WAKE TECH
Building, Engineering, & Skilled Technologies

# Sedona Programming Control Loops Lab

BAT-111: Building Automation Systems

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Name: ___________________________ Section: ____________________________

# Sedona Programming Control Loops Lab

## SYNOPSIS

We have previously wired up an actuator with a voltage control loop and a humidity sensor with a current control loop. We are now going to adjust the damper based upon input.

## OBJECTIVES

Upon completion of this activity the student will be able to:

1. Sedona programming with control loops
2. Utilize 2-10 VDC and 4-20 mA loops programmatically
3. Create a non-graphical HMI for monitoring the program

## PARTS AND EQUIPMENT

- Contemporary Controls BAScontrol22 or BAScontrol22S [https://www.ccontrols.com/basautomation/bascontrol.htm]
- Johnson Controls M9108-GGA-2 (or similar actuator that utilizes a voltage loop & has feedback)
- Kele HW20K [https://www.kele.com/product/humidity/wall-mount/kele/hw20k] (or similar actuator that utilizes a current loop)
- Ethernet cable
- Laptop
- DC multimeter
- 510 Ω resistor
- Short pieces of wire

## REFERENCES

- Contemporary Controls BAScontrol22 User Manual [https://www.ccontrols.com/pdf/um/UM-BASC2200.pdf]
- Johnson Controls M9108, M9116, M9124, and M9132 Series Electric Non-Spring Return Actuators Install Manual [https://cgproducts.johnsoncontrols.com/met_pdf/34636399.pdf]
- Kele HW20K [http://images.salsify.com/image/upload/s--ctPaqYEA--/9217c9fc43b78afb10cca712a4adf56907618e75.pdf]

# <u>Procedures</u>

This lab is a continuation of the Voltage and Current Control Loops Lab. Complete that lab before starting this lab.

## Part 1: Lab Setup

1.1 - <u>Laptop</u>

Set your ethernet adaptor to the following configuration:

- IP address: 192.168.92.35
- Subnet mask: 255.255.255.0
- Default gateway: 192.168.92.1

1.2 - <u>Controller</u>

Wire the controller using 24 VAC.

> Stop! Before proceeding to the next step, have your instructor inspect your wiring.

Use the static default IPv4 address of 192.168.92.68 and install the Lab configuration files.

## Part 2: Actuator

> If you need assistance with wiring the actuator, reference the ***Voltage and Current Control Loops Lab***.

2.1 - <u>Configuration</u>

Set up the actuator for the following conditions by changing the jumpers:

- DA
- Input control loop: VDC
- Input: 2-10 VDC

> In the previous lab, the control voltage for the actuator was 0–10 VDC. In the lab today, we are using 2-10 VDC for the control voltage of the actuator. Make sure you make the appropriate jumpers on the actuator to support this control voltage.

What pins are being jumped for jumper 1?______________________________________

What pins are being jumped for jumper 2?______________________________________

What pins are being jumped for jumper 3?______________________________________

2.2 - <u>Power wiring</u>

Wire the actuator using 24 *VAC*.

2.3 - Control wiring

Wire the actuator to the controller using:

- AO1: Actuator input
- UI5: Actuator feedback

Some of the controllers have IOs that do not work. You can substitute another AO or AI on the controller; however, you will have to make sure you chose the proper IO function block for that IO in the Sedona programming.

2.4 - Instructor Review

Stop! Before proceeding to the next step, have your instructor inspect your wiring.

2.5 - Power on controller and actuator

Apply 24 *VAC* to the controller and actuator.

As your actuator is powered, it will notice 0 VDC input on the control wiring, and you may hear/see the actuator moving if it is not in the correct position.

## Part 3: Humidity Sensor

We are going to read the relative humidity using a current control loop with the Kele HW20K sensor.

If you need assistance with wiring the humidity sensor, reference the ***Voltage and Current Control Loops Lab***.

3.1 - Wiring

Wire the humidity sensor to the controller using:

- UI1: Humidity Sensor

Some of the controllers have IOs that do not work. You can substitute another AO or AI on the controller; however, you will have to make sure you chose the proper IO function block for that IO in the Sedona programming.

3.2 - Instructor Review

Stop! Before proceeding to the next step, have your instructor inspect your wiring.

