专题17-触摸屏

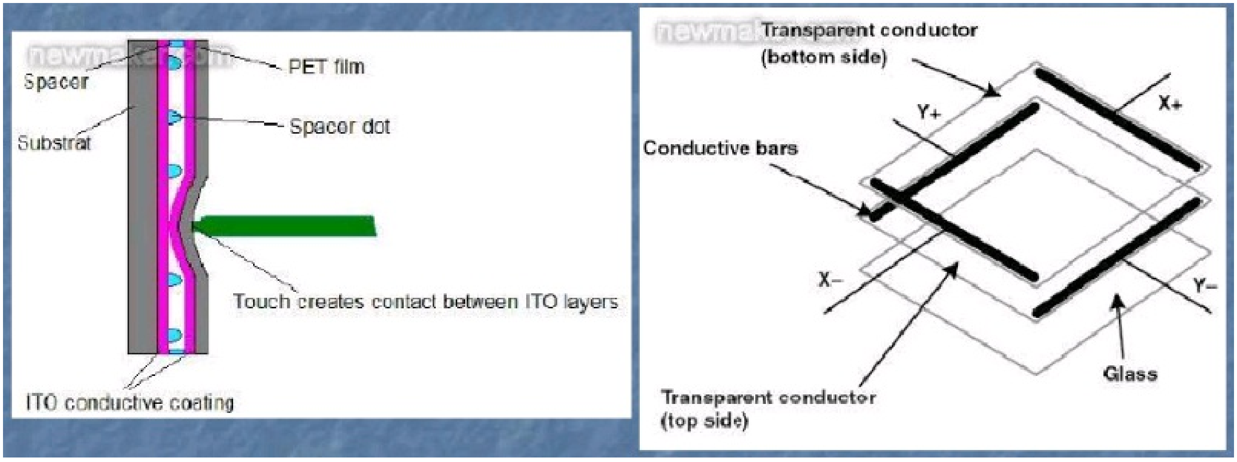
一、触摸屏原理解析

1.1、触摸屏分类

从技术原理来区别触摸屏，可分为5类：

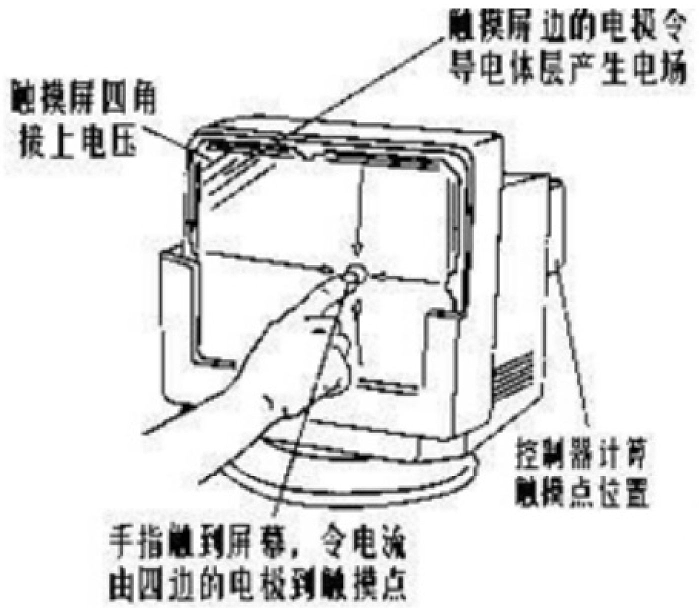
1.电阻式触摸屏
2.电容式触摸屏
3.红外线技术触摸屏
4.表面声波技术触摸屏
5.矢量压力传感技术触摸屏

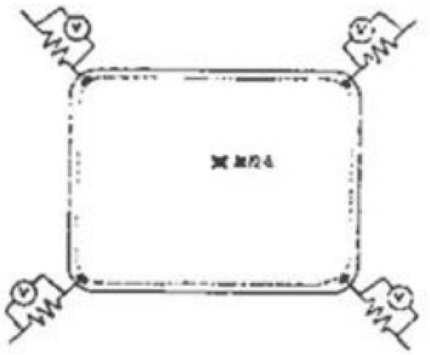
1.2、电阻屏工作原理



当手指触摸屏幕时，两 个相互绝缘的导电层在触摸点处连接，顶层的5伏电压就会加到底层触摸点处，底层该点的电压会发生改变。控制器检测到该点的 变化后，将该点的电 压进行A/D转换，得 到的值与5伏相比，再 乘以该轴总长度即可得触摸点靠地那一端 的坐标。

1.2、电容屏工作原理





给工作面通上一个很低的电压， 当用户触摸屏幕时,手指头吸收 走一个很小的电流,这个电流分 从触摸屏四个角上的电极中流 出,并且理论上流经这四个电极 的电流与手指到四角的距离成 比例,控制器通过对这四个电流 比例的精密计算,得出触摸点的 位置。

二、OK6410电阻屏驱动程序设计

```
#define ADCCON        (*((volatile unsigned long *)0x7E00B000))

#define VIC1INTENABLE   (*((volatile unsigned long *)0x71300010))
#define VIC1INTENCLEAR  (*((volatile unsigned long *)0x71300014))
#define VIC1VECTADDR30  (*((volatile unsigned long *)0x71300178))
#define VIC0ADDRESS     (*((volatile unsigned long *)0x71200f00))
#define VIC1ADDRESS     (*((volatile unsigned long *)0x71300f00))

#define ADCTSC        (*((volatile unsigned long *)0x7E00B004))
#define ADCDLY        (*((volatile unsigned long *)0x7E00B008))
#define ADCDAT0       (*((volatile unsigned long *)0x7E00B00C))
#define ADCDAT1       (*((volatile unsigned long *)0x7E00B010))

#define ADCCLRINT      (*((volatile unsigned long *)0x7E00B018))
#define ADCCLRINTPNDNUP (*((volatile unsigned long *)0x7E00B020))


