CPE301 – SPRING 2019

Design Assignment 6

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Directory: DA6

1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS

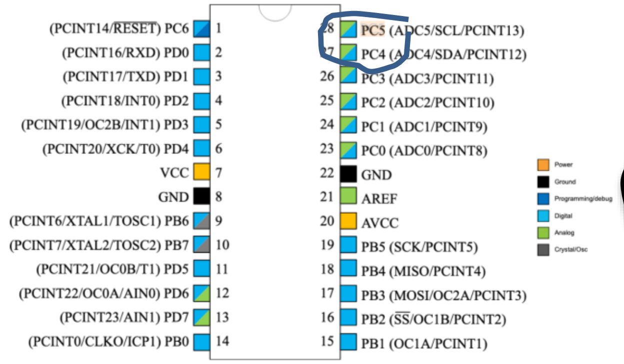
List of Components used

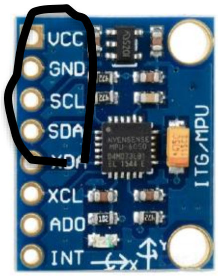
- Atmega 328P
- Xplained mini
- Micro USB
- Male/female wires
- MPU-6050

Block diagram with pins used in the Atmega328P

5.1. Pin-out

Figure 5-1. 28-pin PDIP





2. DEVELOPED C CODE

Other files are in the github

DA6.c

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <util/delay.h>
#include <inttypes.h>
#include <stdlib.h>
#include <stdio.h>
#include "MPU6050_res_define.h"
#include "I2C_Master_H_file.h"
#include "USART_RS232_H_file.h"

float Acc_x,Acc_y,Acc_z,Temperature,Gyro_x,Gyro_y,Gyro_z;

void MPU6050_Init()  // Gyro initialization function
{
       _delay_ms(150);
       // Power up time >100ms
       I2C_Start_Wait(0xD0);       // Start with device write address
       I2C_Write(SMPLRT_DIV);      // Write to sample rate register
       I2C_Write(0x07);            // 1KHz sample rate
       I2C_Stop();

       I2C_Start_Wait(0xD0);
       I2C_Write(PWR_MGMT_1);// Write to power management register
       I2C_Write(0x01);     // X axis gyroscope reference frequency
       I2C_Stop();

       I2C_Start_Wait(0xD0);
       I2C_Write(CONFIG);   // Write to Configuration register
       I2C_Write(0x00);     // Fs = 8KHz */
       I2C_Stop();

       I2C_Start_Wait(0xD0);
       I2C_Write(GYRO_CONFIG);// Write to Gyro configuration register
       I2C_Write(0x18);     // Full scale range +/- 2000 degree/C
       I2C_Stop();

       I2C_Start_Wait(0xD0);
       I2C_Write(INT_ENABLE);// Write to interrupt enable register
       I2C_Write(0x01);
       I2C_Stop();
}

void MPU_Start_Loc()
{
       I2C_Start_Wait(0xD0);       // I2C start with device write address
       I2C_Write(ACCEL_XOUT_H);// Write start location address from where to read
       I2C_Repeated_Start(0xD1);   // I2C start with device read address
}

void Read_RawValue()
{
       MPU_Start_Loc();            // Read Gyro values
       Acc_x = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       Acc_y = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       Acc_z = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       //Temperature = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       Gyro_x = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       Gyro_y = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Ack());
       Gyro_z = (((int)I2C_Read_Ack()<<8) | (int)I2C_Read_Nack());
       I2C_Stop();
}

int main()
{
       char buffer[20], float_[10];
       float Xa,Ya,Za;
       float Xg=0,Yg=0,Zg=0;
       I2C_Init();          //Initialize I2C
       MPU6050_Init();             //Initialize MPU6050
       USART_Init(9600);           //Initialize USART
```

