WAKE TECH
Building, Engineering, & Skilled Technologies

Controller Input Lab

BAT-111: Building Automation Systems

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SYNOPSIS

In a previous lab, we started exploring the BAScontrol22 controller and looking at analog and binary outputs. We will now look at the distinct types of analog inputs.

OBJECTIVES

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

- Understand input and outputs for a device.
- Understand the various inputs the BASControl22 can read.
- Wire a voltage source, thermistor, switch, and resistor as an input to our controller.

PARTS AND EQUIPMENT

- Contemporary Controls BAScontrol22 or BAScontrol22S
  [https://www.ccontrols.com/basautomation/bascontrol.htm]
- Ethernet cable
- Windows Laptop
- Wiring of assorted colors
- Switch
- 510Ω resister

REFERENCES

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MANUALS

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

BACKGROUND

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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: Lab Setup

We need to set up a peer-to-peer network with the controller and download the BASbackup configuration for the lab.

1.1 - Network Configuration

Set up a peer-to-peer network with the controller using the following IPv4 addresses:

- Laptop: 192.168.92.30
- BAScontrol22: 192.168.92.68

1.2 - <u>BASbackup</u>

Restore the lab configuration for this lab to the controller using BASbackup.

Refer to the previous lab if you need help running BASbackup.

1.3 - <u>Controller Webpage</u>

Open the controller's webpage to verify that the peer-to-peer network is set up successfully.

What is your laptop's IP address?_____

What is your controller's IP address?_____

➢ The IP addresses should not be the same.

Part 2: Binary Inputs (BI)

Binary Inputs (BI) are used to check if there is a closed circuit.

The controller checks if there is continuity between the two terminals.

2.1 - <u>Specifications</u>

Open the User Manual and find section 2.3: Binary Inputs.

According to the documentation, how does the controller determine if the Binary Input is True? _____

How does the controller determine if the Binary Input is False? _____

What is the response time? _____

Looking at the controller, how many BIs are on the controller? _____

2.2 - <u>Check Binary Input</u>

We are going to connect a physical switch to a Binary Input.

> Some of the switches are double-pole, single-throw switches so use the continuity on your multimeter to determine which terminals to use. Use the continuity checked of your multimeter to determine which terminals to use for the lab.

Turn off the power to the controller and wire the switch to BI1.

> 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 and refresh the browser.

BI with a closed switch

With the switch closed, answer the following questions:

Is the LED illuminated? _____

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

> Do not check continuity on a live circuit.

Using your multimeter, what is the voltage of BI1? _____

How does the controller use the voltage to determine if the BI is closed? _____

_____

_____

BI with an open switch

With the switch open, answer the following questions:

Is the LED illuminated?_____

> If the LED is illuminated, investigate the issue.

> ⓘ Do not check continuity on a live circuit.

Using your multimeter, what is the voltage of BI1?_____

How does the controller use the voltage to determine if the BI is open?_____

_____

_____

Part 3: Analog Inputs (AI)

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

AIs represent a range of values with a voltage range.

> 👁 For example, an AI can be used for feedback from a damper or valve to explain the percentage open.
> AI could also represent how full a tank is. A voltage from 0 to 10 VDC could represent the percentage of liquid in a tank, where:
> •   0 vdc = 0% full or empty
> •   5 vdc = 50% full
> •   10 vdc = 100% full or completely full

Part 4: Controller

There is connectivity between all the C terminals on the controller.

Controller C terminal

Using your multimeter, is there continuity between AO1-C and AO2-C?_____

Using your multimeter, is there continuity between AO1-C and AI1-C?_____

Using your multimeter, is there continuity between AO1-C and BI1-C?_____

Using your multimeter, is there continuity between AO1-C and power COM?_____

> There should be continuity between all the C terminals and COM.

The second terminal of UI, BI, AO, and power COM all share a common.

Binary Outputs

Using your multimeter, is there continuity between BO1-B and BO2-B?_____

Using your multimeter, is there continuity between BO1-B and BO3-B?_____

Using your multimeter, is there continuity between BO1-B and BO4-B?_____

Using your multimeter, is there continuity between BO1-B and BO5-B?_____

Using your multimeter, is there continuity between BO1-B and BO6-B?_____

Using your multimeter, is there continuity between BO1-B and power COM?_____

➢ There should not be continuity between any of the B terminals and COM.

Part 5: Universal Inputs (UI)

The BAScontrol22 has Universal Inputs which can be configured to represent different inputs:

- Analog – V or mA
- Temperature
- Binary
- Pulse
- Resistance

The Channel Type must be selected to determine how the Universal Input (UI) will behave. To configure the channel type for a UI, click on the title link above the textbox. The Channel Type default defaults to AI unless it is changed

5.1 - Specifications

Analog Input
Open the User Manual and find section 2.2: Analog Outputs.

What is the input voltage range?_____

Is the input voltage DC?_____

What is the maximum amperage?_____

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

Temperature Input
The controller can be used with assorted styles of thermistors.

