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CPE301 – SPRING 2018

Design Assignment 4

DO NOT REMOVE THIS PAGE DURING SUBMISSION:

The student understands that all required components should be submitted in complete for grading of this assignment.

NO	SUBMISSION ITEM	COMPLETED (Y/N)	MARKS (/MAX)
1	COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS		
2.	INITIAL CODE OF TASK 1/A		
3.	INCREMENTAL / DIFFERENTIAL CODE OF TASK 2/B		
3.	INCREMENTAL / DIFFERENTIAL CODE OF TASK 3/C		
3.	INCREMENTAL / DIFFERENTIAL CODE OF TASK 4/D		
3.	INCREMENTAL / DIFFERENTIAL CODE OF TASK 5/E		
4.	SCHEMATICS		
5.	SCREENSHOTS OF EACH TASK OUTPUT		
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6.	VIDEO LINKS OF EACH DEMO		
7.	GOOGLECODE LINK OF THE DA		

1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS

Disclaimer: My partner for this assignment is Nathan Hanuscin

- Atmega328P x 2
- FTDI x 2
- NRF24l01 x 2
- One LM34
- Jumper cables

2. CODE FOR RECEIVER

```
#define F_CPU 8000000UL
#include <avr/io.h>
#include <util/delay.h>
#include <string.h>
#include <stdbool.h>
#include <stdio.h>
#include <avr/interrupt.h>
#include "nrf24l01.h"

volatile bool rf_interrupt = false;


// Set up all of the SPI ports with the nRF struct and turn on int0 interrupt
nRF24L01 *setup_rf(void){
	nRF24L01 *rf = nRF24L01_init();
	rf->ss.port = &PORTB;
	rf->ss.pin = PB2;
	rf->ce.port = &PORTB;
	rf->ce.pin = PB1;
	rf->sck.port = &PORTB;
	rf->sck.pin = PB5;
	rf->mosi.port = &PORTB;
	rf->mosi.pin = PB3;
	rf->miso.port = &PORTB;
	rf->miso.pin = PB4;
	EICRA |= _BV(ISC01);
	EIMSK |= _BV(INT0);		// turn on int0 interrupt
	nRF24L01_begin(rf);
	return rf;
}

void spi_init() {
	DDRB &= ~((1<<2)|(1<<3)|(1<<5));   //SCK, MOSI and SS as inputs
	DDRB |= (1<<4);      // MISO as output
	SPCR &= !(1<<MSTR);    // set as slave
	SPCR |= (1<<SPR0)|(1<<SPR1);   // divide clock by 128
	SPCR |= (1<<SPE);        // enable SPI
}

void init_uart(){
	// setting the baud rate  based on FCPU and baudrate
	UBRR0H =0x00;
	UBRR0L =0x0C;
	// enabling TX & RX
	UCSR0B = (1<<RXEN0)|(1<<TXEN0);			// enable receive and transmit
	UCSR0A = (1<<UDRE0)|(1<<U2X0);
```

```
       UCSR0C =  (1 << UCSZ01) | (1 << UCSZ00);    // Set frame: 8data, 1 stop

}

void ADC_init() {
       ADMUX = 0;                  // read from port ADC0
       ADMUX |= (1<<REFS0);        // use Vcc for reference
       ADCSRA |= (1<<ADPS2) | (1<<ADPS1); // prescalar of 64
       ADCSRA |= (1<<ADEN);        // enable ADC
       ADCSRB = 0;                 // free running mode
}

void USART_Transmit( char *data)
{
       while((*data != '\0')) {    // transmits all chars but null
              while(!(UCSR0A & (1<<UDRE0)));  // waits for transmit flag to clear
              UDR0 = *data;           // transmit next char
              data++;                 // move to next char
       }
}

unsigned int readADC()
{
       ADMUX &= ~(1<<ADLAR);               // clear the adc value
       unsigned int val = 0;
       ADCSRA |= (1 << ADSC);              // start adc
       while(ADCSRA & (1<<ADSC));          // wait until adc is done

       val = ADC;
       val = val * 0.427;                // doing (5 * 100 * adc) / 1024, just simplified

       return val;
}

// nRF24L01 interrupt
ISR(INT0_vect) {
       rf_interrupt = true;    // turn on variable for while loop
       EIFR |= (INTF0);   // reset interrupt flag
}

int main(void)
{
    init_uart();         // set UART variables
       ADC_init();          // set ADC variables
       _delay_ms(150);
       USART_Transmit("Started!\r\n");
       uint8_t address[5] = {0x01, 0x01, 0x01, 0x01, 0x01 };   // address for nRF
       sei();               // turn on global interrupts
       nRF24L01 *rf = setup_rf();      // initialze and setup nRF struct
       nRF24L01_listen(rf, 0, address);
       uint8_t addr[5];
       nRF24L01_read_register(rf, 0x00, addr, 1);


    while (1)
    {
              if (rf_interrupt)
              {
                     rf_interrupt = false;
                     while (nRF24L01_data_received(rf)) {
                            nRF24L01Message msg;
                            nRF24L01_read_received_data(rf, &msg);   // gets data that was
sent
                            USART_Transmit((char *)msg.data);     // transmit the
temperature value sent
                            USART_Transmit("\r\n");               // transmit a line feed
                     }

                     nRF24L01_listen(rf, 0, address);
              }
    }

       return 0;
}
```

