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# Labjack Logger

Logger is a program designed to work primarily with the Labjack U6 Datalogger. It is capable of measuring DC, AC, and differential signals, as well as 3-phase power signals.

## GUIDES

### [Startup Guide](#)

- [Installation](#)

### [UI Overview](#)

- [Measuring Power](#)
- [Measuring DC Voltage](#)
- [Measuring DC Voltage With Temperature](#)

### [Calc File](#)

## SENSORS

- [Current Transducer](#)
- [Current Transformer](#)
- [Honeywell S&C - HIH-4000-002 - Humidity Sensor](#)
- [ONICON System-10 BTU Meter](#)
- [Setra Model 256 Pressure Transducer \(Current Output\)](#)
- [Setra Model 256 Pressure Transducer \(Voltage Output\)](#)
- [SLQ-HC60 Milliliter Flow Meter](#)
- [Thermistor](#)
- [Thermocouple](#)
- [Wood Moisture Content Sensor](#)

## DOWNLOADS

2/18/2013

Windows:

[Logger.zip](#)

For detailed installation instructions, see [Installation](#). A list of the items contained in this package can be found in the [Dependencies List](#).

## Recently Updated

[CCHRC\\_Seminar\\_2014-05-06.pptx](#)

May 07, 2014 • attached by [Q Mackey](#)

[Alternative Logging Systems](#)

May 07, 2014 • created by [Q Mackey](#)

[Labjack Logger](#)

Feb 18, 2013 • updated by Anonymous • [view change](#)

[Logger.zip](#)

Feb 18, 2013 • attached by Anonymous

[How to set up WinSCP](#)

Jan 25, 2013 • updated by Anonymous • [view change](#)

[untitled15.jpg](#)

Jan 25, 2013 • attached by Anonymous

[untitled14.jpg](#)

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[untitled7.jpg](#)

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[untitled6.jpg](#)

Jan 25, 2013 • attached by Anonymous

Navigate space

# Calc File

## Overview

A calc file is a Python source code file located in the /calc/ folder in the Logger directory. It contains a single function called "calc", which accepts a single float corresponding to the voltage reading for an analog input. If Power was set in the MODE drop-down box in GUI.bat, this float represents the voltage readings from two analog inputs multiplied together and averaged (for more information see [here](#)). It also accepts an optional float called Temperature which is a reading from the Labjack's internal temperature sensor in units of Kelvin. It returns the converted result in appropriate units.

Example calc file contents:

```
def calc(x, Temperature=0):  
    return x * 115
```

In this case, the calc file multiplies the raw voltage measurement from the Labjack by 115 and returns that as the final result.

In order to use a calc file, it must be saved in the /calc/ folder, must have a filename which python can recognize, and must be selected in the "calc" field on the [user interface](#).

## Pitfalls

Beware that calc files are actual code being run by the program, and as such, errors in them can crash the program. Beware of:

- Division by Zero
- Taking the logarithm of a negative number
- Raising exceptions

Calc files should handle any exceptions they raise on their own. If for whatever reason, a calc file fails and cannot achieve the desired result, simply return -999999999 as the result instead.

# Current Transducer

A current transducer is a device which creates a signal which is a scaled-down replica of the current passing through it. They are used to measure high currents without damaging sensitive measuring equipment.

A current transducer will always have some sort of hole, through which a wire must be placed. The current through this wire will be replicated. The transducer will have two wires coming out of it, and these wires will carry the replicated signal to the measurement device.

Current transducers output their replicated signal using voltage, while [Current Transformers](#) output their replicated signal using current. Note that current transducers are usually easier to use with the Labjack.

## MATERIALS

No additional materials required

## SETUP

1. Clamp the current transducer onto the wire containing the current to be measured, or if necessary, thread the wire through the hole on the current transducer.
2. Attach the positive lead of the current transducer to an AIN port on the Labjack
3. Attach the negative lead of the current transducer to GND. (there are several ports marked GND. Any can be used.)
4. See [Measuring Power](#) if the current is part of an AC power signal. See [Measuring DC Voltage](#) if the current is a DC signal.

## CALC FILE

[Current Transducer.py](#) (INCOMPLETE: This file is generic and intended as a starting point. You must edit it with values specific to your transducer before use. See [Calculations](#))

## CALCULATIONS

A Current transducer, provided it does not have built-in circuitry, will usually say X Amps to Y Volts on the label. For example, the [MagneLab SCT 0400-010](#) is listed as 10 Amps to 0.333 Volts. This means that the Voltage signal is  $10/0.333 = 30$  times smaller than the input Current Signal. In order to convert the LabJack's readings from Volts to Amps, one would simply multiply by the listed Amp rating and divide by the Volt rating.

## ADJUSTING THE SIGNAL

The labjack U6 has a range of +/- 10V, and a resolution of within approximately 0.29mV with usual operation at room temperature. Should the output of the current transducer fall outside this range, it can be adjusted.

Should the replicated signal be too small, it can be scaled up by looping the wire around and back through the current transducer's hole. Check the transducer's datasheet for "Primary Turns". Primary Turns should be listed as 1. If so, this technique can be used. When looping the wire through the transducer's hole, each time the wire passes through the hole will increase the signal to the measuring device by one fold. So looping around once so that the wire passes through two times will double the signal. Looping around twice so that the wire passes through three times will triple the signal. This **must be accounted for** in the calculations. For example, if I passed the wire through the hole three times, I would divide the Amps to Volts ratio listed on the sensor by three.

Should the replicated signal be too large, it can be scaled down with a pair of resistors.

1. Attach the positive lead of the Current Transducer to resistor A
2. Attach the other lead of resistor A to resistor B.
3. Take a wire and attach it to the connection between resistors A and B.
4. Attach the other end of the wire to one of the Labjack's analog inputs.
5. Attach the other end of resistor B to GND on the Labjack (there are several ports marked GND. Any can be used.)
6. Attach the negative lead of the Current Transducer to GND (again, any can be used)

The output voltage is given by the following formula. You can use this to determine appropriate resistance values for Ra and Rb.

$$V_{out} = \frac{R_b}{R_a + R_b} V_{in}$$

Where

Vout is the new voltage

Vin is the original voltage

CAUTION: If the voltage is relatively high, and one of the resistors has a relatively low resistance, it might damage the resistors. Putting more power through a resistor than it is rated for can melt it, and will break the circuit. You can check the power going through each resistor through the following formulas. Compare this with the resistor's power rating to determine if it's safe to use. If not, find resistors with higher power ratings. Typically, the higher a resistor's power rating, the bigger and thicker it is.

$$Power_{R_b} = \frac{R_b}{(R_a + R_b)^2} V_{in}^2$$

$$Power_{R_a} = \frac{R_a}{(R_a + R_b)^2} V_{in}^2$$

# Current Transformer

A current transformer is a device which creates a signal which is a scaled-down replica of the current passing through it. They are used to measure high currents without damaging sensitive measuring equipment.

A current transformer will always have some sort of hole, through which a wire must be placed. The current through this wire will be replicated. The transformer will have two wires coming out of it, and these wires will carry the replicated signal to the measurement device.

It is important that the wire be threaded through the hole in the correct direction. Current transformers will always have some indication of their polarity. If the direction is not written explicitly on the transformer, then the transformer will likely have a dot on one side of it. The wire should be placed through the transformer so that the dot faces towards the power source.

A Current transformer outputs current, while a [current transducer](#) outputs voltage. Note that current transducers are usually easier to use with the Labjack.

## MATERIALS

**Resistor (240)** A 240 resistor is commonly used for current transformers with outputs of 4-20mA. This results in a signal from 0.96V to 4.8V, which is within the Labjack's +/-10V range. If your transformer has a different output range, you may need to use a different resistor in order to keep the signal within range. See [Adjusting The Signal](#).

## SETUP

1. Clamp the current transformer onto the wire containing the current to be measured, or if necessary, thread the wire through the hole on the current transformer. Ensure that the wire is threaded in the correct direction. If there is no writing on the transformer, there should be a dot. This dot should point towards the power source.
2. Attach the positive lead of the current transformer to an AIN port on the Labjack
3. Attach one end of the resistor to this same AIN port as well.
4. Attach the negative lead of the current transformer to GND. (there are several ports marked GND. Any can be used.)
5. Attach the other end of the resistor to GND. (again, any GND can be used)
6. See [Measuring Power](#) if the current is part of an AC power signal. See [Measuring DC Voltage](#) if the current is a DC signal.

## CALC FILE

[Current Transformer.py](#) (INCOMPLETE: This file is generic and intended as a starting point. You must edit it with values specific to your transformer before use. See [Calculations](#))

## CALCULATIONS

A Current transformer, provided it does not have built-in circuitry, will usually have some sort of ratio of input current to output current on the label. For example, [this Current Transformer](#) says 200 : 0.1 A on the label. That means that it takes a 200A signal and scales it down to 0.1A, for a ratio of 2000:1.

In order to calculate the current in the wire, you would first calculate the current passing through your resistor with the following formula:

$$Current = \frac{Voltage}{Resistance}$$

Where

Current is the current flowing through the resistor (in Amps)

Voltage is the voltage measured by the LabJack (in Volts)

Resistance is the resistance of the resistor you used. (in Ohms)

Once you've calculated the current flowing through your resistor, you can multiply that by the ratio on the transformer, which in this case was 2,000:1.

## ADJUSTING THE SIGNAL

The labjack U6 has a range of +/- 10V, and a resolution of within at least 0.29mV with usual operation at room temperature. Should the output of the current transformer fall outside this range, it can be adjusted.

Should the replicated signal be too small, it can sometimes be scaled up by looping the wire around and back through the current transformer's hole. Check the transformer's datasheet for "Primary Turns". Primary Turns should be listed as 1. If so, this technique can be used. When looping the wire through the transformer's hole, each time the wire passes through the hole will increase the signal to the measuring device by one fold. So looping around once so that the wire passes through the hole two times will double the output signal. Looping around twice so that the wire passes through three times will triple the output signal. Keep in mind that this **must be accounted for** in the calculations if you choose this method. For example, if I passed the wire through the hole three times, I would divide the ratio listed on the current transformer by 3.

Should the replicated signal be too large, it can be scaled down by substituting a resistor with a different resistance value. Use the following formula to determine the needed resistance.

$$\text{Voltage/Current} = \text{Resistance}$$

Where:

Voltage is the desired voltage in Volts (typically 5V, but the Labjack can measure from +/-10V)

Current is the output current of the Current Transformer, in Amps (not milli amps)

Resistance is the resistance, in Ohms, of the resistor you will require in order to meet that voltage and current combination.

CAUTION: If the current is relatively high, and your resistor has a relatively low resistance, it might damage the resistor. Putting more power through a resistor than it is rated for can melt it, and will break the circuit. You can check the power going through the resistor with the following formula. Compare this with the resistor's power rating to determine if it's safe to use. If the power going through the resistor is greater than the resistor's power rating, it is not safe. If not, find resistors with higher power ratings. Typically, the higher a resistor's power rating, the bigger and thicker it is.

$$\text{Power} = \text{Current}^2 * \text{Resistance}$$

Where

Power is the electric power being dissipated across the resistor (In Joules)

Current is the current output of the current transformer, in Amps (not milli amps)

Resistance is the resistance, in Ohms, of the resistor you plan to use.

# Dependencies List

Logger requires the following other programs in order to function

## [Python 2.6](#)

- Logger is programmed in Python.

## [LabJackUD](#)

- Driver software for the Labjack.

## [MySQL-Python aka MySQLdb](#)

- Used to interface with MySQL databases. Still required even if you're not using MySQL.

## [Python Megawidgets](#)

- User Interface creation toolkit.



# Honeywell S&C - HIH-4000-002 - Relative Humidity Sensor

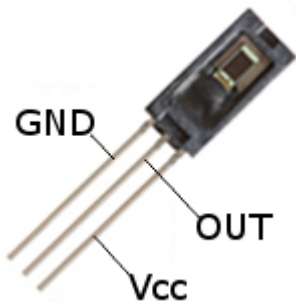
This component outputs voltage linearly proportional to relative humidity.

By default it assumes the temperature is 25 degrees C, however, with temperature readings from another sensor its results can be adjusted to be accurate from -40 to 80 degrees C. (note that high humidities and extreme temperatures combined reduce the sensor's lifespan to less than 50 hours. See Figure 1, page 2 of [this document](#)) The Labjack itself has an internal temperature sensor, so if the sensor and the Labjack will be the same temperature, the Labjack's temperature sensor may be used for this purpose.

## MATERIALS

None

## SETUP



1. Make sure your sensor is oriented the same as the diagram above.
2. Attach the lead marked GND to GND on the Labjack (There are several ports marked GND. Any can be used)
3. Attach the lead marked OUT to one of the AIN ports on the Labjack
4. Attach the lead marked Vcc to Vs on the Labjack (There are several ports marked Vs. Any can be used)
5. Will the Labjack itself be at the same temperature as the sensor?
  - a. Yes See [Measuring DC Voltage With Temperature](#)
  - b. No See [Measuring DC Voltage](#)

## CALC FILE

[Honeywell HIH4000 002.py](#)

## CALCULATIONS

The sensor is designed to function at 25 degrees C. Relative Humidity at this temperature can be found with the following formula.

$$Sensor RH = \frac{\frac{V_{out}}{V_{in}} - 0.16}{0.0062}$$

Where

SensorRH is the relative humidity in percent, assuming that the temperature is 25 degrees C

Vout is the voltage reading from the LabJack

Vin is Vcc on the Labjack, which is nominally 5V, but may vary slightly. For greater accuracy you may measure Vcc and substitute its real value in place of 5V.

For temperatures other than 25 degrees C, the following equation may be used.

$$True RH = \frac{Sensor RH}{1.0546 - 0.00216 * T}$$

Where

True RH is the relative humidity in percent at temperature T

Sensor RH is the result from the previous equation in percent

T is the temperature in degrees C

# Ideas for Improvement

Allow the "Voltage" drop-down menu to accept custom floating point values, which are used in place of an analog input channel.

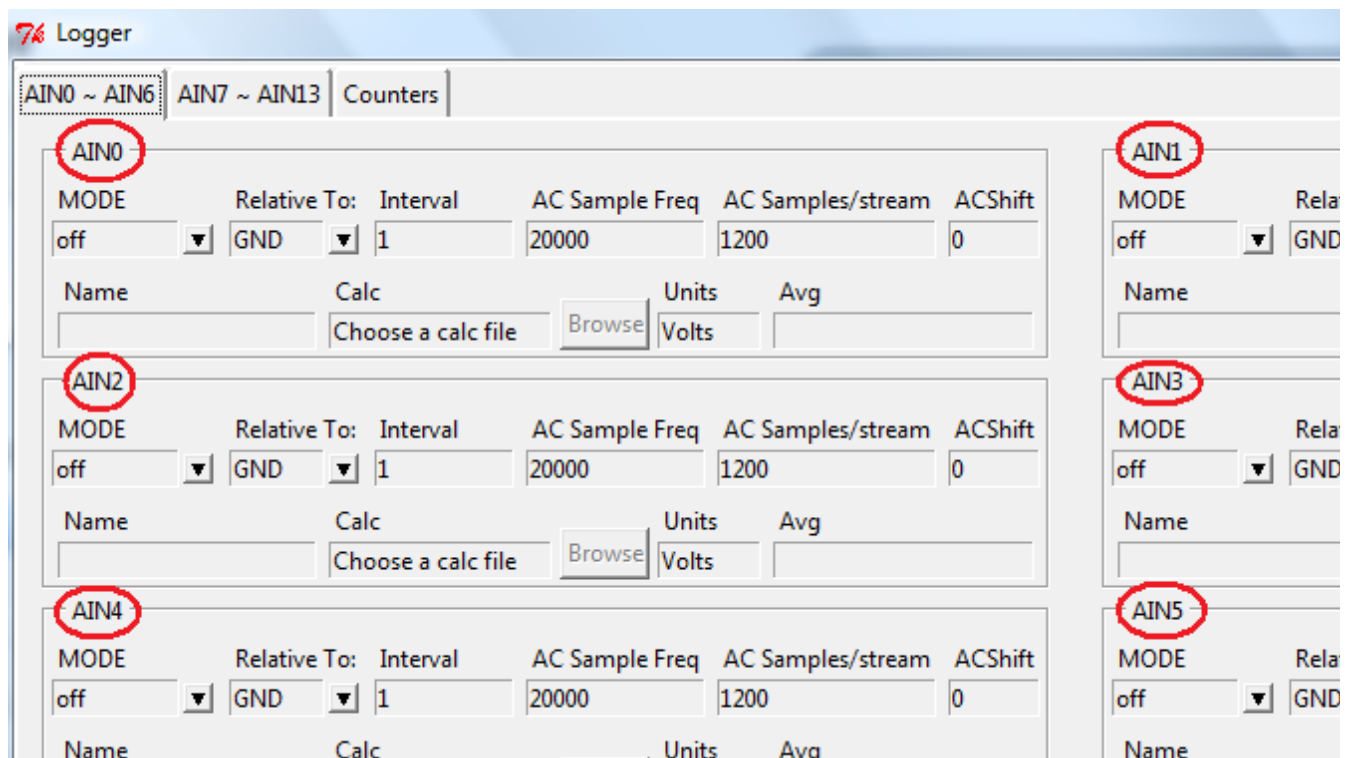
Instructions for what to do when you plug in the Labjack. (don't use windows update, do install automatically)

