Gas Detector

System Requirements

- Ti Tiva TM4C123GH6PM MCU
- Wires
- 1602A LCD
- Potentiometer
- MQ-2 Gas sensor
- Passive Buzzer
- 3x 1kΩ resistors

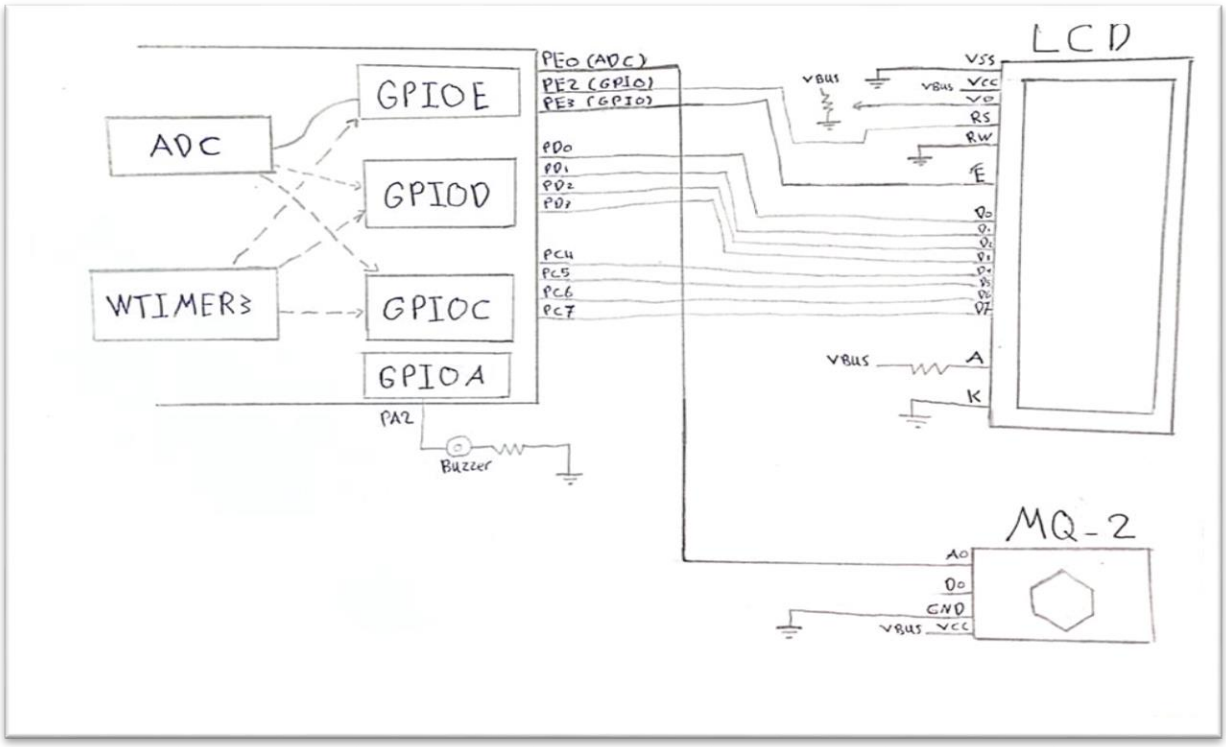
System description:

With the gas detection system, we are using the MQ-2 gas sensor in Detecting LPG gas which is used in home kitchens and used in lighters. An LCD will show the gas concentration (PPM). And in case there is gas leakage, a buzzer will make alarming sound and an alerting message will pop out on the LCD.

Hardware Setup (HS):

Ex: →

PE0:	Analog.	Connected to A0	|	PE2:	output.	Connected to RS
PE3:	output.	Connected to E	|	PD0:	output.	Connected to D0
PD1:	output.	Connected to D1	|	PD2:	output.	Connected to D2
PD3:	output.	Connected to D3	|	PC4:	output.	Connected to D4
PC5:	output.	Connected to D5	|	PC6:	output.	Connected to D6
PC7:	output.	Connected to D7	|	PA2:	output.	Connected to Buzzer



We took the sensor readings from A0 of MQ-2 and stored it in PE0 which we will use it to calculate the ppm through ppm function, then printing it on the LCD by separating the ppm value in a buffer then sending each character alone with a delay(wtimer3) to the LCD through port D and C to print them. We are using PE2 and PE3 for RS and E to chose between sending an instruction or data, and we are making a delay(wtimer3) when sending so we could fetch the data. In case there is gas leakage, we'll print an alert message and use PA2 to activate the buzzer.

