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DesignNews

PIC Microcontroller Embedded Development Using the CCS PIC MCU C Compiler

Day 5:

Coding a Winbond SpiFlash Driver Using CCS C

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Fred Eady

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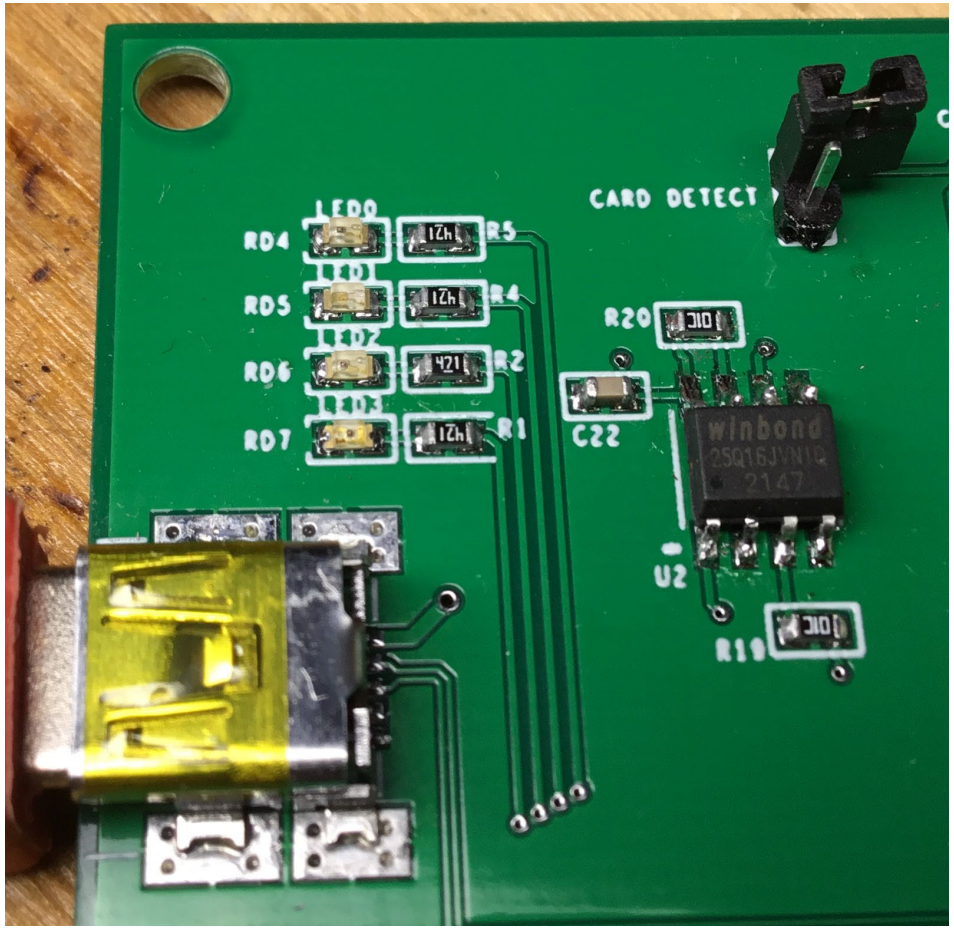
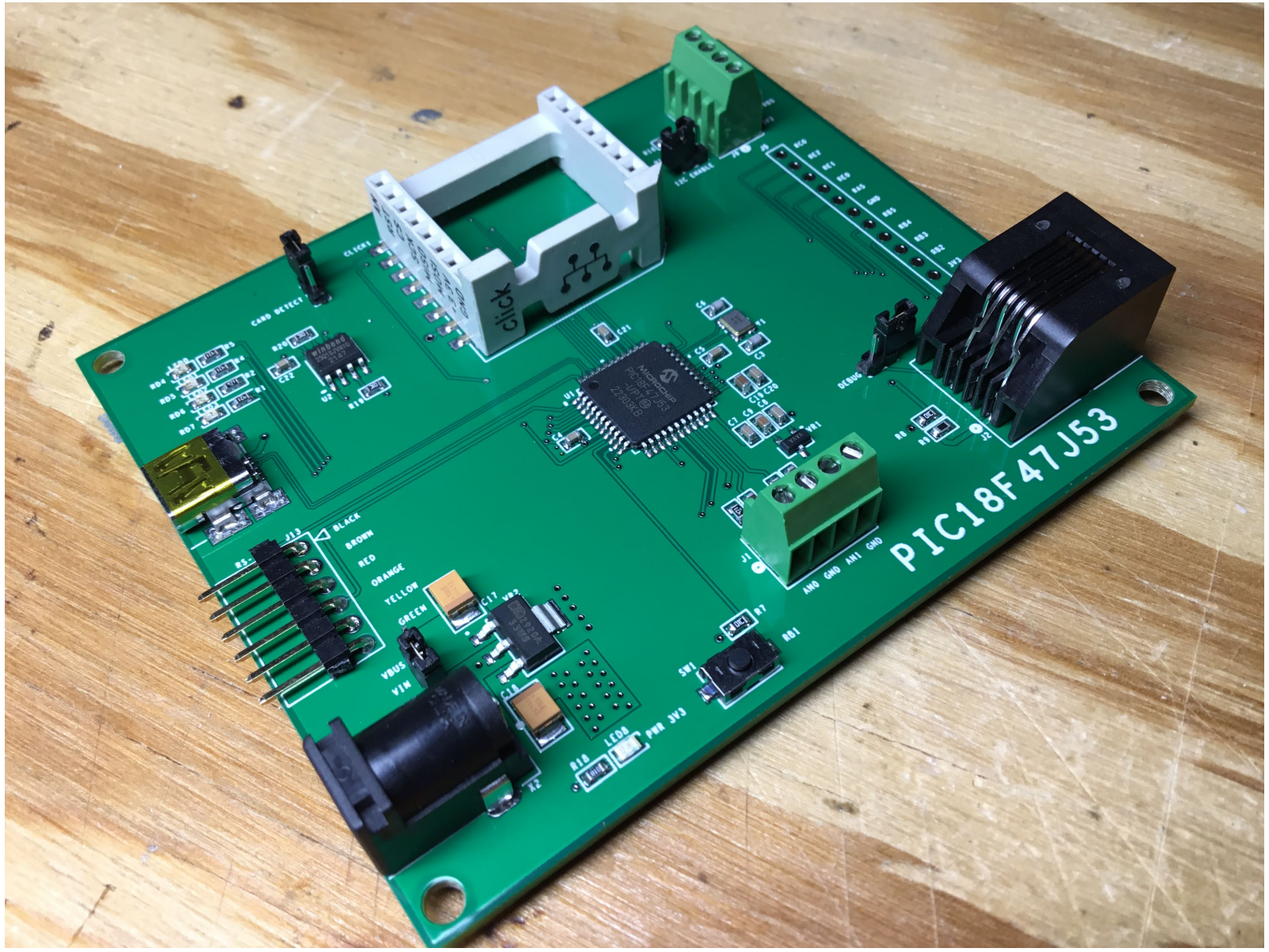
AGENDA