```
       while(1)
       {
              Read_RawValue();
       //Divide raw value by sensitivity scale factor to get real values
              Xa = Acc_x/16384.0;
              Ya = Acc_y/16384.0;
              Za = Acc_z/16384.0;

              Xg = Gyro_x/16.4;
              Yg = Gyro_y/16.4;
              Zg = Gyro_z/16.4;

       //Output values
              dtostrf( Xa, 3, 2, float_ );
              sprintf(buffer," Ax = %s g\t",float_);
              USART_SendString(buffer);

              dtostrf( Ya, 3, 2, float_ );
              sprintf(buffer," Ay = %s g\t",float_);
              USART_SendString(buffer);

              dtostrf( Za, 3, 2, float_ );
              sprintf(buffer," Az = %s g\t",float_);
              USART_SendString(buffer);

              dtostrf( Xg, 3, 2, float_ );
              sprintf(buffer," Gx = %s%c/s\t",float_,0xF8);
              USART_SendString(buffer);

              dtostrf( Yg, 3, 2, float_ );
              sprintf(buffer," Gy = %s%c/s\t",float_,0xF8);
              USART_SendString(buffer);

              dtostrf( Zg, 3, 2, float_ );
              sprintf(buffer," Gz = %s%c/s\r\n",float_,0xF8);
              USART_SendString(buffer);
              _delay_ms(1000);
       }
}
```

USART.c

```
#include "USART_RS232_H_file.h"

void USART_Init(unsigned long BAUDRATE)
{
       UCSR0B = (1<<RXEN0)|(1<<TXEN0);// Enable USART transmitter and receiver
              // Write USCRC for 8 bit data and 1 stop bit
       UBRR0L = BAUD_PRESCALE;     // Load UBRRL with lower 8 bit of prescale value
       UBRR0H = (BAUD_PRESCALE >> 8);// Load UBRRH with upper 8 bit of prescale value
}

char USART_RxChar()                // Data receiving function
{
       while (!(UCSR0A & (1 << RXC0)));   // Wait until new data receive
       return(UDR0);                      // Get and return received data
}
```

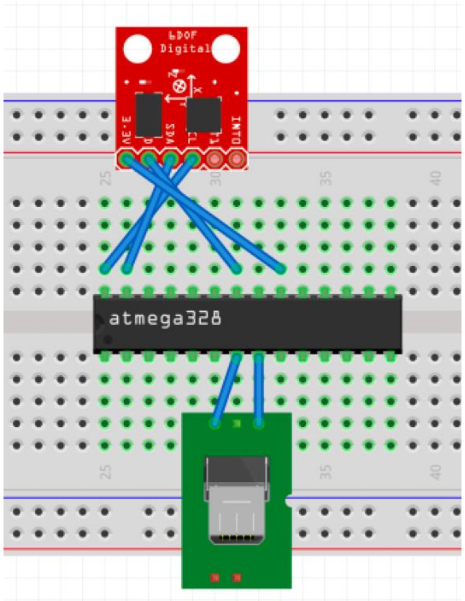
```
void USART_TxChar(char data)      // Data transmitting function
{
       UDR0 = data;                          //Write data to be transmitting in UDR
       while (!(UCSR0A & (1<<UDRE0)));// Wait until data transmit and buffer get empty
}

void USART_SendString(char *str)   // Send string of USART data function
{
       int i=0;

