

Final Lab

BAT-111: Building Automation Systems



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The opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Name: _____

Section: _____

Final Lab

SYNOPSIS

Students will demonstrate the skills they have learned in BAT-111: Building Automation Systems.

OBJECTIVES

Upon completion of this activity, the student will demonstrate they can:

- Wire an actuator using a voltage control loop.
- Wire a humidity sensor using a current control loop.
- Wire a SPST switch.
- Wire a pilot light.
- Programmatically illuminate a pilot light.

PARTS AND EQUIPMENT

- [Contemporary Controls BAScontrol22 or BAScontrol22S Johnson Controls M9108-GGA-2](#)
(or similar actuator that uses a voltage loop & has feedback)
- [Kele HW20K](#) (or similar actuator that uses a current loop)
- Ethernet cable
- Laptop
- DC multimeter
- SPST switch
- Pilot light

MANUALS

- [Contemporary Controls BAScontrol22 User Manual Johnson Controls M9108, M9116, M9124, and M9132 Series Electric Non-Spring Return Actuators Install Manual](#)

- [Kele HW20K](#)

PROCEDURES

Students will not be able to reference any other resources, including labs.



There is a 10-point penalty for changing live wiring.

Part 1: Controller Power (2 points)

Wire the controller using 24 VAC.

1.1 - Instructor Review

Show the instructor the controller's power wiring.



Stop! Do not continue until the instructor inspects the wiring.

Part 2: Laptop IP address – static (2 points)

Change the laptop's IP address to 192.168.92.60.

2.1 - Instructor Review

Show the instructor the highlighted IP address for the correct network adaptor in the ipconfig.

```
Ethernet adapter Ethernet 2:

Connection-specific DNS Suffix . : 
Link-local IPv6 Address . . . . . : fe80::7350:d348:53fb:3626%11
IPv4 Address. . . . . : 192.168.92.60
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.92.1
```



Stop! Do not continue until the instructor verifies the IP address.

Part 3: Lab Configuration (2 points)

It is your responsibility to troubleshoot connectivity to the controller.

3.1 - Controller configuration

Restore the proper lab configuration to the controller.



Enter your First & Last Name for the BACnet Device Name.

Restore Setup

Configuration values in the text boxes will replace values in the Main Configuration file when a recovery operation is performed.

The recovery process generates new files to be uploaded to the controller. If you want to save a backup of the recovery data, choose a file; when the recovery process is complete, a new zip file will be created.

IP Address: 192.168.92.68

Netmask: 255.255.255.0

Gateway: 0.0.0.0

DNS1: 8.8.8.8

DNS2: 8.8.4.4

BACnet Device Instance: 2749

BACnet Port: 47808

BACnet Device Name: First & Last Name

Recovery File Name:

Restore Options

- ☒ Wire Sheet
- ☒ Main Configuration
- ☒ Web Component Configuration

3.2 - Verify

Confirm the proper configuration file has been installed by looking at the controller's webpage and the label for BO6 should be "Final Lab."

3.3 - Instructor Review

Show the instructor the controller's webpage.



Stop! Do not continue until the instructor verifies the controller's configuration.

Part 4: Web Components - HMI

Web Components

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	Description	Value	Wire Sheet	Min	Max
WC01	Actuator %	50.000000	Input	0.000000	100.000000
WC02	Actuator Input Voltage	6.000000	Output		
WC03	Actuator Feedback Voltage	0.004340	Output		
WC04	Actuator Feedback %	0.000000	Output		
WC05	Humidity Sensor Voltage	0.005574	Output		
WC06	Relative Humidity %	0.000000	Output		
WC07	Switch	0.000000	Input	0.000000	100.000000
WC08	Pilot Light	0.000000	Input	0.000000	100.000000

Auto Refresh ON

NOTE: A GREEN label indicates that the component has been placed on the wire sheet.

Close

Submit

The HMI has already been created and was installed with the lab configuration.

View the Web Components and verify the HMI for the actuator, humidity sensor, SPST switch, & pilot light.

There is no student work for this part.

Part 5: Actuator – wiring (10 points)

Wire the actuator input and feedback to the controller.

5.1 - Configuration

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

- Reverse Action
- Actuator input: 2-10 VDC
- Actuator feedback: 2-10 VDC

5.2 - Wiring

Wire the actuator using 24 VAC and use the UI5 and AO1 terminals on the controller.