It's labeled "Vs", not "Vcc"

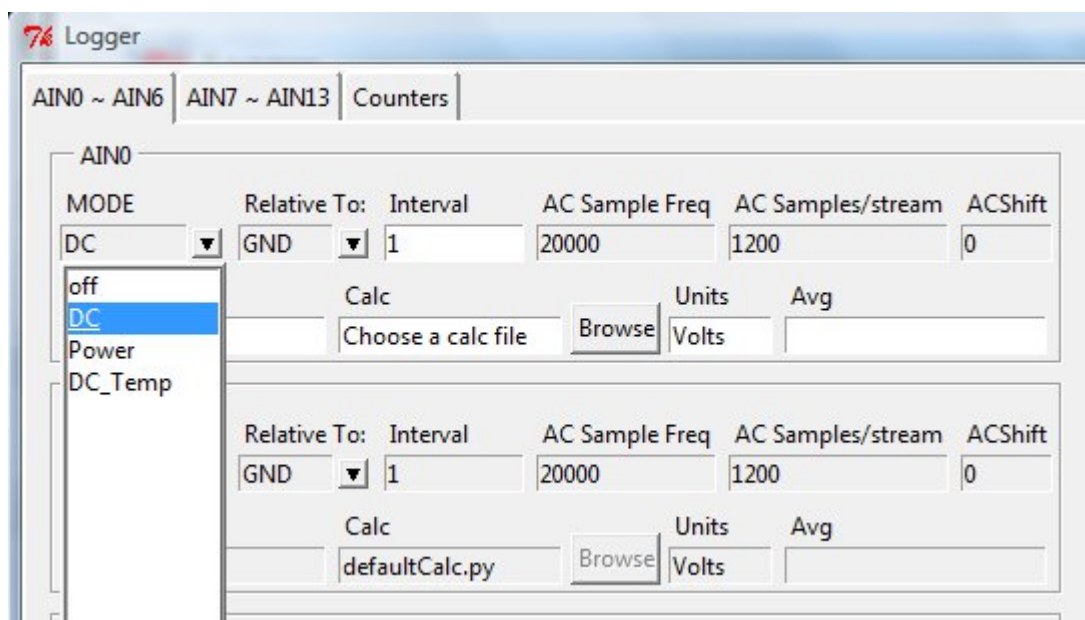
# Measuring DC Voltage

HOW TO MEASURE DC VOLTAGE:

1. Open GUI.bat
2. Locate the panel for the AIN port which your sensor is connected to. AIN0 is used for this demonstration, however, yours may vary. Be aware of the additional tab at the top if you are using an adapter to access the Labjack's full array of 14 AIN ports.



3. In the panel for your AIN port, set the MODE drop-down box to "DC".



4. In the Interval box, enter the amount of time (in seconds) between each datapoint recording. In the image below, Logger will record a measurement once every 15 seconds.

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

AIN0

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
DC	GND	15	20000	1200	0

Name:  Calc:  Units:  Avg:

AIN2

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
off	GND	1	20000	1200	0

Name:  Calc:  Units:  Avg:

AIN4

5. Enter a descriptive name in the Name box

7. Enter the name of the Units being used in the Units box

8. If you would like additional averaged copies of the data, in the avg field enter a comma-separated list of intervals (in seconds) for which to average. Leave blank or 0 for no additional averages.

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

AIN0

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
DC	GND	15	20000	1200	0

Name:  Calc:  Units:  Avg:

AIN2

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
off	GND	1	20000	1200	0

Name:  Calc:  Units:  Avg:

AIN4

9. For the "calc" field, click browse and select the appropriate calc file for this task. Calc files may be downloaded on the page for the sensor you wish to use. For technical information see [Calc File](#).

10. Press OK to save your settings.

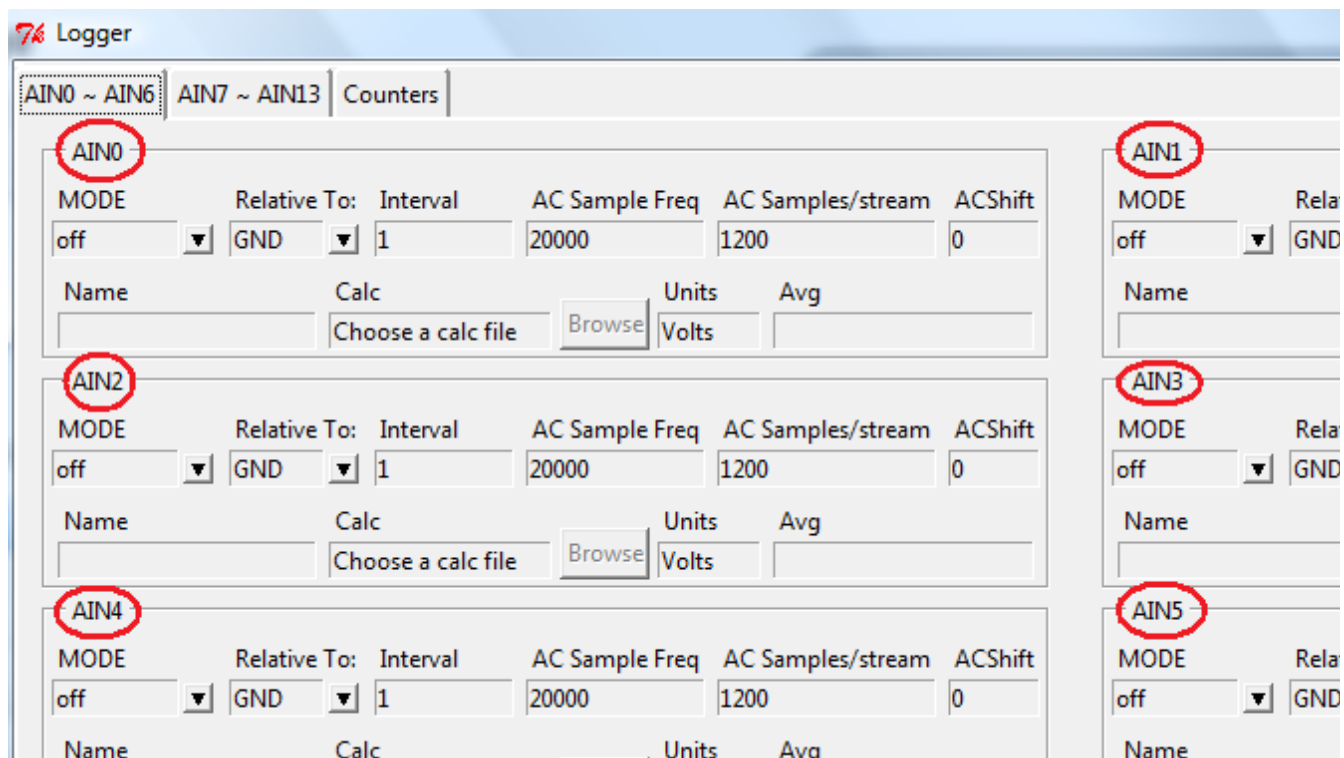
11. Run Logger.bat to begin logging. Data will be stored in the data folder. For more information see [here](#).

12. Close Logger.bat to end logging.

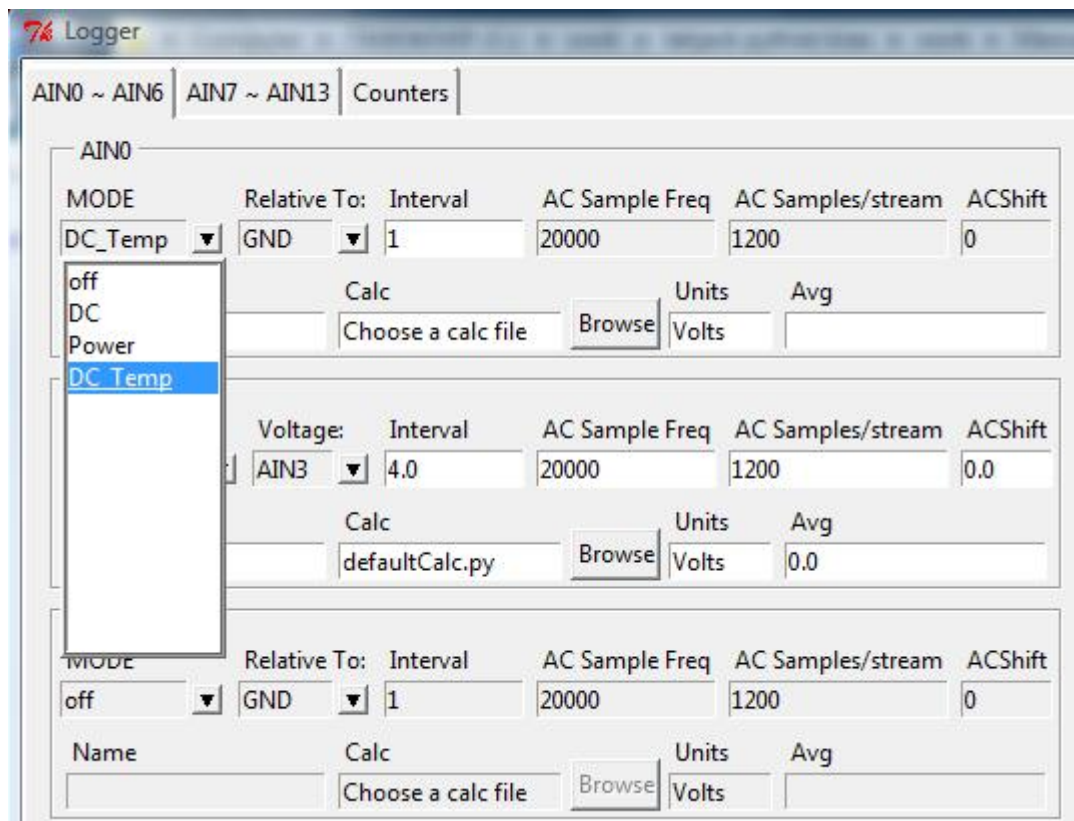
# Measuring DC Voltage With Temperature

1. Open GUI.bat

2. Locate the panel for the AIN port which your sensor is connected to. AIN0 is used for this demonstration, however, yours may vary. Be aware of the additional tab at the top if you are using an adapter to access the Labjack's full array of 14 AIN ports.



3. In the panel for your AIN port, set the MODE drop-down box to "DC\_Temp".



4. In the Interval box, enter the amount of time (in seconds) between each datapoint recording. In the image below, Logger will record a measurement once every 15 seconds.

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

**AIN0**

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
DC_Temp ▼	GND ▼	15	20000	1200	0

Name:  Calc:  Units:  Avg:

**AIN2**

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
off ▼	GND ▼	1	20000	1200	0.0

Name:  Calc:  Units:  Avg:

5. Enter a descriptive name in the Name box

6. Enter the name of the Units being used in the Units box

7. If you would like additional averaged copies of the data, in the avg field enter a comma-separated list of intervals (in seconds) for which to average. Leave blank or 0 for no additional averages. In the image below, Logger will record one copy of unaveraged results, one with 5 second averages, and one with 15 second averages.

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

**AIN0**

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
DC_Temp ▼	GND ▼	15	20000	1200	0

Name:  Calc:  Units:  Avg:

**AIN2**

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
off ▼	GND ▼	1	20000	1200	0.0

Name:  Calc:  Units:  Avg:

8. For the "calc" field, click browse and select the appropriate calc file for this task. Calc files may be downloaded on the page for the sensor you wish to use. For technical information see [Calc File](#).

9. Press OK to save your settings.

10. Run Logger.bat to begin logging. Data will be stored in the data folder. For more information see [here](#).

11. Close Logger.bat to end logging.



# Measuring Power

HOW TO MEASURE POWER:

1. Open GUI.bat

2. Locate the AIN ports on the labjack to which the voltage sensor and current sensor are connected. For the purposes of this demonstration we will assume that AIN0 as the port to which the current sensor is attached, and AIN1 as the port to which the voltage sensor is attached. You may substitute any two separate AIN ports for AIN0 and AIN1.

The screenshot shows the '76 Logger' application window. It has three tabs: 'AIN0 ~ AIN6', 'AIN7 ~ AIN13', and 'Counters'. The 'AIN0 ~ AIN6' tab is active. It displays six configuration panels for AIN0 through AIN5. Each panel has a 'MODE' dropdown menu, a 'Relative To' dropdown menu, an 'Interval' input field, an 'AC Sample Freq' input field, an 'AC Samples/stream' input field, and an 'ACShift' input field. Below these are fields for 'Name', 'Calc' (with a 'Choose a calc file' button and a 'Browse' button), 'Units', and 'Avg'. The 'MODE' dropdown for AIN0 and AIN1 is circled in red. The 'Relative To' dropdown for AIN0 and AIN1 is set to 'GND'. The 'Interval' input field for AIN0 and AIN1 is set to '1'. The 'AC Sample Freq' input field for AIN0 and AIN1 is set to '20000'. The 'AC Samples/stream' input field for AIN0 and AIN1 is set to '1200'. The 'ACShift' input field for AIN0 and AIN1 is set to '0'. The 'Units' field for AIN0 and AIN1 is set to 'Volts'.

3. In the panel for the AIN port to which your CURRENT sensor is attached, set the MODE drop-down box to "Power"

The screenshot shows the '76 Logger' application window with the 'AIN0 ~ AIN6' tab active. The 'MODE' dropdown menu for AIN0 is open, showing options: 'off', 'DC', 'Power', and 'DC\_Temp'. The 'Power' option is highlighted. The 'Relative To' dropdown menu for AIN0 is set to 'GND'. The 'Interval' input field for AIN0 is set to '1'. The 'AC Sample Freq' input field for AIN0 is set to '20000'. The 'AC Samples/stream' input field for AIN0 is set to '1200'. The 'ACShift' input field for AIN0 is set to '0'. The 'Units' field for AIN0 is set to 'Volts'.

4. In the Voltage drop-down box, choose the AIN port to which you have connected your Voltage sensor.

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

AIN0 ← *Current goes here*

MODE Voltage: Interval AC Sample Freq AC Samples/stream ACShift

Power ▼ AIN1 ▼ 15 20000 1200 0

Name Calc Units Avg

Stove Power Choose a calc file Browse Watts

AIN2

MODE Relative To: Interval AC Sample Freq AC Samples/stream ACShift

off ▼ GND ▼ 1 20000 1200 0

Name Calc Units Avg

defaultCalc.py Browse Volts

5. In the panel for the AIN port which your voltage sensor is attached, ensure that the MODE drop-down box is set to "off".

**7% Logger**

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

AIN0

MODE Voltage: Interval AC Sample Freq AC Samples/stream ACShift

Power ▼ AIN1 ▼ 1 20000 1200 0

Name Calc Units Avg

Choose a calc file Browse Volts

AIN2

MODE Relative To: Interval AC Sample Freq AC Samples/stream ACShift

off ▼ GND ▼ 1 20000 1200 0

Name Calc Units Avg

Choose a calc file Browse Volts

AIN4

MODE Relative To: Interval AC Sample Freq AC Samples/stream ACShift

off ▼ GND ▼ 1 20000 1200 0

Name Calc Units Avg

Choose a calc file Browse Volts

AIN1

MODE Relative To: Interval

off ▼ GND ▼ 1

Name Calc

Choose a calc

AIN3

MODE Relative To: Interval

off ▼ GND ▼ 1

Name Calc

Choose a calc

AIN5

MODE Relative To: Interval

off ▼ GND ▼ 1

Name Calc

Choose a calc

6. In the Interval box, enter the amount of time (in seconds) between each datapoint recording.

7. If you are measuring 3-phase power, put -30 (negative thirty) in the ACShift box. Otherwise leave it at the default of 0 or blank.

8. Enter a descriptive name in the Name box

9. Enter the name of the Units being used in the Units box

10. If you would like additional averaged copies of the data, in the avg field enter a comma-separated list of intervals (in seconds) for which to average. Leave blank or 0 for no additional averages. In the image below, Logger will record an unaveraged copy along with copies averaged every 5 and 15 seconds.



