

# QuIN Lab Automation Guide

Version 2.0.2

Hayden Jones

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## Preface

This guide is intended to provide instructions and assistance in the following categories:

- Software Installation
- Hardware Operation
- Software Operation
- Troubleshooting
- Programming

## Changes

The Version 2.0.2 Updates are as follows:

- Software Operation
  - **CHANGED:** Updates to reflect software updates.

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# 1 Software Installation

This section details the installation of necessary software for running the automation.

## 1.1 Anaconda

For our project, we are using Anaconda 3 64-bit as our Python distribution.

### 1.1.1 Downloads

The Anaconda distribution can be downloaded [here](#). The Python version number is different from the Anaconda version number, but we only care about the Python version number. The download required is “Python 3.5 version 64-bit Installer”.

### 1.1.2 Install Guide

1. Run the executable downloaded as administrator.
2. Select “Next”, then “I Agree”.
3. Select “Install for: All Users”, then “Next”. All other settings can be left default.
4. Select “Yes” to administrator privileges.
5. Select “Next”.
6. Ensure both checkboxes are checked. Then select “Install”.
7. Wait for the installation process to finish.
8. Select “Next”.
9. Uncheck “Learn more about Anaconda Cloud” then “Finish”.
10. Right-click the start menu icon, then click “System”.
11. Click “Advanced System Settings”.
12. Click “Environment Variables” (under the “Advanced” tab).
13. Click on “PATH” then “Edit”.
14. If there are no Anaconda directories specified, we need to add them.
  - (a) Click “New” then type “C:\”. Make two entries.
  - (b) Click “Browse...” then navigate to and select the installation directory for Anaconda.

They should look similar to Figure 1.
  - (c) Restart the computer.

### 1.1.3 Verify Installation

In order to check that Anaconda is installed correctly, and has proper PATH variables, open a command prompt and enter “python”. It should look very similar to Figure 2.

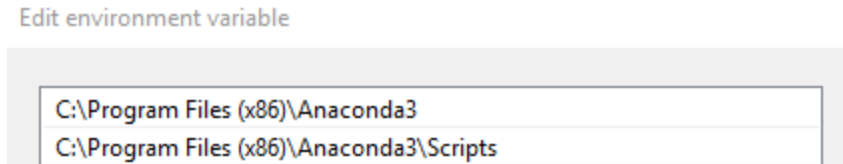


Figure 1: PATH Variables for Anaconda 3

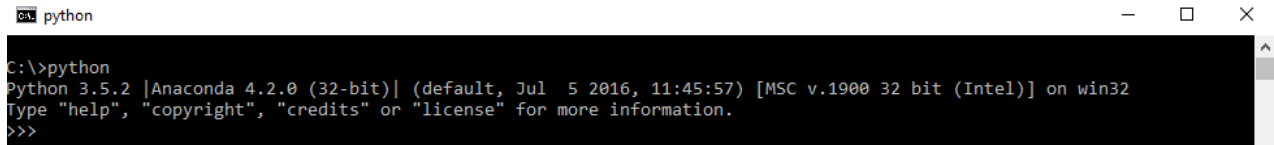


Figure 2: Anaconda Python in Command Prompt

## 1.2 Anaconda Packages

These are the packages that must be installed after Anaconda is installed.

### 1.2.1 Downloads

Open the QuIN Lab Google Drive, navigate to “Hayden Jones\Automation”. Download “wxpython-phoenix.zip”, and “source-code.zip”. It is safe to rename “source-code.zip” to something more descriptive; however “wxpython-phoenix.zip” cannot be renamed.

### 1.2.2 Install Guide

1. Extract the downloaded zips to a folder on the desktop.
2. Open an elevated command prompt.

An elevated command prompt is a command prompt in administrator mode.

3. Navigate in the command prompt to the desktop.

You can do this by entering “cd\”, then “cd <dir\_name>”.