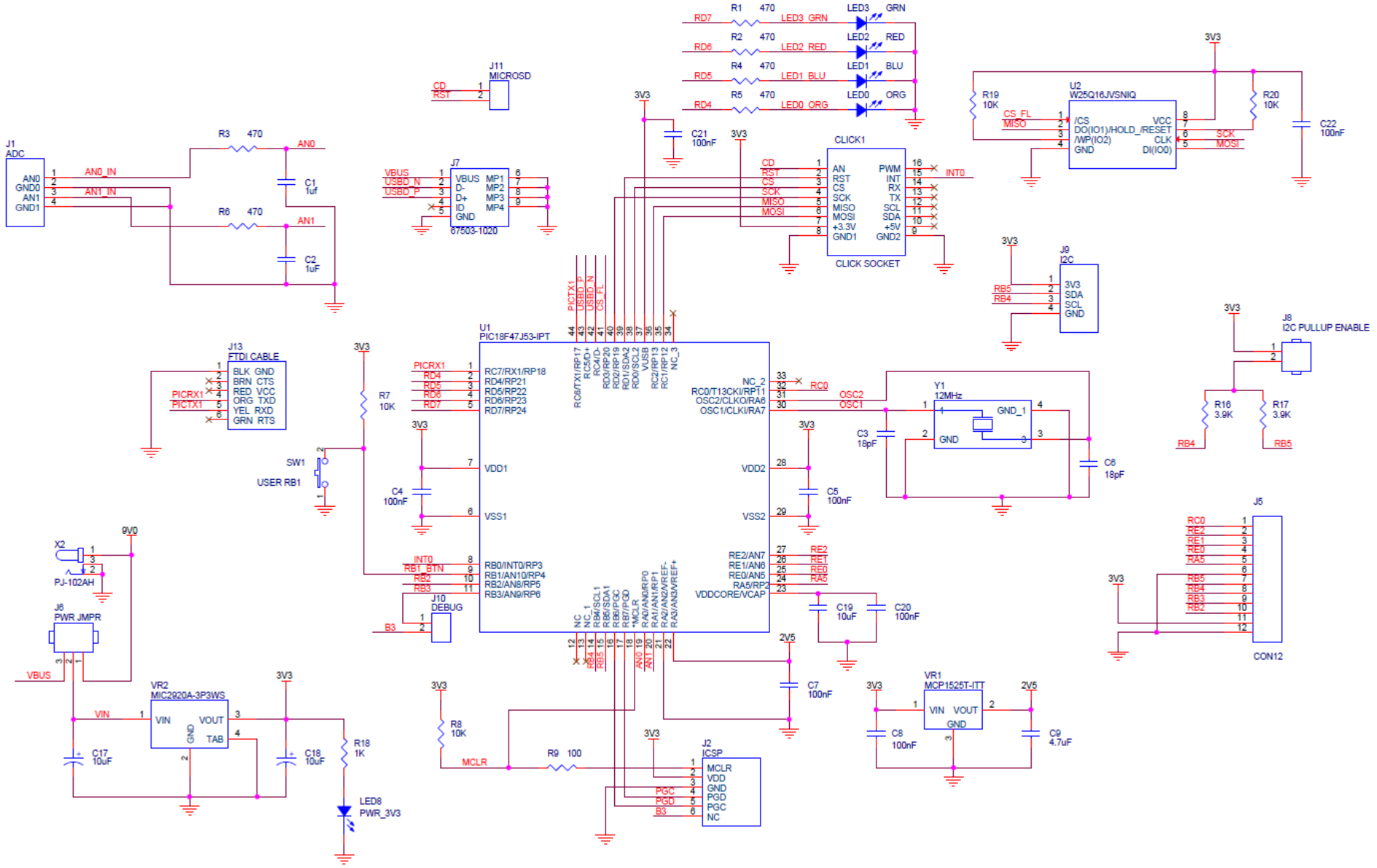
- SpiFlash Hardware
- Code the W25Q Driver
- Test the W25Q Driver



