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AN205508

F²MC-8FX Family, MB95200 Series Keyboard development using AD

This application note describes how to use the AD Conversion to design the keyboard and also describes the realization theories of AD conversion by examples.

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1 Introduction

There are three methods to develop a keyboard by MB95200 series MCU: external interrupt, AD conversion and matrix.

This document describes how to use the AD Conversion to design the keyboard.

This document also describes the realization theories of AD conversion by examples.

2 Introduction to AD Function

This chapter introduces the functions of using AD Conversion to realize the keyboard.

2.1 Function of AD Conversion

The function of AD Convertor is to convert an analog voltage (input voltage) value on an analog input pin to a 10-bit digital value. The MCU of MB95200 series has at least 2 analog input pins. When AD convertor is enabled, the analog input signal on the selected channel will be sampled and compared inside the AD convertor and finally converted to a digital value stored into the A/D converter data register (ADDH, ADDL).

2.2 Jittering Elimination in Keyboard

Jittering elimination has been one of important problems in keyboard design. In hardware circuit design, add a capacitor to the analog input pin to weaken the jittering, while in software design, re-confirm the data to avoid jittering occurred on a real keyboard.

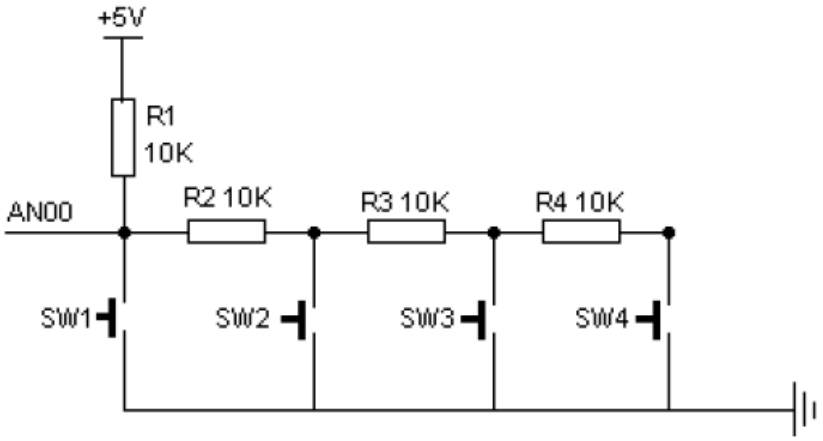
3 Hardware Design

This chapter introduces the hardware design to develop keyboard using AD Conversion.

3.1 Hardware Circuit

The resistors in the following hardware circuit are designed to divide voltage. And the analog input pin will get a different voltage from the circuit. The following circuit is for your reference:

Figure 1. Hardware Design for Keyboard Using AD



3.2 Relationship between Key Status and Input Voltage

Table 1. Relationship between Key Status and Input Voltage

Pressed key	AN00 Voltage	ADDL value	Virtual value
SW1	0 V	0x00	0x00>=ADDL<=0x05
SW2	2.5 V	0x7F	0x79>=ADDL<=0x85
SW3	3.3 V	0xAA	0xA1>=ADDL<=0xB2
SW4	3.75 V	0xBF	0xB5>=ADDL<=0xC8

