WAKE TECH
Building, Engineering, & Skilled Technologies

Controller Output Lab

BAT-111: Building Automation Systems

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Name: _____ Section: _____

Controller Output Lab

BAT-111: Building Automation Systems

SYNOPSIS

In a previous lab, we configured a peer-to-peer network with out controller. In this lab, we will start to work with our controller and investigate outputs.

OBJECTIVES

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

- Understand the power requirements of the BAScontrol22 controller.
- Restore a configuration to the BASControl22 controller.
- Configure an output for the controller.
- Wire an analog and binary output.

PARTS AND EQUIPMENT

- Contemporary Controls BAScontrol22 or BAScontrol22S [https://www.ccontrols.com/basautomation/bascontrol.htm]
- Ethernet cable
- Windows Laptop
- Wiring of assorted colors
- Switch

REFERENCES

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MANUALS

- Contemporary Controls BAScontrol22 User Manual [https://www.ccontrols.com/pdf/um/UM-BASC22V4.pdf]

BACKGROUND

In a previous lab, we successfully powered the BAScontrol22 controller, set up a peer-to-peer connection with the controller and viewed the controller's webpage. This is where this lab begins.

1.1 - Controller

A controller is a device which has input and output functionality to and from an end device.

1.2 - Inputs vs Outputs

An input or output is considered from the reference of the device being discussed.

Input

An input is information coming into the device from another device. A good example of a controller input would be signaling to know whether a light is on or off.

Output

An output is information or a control action leaving the controller to control an end device. An example of an output is signaling to turn the light on or off.

Feedback

Often a controller input is used to verify an output is done correctly. Feedback is knowing/checking the state of the light, after you have signaled to turn the light off.

1.3 - Binary vs Analog

Binary

Binary only has two states. It can be referred to as the following:

- True vs False
- Closed vs Open
- On vs Off
- 1 vs 0

We will refer to binary as any of these and use them interchangeably so note that:

- True = Closed = On = 1
- False = Open = Off = 0

Analog

Analog values have a range of values. A subtle difference in an analog value might mean significant difference in what that value represents.

PROCEDURES

Part 1: Peer-to-Peer network

In a previous lab, we successfully powered the BAScontrol22 controller, set up a peer-to-peer connection with the controller and viewed the controller's webpage. This is where this lab begins.

1.1 - Network Configuration

In BAT-111, we are going to use the default IP address for our controller which is 192.168.92.68.

As we learned in a previous lab, we need to change the IPv4 address of the ethernet adaptor on our laptop so that it is on the same local area network as our controller.

- Laptop: 192.168.92.25
- BAScontrol22: 192.168.92.68

Refer to the previous lab, if you need help to setting up a peer-to-peer network with your controller and laptop.

The IPv4 address we statically assign to out laptop is going to change every lab so we get practice setting different IP addresses on the laptop.
In BAT-111, we are going to use the default IP address for our controller which is 192.168.92.68. In future classes, we will also be changing the IP address of the controller.

Part 2: Controller Configuration

At the beginning of each lab, you will be given a configuration that you will have to restore to your controller.

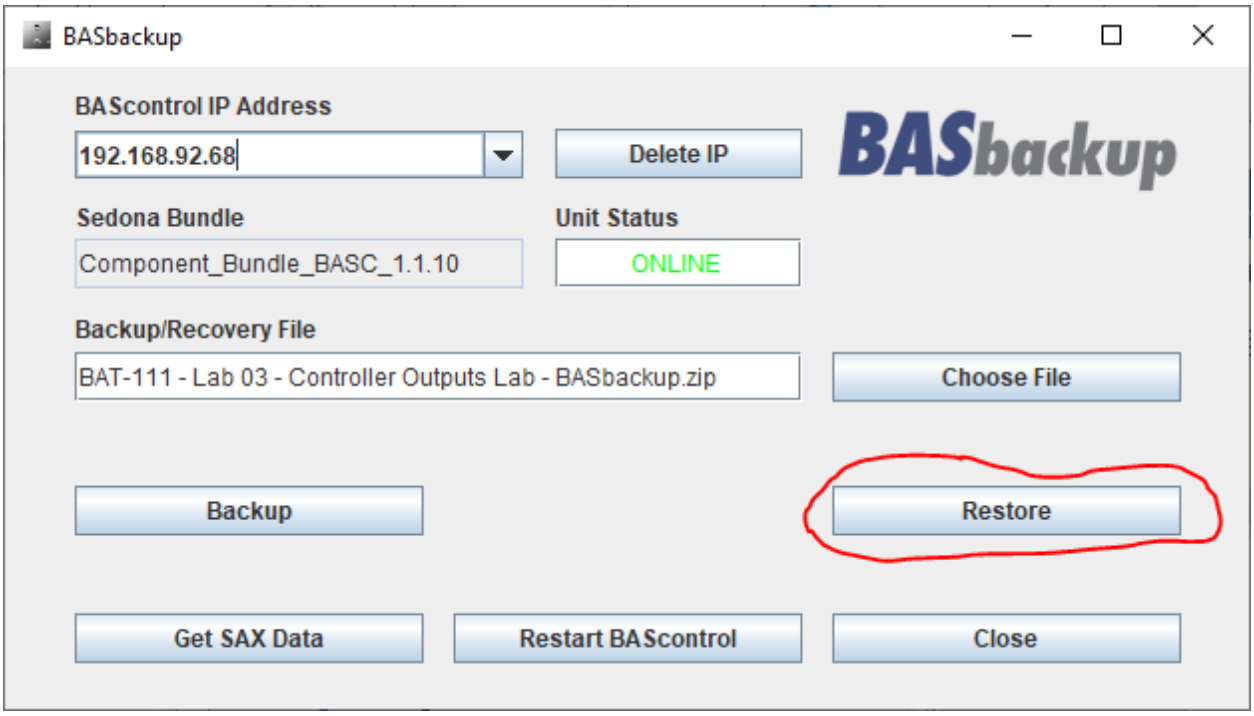
The file is zip and will be included with the lab