Program Skelton:

```
int main(void){
    //Function calls
    portA2_setup();
    portE0_and_ADC_setup();
    portD0_1_2_3_setup();
    portC4_5_6_7_setup();
    portE2_3_setup();
    lcd_setup();

    while(1){
     // Start of conversion
     // wait for conversion to finish
     // Clear end of conversion flag

     // read the calculated ppm of the sensor value
     // store formatted output on temp buffer

     // print ppm on LCD

     // Check if PPM is more than 100
        If True:
        activate buzzer
        print alert message
        If False:
        Deactivate buzzer

     // delay 1sec
     // clear display on LCD
    }
}
```

Code

```
#include "TM4C123GH6PM.h"
#include <math.h>
#include <stdio.h>

//Sensor PPM  Functions and variables
void portE0_and_ADC_setup(void);
float ppm(float);
float r0 = 0.4388;
float b = 1.2506;
float m = -0.4548;
float ppm_val;
char temp[15];

// LCD Functions and variables
void portD0_1_2_3_setup(void);
void portC4_5_6_7_setup(void);
void portE2_3_setup(void);
void lcd_setup(void);
void lcd_inst(unsigned char);
void lcd_data_char(unsigned char);
void lcd_data_string(char *);
const unsigned char portD_mask = 0x0F;
const unsigned char portC_mask = 0xF0;

// Delay funtions
void wtimer3_setup(int);
void delay(int);

// Passive buzzer function
void portA2_setup(void);


int main(void){
    //Function calls
    portA2_setup();
    portE0_and_ADC_setup();
```

```
    portD0_1_2_3_setup();
    portC4_5_6_7_setup();
    portE2_3_setup();
    lcd_setup();

    while(1){
      ADC0->PSSI |= 0x08; // Start of conversion
      while(~ADC0->RIS&0x08); // wait for conversion to finish
      ADC0->ISC |= 0x08; // Clear end of conversion flag

      ppm_val = ppm(ADC0->SSFIFO3); // read the calculated ppm of the sensor
value
      sprintf(temp, "%f", ppm_val); // store formatted output on temp buffer

      lcd_data_string("LPG PPM: "); // print on LCD
      lcd_data_string(temp); // print ppm on LCD

      if(ppm_val>100){
        GPIOA->DATA |= 0x04; // Activate buzzer
        lcd_inst(0xC0); // Go to second line on LCD
        lcd_data_string("Gas detected!"); // print on LCD
      }
      else{
        GPIOA->DATA &= ~0x04; // Deavtivate buzzer
      }
      delay(1000); //delay 1sec
      lcd_inst(0x01); // clear display on LCD
    }
}

void delay(int ms){
    wtimer3_setup(ms); // call for delay
    while(~WTIMER3->RIS&0x01); //Block statment
}

// setting up Wide Timer 3
void wtimer3_setup(int ms){
    SYSCTL->RCGCWTIMER |= 0x08; //connect clock to Wide Timer 3
    WTIMER3->CTL &= ~0x01; //Disable timer
    WTIMER3->CFG |= 0x04; // Single timer
    WTIMER3->TAMR |= 0x01; // one-shot mode
    WTIMER3->TAILR = (16000*ms)-1; //number of counts
    WTIMER3->ICR |= 0x01; // clear bit0 of RIS register
    WTIMER3->CTL |= 0x01; // enable timer
}
```

```
// setting pin(0, 1, 2, 3) of port D for sending first half instruction to LCD
void portD0_1_2_3_setup(void){
    SYSCTL->RCGCGPIO |= 0x08; //Connect clock to port D
    GPIOD->DIR |= 0x0F; //Put pins 0, 1, 2, 3 of port D as an Output
    GPIOD->DEN |= 0x0F; //Digitally enable pins 0, 1, 2, 3 of port D
}

// setting pin(4, 5, 6, 7) of port C for sending second half instruction to LCD