3. CODE FOR TRANSMITTER

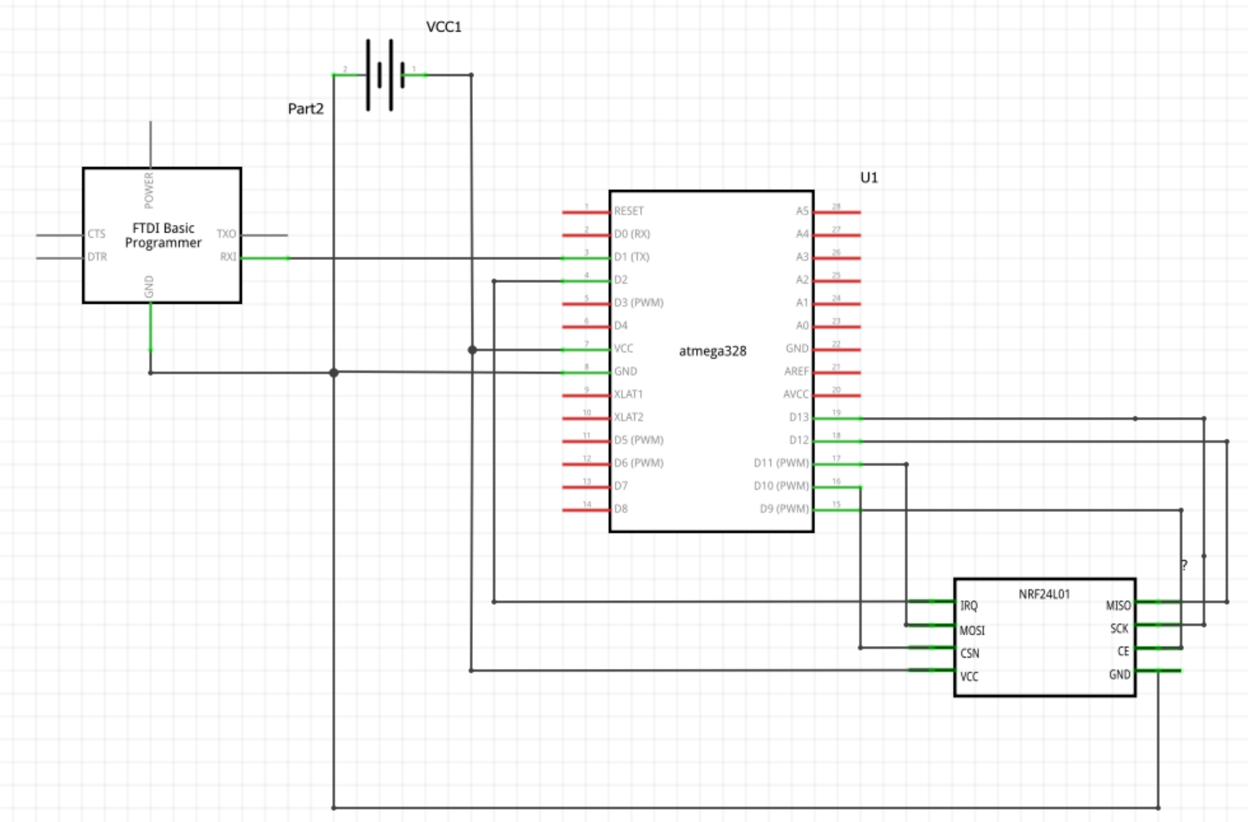
```
#include <avr/io.h>
#include <avr/interrupt.h>
#include <stdbool.h>
#include <string.h>
#include <stdio.h>
#include "nrf24l01.h"
#define UBRR_9600 51 // for 8Mhz with .2% error
#define F_CPU 8000000UL
#include <util/delay.h>

void spi_init(void);
void setup_timer(void);
nRF24L01 *setup_rf(void);
void adc_init(void);
void read_adc(void);
void USART_init( unsigned int ubrr );
void USART_tx_string( char *data );
volatile bool rf_interrupt = false;
volatile bool send_message = false;
volatile unsigned int adc_temp;
char outs[20];

int main(void)
{
    uint8_t to_address[5] = { 0x01, 0x01, 0x01, 0x01, 0x01 };
    spi_init();
    USART_init(UBRR_9600);                                 //Initialize the USART
(RS232 interface)
    USART_tx_string("Connected!\r\n");                     //Display connected
    _delay_ms(125);                                 //wait a bit
    sei();
    nRF24L01 *rf = setup_rf();
    adc_init();                        // start ADC
    setup_timer();                     // setup timer for CTC every 1 second

    while (true)
    {
          if (rf_interrupt)
          {
                 rf_interrupt = false;
```

```
                  int success = nRF24L01_transmit_success(rf);
                  if (success != 0)
                  nRF24L01_flush_transmit_message(rf);
           }

           if (send_message)
           {
                  read_adc();           // read ADC value
                  send_message = false;
                  nRF24L01Message msg;
                  snprintf(outs,sizeof(outs),"%3d\r\n", adc_temp);
                  USART_tx_string(outs);      // display temperature read
                  memcpy(msg.data, outs, 3);
                  msg.length = strlen((char *)msg.data) + 1;
                  nRF24L01_transmit(rf, to_address, &msg);  // transmit the
temperature value
           }

    }
    return 0;
}

void adc_init(void)
{
    /** Setup and enable ADC **/
    ADMUX = 0;                        //select ADC0 Pin as input
    ADMUX = (0<<REFS1)|        //Reference Selection Bits
    (1<<REFS0)|                       //AVcc - external cap at AREF
    (1<<ADLAR);                       //ADC right Adjust Result

    ADCSRA = (1<<ADEN)|               //ADC ENable
    (1<<ADSC)|                               //ADC Start Conversion