       while (str[i]!=0)
       {
              USART_TxChar(str[i]);       // Send each char of string till the NULL
              i++;
       }
}
```

I2C_Master_C_file.c

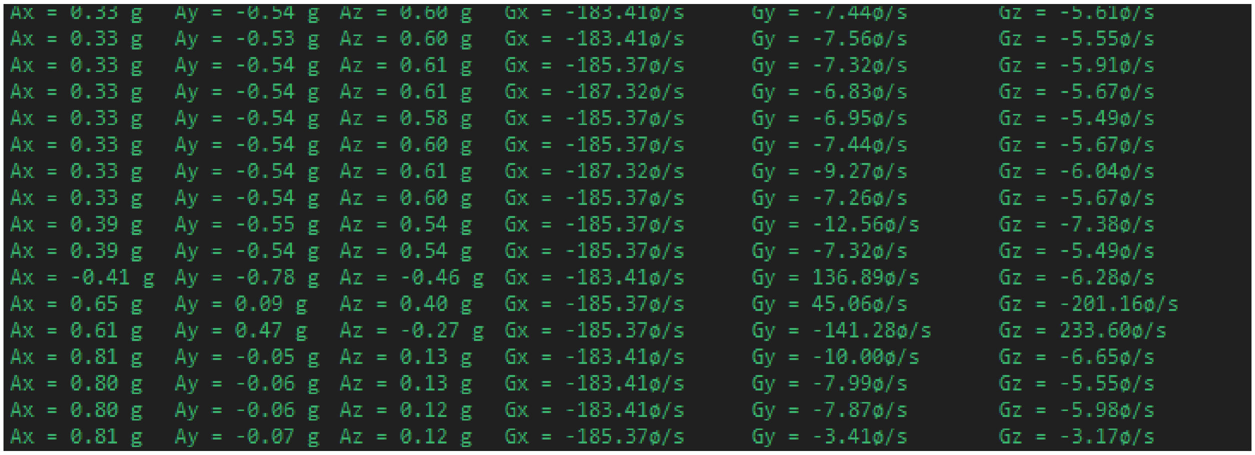
```
#include "I2C_Master_H_file.h"

void I2C_Init()
       // I2C initialize function
{
       TWBR = BITRATE(TWSR = 0x00);// Get bit rate register value by formula
}


uint8_t I2C_Start(char slave_write_address)            // I2C start function
{
       uint8_t status;

       TWCR = (1<<TWSTA)|(1<<TWEN)|(1<<TWINT);//Enable TWI, generate start condition and
clear interrupt flag
       while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (start
condition)
       status = TWSR & 0xF8;
       // Read TWI status register with masking lower three bits
       if (status != 0x08)
       // Check weather start condition transmitted successfully or not?
       return 0;
       // If not then return 0 to indicate start condition fail
       TWDR = slave_write_address; // If yes then write SLA+W in TWI data register
       TWCR = (1<<TWEN)|(1<<TWINT);// Enable TWI and clear interrupt flag
       while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (Write
operation)
       status = TWSR & 0xF8;
       // Read TWI status register with masking lower three bits
       if (status == 0x18)
       // Check weather SLA+W transmitted & ack received or not?
       return 1;
       // If yes then return 1 to indicate ack received i.e. ready to accept data byte
       if (status == 0x20)
       // Check weather SLA+W transmitted & nack received or not?
       return 2;
       // If yes then return 2 to indicate nack received i.e. device is busy
       else
       return 3;
       // Else return 3 to indicate SLA+W failed
}

uint8_t I2C_Repeated_Start(char slave_read_address)// I2C repeated start function
{
       uint8_t status;

       TWCR = (1<<TWSTA)|(1<<TWEN)|(1<<TWINT);  // Enable TWI, generate start condition
and clear interrupt flag
       while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (start
condition)
       status = TWSR & 0xF8;
       // Read TWI status register with masking lower three bits
       if (status != 0x10)
       // Check weather repeated start condition transmitted successfully or not?
       return 0;
       // If no then return 0 to indicate repeated start condition fail
       TWDR = slave_read_address;  // If yes then write SLA+R in TWI data register
       TWCR = (1<<TWEN)|(1<<TWINT);// Enable TWI and clear interrupt flag
       while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (Write
operation)
       status = TWSR & 0xF8;
       // Read TWI status register with masking lower three bits
       if (status == 0x40)
       // Check weather SLA+R transmitted & ack received or not?
       return 1;
       // If yes then return 1 to indicate ack received
       if (status == 0x20)
       // Check weather SLA+R transmitted & nack received or not?
       return 2;
       // If yes then return 2 to indicate nack received i.e. device is busy
       else
       return 3;
       // Else return 3 to indicate SLA+W failed
}

