ESE381 Embedded Microcontroller Systems Design II

Spring 2022, K. Short revised April 20, 2022 7:21 pm

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Laboratory 11: Air Quality System II - Extension of the Features of the Air Quality System I

To be performed the week starting April 24th.

Prerequisite Reading

(All items are posted on Blackboard.)

1. Doxygen ESE 381 Introduction
2. Doxygen Manual for version 1.1.13
3. Doxygen Download Link: http://www.doxygen.nl/download.html
4. Indoor CO2: Dumb and dumber?
5. Is CO2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO2 Concentrations on Human Decision-Making Performance
6. Direct human health risks of increased atmospheric carbon dioxide (link on Blackboard).

Overview

This laboratory extends the design from Laboratory 10 by adding features to that design. One feature added is the transmission of the measurement results to a remote location. Another feature is a relative display of the CO2 concentration using the existing bargraph. This second feature puts another operating slave device on the I2C bus and will determine if your software allows the two I2C devices to play well together.

Design Tasks

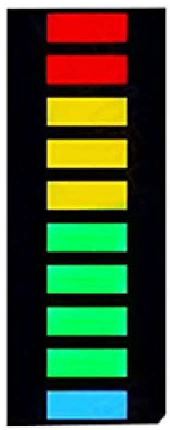
Design Task 1: Sending CO_2, Humidity, and Temperature to a Remote Location.

Revise your program from Laboratory 10 Design Task 3 to create a program that, in addition to the system's features from that task, also transmits the measured CO_2, humidity, and temperature serially using the asynchronous serial protocol. Configure USART3 to send the serial data to either a Termite or Tera Term terminal emulator. The complete set of readings must be transmitted once a second. Format the data so that it is easy to be read by the recipient.

Design Task 2: Simple Display of CO_2 Level

The US government considers concentrations of CO_2 greater than 5000 ppm to be unhealthy. However, more recent studies indicate that concentrations of CO_2 greater than 1000 ppm can affect mental concentration and over extended periods of time can be unhealthy.

While our current system can measure and display CO_2, humidity, and temperature. Most people do not have an understanding of the impact of different numerical values of CO_2. An additional way of providing CO_2 information might be helpful. Since we have a 10 element bargraph available, it could be used to provide a more qualitative measure of the CO_2 concentration and indicate whether it is an issue that needs to be respond to. The LEDs in the bargraph must be turned on from the bottom to the top based on concentrations of CO_2. While all the elements of our bargraph are red, a multi color bargraph would probably be preferable. Here is on that could simple be plugged into your bread board to replace the existing one.



Revise your program from Design Task 1, to create a program that turns ON the bottom LED for CO_2 concentrations from 400 to 499 ppm. Then turns ON the bottom two LEDs for concentrations from 500 to 599 ppm, and so on.

Design Task 3: Doxygen Documentation of Your Multi-Module Program

Use Doxygen to document your multi-module program. Generate a RTF version of this document in PDF form.

Submit your Doxygen documentation for this program as part of your prelab. And submit your .c and .h files. Make sure your program files include a program header, a header for each function, and clear comments throughout.

Laboratory Activity

Laboratory Task 1: Sending CO_2, Humidity, and Temperature to a Remote Location.

Create a project using your program for Design Task 1. Set the compiler optimization to -Og. Build the program. Place any appropriate variables in a watch window to observe their values. Single step through the instructions in your program to verify that USART3 is properly configured to communicate the with the terminal emulator. Prior to single-stepping each instruction, determine what changes you expect in the values of the port registers and any variables you created.

Run your program and the Saleae logic analyzer verify that the correct transactions take place on the asynchronous bus. Use the Saleae logic analyzer to capture the first few frames sent from the microcontroller to the terminal emulator. Submit this screen capture with your laboratory.

When your program is working correctly, have a TA verify that your program performs as required. Get the TA's signature.

Laboratory Task 2: Simple Display of CO_2 Level

Create a project using the program you wrote for Design Task 2. Set the compiler optimization to -Og. Build the program. Place any appropriate variables in a watch window to observe their values. Run you program using breakpoints to verify that the overall flow of control is correct.

When your program is working correctly, have a TA verify that your program performs as required. Get the TA's signature.

Leave the circuit you have constructed on your breadboard insert, it may be used in later laboratories.