**76** Logger

AIN0 ~ AIN6 | AIN7 ~ AIN13 | Counters

---

AIN0

MODE	Voltage:	Interval	AC Sample Freq	AC Samples/stream	ACShift
Power ▼	AIN1 ▼	15	20000	1200	0
Name		Calc	Units	Avg	
Stove Power		Choose a calc file <input type="button" value="Browse"/>	Watts	0,5,15	

---

AIN2

MODE	Relative To:	Interval	AC Sample Freq	AC Samples/stream	ACShift
off ▼	GND ▼	1	20000	1200	0
Name		Calc	Units	Avg	
		defaultCalc.py <input type="button" value="Browse"/>	Volts		

---

AIN4

11. For the “calc” field, click browse and select the appropriate calc file for this task. Calc files may be downloaded on the page for the sensor you wish to use. For technical information see [Calc File](#).

12. Press OK to save your settings.

13. Run Logger.bat to begin logging. Data will be stored in the data folder. For more information see [here](#).

14. Close Logger.bat at any time to end logging.

# **Omegadyne Load Cell**

The load cell is a strain gauge that sends out a differential voltage depending how much strain is placed on the sensor.

## **MATERIALS**

A 10Vdc power supply

## **SETUP**

1. Connect the positive lead of the 10V power supply to the red wire on the load cell
2. Connect the negative lead of the 10V power supply to the black wire on the load cell
3. Connect the green wire on the load cell to an AIN port on the Labjack
4. Connect the white wire on the load cell to an adjacent AIN port on the Labjack
5. Set the Labjack GUI to read a differential output from the two AIN ports

## **CALC FILE**

[straingauge.py](#)

## **CALCULATIONS**

# ONICON System-10 BTU Meter

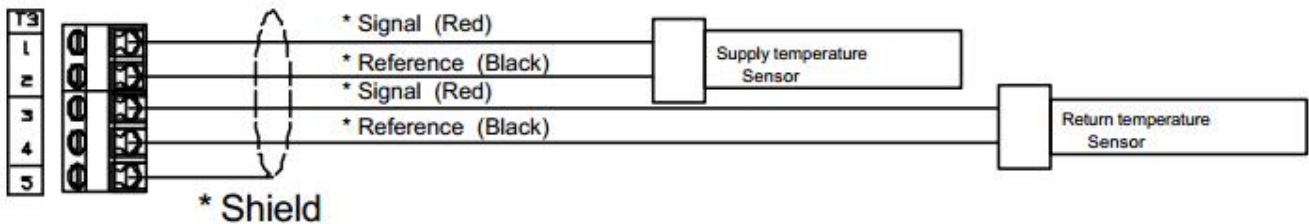
Note: This article covers electrical setup only.

## MATERIALS

Resistors 250 (only used if the analog outputs are set to 4-20mA)

## SETUP

### Temperature Inputs



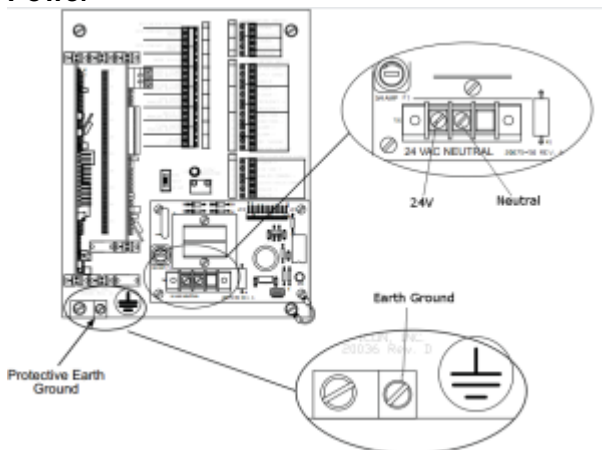
### Temperature Sensors

1. Locate terminal strip T3 on the motherboard.
2. At port #1, connect the red wire from the Supply temperature sensor
3. At port #2, connect the black wire from the Supply temperature sensor
4. At port #3, connect the red wire from the Return temperature sensor
5. At port #4, connect the black wire from the Return temperature sensor
6. At port #5, connect the shield surrounding the temperature sensor wires. See [Shield](#)

### F-1100 Series Flow Meter

1. Locate terminal strip T4 on the motherboard
2. Connect the red wire from the F-1100 to T4 port 1 on the motherboard
3. Connect the black wire on the F-1100 to T4 port 2 on the motherboard
4. Connect the green wire on the F-1100 to T4 port 6 on the motherboard
5. Connect the grey wire on the F-1100 to T4 port 8 on the motherboard
6. Connect the violet wire on the F-1100 to T4 port 9 on the motherboard
7. Connect the white wire on the F-1100 to T4 port 12 on the motherboard
8. Connect the orange wire on the F-1100 to T4 port 13 on the motherboard
9. Connect the shield surrounding the wires to port 3 on the motherboard. See [Shield](#).

### Power



1. At the bottom-left corner of the motherboard there should be a screw on the left, and a screw port on the right. The one on the right is the earth ground.
2. Connect the earth ground to the earth. (Earth ground is the round middle plug in most household electrical outlets. If it is not connected, the unit will still function, but there is risk that the metal case may become a shock hazard should it ever come into contact with the high voltage wire for any reason.)
3. Connect the high wire from the 24V power supply to the 24V screw port.
4. Connect the low wire from the 24V power supply to the neutral screw port.
5. The unit should begin to power up, indicated by the letter P displayed in every position on the display, followed by a countdown from 9 to 0 on every position. If this is not the case, disconnect the power immediately. Consult manual page 18.

## Outputs

Locate Terminal strip T1. The specific values listed on T1 vary, as do the form of their output. The following are generic instructions on how to connect a single analog input. Repeat these for any analog input.

1. Locate the two ports on terminal strip T1 corresponding to the analog output you wish to connect. They should both be adjacent and share a common label to the left.
2. Connect the lower-numbered port to an AIN port on the Labjack.
3. Connect the higher-numbered port to GND on the Labjack (there are several ports marked GND. Any can be used.)
4. Consult the Certificate of Calibration. If this Analog output is outputting 4-20mA, follow these additional instructions.
  - a. Connect one end of a 250 resistor to the previous AIN port.
  - b. Connect the other end of the resistor to GND. (there are several ports marked GND. Any can be used.)

## FINALLY

See [Measuring DC Voltage](#) to configure the Labjack

## SHIELD

When something says "Shield" it is referring to any kind of metal which covers or surrounds wires or electrical equipment. For example, the System-10 itself comes in a metal case. This acts as a shield. If you had a piece of metal tubing surrounding the wires coming out of the System-10, this would also be a shield. Some wires have a sheet of conducting metal inside them. This would also be a shield. If a step asks you to connect a shield to a port, it means that you should attach a wire to whatever is acting as a shield, and connect that wire to that port.

## CALC FILE

[System10 Voltage 0-5V.py](#) (0-5V Analog Output. You must set values before use.)

[System10 Voltage 0-10V.py](#) (0-10V Analog Output. You must set values before use.)

[System10 Current 4-20mA.py](#) (4-20mA Analog Output. You must set values before use.)

## CALCULATIONS

There are three output types available with the Onicon system. 4-20mA, 0-10VDC, and 0-5VDC. Of these, the 0-10VDC is best suited for use with the Labjack, however, explanations on how to use all of the options are provided.

### 4-20mA

The Certificate of Calibration that came with the ONICON system should list ranges for each of the analog output ports. For example, if the certificate, for a supply temperature output reads 4-20mA and 10-70 degrees F, that means that 4mA corresponds to 10 degrees, and 20mA corresponds to 70 degrees. Because the labjack only measures voltage, however, you must first convert from voltage to current using the following formula.

$$Current = \frac{Voltage}{Resistance}$$

Where

Current is the current output of the analog output.

Voltage is the voltage read by the Labjack

Resistance is the value of the resistor connected to the Labjack

After you have converted to current, you can then convert to the final units. You're looking for the equation of a line intercepting points (4mA, 10°F), (20mA, 70°F). That equation is as follows.

$$Output = \frac{Current(Min - Max)}{16} + \frac{5 * Min - Max}{4}$$

Where

Current is the current coming out of the Analog output

Min is the minimum range of the value being tracked by the analog output (10°F in the example)

Max is the maximum range of the value being tracked by the analog output (70°F in the example)

Output is the final converted reading, in the same units as Min and Max.

## 0-5VDC or 0-10VDC

The Certificate of Calibration that came with the ONICON system should list ranges for each of the analog output ports. For example, if the certificate, for a supply temperature output reads 0-5VDC and 10-70 degrees F, that means that 0V corresponds to 10 degrees, and 5V corresponds to 70 degrees. You're looking for the equation of a line intercepting (0V, 10°F), (5V, 70°F). In general, the equation for such a line is:

$$Output = \frac{Voltage_{reading}(Max - Min)}{Voltage_{high}} + Min$$

Where

Output is the final converted reading, in the same units as Min and Max.

Voltage<sub>reading</sub> is the voltage measured on the Labjack's analog inputs.

Voltage<sub>high</sub> is 5V if you were using a 0-5VDC analog output, or 10V if you were using a 0-10VDC analog output

Min is the minimum range of the value being tracked by the analog output (10°F in the example)

Max is the maximum range of the value being tracked by the analog output (70°F in the example)

## EXTERNAL LINKS

[Manual](#)

# Setra Model 256 Pressure Transducer (Current Output)

The Setra Model 256 outputs current or voltage dependent on pressure. The Model 256 comes in a variety of pressure ranges and two output options. This article covers the Current output version.

## MATERIALS

Wire

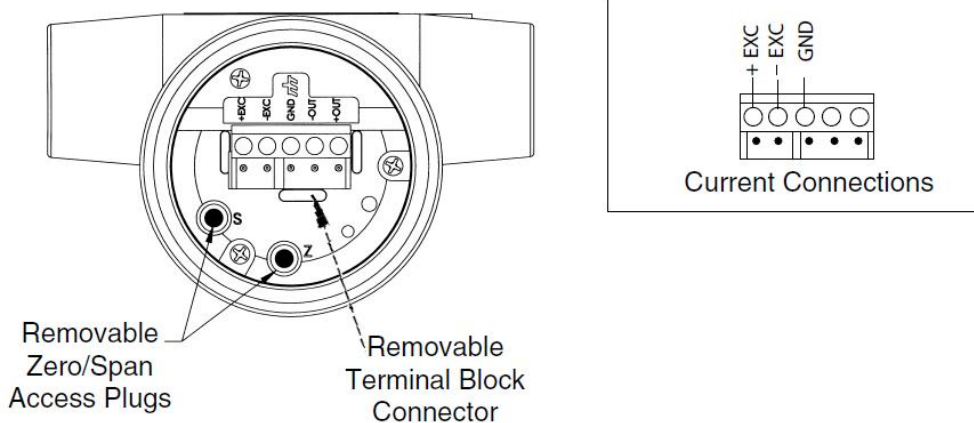
Resistor 250 Ohms. Resistors from 0 to 800 ohms may be used, but factory calibration assumes 250 ohms.

Power source 9V to 30V DC. An unused "wall wart" AC Adapter power source may be adapted for this purpose so long as its nominal output voltage is within 9V to 30V.

1. Cut off the end of the AC Adapter's wire.
2. Strip the wire.
3. There should be two leads. The positive lead is typically marked with a white stripe.
  - a. If the polarity is in doubt, it can be determined with a multimeter. You will also need two probe wires for the multimeter.
  - b. Secure the wire, ensuring that neither you nor any conducting material is touching the leads.
  - c. Plug the AC adapter in. **DO NOT touch the leads while the AC adapter is plugged in. DO NOT touch the leads to one another while the AC adapter is plugged in.**
  - d. Touch the leads on the AC adapter to the probes on the multimeter. **DO NOT touch both leads with a single probe.**
  - e. The reading on the multimeter should be greater than or equal to the voltage listed on the AC adapter. This is normal. If the reading is zero, or the magnitude is less than the nominal voltage, ensure that the multimeter probes are touching the AC adapter's leads more solidly.
  - f. If the reading on the multimeter is negative, then the positive probe is touching the negative lead. If the reading on the multimeter is positive, then the positive probe is attached to the positive lead.
4. Once you have determined the polarity of the power source, proceed to Setup.

## SETUP

Diagram 1



1. Connect +EXC to the positive lead on the power supply.
2. Connect GND on the Setra to the negative lead on the power supply.
3. Connect -EXC to an AIN port on the Labjack.
4. Connect GND on the Setra to GND on the Labjack. (There are multiple ports marked GND. Any of them can be used)
5. Connect one end of the resistor to the AIN port on the Labjack
6. Connect the other end of the resistor to GND on the Labjack (There are multiple ports marked GND. Any of them can be used)

## CALC FILE

[SetraCurrent.py](#) (You must set values for the range of your sensor and for the value of your resistor)

## CALCULATIONS

The Pressure Transducer should list a range on its label, for example, 0 - 100 PSIG. 20mA corresponds to the high value and 4mA corresponds to the low value. The current can be calculated with the following formula

$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

Where

Current is the current being produced by the pressure transducer in Amps.

Voltage is the voltage reading on the Labjack in Volts

Resistance is the value of the resistor used in Ohms

To convert to pressure, you need the formula for a line intercepting (4 mA, min range) and (20 mA, max range). That formula is as follows.

$$Pressure = 62.5 * range * Current - \frac{range}{4}$$

Where

Current is the current calculated in the previous formula, still in Amps

Pressure is the pressure reading from the sensor, in the same units that "range" is in.

range is the maximum range of the pressure transducer, listed on the sticker on the front of the sensor

## LINKS

[Manual](#) (The wiring instructions for the current version are very confusing in the manual)

[Setra Store Page](#)

# Setra Model 256 Pressure Transducer (Voltage Output)

The Setra Model 256 outputs voltage or current dependent on pressure. There are several versions of the Model 256, with different pressure ranges and two output options. This article covers the Voltage output version.

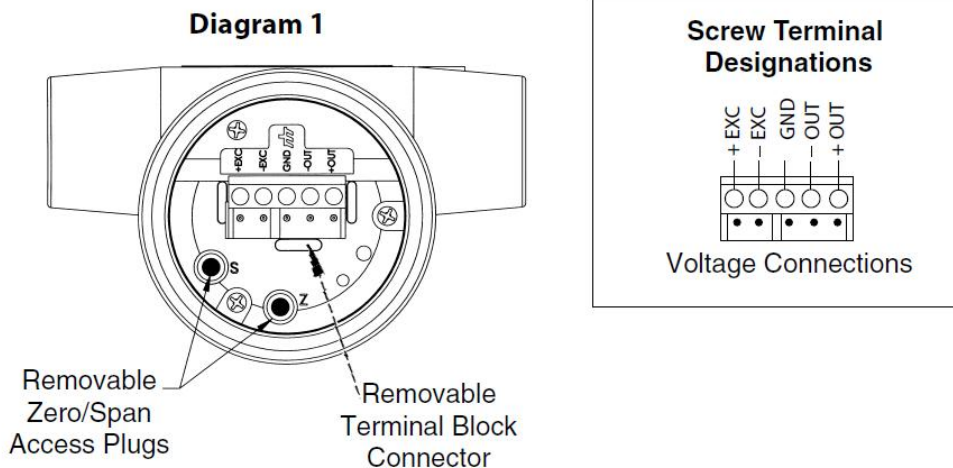
## MATERIALS

Wire

Power source 10V to 28V DC. An unused "wall wart" AC Adapter power source may be adapted for this purpose so long as its nominal output voltage is within 10V to 28V.

1. Cut off the end of the AC adapter's wire.
2. Strip the wire.
3. There should be two leads. The positive lead is typically marked with a white stripe.
  - a. If the polarity is in doubt, it can be determined with a multimeter. You will also need two probe wires for the multimeter.
  - b. Secure the wire, ensuring that neither you nor any conducting material is touching the leads.
  - c. Plug the AC adapter in. **DO NOT touch the leads while the AC adapter is plugged in. DO NOT touch the leads to one another while the AC adapter is plugged in.**
  - d. Touch each lead on the AC adapter with one probe from the multimeter. **DO NOT touch both leads with a single probe.**
  - e. The reading on the multimeter should be greater than or equal to the voltage listed on the AC adapter. Higher than listed voltages are normal. If the reading is zero, or the magnitude is less than the nominal voltage, ensure that the multimeter probes are touching the AC adapter's leads.
  - f. If the reading on the multimeter is negative, then the positive probe is touching the negative lead. If the reading on the multimeter is positive, then the positive probe is attached to the positive lead.
4. Once you have determined the polarity of the power source, proceed to Setup.

