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# M16C/62

## Using the M16C/62 Analog to Digital Converter in One-Shot Mode

### 1.0 Abstract

The following article outlines the steps necessary to set up, perform, and read a single conversion 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.

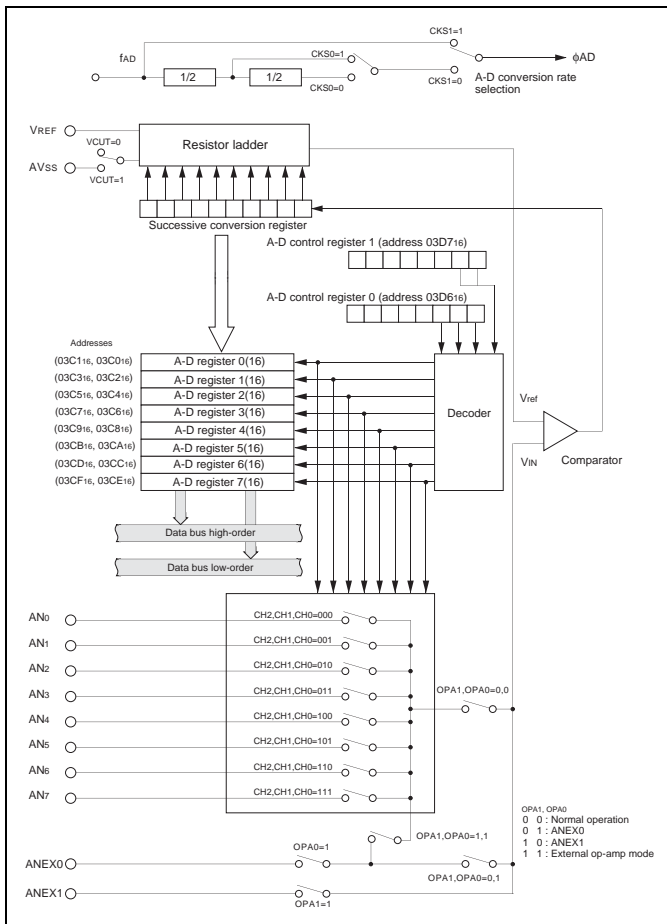
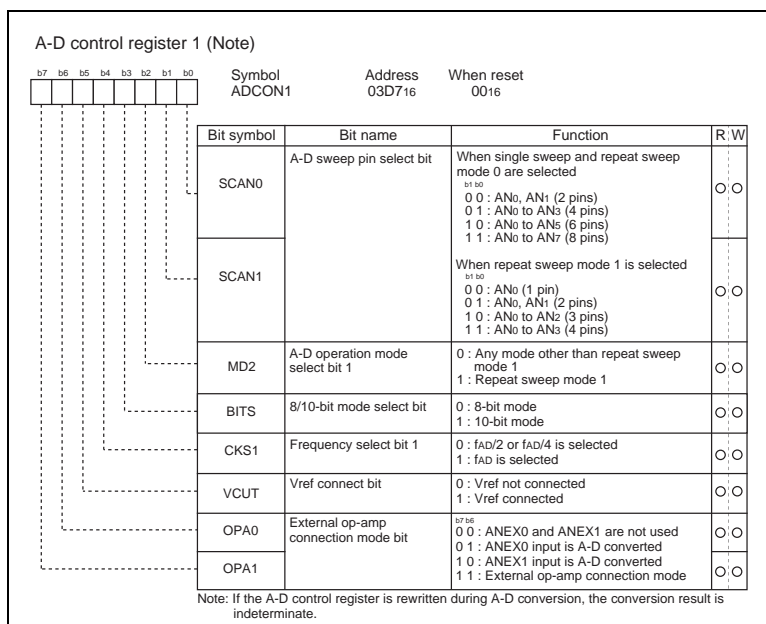
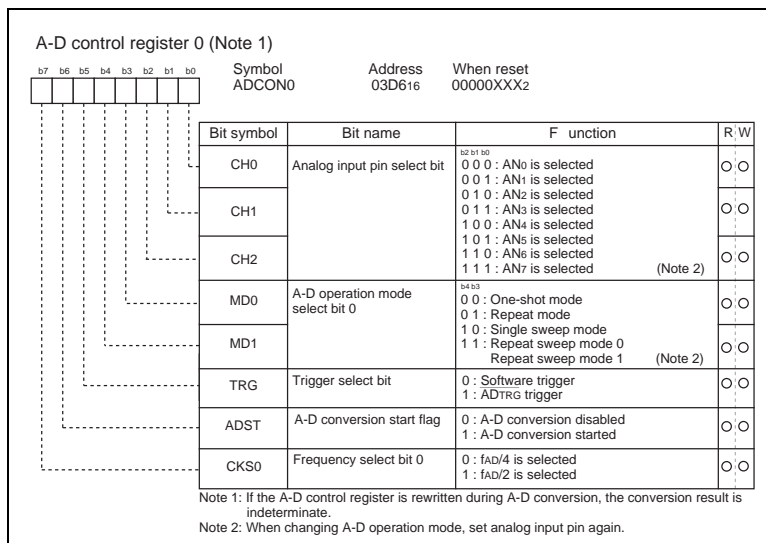


