaving only the result
                                          // in the variable itself

       TempStore3 = ad3 & 0x03ff;  // Mask off the upper 6 bits of the
                                          // variable leaving only the result
                                          // in the variable itself
           }
}
```

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