What thermistors can be used with the controller?_____

What is the temperature range of a Type 2 10kΩ thermistor?_____

Contact Closure Input
If more than 4 Bis are required, Universal Inputs can be configured to be BIs.

Resistance
What is the range of resistance the controller can read?_____

5.2 - <u>Wire Universal Inputs</u>

We are going to read several diverse types of Inputs.

We are going to configure the following UIs:

- UI1 – Voltage Input
- UI2 – Thermistor
- UI3 – Switch
- UI4 – Resistor

Turn off the controller so that we can wire all the Universal Inputs.

UI1 – Voltage Input
The Analog Input can detect a voltage of 0-10 VDC. We are going to use the voltage supplied by an AO as an input to our UII.

Wire a conductor from AO1-A to UI1-A. You do not need to connect a wire between AO-C and UI1-C as there is already continuity between these points on the controller.

UI2 – Thermistor
A thermistor is a device used to measure temperature and the temperature is mapped to the resistance of the device.

Using your multimeter, what is the resistance of the thermistor?_____

Wire the thermistor to UI2.

UI3 – Switch
Move the switch from BI1 to UI3.

UI4 – Resistor
We are going to measure the resistance of a resistor.

Using your meter, what is the resistance of the resistor?_____

What are the color bands of the resistor?_____

Place the 510Ω resistor in the terminals of UI4.

Note: We are using a resistor outside the range of resistance for the controller, however the resistance reading is reasonably accurate, and it is commonly used in Building Automation.
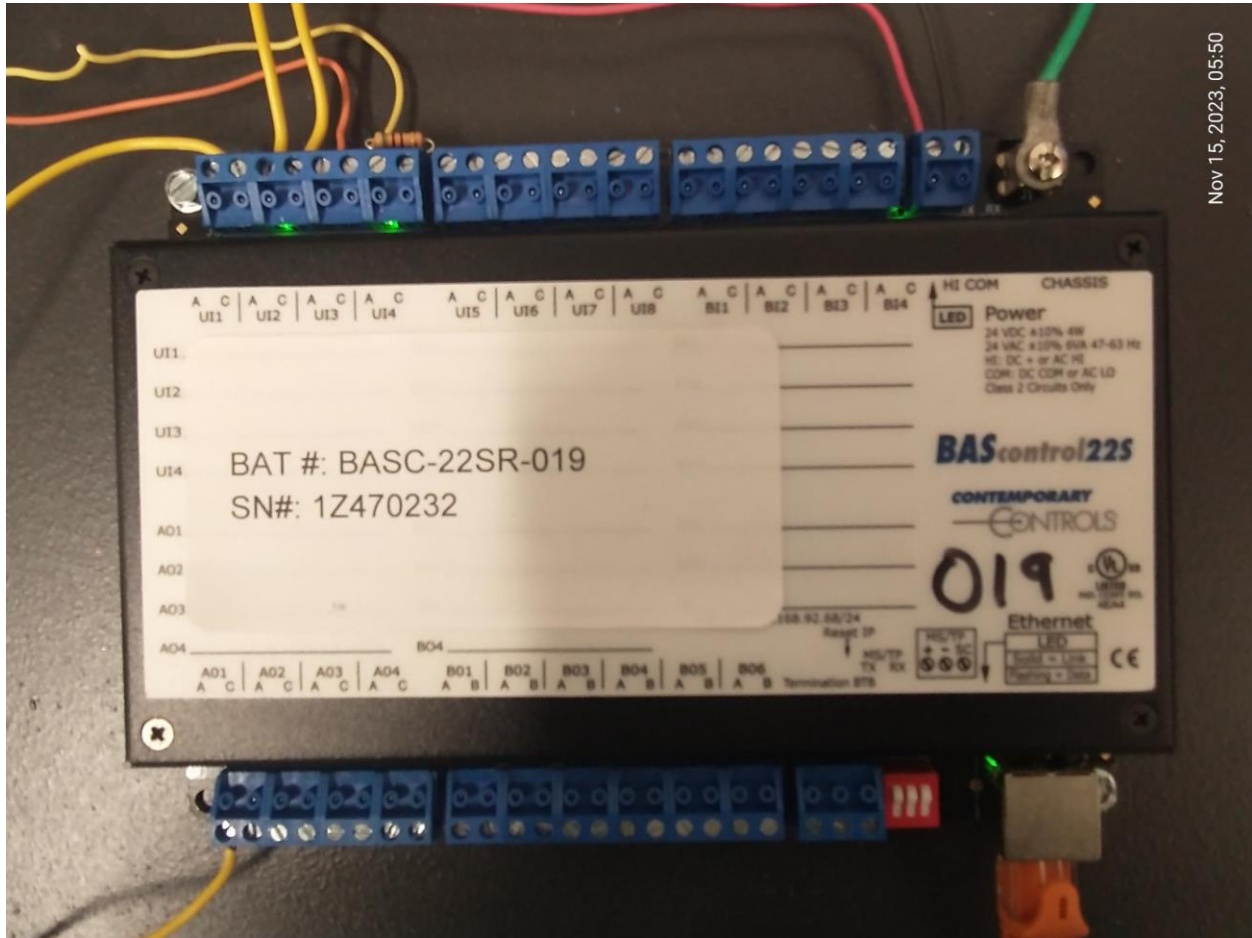
Instructor Wiring Check

> ⚠️ 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 and refresh the browser.