2.1 - BASbackup

The BASbackup program can backup the controller or restore a previously backed-up configuration.

If you want to save your work between classes, you will run BASbackup to backup your work on the controller.

Run the Windows program BASbackup.



BAScontrol IP Address

This is the IP address of your controller.

Unit Status

This field shows if you a connection to your controller.

What is the Unit Status?_____

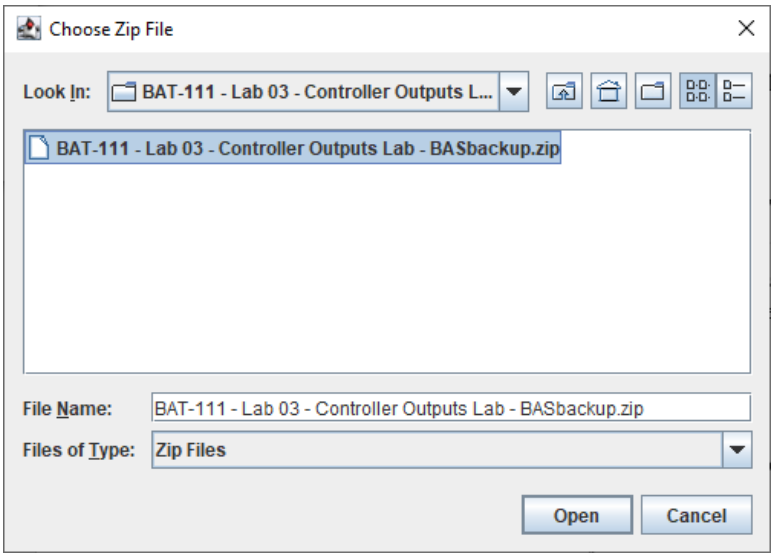
- If the Unit Status is not ONLINE, we need to check the peer-to-peer network.

Backup/Recovery File

- Backup → If you are doing a backup, this is the file saved from your controller's configuration.
- Restore → If you are doing a restore, this is the file used for your controller's configured.

We are doing a restore, so click the "Choose File" button and find the lab's configuration zip file.

Click "Open" button.

