WAKE TECH
Building, Engineering, & Skilled Technologies

Voltage and Current Control Loops Lab

BAT-111: Building Automation Systems

This material is based upon work supported by the National Science Foundation Advanced Technical Education grant program, A New Technician Training Program for Advanced Building Technologies, DUE-2000190.

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Name: ______________________________ Section: ____________________________

Voltage and Current Control Loops Lab

Synopsis

We are going to look at communication between our controller and our devices. We are going to open and close an actuator and examine feedback to make sure the actuator moved using a voltage loop. We are going to read the humidity using a current loop.

This is the hardware setup for the next lab where we will be programming the controller using Sedona.

Objectives

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

1. Connect an actuator using a voltage loop
2. Read the position of the actuator using a voltage loop
3. Read the relative humidity using a current loop

Parts and Equipment

- Contemporary Controls BAScontrol22 or BAScontrol22S
- Ethernet cable
- Laptop
- DC multimeter
- Resistor (510 Ω)
- Short pieces of wire
- Johnson Controls M9108-GGA-2 (or similar actuator that utilizes a voltage loop & has feedback)
- Kele HW20K (or similar actuator that utilizes a current loop)

References

- Contemporary Controls BAScontrol22 User Manual

Background

There are multiple ways to communicate an analog value between the controller and a device. Two simple methods are voltage and current loops.

1.1 - Voltage loop

With a voltage loop, an analog value is expressed with a voltage within a specified range. There is a mapping between a voltage and what it represents.

Common voltage ranges are:

- 2 – 10 VDC
- 0 – 10 VDC

1.2 - Current loop

With a current loop, an analog value is expressed with a current within a specified range. There is a mapping between a current and what it represents.

Common current ranges are:

- 4 – 20 mA
- 0 – 20 mA

One advantage of the current loop is that current remains constant and there may be a voltage drop if we were reading voltage.

A current loop is measured by placing a resistor in the path and is placed at the controller board between the A and C terminal for a Universal Input. By utilizing Ohm's Law, a 500 Ω resistor would translate to the following:

- 4 – 20 mA → 2 – 10 V
- 0 – 20 mA → 0 – 10 V

The controller reads the voltage. With the voltage, we can use ohm's law, to calculate the current.

PROCEDURES

Part 1: Lab Setup

1.1 - Laptop

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 - Controller

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 manual

2.1 - User manual

Find the user manual for your actuator. This will help us determine how to properly install the device.

What is the model of the actuator?______________________________

Power requirements

Can AC be used to power the actuator?______________________________

Can DC be used to power the actuator?______________________________

What are the power requirements for the actuator?______________________________

Input signal

Can a voltage control loop be used to change the position?______________________________

Is the voltage control loop AC or DC?______________________________

Can a current control loop be used to change the position?______________________________

Input signal adjustments:

If the actuator position can be changed by either a voltage or control loop, how do you set that on the actuator?______________________________

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Feedback signal

Can this actuator use a voltage control loop for feedback?______________________________

Can this actuator use a current control loop for feedback?______________________________

Part 3: Actuator

3.1 - Configuration

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

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

3.2 - Power wiring

Wire the actuator using 24 *VAC*.

3.3 - 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.

3.4 - Instructor Review

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

3.5 - 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.

3.6 - Verification – AO

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

Is the AO voltage measurement close to 0 VDC?__________________________________

Looking at the actuator, is it approximately 0% open?______________________________

- ➢ If you answered No to either of the last two questions, troubleshoot the issue.

3.7 - Verification – AI

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

Is the AI voltage measurement close to 2 VDC?__________________________________

- ➢ If the AI is not approximately about 2 VDC, troubleshoot the issue. The actuator may be set to 0-10 VDC instead of 2-10 VDC.

If the AO is 0 VDC, why is the AI 2 VDC?______________________________________

____

____

____

Did we wire the actuator feedback utilizing a voltage or current loop?_______________________

Part 4: Humidity Sensor manual

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

4.1 - User manual

Find the user manual for your humidity sensor. This will help us determine how to properly install the device.