4 Resource Usage

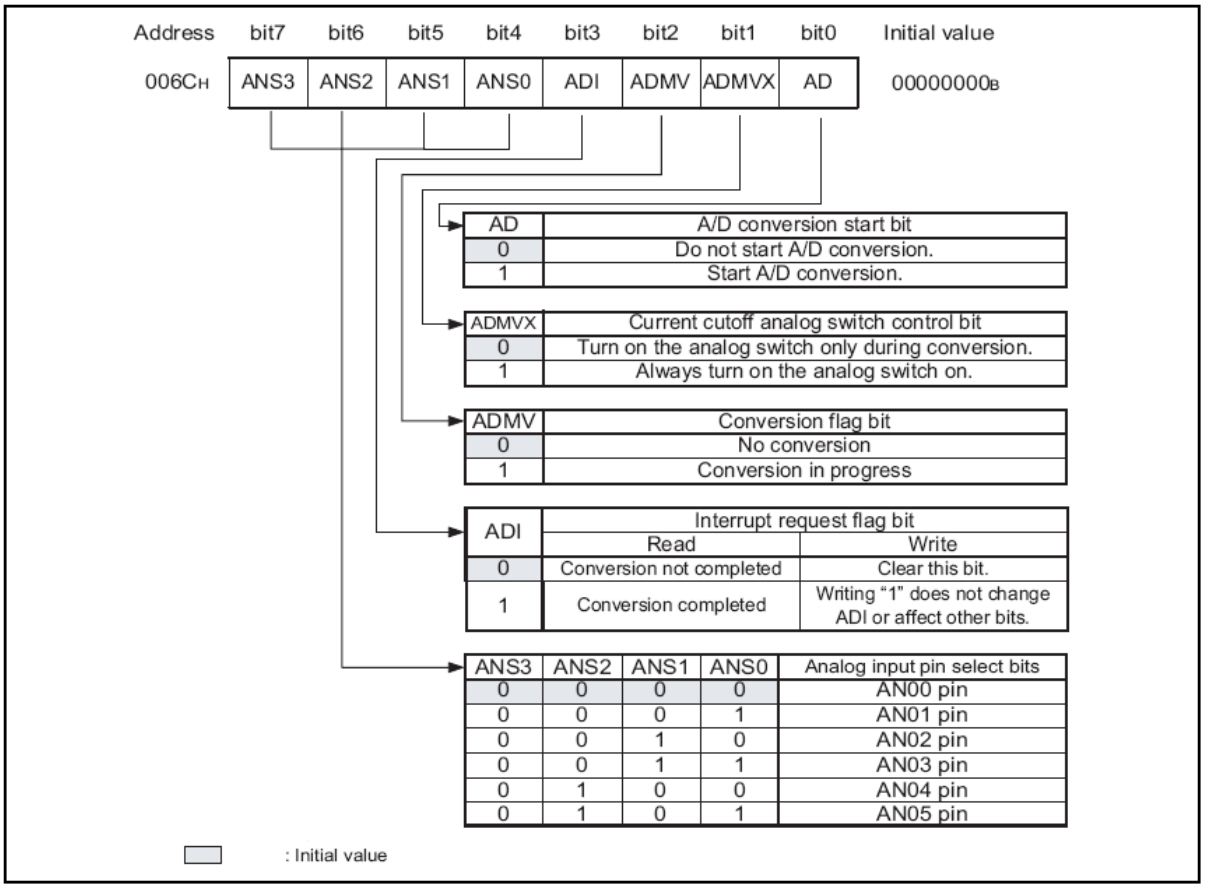
This chapter introduces the resource usage of AD Conversion.

Please refer to Chapter 17 of MB95200 Series Hardware Manual for detailed register setting.

4.1 8/10-bit A/D Converter Control Register 1 (ADC1)

The 8/10-bit A/D converter control register 1 (ADC1) is used to enable and disable individual functions of the 8/10-bit A/D converter, select an analog input pin and check the status of the converter.