3.3 - Power on controller and sensor

Apply 24 *VAC* to the controller and 24 *VDC* to the humidity sensor.

## Part 4: HMI

We are going to use the Web Components to be our HMI for the lab.

> An HMI stands for Human Machine Interface, and it is the UI (user interface) the end-user such as operators or managers interact with the system. End users do not use wiresheets to work directly with the system but rely on a nice UI that abstracts away the underlying code.

4.1 - Web Components

Using your laptop, log into your controller.

Using the controller's webpage, click on the Web Components button near the bottom of the browser.

4.2 - Web Components description

Add the following Descriptions:

- WC01: Dry Bulb
- WC02: Wet Bulb
- WC03: Damper Position %
- WC04: Damper Position % Feedback

> With an HMI, the UI needs to be clean, and neat. Use proper capitalization, spacing, and spelling.

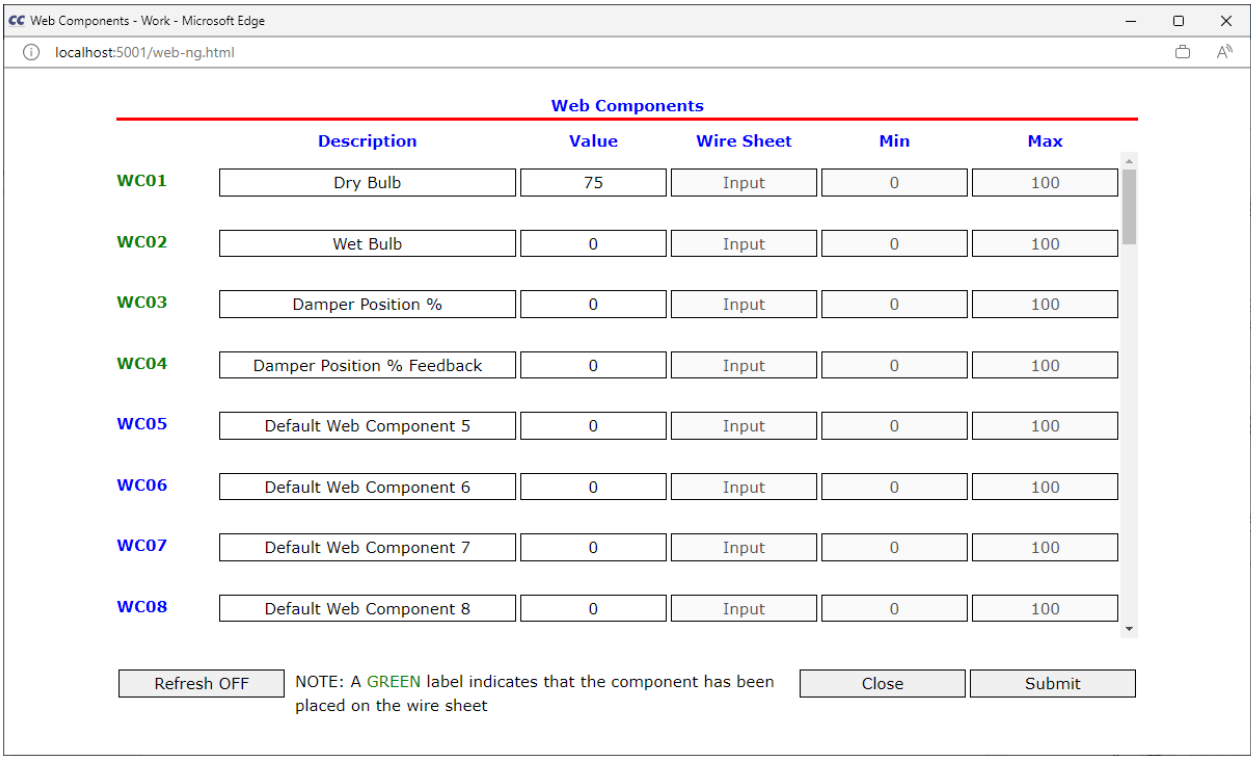
4.3 - Dry Bulb

For the purpose of this lab, we are going to make the dry bulb be a user configurable input. Normally this would be a thermistor and not a configurable input, but for the lab, we want the ability to change the value here to see the changes to the wet bulb and then change the actuator.