What is the model of the humidity sensor?____

Measurement Range

What type of humidity does this sensor measure?____

What is the measurement range of the sensor?____

Sensor Power requirements

Can AC be used to power the sensor?____

Can DC be used to power the sensor?____

What are the power requirements for the sensor?____

Are we wiring the sensor utilizing a voltage or current loop?_______________________________

Part 5: Humidity Sensor wiring

The sensor is going to give us the relative humidity, so it is an Input and since we are getting a range of values this is an Analog Input.

5.1 - Resistor

We are going to use a current control loop. The current loop requires the usage of a 500 Ω resistor. We use a 510 Ω resistor because it is a standard size, and the error percent is small enough to meet our requirements.

Using your multimeter, what is the resistance of the resistor?______________________________

Is the resistor around 510 Ω?____

- If you answered No, check out if you have the correct resistor.

5.2 - Wiring

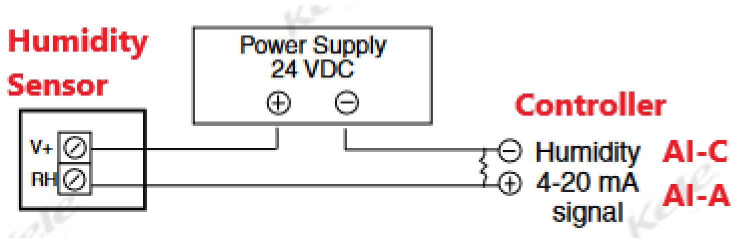
We are going wire the Humidity Sensor utilizing a control loop which requires 24 VDC.

Wire the humidity sensor to the controller using:

- UI1: Humidity Sensor

Wire the humidity sensor according to the following diagram:

Do not forget to utilize the 510 Ω resistor between the A and C terminals on the UI.



5.3 - Instructor Review

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

5.4 - Power on controller and sensor

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

5.5 - Verification

While we are using a current control loop, the mA is so small that most of our multimeters cannot read this small amount of current accurately. We can measure the voltage drop across the resistor and this value should be in the range of 2-10 VDC.

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% which would 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 AI voltage between 5.2-6.8 VDC?____

What does the controller webpage say is the voltage of the AI?______________________

Is the webpage AI voltage between 5.2-6.8 VDC?___________________________________

- If you answered No to any of the questions, troubleshoot the issue.

5.6 - Ohm's law

Ohm's Law is a relationship between voltage, current and resistance.

$$E = I * R$$

The current is dictated by our device and current stays constant throughout the circuit. Since we have a known resistor between the controller's UI-A and UI-C, we can measure the voltage drop and calculate the current on the loop.

What is the control loop voltage (E)? E = ______________________________

What is the resistance (R)? R = ______________________________

Using Ohm's Law, solve for Current.

What is current (give answers in mA and include units)? I = ______________________________

We should expect the current to be in the expected range of 4 – 20 mA.

5.7 - Relative Humidity

We now have the current, but what we want is the relative humidity. Relative humidity is a percentage.

Based upon the current:

- 4 mA: 0% relative humidity
- 20 mA: 100% relative humidity

This dictates the following:

- I_{low}: 4 mA
- I_{high}: 20 mA

We need to calculate the percentage based upon the current, we use the following formula:

$$\% = (I_{loop} - I_{low}) / (I_{high} - I_{low})$$

You should expect this to be a percentage between 0 and 100.

What is the relative humidity?______________________________

➢ If the relative humidity is not between 40 and 60%, troubleshoot the math.

Is this a reasonable relative humidity?______________________________

____

____

Part 6: Points List

Fill out the Points List for every input and output connected to the controller. For Universal Inputs include the Channel Type. Sum the columns to give the number of Points used per Point Type.

Point Description	Point Type						
	Universal Input					Virtual	
	Analog Input	Channel	Binary Input	Analog Output	Binary Output	Analog	Binary
Point Totals:							

- You should have 2 AIs and 1 AO.

Part 7: Instructor Verification

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

Instructor Signature: ____

Part 8: Wiring Diagram

Draw and label all the power and control wiring for your controller, actuator, and sensor.

This must be drawn neatly and be able to be used by someone else to do the wiring.

This is worth ten points.

Part 9: Tear-down

9.1 - Controller Factory Reset

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

Instructor Signature: ____

9.2 - Laptop IP address

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

Instructor Signature:____

9.3 - 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.