5.3 - Instructor Review

Show the instructor the wiring for the actuator.



Stop! Do not continue until the instructor inspects the wiring.

Part 6: Humidity Sensor - wiring (10 points)

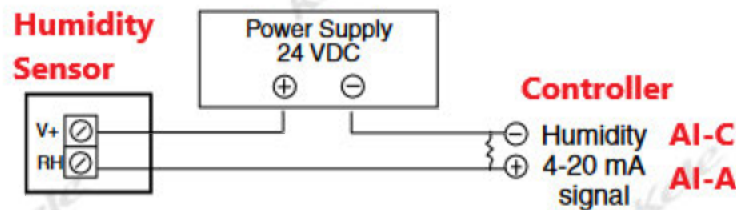
Wire the humidity sensor to the controller.

6.1 - Wiring

Wire the humidity sensor using 24 VDC and use the first appropriate available IO terminal on the controller.



Do not forget to use the resistor.



6.2 - Instructor Review

Show the instructor the wiring for the humidity sensor.



Stop! Do not continue until the instructor inspects the wiring.

Part 7: Switch - wiring (5 points)

Wire a SPST switch to the controller and use the first appropriate available IO terminal on the controller. Do not use a Universal Input for the switch.

7.1 - Instructor Review

Show the instructor the wiring for the SPST switch.



Stop! Do not continue until the instructor inspects the wiring.

Part 8: Pilot Light - wiring (5 points)

Wire the green pilot light to the controller using 24 VDC and use the first appropriate available IO terminal on the controller.

8.1 - Instructor Review

Show the instructor the wiring for the pilot light.



Stop! Do not continue until the instructor inspects the wiring.

Part 9: Demonstrate IO (5 points)

Turn on the Controller and verify the IO devices.

9.1 - Actuator

Use the HMI, to verify the actuator input and feedback are working correctly. Change the “Actuator %” in WC01 to verify the actuator is behaving as expected. Verify that feedback changes appropriately as “Actuator %” changes.

9.2 - Humidity Sensor

View the HMI, to verify the humidity sensor is working correctly and the Relative Humidity is reasonable.

9.3 - SPST Switch

Toggle the SPST switch and verify that the controller’s indicator for the switch illuminates only when the switch closes.

9.4 - Pilot Light

In a later part of the lab, we will be using Sedona programming to illuminate the pilot light. There is no demonstration for the pilot light.

9.5 - Instructor Review

Show the instructor that the actuator, humidity sensor, and SPST switch are functioning correctly.



Stop! Do not continue until the instructor verifies the IO.

Part 10: Points List (5 points – one attempt)

Fill out the Points List and include all physical connections to the controller. Do not include any Virtual/Web points.

Students only get one attempt at the Points List.

10.1 - Instructor Review

Have the instructor grade the Points List.



Stop! Do not continue until the instructor grades the Points List.

Part 11: Sedona - Switch & Pilot Light (8 points – one attempt)

Using Sedona, code the pilot light to illuminate only when the switch closes. The status of the switch and pilot light should also update on the Web Component HMI.