For WC01, set a Value of 75. This represents a dry bulb of 75 degrees Fahrenheit.

4.4 - Review Web Components

Review the Web Components to make sure your page matches.




4.5 - Submit

Click the Submit button to save the changes.

## Part 5: Sedona

5.1 - Sedona connection

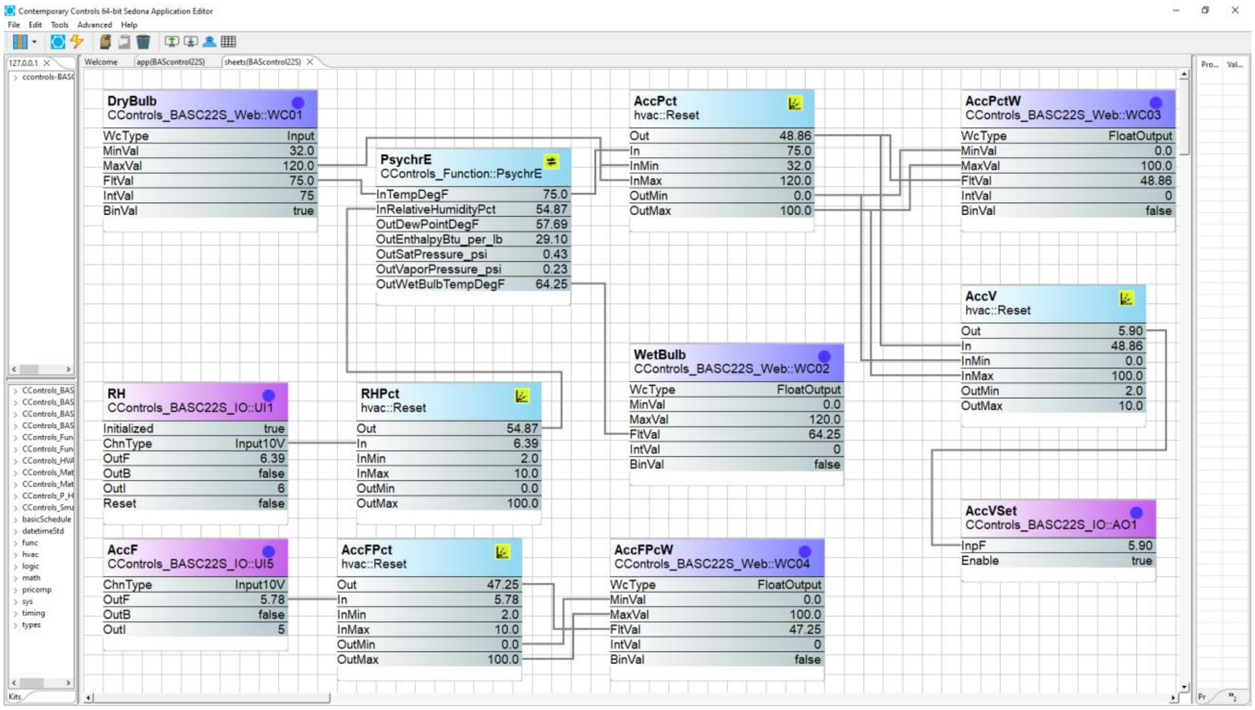
Open a Sedona connection to your controller.

If you need assistance with Sedona, reference the previous BAT-111 Sedona lab.

5.2 - Wiresheet

We are going to put all our work on the Sheets sheet.

The Sedona wire sheet picture is intended to give you an overall picture of the final product. Add the blocks as outlined in the lab steps while going through the lab.



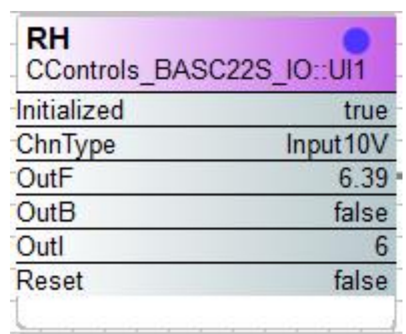

When adding function blocks to the wiresheet, move the blocks around so the code is easy to read and understand the code and its intended functionality.

