应用指南

32位 Cortex™-M0 单片机
NuMicro® 系列

怎样通过SPI使用AD7793?

目录

1 简介

本应用指南介绍了NUC1xx的SPI结构，并通过一个简单程序讲解如何通过SPI接口控制AD7793

1.1 性能

- 支持主/从操作
- 支持1位和2位数据传输
- 可配置最大传输32位数据
- 主模式下输出时钟频率可变
- 支持突发模式，一次传输可以发送/接收2次
- 支持MSB或LSB在前传输模式
- 主模式下2条主/从选择线，从模式下1条选择线
- 同一组时钟下，全静态同步设计
- 字节睡眠模式
- 支持两组可编程串行时钟频率输出

1.2 结构

串行设备接口（SPI）是一个全双工同步串行数据通信协议，设备使用4线双向接口在主/从模式下通信。

NUC1xx系列MCU内置了一些SPI控制器，用来将接收到的终端设备数据进行串并转换，以及在向设备发送数据时进行并串转换。每个SPI可以最多驱动两个外设，但是此操作是分时进行的，不可同时操作。当SLAVE(CNTRL[18])位被置1时，也可以当作从设备使用。

当数据传送结束时，每组SPI控制器可以单独产生中断，相应中断标志位写1清零。根据外设配置SSR[SS_LVL]可以设定主/从设备的使能电平是高还是低。在主机模式下，对DIVIDER写入值，可以配置传输时钟的频率。如果SPI_CNTRL[23]寄存器的VARCLK_EN 位被使能，传输时钟可根据DIV和DIV2 ，被分为两组不同的频率。可变频率根据VARCLK来确定

该主/从机内核包含2组32位输出/输入数据缓存，可支持突发传输 (burst mode)模式，并支持各种不同长度的变量数据模式，最多可支持64 位数据传输

通过配置SPI_CNTL[22]，MCU也可支持2位数据传输模式，当SPI_CNTL[22]寄存器的TWOB位使能，即可传输2位数据的输入/输出。第一位数据从SPI_TX0输出或从SPI_RX0输入，第二位数据从SPI_TX1输出或从SPI_RX0输入。

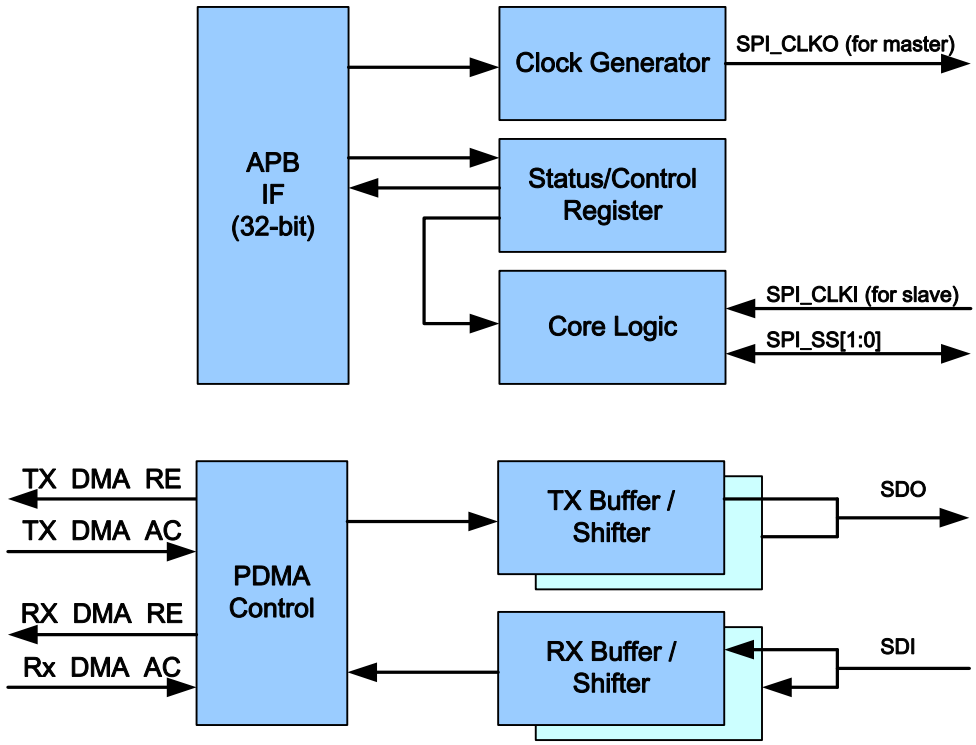

APB
IF
(32-bit)
Clock Generator
SPI_CLKO (for master)
Status/Control
Register
Core Logic
SPI_CLKI (for slave)
SPI_SS[1:0]
TX DMA RE
TX DMA AC
RX DMA RE
Rx DMA AC
PDMA
Control
TX Buffer /
Shifter
SDO
RX Buffer /
Shifter
SDI