4. Enter the following commands consecutively, entering “y” when prompted:

```
conda install pyserial
conda install git
conda install patch
conda update -n root conda-build
python -m pip install PyVISA
python -m pip install thorlabs_ap
python -m pip install -U --pre -f \
    https://wxpython.org/Phoenix/snapshot-builds/ wxPython_Phoenix
python -m pip install pyautoit
python -m pip install --upgrade \
    https://github.com/jacexh/pyautoit/archive/master.zip
```

5. Note that the URLs in the wxPython Phoenix and PyAutoIt installations commands should be part of the same command that starts with “python -m pip install”.
6. Close the command prompt.
7. Open Windows Explorer and navigate to the Anaconda installation directory.
8. Open “pkgs\thorlabs\_apt-0.1-py35\_0\Lib\site-packages\thorlabs\_apt”.
9. Edit core.py with a Python IDE, Notepad++, or other similar program.  
Built-in Notepad is not recommended.
10. Enter “import ctypes.util” on a new line below “import ctypes”.
11. Save the file, this should prompt you to use administrator privileges.  
If unable to save, copy it to the desktop, edit it, then move it back into the directory.

### 1.2.3 Verify Installation

In order to verify that packages are installed correctly, open a command prompt and type “conda list”. The list should include many packages. Check that pyserial, pyautoit, git, patch, PyVISA, thorlabs\_apt, and wxpython-phoenix are included in the list. This indicates a successful installation, but it can also be tested by opening a command prompt and attempting to use the packages. Note that pyautoit will not work properly unless AutoIt is installed on the system.

## 1.3 Newport Software

This is the software and drivers provided by Newport.

### 1.3.1 Downloads

Download Computer Interface Software from [here](#).

### 1.3.2 Install Guide

1. Extract “Computer-Interface-Software-vx.x.x.zip”.
2. Open the “C:\Computer-Interface-Software-vx.x.x.x” folder that you just created. Run “Setup.exe”.
3. Select “64-bit mode on a 64-bit Operating System” then “Ok”.
4. Select “Next”.
5. Select “Everyone” then “Next”.
6. Select “Next”.
7. Select “Yes” for administrator privileges.
8. Wait for the installation to complete.
9. Select “Close”.



## 1.4 ThorLabs Software

This is the software and drivers provided by ThorLabs.

### 1.4.1 Downloads

Download APT 64-bit for 64-bit Windows and Kinesis 64-bit for 64-bit Windows from here. Since the downloaded file is “setup.exe”, it is recommended to rename this to a more descriptive title such as “ThorLabs-APT-Setup.exe”.

### 1.4.2 Install Guide

1. Run the setup file for ThorLabs APT.
2. Select “Yes” to administrator privileges.
3. Select “Install”.
4. Wait for the installation to complete.

If a fail error popup appears, ignore it and continue following steps.

5. Select “Next.”
6. Select “I Accept”, then “Next”.
7. Select “Anyone who uses this computer (all users)”, then “Next”.  
User name and organization can be anything, they do not affect installation.
8. Select “Complete”, then “Next”.
9. Select “Install”.
10. Wait for the installation to finish.
11. Select “Finish”.
12. Run the setup file for Kinesis.
13. Select “Yes” to administrator privileges.
14. Select “Install”.
15. Wait for the installation to complete.  
If a fail error popup appears, ignore it and continue following steps.
16. Select “Next.”
17. Select “I Accept”, then “Next”.
18. Select “Next”.  
User name and organization can be anything, they do not affect installation.
19. Select “Complete”, then “Next”.

20. Select “Install”.
21. Wait for the installation to finish.
22. Select “Finish”.

## 1.5 Keysight (Agilent) Software

This is the software provided by Keysight, which is used with Agilent (and Keysight) electronic devices.

### 1.5.1 Downloads

Download the most recent version of IO Libraries Suite from here, if necessary put in your name and email to download the file. Note that you do not have to create an account to download the file. The email you enter will receive download confirmation emails, however they may come 1-2 weeks after downloading.