5.3 - <u>RH - Relative Humidity voltage</u>

We want to read the relative humidity from the humidity sensor connected to the AI.

You will find the UI blocks under the CControls_BASC22_IO or CControls_BASC22S_IO kits depending on your controller.

Add the CControls_BASC22x_IO::UI1 block for the humidity sensor to the wire sheet and make the following changes:




- Name: RH

The humidity sensor is 4-20 mA, so across the 500 Ω resistor, the voltage should be 2-10 VDC.

Relative humidity should be around 50% so since the range is 2-10 VDC, I would expect the RH to be around 6 V. If we have a relative humidity of between 40-60%, then the voltage should be 5.2-6.8 VDC.

Using your multimeter, what is the voltage of the AI?________________________________

Is the voltage between 2-10 VDC?________________________________________________

What does the OutF slot read?__________________________________________________

Is the voltage measurement close to OutF?________________________________________

- ➢ If this does not represent a RH voltage value between 2-10 VDC, you need to troubleshoot the analog input.

5.4 - RHPct - Relative Humidity percentage

The AI for the humidity sensor is a voltage from 2-10 VDC. However, we want to convert that voltage to represent the relative humidity percentage.

The value in the range from 2-10 needs to be converted to 0-100 to represent the relative humidity percentage.

Explanation:

For example, suppose you had a 10-question quiz, and you got 9 out of 10 correct.

In this example you got 9 points and that is also important to know that there were 10 questions. 9 questions correct out of 10 questions is not the same grade as getting 9 questions correct out of 20.

We often convert grades to a percentage. A percentage is the number you would have correct if there had been 100 questions. Converting a ten question quiz, is as easy as multiplying the number of questions you correct by 10. So if you had 9 correct answers, you received a 90 percent.

If we are converting the range 0-10 to 0-100, we do that by just multiplying the number of correct answers by 10.

However, sometimes the ranges lower bounds is not 0 as our voltage control loop uses 2-10 VDC which has a lower bound of 2 VDC.

So:

2 VDC = 0% relative humidity

5.6 VDC = 40% relative humidity

6 VDC = 50% relative humidity

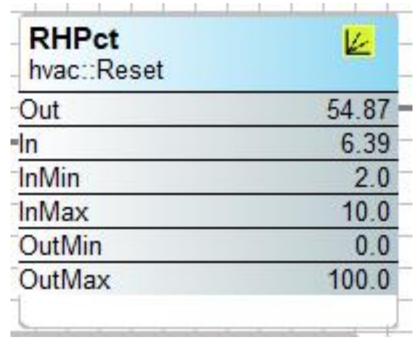
6.4 VDC = 60% relative humidity

10 VDC = 100% relative humidity

Contemporary Controls has a function that maps one range to another without having to do the math ourselves.

You will find the Reset block under the hvac kit.

Add a hvac::Reset block for the Relative Humidity percentage to the wire sheet and make the following changes:




- Name: RHPct
- InMin: 2
- InMax: 10
- OutMin: 0
- OutMax: 100

Make the following connections:

- RH:OutF → RHPct:In

The Out slot represents the relative humidity. Relative humidity should be around 50% so we are looking for a range between 40-60%.

What does the Out slot read?________________________________________

Does this value represent a RH between 40-60%?______________________________

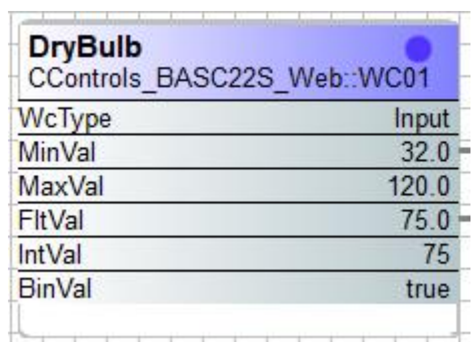
➢ If you answered No, you need to troubleshoot the issue.

5.5 - DryBulb - Dry Bulb (HMI)

We are going to use a Web Component (WC) to represent the ambient dry bulb. We are doing this so when we make changes to the dry bulb temperature, we can see the change in the wet bulb and actuate the damper.

> You will find the WC blocks under the CControls_BASC22_Web or CControls_BASC22S_Web kits depending on your controller.