## SETUP



1. Connect the positive lead on the AC adapter to +EXC on the pressure transducer.
2. Connect the negative lead on the AC adapter to -EXC on the pressure transducer.
3. Using some wire, connect -OUT on the pressure transducer to GND on the Labjack (There are multiple ports marked GND. Any of them can be used)
4. Using some wire, connect +OUT on the pressure transducer to an AIN port on the Labjack
5. Using some wire, connect GND on the pressure transducer to -OUT on the pressure transducer (This step may not be necessary, but I can't find anything explicit in the manual that says it's not.)

## CALC FILE

[Setra Voltage.py](#) (You must set the Range value in this file specific to your pressure transducer)

## CALCULATIONS

The Pressure Transducer should list a range on its label, for example, 0 - 100 PSIG. 5.1V corresponds to the high value and 0.1V (+/- 25mV) corresponds to the low value. Therefore, the pressure can be calculated from the equation of a line that intercepts (0.1V, min range) and (5.1V, max range). The following equation corresponds to that line.

$$Pressure = \frac{MaxRange}{5 * Voltage - 0.5}$$

Where

Pressure is the pressure measured by the pressure transducer, Its units are the same as High's.

Voltage is the voltage reading on the Labjack in Volts

High is the maximum range of the pressure transducer, listed on the sticker on the front of the sensor.



## LINKS

[Manual](#)

[Setra Store Page](#)

# SLQ-HC60 Milliliter Flow Meter

## MATERIALS

No additional materials required

## SETUP

1. Connect the positive lead of the 24V power supply to the White wire on the Flow Sensor
2. Connect the negative lead of the 24V power supply to the blue wire on the Flow Sensor
3. Connect the pink wire on the Flow Sensor to an AIN port on the Labjack
4. Connect the red wire on the Flow Sensor to GND on the Labjack (There are several ports marked GND. Any can be used.)

## CALC FILE

[flow.py](#)

## CALCULATIONS

A linear interpolation program is necessary to obtain the fuel flow rate from the voltage readings on the Sensirion. The "look-up table" of values is obtained from calibration to the specific fuel type. This program is designed and tested in Python 2.6.

# The program accepts a voltage reading from the Sensirion, converts it into a reported flow rate reading using a formula described in the Sensirion documentation. The program then takes this reported value, and uses linear interpolation along with a table of Sensirion flow rate readings and corresponding known flow rates to find the actual value. The x values in the table represent the Sensirion's reported flow rate, while the y value represents the known rate which corresponds to that reading. Linear interpolation involves finding which two pairs of coordinates in the table which the measured value falls between. It then estimates the flow rate associated with the measured value by drawing a line between the two and finding which point on the line the measured value corresponds to. See [http://en.wikipedia.org/wiki/Linear\\_interpolation](http://en.wikipedia.org/wiki/Linear_interpolation) for more information.

```
import math
```

```
#x is a floating point voltage reading from the datalogger. temperature can be ignored.
```

```
#returns a float with the flow rate calculated through linear interpolation
```

```
def calc(x, temperature=0):
```

```
    #convert x into a value which scales linearly with flow rate. (voltage does not scale linearly with flow rate). This formula comes from Sensirion documentation.
```

```
    x = (1.0/3.0)*(math.exp((x-5.0)/0.729)-1.0)
```

```
    #lookup table; data obtained from calibration testing. F
```

```
    table = [(0,0),  
             (0.2669512,0.1443),  
             (0.374306649,0.3229),  
             (0.514364324,0.5702),  
             (0.717738259,1.0701),  
             (0.981278379,1.4043),  
             (1.175715913,1.6854),  
             (3.563983042,6.0575),  
             (5.23721547,9.1288),  
             (14.96496035,25.949),  
             (21.03048245,39.995)]
```

```
    low = 1000000
```

```
    high = 0
```

```
    found = False #Set to True when a result is found in the main loop
```

```
    result = 0.0
```

```

for i in range(len(table)):

    #initialize

    if i == 0:

        low = table[i][0]

        if x == low:

            found = True

            result = table[i][1]

            break

        continue

    elif i == 1:

        high = table[i][0]

    else:

        low = high

        high = table[i][0]

#main body. Here the program tries to find which two data points the given value is between.

#x is off the low end of the scale

if x < low:

    found = True

    high = table[1][0]

    lowValue = table[0][1]

    highValue = table[1][1]

    slope = (highValue - lowValue) / (high - low)

    result = lowValue - (low-x) * slope

    break

#x is found, and is exactly equal to a value in the table.

if (x == high):

    found = True

    result = table[i][1]

    break

#x is found, and is between two values in the table.

if (x > low and x <= high):

    found = True

    #On a scale of 0 to 1, with 0 being low and 1 being high, calculate x

    scale = (x-low)/(high-low)

    #look up the values in the table which correspond to low and high

    lowValue = table[i-1][1]

    highValue = table[i][1]

    #use scale to find the point between highValue and lowValue which corresponds to x

    result = (highValue-lowValue) * scale + lowValue

    break

#x is off the high end of the scale

if not found:

    i = len(table)

```

```
low = table[i-2][0]
high = table[i-1][0]
lowValue = table[i-2][1]
highValue = table[i-1][1]
slope = (highValue - lowValue) / (high - low)
result = highValue + (x-high) * slope
return result
```

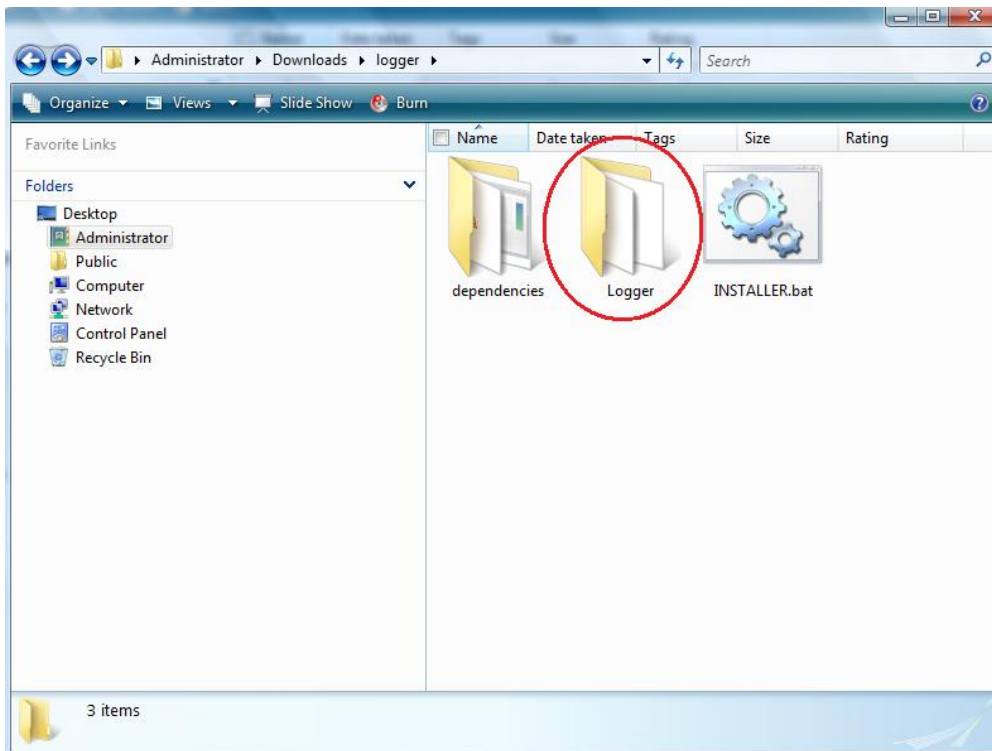
# Startup Guide

## Install

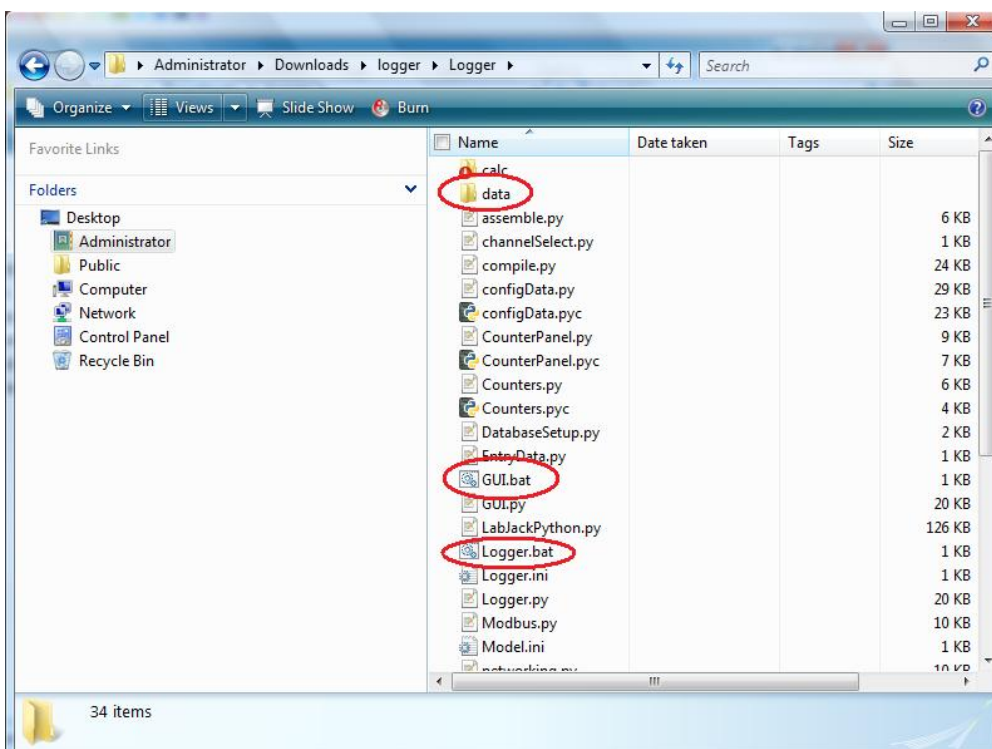
First, you need to download and install Logger. See the [Installation](#) page.

## Important Files

To use Logger, double-click the Logger folder.



Inside there are three things that are important: Logger.bat, GUI.bat, and the “data” folder.



## Change Settings

"GUI.bat" is where you tell Logger what to measure. For an overview of what its settings mean, see [UI Overview](#). For a quick guide on how to set it up, see the page for the sensor you want to use, or consult one of these guides.

[Measuring Power](#)

[Measuring DC Voltage](#)

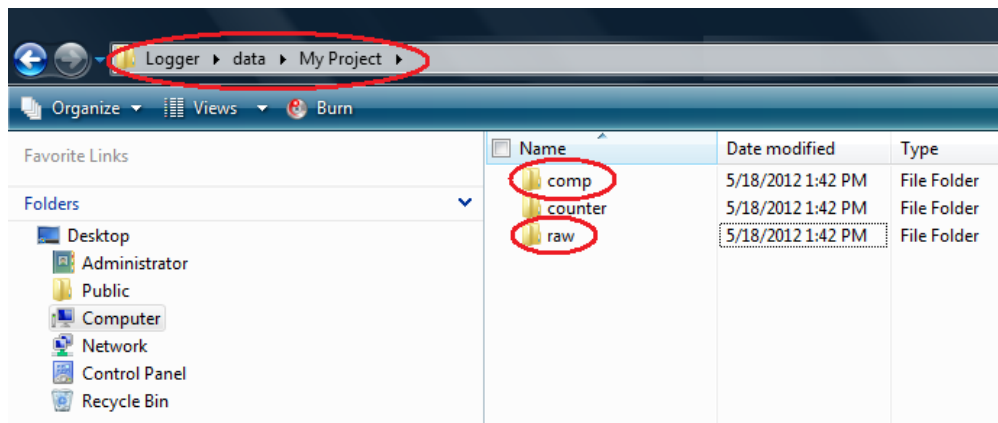
[Measuring DC Voltage With Temperature](#)

## Start Logging

Once you've put in the settings for what you want to measure, double-clicking "Logger.bat" begins logging. After you double-click it, a black window with a bunch of jibberish will pop up, and Logger will begin recording data to the data folder. It won't do anything unless you've told it what to log in GUI.bat. It also won't do anything if a Labjack is not plugged into the computer.

To stop logging, close the black window.

## Get Data



The "data" folder is where logged data is stored. If you've logged any data, you'll find a folder inside it with the project name you chose in GUI.bat. By default, it's called "My Project". Inside this folder you'll find three new folders. One is called "comp". This contains spreadsheets with data measurements from the Labjack that have been converted into the units you chose. The next folder is called "raw". This contains unconverted voltage measurements from the Labjack. These files can be used as backups in case there are any mistakes in your unit conversion calculations.

Here is an example of what you'll find in one of these spreadsheets.

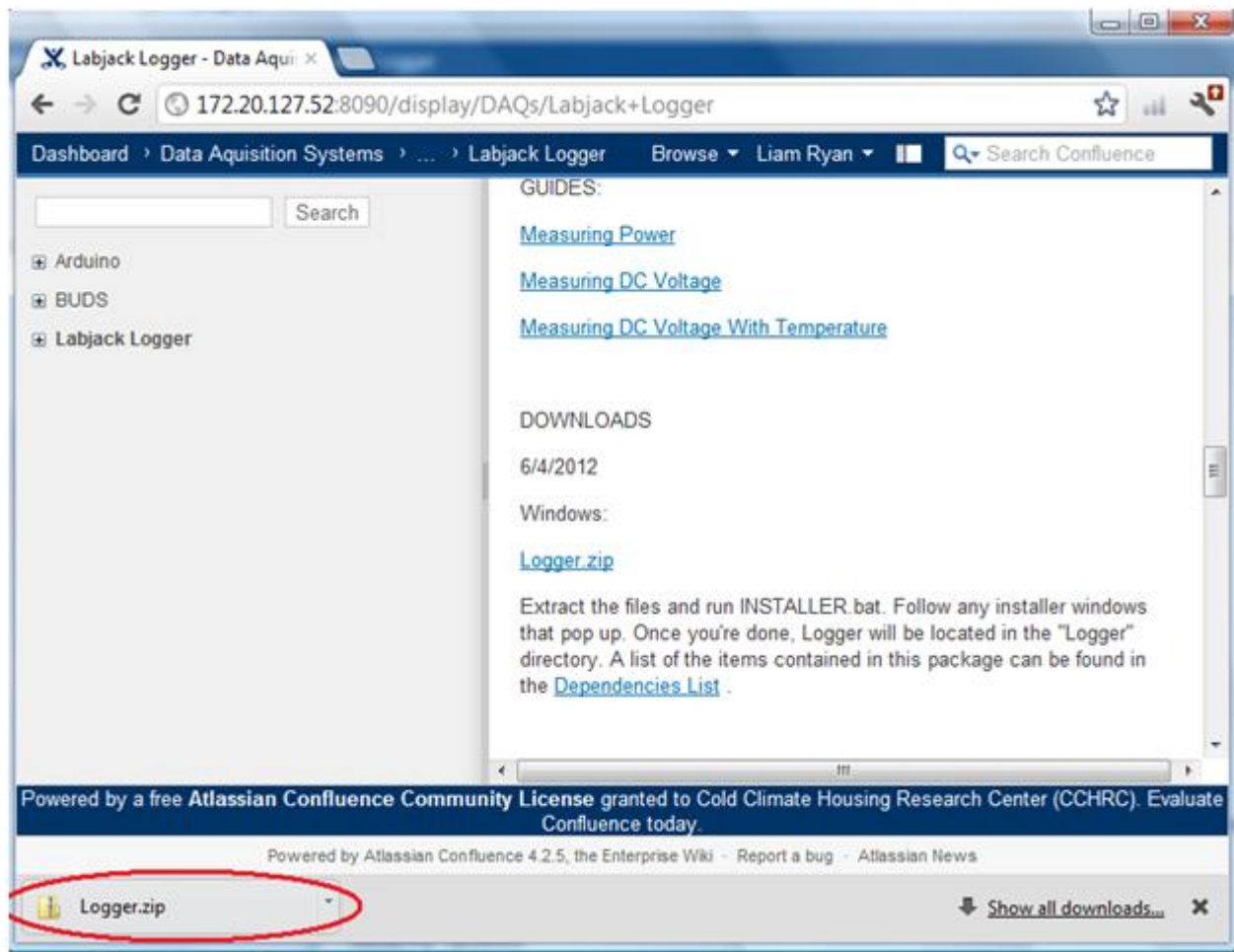
	A	B	C	D	E
1	File:	data/My Project/comp/AIN0_0.0.csv			
2	Date/Time	Volts	Samples		
3	8/10/2011 15:03	5.574879	1		
4	8/10/2011 15:03	60.17681	1		
5	8/10/2011 15:03	61.94473	1		
6	8/10/2011 15:03	53.9964	1		
7	8/10/2011 16:45	0.115702	1		

1. Date/Time column. This shows the date and time that this datapoint was measured at.
2. Units column. In this case, it reads "Volts". The particular unit can be set in GUI.bat. This column shows the data, in this case in converted units since this file was in the calc/ directory.
3. Filename. The name and location of this file.
4. Samples. If you chose to have data averaged, this column shows how many original samples were averaged together to obtain this single sample. In this case, because there was no averaging, Samples is 1 for every datapoint.