Figure 1 Internal Circuitry for ADC Block—Overview

### 3.0 One-Shot Mode Description

In one-shot mode, one pin of the ADC is selected as the input source. Once triggered, a conversion takes place on the selected pin and the result is stored in the ADC result register corresponding to the selected channel. An interrupt signifies the completion of a conversion. Figure 2 and Figure 3 are 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 M16C/.



**Figure 2 A-D Converter Related Registers**

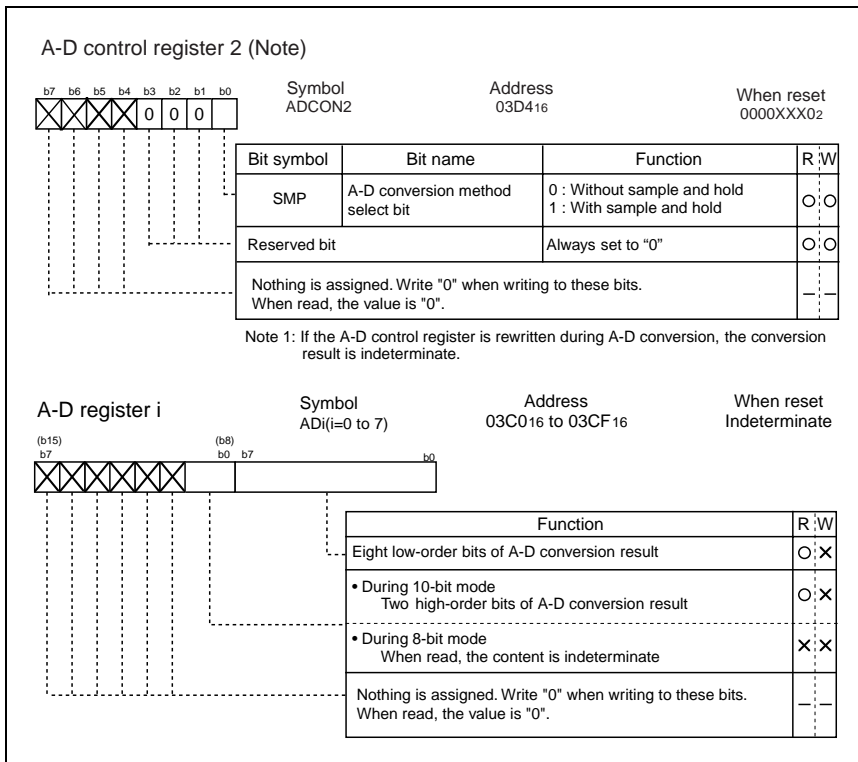


Figure 3 A-D Converter Related Registers

### 4.0 Example Program

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

#### Environment Setup

- One-shot conversion
- 10-bit mode
- Analog input 0 used
- Sample and hold enabled
- Vref connected
- Conversion clock used will be  $f_{AD}/2$  (if  $f(X_{in})$  is greater than 10 MHz,  $f_{AD}$  must be divided )
- Software conversion start

#### ADC Software Setup

- Set the ADCON0 register for  $f_{AD}/2$ , one-shot operation using AN0 (0x80)
- Set the ADCON1 register for 10 bit mode,  $f_{AD}$  divided, and connect Vref (0x28)
- 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' in the AD Interrupt Service Routine