```

2.1、触摸屏初始化

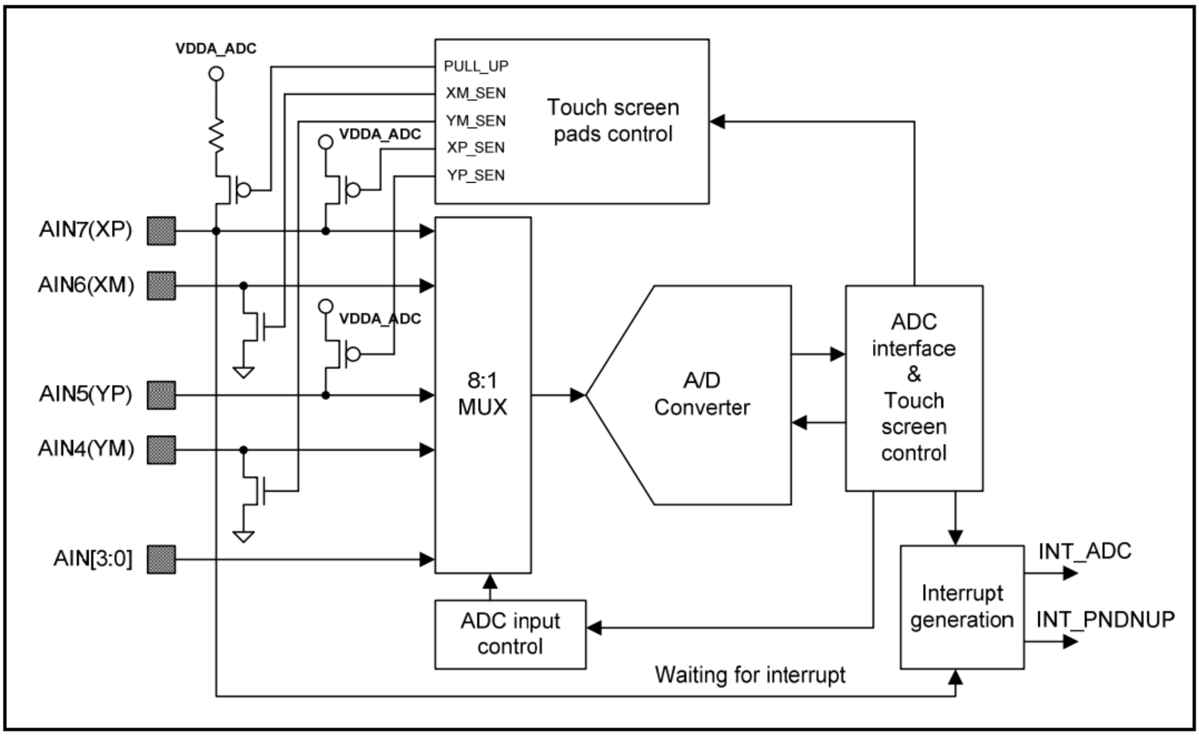
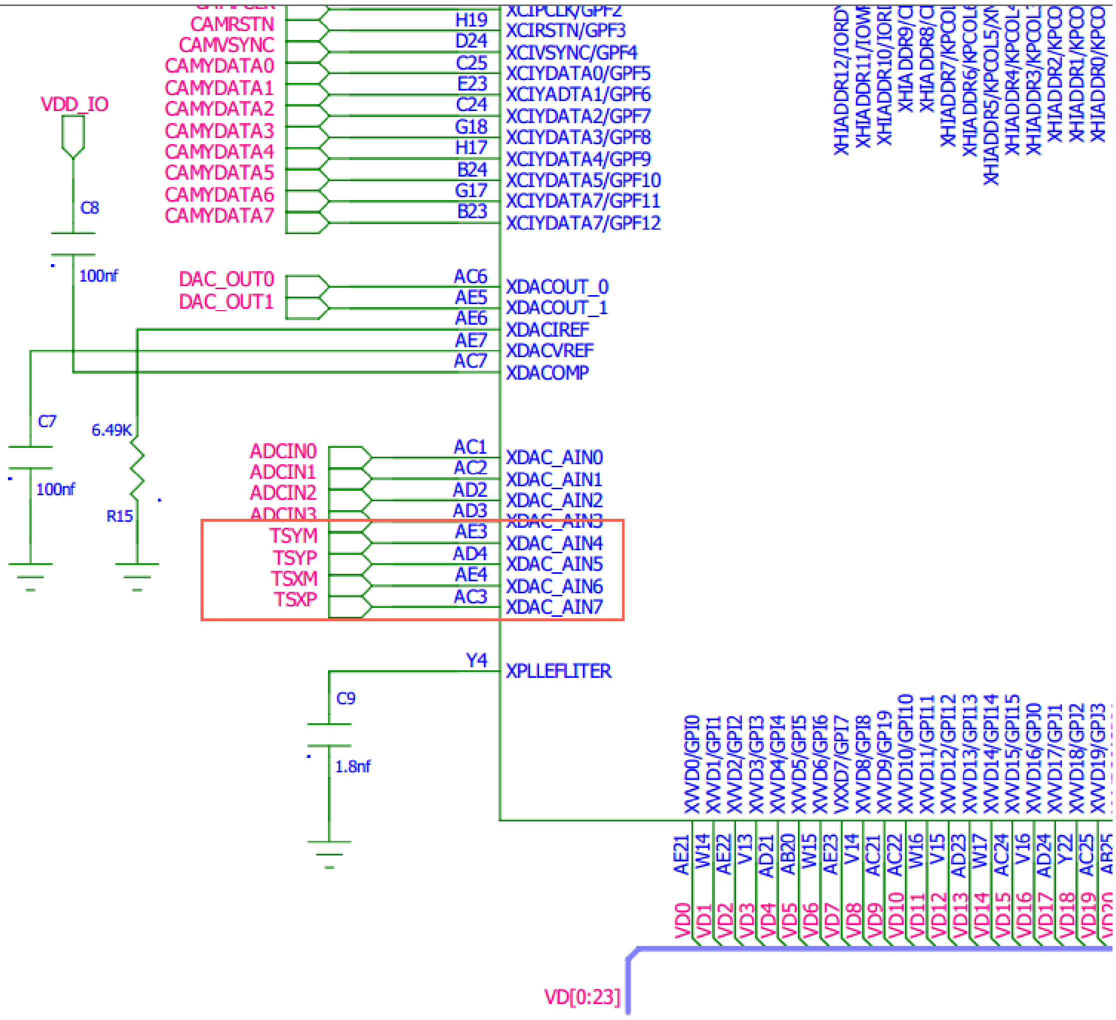


Figure 39-1. ADC and Touch Screen Interface Functional Block Diagram

NOTE

When Touch Screen device is used, XM or YM is only connected to ground for Touch Screen I/F.