图 1 SPI 控制器框图

1.3 SPI时序图(Master/Slave)

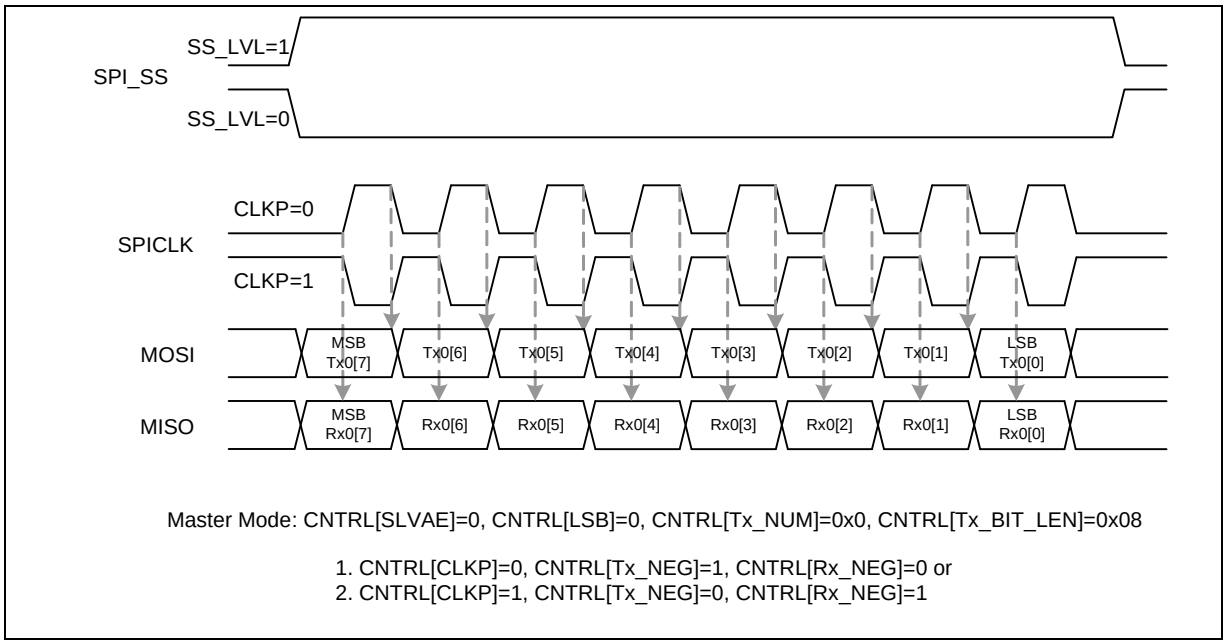


图 2 MICROWIRE/SPI 时序 (主)