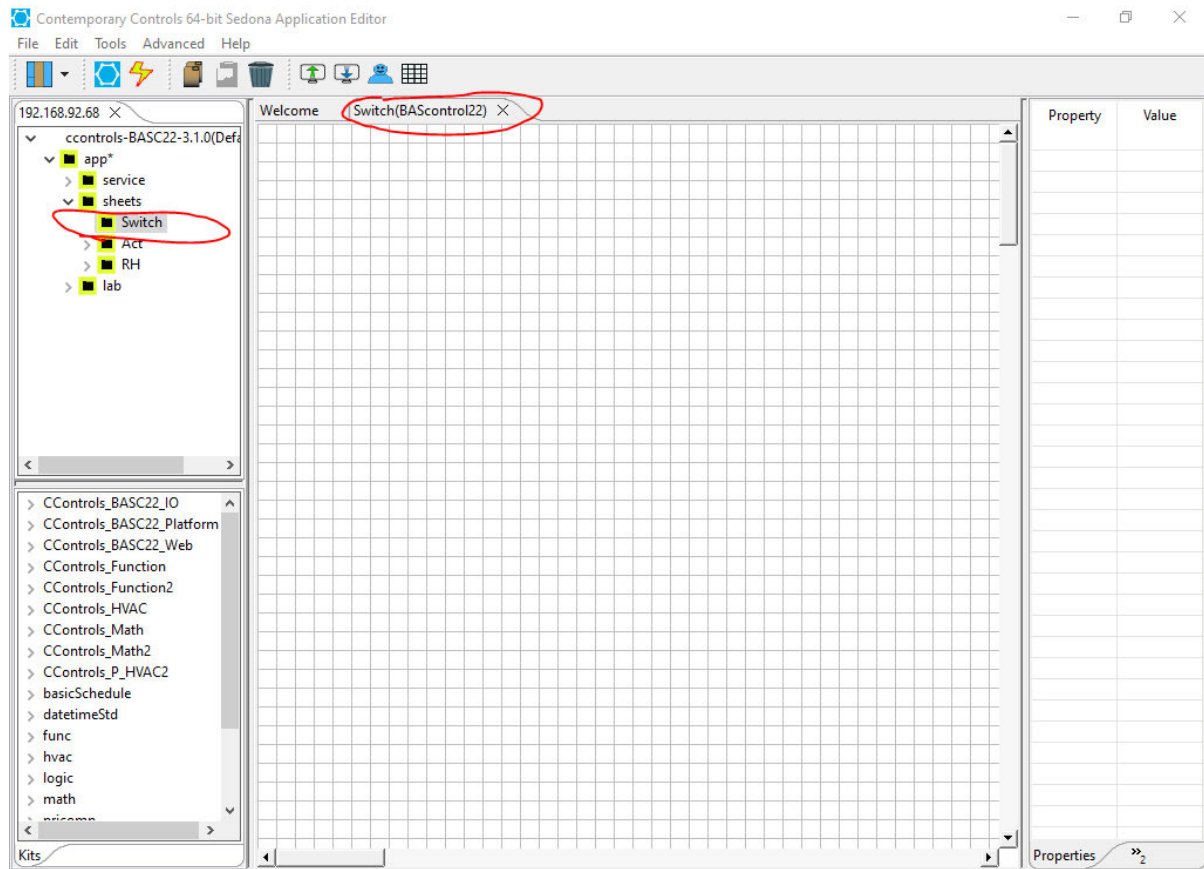
Students only get one attempt at the Sedona programming.



Do not change any wiring!

11.1 - Wire sheet (2 points)

The coding for the switch and pilot light needs to be on the Switch wire sheet.



11.2 - HMI – Switch (2 points)

Add the proper code so the SPST switch displays as an output for WC07 in the HMI.

Note: The WC07 function block should reference the IO block function directly.

11.3 - HMI – Pilot Light (2 points)

Add the proper code so the pilot light displays as an output for WC08 in the HMI.

Note: The WC08 function block should reference the IO block function directly.

11.4 - Pilot light illumination (2 points)

Add the proper code to illuminate the pilot light when the SPST switch closes.

Note: The BO function block should take the BI function block as an input and not the WC07 or WC08 function blocks.

11.5 - Verify – Switch Open

Verify that when the SPST switch opens, the pilot light does not illuminate, and the Switch and Pilot Light have a value of false (0) in the HMI.

Web Components - Google Chrome

Not secure 192.168.92.68/web.html

Web Components

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	Description	Value	Wire Sheet	Min	Max
WC01	Actuator %	50.000000	Input	0.000000	100.000000
WC02	Actuator Input Voltage	6.000000	Output		
WC03	Actuator Feedback Voltage	0.004960	Output		
WC04	Actuator Feedback %	0.000000	Output		
WC05	Humidity Sensor Voltage	0.005574	Output		
WC06	Relative Humidity %	0.000000	Output		
WC07	Switch	0.000000	Output		
WC08	Pilot Light	0.000000	Output		

Auto Refresh ON

NOTE: A GREEN label indicates that the component has been placed on the wire sheet.

Close Submit

11.6 - Verify – Switch Closed

Verify that when the SPST switch closes that the pilot light illuminates, and the Switch and Pilot Light have a value of true (1) in the HMI.

Web Components - Google Chrome

Not secure 192.168.92.68/web.html

Web Components

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	Description	Value	Wire Sheet	Min	Max
WC01	Actuator %	50.000000	Input	0.000000	100.000000
WC02	Actuator Input Voltage	6.000000	Output		
WC03	Actuator Feedback Voltage	0.004340	Output		
WC04	Actuator Feedback %	0.000000	Output		
WC05	Humidity Sensor Voltage	0.004335	Output		
WC06	Relative Humidity %	0.000000	Output		
WC07	Switch	1.000000	Output		
WC08	Pilot Light	1.000000	Output		

Auto Refresh ON

NOTE: A GREEN label indicates that the component has been placed on the wire sheet.