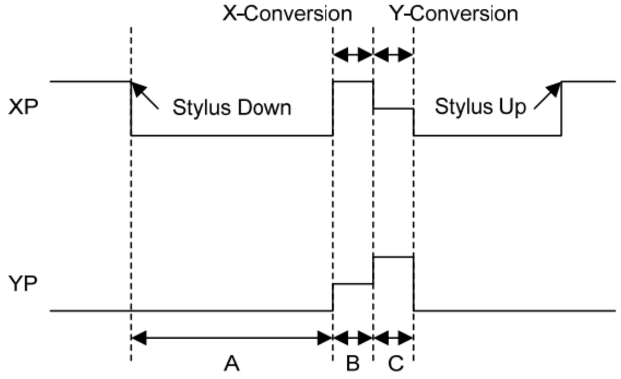
When Touch Screen device is not used, XM or YM is connecting Analog Input Signal for Normal ADC conversion



39.5 PROGRAMMING NOTES

1. The A/D converted data can be accessed by means of interrupt or polling method. With interrupt method, the overall conversion time - from A/D converter start to convert data read - may be delayed because of the return time of interrupt service routine and data access time. With polling method, by checking the ADCCON [15] – end of conversion flag – bit, the read time from ADCDAT register can be determined.

2. A/D conversion can be activated in different way. After ADCCON [1] - A/D conversion start-by-read mode-is set to 1. A/D conversion starts simultaneously when converted data is read.



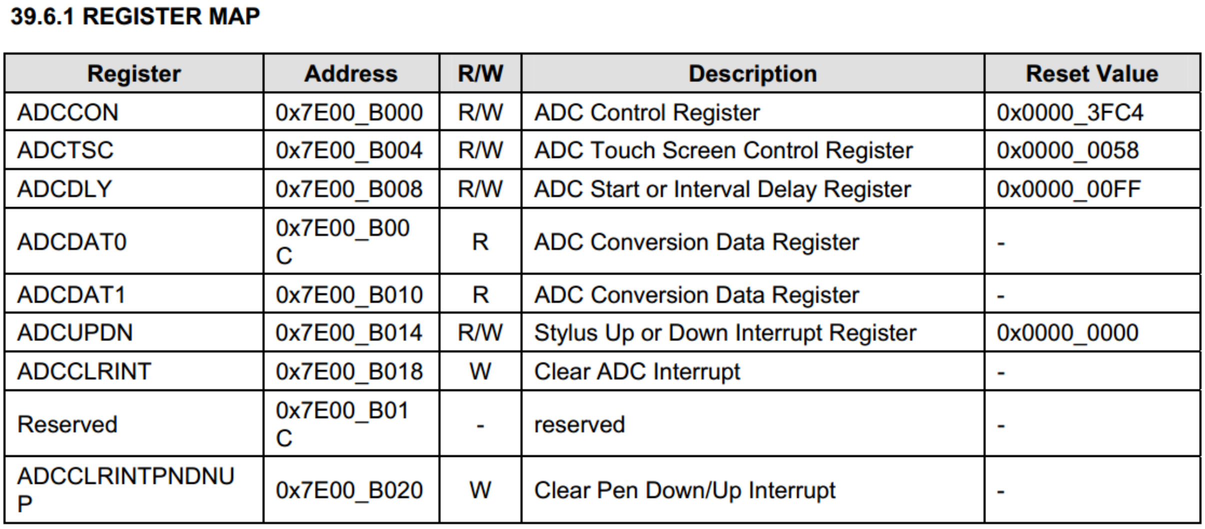
A = D x (1/Xrtc clock) or **D** x (1/X-tal clock) or **D** x (1/EXTCLK clock)
B = **D** x (1/PCLK clock) + 5 x (1/PCLK clock) x (PRSCVL+1)
C = **D** x (1/PCLK clock) + 5 x (1/PCLK clock) x (PRSCVL+1)

D = Delay value of ADCDLY register

Figure 39-2. ADC and Touch Screen Operation signal (Touch Normal Operation)

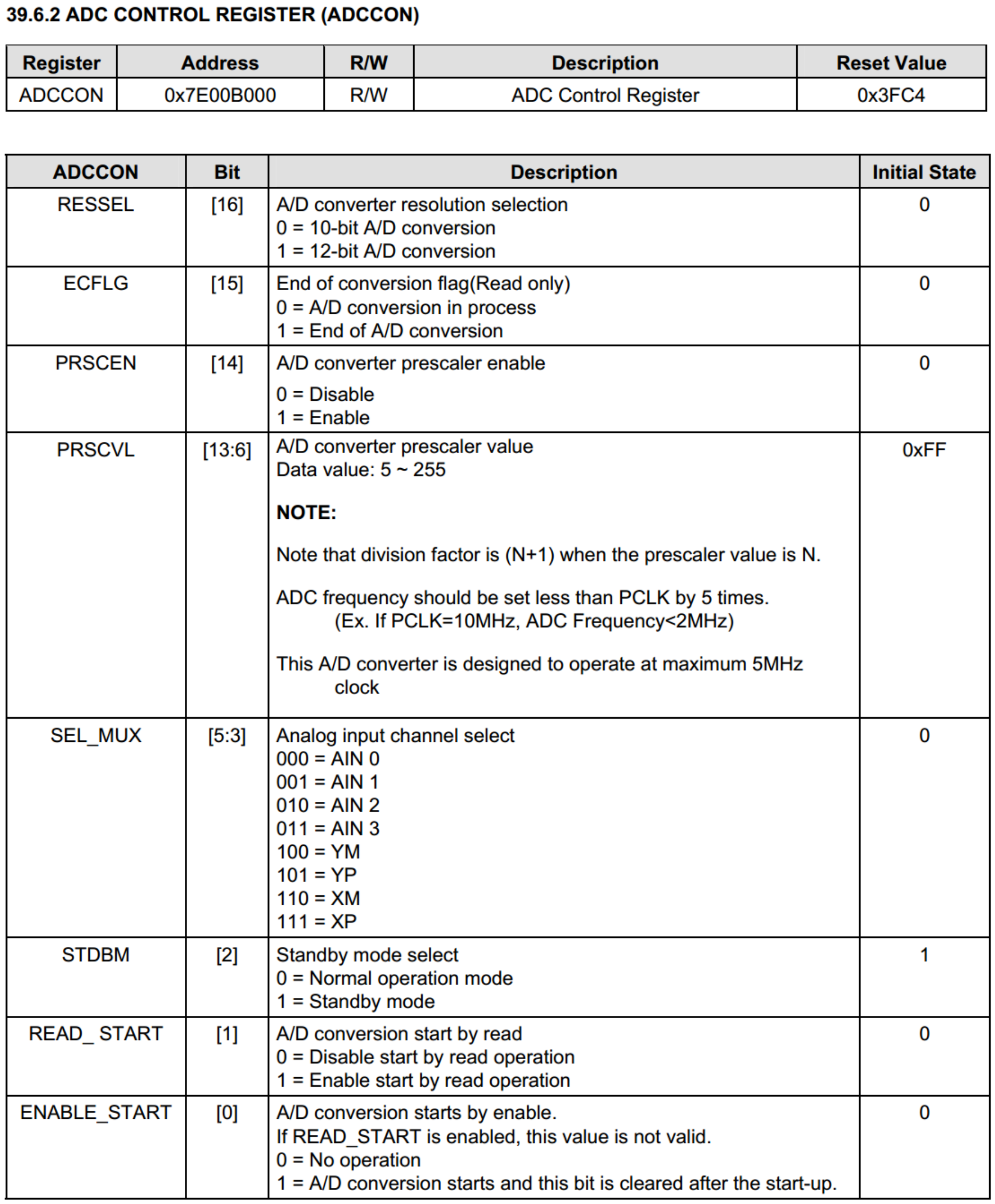
3. If pen down/up interrupt is used as a wakeup source in STOP mode, XY_PST bit (ADCTSC [1:0]) should be set to waiting for interrupt mode (2b'11). To choose stylus pen up or pen down wakeup, UD_SEN bit (ADCTSC [8]) is used.