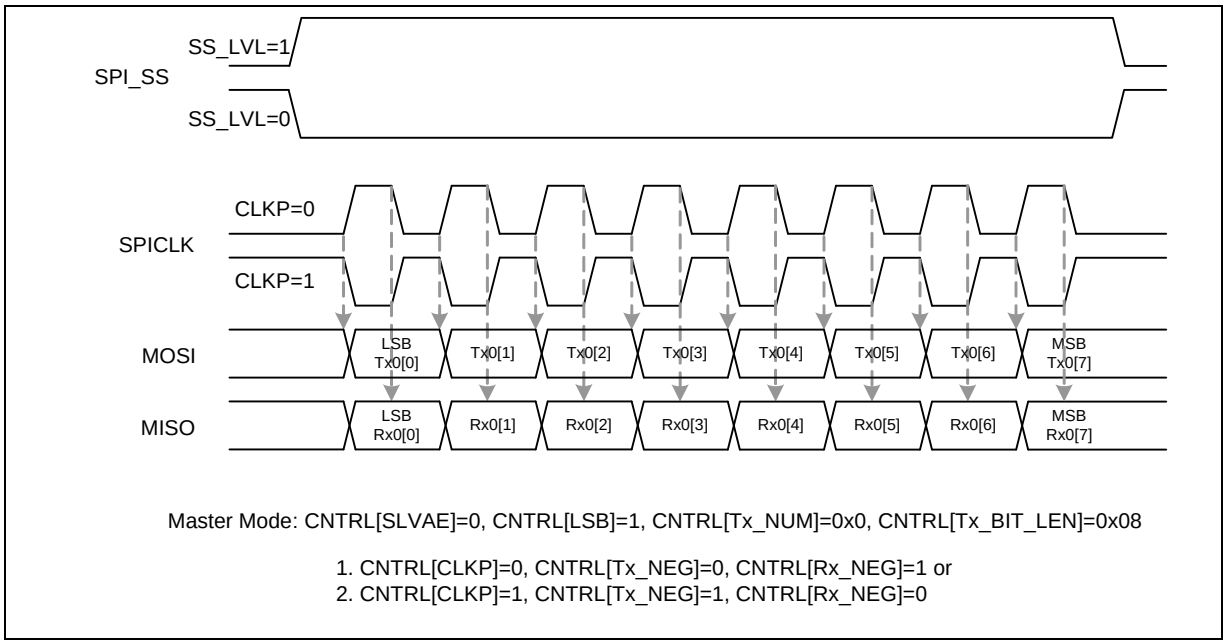
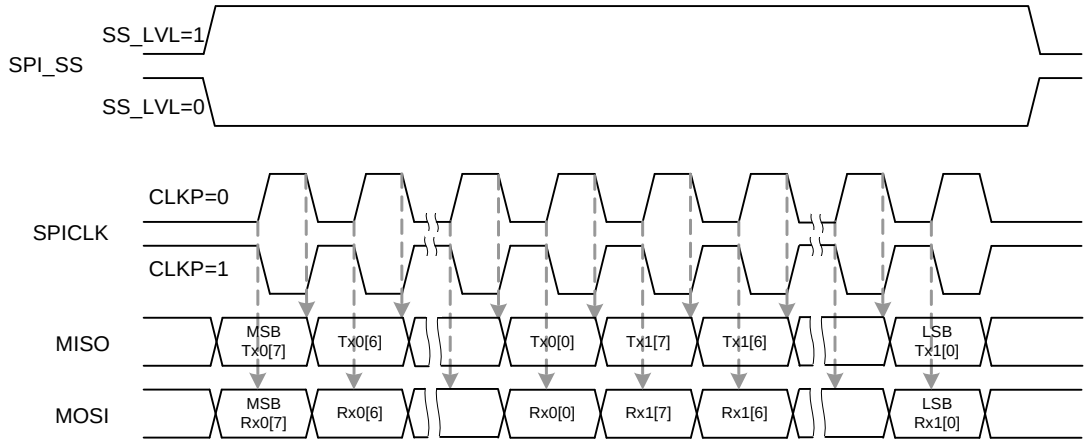


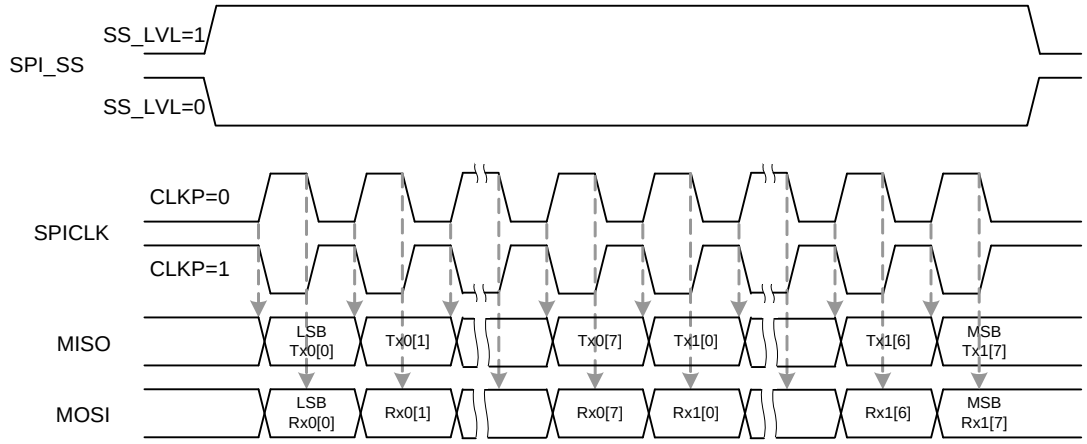
图 3 相位变化的 SCLK 时钟时序(主)