Close Submit

11.7 - Save

Save the Sedona programming to the controller.

11.8 - Instructor Review

Have the instructor grade the Sedona programming.



Stop! Do not continue until the instructor grades the Sedona programming.

Part 12: Electronic Submission (2 points)

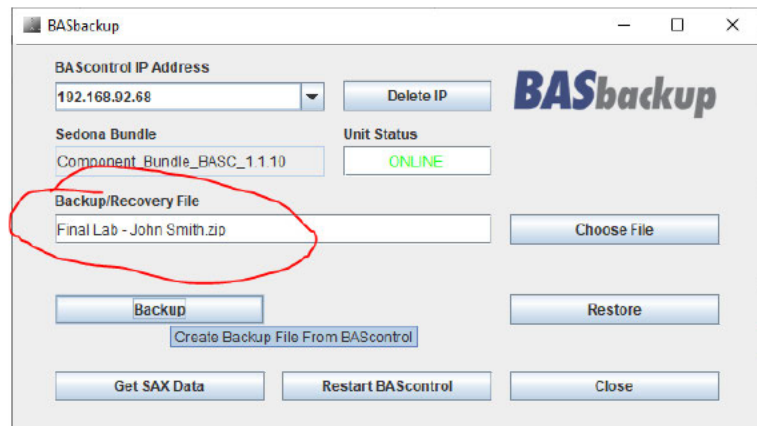
Submit a backup of the work electronically.

12.1 - Backup

Using BASbackup, create a backup of your work.

The Backup file should be named:

“Final Lab – [First & Last Name].zip”



12.2 - Electronic Lab Submission

Electronically submit the lab and include the following in the submission:

- Backup (zip file)

12.3 - Instructor Review

Have the instructor verify the lab submission.



Stop! Do not continue until the instructor verifies the lab submission.

Part 13: Controller Factory Reset (2 points)

Factory reset the controller.

13.1 - Instructor Review

After the controller resets, show the instructor the controller's *refreshed* webpage.



Stop! Do not continue until the instructor verifies the controller has been factory reset.

Part 14: Laptop IP address – dynamic (2 points)

Change the laptop's network adaptor to obtain the IP address automatically from a DHCP server.

```
Ethernet adapter Ethernet 2:  
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::7350:d348:53fb:3626%11  
Autoconfiguration IPv4 Address. . : 169.254.251.87  
Subnet Mask . . . . . : 255.255.0.0  
Default Gateway . . . . . :
```

14.1 - Instructor Review

Show the instructor the highlighted IP address for the correct network adaptor in the ipconfig.



Stop! Do not continue until the instructor verifies the laptop's network adaptor's IP settings.

Part 15: Lab Packet

Hand in the lab packet and Submission Sheet to the instructor.

Part 16: Controller Tear-down



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

When removing conductors from the terminal blocks, unscrew the terminals enough so the wires can be removed without damaging the terminal blocks. Do not forcefully yank the wires out as this will damage the terminals.

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

FINAL LAB SUBMISSION SHEET

Name: _____

Section: _____

Part 1: Points List

Note: For any Universal Input(s), fill out both the Input and Channel columns.

Point Description	Point Type				
	Universal Input		Binary Input	Analog Output	Binary Output
	Input	Channel			

Part 2: Instructor Section**THIS SECTION IS FOR INSTRUCTOR USE ONLY.**

Start Time: _____ Finish Time: _____ Live Wiring penalty: _____

Start Time: _____ Finish Time: _____ Total Time: _____

	Maximum Points	Point loss per add. Attempt	Attempts	Points Earned
Controller Power	2	1		
Laptop IP address - static	2	1		
Lab Configuration	2	1		
Actuator - wiring	10	4		
Humidity Sensor - wiring	10	4		
Switch - wiring	5	2		
Pilot Light - wiring	5	2		
Demonstrate IO	5	2		
Points List	5	5		
Sedona	8	8		
Submission	2	1		
Controller Factory Reset	2	1		
Laptop IP address - dynamic	2	1		
Total	60			