### 1.5.2 Install Guide

If NI VISA and Keysight software have been previously installed, as per Version 1 editions of this automation guide, simply run the Keysight installer and select the option to modify installation. Modify the installation such that the Keysight VISA becomes the primary VISA.

1. Run “IOLibSuite\_version.exe” wait for it to unzip.
2. Close the unzip window, press yes when it asks for administrator privileges.
3. Wait for the InstallShield Wizard window to load.
4. Press next, then agree, then next.
5. A pop-up window should appear as seen in 3, press OK.

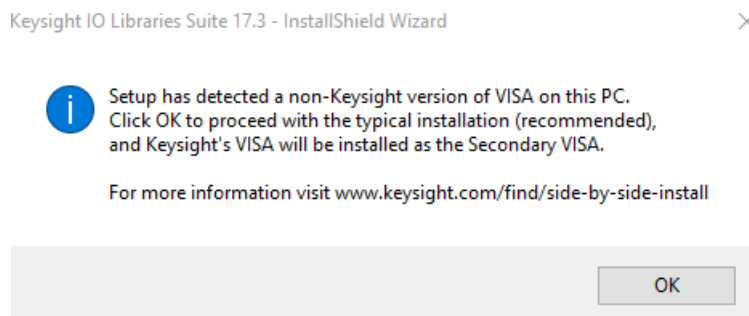


Figure 3: Keysight VISA detection pop-up.

6. Choose “Custom”, then press next.
7. Ensure the “Install Keysight VISA as sprimary VISA.” is checked, then press next.
8. Press install, then wait for it to complete installation (this will take several minutes).

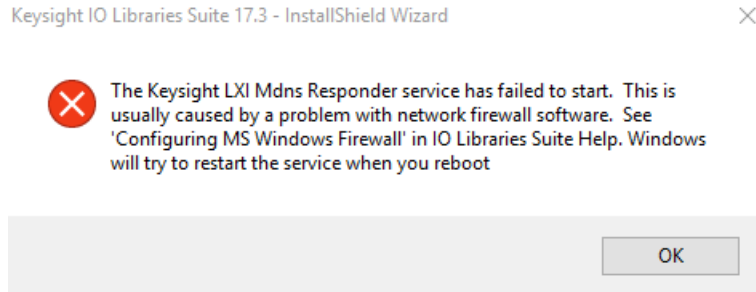


Figure 4: Keysight error pop-up during installation of IO Libraries Suite.

9. If an error pop-up appears, as seen in 4, press OK.
10. Press finish, then restart the computer.

## 1.6 AutoIt

AutoIt is a scripting language developed to use Windows features to automate GUIs.

### 1.6.1 Downloads

Download AutoIt Full Installation (top option in the downloads table) from here.

### 1.6.2 Install Guide

1. Run the setup file which was downloaded.
2. Select “Yes” to administrator privileges.
3. Select “Next”.
4. Select “I Agree”.
5. Select “Use native x64 tools by default”.
6. Select “Next”.
7. Select “Run the script”.
8. Select “Next”, twice.
9. Select “Install”.
10. Wait for the installation to complete.
11. Uncheck “Show release notes”, then select “Finish”.

## 2 Hardware Operation

This section details the setup of different hardware devices for use with the computer. This does not cover laser usage, as this is beyond the scope of the guide and requires proper safety and equipment training.

### 2.1 Supported Devices

- ThorLabs PRM1Z8 DC Servo/Rotation Stage
- Newport 1918-R Handheld Optical Power Meter
- Meadowlark D3050 Four Channel Digital Interface
- Zaber T-NA08A25 Linear Actuator
- Newport 1830-C Optical Power Meter
- Princeton Instruments Spectrometer and CCD Camera

### 2.2 ThorLabs PRM1Z8 DC Servo

The ThorLabs PRM1Z8 is a DC servo motor which can be used as a rotation stage with different optics mounted inside. A current example of usage is with a linear polarizing filter in order to measure the polarization of the laser outputs.