Slave Mode: CNTRL[SLVAE]=1, CNTRL[LSB]=0, CNTRL[Tx_NUM]=0x01, CNTRL[Tx_BIT_LEN]=0x08

1. CNTRL[CLKP]=0, CNTRL[Tx_NEG]=1, CNTRL[Rx_NEG]=0 or
2. CNTRL[CLKP]=1, CNTRL[Tx_NEG]=0, CNTRL[Rx_NEG]=1

图 4 MICROWIRE /SPI 时序(从)



Master Mode: CNTRL[SLVAE]=1, CNTRL[LSB]=1, CNTRL[Tx_NUM]=0x01, CNTRL[Tx_BIT_LEN]=0x08

1. CNTRL[CLKP]=0, CNTRL[Tx_NEG]=0, CNTRL[Rx_NEG]=1 or
2. CNTRL[CLKP]=1, CNTRL[Tx_NEG]=1, CNTRL[Rx_NEG]=0

图 5 相位变化的 SCLK 时钟时序 (从)

2 如何编程SPI

2.1 SPI的编程流程

1. 设置APBCLK[SPIx_EN]位使能SPIx时钟，设置IPRSTC2[SPIx_RST]位复位SPIx模块
2. 选择GPxMFP中SPIx_SS0, SPIx_CLK, SPI0_MISOx 和 SPIx_MOSI0 使能复用脚的SPI接口
3. 设置SPI_DIVIDER寄存器中的值,定义SPIx时钟= HCLK/(DIVIDER+1).
4. 设置CNTRL寄存器SLAVE位定义主/从模式，然后设置LSB, CLKP, TX_NEG 和RX_NEG 定义SPI的时序
5. 设置SSR寄存器中ASS, SS_LVL以及SSR位定义SPIx_SS引脚状态