Add the CControls_BASC22x_Web::WCO1 block for the ambient temperature dry bulb to the wire sheet and make the following changes:




- Name: DryBulb
- WcType: Input
- MinVal: 32
- MaxVal: 120

We are setting this web component to only accept the range of 32 to 120, which is the range in Fahrenheit of the ambient temperature. This is a reasonable range for the indoor temperature in a controlled space.

We have already set this value in the WebComponents.

What does the FltVal slot read?________________________________________

Does the FltVal slot match the value we set in the Web Components?________________

➢ If this does not match the value you set in the Web Component, you need to troubleshoot.

5.6 - PsychrE - Psychrometric calculator

We want to know the wet bulb which is based on the ambient temperature and the relative humidity.

The PsychrE block calculates web bulb and several other psychrometric values based upon the dry bulb and relative humidity.

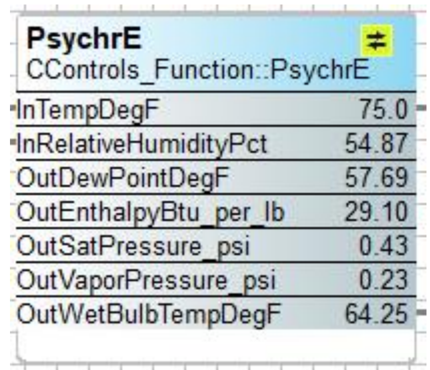
You will find the PsychrE function block under the CControls_Function kit.

Add a CControls_Function::PsychrE block for the psychrometric calculator to the wire sheet and make the following changes:

- Name: PsychrE

Make the following connections:

- DryBulb:FltVal → PsychrE:InTempDegF
- RHPct:Out → PsychrE:InRelativeHumidityPct




What does the OutWetBulbTempDegF slot read?______________________________

Is OutWetBulbTempDegF less than the DryBulb?______________________________

➢ If this does not represent a valid wet bulb temperature, you need to troubleshoot.

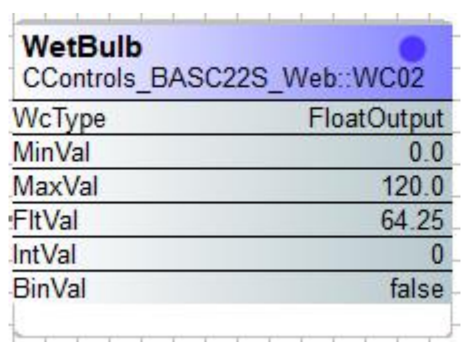
5.7 - WetBulb – Wet Bulb (HMI)

We are going to use a Web Component (WC) to show the wet bulb. The wet bulb is calculated by the Psychrometric calculator function block.

The WetBulb will always be equal to or lower than our DryBulb. The WetBulb is going to be an output.

Add the CControls_BASC22x_Web::WCO2 block for the wet bulb to the wire sheet and make the following changes:

- Name: WetBulb
- WcType: FloatOutput
- MinVal: 0
- MaxVal: 120




Make the following connections:

- PsychrE:OutWetBulbTempDegF → WetBulb:FltVal

What does the FltVal slot read?________________________________________________

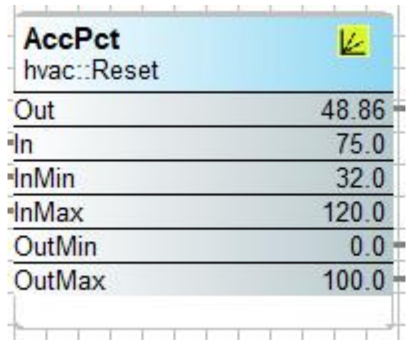
Is FltVal less than the DryBulb?_______________________________________________

➢ If FltVal does not represent a valid wet bulb temperature, you need to troubleshoot.

5.8 - AccPct - Actuator Percentage

We are going to utilize the dry bulb object to determine how much the damper should be open. The actuator should be open 0-100%.

