Lab Assignment 2. Programming a CR1000

Objective: Become familiar with wiring a temperature/relative humidity sensor to the CR1000, programming the logger to obtain data from the sensor, and modifying the program to indicate when an environmental condition is met.

Before the Lab Session

1. Read through the brochure about the CS215 temperature and relative humidity sensor available from: http://www.campbellsci.com/documents/product-brochures/cs215.pdf. SDI-12 comms is a protocol that allows many sensors to use the same control port, making it possible to have a large number of sensors controlled by a single CR1000.

2. *Question 1.* Much of that content won't make a lot of sense. The CS215 uses a single chip for both the temperature and RH sensor (the Sensirion SHT75- google that). Undergrads: how does the Sensirion measure temperature and relative humidity? (Graduate students only). Read the datasheet on the Sensirion sensor and describe in a paragraph or two briefly how it works.

3. *Question 2*. What's the difference between the CrBasic commands 'Sample' , 'Average', and 'Totalize'.

4. *Question 3.* But there are some basic nuggets of info that you need to recognize in the documentation. Based on the manufacturer's information complete the following:

Temp Accuracy 5C to 40C	Temp Accuracy -40 to 70C	Temp Response time(sec)	RH Accuracy 10-90%	RH Accuracy 0-100%	RH Response Time (sec)

5. *Question 4.* How long does it take for the temperature sensor to increase by 0.95C when the environment experiences a 1C step temperature increase? Hint: go back to the info on time response from last week. What impact might the relatively slow time response of this sensor have on estimating the daily minimum or maximum temperature?

6. *Question 5*. What is the pore size of the cover in microns? How does that compare to the size of small particulates associated with air pollution that we often worry about? Will those small particles make it through the cover?

1. **Equipment List. You will check out, be responsible for, and return the following:**
    a. PS100 power supply
    b. CS1000 datalogger
    c. USB- 9 pin serial cable
    d. CR1000KD keypad display and cable
    e. CS215 temp/rh probe
    f. LED
    g. Straight screwdriver

2. **Setting up the Logger**
    a. Use your folder on the netbook Desktop using your team number (M-T, tables 1-4), e.g., M_1, etc.
    b. Click on LoggerNet and select "Setup" from the "Main" menu. You should be in the EZ View. If you see a CR1000 (which you will once someone does the assignment), click on the CR1000 and select Delete.
    c. Add a CR1000 data logger. You should see DataLogger Name "CR1000".
    d. Select "Direct Connect" Connection Type. Be sure the serial cable is connected from the netbook to the RS-232 port on the logger. Option should be serial port "COM3".

    e. Leave Datalogger settings alone. Test Communications. If you do not get to the DataLogger Clock option, then something is haywire. Don't send program, select Finish.

3. **Creating a Program and Sending it to the Datalogger. Select Short Cut under Program**
   a. Step 1. Select New Program
      i. Datalogger model (CR1000)
      ii. Scan interval (15 sec)
   b. Step 2. Sensors
      i. Leave Default measurement of battery voltage (BattV)
      ii. Add from sensors- category Relative Humidity and Temperature. Click red arrow and should have on right side: AirTC and RH
      iii. Follow instructions from wiring diagram
   c. Step 3. Output
      i. Store every 15 seconds for Table 1. Rename Table 1 to be CS215. Remove Table 2.
      ii. Select sample for airTC and for RH
      iii. Save program to your Team's Desktop folder. YourName_Lab2. Do not send the program to the Datalogger yet
   d. Step 4. Exit out of Short Cut and select the CRBasic Editor from the Program Menu
      i. Open your program
      ii. There are three parts
         1. Declare variables and units
         2. Define Data Tables
         3. Main Program
      iii. An initial quote indicates it is a comment. You can use the help to see what each of the statements mean.
      iv. Under the Compile menu, Select Compile, Save, and Send
      v. If everything is ok, you should not receive any error messages and if you have the CR1000KD plugged in, you can now check out the data.
      vi. LIGTHLY blow on the sensor to see the response in terms of RH. Enclose the sensor GINGERLY in your hand to see a response to your body temperature.
      vii. From Main Menu, select Connect.

4. **Modifying the Program**
   a. Declare two new variables and provide units where appropriate:
      i. Public AirTF
      ii. Public Flag as BOOLEAN
      iii. Units AirTF=Deg F
   b. *Question 6.* What does the 7 in the SDI12Recorder command mean? Hint: use the help.

   c. Add below the SDI… command: AirTF = AirTC*1.8+32
   d. Select Compile, Save, and Send and verify that you are now recording air temperature in F
   e. *Question 7.* Why can't you put in the multiplier 1.8 and offset 32 in the SDI12 command to get the temperature in F? Hint: what happens to the RH when you do? Yes, try it.
   f. We now want to have the RH control whether a control port is turned on. Put the red wire from the LED into C1 and the black wire from the LED into G.
   g. Add to the program beneath the SDI12 command the following
      i. 'if rh > 40 then set flag true else false

    ii. If RH>40 Then

    iii. Flag = True

    iv. Else

    v. Flag = False

    vi. Endif

    vii. 'Turn LED connected to Port 1 on when Flag is True

    viii. If Flag = True Then

    ix. PortSet(1,true)

    x. Else

    xi. PortSet(1,false)

    xii. Endif

5. Verify that the LED is not lit when the RH is <=40% and becomes lit when you breath on it. Change the RH threshold if you need to make it easier to see a response.

6. **Further Modification of the Program**

    a. Use the integrated processing commands to compute dewpoint temperature in Celsius DWTC, saturation vapor pressure in **kPa** ES, and vapor pressure in **kPa** E. You will need to declare the variables, units, and sample them to put them into the CS215 data table. Hint: use help and the online docs on the netbooks.

    b. *Question 8.* Complete the following table for 1 set of observations with the vapor pressures in **hPa**

Time	Air Temp (C)	RH (%)	DWTC (C)	ES (hPa)	E (hPa)

7. **Circuits and Synthesizing Question**

    a. *Question 9.* Three resistors (10 ohms, 100, ohms, and 1000 ohms) are connected in series to a 12V battery (ignore its internal resistance).

        i. Sketch the situation

        ii. Find the equivalent resistance of the combination

        iii. Find the current in each resistor

        iv. Find the total current through the battery

        v. Find the voltage across each resistor

        vi. Find the power dissipated in each resistor

    b. *Question 10.* The three resistors described in 5a are connected in parallel to the same battery. Repeat the same six questions

    c. *Question 11.* A thermistor is exposed to the environment at a temperature of 30C. The instrument manufacturer states that the resistance of the thermistor at that temperature is 79.422 kohms. The thermistor is placed in series with a 249kohms resistor and the voltage is measured across a 1 kohm resistor as part of a half bridge. What voltage will be detected in this case?

    d. *Question 12.* When does it make sense to put in the bells and whistles (and when does it not make sense to do so)? That is, conditions such as using RH> 50% to turn on a control port or compute dewpoint and vapor pressure in the datalogger program vs. postprocessing the data once it is retrieved from the logger?

8. **Final Steps**

    a. **Create a lab report with all of your answers to Questions 1-12 and the final CS215 code. This must be typed.**

    b. **Turn your lab report in by the following lecture.**