    (1<<ADATE)|                       //ADC Auto Trigger Enable
    (0<<ADIF)|                               //ADC Interrupt Flag
    (0<<ADIE)|                               //ADC Interrupt Enable
    (1<<ADPS2)|                       //ADC Prescaler of 64
    (1<<ADPS1)|
    (0<<ADPS0);

    ADCSRB = 0;
}

nRF24L01 *setup_rf(void)
{
    nRF24L01 *rf = nRF24L01_init();

    rf->ss.port = &PORTB;
    rf->ss.pin = PB2;
    rf->ce.port = &PORTB;
    rf->ce.pin = PB1;
    rf->sck.port = &PORTB;
    rf->sck.pin = PB5;
    rf->mosi.port = &PORTB;
    rf->mosi.pin = PB3;
    rf->miso.port = &PORTB;
    rf->miso.pin = PB4;
    // interrupt on falling edge of INT0 (PD2)
    EICRA |= _BV(ISC01);
    EIMSK |= _BV(INT0);
    nRF24L01_begin(rf);
    return rf;
}

void read_adc(void)
{

    adc_temp = 0;                                   //initalize temp to 0
    ADCSRA |= (1<<ADSC);                            //start the conversion
    while((ADCSRA & (1<<ADIF)) == 0);
    {
        //wait for conversion to finish
    }
    adc_temp = ADCH;                                //get temp value
}

void spi_init(void)
{
    DDRB |= (1<<2)|(1<<3)|(1<<5);            // SCK, MOSI and SS as outputs
    DDRB &= ~(1<<4);                  // MISO as input
    SPCR |= (1<<MSTR);                // Set as Master
    SPCR |= (1<<SPR0)|(1<<SPR1);             // divided clock by 128
    SPCR |= (1<<SPE);                 // Enable SPI
}

// setup timer to trigger interrupt every second when at 8MHz
void setup_timer(void)
{
    TCCR1B |= _BV(WGM12);
    TIMSK1 |= _BV(OCIE1A);
    OCR1A = 31250;
    TCCR1B |= _BV(CS12);
}

/* INIT USART (RS-232) */
void USART_init( unsigned int ubrr )
{
    UBRR0H = (unsigned char)(ubrr>>8);       //set baud rate
    UBRR0L = (unsigned char)ubrr;
    UCSR0B = (1 << TXEN0) | (1 <<RXEN0);            // Enable receiver, transmitter
    UCSR0C = (1 << UCSZ00) | (1 << UCSZ01);  //asynchronous 8-bit data 1 stop bit
}

/* SEND A STRING TO THE RS-232*/
void USART_tx_string( char *data )
{
    while ((*data != '\0'))
    {
        while (!(UCSR0A & (1 <<UDRE0)))
        {
            //wait for the transmit buffer to empty
        }
        UDR0 = *data;                        //put the data into the empty buffer,
which sends the data
        _delay_ms(125);                      // wait a bit
        data++;
    }
```