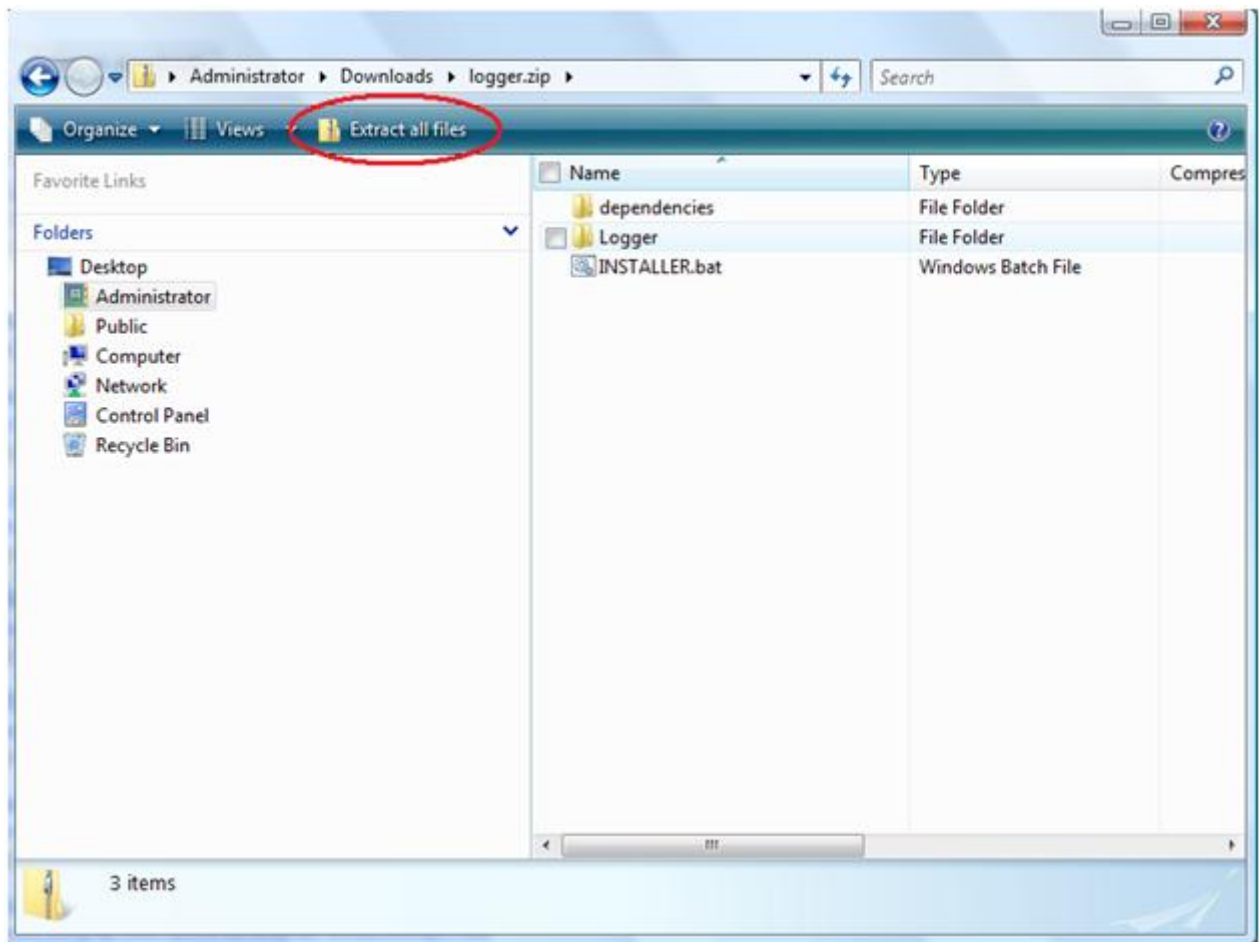
# Installation

Download [Logger.zip](#)

Click on Logger.zip, or open it depending on your web browser.

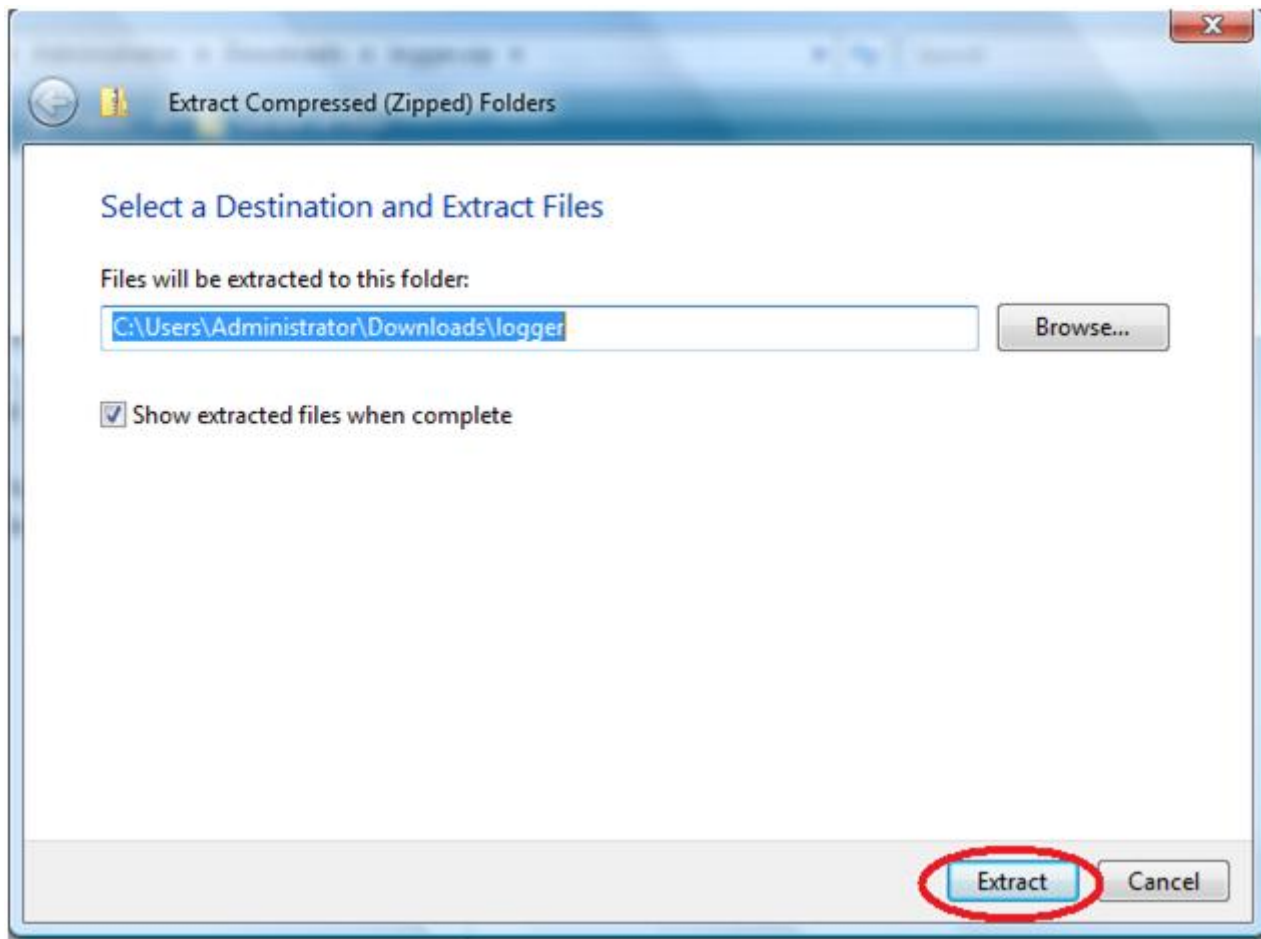


Click on "Extract all files"

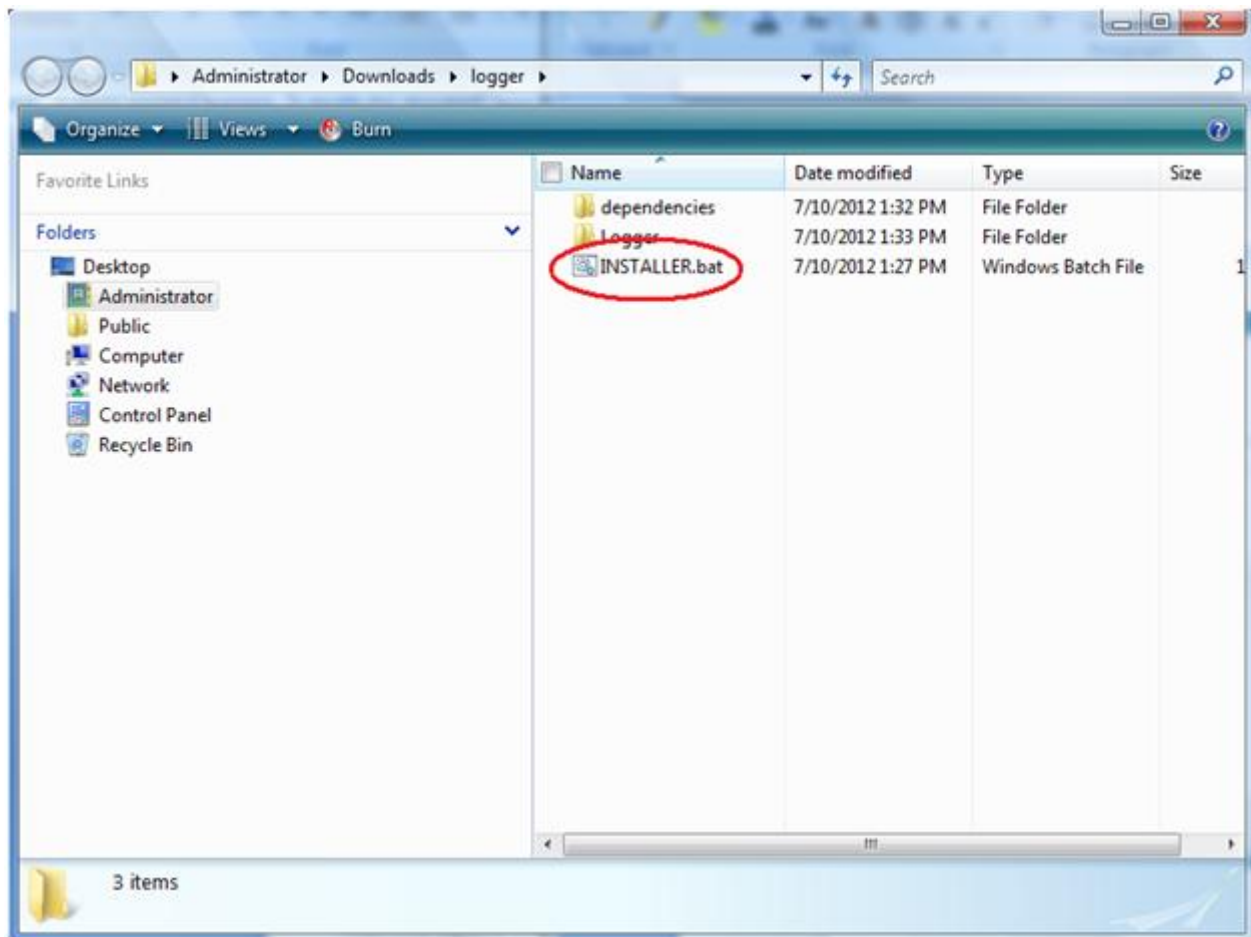


Click Extract, and make sure "Show extracted files when complete" is checked.

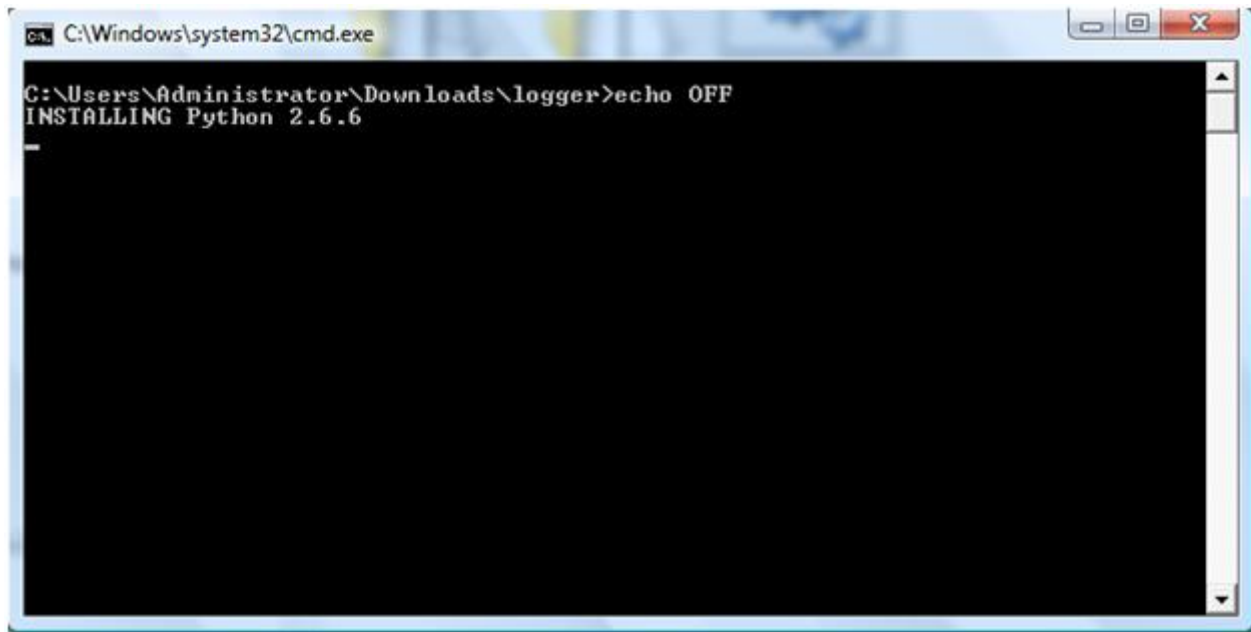




A new window will pop up. Double-click "INSTALLER.bat"



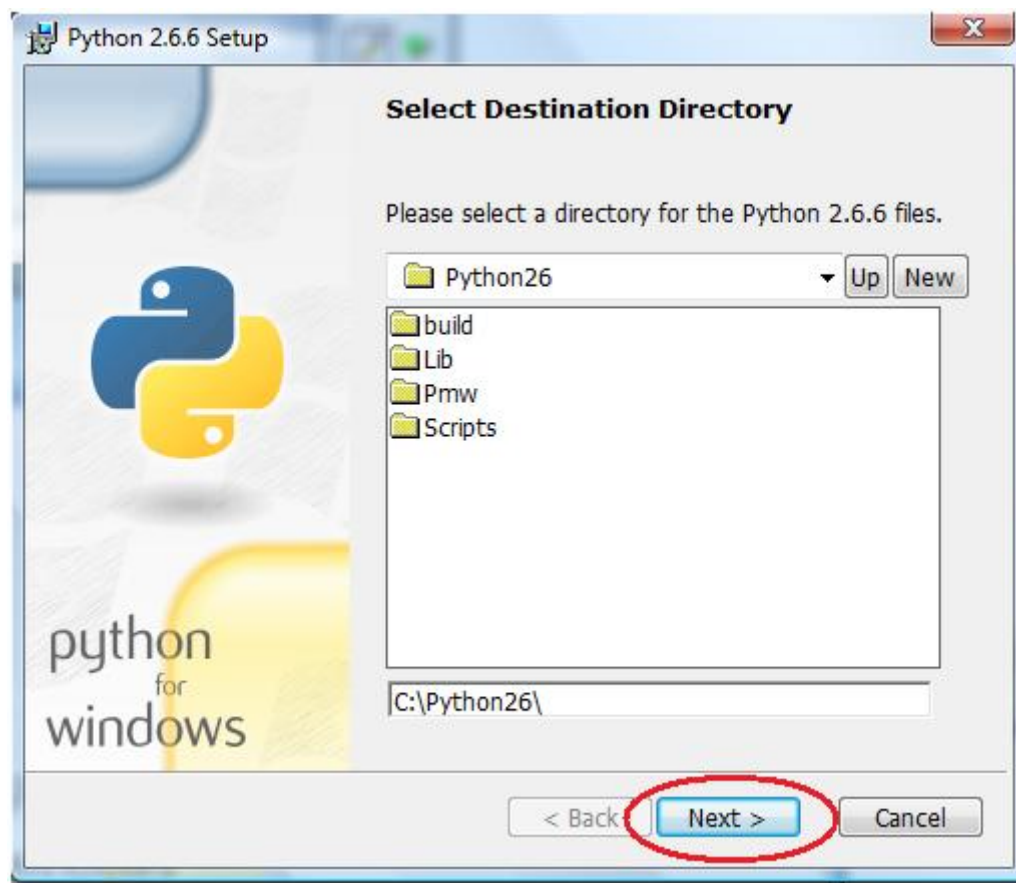
A black window will pop up. Leave it alone.



