

LAB Lecture 3: SPI Communication

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

The schematic diagram illustrates the LAB4_SPI circuit. It features an ATmega328P-PU microcontroller (U4) connected to an MCP3201-CP converter (U5) and an MCP3202-AD converter (U6). The microcontroller's pins are connected to the converters' inputs and outputs. The MCP3201-CP is connected to an H4 USBASP interface (U7) and an H3 CH340 interface (U8). The MCP3202-AD is connected to an H4 USBASP interface (U9) and an H3 CH340 interface (U10). The circuit also includes a 10k pull-up resistor (R1) and a 10k pull-down resistor (R2). The power supply is connected to the VCC and GND pins of the microcontroller and the VDD and GND pins of the converters.

Pin	Signal	Component
1	PC6 RESET4	U4
2	PDD RXD	U4
3	PDS TXD	U4
4	PB6 XTAL1	U4
5	PB7 XTAL2	U4
6	VCC	U4
7	ADCC	U4
8	AREF	U4
9	GND	U4
10	GND	U4
11	PC0 ADC0	U4
12	PC1 ADC1	U4
13	PC2 ADC2	U4
14	PC3 ADC3	U4
15	PC4 ADC4	U4
16	PC5 ADC5	U4
17	INT0 PD2	U4
18	INT1 PD3	U4
19	TO PD4	U4
20	T2 PD5	U4
21	AIN0 PD6	U4
22	AIN1 PD7	U4
23	PCINT0 PB0	U4
24	PCINT1 PB1	U4
25	PCINT2 PB2	U4
26	PCINT3 PB3	U4
27	PCINT4 PB4	U4
28	PCINT5 PB5	U4
29	VDD	U5
30	GND	U5
31	INP	U5
32	OUT	U5
33	VSS	U5
34	CS	U5
35	VDD	U6
36	GND	U6
37	INP	U6
38	OUT	U6
39	VSS	U6
40	CS	U6
41	GND	U7
42	VCC	U7
43	AST	U7
44	MODE	U7
45	SC	U7
46	GND	U8
47	TX	U8
48	RX	U8
49	GND	U9
50	VCC	U9
51	AST	U9
52	MODE	U9
53	SC	U9
54	GND	U10
55	TX	U10
56	RX	U10

```
#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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 CPE328 Embedded System, 2/2020

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```
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);
}
```

```
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 0 0 *//
    /*                                OR */
    /*000 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;
}
```

```
int main(void)
{
    USART_Init(53);                // SPI initial
    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);
    }
}
```

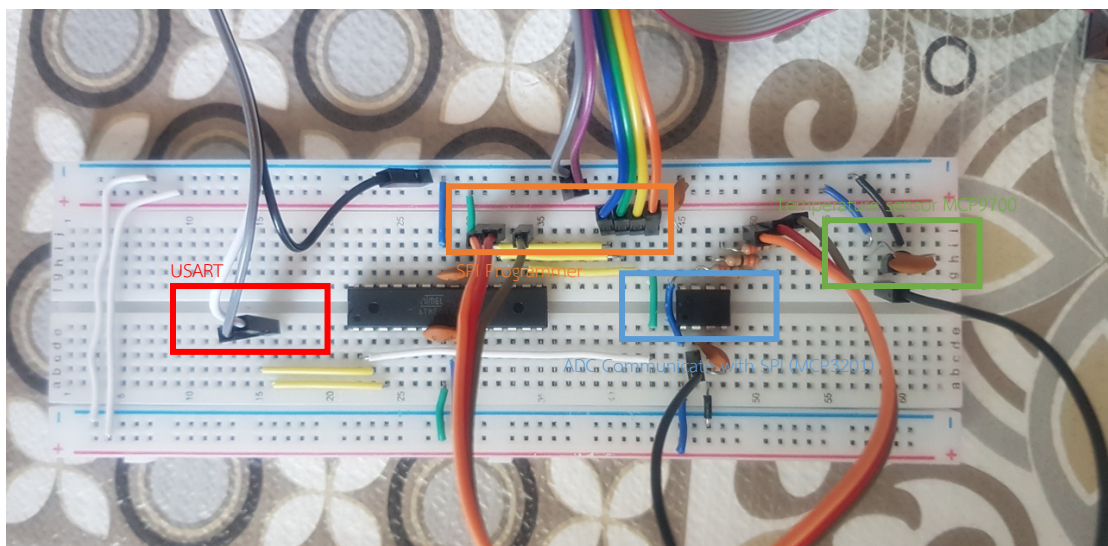


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On board



Result