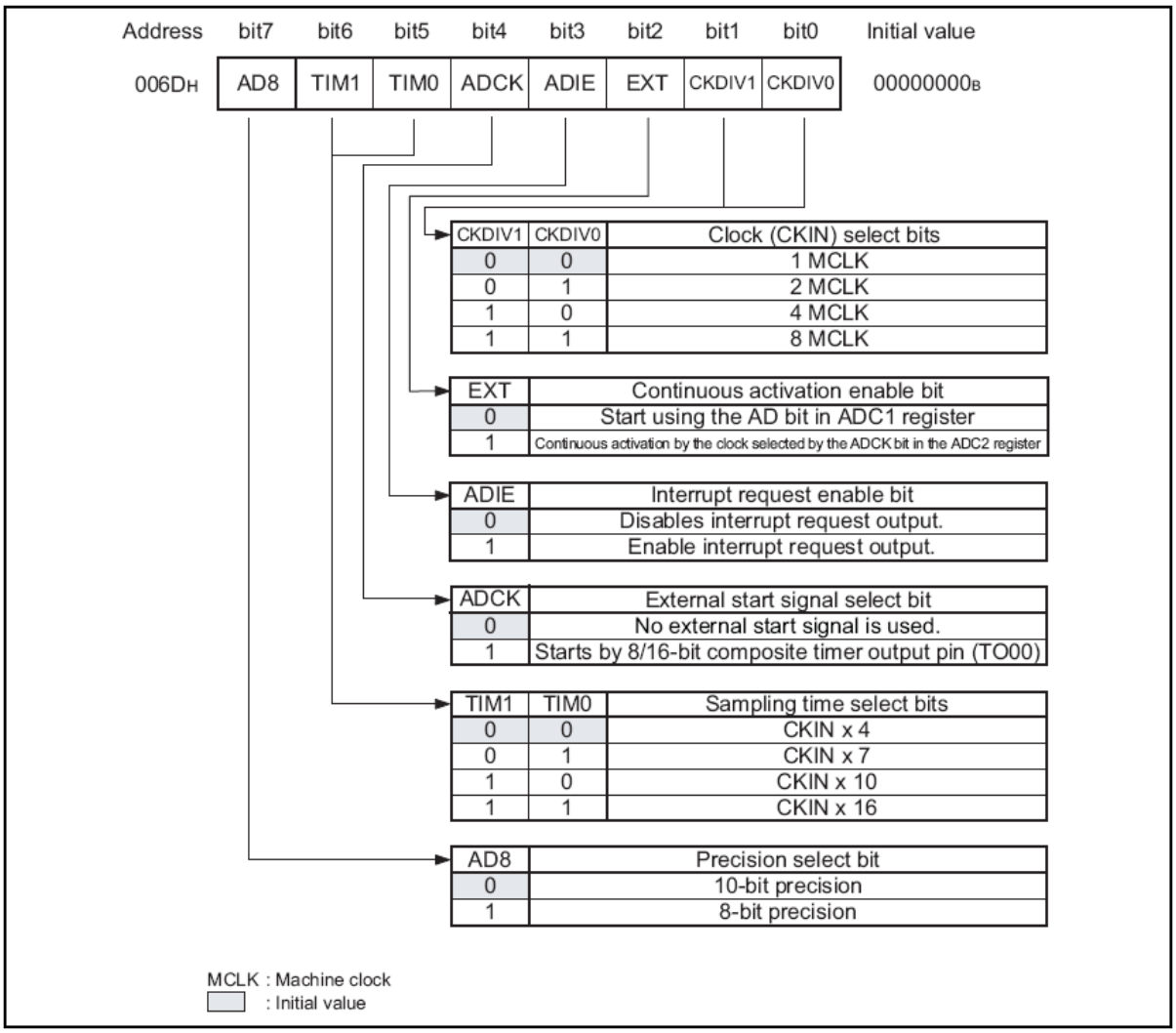
Figure 2. ADC1 Register



4.2 8/10-bit A/D Converter Control Register 2 (ADC2)

The 8/10-bit A/D converter control register 2 (ADC2) is used to control different functions of the 8/10-bit A/D converter, select the input clock, and enable and disable interrupts.

Figure 3. ADC2 Register



4.3 8/10-bit A/D Converter Data Registers Upper/Lower (ADDH, ADDL)

The 8/10-bit A/D converter data registers upper/lower (ADDH, ADDL) store the results of 10- bit A/D conversion during 10-bit A/D conversion. The upper two bits of 10-bit data are stored in the ADDH register and the lower eight bits the ADDL register.