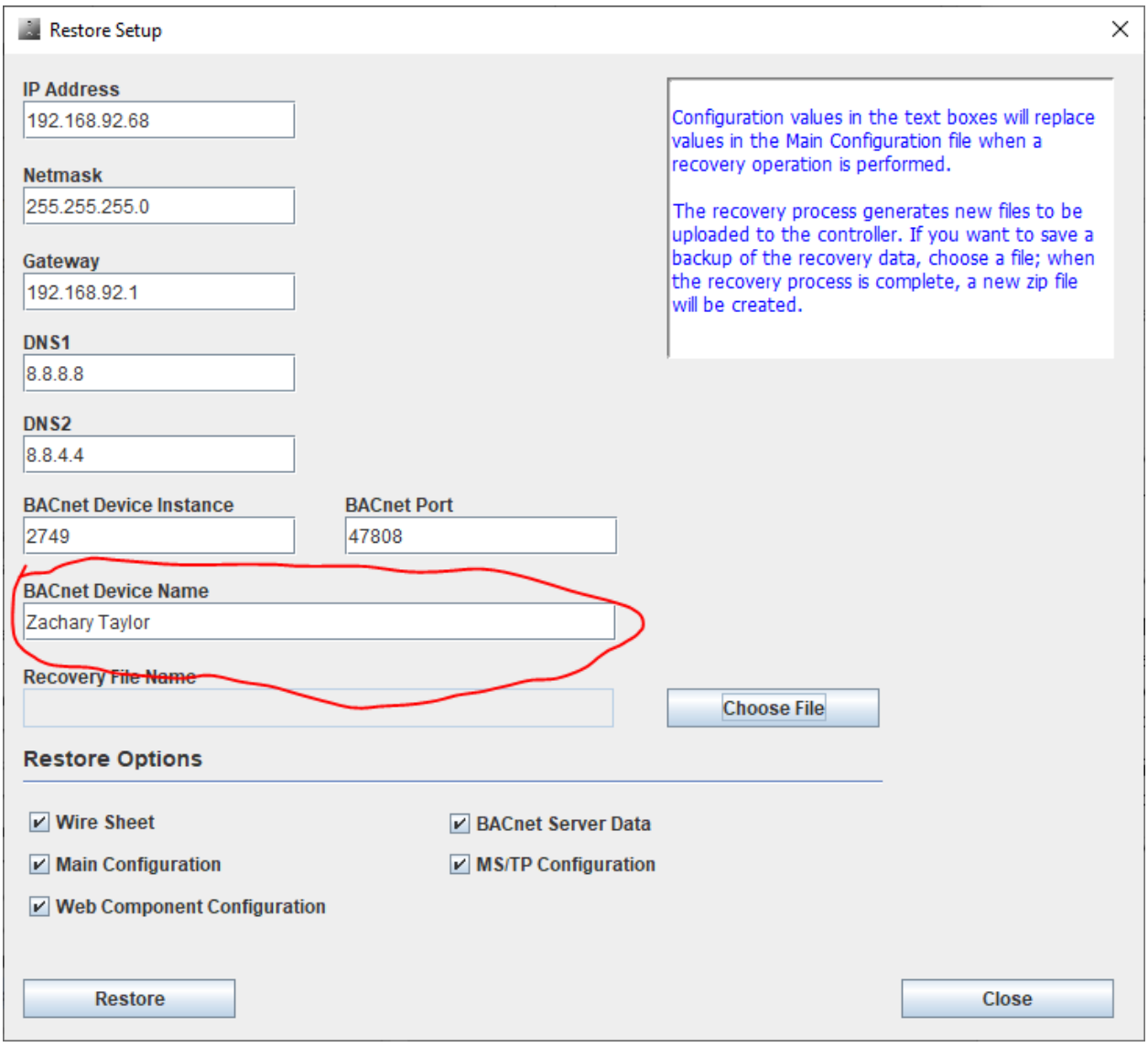


Restore

Click the “Restore” button to start the restore process.

2.2 - Restore Setup

The Restore Setup window will open.



BACnet Device Name

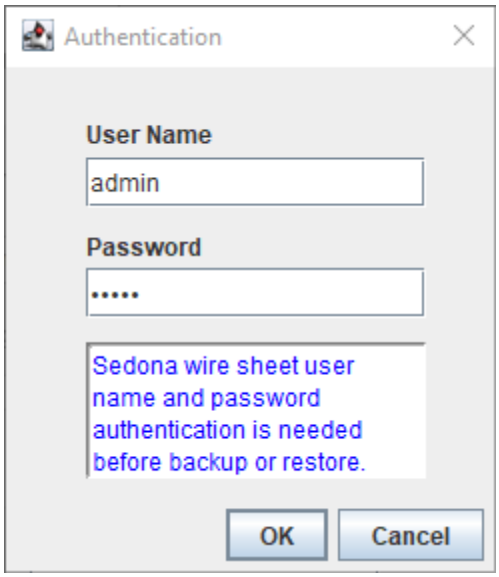
Change the BACnet Device Name, to be your full name.

Restore

Click the “Restore” button.

2.3 - Authentication

The Authentication window will open.



- User Name: admin
- Password: admin

Enter the User Name and Password in the Authentication window.

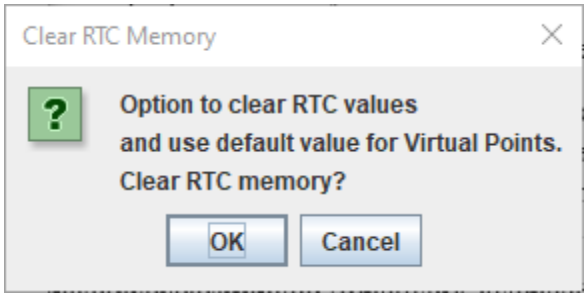
Click the "OK" button to close the Authentication window.

2.4 - Watch

At the bottom of the Restore Setup window, you can watch the configuration steps on the controller.

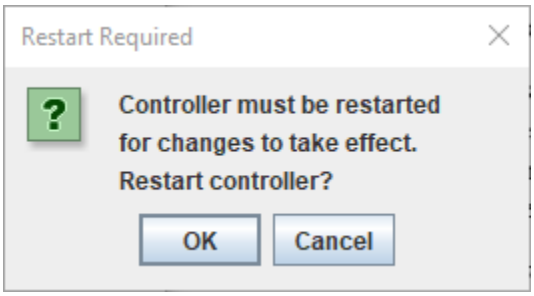
2.5 - Clear RTC Memory

Click "OK" to clear the controller's RTC memory.