Add a hvac::Reset block for the Actuator Percentage to the wire sheet and make the following changes:




- Name: AccPct

Make the following connections:

- DryBulb:FltVal → AccPct:In
- DryBulb:MinVal → AccPct:InMin
- DryBulb:MaxVal → AccPct:InMax

What does the Out slot read?__________________________________________________

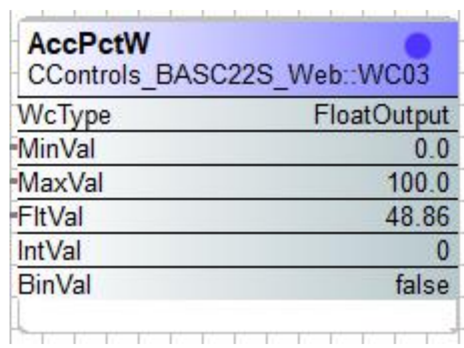
Is Out between 0-100%?______________________________________________________

➢ If this does not represent a percentage between 0-100%, you need to troubleshoot.

5.9 - AccPctW – Actuator Percentage (HMI)

We are going to use a Web Component (WC) to show the damper position percentage.

Add the CControls_BASC22x_Web::WCO3 block for the damper position percentage to the wire sheet and make the following changes:




- Name: AccPctW
- WcType: FloatOutput

Make the following connections:

- AccPct:Out → AccPctW:FltVal
- AccPct:OutMin → AccPctW:MinVal
- AccPct:OutMax → AccPctW:MaxVals

What does the FltVal slot read?________________________________________________

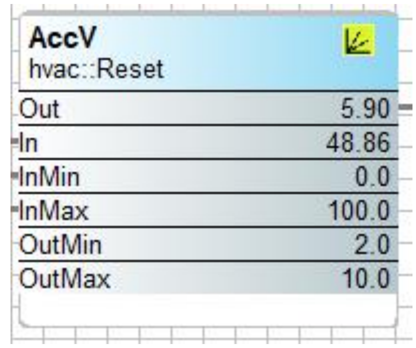
Is FltVal between 0-100%?____________________________________________________

➢ If this does not represent a percentage between 0-100%, you need to troubleshoot.

5.10 - AccV - Actuator Input voltage

We need to map our damper position percentage to 2-10 VDC in order to tell the actuator how much to open.

Add a hvac::Reset block for the Actuator Input voltage to the wire sheet and make the following changes:




- Name: AccV
- OutMin: 2
- OutMax: 10

Make the following connections:

- AccPct:Out → AccV:In
- AccPct:OutMin → AccV:InMin
- AccPct:OutMax → AccV:InMax

What does the Out slot read?________________________________________

Is Out between 2-10 VDC?________________________________________

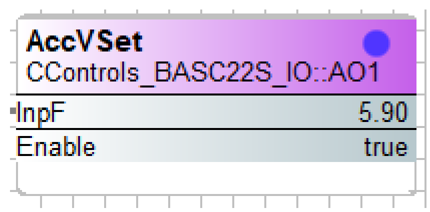
➢ If this does not represent a voltage between 2-10 VDC, you need to troubleshoot.

5.11 - AccVSet – Actuator AO

We now need to tell the actuator how much to open or close and we do that with an AO.

> You will find the AO blocks under the CControls_BASC22_IO or CControls_BASC22S_IO kits depending on your controller.

Add the CControls_BASC22x_IO::AO1 block for the Actuator Input to the wire sheet and make the following changes:




- Name: AccVSet
- Enable: true

Make the following connections:

- AccV:Out → AccVSet:InpF

> By default, Output (AO or BO) blocks are initially disabled when added to the wiresheet. This is for safety when functionality is being added so that the control logic will not engage devices until you actively Enable them.

Using your multimeter, what is the voltage of the AO?________________________________

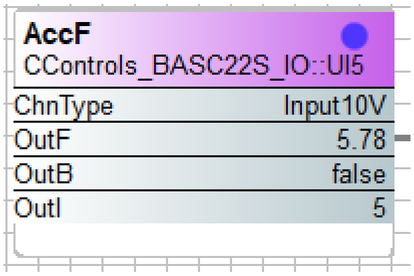
Is the voltage between 2-10 VDC?______________________________________

What does the InpF slot read?________________________________________

Is the voltage measurement close to InpF?___________________________________

➢ If this does not represent a voltage between 2-10 VDC, you need to troubleshoot.