PIC18F47J53 Hardware



PIC18F47J53 Hardware



main.h

```
#include <18F47J53.h>
#device ADC=12

#FUSES NOWDT                    //No Watch Dog Timer
#FUSES SOSC_HIGH                //High-power SOSC circuit is selected
#FUSES DSWDTOSC_INT             //DSWDT uses INTRC as reference clock
#FUSES RTCOSC_T1                //RTCC uses Secondary Oscillator as reference source
#FUSES IOL1WAY                  //Allows only one reconfiguration of peripheral pins
#FUSES ADC12                    //ADC is 12-bits
#FUSES MSSPMSK7                 //MSSP uses 7 bit Masking mode
#FUSES WPFP                     //Write/Erase Protect Page Start/End Location, set to last page or use WPFP=x to set page
#FUSES WPDIS                    //All Flash memory may be erased or written
#FUSES WPEND                    //Flash pages WPFP to Configuration Words page are write/erase protected

#use delay(clock=48MHz,crystal=12MHz,USB_FULL)
#use FIXED_IO( D_outputs=PIN_D7,PIN_D6,PIN_D5,PIN_D4,PIN_D3,PIN_D2)

#define btnB1  PIN_B1
#define led0   PIN_D4
#define led1   PIN_D5
#define led2   PIN_D6
#define led3   PIN_D7
#define CS_FL  PIN_D3

#use rs232(baud=9600,parity=N,xmit=PIN_C6,rcv=PIN_C7,bits=8,stream=EUSART1)

#define USB_CONFIG_BUS_POWER 500
#include <usb_cdc.h>
```

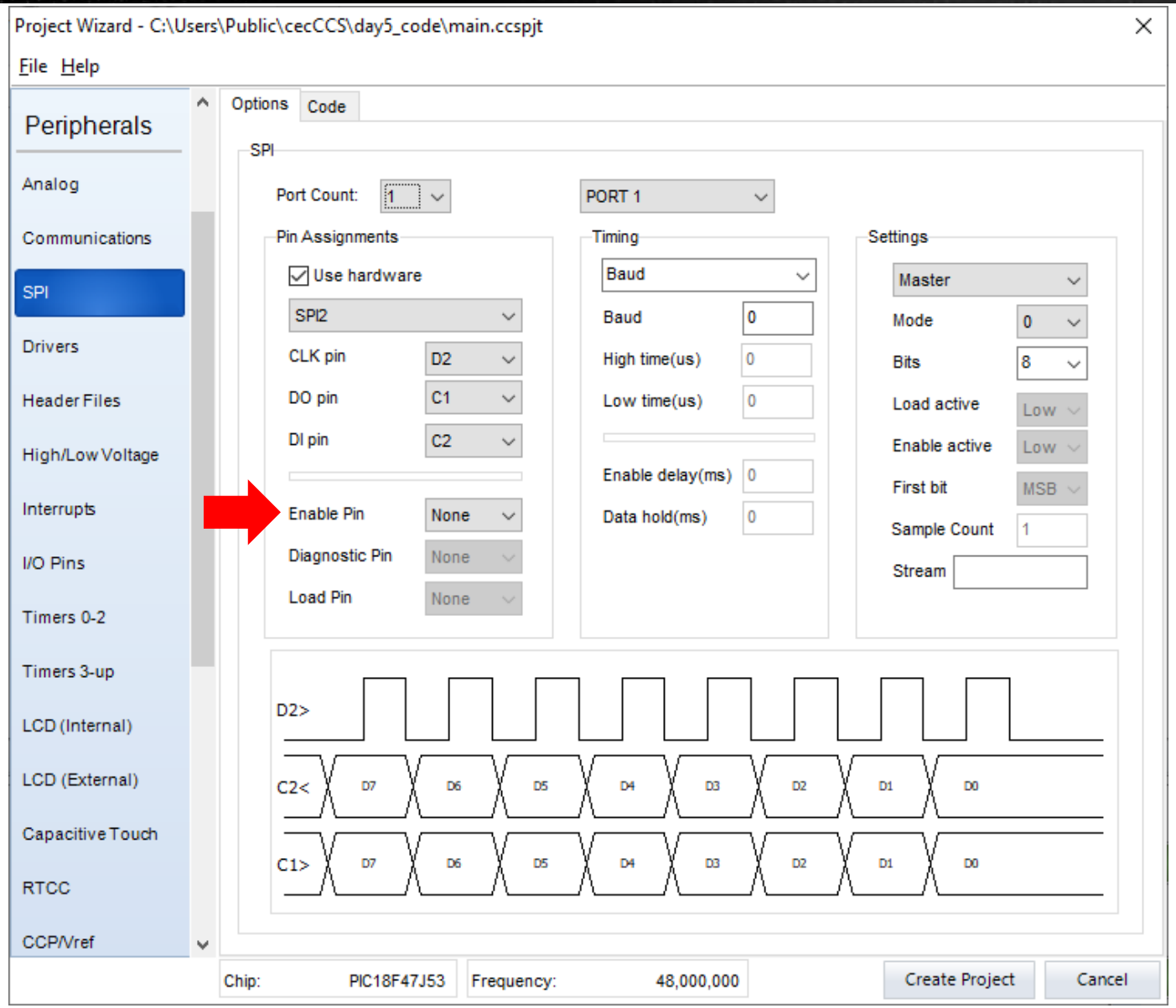
Function Prototypes

```
//*****************************************************************
//*   FUNCTION PROTOTYPES
//*****************************************************************
void readFlashByte(uint8_t hiAddr, uint8_t midAddr, uint8_t loAddr);
void writeFlashByte(uint8_t hiAddr, uint8_t midAddr, uint8_t loAddr, uint8_t data);
void readBlock(uint8_t hiAddr, uint8_t midAddr, uint8_t loAddr, uint8_t *buffer, uint16_t len);
void writeBlock(uint8_t hiAddr, uint8_t midAddr, uint8_t loAddr, uint8_t *buffer, uint16_t len);
void eraseBulk(void);
void readStatusReg1(void);
void readStatusReg2(void);
void getJEDECID(void);
uint32_t getAddress(uint16_t size);
uint16_t sizeofStr(&inputStr);
uint32_t getCapacity(void);
uint32_t getMaxPage(void);

typedef struct
{
    BOOLEAN supported;
    BOOLEAN supportedMan;
    BOOLEAN sfdpAvailable;
    uint8_t manufacturerID;
    uint8_t memoryTypeID;
    uint8_t capacityID;
    uint32_t capacity;
    uint32_t eraseTime;
}chipID;
chipID chip;
```