2.2 示例代码

2.2.1 AD7793.c

此代码支持两种SPI操作模式，如果定义了SPI_EN_ASS，自动从选择模式可以在设置SPx->CNTRL.GO_BUSY位后自动使能或禁止SPI_SS脚，或者在手动从选择模式下，SPI_SS脚被SPIx->SSR.SSR控制

```
#include <stdio.h>
#include "NUC1xx.h"
#include "AD7793.h"

// Define AD7793 register size and mode (read/write)
REGISTER_TYPE AD7793_REG[ALL_REGS]={
  {8, REG_RD},                          // Status Reg
  {16,REG_RD_WR},                         // Mode Reg
  {16,REG_RD_WR},                         // Configuration Reg
  {24,REG_RD},                          // Data Reg
  {8, REG_RD},                          // ID Reg
  {8, REG_RD_WR},                         // IO Reg
  {24,REG_RD_WR},                         // Offset Reg
  {24,REG_RD_WR},                         // Full-Scale Reg
};

#ifdef SPI_EN_ASS
/*---------------------------------------------------------------------------------------------------------*/
/* Enable automatic slave select                                       */
/*---------------------------------------------------------------------------------------------------------*/
// Initialize required GPIO ports and SPI interface
```

```
void  InitSPI(void)
{
        /* Step 1. Enable and Select SPI clock source*/
        SYSCLK->APBCLK.SPI0_EN  =1;
        SYS->IPRSTC2.SPI0_RST   =1;
        SYS->IPRSTC2.SPI0_RST   =0;

        /* Step 2. GPIO initial */
        SYS->GPCMFP.SPI0_SS0      =1;
        SYS->GPCMFP.SPI0_CLK      =1;
        SYS->GPCMFP.SPI0_MISO0    =1;
        SYS->GPCMFP.SPI0_MOSI0    =1;

        /* Step 3. Set SCLK */
        SPI0->DIVIDER.DIVIDER=4;    //HCLK/(DIVIDER+1) = 22.1184Mhz/(4+1) = 4.42568Mhz

        /* Step 4. Select Operation mode */
        SPI0->CNTRL.SLAVE = 0;      //Master mode

        SPI0->CNTRL.LSB = 0;        //MSB
//      SPI0->CNTRL.TX_BIT_LEN = 8; //Length:8 bit

        SPI0->CNTRL.CLKP = 1;       //SCLK idle high
        SPI0->CNTRL.TX_NEG = 1;     //Change SDO on falling edge of SCLK
        SPI0->CNTRL.RX_NEG = 0;     //Latch SDI on rising edge of SCLK

        SPI0->SSR.ASS = 1;          //Disable automatic slave select
        SPI0->SSR.SS_LVL = 0;       //SS low active
        SPI0->SSR.SSR = 1;          //SPI0_SS0
}


void  wAD7793(uint8_t RegAdr,uint32_t RegData)
{
```

```
  while(SPI0->CNTRL.GO_BUSY);                  //Check busy
  SPI0->CNTRL.TX_BIT_LEN = 8 + AD7793_REG[RegAdr].len;  //Set length of TX and RX
  SPI0->TX[0] = (RS(RegAdr)<<AD7793_REG[RegAdr].len) + RegData; //Store data into TX buffer
  SPI0->CNTRL.GO_BUSY=1;                       //Start TX and RX
}
uint32_t rAD7793(uint8_t RegAdr)
{
  while(SPI0->CNTRL.GO_BUSY);                  //Check busy
  SPI0->CNTRL.TX_BIT_LEN = 8 + AD7793_REG[RegAdr].len;  //Set length of TX and RX
  SPI0->TX[0] = (RW + RS(RegAdr))<<AD7793_REG[RegAdr].len;//Store data into TX buffer
  SPI0->CNTRL.GO_BUSY=1;                       //Start TX and RX

  while(SPI0->CNTRL.GO_BUSY);                  //Check busy
  return SPI0->RX[0]&((1<<AD7793_REG[RegAdr].len)-1);
}

void ResetAD7793(void)
{
  while(SPI0->CNTRL.GO_BUSY);         //Check busy