void I2C_Stop()
       // I2C stop function
{
       TWCR=(1<<TWSTO)|(1<<TWINT)|(1<<TWEN);// Enable TWI, generate stop condition and
clear interrupt flag
       while(TWCR & (1<<TWSTO));  // Wait until stop condition execution
}

void I2C_Start_Wait(char slave_write_address)// I2C start wait function
{
       uint8_t status;

       while (1)
       {
              TWCR = (1<<TWSTA)|(1<<TWEN)|(1<<TWINT);  // Enable TWI, generate start
condition and clear interrupt flag
              while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job
(start condition)
              status = TWSR & 0xF8;
       // Read TWI status register with masking lower three bits
```

```
                if (status != 0x08)
        // Check weather start condition transmitted successfully or not?
                continue;
        // If no then continue with start loop again
                TWDR = slave_write_address; // If yes then write SLA+W in TWI data register
                TWCR = (1<<TWEN)|(1<<TWINT);// Enable TWI and clear interrupt flag
                while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job
                status = TWSR & 0xF8;
        // Read TWI status register with masking lower three bits
                if (status != 0x18 ) // Check weather SLA+W transmitted & ack received or
not?
                {
                        I2C_Stop();
        // If not then generate stop condition
                        continue;
        // continue with start loop again
                }
                break;
        // If yes then break loop
        }
}

uint8_t I2C_Write(char data)// I2C write function
{
        uint8_t status;

        TWDR = data;
        // Copy data in TWI data register
        TWCR = (1<<TWEN)|(1<<TWINT);// Enable TWI and clear interrupt flag
        while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (Write
operation)
        status = TWSR & 0xF8;
        // Read TWI status register with masking lower three bits
        if (status == 0x28)
        // Check weather data transmitted & ack received or not?
        return 0;
        // If yes then return 0 to indicate ack received
        if (status == 0x30)
        // Check weather data transmitted & nack received or not?
        return 1;
        // If yes then return 1 to indicate nack received
        else
        return 2;
        // Else return 2 to indicate data transmission failed
}

char I2C_Read_Ack()         // I2C read ack function
{
        TWCR=(1<<TWEN)|(1<<TWINT)|(1<<TWEA);// Enable TWI, generation of ack and clear
interrupt flag
        while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (read
operation)
        return TWDR;
        // Return received data
}