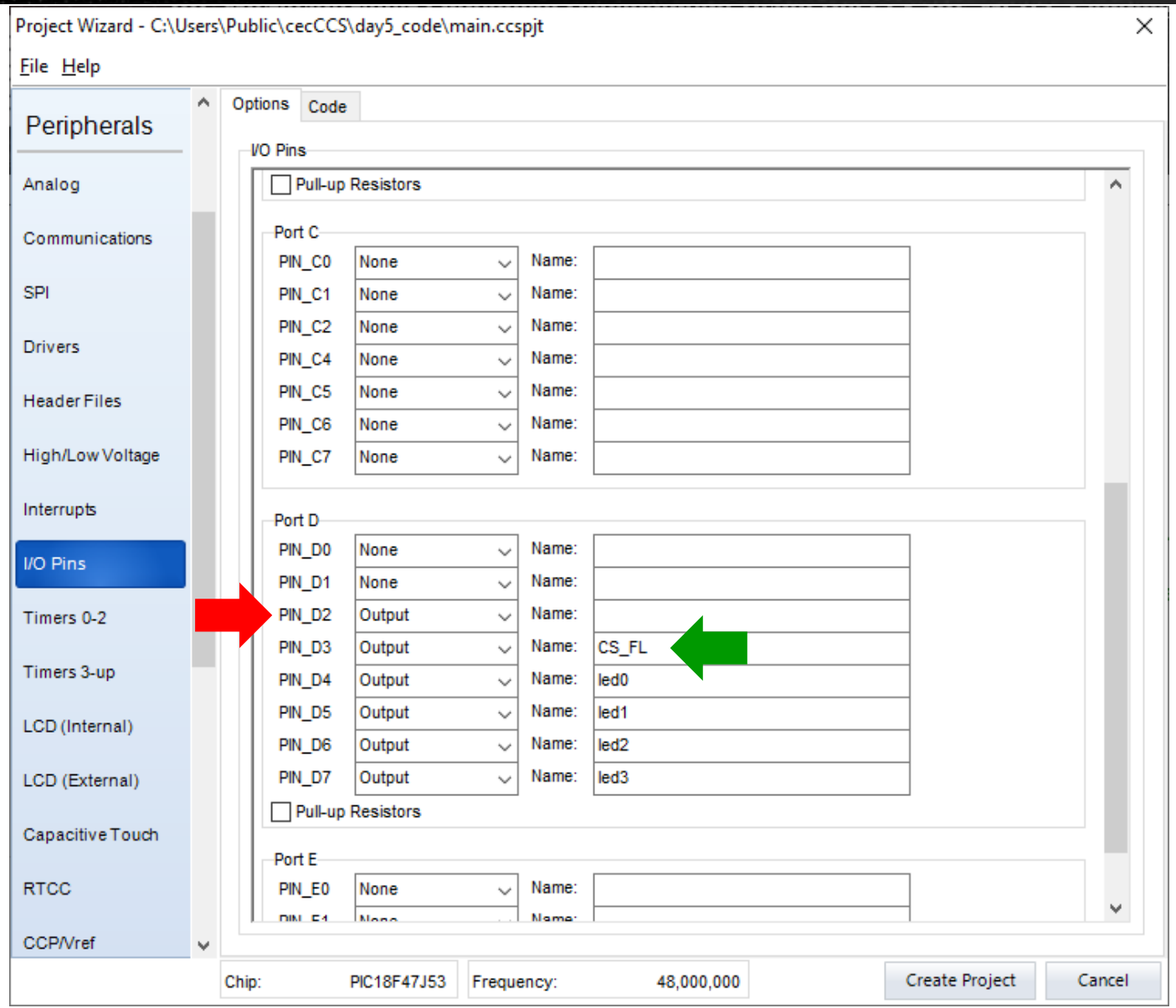
SRAM Variables

```
//*****************************************************************
//*   SRAM VARIABLES
//*****************************************************************
uint8_t scratch8;
uint16_t scratch16;

uint8_t tempVal;
uint8_t bufJEDEC[8];
uint8_t readbuf256[256];
uint8_t writebuf256[256];
uint8_t flashdata;
uint8_t eraseCmd;

uint32_t  currentAddress;
uint8_t   statusRegister1;
uint8_t   statusRegister2;
```

