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

1.0 Abstract
The following article outlines the steps necessary to set up, perform, and read multiple conversions on a single channel 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 Mode Description

In repeat 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. This is repeated until the ADC conversion start flag is disabled. No interrupt is generated on the completed conversion, but rather the ADC output register can be read anytime to determine the converted value. 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 MCU specification for the device in question.

### Figure 2 A-D Converter Related Registers

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Address</th>
<th>When reset</th>
<th>F.</th>
<th>R.</th>
<th>W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADCON0 03D616 00000XXX</td>
<td></td>
<td>00000000X0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>ADCON1 03D716 0016</td>
<td></td>
<td>0001000000</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>SCAN0</td>
<td>bit symbol</td>
<td>Bit name</td>
<td>function</td>
<td>R.</td>
<td>W.</td>
</tr>
<tr>
<td>SCAN1</td>
<td>when single sweep and repeat sweep mode 0 are selected</td>
<td>0 0: AN0, AN1 (2 pins)</td>
<td>1 0: AN0 to AN5 (8 pins)</td>
<td>1 1: AN0 to AN7 (8 pins)</td>
<td>O</td>
</tr>
<tr>
<td>MD2</td>
<td>when repeat sweep mode 1 is selected</td>
<td>0 0: AN0 (1 pin)</td>
<td>1 0: AN0 to AN2 (3 pins)</td>
<td>1 1: AN0 to AN3 (4 pins)</td>
<td>O</td>
</tr>
<tr>
<td>MD0</td>
<td>A-D operation mode select bit 0</td>
<td>0 0: One-shot mode</td>
<td>0 1: Repeat mode</td>
<td>1 0: Single sweep mode</td>
<td>1 1: Repeat sweep mode 0</td>
</tr>
<tr>
<td>MD1</td>
<td>Repeat sweep mode 0</td>
<td>0 0: AN0, AN1 (2 pins)</td>
<td>0 1: AN0 to AN3 (4 pins)</td>
<td>1 0: AN0 to AN5 (6 pins)</td>
<td>1 1: AN0 to AN7 (8 pins)</td>
</tr>
<tr>
<td>TRG</td>
<td>Trigger select bit</td>
<td>0 0: Software trigger</td>
<td>0 1: ADTRG trigger</td>
<td>1 0: A-D conversion started</td>
<td>1 1: A-D conversion started</td>
</tr>
<tr>
<td>ADST</td>
<td>A-D conversion start flag</td>
<td>0 0: ANEX0 and ANEX1 are not used</td>
<td>0 1: ANEX0 input is A-D converted</td>
<td>1 0: ANEX1 input is A-D converted</td>
<td>1 1: External op-amp connection mode</td>
</tr>
</tbody>
</table>

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.
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### 4.0 Example Program

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

**Environment Setup**
- Repeat mode conversion
- 10-bit mode
- Analog input 0 used
- Sample and hold enabled
- Vref connected
- Conversion clock used will be fAD/2 (if f(Xin) is greater than 10 MHz, fAD must be divided)
- Software conversion start

**ADC Software Setup**
- Set the ADCON0 register for AN0 input, fAD/2 and repeat mode operation (0x08)
- Set the ADCON1 register for 10-bit mode, fAD divided, and connect Vref (0x38)
- 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 value in variable ‘TempStore’
5.0 Reference

Renesas Technology Corporation Semiconductor Home Page
http://www.renesas.com

E-mail Support
support_apl@renesas.com

Data Sheets
- M16C/62 datasheets, 62aeds.pdf

User's Manual
- M16C/60 and M16C/20 C Language Programming Manual, 6020EC.pdf
- Application Note: Writing Interrupt Handlers in C for the M16C
- 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_mode.c
* AUTHOR: Renesas Technology Corporation (June 2003)
* PURPOSE: Outlines how to use the M16C/62 ADC in repeat
* mode. 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 or similar tool.
******************************************/

#include "sfr62.h"

unsigned int TempStore = 0x0000;       // Location where ADC result is stored

/ ** main
* PARAMETERS: None
*
**DESCRIPTION:** Main function. Where program execution starts. Sets up the ADC then begins conversions.

* RETURNS: Nothing

*/

```c
void main (void){

    adcon0 = 0x88; // 01000100; /* AN0 input, repeat mode, software trigger, fAD/2

    adcon1 = 0x28; // 00101000 10 bit mode, fAD2, Vref connected

    adcon2 = 0x01; // 00000001 Sample and hold enabled

    adst = 1;  // Start a conversion here

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