2.6 - Restart Required

After restoring the configuration file to the controller, the controller must be restarted.



Click "OK" to restart the controller.

As the controller restarts, the LEDs illuminate the startup sequence of the controller.

Close the Restore Setup window by clicking the "Close" button.

BASbackup window

Look at the BASbackup window, check the Unit Status to make sure after the controller has finished the startup sequence and that the Unit Status is ONLINE.

Close the BASbackup window.

Part 3: Controller Webpage

3.1 - IP address

Devices in the local area network must each have a unique IP address.

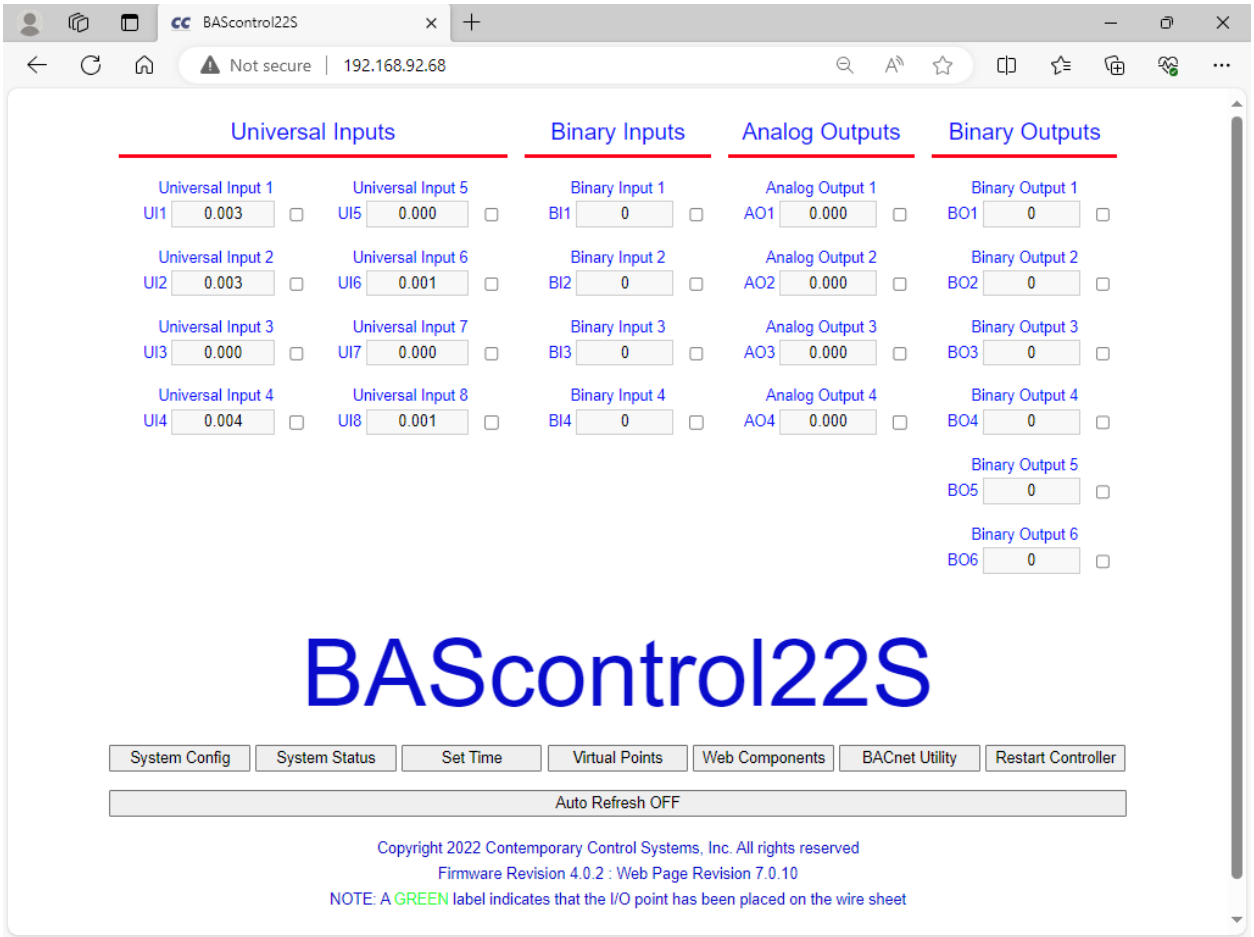
What is your laptop's IP address?_____

What is your controller's IP address?_____

- The IP addresses should not be the same.

3.2 - Webpage

Open a browser and go to the controller's webpage using the controller's IP address.



Part 4: Controller

We need to learn a little about the BAScontrol22 by referencing the controller's manual.

4.1 - Power Supply

Open the User Manual for your controller and find section 3.1: Power Supply.