5.12 - AccF – Actuator Feedback voltage




We want to verify that our actuator is operating properly based upon the control voltage we sent to our AO. The feedback voltage should be between 2-10 VDC and the voltage should match closely to the AO for the actuator.

Add the CControls_BASC22x_IO::UI5 block for the actuator feedback to the wire sheet and make the following changes:

- Name: AccF

Using your multimeter, what is the voltage of the AI?___________________________

Is the voltage between 2-10 VDC?_______________________________________

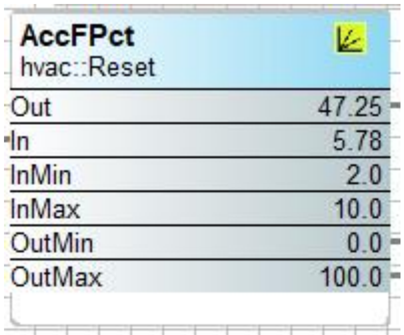
What does the OutF slot read?__________________________________________

Is the voltage measurement close to OutF?_________________________________

➢ If this does not represent a percentage between 2-10 VDC, you need to troubleshoot.

5.13 - AccFPct - Actuator Feedback percentage

We need to map our damper position feedback from 2-10 VDC to a percentage.




Add a hvac::Reset block for the Actuator Feedback voltage to the wire sheet and make the following changes:

- Name:AccFPct
- InMin: 2
- InMax: 10

Make the following connections:

- AccF:OutF → AccFPct:In

What does the Out slot read?___________________________________________

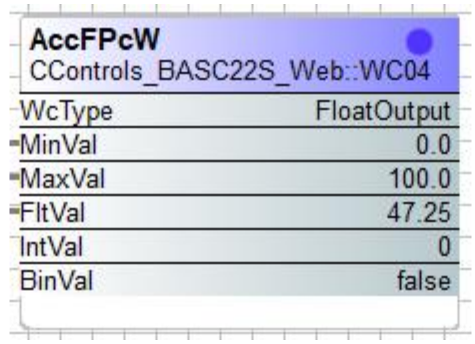
Is Out between 0-100%?_______________________________________________

➢ If this does not represent a percentage between 0-100%, you need to troubleshoot.

5.14 - AccFPcW – Actuator Feedback percentage (HMI)

We are going to use a Web Component (WC) to show the damper position feedback percentage.

Add the CControls_BASC22x_Web::WCO4 block for the damper position feedback percentage to the wire sheet and make the following changes:




- Name: AccFPcW
- WcType: FloatOutput

Make the following connections:

- AccFPct:Out → AccFPcW:FltVal
- AccFPct:OutMin → AccFPcW:MinVal
- AccFPct:OutMax → AccFPcW:MaxVal