2.1.1、设置AD转换时钟



39.6.1 REGISTER MAP

Register	Address	R/W	Description	Reset Value
ADCCON	0x7E00_B000	R/W	ADC Control Register	0x0000_3FC4
ADCTSC	0x7E00_B004	R/W	ADC Touch Screen Control Register	0x0000_0058
ADCDLY	0x7E00_B008	R/W	ADC Start or Interval Delay Register	0x0000_00FF
ADCDAT0	0x7E00_B00C	R	ADC Conversion Data Register	-
ADCDAT1	0x7E00_B010	R	ADC Conversion Data Register	-
ADCUPDN	0x7E00_B014	R/W	Stylus Up or Down Interrupt Register	0x0000_0000
ADCCLRINT	0x7E00_B018	W	Clear ADC Interrupt	-
Reserved	0x7E00_B01C	-	reserved	-
ADCCLRINTPNDNUP	0x7E00_B020	W	Clear Pen Down/Up Interrupt	-



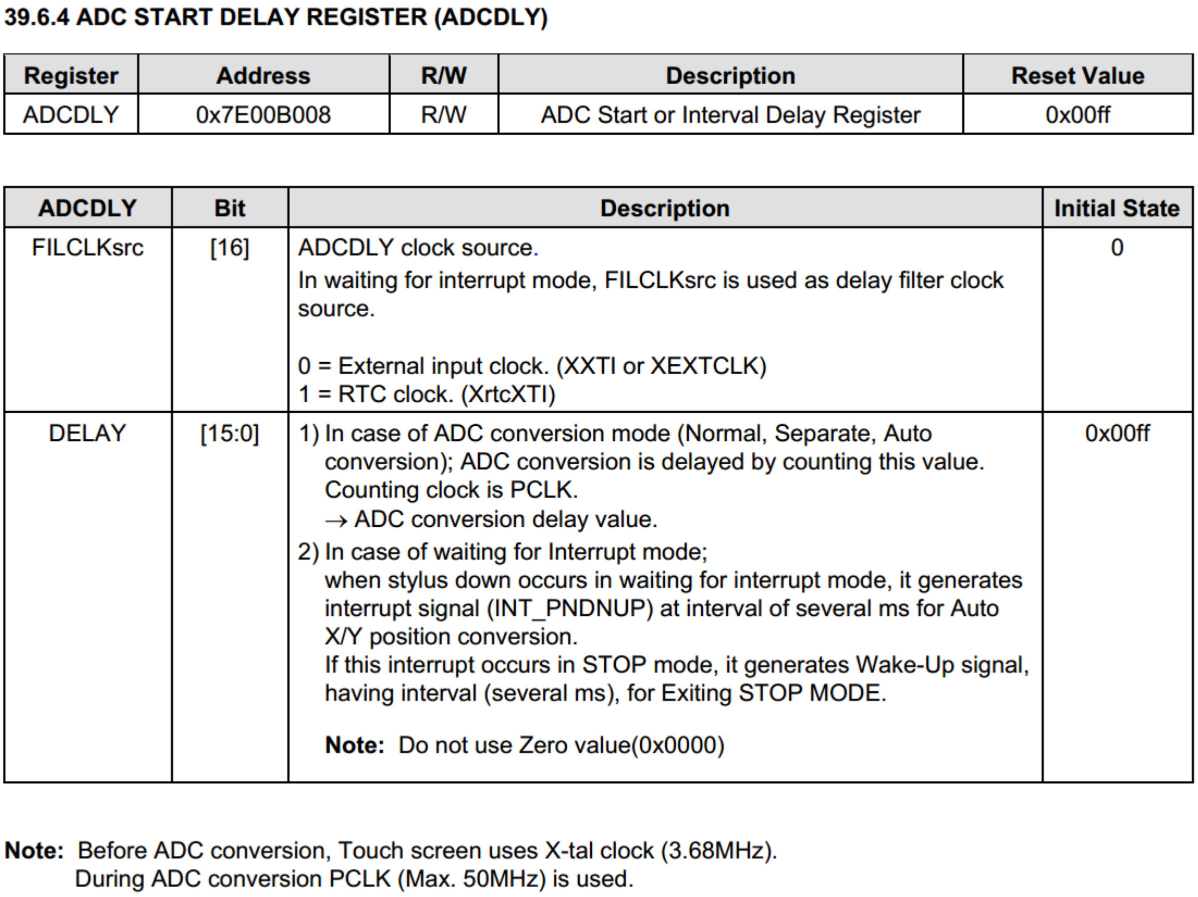
39.6.2 ADC CONTROL REGISTER (ADCCON)

Register	Address	R/W	Description	Reset Value
ADCCON	0x7E00B000	R/W	ADC Control Register	0x3FC4