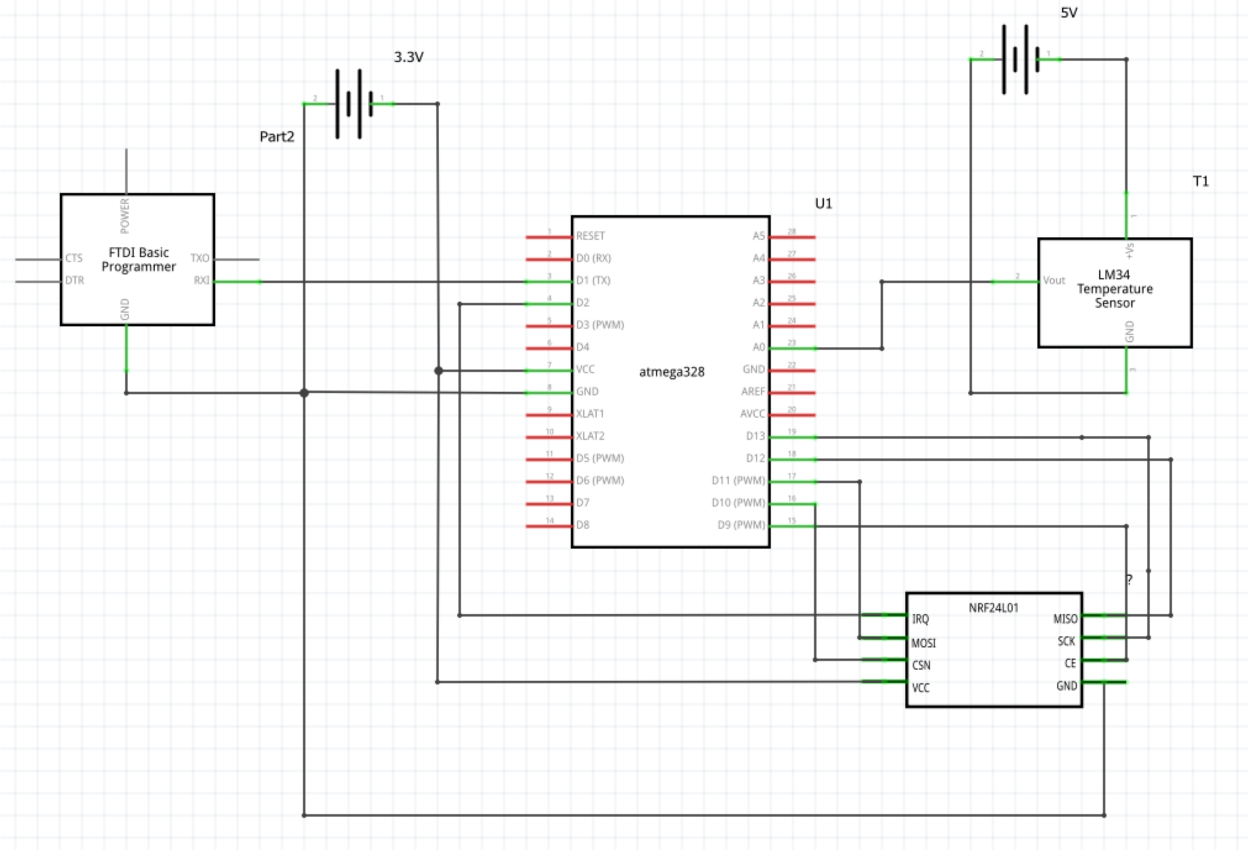
```
}

// each one second interrupt
ISR(TIMER1_COMPA_vect)
{
    send_message = true;
    TIFR1 |= (1<<OCF1A);
}

// nRF24L01 interrupt
ISR(INT0_vect)
{
    rf_interrupt = true;
    EIFR |= (1<<INTF0);
}
```