## 5.0 Reference

### Renesas Technology Corporation Semiconductor Home Page

<http://www.renesas.com>

### E-mail Support

[support\\_apl@renesas.com](mailto:support_apl@renesas.com)

### Data Sheets

- M16C/62 datasheets, 62aeds.pdf

### User's Manual

- NC30 Ver. 4.0 User's Manual, NC30UE.pdf
- M16C/60 and M16C/20 C Language Programming Manual, 6020EC.pdf
- M16C/62 User's Manual, 62eum.pdf
- Application Note: Writing Interrupt Handlers in C for the M16C

## 6.0 Software Code

The sample software provided was written using the NC30 compiler. The program performs one conversion on reset. This code could be simply modified to use a timer for the trigger of the ADC to provide multiple conversions at specific intervals.

```
/*
 *
 * DESCRIPTION: single_shot.c
 *
 * AUTHOR: Renesas Technology Corporation (June 2003)
 *
 * PURPOSE:      Outlines how to use the M16C/62 ADC in single shot mode.
 *              On reset, program 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 TempStore = 0x0000; // Location where ADC result is stored

#pragma INTERRUPT ADCInt // compiler directive telling where
// the ADC interrupt is located

void ADCInt(void);

/*
```

```

** main
*
* PARAMETERS: None
*
* DESCRIPTION: Main function. Where program execution starts. Sets
*               up the ADC then waits for interrupt to occur.
*
* RETURNS: Nothing
*/
void main (void){

    adcon0 = 0x80; 00000000 AN0 input, fAD/2, 1 shot mode, software trigger
                   | | | | | | | | _____ 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 = 0x28; 00101000; /* 10 bit mode, fADdivided, Vref connected
                   | | | | | | | | _____ 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 */

    adic = 0x01; 00000001; /* Enable the ADC interrupt
                   | | | | | | | | _____ interrupt priority select bit 0
                   | | | | | | | | _____ interrupt priority select bit 1
                   | | | | | | | | _____ interrupt priority select bit 2
                   | | | | | | | | _____ interrupt request bit
                   | | | | | | | | _____ reserved
                   | | | | | | | | _____ reserved
                   | | | | | | | | _____ reserved
                   | | | | | | | | _____ reserved */

    _asm (" fset i" ) ; /* globally enable interrupts

    adst = 1; /* Start a conversion here

```

```

    while (1){}                // Program waits here forever
}

/*
** ADCInt
*
* PARAMETERS: None
*
* DESCRIPTION: Interrupt routine of the ADC. Here the converted value is
*               loaded into a variable and masked off to show the result.
*
* RETURNS: Nothing
*
*/

void ADCInt(void){

    TempStore = ad0 & 0x03ff;    // Mask off the upper 6 bits of the
                                // variable leaving only the result
                                // in the variable itself
}

```

In order for this program to run properly, the ADC interrupt vector needs to point to the function. The interrupt vector table is near the end of the startup file "sect30.inc". Insert the function label "\_ADCInt" into the interrupt vector table at vector 14 as shown below.

```

:
:
:

;-----
; variable vector section
;-----

.section      vector          ; variable vector table
.org      VECTOR_ADR

.lword      dummy_int          ; BRK (vector 0)
.org      (VECTOR_ADR+16)
.lword      dummy_int          ; int3(for user)(vector 4)
.lword      dummy_int          ; timerB5(for user)(vector 5)
.lword      dummy_int          ; timerB4(for user)(vector 6)
.lword      dummy_int          ; timerB3(for user)(vector 7)
.lword      dummy_int          ; si/o4 /int5(for user)(vector 8)
.lword      dummy_int          ; si/o3 /int4(for user)(vector 9)
.lword      dummy_int          ; Bus collision detection(for user)(v10)
.lword      dummy_int          ; DMA0(for user)(vector 11)
.lword      dummy_int          ; DMA1(for user)(vector 12)
.lword      dummy_int          ; Key input interrupt(for user)(vect 14)
.glob      _ADCInt
.lword      _ADCInt            ; A-D(for user)(vector 14)

```



```
.lword      dummy_int      ; uart2 transmit(for user) (vector 15)
.lword      dummy_int      ; uart2 receive(for user) (vector 16)
.lword      dummy_int      ; uart0 transmit(for user) (vector 17)

:
:
:
```

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