Can the controller be powered by AC, DC, or either?_____

What are the voltage requirements for the controller defined by the user manual?_____

Are you powering your controller by AC or DC?_____

Using your voltmeter, what is the source voltage at the power terminal screws?_____

4.2 - Cabling

Open the User Manual and find section 3.2: Cabling Considerations.

Can you use solid, stranded, or both for I/O?_____

What are the specifications for solid conductors?_____

What are the specifications for stranded conductors?_____

4.3 - Device

Take a look at the controller. You have previously found the Power LED.

Are the power requirements shown on the controller?_____

Does the controller have a chassis ground?_____

Part 5: Analog Outputs (AO)

Analog Outputs (AO) are used to produce a range of values. Analog Outputs represent data that is not just binary.

AOs represent a range of values with a voltage range.

For example, an AO can be used to tell a damper or valve to be a certain percentage open.
With an economizer, we want a percentage of the mixer air to come from the outside and the rest from the return. For example, we could have the outside air damper open 30% and the return air damper open 70%. If we used a BO to adjust the outside air damper, we could only tell the damper to be completely open or completely closed.

5.1 - Specifications

Open the User Manual and find section 2.4: Analog Outputs.

What is the output voltage range?_____

Is the output voltage AC or DC?_____

What is the maximum amperage?_____

Looking at the controller, how many AOs are there?_____

5.2 - Check Analog Output

AO with 0 volts

We are going to start by looking at AO1 which is Analog Output 1.

Looking at the webpage find AO1. If AO1 is checked, uncheck the override.

The value represents the voltage at this output. You should see ‘0.000’ which represents 0 volts dc.

There are no LEDs for the Analog outputs.

Check the voltage of AO1 by placing one probe on A and the other probe on C.

Make sure your multimeter is reading VDC.

Using your meter, what is the voltage of AO1?_____

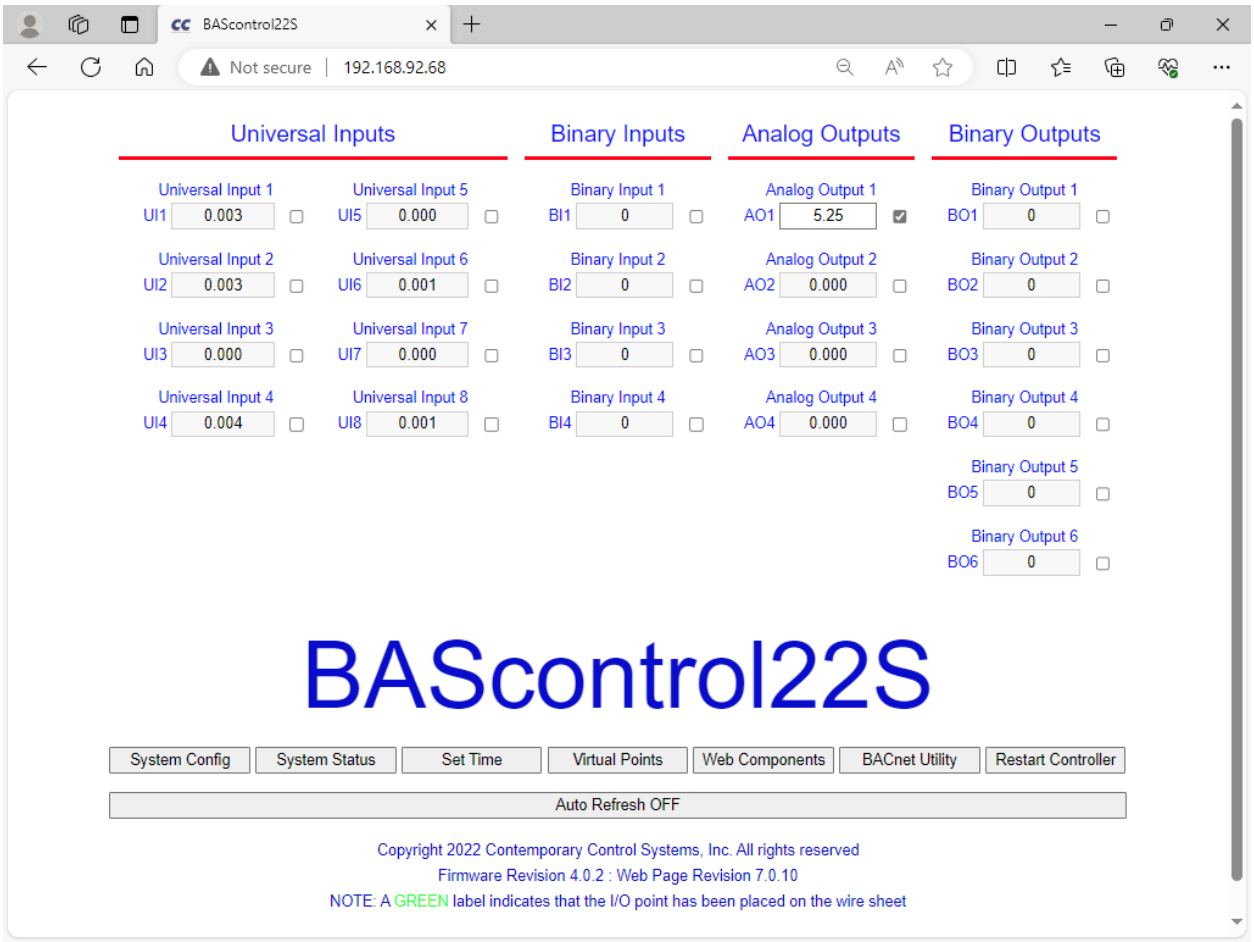
Since the webpage has a ‘0.000’ for AO1, the voltage should be close to 0 volts. I would expect some minor differences in voltage within 100 mV with your meter. A large difference could mean an issue with the controller or the meter. Check with a second meter if the voltage difference is large.