void portC4_5_6_7_setup(void){
    SYSCTL->RCGCGPIO |= 0x04; //Connect clock to port C
    GPIOC->DIR |= 0xF0; //Put pins 4, 5, 6, 7 of port C as an Output
    GPIOC->DEN |= 0xF0; //Digitally enable pins 4, 5, 6, 7 of port C
}

// setting pin(2, 3) of port E for RS and E respectively for LCD
void portE2_3_setup(void){
    SYSCTL->RCGCGPIO |= 0x10; //Connect clock to port E
    GPIOE->DIR |= 0x0C; //Put pins 2, 3 of port E as an Output
    GPIOE->DEN |= 0x0C; //Digitally enable pins 2, 3 of port E
}

// setting LCD calls
void lcd_setup(void){
    lcd_inst(0x01); // Clear LCD display
    lcd_inst(0x02); // Return home
    lcd_inst(0x06); // Increment cursor mode enabled
    lcd_inst(0x38); // 8-bit mode, two line mode
    lcd_inst(0x0E); // Display on, Cursor on
}

// Sending instruction to LCD
void lcd_inst(unsigned char com){
    delay(4); // delay 4msec
    GPIOE->DATA &= ~0x04; // RS = 0
    GPIOE->DATA &= ~0x08; // E = 0
    GPIOD->DATA = portD_mask&com; // write the fisrt four command bits to LCD
    GPIOC->DATA = portC_mask&com; // write the second four command bits to LCD
    GPIOE->DATA |= 0x08; // E = 1
    GPIOE->DATA &= ~0x08; // E = 0
}

// write a char to LCD
void lcd_data_char(unsigned char da){
    delay(4); // delay 4msec
```

```
    GPIOE->DATA |= 0x04; // RS = 1
    GPIOE->DATA &= ~0x08; // E = 0
    GPIOD->DATA = portD_mask&da; // write the fisrt four data bits to LCD
    GPIOC->DATA = portC_mask&da; // write the second four data bits to LCD
    GPIOE->DATA |= 0x08; // E = 1
    GPIOE->DATA &= ~0x08; // E = 0
}

// write a string to LCD
void lcd_data_string(char *da){
    delay(4); // delay 4msec
    // while data not pointed to 0
    while(*da != 0){
        lcd_data_char(*da); // write the pointed char to LCD
        da++; // Increment data by 1
    }
}

// ppm calculation
float ppm(float sensor_val){
    // declare variables
    float sensor_volt;
    float rs;
    float rs_ro_ratio;
    float ppm;

    sensor_volt = (sensor_val*5)/ 4096; // Sensor voltage formula
    rs = (5-sensor_volt)/sensor_volt; // resistance of air with change of gas
concentration formula
    rs_ro_ratio = rs/r0; // resistance ratio of rs and r0(resistance of sensor in
fresh air) formula
    ppm = pow(10, (((log10(rs_ro_ratio))-b)/m)); // gas concentration formula

    return ppm;
}

// setting pin 0 of port E for ADC, and setting ADC
void portE0_and_ADC_setup(void){
    SYSCTL->RCGCADC |= 0x01;//Connect clock to ADC 0
    SYSCTL->RCGCGPIO |= 0x10; //Connect clock to port E
    GPIOE->AFSEL |= 0x01;  //Alternative function of pin 0 of port E
    GPIOE->DEN &= ~0x01; //Digitally disable pin 0 of port E
    GPIOE->AMSEL |= 0x01; // Analog mode(function)

    ADC0->ACTSS &= ~0x08; // Deactivate sample sequencer 3
```

```
    ADC0->EMUX &= ~0xF000; // Select processor event for sample sequencer 3
    ADC0->SSMUX3 = 3; // Select AIN3(Channel 3) for sample sequencer 3
    ADC0->SSCTL3 |= 0x06; // Interrupt event(2nd bit), End of sequence(1th bit)
    ADC0->ACTSS |= 0x08; // Activate sample sequencer 3
}

void portA2_setup(void){
    SYSCTL->RCGCGPIO |= 0x01; //Connect clock to port A
    GPIOA->DIR |= 0x04; //Put pin 2 of port A as an Output
    GPIOA->DEN |= 0x04; //Digitally enable pin 2 of port A
}
```