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King Mongkut's University of Technology Thonburi

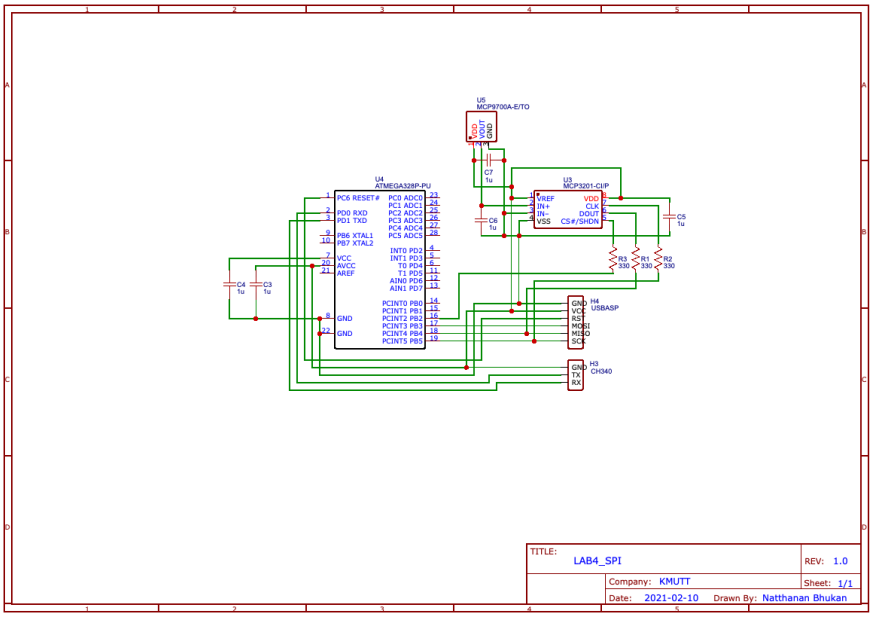
Faculty of Engineering, Department of Computer Engineering

CPE328 Embedded System, 2/2020

LAB Lecture 3: SPI Communication

Assign Date: 10 Feb 2021 Due Date: 16 Feb 2021

Schematic Diagram



Code

```c
#define F_CPU 8000000L

#include <avr/io.h>
#include <util/delay.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

#define CS PB2
#define CS_DDR DDB2
#define MOSI DDB3
#define CLK DDB5


void USART_Init(unsigned int ubrr) {
    UBRR0 = ubrr;
    UCSR0B |= (1 << RXEN0) | (1 << TXEN0);
    UCSR0C |= (1 << UCSZ01) | (1 << UCSZ00);
}

void USART_Transmit( unsigned char data ) {
    while ( !( UCSR0A & (1 << UDRE0)) );
    UDR0 = data;
}

void print(unsigned char *buffer) {
    for(int i=0; buffer[i] != 0; i++){
        USART_Transmit(buffer[i]);
    }
}
```

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```c
void SPI_Init()
{
    /* set MOSI CLK CS as Output*/
    DDRB |= (1 << CS_DDR) | (1 << CLK) | (1 << MOSI);
    // Chip select high
    PORTB |= (1 << CS);
    // Chip select low
    PORTB &= ~(1 << CS);
    /* Enable SPI, Master mode, clk/16 */
    SPCR |= (1 << SPE) | (1 << MSTR) | (1 << SPR0);
}
```

```c
uint16_t SPI_READ()
{
    uint16_t high_byte;
    uint16_t low_byte;
    uint16_t out_12bits;

    PORTB &= ~(1 << CS);                                    // Chip select low

    SPDR = 0xFF;                                            // put dummy byte in SPDR

    while(!(SPSR & (1<<SPIF)));                             // wait for SPIF high

    /*xx0[B11][B10][B9][B8][B7]*/
    high_byte = SPDR;                                       // copy SPDR out