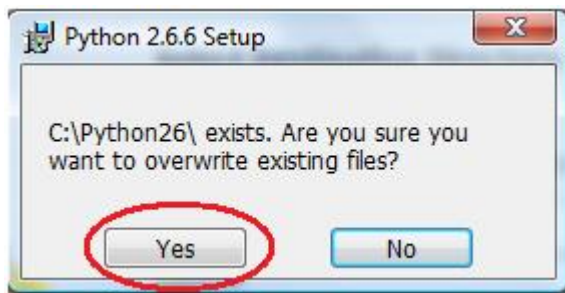
This window will pop up. Press Next.



Press Next again



If this window pops up, click Yes.



Click Next again

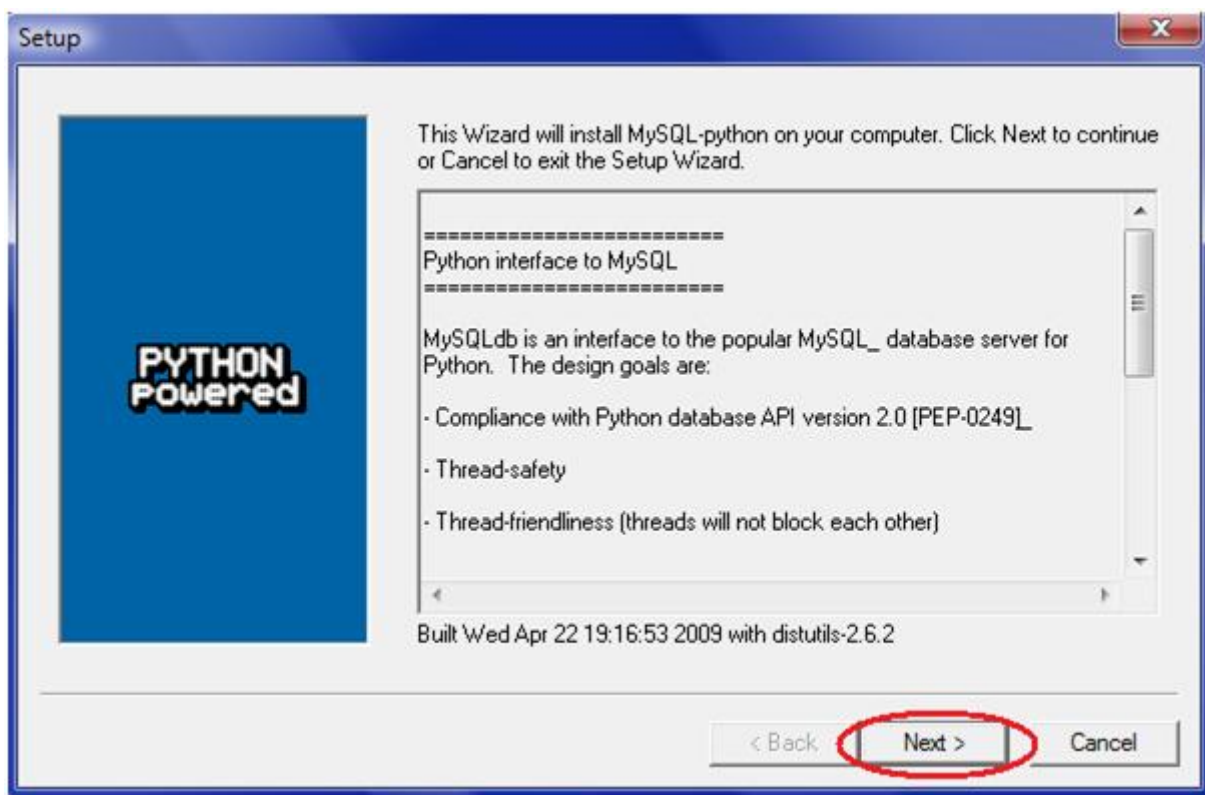


Python will install. Wait a minute or so.

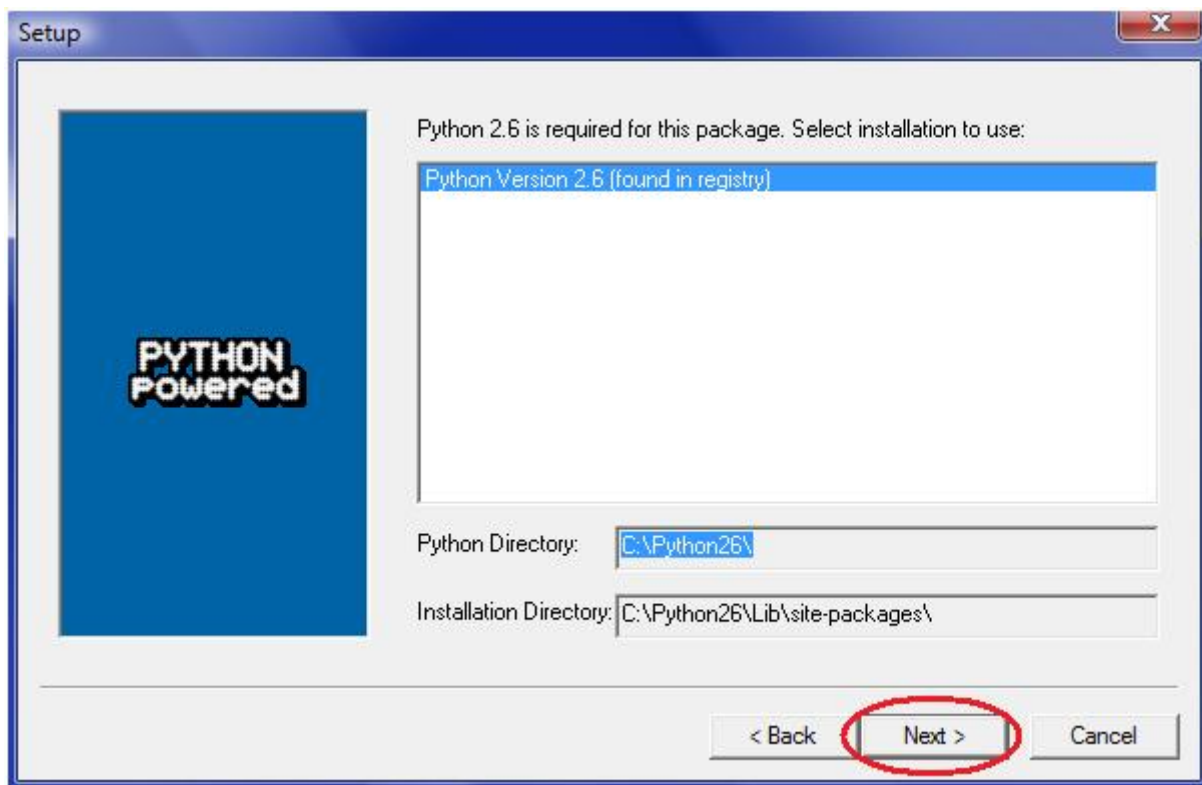
Click Finish



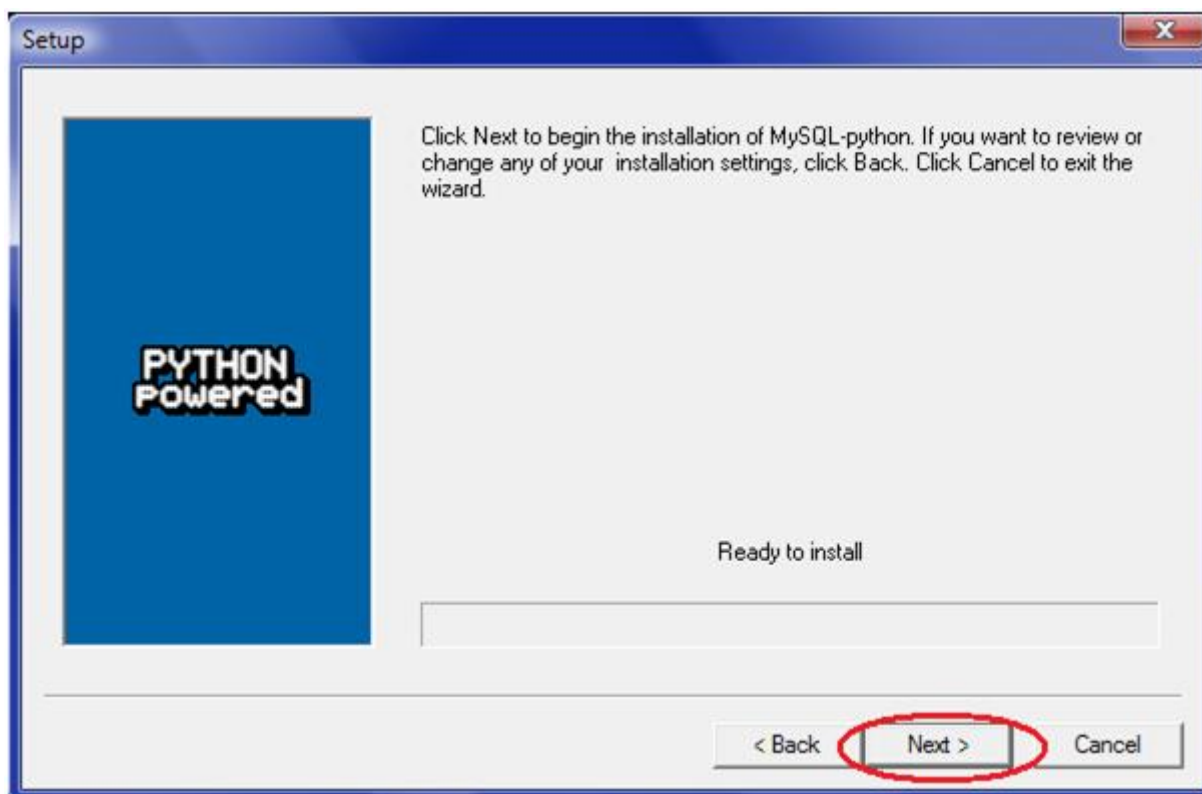
After a few seconds, this window will pop up along with a blue background. Click Next