ADCCON	Bit	Description	Initial State
RESSEL	[16]	A/D converter resolution selection 0 = 10-bit A/D conversion 1 = 12-bit A/D conversion	0
ECFLG	[15]	End of conversion flag(Read only) 0 = A/D conversion in process 1 = End of A/D conversion	0
PRSCEN	[14]	A/D converter prescaler enable 0 = Disable 1 = Enable	0
PRSCVL	[13:6]	A/D converter prescaler value Data value: 5 ~ 255 **NOTE:** Note that division factor is (N+1) when the prescaler value is N. ADC frequency should be set less than PCLK by 5 times. (Ex. If PCLK=10MHz, ADC Frequency<2MHz) This A/D converter is designed to operate at maximum 5MHz clock	0xFF
SEL_MUX	[5:3]	Analog input channel select 000 = AIN 0 001 = AIN 1 010 = AIN 2 011 = AIN 3 100 = YM 101 = YP 110 = XM 111 = XP	0
STDBM	[2]	Standby mode select 0 = Normal operation mode 1 = Standby mode	1
READ_ START	[1]	A/D conversion start by read 0 = Disable start by read operation 1 = Enable start by read operation	0
ENABLE_START	[0]	A/D conversion starts by enable. If READ_START is enabled, this value is not valid. 0 = No operation 1 = A/D conversion starts and this bit is cleared after the start-up.	0

```
void ts_init(void)
{
        //set adc clk source:enable A/D converter prescaler;
        ADCCON &= ~((1 << 16) | (1 << 14) | (0xff << 6) | (1 << 2) | (1 << 1) | (1 << 0));
        //set adc clk = PCLK / (PRSCVL + 1), ADC frequency should be set less than PCLK by 5 times.This A/D converter is designed to operate at maximum 5MHz clock
        ADCCON |= ((1 << 14) | (65 << 6));      //adc clk = 66.5MHz / (65+1) = 1MHz

```

设置转换延时(功能暂时无法确定是否生效）



39.6.4 ADC START DELAY REGISTER (ADCDLY)

Register	Address	R/W	Description	Reset Value
ADCDLY	0x7E00B008	R/W	ADC Start or Interval Delay Register	0x00ff

ADCDLY	Bit	Description	Initial State
FILCLKsrc	[16]	ADCDLY clock source. In waiting for interrupt mode, FILCLKsrc is used as delay filter clock source. 0 = External input clock. (XXTI or XEXTCLK) 1 = RTC clock. (XrtcXTI)	0
DELAY	[15:0]	1) In case of ADC conversion mode (Normal, Separate, Auto conversion); ADC conversion is delayed by counting this value. Counting clock is PCLK. → ADC conversion delay value. 2) In case of waiting for Interrupt mode; when stylus down occurs in waiting for interrupt mode, it generates interrupt signal (INT_PNDNUP) at interval of several ms for Auto X/Y position conversion. If this interrupt occurs in STOP mode, it generates Wake-Up signal, having interval (several ms), for Exiting STOP MODE. **Note:** Do not use Zero value(0x0000)	0x00ff

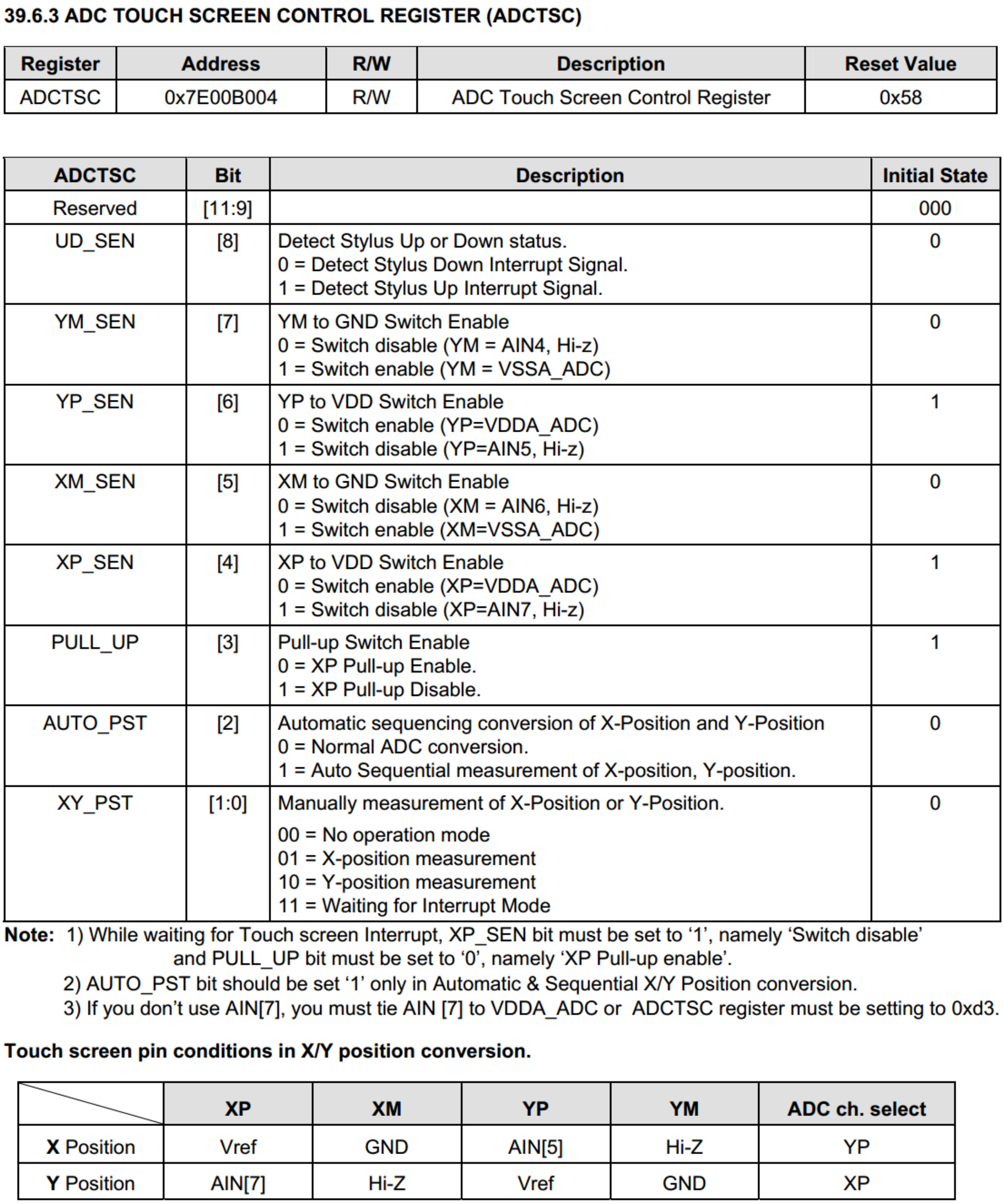
Note: Before ADC conversion, Touch screen uses X-tal clock (3.68MHz).
During ADC conversion PCLK (Max. 50MHz) is used.

```
    //set ADC Start or Interval Delay
    ADCDLY = 0xffff;