AO with 5.25 volts

We are now going to override AO1 to output 5.25 volts dc.

On the webpage, override the current value by checking the checkmark to the right of AO1. We are going to change AO1, by placing a ‘5.25’ in the textbox which would represent 5.25 volts.

There is no audible click from your controller when you change analog outputs.



Using your meter, what is the voltage of AO1?_____

What is the difference between the overridden voltage and what your meter reads?_____

Is this voltage difference reasonable (within 100 mV)?_____

- If the voltage difference is not within 100 mV, investigate the issue.

Did AO1 behave correctly and if not, what was wrong?_____

_____

_____

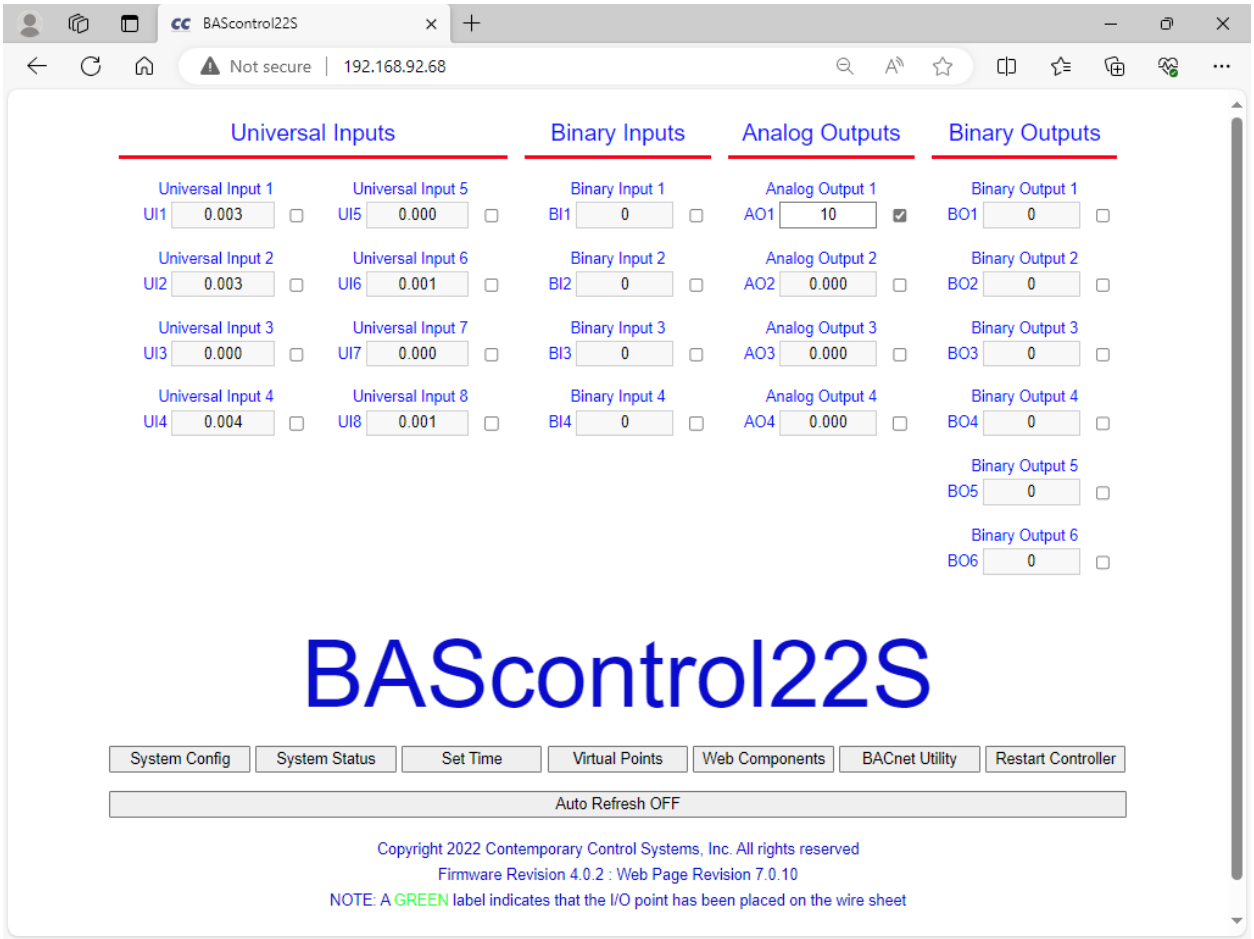
Part 6: LED

LEDs are utilized to give feedback to humans. For example, the LED on the Power terminal of the controller tells us that the controller is receiving the correct voltage.