What does the FltVal slot read?________________________________________

Is FltVal between 0-100%?____________________________________________

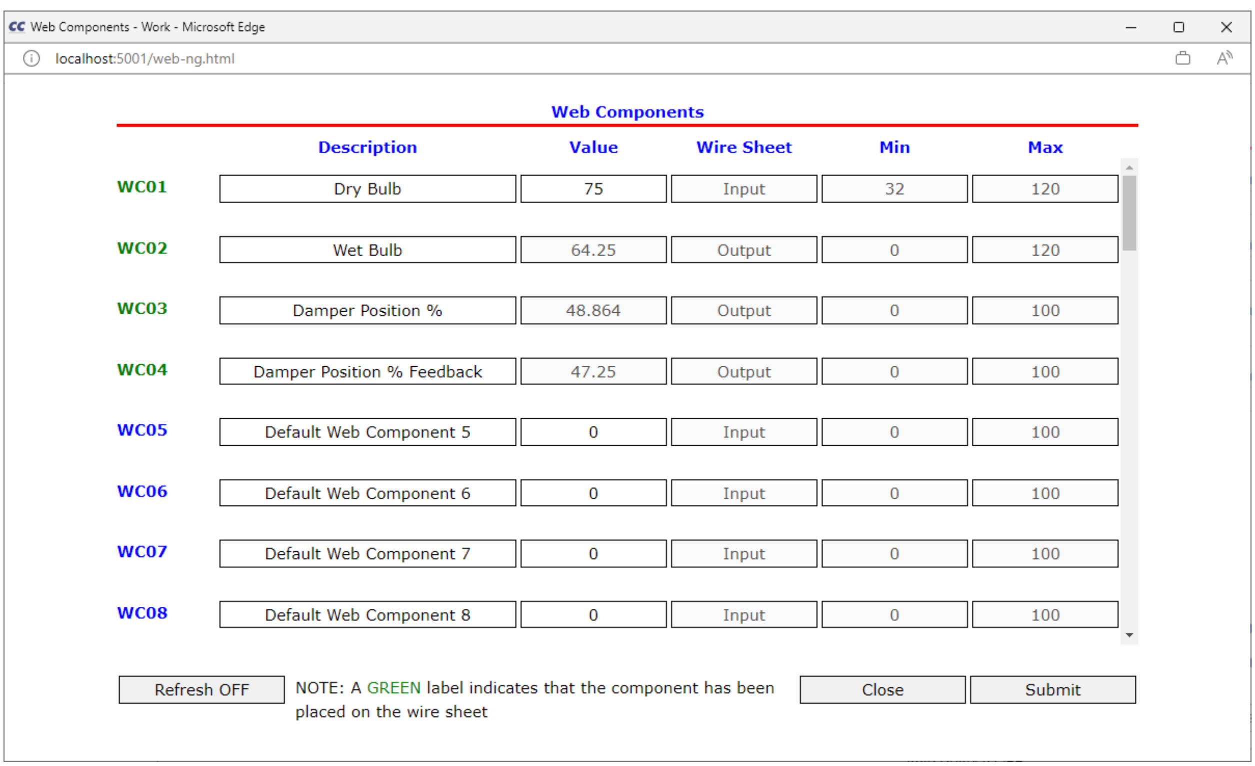
➢ If this does not represent a percentage between 0-100%, you need to troubleshoot.

## Part 6: Verification

We are going to test the functionality of our devices and programming.

6.1 - HMI - Web Components

Open up the controller's webpage and click on the Web Components button near the bottom of the browser.



Verify that you can set the Dry Bulb on the Web Components. The Wet Bulb should adjust and so should the damper position. As the damper position changes, you should the damper position feedback slowly change as it approaches the damper position value.

Make sure you turn Refresh On.

Try different values to make sure the functionality works as expected.

## Part 7: Points List

Fill out the Points List for this lab:

| | Point Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Universal Input | | | | | Virtual / Web | | |
| Point Description | Analog Input | Channel | Binary Input | Analog Output | Binary Output | Analog | Binary | Terminal |
| Actuator Input | | | | | | | | |
| Actuator Feedback | | | | | | | | |
| Humidity Sensor | | | | | | | | |
| | | | | | | | | |
| Dry Bulb | | | | | | | | |
| Wet Bulb | | | | | | | | |
| Actuator % | | | | | | | | |
| Actuator % Feedback | | | | | | | | |
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## Part 8: Instructor Verification

Have the instructor sign your lab demonstrating that you have completed the lab.

Instructor Signature: ___________________________________________

## Part 9: Backup

You will be electronically submitting the work for this lab.

Create a Backup using BASbackup. Make sure you save a copy of this lab.

9.1 - Backup

You are going to use BASbackup to make a backup for submission. The output is a zip file.

## Part 10: Submission

You need to turn in your lab packet as well submit files electronically.

If you do not turn in your lab packet or submit the required files, you will receive a zero for that part of the lab.

10.1 - Electronic lab submission

Electronically submit your lab:

- Backup (zip file)

10.2 - Lab packet

Before leaving class, you must turn in your completed lab packet.

## Part 11: Tear-down

! Stop! Do not start the tear down process until you have electronically submitted your lab.

11.1 - Controller Factory Reset

Factory reset the controller and show your instructor the controller's webpage.

Instructor Signature: ________________________________________________

11.2 - Laptop IP address

Show your instructor that you have successfully changed the IP address to use DHCP.

Instructor Signature:________________________________________________

11.3 - Controller Tear-down

! When disassembling your work, make sure there is no power to the controller or any other device.

When removing conductors from the terminal blocks, unscrew them enough so you can gently remove the wires. Do not forcefully yank the wires out as this will damage the terminals.

After removing a conductor, please make sure the screw is seated in the threads by tightening the screw two turns.