```

2.1.2、中断屏蔽设置

```
    //set interrupt:TC interrupt enable;adc interrupt disable.
    VIC1INTENABLE |= (1 << 30);
    VIC1INTENCLEAR &= ~(1 << 31);

    VIC1VECTADDR30 = (int)ts_handler;

    ADCCLRINT = 0;
    ADCCLRINTPNDNUP = 0;
```

2.1.3、进入等待中断模式



39.6.3 ADC TOUCH SCREEN CONTROL REGISTER (ADCTSC)

Register	Address	R/W	Description	Reset Value
ADCTSC	0x7E00B004	R/W	ADC Touch Screen Control Register	0x58

ADCTSC	Bit	Description	Initial State
Reserved	[11:9]		000
UD_SEN	[8]	Detect Stylus Up or Down status. 0 = Detect Stylus Down Interrupt Signal. 1 = Detect Stylus Up Interrupt Signal.	0
YM_SEN	[7]	YM to GND Switch Enable 0 = Switch disable (YM = AIN4, Hi-z) 1 = Switch enable (YM = VSSA_ADC)	0
YP_SEN	[6]	YP to VDD Switch Enable 0 = Switch enable (YP=VDDA_ADC) 1 = Switch disable (YP=AIN5, Hi-z)	1
XM_SEN	[5]	XM to GND Switch Enable 0 = Switch disable (XM = AIN6, Hi-z) 1 = Switch enable (XM=VSSA_ADC)	0
XP_SEN	[4]	XP to VDD Switch Enable 0 = Switch enable (XP=VDDA_ADC) 1 = Switch disable (XP=AIN7, Hi-z)	1
PULL_UP	[3]	Pull-up Switch Enable 0 = XP Pull-up Enable. 1 = XP Pull-up Disable.	1
AUTO_PST	[2]	Automatic sequencing conversion of X-Position and Y-Position 0 = Normal ADC conversion. 1 = Auto Sequential measurement of X-position, Y-position.	0
XY_PST	[1:0]	Manually measurement of X-Position or Y-Position. 00 = No operation mode 01 = X-position measurement 10 = Y-position measurement 11 = Waiting for Interrupt Mode	0

Note: 1) While waiting for Touch screen Interrupt, XP_SEN bit must be set to '1', namely 'Switch disable' and PULL_UP bit must be set to '0', namely 'XP Pull-up enable'.
2) AUTO_PST bit should be set '1' only in Automatic & Sequential X/Y Position conversion.
3) If you don't use AIN[7], you must tie AIN [7] to VDDA_ADC or ADCTSC register must be setting to 0xd3.

Touch screen pin conditions in X/Y position conversion.

	XP	XM	YP	YM	ADC ch. select
X Position	Vref	GND	AIN[5]	Hi-Z	YP
Y Position	AIN[7]	Hi-Z	Vref	GND	XP

```
        //into wait interrupt(dowm)
        ADCTSC = 0xd3;
}
```

2.2、TC中断处理（按下）

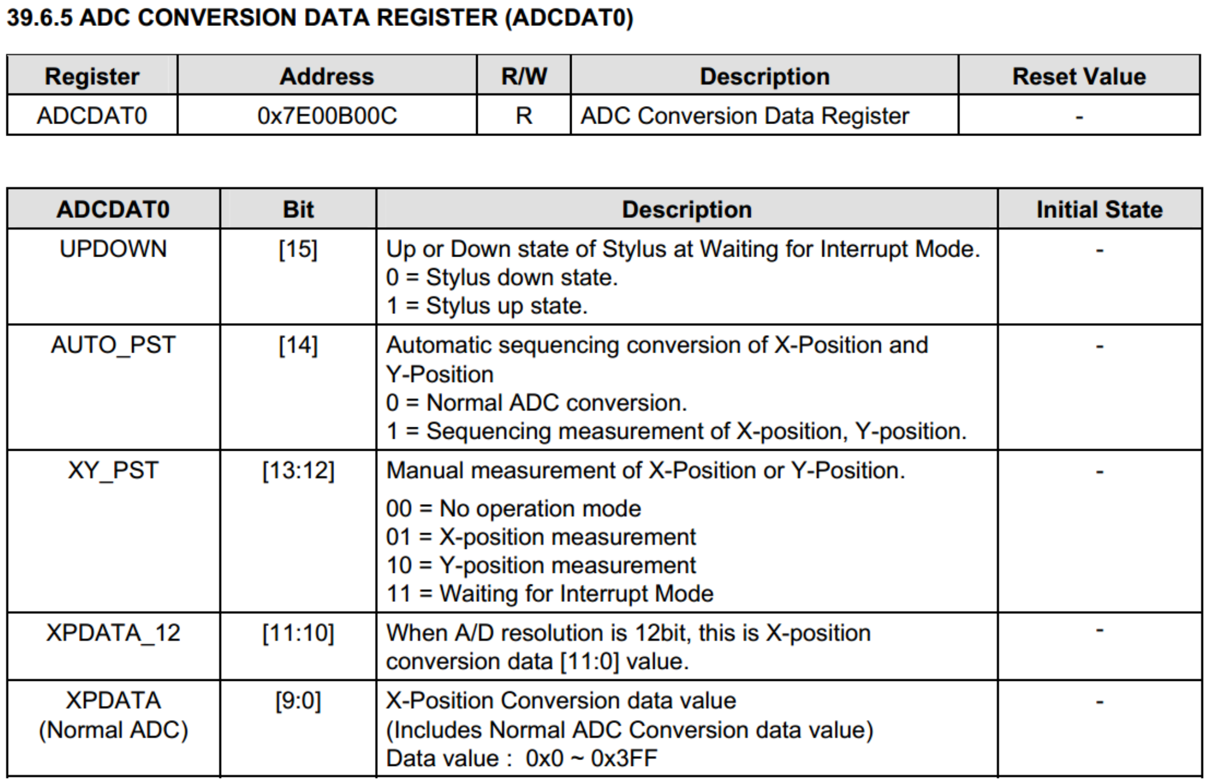
```
int x_position, y_position;

void ts_handler()
{
        __asm__ volatile (
                "sub lr, lr, #4\n"
                "stmfd sp!, {r0-r12, lr}\n"
                :
                :
        );