SPI Definitions

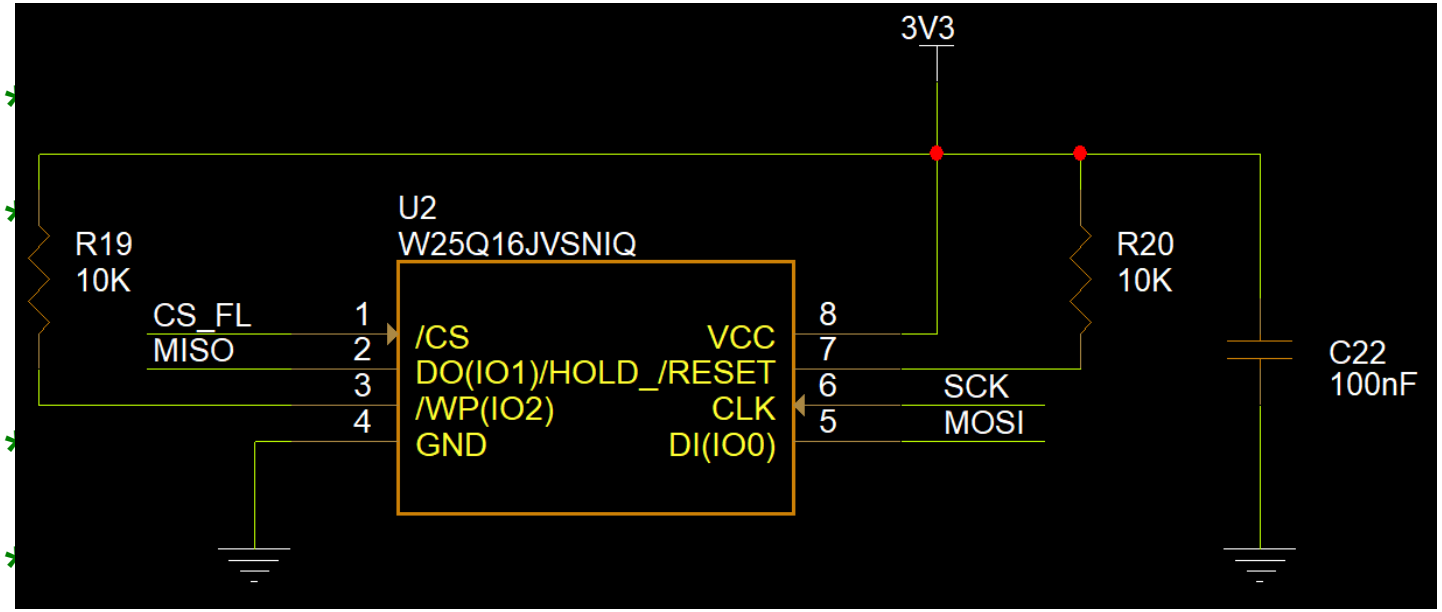


SPI Definitions



SPI Definitions

```
//*****************************************
//*   SPI PIN SELECT DEFINITIONS
//*****************************************
#pin_select SCK2=PIN_D2
#pin_select SDI2=PIN_C2
#pin_select SDO2=PIN_C1
//*****************************************
//*   I/O MACROS AND ALIASES
//*****************************************
#define selectFlash output_low(CS_FL)
#define deselectFlash output_high(CS_FL)

#use spi (MASTER, SPI2, MODE=0, BITS=8, STREAM=spiflash)
```



Commands

```
//*****************************************************************
//*   COMMANDS
//*****************************************************************
#define MANID          0x90
#define PAGEPROG       0x02
#define READDATA       0x03
#define FASTREAD       0x0B
#define WRITEDISABLE   0x04
#define READSTAT1      0x05
#define READSTAT2      0x35
#define READSTAT3      0x15
#define WRITESTATEN    0x50
#define WRITESTAT1     0x01
#define WRITESTAT2     0x31
#define WRITESTAT3     0x11
#define WRITEENABLE    0x06
#define ADDR4BYTE_EN   0xB7
#define ADDR4BYTE_DIS  0xE9
#define SECTORERASE    0x20
#define BLOCK32ERASE   0x52
#define BLOCK64ERASE   0xD8
#define CHIPERASE      0x60
#define ALT_CHIPERASE  0xC7    // Some flash chips use a different chip erase command
#define SUSPEND        0x75
#define ID             0x90
#define RESUME         0x7A
#define JEDECID        0x9F
#define POWERDOWN      0xB9
#define RELEASE        0xAB
#define READSFDP       0x5A
#define UNIQUEID       0x4B
#define FRAMSERNO      0xC3

#define NOTBUSY        0x00
#define BUSY           0x01
#define WRTEN          0x02
```

Manufacturer IDs

```
// MANUFACTURER IDs
#define microchipID 0xBF
#define winbondID   0xEF
#define cypressID   0x01
```

Read Status Register 1

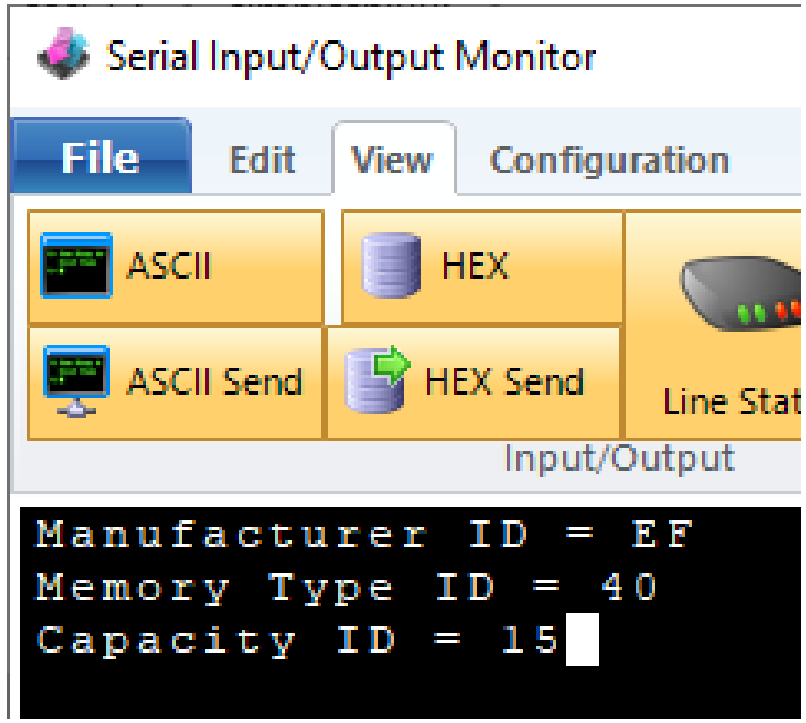
```
//*****************************************************************
//*   READ STATUS REGISTER 1
//*   Returns contents of Status Register 1 in statusRegister1
//*****************************************************************
void readStatusReg1(void)
{
    selectFlash;
    spi_xfer(READSTAT1);
    statusRegister1 = spi_xfer(0);
    deselectFlash;
}
```