Click Next again

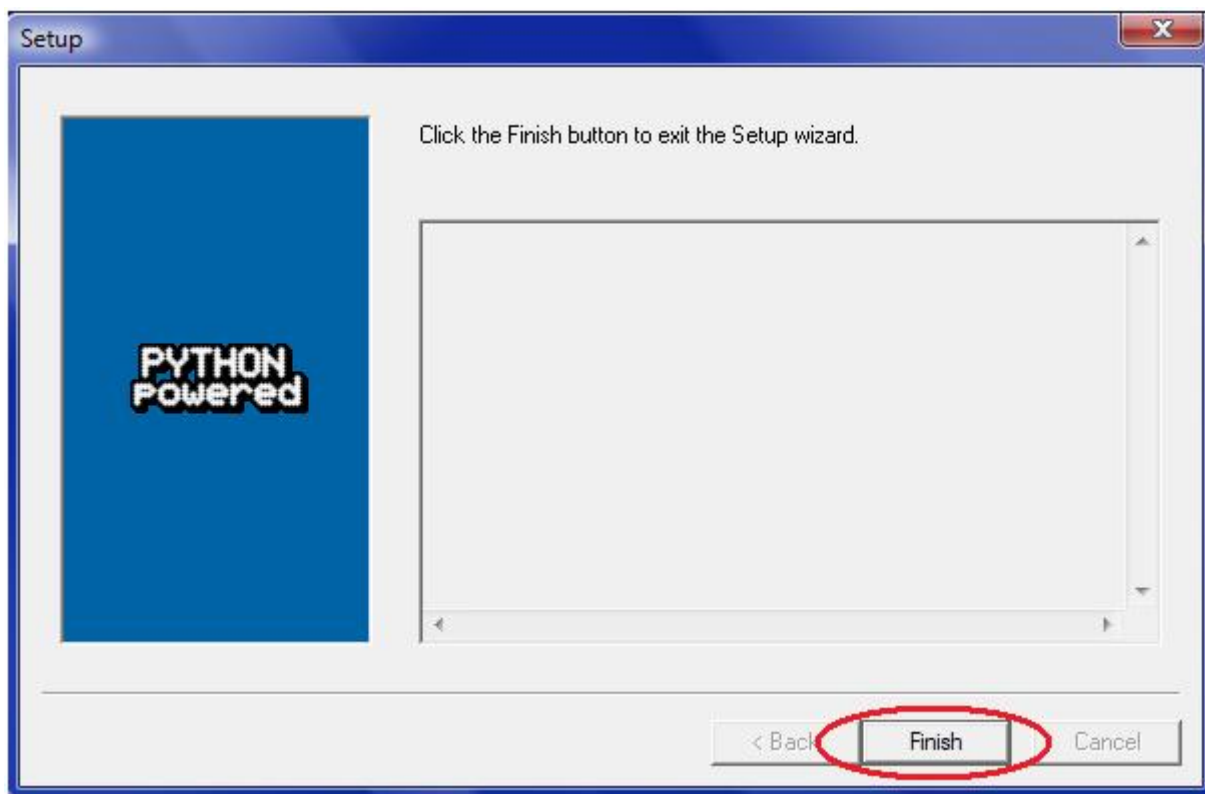


Click Next again



Click Finish

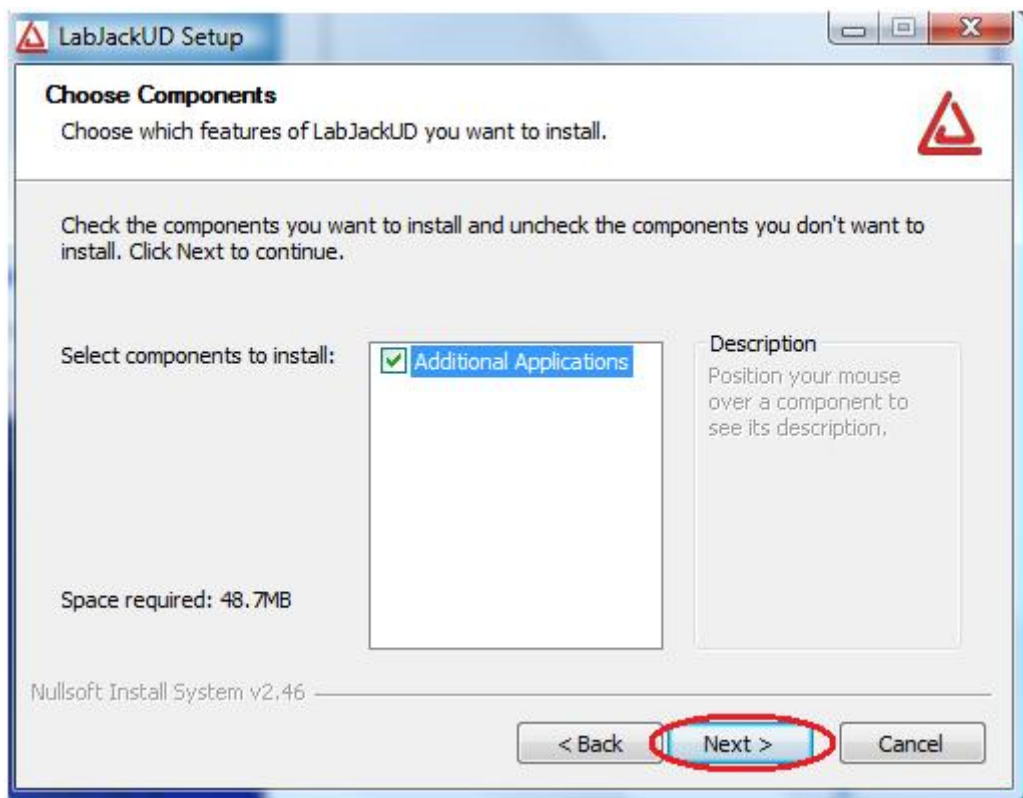




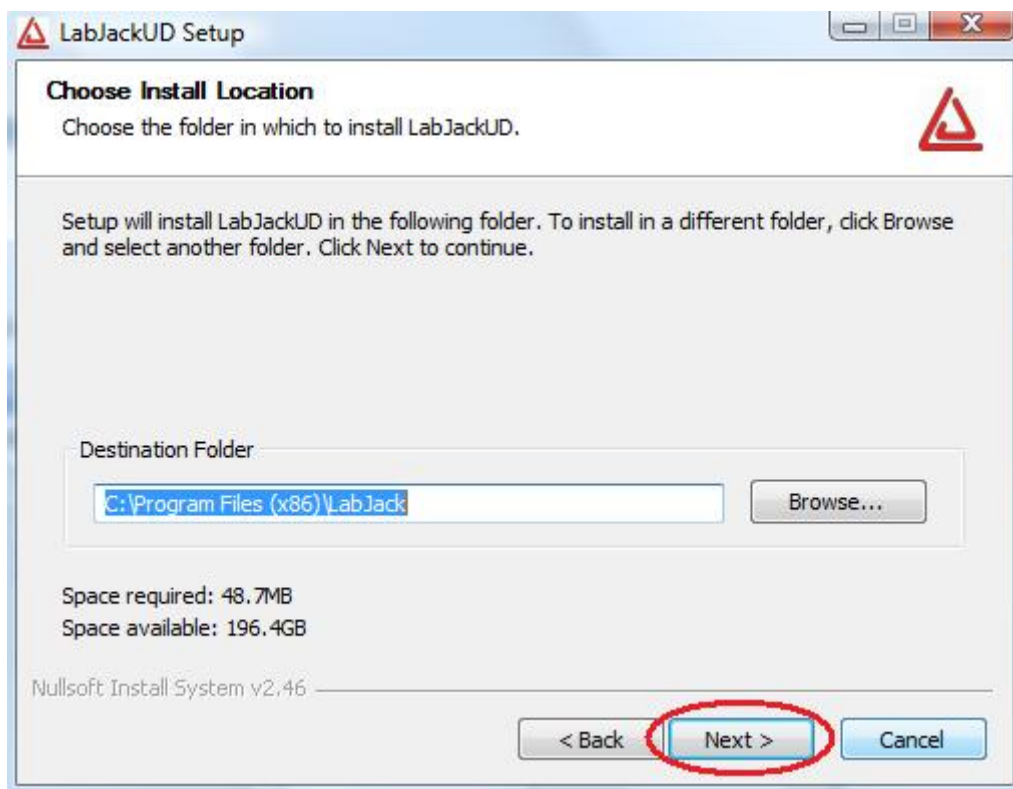
This window will pop up. Click Next.



Click Next again

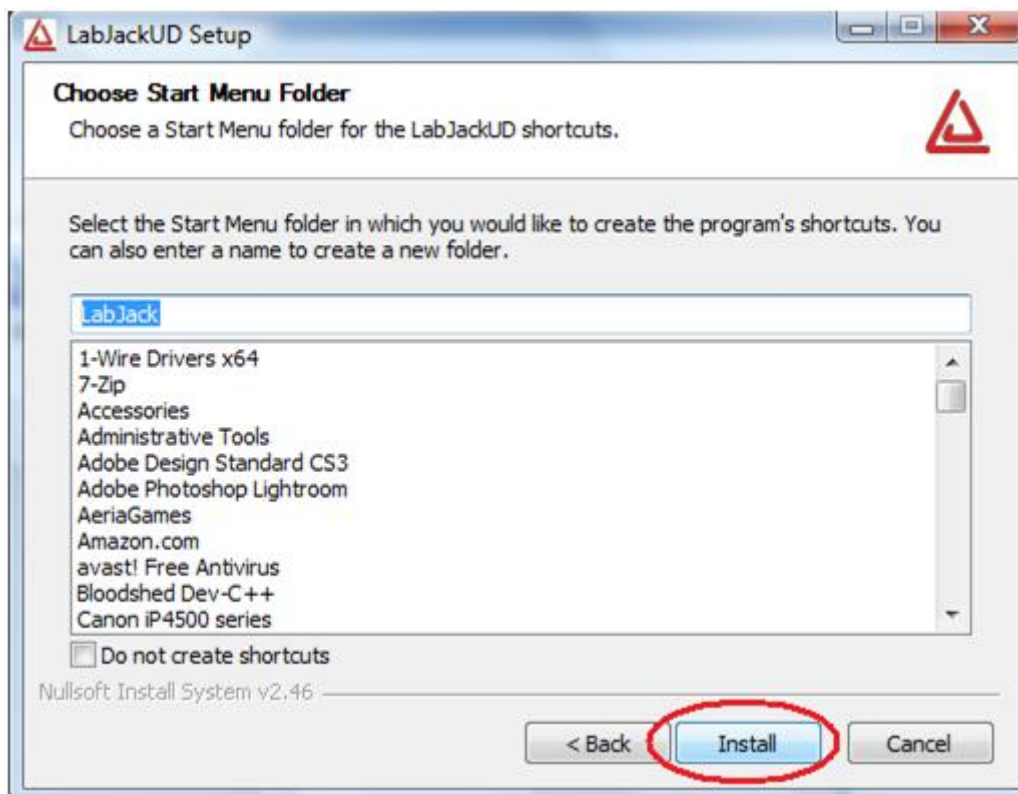


Click Next again.

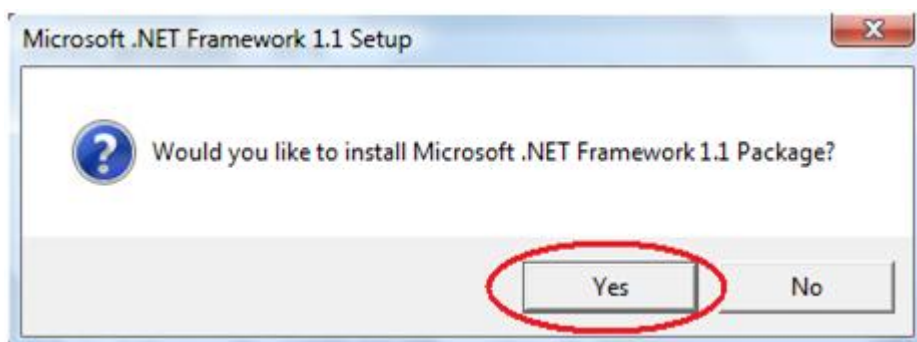


Click Install

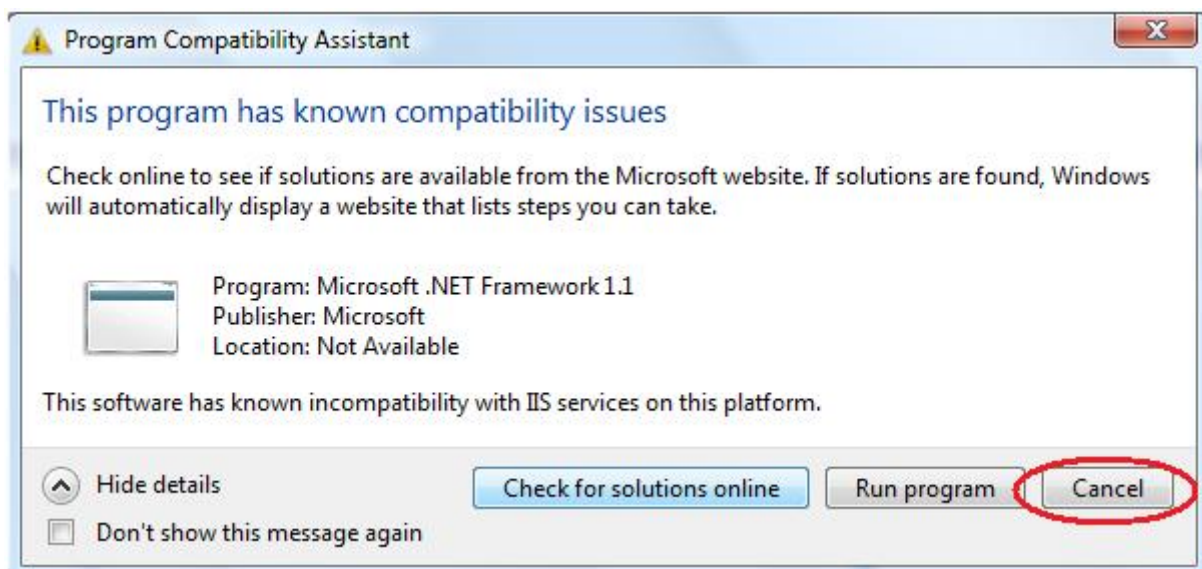




This window may pop up. Click yes.



If this window pops up, click Cancel



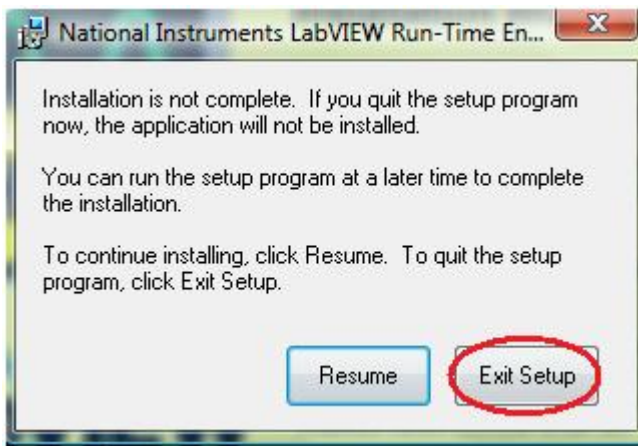
Otherwise, this window will pop up. click I agree, and Install



This Window will pop up. Click Cancel.



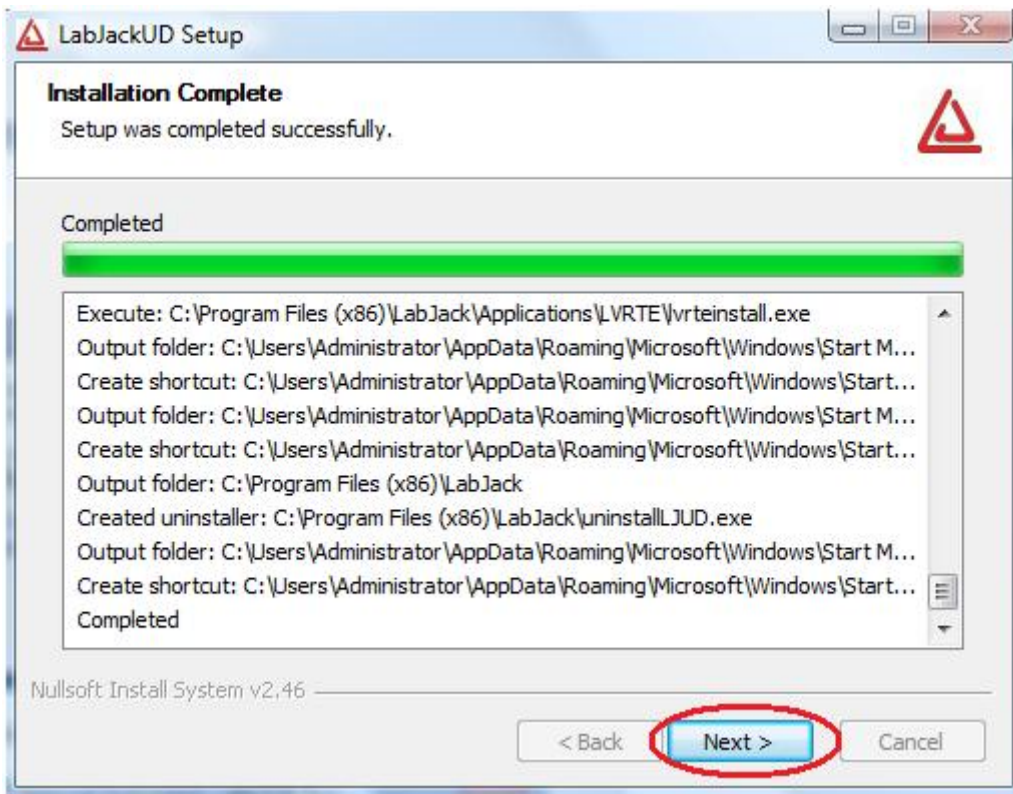
This window will pop up. Click Exit Setup



Click OK



Back in this window, click Next.



Click Finish





The black window should look like this. You can close it.

```

C:\Windows\system32\cmd.exe
t.py to ScrolledFrame_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\ScrolledListBox_t
est.py to ScrolledListBox_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\ScrolledText_test
.py to ScrolledText_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\SelectionDialog_t
est.py to SelectionDialog_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\Test.py to Test.p
yc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\TestVersion.py to
TestVersion.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\TextDialog_test.p
y to TextDialog_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\tests\Tkinter_test.py t
o Tkinter_test.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\Pmw_1_3\__init__.py to __init__
.pyc
byte-compiling C:\Python26\Lib\site-packages\Pmw\__init__.py to __init__.pyc
running install_egg_info
Removing C:\Python26\Lib\site-packages\Pmw-1.3.2-py2.6.egg-info
Writing C:\Python26\Lib\site-packages\Pmw-1.3.2-py2.6.egg-info
INSTALLING MySQL-Python 1.2.2
INSTALLING LabJackPython Driver v325
INSTALLATION COMPLETE
Press any key to continue . . .

```

Logger is now installed.

Ness addition 11/6/2012:

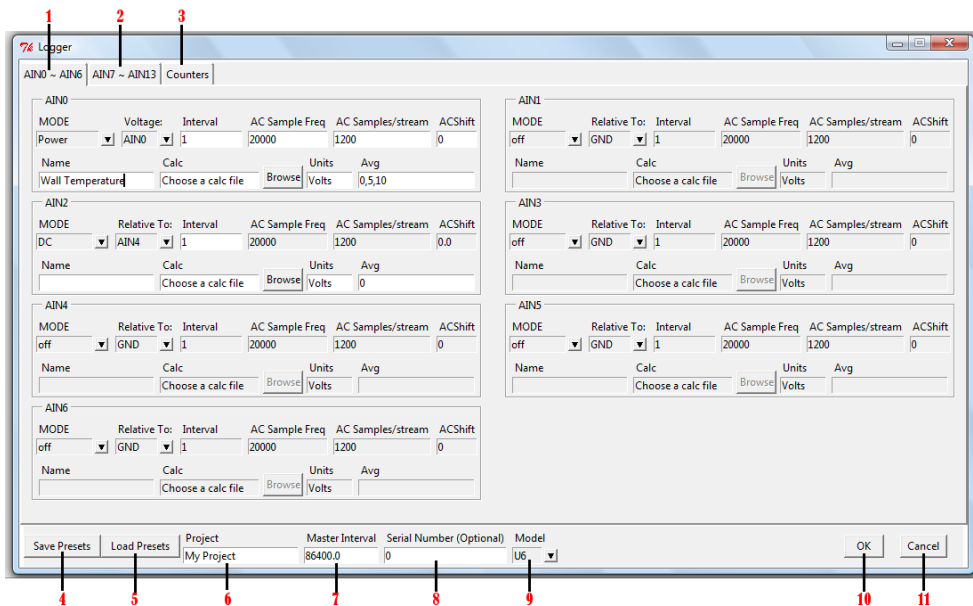
Go to My Computer -> Properties -> Advanced System Properties

Environmental Variables

Then you need to edit the path in System Variables: add c:\python26 to the end of the existing value

# UI Overview

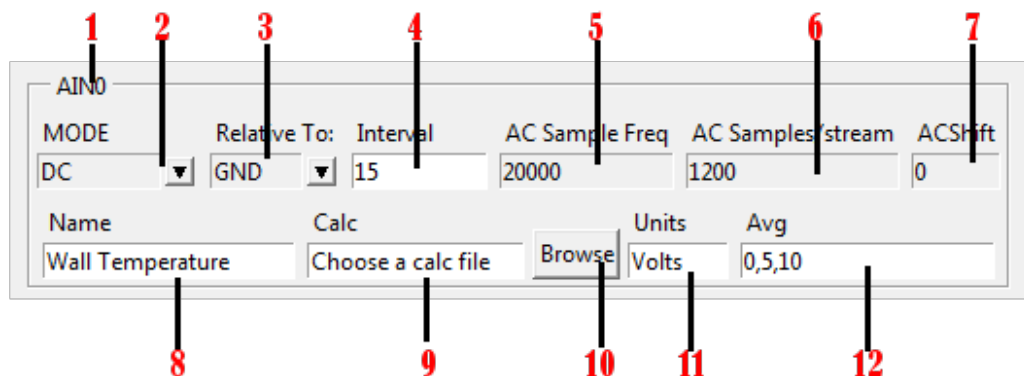
## General



1. This tab contains panels for the first seven analog inputs.
2. This tab contains panels for the last seven analog inputs.
3. This tab contains panels for the Labjack's counters.
4. Press this button to backup your settings to a file.
5. Press this button to load previously saved settings
6. Enter a name for your project. A folder inside the data/ folder will be created with this name, and your data will be stored inside it.
7. Enter an amount of time (in seconds) after which all the data for this project will be copied to a single file. By default this is set to approximately one day.
8. If you are using multiple Labjacks attached to the same computer, you must enter the serial number of the one you want these settings to apply to here.
9. Choose whether you're using a Labjack U6, or a Labjack UE9. Not all settings are available with the UE9.
10. Press OK to use the current settings. The next time you run Logger.bat, these settings will be used.
11. Press cancel to clear changes and close the window. Your changes to the current settings, if not saved with the "Save Presets" button, will be lost.