```

```
    //exit interrupt
    VIC0ADDRESS = 0;
    VIC1ADDRESS = 0;

    __asm__ volatile (
            "ldmfd sp!, {r0-r12, pc}^ \n"
            :
            :
    );

}

```

2.2.1、启动XY坐标自动转换

```
    //start Auto Sequential measurement of X-position, Y-position.
    ADCCON |= 1;
    ADCTSC |= (1 << 2);

```

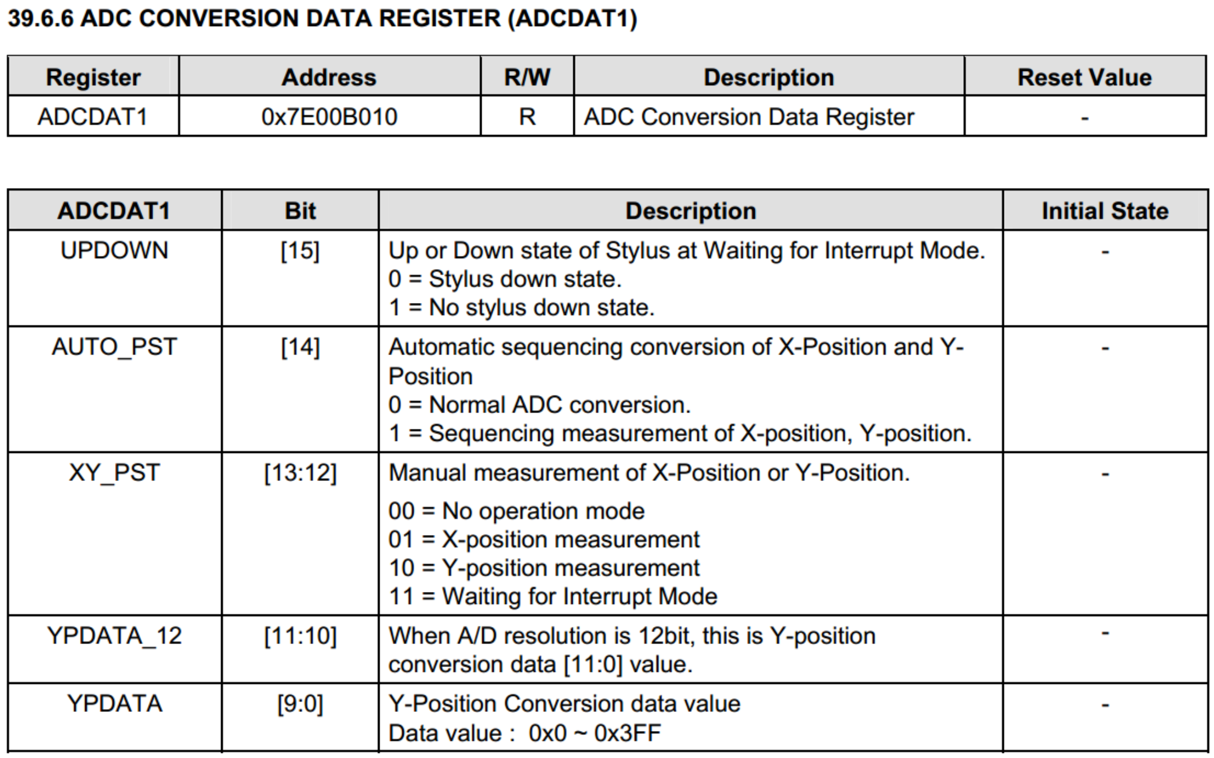
2.2.2、等待转化完成，获取坐标



39.6.5 ADC CONVERSION DATA REGISTER (ADCDAT0)

Register	Address	R/W	Description	Reset Value
ADCDAT0	0x7E00B00C	R	ADC Conversion Data Register	-

ADCDAT0	Bit	Description	Initial State
UPDOWN	[15]	Up or Down state of Stylus at Waiting for Interrupt Mode. 0 = Stylus down state. 1 = Stylus up state.	-
AUTO_PST	[14]	Automatic sequencing conversion of X-Position and Y-Position 0 = Normal ADC conversion. 1 = Sequencing measurement of X-position, Y-position.	-
XY_PST	[13:12]	Manual measurement of X-Position or Y-Position. 00 = No operation mode 01 = X-position measurement 10 = Y-position measurement 11 = Waiting for Interrupt Mode	-
XPDATA_12	[11:10]	When A/D resolution is 12bit, this is X-position conversion data [11:0] value.	-
XPDATA (Normal ADC)	[9:0]	X-Position Conversion data value (Includes Normal ADC Conversion data value) Data value : 0x0 ~ 0x3FF	-



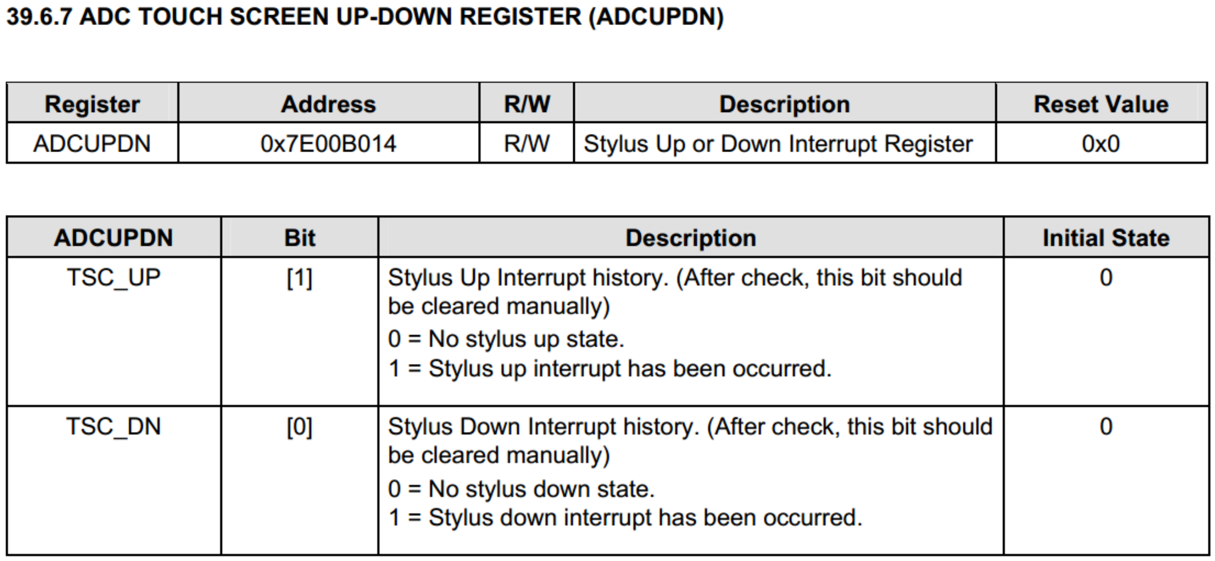
39.6.6 ADC CONVERSION DATA REGISTER (ADCDAT1)