Read W25Q16JV-IQ JEDEC ID

```
//*************************************************************
//*   READ FLASH JEDEC ID
//*************************************************************
void getJEDECID(void)
{
    uint8_t status;

    do{
    readStatusReg1();
    status = statusRegister1 & (BUSY | WRTEN);
    }while(status != NOTBUSY);

    selectFlash;
    spi_xfer(JEDECID);
    chip.manufacturerID = spi_xfer(0);    // manufacturer id
    chip.memoryTypeID = spi_xfer(0);      // memory type
    chip.capacityID = spi_xfer(0);        // capacity
    deselectFlash;
}
```

Read W25Q16V-IQ JEDEC ID

```
void main()
{
   deselectFlash();
   getJEDECID();
   printf("Manufacturer ID = %02X\r\nMemory Type ID = %02X\r\nCapacity ID = %02X",chip.manufacturerID,chip.memoryTypeID,chip.capacityID);
   while(1);
}
```



9.1 Device ID and Instruction Set Tables

9.1.1 *Manufacturer and Device Identification*

MANUFACTURER ID	(MF7 - MF0)	
Winbond Serial Flash	EFh	
Device ID	(ID7 - ID0)	(ID15 - ID0)
Instruction	ABh, 90h, 92h, 94h	9Fh
W25Q16JV-IQ/JQ	14h	4015h
W25Q16JV-IM*/JM*	14h	7015h

Bulk Erase Function

```
//*****************************************************************
//*   BULK ERASE ENTIRE FLASH ARRAY
//*   THIS TAKES A BIT OF TIME...
//*****************************************************************
void eraseBulk(void)
{
    uint8_t status;

    fprintf(EUSART1,"\r\nBulk Erase Started \r\n");
    delay_ms(100);

    selectFlash;
    spi_xfer(WRITEENABLE);
    deselectFlash;

    selectFlash;
    switch(chip.manufacturerID)
    {
        case microchipID:
            spi_xfer(0xC7);
            break;
        case winbondID:
            spi_xfer(0x60);
            break;
        case cypressID:
            spi_xfer(0x60);
            break;
    }
    deselectFlash;

    do{
    readStatusReg1();
    status = statusRegister1 & (BUSY | WRTEN);
    }while(status != NOTBUSY);

    fprintf(EUSART1,"Bulk Erase Complete \r\n");
    delay_ms(100);
}
```

```
//*****************************************************************
//*   COMMANDS
//*****************************************************************
#define MANID          0x90
#define PAGEPROG       0x02
#define READDATA       0x03
#define FASTREAD       0x0B
#define WRITEDISABLE   0x04
#define READSTAT1      0x05
#define READSTAT2      0x35
#define READSTAT3      0x15
#define WRITESTATEN    0x50
#define WRITESTAT1     0x01
#define WRITESTAT2     0x31
#define WRITESTAT3     0x11
#define WRITEENABLE    0x06
#define ADDR4BYTE_EN   0xB7
#define ADDR4BYTE_DIS  0xE9
#define SECTORERASE    0x20
#define BLOCK32ERASE   0x52
#define BLOCK64ERASE   0xD8
#define CHIPERASE      0x60
#define ALT_CHIPERASE  0xC7    // Some flash chips use a different chip erase command
```

Write Block Function

```
//*************************************************************
//*   WRITE A BLOCK OF DATA TO FLASH
//*   flashAddr = 32-bit flash address
//*   len = number of bytes to write
//*   *buffer = array of data to write to flash
//*************************************************************
void writeBlock(uint32_t flashAddr, uint8_t *buffer, uint16_t len)
{
     uint16_t indx = 0;
     uint8_t status;

    selectFlash;
    spi_xfer(WRITEENABLE);
    deselectFlash;

    do{
    readStatusReg1();
    status = statusRegister1 & WRTEN;
    }while(status != WRTEN);

    selectFlash;
    spi_xfer(PAGEPROG);
    spi_xfer(High(flashAddr));
    spi_xfer(Mid(flashAddr));
    spi_xfer(Low(flashAddr));
    do{
        spi_xfer(buffer[indx++]);
    }while(indx < len);
    deselectFlash;
}
```

```
#define Low(param) ((char *)&param)[0] //0x000y
#define Mid(param) ((char *)&param)[1] //0x00y0
#define High(param) ((char *)&param)[2] //0x0y00
#define Highest(param) ((char *)&param)[3] //0xy000
#define Loww(param) ((int *)&param)[0] //0x00yy
#define Top(param) ((int *)&param)[1] //0xyy00
```

Read Block Function

```
//*****************************************************************
//*   READ A BLOCK OF DATA FROM FLASH
//*   flashAddr = 32-bit flash address
//*   len = number of bytes to read
//*   *buffer = array to store data read from flash
//*****************************************************************
void readBlock(uint32_t flashAddr, uint8_t *buffer, uint16_t len)
{
     uint8_t status;
     uint16_t indx = 0;

    do{
    readStatusReg1();
    status = statusRegister1 & (BUSY | WRTEN);
    }while(status != NOTBUSY);

    selectFlash;
    spi_xfer(READDATA);
    spi_xfer(High(flashAddr));
    spi_xfer(Mid(flashAddr));
    spi_xfer(Low(flashAddr));
    do{
        buffer[indx++] = spi_xfer(0);
    }while(indx < len);
    deselectFlash;
}
```

```
#define Low(param) ((char *)&param)[0] //0x000y
#define Mid(param) ((char *)&param)[1] //0x00y0
#define High(param) ((char *)&param)[2] //0x0y00
#define Highest(param) ((char *)&param)[3] //0xy000
#define Loww(param) ((int *)&param)[0] //0x00yy
#define Top(param) ((int *)&param)[1] //0xyy00
```