Figure 4. AD Data Registers

ADDH	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Initial value
Address $006E_H$	-	-	-	-	-	-	SAR9	SAR8	00000000_B
ADDL	bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8	Initial value
Address $006F_H$	SAR7	SAR6	SAR5	SAR4	SAR3	SAR2	SAR1	SAR0	00000000_B

The upper two bits of 10-bit A/D data correspond to bit1 and bit0 in the ADDH register and the lower eight bits bit15 to bit8 in the ADDL register.

If the AD8 bit in ADC2 register is set to "1", 8-bit precision is selected. Reading the ADDL register can obtain 8-bit data.

4.4 AD Converter Process

After the conversion time according to the register settings elapses, the results of conversion are finalized and stored in the ADDH and ADDL registers. After A/D conversion is completed and before the next A/D conversion is started, it's required to read A/D data registers (conversion results) and clear ADI flag bit (bit 3) in the ADC1 register.

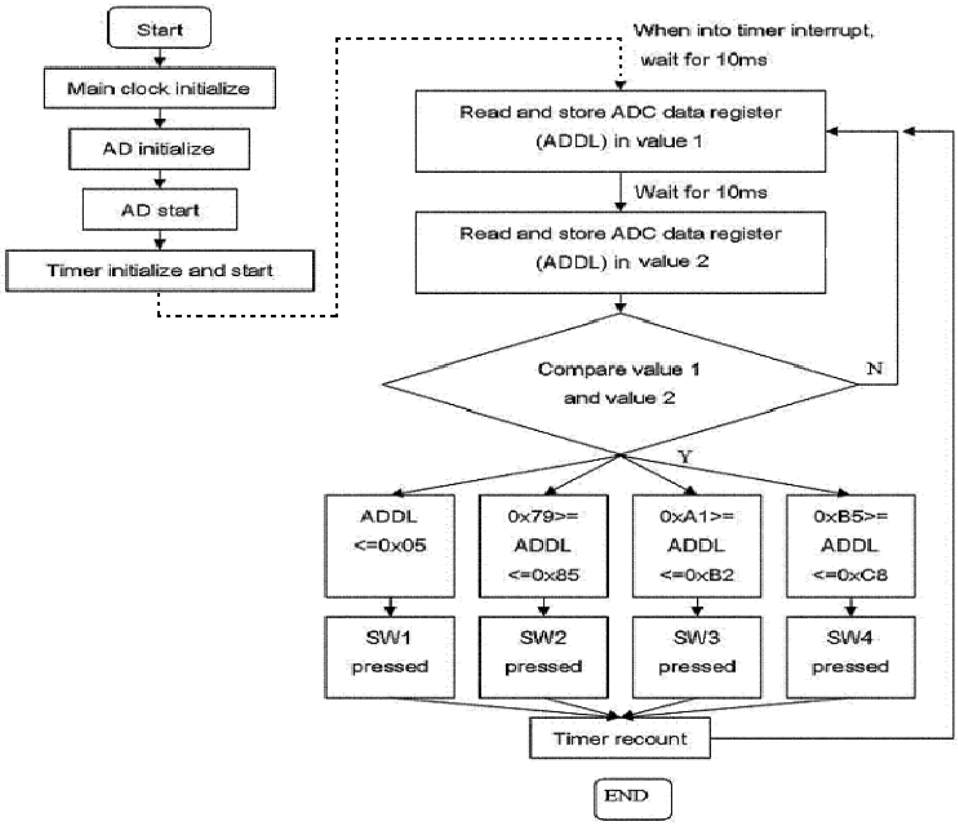
5 Software Design

This chapter introduces the software design to develop keyboard using AD conversion.

Once the AD convertor is enabled, it will capture the status information of keyboard. If the value (Distem0) belongs to the key-value, restored it, if not, the AD Convertor continues to sample. After this, stop the AD Convertor and make the system wait for about 20ms, then restart the AD Convertor and get a sample value (Distem1) again. Finally, judge this value to see if it is equal to Distem0. If it is different from Distem0, it is regarded that jittering happens; otherwise, judge which key has been pressed.

Below is the flow chart of this software design.

Figure 5. Software Design Flow Chart for Keyboard Development



6 Sample Code

This chapter illustrates keyboard development using AD Conversion.