Register	Address	R/W	Description	Reset Value
ADCDAT1	0x7E00B010	R	ADC Conversion Data Register	-

ADCDAT1	Bit	Description	Initial State
UPDOWN	[15]	Up or Down state of Stylus at Waiting for Interrupt Mode. 0 = Stylus down state. 1 = No stylus down state.	-
AUTO_PST	[14]	Automatic sequencing conversion of X-Position and Y-Position 0 = Normal ADC conversion. 1 = Sequencing measurement of X-position, Y-position.	-
XY_PST	[13:12]	Manual measurement of X-Position or Y-Position. 00 = No operation mode 01 = X-position measurement 10 = Y-position measurement 11 = Waiting for Interrupt Mode	-
YPDATA_12	[11:10]	When A/D resolution is 12bit, this is Y-position conversion data [11:0] value.	-
YPDATA	[9:0]	Y-Position Conversion data value Data value : 0x0 ~ 0x3FF	-

```
        //wait conversion complete
        while(!(ADCCON & (1 << 15))) ;

        //get x,y position
        x_position = (ADCDAT0 & 0x3ff);
        y_position = (ADCDAT1 & 0x3ff);
        printf("x is %d, y is %d\n\r", x_position, y_position);

```

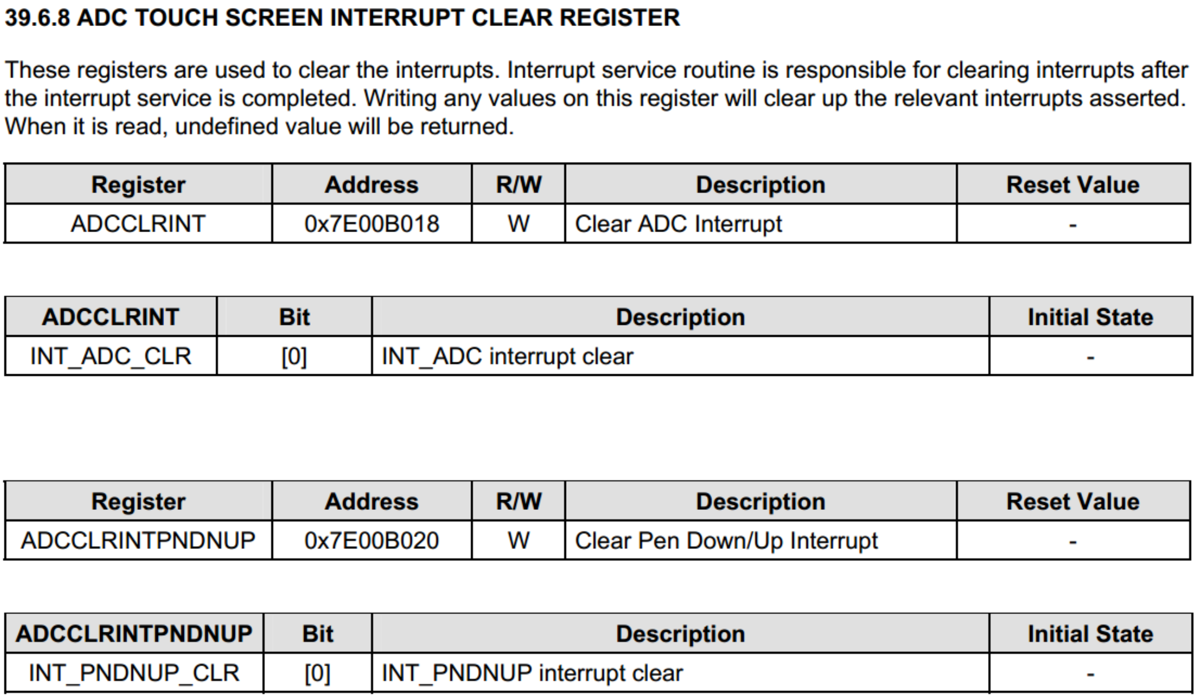
2.2.3、清除中断



39.6.7 ADC TOUCH SCREEN UP-DOWN REGISTER (ADCUPDN)

Register	Address	R/W	Description	Reset Value
ADCUPDN	0x7E00B014	R/W	Stylus Up or Down Interrupt Register	0x0

ADCUPDN	Bit	Description	Initial State
TSC_UP	[1]	Stylus Up Interrupt history. (After check, this bit should be cleared manually) 0 = No stylus up state. 1 = Stylus up interrupt has been occurred.	0
TSC_DN	[0]	Stylus Down Interrupt history. (After check, this bit should be cleared manually) 0 = No stylus down state. 1 = Stylus down interrupt has been occurred.	0



39.6.8 ADC TOUCH SCREEN INTERRUPT CLEAR REGISTER

These registers are used to clear the interrupts. Interrupt service routine is responsible for clearing interrupts after the interrupt service is completed. Writing any values on this register will clear up the relevant interrupts asserted. When it is read, undefined value will be returned.

Register	Address	R/W	Description	Reset Value
ADCCLRINT	0x7E00B018	W	Clear ADC Interrupt	-

ADCCLRINT	Bit	Description	Initial State
INT_ADC_CLR	[0]	INT_ADC interrupt clear	-

Register	Address	R/W	Description	Reset Value
ADCCLRINTPNDNUP	0x7E00B020	W	Clear Pen Down/Up Interrupt	-

ADCCLRINTPNDNUP	Bit	Description	Initial State
INT_PNDNUP_CLR	[0]	INT_PNDNUP interrupt clear	-

```
    // INTERRUPT CLEAR(dowm)
    ADCCLRINT = 0;
    ADCCLRINTPNDNUP = 0;

```

2.2.4、进入等待TC中断模式（弹起）

```
    // into wait interrupt(up)
    ADCTSC = 0xd3;
    ADCTSC |= (1 << 8);

```

2.2.5、清除弹起中断

```
    //clear interrupt(up)
    ADCCLRINT = 0;
    ADCCLRINTPNDNUP = 0;

```

2.2.6、进入等待中断模式（按下）

```
    //into wait interrupt(dowm)
    ADCTSC = 0xd3;

```