6.1 - AO1 Voltage

The Analog Outputs of the BAScontroll22 can deliver 0-10 VDC. We are going to use 10 VDC from AO1 to illuminate an LED.

Override AO1 to have a voltage of 10 VDC.



Using your meter, what is the voltage of AO1?_____

- If the voltage is not approximately 10 VDC, investigate the issue with your instructor.

6.2 - LED

We are going to wire the AO1 to a 10 VDC LED.

Turn off the power to the controller and wire the LED to A01.

The instructor must check all wiring, before power is applied to the controller.

After the instructor has checked the wiring, apply power to the controller and wait until the startup sequence has finished.

Is the LED illuminated?_____

- If the LED is not illuminated, investigate the issue.

Part 7: Physical switch

We now wired and illuminated an LED to our controller, but now we want to add a physical switch so we can manually turn the LED on or off.

Turn off the power to the controller and wire the switch in between the AO1-A terminal and the LED terminal.

The instructor must check all wiring, before power is applied to the controller.

After the instructor has checked the wiring, apply power to the controller and wait until the startup sequence has finished.

Does the switch toggle the illuminated LED?_____

- If the LED is not illuminated, investigate the issue.

Part 8: Binary Output

We have wired the lab to use a physical switch that can turn the LED on and off.

What if we want to control the LED remotely and there is no one available to physically flip the switch? We can use the controller to operate as the switch.

A binary output is like a physical switch we control. We can flip the switch and open or close a connection. With a binary output instead of flipping a physical switch, we can have the controller open or close the relay through software.

We can do this via the controller's webpage or through programming the controller. For this lab, we will override the switch using the controller's webpage.

8.1 - Specifications

Open the User Manual and find section 2.5: Relay Outputs

Is the relay contact normally open or closed?_____

What is the maximum voltage allowed to flow through this relay?_____

What is the maximum amperage allowed to flow this relay?_____

8.2 - Continuity Tester

We are going to be using the continuity tester functionality of our multimeter to verify if our binary outputs are open or closed as expected.

Make sure your continuity checker is working by touching the probes together. Some continuity testers may emit a noise when there is continuity. Depending on your meter, when you separate your probes, you may see 'OL' for open load if there is no continuity.

8.3 - Check Binary Output

BO set to False

Looking at the webpage find BO1. If BO1 is checked, uncheck the override. You should see a value of '0' to the right of BO1. '0' represents false or open or off.

There is an LED light on your controller which will physically tell you if the binary output is open or closed. The LED on the controller is located between the terminal block and cover.

Is the LED light illuminated for BO1?_____

Check the continuity of BO1 by placing one probe on A and the other probe on B.

Is there continuity for BO1?_____

Since the webpage has a '0' for BO1, the LED light should not be lit and there should not be continuity on BO1.

BO set to True

We are now going to change BO1 to be True.

On the webpage, override the current value by checking the checkmark to the right of BO1. We now have the ability to override and edit the value for BO1. We are going to change BO1 to True, by placing a '1' in the textbox and hit Enter.

Did you hear an audible click from your controller?_____

- As soon as you hit Enter or click somewhere else on the webpage, you should hear an audible click from your controller.

Is the LED light illuminated for BO1?_____

Check the continuity of BO1 by placing one probe on A and the other probe on B.