## DC/DC Temp

These settings are available when the "MODE" drop-down box is set to "DC" or "DC Temp"



1. The analog input that this panel corresponds to. By default, there are four (AIN0 through AIN3), but with an adapter for the Labjack, up to fourteen analog input ports can be accessed
2. The type of measurement being taken. Options are DC, DC with Temperature measurements, and Power. DC records a voltage measurement, DC with temperature records a voltage measurement and a measurement from the Labjack's internal temperature sensor, and Power records a power measurement.

3. This field is for measuring differential signals. leave it at GND for no differential measurements. Otherwise, select the pair of this analog input. For example, AIN0 and AIN1 are a pair as they are located on the same 4-port screw terminal on the Labjack. The following analog inputs are pairs (AIN0, AIN1), (AIN2, AIN3), (AIN4, AIN5), (AIN6, AIN7), (AIN8, AIN9), (AIN10, AIN11), (AIN12, AIN13)
4. The amount of time (in seconds) between datapoint recordings
5. Only available in "Power" mode.
6. Only available in "Power" mode.
7. Only available in "Power" mode.
8. Enter a name for what's being measured here. This name will be used as a filename for the recorded output data.
9. The name of a calc file, located under the /calc/ folder in the Logger/ directory. Calc files for various sensors can be downloaded on this wiki from the pages for those sensors.
10. Click this button to browse for a calc file.
11. The units that are being measured here. This field is just a label and can be whatever you want.
12. A comma-separated list of numbers. This field determines how many copies of averaged data are created. Zero, or a blank field means no averaging, while any other number represents the amount of seconds worth of data that should be averaged. For example, 0,5,10 entered in this field would record one copy with no averaging (0), one copy which averages every 5 seconds worth of data, and one copy that averages every 10 seconds worth of data.

## Power Mode

These settings are available when the "MODE" drop-down box is set to "Power". For any settings not marked on the diagram below, see above.

1. The type of measurement being taken. Options are DC, DC with Temperature measurements, and Power. DC records a voltage measurement, DC with temperature records a voltage measurement and a measurement from the Labjack's internal temperature sensor, and Power records a power measurement.
2. Because this panel is in Power mode, this drop-down menu is labeled Voltage. This is because Power measurements require both a voltage and a current measured together. In this case, AIN0 is connected to the current signal, while AIN1 is connected to the voltage signal. When using Power mode, [make sure the MODE drop-down box in the panel listed under Voltage \(AIN1 in this example\) is set to "off"](#).
  - It's ok to select AIN1 in the voltage drop-down boxes for multiple panels. So for example, if I had two devices hooked up to the same voltage source, and wanted to measure each of their power usages, I could hook the voltage sensor to AIN1, and set AIN1 in the "Voltage" drop-down boxes for both devices.
  - (NOTE: If for whatever reason you can't measure voltage, you still get (less accurate) readings by measuring just the current. This method is more accurate if the thing whose power use you're measuring has few inductive loads. In order to do this, you would connect a wire from VCC on the Labjack to the Analog input selected in the Voltage drop-down. Then, in the calc file, you would multiply the final result by (Desired Voltage/5).

BACKGROUND: Fields 3, 4, and 5 deal with the details of how Logger measures Power. If you don't know what they mean, leave them alone. Otherwise they can be used to ensure accurate readings.

- When measuring power, Logger records a large number of synchronized datapoints very quickly from both the voltage signal and the current signal. From these datapoints it obtains waveforms for voltage and current, then multiplies the waveforms together point by point in order to obtain a waveform for the power used. It then takes the average power, and records that number as the final result.
3. AC Sample Freq represents the frequency (in Hz) at which Logger records waveform datapoints. This should be at least 100 times higher than the frequency of the signal being measured. The Labjack website lists the maximum frequency as 50,000 Hz, however since two signals are being recorded simultaneously when performing power measurements, that number is approximately halved for these purposes down to around 25,000 Hz. I use 20,000 Hz as the default in order to remain conservative and ensure that the program does not request more of the Labjack than it is capable of giving.
  4. AC Samples/stream represents how many datapoints are used to create each waveform. This should be at least three periods worth of data, and should preferably not include fractions of a period.
  5. ACShift is an angle (in degrees) by which the voltage waveform is shifted before it's multiplied by the current waveform to create a Power waveform. This is useful for measuring multi-phase power, as the voltage must be measured indirectly, and the indirect measurement is not at the correct angle. For 3-phase power, enter -30 in this box. For applications not involving multi-phase power, leave it blank or zero.

# Thermistor

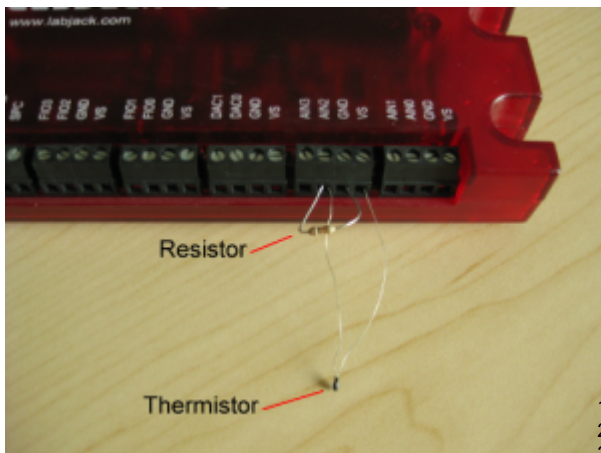
Thermistors are a device whose electrical resistance changes depending on temperature.

## MATERIALS

Power source (usually the 5V Vs on the Labjack, but other DC sources can be substituted so long as their ground wire is connected to the Labjack's ground, and calculations are adjusted to account for the voltage of the new power source. The voltage of the new power source must also not exceed what the Labjack is capable of measuring. See [Limitations](#))

Resistor (Usually 10 kilo Ohms (k), but other values can be substituted. Most accurate readings are obtained when the thermistor's resistance and the resistor's resistance are close to the same)

## SETUP



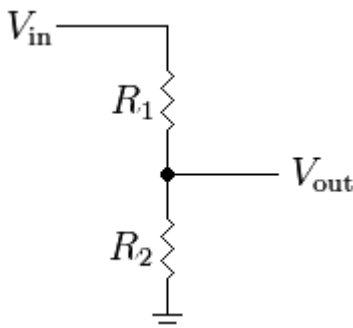
1. Attach one end of the thermistor to Vs on the Labjack.
2. Attach the other end of the thermistor to one of the AIN ports on the Labjack.
3. Attach one end of a 10k resistor to the same AIN port. (Thermistor and resistor wires can be of very different thickness. Make sure both wires are snug.)
4. Attach the other end of the 10k resistor to GND on the Labjack. (There are multiple ports marked GND. Any of them can be used)
5. See [Measuring DC Voltage](#) in order to configure Logger to read from the sensor.

NOTE: Try to keep wires from touching. Wires that touch may cause short-circuits that can damage the Labjack.

## CALC FILE

[thermistor.py](#) (WARNING: You must edit this file and set constants a,b, and c for the thermistor before use. This file will not function in its default state.)

## CALCULATIONS



In the image above,

R1 is the resistance of the thermistor

R2 is the resistance of the resistor

Vin is the voltage of the power source in Volts (i.e. the Labjack's Vs)

Vout is the voltage measurement taken from the Labjack.

$$R_1 = \frac{R_2 \cdot V_{in}}{V_{out}} - R_2$$

This gives you the resistance of the thermistor. Once you have this, you can convert from resistance to temperature.

$$Temperature = \frac{1}{a + b * d + c * d^3} - 273.15$$

Where:

a, b, and c are dependent on the thermistor used and should be listed in the thermistor's datasheet

$$d = \ln(R_1)$$

ln is the [Natural Logarithm](#).

(Be careful that your calculated resistance is not negative or you will not be able to take its log! This should hypothetically be impossible but can happen sometimes due to noise.)

## LIMITATIONS

The Labjack can only measure up to +/-10V, and can only handle up to +/-20V without being damaged. If you are using a different power source, ensure that the voltage on the AIN sensor will not exceed 10V. You can calculate the voltage on the AIN sensor with the following formula.

$$V_{out} = \frac{R2 * V_{in}}{R1 + R2}$$

Where

V<sub>out</sub> is the voltage on the AIN sensor

V<sub>in</sub> is the voltage of the new DC power source

R<sub>1</sub> is the resistance of the thermistor

R<sub>2</sub> is the resistance of the resistor



# Thermocouple

Thermocouples are a device composed of two different conducting metals that produces a voltage when the metal on one side is at a different temperature than the metal on the other. They are usually less accurate than thermistors, however, it is usually easier to insulate them against high temperature than thermistors.

## MATERIALS

LJTick-InAmp (Optional. You can also use the differential feature on the Labjack.)

## SETUP

1. Attach the LJTick-InAmp to one of the AIN four-screw terminals on the Labjack, and secure the screws.
2. Attach the positive lead of the Thermocouple to IN A+ on the LJTick-InAmp
3. Attach the negative lead of the Thermocouple to IN A- on the LJTick-InAmp
4. See [Measuring DC Voltage With Temperature](#) in order to configure Logger to read from the sensor.

## CALC FILE

[thermocouple.py](#)

## CALCULATIONS

K-type thermocouples are measured in two major steps. One, measure the reference temperature and convert it to an equivalent thermocouple voltage, then add that to the measured voltage. Two, convert the voltages into the final temperature measurement.

To convert the reference temperature to equivalent voltage, use the following formula.

$$V_{ref} = c_0 + c_1 * T_{ref} + c_2 * T_{ref}^2 + c_3 * T_{ref}^3 + c_4 * T_{ref}^4 + c_5 * T_{ref}^5 + c_6 * T_{ref}^6 + c_7 * T_{ref}^7 + c_8 * T_{ref}^8 + c_9 * T_{ref}^9$$

Where

Vref is the equivalent thermocouple voltage for the reference temperature

Tref is the reference temperature

c0 through c9 are the following constants

```
c0 = -1.7600413686 * 10^-2
c1 = 3.8921204975 * 10^-2
c2 = 1.8558770032 * 10^-5
c3 = -9.9457592874 * 10^-8
c4 = 3.1840945719 * 10^-10
c5 = -5.6072844889 * 10^-13
c6 = 5.6075059059 * 10^-16
c7 = -3.2020720003 * 10^-19
c8 = 9.7151147152 * 10^-23
c9 = -1.2104721275 * 10^-26
```

Once you have Vref, add it to the voltage measured by the Labjack in order to get V.

Finally, you must convert measured and reference voltages into temperature

$$T = c_0 + c_1 * V + c_2 * V^2 + c_3 * V^3 + c_4 * V^4 + c_5 * V^5 + c_6 * V^6 + c_7 * V^7 + c_8 * V^8 + c_9 * V^9$$

Where

T is the temperature at the thermocouple

c0 through c9 are constants which depend on the value of V and are listed below. Do not use the previous values for c0 through c9

V is equal to Vref plus the voltage measured on the Labjack.

The values of c0 through c9 are as follows. Do not use the previous values for c0 through c9

When  $V < 0$

```
c0 = 0
c1 = 2.5173462 * 10^-1
c2 = -1.1662878
c3 = -1.0833638
c4 = -8.9773540 * 10^-1
c5 = -3.7342377 * 10^-1
c6 = -8.6632643 * 10^-2
c7 = -1.0450598 * 10^-2
c8 = -5.1920577 * 10^-4
c9 = 0
```

When  $0 \leq V \leq 20.644\text{mV}$

$c_0 = 0.000000$   
 $c_1 = 2.508355 * 10^1$   
 $c_2 = 7.860106 * 10^{-2}$   
 $c_3 = -2.503131 * 10^{-1}$   
 $c_4 = 8.315270 * 10^{-2}$   
 $c_5 = -1.228034 * 10^{-2}$   
 $c_6 = 9.804036 * 10^{-4}$   
 $c_7 = -4.413030 * 10^{-5}$   
 $c_8 = 1.057734 * 10^{-6}$   
 $c_9 = -1.052755 * 10^{-8}$

When  $V > 20.66\text{mV}$

$c_0 = -1.318058 * 10^2$   
 $c_1 = 4.830222 * 10^1$   
 $c_2 = -1.646031 * 10^0$   
 $c_3 = 5.464731 * 10^{-2}$   
 $c_4 = -9.650715 * 10^{-4}$   
 $c_5 = 8.802193 * 10^{-6}$   
 $c_6 = -3.110810 * 10^{-8}$   
 $c_7 = 0$   
 $c_8 = 0$   
 $c_9 = 0$

# Wood Moisture Content Sensor

Wood moisture content sensors allow one to measure moisture percentage by measuring the electrical resistance of the wood.

## MATERIALS

**Power source** (usually the 5V Vcc on the Labjack, but other DC sources can be substituted so long as their ground wire is connected to the Labjack's ground, and calculations are adjusted to account for the voltage of the new power source. The voltage of the new power source must also not produce a final output which exceed what the Labjack is capable of measuring. See [Limitations](#))

**Resistor** You'll need one resistor. Changing the resistance allows one to calibrate the minimum and maximum range of the sensor. Increasing the resistance allows the sensor to measure lower moisture content values, but prevents it from accurately measuring higher values. Decreasing the resistance allows the sensor to measure higher moisture content values, but prevents it from measuring lower moisture content values.

Resistance	Min	Max
5k	20%	300%
20k	14%	165%
3M	8%	50%

(Values are for the LabJack U6 standard edition. Ranges for other DAQs may vary.)

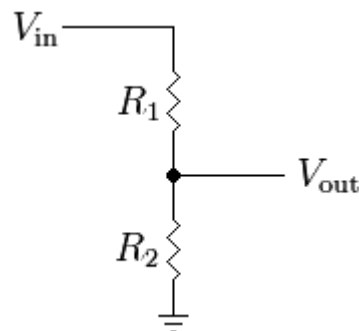
## SETUP

1. Attach one lead from the block to Vcc on the Labjack.
2. Attach the other lead from the block to one of the AIN ports on the Labjack.
3. Attach one end of a 3M resistor to the same AIN port.
4. Attach the other end of the 3M resistor to GND on the Labjack. (There are multiple ports marked GND. Any of them can be used)
5. See [Measuring DC Voltage](#) in order to configure Logger to read from the sensor.

## CALC FILE

[wood\\_block.py](#) (Be sure to update this if you're using a different resistor!)

## CALCULATIONS



In the image above,

R1 is the resistance of the wood

R2 is the resistance of the resistor

Vin is the voltage of the power source in Volts (i.e. the Labjack's Vcc, which is 5V)

Vout is the voltage measurement taken from the Labjack.

$$R_1 = \frac{R_2 \cdot V_{in}}{V_{out}} - R_2$$

This gives you the resistance of the wood. Once you have this, you can convert from resistance to percentage moisture content

$$Moisturepercent = 10^{(2.99 - 2.113 * \log_{10}(\log_{10}(resistance)))}$$

(log10 is the [logarithm](#) base 10)

(Be careful that your calculated resistance is not negative or you will not be able to take its log! This should hypothetically be impossible but can happen sometimes due to noise.)

## LIMITATIONS

The Labjack can only measure up to 10V. If you are using a different power source, ensure that the voltage on the AIN sensor will not exceed 10V. You can calculate the voltage on the AIN sensor with the following formula.

$$V_{out} = \frac{R2 * V_{in}}{R1 + R2}$$

Where

Vout is the voltage on the AIN sensor

Vin is the voltage of the new DC power source

R1 is the resistance of the wood

R2 is the resistance of the resistor