    SPDR = 0xFF;                                            // put dummy byte in SPDR

    while(!(SPSR & (1<<SPIF)));                             // wait for SPIF high

    /*[B6][B5][B4][B3][B2][B1][B0][B1]*/
    low_byte = SPDR;                                        // copy SPDR out

    /*xx0[B11][B10][B9][B8][B7] 0   0   0   0   0   0   0    0 */
    /*                                                    OR */
    /*000 0     0    0   0  0  [B6][B5][B4][B3][B2][B1][B0][B1]*/
    /*--------------------------------------------------------*/
    /*xx0[B11][B10][B9][B8][B7][B6][B5][B4][B3][B2][B1][B0][B1]*/
    out_12bits = (high_byte << 8) | low_byte;               // Concatenate bit

    /*[B11][B10][B9][B8][B7][B6][B5][B4][B3][B2][B1][B0][B1]000*/
    out_12bits <<= 3;                                       // Shift left 3

    /*0000[B11][B10][B9][B8][B7][B6][B5][B4][B3][B2][B1][B0]*/
    out_12bits >>= 4;                                       // Shift right 4

    PORTB |= (1 << CS);                                     // Chip select high

    return out_12bits;
}
```

```c
int main(void) {

    USART_Init(53);                                         // SPI intial
    SPI_Init();                                             // USART initial

    uint16_t sensor;
    float temp;
    unsigned char text[] = "Temperature = ";
    unsigned char buffer[10];

    while (1) {
        sensor = SPI_READ();                                 // Read data from sensor
        temp = (((sensor/4096.0) * 5.0) - 0.5) * 100.0 ;     // Convert Analog value to temperature

        dtostrf(temp, 3, 2, buffer);                         // Convert Float to string
        strcat(buffer, " °C\n");                             // Concatenate unit

        print(text);                                         // Print First Text
        print(buffer);                                       // Print temperature and unit

        _delay_ms(1000);
    }
}
```

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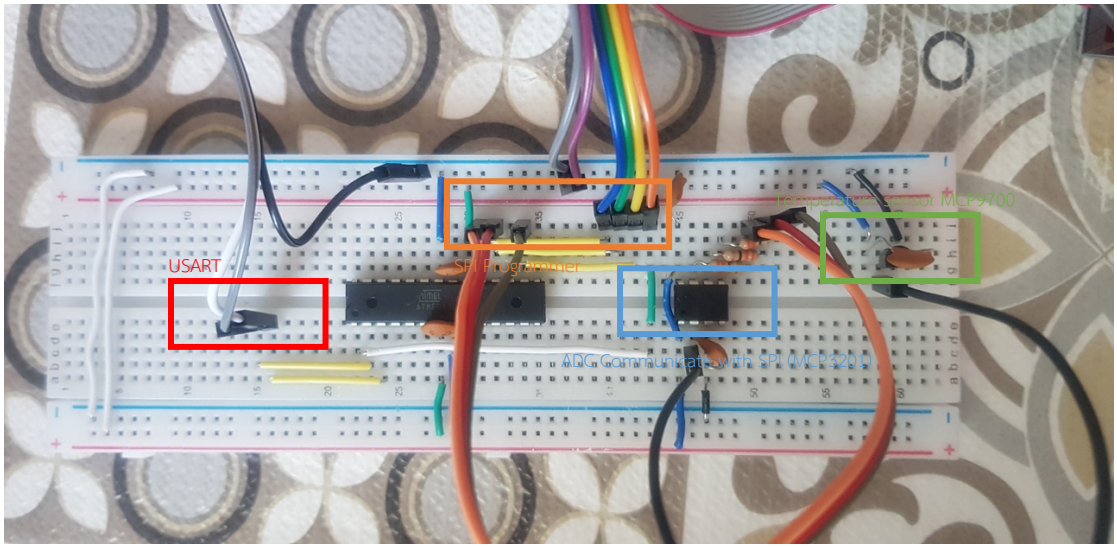
On board



Result