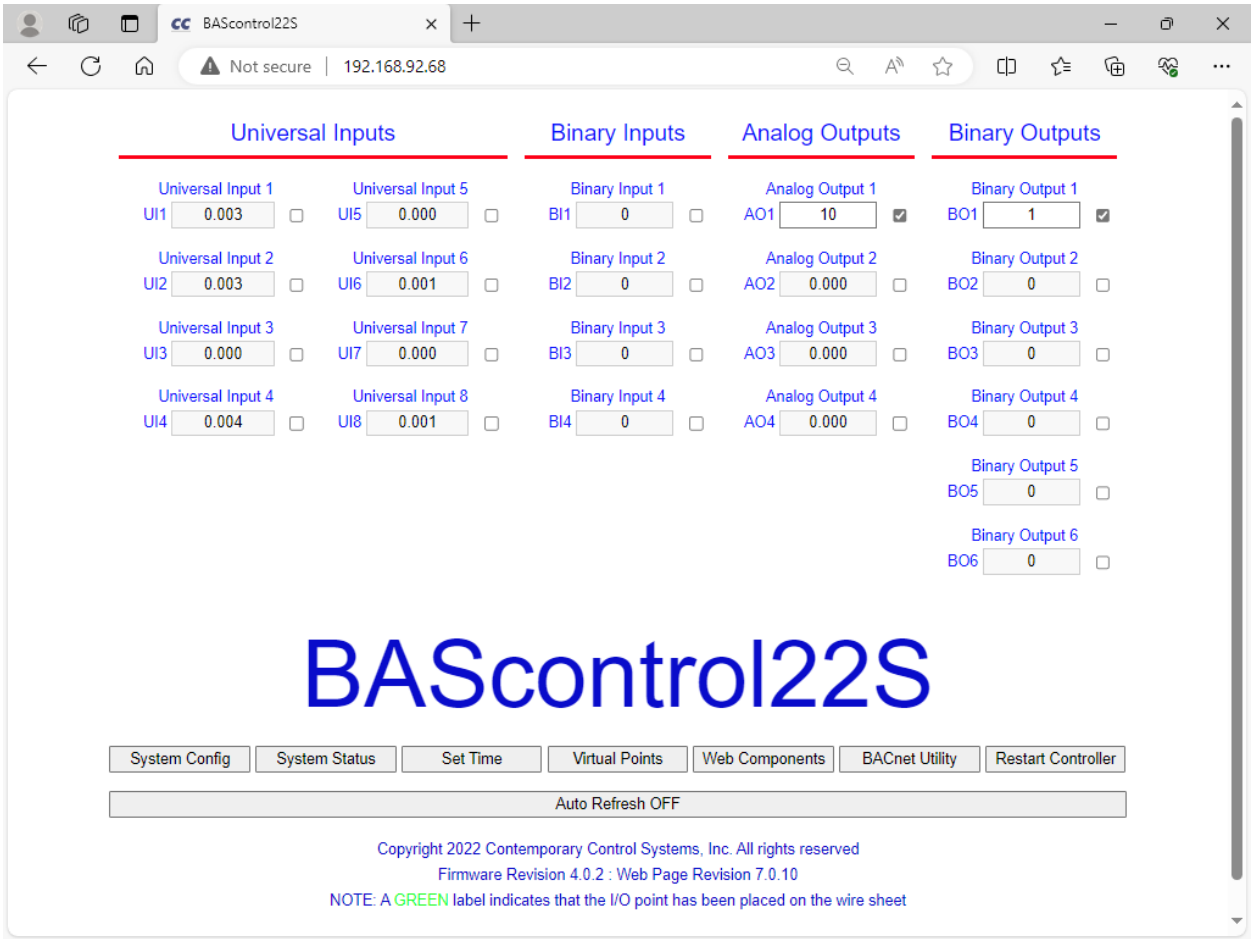
Is there continuity for BO1?_____

Since the webpage has a '1' for BO1, the LED light should be lit and there should be continuity on BO1.

Did BO1 behave correctly and if not, what was wrong?_____

_____

_____



Part 9: Binary switch

We now wired and illuminated an LED to our controller with a physical switch, but now we want to have the controller be able to switch the LED.

Turn off the power to the controller and replace the physical switch with BO1.

The instructor must check all wiring, before power is applied to the controller.

After the instructor has checked the wiring, apply power to the controller and wait until the startup sequence has finished.

BO1 set to false

Clear the override for BO1 which sets BO1 to false.

Is the LED illuminated?_____

- If the LED is illuminated, investigate the issue.

BO1 set to true

Override BO1 to be true.

Is the LED illuminated?_____

- If the LED is not illuminated, investigate the issue.

Part 10: Switches in Series

We are now going to wire the switches in series.

Turn off the power to the controller and wire the physical switch in series with BO1.

The instructor must check all wiring, before power is applied to the controller.

After the instructor has checked the wiring, apply power to the controller and wait until the startup sequence has finished.

Fill out the table on whether the LED is illuminated:

		Physical Switch	
		True	False
BO1	True		
	False		

Part 11: Switches in Parallel

We are now going to wire the switches in parallel.

Turn off the power to the controller and wire the physical switch in parallel with BO1.

The instructor must check all wiring, before power is applied to the controller.

After the instructor has checked the wiring, apply power to the controller and wait until the startup sequence has finished.

Fill out the table on whether the LED is illuminated:

		Physical Switch	
		True	False
BO1	True		
	False		

Part 12: Instructor Verification

Demonstrate to your instructor that you have successfully illuminated an LED with two switches in parallel.

12.1 - Instructor Signature

Have the instructor sign your lab demonstrating that you have successfully illuminated an LED with two switches in parallel.

Instructor Signature?_____

Part 13: Tear-down

13.1 - Laptop

Set the ethernet adaptor to receive its IP address dynamically from DHCP.

13.2 - Controller

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.