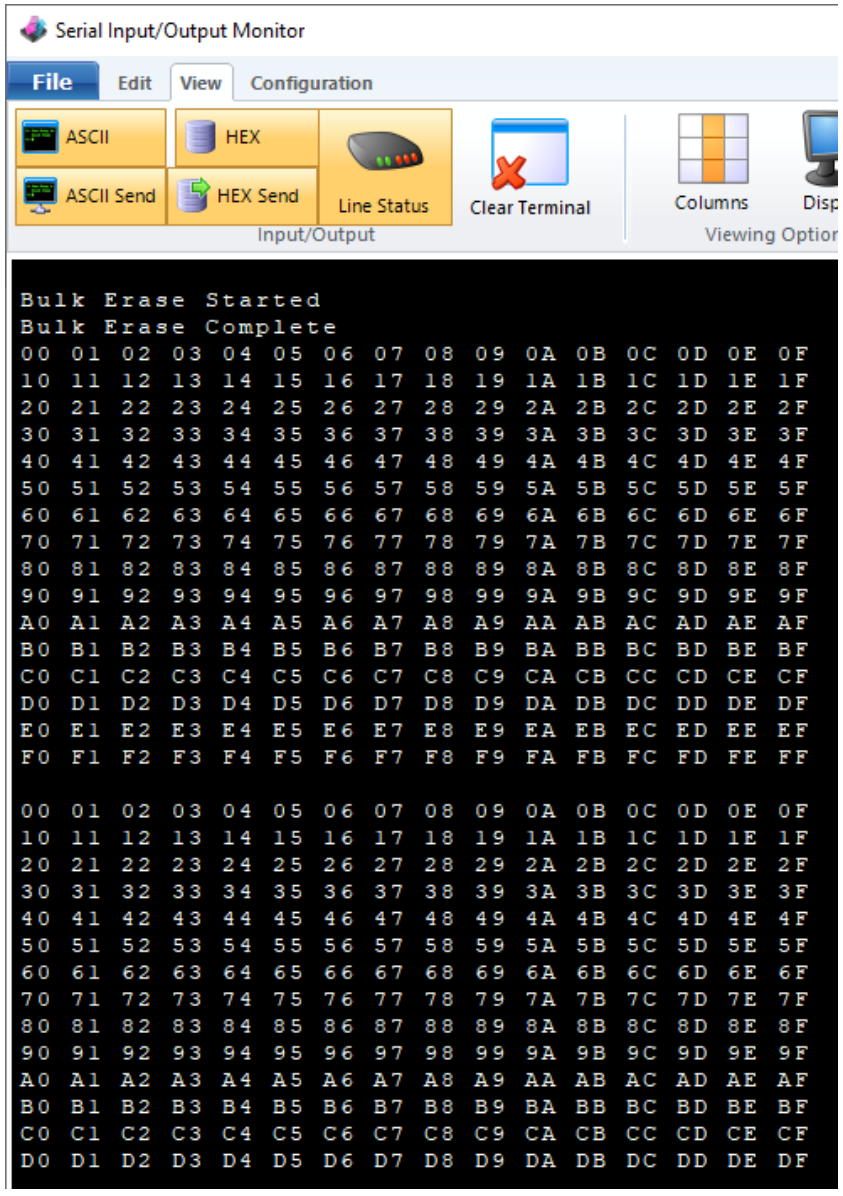
Initialize Function

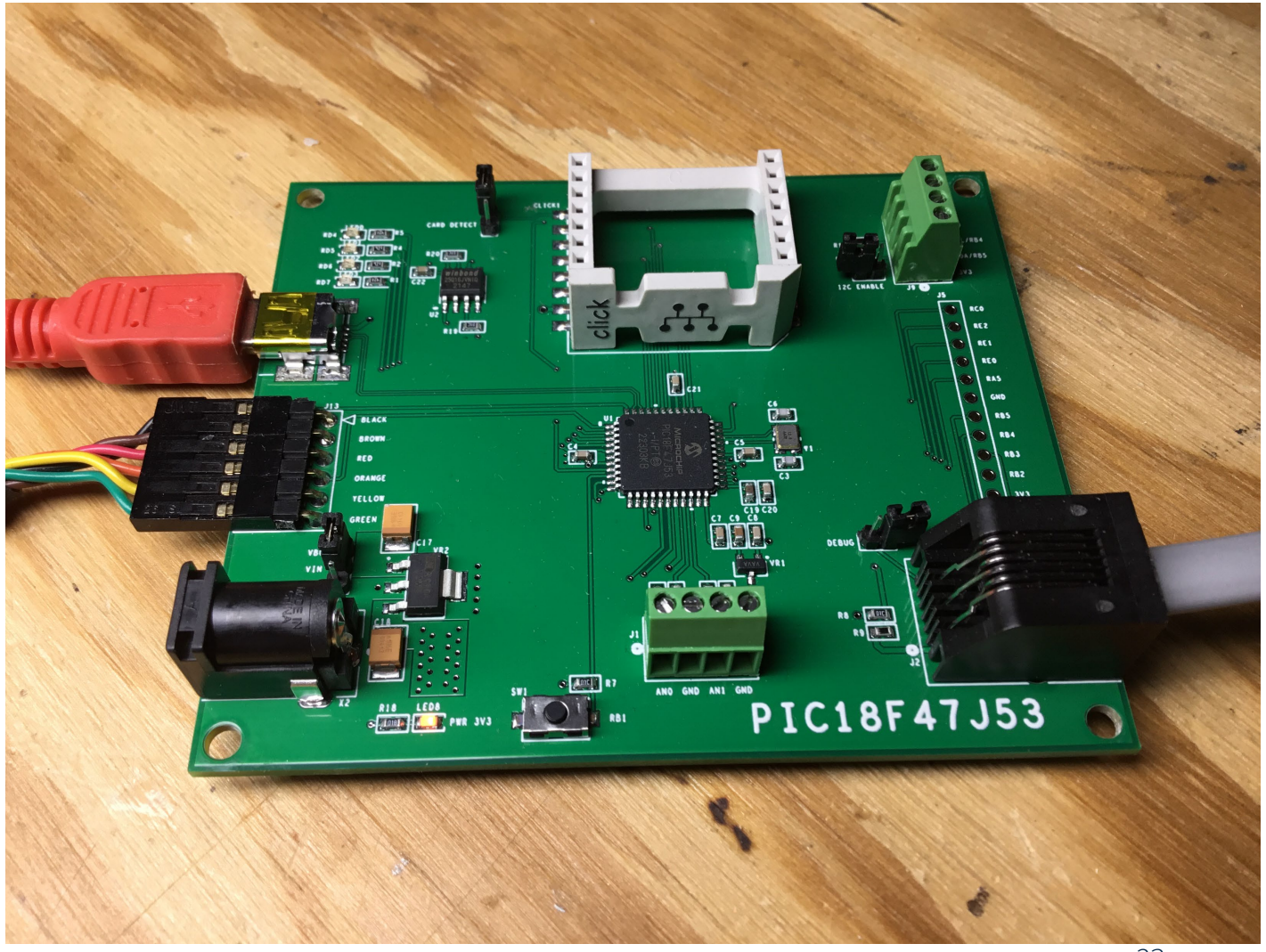
```
//*************************************************************
//*   INITIALIZE FUNCTION
//*************************************************************
void init(void)
{
    deselectFlash;
    delay_ms(100);

    setup_adc_ports(sAN1 | sAN0, VREF_VREF);
    setup_adc(ADC_CLOCK_INTERNAL | ADC_TAD_MUL_20);
    setup_spi(SPI_MASTER|SPI_XMIT_L_TO_H|SPI_CLK_DIV_64);

    //LOAD writebuf256 for testing
    scratch8 = 0x00;

    for(scratch16=0;scratch16<0x0100;scratch16++)
    {
        writebuf256[scratch16] = scratch8++;
    }

    usb_init();
    getJEDECID();
}
```