4. SCHEMATICS

For Receiver:

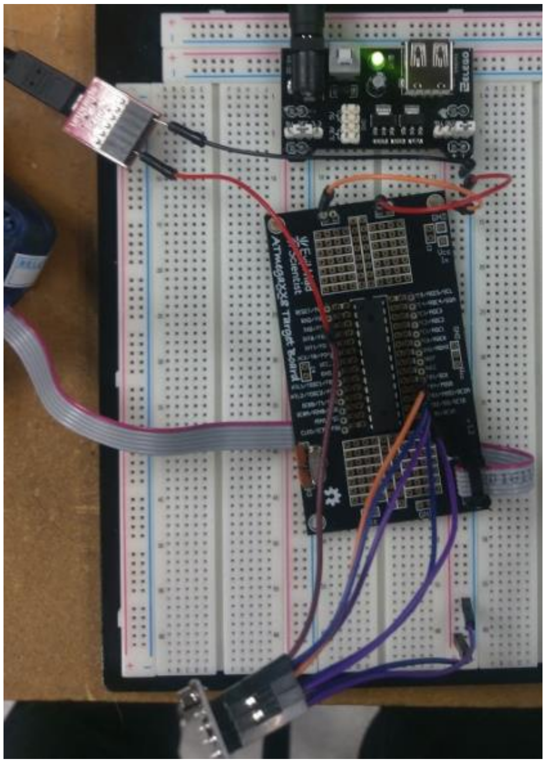


For Transmitter:

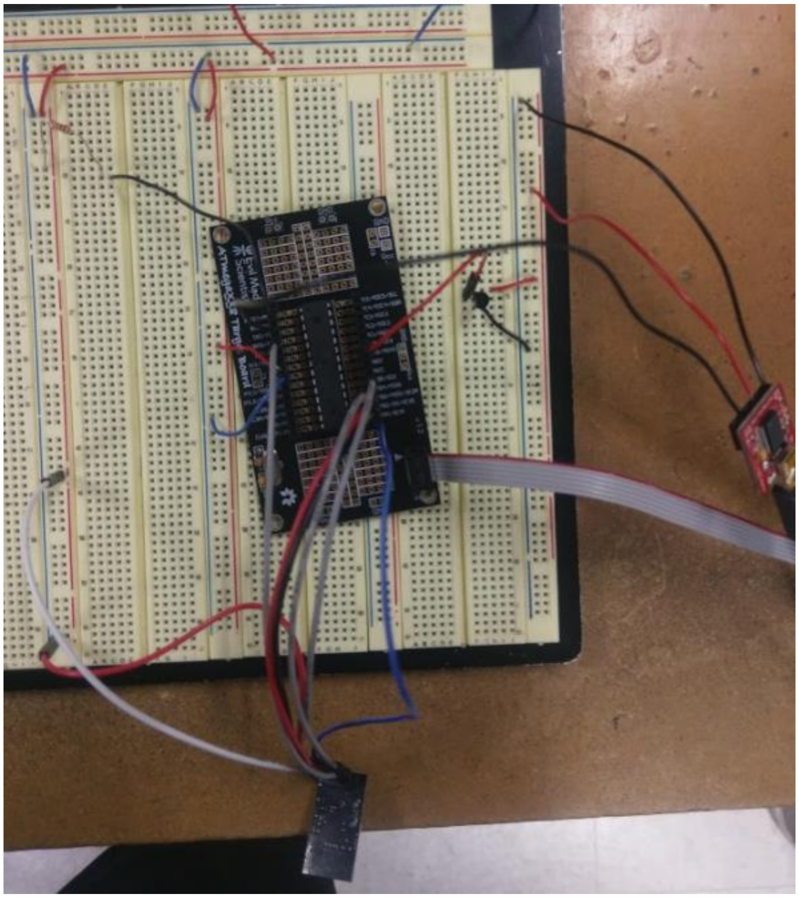


5. **SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)**
   N/A
6. **SCREENSHOT OF EACH DEMO (BOARD SETUP)**

Receiver:



Transmitter:



7. VIDEO LINKS OF EACH DEMO

https://www.youtube.com/watch?v=BUFPaYAD4H8

8. GITHUB LINK OF THIS DA

Student Academic Misconduct Policy
http://studentconduct.unlv.edu/misconduct/policy.html

"This assignment submission is my own, original work".
Brian Lopez