5.3 - <u>Configure Universal Inputs</u>

We have wired all the inputs, and we now need to configure the controller to read them.

UI1 – Voltage Input

We are using UI1 to read voltage, so we need to configure UI1 as an Analog Input.

On the webpage, click "Universal Input 1" to open the configuration for UI1.

Make the following changes for UI1:

- Channel Type: Analog Input
- Object Name: Voltage

Click "Submit" to save the changes and then click "Close" to close the window.

UI2 – Thermistor Input

We are using UI2 to read the temperature from a thermistor. We are using a 10K Type 2 thermistor for our lab.

Open the configuration for UI2 and make the following changes:

- Channel Type: Therm 10KT2
- Object Name: Temperature

Click "Submit" to save the changes and then click "Close" to close the window.

UI3 – Binary Input

We are using UI3 as an additional binary input.

Make the following Configuration for UI3:

- Channel Type: Binary Input
- Object Name: Switch

UI4 – Resistance

We are using UI4 to read the resistance of a 510Ω resistor.

Make the following Configuration for UI4:

- Channel Type: Resistance
- Object Name: Resistor

Browser Refresh

Refresh the browser and you should see the Object Names for UI1 – UI4.

Auto Refresh

We want to turn Auto Refresh on so that webpage automatically updates the values of the IO.

Click the "Auto Refresh OFF" button and the button should change to be "Auto Refresh ON."

With Auto Refresh on, you should see slight fluctuations with your Inputs.

5.4 - Check Analog Input

We are going to read the voltage of UI1.

AI with 0 volts

The value represents the voltage at this output. You should see approximately '0.000' which represents 0 VDC.

> There might be a slight voltage showing on UI1 and as long as it is within 100 mV the reading is acceptable.

One the webpage, what is the voltage of AI1?_____

Make sure your multimeter is reading VDC and pay attention to the units whether it is V or mV.

On the controller, is the AI1 LED illuminated?_____

Using your meter, what is the voltage of AI1?_____

➢ The webpage and meter should be within 100 mV. A significant difference could mean an issue with the controller or the meter. Check with a second meter if the voltage difference is large.

AI with 5.25 volts

We are now going to set AO1 to output 5.25 VDC which is the input to UI1.

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 and hit "Enter" 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?_____

On the webpage, what is the value of UI1?_____

On the controller, is the UI1 LED illuminated?_____

Using your meter, what is the voltage of UI1?_____

➢ If the voltage of either of these is not within 100 mV of 5.25 VDC, investigate the issue.

5.5 - Check Thermistor Input

We are going to check the temperature using a thermistor. A thermistor shows a temperature by changing the resistance.

Thermistor

For UI2, what is the temperature?_____

Is this the approximate air temperature?_____

Thermistor with wrong configuration

We are now going to set the wrong thermistor type in the Channel Type, to see how this changes the value.

For UI2, what is the value when the Channel Type is "Therm 10KT2"?_____

For UI2, what is the value when the Channel Type is "Therm 10KT3"?_____

For UI2, what is the value when the Channel Type is "Therm 20K"?_____

For UI2, what is the value when the Channel Type is "Therm 100K"?_____

Changing the thermistor type, should significantly change some of the values. It is important to correctly set the correct thermistor type in the Channel Type.

Change the UI2 Channel Type back to "Therm 10KT2."

5.6 - Check Binary Input

We are going to use UI3 as a binary input.

UI with a closed switch

With the switch closed, answer the following questions:

Is the LED illuminated?_____

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

> Do not check continuity on a live circuit.

Using your multimeter, what is the voltage of BI1?_____

How does the controller use the voltage to determine if the BI is closed?_____

_____

_____

UI with an open switch

With the switch open, answer the following questions:

Is the LED illuminated?_____

➢ If the LED is illuminated, investigate the issue.

> **!** Do not check continuity with your multimeter on a live circuit.

Using your multimeter, what is the voltage of BI1?_____

Is there any difference between a BI and a UI configured with a Channel Type of Binary Input?_____

5.7 - Check Resistance Input

We wired a 510Ω in UI4

> **!** Do not read the resistance with your multimeter on a live circuit.

Is the LED illuminated for UI4?_____

Previously you read the resistance of the resistor, what was the resistance?_____

According to the webpage, what is the resistance of UI4?_____

➢ If the resistance is not close in value, investigate the issue.

Part 6: Instructor Verification

Demonstrate to your instructor that you have read Analog Inputs.

6.1 - Instructor Signature

Have the instructor sign your lab demonstrating that you can successfully read Analog Inputs.

Instructor Signature?_____

Part 7: Tear-down

7.1 - Laptop

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

7.2 - <u>Controller</u>

> (!) 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.