  SPI0->CNTRL.TX_BIT_LEN = 0;         //Set length for 32 bits
  SPI0->TX[0] = 0xFFFFFFFF;           //MOSI keep high
  SPI0->CNTRL.GO_BUSY=1;              //Start TX and RX
}
#else
/*---------------------------------------------------------------------------------------------------------*/
/* Disable automatic slave select                                        */
/*---------------------------------------------------------------------------------------------------------*/
void  InitSPI(void)
{
        /* Step 1. Enable and Select SPI clock source*/
        SYSCLK->APBCLK.SPI0_EN  =1;
        SYS->IPRSTC2.SPI0_RST   =1;
        SYS->IPRSTC2.SPI0_RST   =0;
```

```
        /* Step 2. GPIO initial */
        SYS->GPCMFP.SPI0_SS0      =1;
        SYS->GPCMFP.SPI0_CLK      =1;
        SYS->GPCMFP.SPI0_MISO0    =1;
        SYS->GPCMFP.SPI0_MOSI0    =1;

        /* Step 3. Set SCLK */
        SPI0->DIVIDER.DIVIDER     =4;//HCLK/(DIVIDER+1)     =     22.1184Mhz/(4+1)     =
4.42568Mhz

        /* Step 4. Select Operation mode */
        SPI0->CNTRL.SLAVE = 0;              //Master mode

        SPI0->CNTRL.LSB = 0;        //MSB
//      SPI0->CNTRL.TX_BIT_LEN = 8; //Length:8 bit

        SPI0->CNTRL.CLKP = 1;       //SCLK idle high
        SPI0->CNTRL.TX_NEG = 1;     //Change SDO on falling edge of SCLK
        SPI0->CNTRL.RX_NEG = 0;     //Latch SDI on rising edge of SCLK

        SPI0->SSR.ASS = 0;          //Disable automatic slave select
        SPI0->SSR.SS_LVL = 0;       //SS low active
//      SPI0->SSR.SSR = 1;          //SPI0_SS0
}


void  wAD7793(uint8_t RegAdr,uint32_t RegData)
{
  SPI0->SSR.SSR = 1;                                        //SPI0_SS0 active
  SPI0->CNTRL.TX_BIT_LEN = 8 + AD7793_REG[RegAdr].len;  //Set length of TX and RX
  SPI0->TX[0] = (RS(RegAdr)<<AD7793_REG[RegAdr].len) + RegData; //Store data into TX buffer
  SPI0->CNTRL.GO_BUSY=1;                                //Start TX and RX
  while(SPI0->CNTRL.GO_BUSY);                               //Check busy
  SPI0->SSR.SSR = 0;                                        //SPI0_SS0 inactive
}
```

```
uint32_t rAD7793(uint8_t RegAdr)
{
  SPI0->SSR.SSR = 1;                                          //SPI0_SS0 active
  SPI0->CNTRL.TX_BIT_LEN = 8 + AD7793_REG[RegAdr].len;  //Set length of TX and RX
  SPI0->TX[0] = (RW + RS(RegAdr))<<AD7793_REG[RegAdr].len;//Store data into TX buffer
  SPI0->CNTRL.GO_BUSY=1;                                      //Start TX and RX

  while(SPI0->CNTRL.GO_BUSY);                                 //Check busy
  SPI0->SSR.SSR = 0;                                          //SPI0_SS0 inactive

  return SPI0->RX[0]&((1<<AD7793_REG[RegAdr].len)-1);
}

void ResetAD7793(void)
{
  SPI0->SSR.SSR = 1;                  //SPI0_SS0 active
  SPI0->CNTRL.TX_BIT_LEN = 0;         //Set length for 32 bits
  SPI0->TX[0] = 0xFFFFFFFF;     //MOSI keep high
  SPI0->CNTRL.GO_BUSY=1;              //Start TX and RX
  while(SPI0->CNTRL.GO_BUSY);         //Check busy
  SPI0->SSR.SSR = 0;                  //SPI0_SS0 inactive
}
#endif
```