main Function

```
void main()
{
    uint16_t readbufindx,outerloop;
    init();
    eraseBulk();
    writeBlock(0x00000000,writebuf256,0x0100);
    readBlock(0x00000000,readbuf256,0x0100);
    readbufindx = 0x00;
    do{
        for(outerloop=0;outerloop<16;outerloop++)
        {
            for(scratch8=0;scratch8<16;scratch8++)
            {
                fprintf(EUSART1,"%2X ",readbuf256[readbufindx++]);
            }
            fprintf(EUSART1,"\r\n");
        }
        fprintf(EUSART1,"\r\n");
    delay_ms(500);
    readbufindx = 0x00;
    }while(1);

   while(TRUE)
   {
      //TODO: User Code
   }

}
```

Build and Run



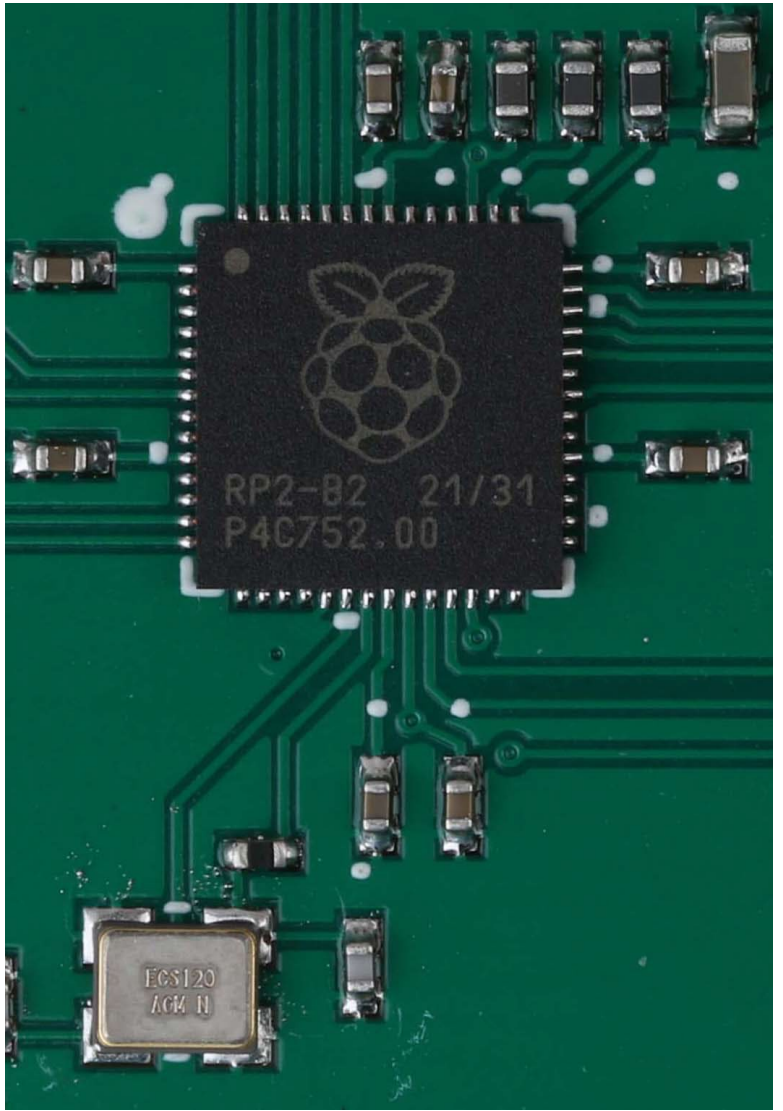


Thank you for attending!!!

Please consider the resources below:

- ccsinfo.com
- CCS C Compiler Manual
- Master and Command C for PIC MCU (PDF)

MORE TO COME..



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