char I2C_Read_Nack()        // I2C read nack function
{
	TWCR=(1<<TWEN)|(1<<TWINT);		// Enable TWI and clear interrupt flag
	while (!(TWCR & (1<<TWINT)));// Wait until TWI finish its current job (read
operation)
	return TWDR;
	// Return received data
}
```

3. SCHEMATICS



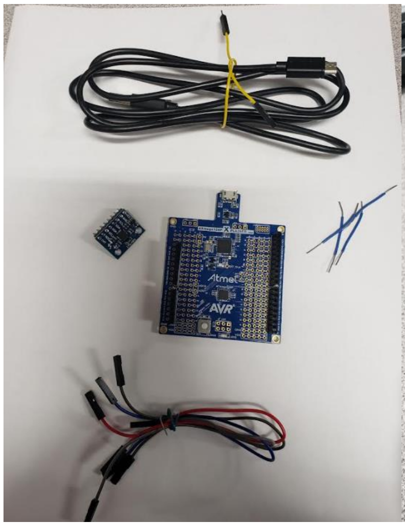
4. SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)



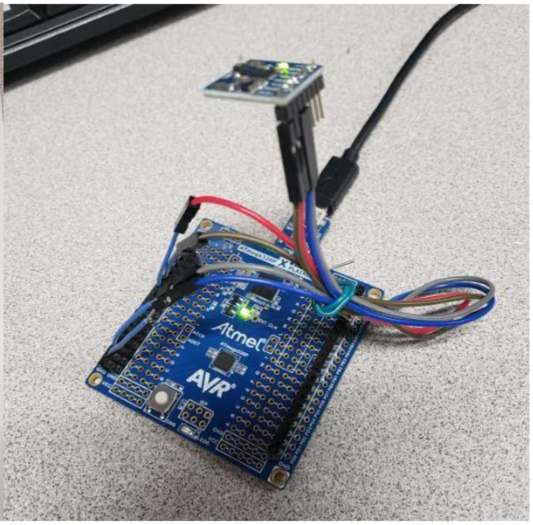
```
Ax = 0.33 g   Ay = -0.54 g  Az = 0.60 g   Gx = -183.41ø/s       Gy = -7.44ø/s         Gz = -5.61ø/s
Ax = 0.33 g   Ay = -0.53 g  Az = 0.60 g   Gx = -183.41ø/s       Gy = -7.56ø/s         Gz = -5.55ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.61 g   Gx = -185.37ø/s       Gy = -7.32ø/s         Gz = -5.91ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.61 g   Gx = -187.32ø/s       Gy = -6.83ø/s         Gz = -5.67ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.58 g   Gx = -185.37ø/s       Gy = -6.95ø/s         Gz = -5.49ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.60 g   Gx = -185.37ø/s       Gy = -7.44ø/s         Gz = -5.67ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.61 g   Gx = -187.32ø/s       Gy = -9.27ø/s         Gz = -6.04ø/s
Ax = 0.33 g   Ay = -0.54 g  Az = 0.60 g   Gx = -185.37ø/s       Gy = -7.26ø/s         Gz = -5.67ø/s
Ax = 0.39 g   Ay = -0.55 g  Az = 0.54 g   Gx = -185.37ø/s       Gy = -12.56ø/s        Gz = -7.38ø/s
Ax = 0.39 g   Ay = -0.54 g  Az = 0.54 g   Gx = -185.37ø/s       Gy = -7.32ø/s         Gz = -5.49ø/s
Ax = -0.41 g  Ay = -0.78 g  Az = -0.46 g  Gx = -183.41ø/s       Gy = 136.89ø/s        Gz = -6.28ø/s
Ax = 0.65 g   Ay = 0.09 g   Az = 0.40 g   Gx = -185.37ø/s       Gy = 45.06ø/s         Gz = -201.16ø/s
Ax = 0.61 g   Ay = 0.47 g   Az = -0.27 g  Gx = -185.37ø/s       Gy = -141.28ø/s       Gz = 233.60ø/s
Ax = 0.81 g   Ay = -0.05 g  Az = 0.13 g   Gx = -183.41ø/s       Gy = -10.00ø/s        Gz = -6.65ø/s
Ax = 0.80 g   Ay = -0.06 g  Az = 0.13 g   Gx = -183.41ø/s       Gy = -7.99ø/s         Gz = -5.55ø/s
Ax = 0.80 g   Ay = -0.06 g  Az = 0.12 g   Gx = -183.41ø/s       Gy = -7.87ø/s         Gz = -5.98ø/s
Ax = 0.81 g   Ay = -0.07 g  Az = 0.12 g   Gx = -185.37ø/s       Gy = -3.41ø/s         Gz = -3.17ø/s
```

5. SCREENSHOT OF EACH DEMO (BOARD SETUP)

Before:



After:



6. VIDEO LINKS OF EACH DEMO

https://www.youtube.com/watch?v=SrYgF0k2Xqc

7. GITHUB LINK OF THIS DA

https://github.com/HadidBuilds/hw_sub_da1

Student Academic Misconduct Policy

http://studentconduct.unlv.edu/misconduct/policy.html

"This assignment submission is my own, original work".
Itzel Becerril