2.2.2 Smpl_SPI.c

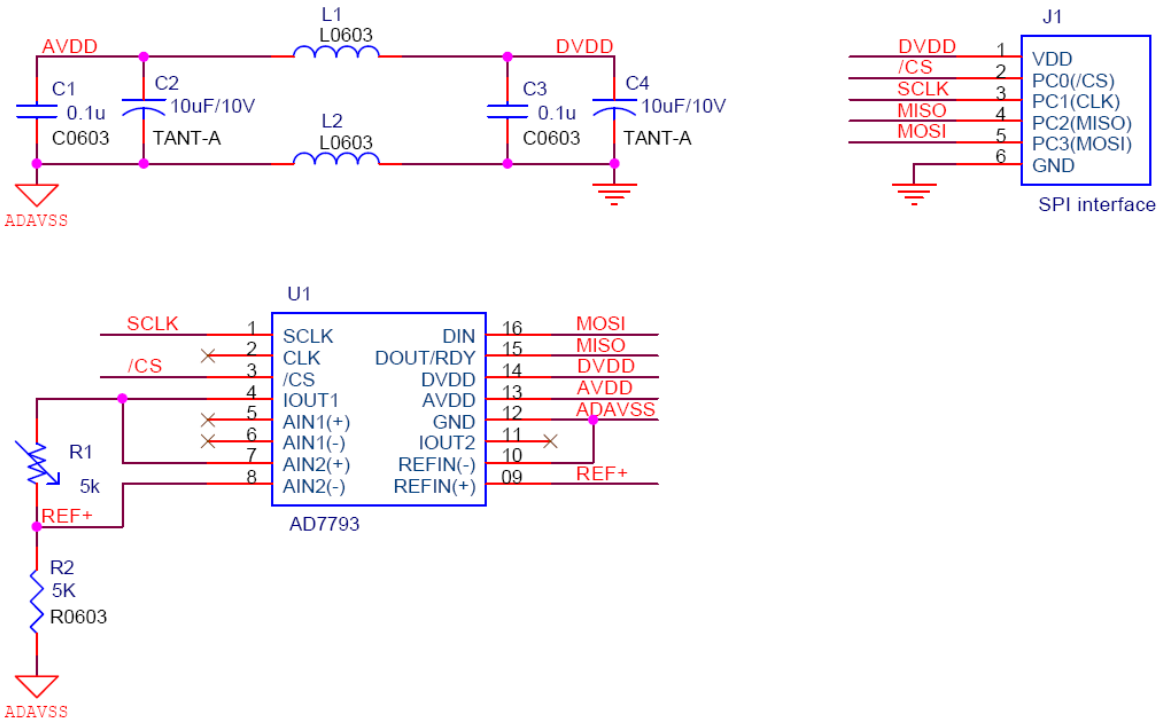
查询AD7793状态并显示ADC结果

```
#include <stdio.h>
#include "NUC1xx.h"
#include "AD7793.h"



void InitUART(void)
{
        /* Step 1. Enable and Select UART clock source*/
```

```
    UNLOCKREG();
    SYSCLK->PWRCON.XTL12M_EN = 1;
    LOCKREG();

    SYSCLK->APBCLK.UART0_EN = 1;//Enable UART clock
    SYSCLK->CLKSEL1.UART_S = 0;     //Select external 12Mhz for UART clock source

    SYSCLK->CLKDIV.UART_N = 0;      //UART clock source = 12Mhz;

    /* Step 2. GPIO initial */
    SYS->GPBMFP.UART0_RX    =1;
    SYS->GPBMFP.UART0_TX    =1;

    /* Step 3. Set BaudRate */
    UART0->BAUD.DIVX_EN = 1;
    UART0->BAUD.DIVX1   = 1;
    UART0->BAUD.DIV = 12000000 / 115200  -2;

    /* Step 4. Select Operation mode */
    UART0->FCR.TFR =1;              //Reset Tx FIFO
    UART0->FCR.RFR =1;              //Reset Rx FIFO

    UART0->FCR.RFITL = 0;//Set Rx Trigger Level -1byte FIFO
    UART0->LCR.PBE      = 0;//Disable parity
    UART0->LCR.WLS      = 3;//8 data bits
    UART0->LCR.NSB      = 0;//Enable 1 Stop bit
}

/*---------------------------------------------------------------------------
  MAIN function
  ---------------------------------------------------------------------------*/
int32_t main (void)
{
    InitUART();
    printf("\nUART initial ok\n");
```

```
        InitSPI();
        ResetAD7793();
        wAD7793(CONF_REG,0x0011);//Gain = 1, external reference, select AIN2(+)-AIN2(-)
        wAD7793(IO_REG,0x0A);          //Both current source connect to pin IOUT1. (200uA mode)
        printf("\n");
        printf("+---------------------------------------+\n");
        printf("|          AD7793 setting               |\n");
        printf("+---------------------------------------+\n");
        printf("|STAT_REG:%x\n",rAD7793(STAT_REG));
        printf("|MODE_REG:%x\n",rAD7793(MODE_REG));
        printf("|CONF_REG:%x\n",rAD7793(CONF_REG));
        printf("|ID_REG:%x\n",rAD7793(ID_REG));
        printf("|IO_REG:%x\n",rAD7793(IO_REG));
        printf("|OFFS_REG:%x\n",rAD7793(OFFS_REG));
        printf("|FUL_SC_REG:%x\n",rAD7793(FUL_SC_REG));
        printf("+---------------------------------------+\n");

        do
        {
                while(rAD7793(STAT_REG)&0x80);                  //Wait ADC data ready
                printf("DATA_REG:%x\n",rAD7793(DATA_REG));//print the result of ADC
                printf("Please press any key to update ADC, except \"ESC\".\n");
        }while(GetChar()!=0x1B);
        //Continuous or not

        printf("Exit\n");
}
```

3 电路图


L1
L0603
AVDD
DVDD
C1
0.1u
C0603
C2
10uF/10V
TANT-A
L2
L0603
C3
0.1u
C0603
C4
10uF/10V
TANT-A
ADAVSS
J1
DVDD
/CS
SCLK
MISO
MOSI
1
2
3
4
5
6
VDD
PC0(/CS)
PC1(CLK)
PC2(MISO)
PC3(MOSI)
GND
SPI interface
U1
SCLK
/CS
R1
5k
REF+
R2
5K
R0603
ADAVSS
SCLK
CLK
/CS
IOUT1
AIN1(+)
AIN1(-)
AIN2(+)
AIN2(-)
DIN
DOUT/RDY
DVDD
AVDD
GND
IOUT2
REFIN(-)
REFIN(+)
MOSI
MISO
DVDD
AVDD
ADAVSS
REF+
AD7793

4 修订历史

版本.	日期	描述
1.00	2010-3-1	1. 初次发布
1.01	2010-4-8	1. 移除寄存器描述

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