The following example shows how to use the AD Conversion input pin AN00 to design a 4- key keyboard.

As discussed in chapter 5, if using AD Conversion to design a keyboard system, initialize the AD Conversion first, then AD conversion starts sampling, and gets an sample value, read this value and judge that if it belongs to the key-value. if does not, system continues to sample; if does, stop the AD Conversion and let the system waits for about 20 ms, and then restart AD Conversion, get an another sample value. If the two sample values are the same, it shows that one of the keys has been pressed; if not, it shows only a jittering happens.

```
#include "../MB95200_IO/mb95200.h". . .
void clock_Select(void)    // Main clock initialize
{
       SYCC = 0x00;
       WATR = 0x00;
       STBC = 0x01;
       SYCC2= 0xF4;
}
void syinit(void)
{
       DDR0_P00 = 0;        //P00 input enable
       ADC1 = 0x01;         //AN00 as input
       ADC2 = 0x80;         //8-bit resolution,1×MCLK
       ADC1_AD = 1;         //start A/D converter
       DDR0 = 0xF0;         //P4~P7 as output pin
       PUL0 = 0x00;
       AIDRL = 0xFE;
}
void timer_init(void)
{
       TMCR0 = 0x10;        // 16-bit
       T00CR0 = 0x81;       // interval timer with continuous mode
       T00CR1 = 0xA0;       // disable output, start timer
       T01DR = 0x27;        // 10000us
       T00DR = 0x10;
       while(STBC_MRDY);
}
__interrupt void Timer_Interrupt (void)
{
       T00CR1_IF = 0;
       T00CR1_IE = 0;
       timer_counter++;
       if(timer_counter==1) // Read and store ADDL in value 1
       {
       AD_Sample();
       }
```

```
        if(timer_counter==2)   // Read and store ADDL in value 2 and
                                       compare value and value 2
        {
                key_judge();
        }
        if(timer_counter>=3)   /Timer_counter restart
        {
        timer_counter=0;
        }
}
void AD_Sample(void)
{
        if(ADC1_ADI==1)
        {
        while(!ADC1_ADI);
        Distem0 = ADD_ADDL; // Read AD Sample value 1
        }
        ADC1_AD=1;             // Start AD again
}
void key_judge(void)
{
        if(ADC1_ADI==1)        // Read and store ADDL in value 2
        {
                while(!ADC1_ADI);
                Distem1 = ADD_ADDL;
        }
        if(Distem1==Distem0)   // Judge if value 1 and value 2 equality
        {
                if(Distem1 == Range_value0) // Key process
                {
                        DDR0_P04 = 1;
                        PDR0_P04 = 0;
                }
                if((Distem1 >= Range_value1)&&(Distem1 <= Range_value2))
                {
                        DDR0_P05 = 1;
                        PDR0_P05 = 0;
                }
                if((Distem1 >= Range_value3)&&(Distem1 <= Range_value4))
                {
                        DDR0_P06 = 1;
                        PDR0_P06 = 0;
                }
                if((Distem1 >= Range_value5)&&(Distem1 <= Range_value6))
                {
                        DDR0_P07 = 1;
                        PDR0_P07 = 0;
                }
        }
}
void main(void)
{
        InitIrqLevels();       //initialise Interrupt level and IRQ vector table
        __EI();                // global interrupt enable
        clock_Select();
        while(1)
        {
        syinit();
        timer_init();
        }
}
```

Note: This sample project is based on our starter-kit MB2146-410A. The target MCU is MB95F304K. AN0 is used as an analog input pin, and LED1 to LED4 an indicator. If keyboard hardware circuit as shown in chapter 3.1 is not provided, stop a jumper and connect VR3 to MCU so that VR3 can be used as an analog input. Then observe how LED changes in adjusting VR3.

7 Additional Information

For more Information on MB95200 Products, visit the following website:

http://www.cypress.com/8fx-mb95200

8 Document History

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	-	HUAL	02/24/2009	Initial release
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