#### 2.2.1 Setup

1. Ensure you have the following required items:
  - ThorLabs TCH002 Controller Hub
  - ThorLabs TCH002 Controller Hub Power Supply
  - 3-pin Power Cable (for power supply)
  - Male to Male USB2 Type-A to USB2 Type-B Cable
  - ThorLabs TDC001 DC Servo Motor Controller
  - ThorLabs PRM1Z8 DC Servo
  - Optics Table Mounting Equipment
2. Install the motor controller onto the controller hub.
3. Connect the controller hub to the power supply.
4. Connect the controller hub to the computer via USB.
5. Mount the controller hub to the optics table in a convenient location.
6. Mount the PRM1Z8 servo to the optics table as desired.
7. Connect the servo to the motor controller.

## 2.3 Newport 1918-R Handheld Optical Power Meter

The Newport 1918-R handheld optical power meter is a compact optical power meter with an LCD display. It is useful for measuring the power output of the laser.

### 2.3.1 Setup

1. Ensure you have the following required items:
  - Newport 1918-R Handheld Optical Power Meter
  - Newport 1918-R Handheld Optical Power Meter Power Supply
  - Newport Optical Power Sensor
  - Male to Male USB Mini-b to USB2 Type-A Cable
  - Optics Table Mounting Equipment
2. Connect the sensor to the power meter.
3. Connect the power supply to the power meter.
4. Connect the power meter to the computer via USB.
5. Mount the optical power meter sensor as desired.

## 2.4 Meadowlark D3050 Four Channel Digital Interface

The Meadowlark D3050 four channel digital interface is a controller which is used to control up to four Meadowlark liquid crystal devices. This can be used to control an LCVR in the laser beam path, changing the power and polarization of the beam.

### 2.4.1 Setup

1. Ensure you have the following required items:
  - Meadowlark D3050 Four Channel Digital Interface
  - Meadowlark D3050 Four Channel Digital Interface Power Supply
  - Female to Male RS232 Serial Port Cable
  - Zaber T-USB Serial to USB Converter
2. Connect the power supply to the controller.
3. Connect the controller to the serial to USB converter via RS232.
4. Connect the serial to USB converter to the computer.
5. Connect liquid crystal devices to the controller as desired.

## 2.5 Zaber T-NA08A25 Linear Actuator

The Zaber T-NA08A25 linear actuator is a linear actuator with up to 25mm of travel distance, using either manual or computer control. This can be used to change the position of optics, and multiple devices can be daisy chained to a single computer port.

### 2.5.1 Setup

1. Ensure you have the following required items:
  - Zaber T-NA08A25 Linear Actuator
  - Zaber T-NA08A25 Linear Actuator Power Supply
  - Zaber T-USB Serial to USB Converter
  - Zaber Mini-DIN to 9-Pin Serial Adapter
2. Connect the power supply to the linear actuator(s).
3. Connect the linear actuators to each other if using more than one.
4. Connect the actuator to the Mini-DIN to 9-Pin serial adapter.
5. Connect the Mini-DIN to 9-Pin serial adapter to the serial to USB converter.
6. Connect the serial to USB adapter to the computer.

## 2.6 Newport 1830-C Optical Power Meter

The Newport 1830-C optical power meter is a desktop optical power meter which uses photodiode sensors to take optical power measurements. This can be used to calibrate the laser input power, and to monitor the power during experimentation.

### 2.6.1 Setup

1. Ensure you have the following required items:
  - Newport 1830-C Optical Power Meter
  - Newport Optical Power Sensor
  - Agilent GPIB-USB Converter Cable
2. Connect the optical power meter to power.
3. Connect the GPIB-USB cable to the optical power meter and computer.
4. Connect the optical power sensor to the optical power meter.
5. Mount the optical power sensor in the beam path.

## 2.7 Princeton Instruments Spectrometer and CCD Camera

The Princeton Instruments Spectrometer and CCD Camera require LightField to be installed in order to function. The full initial setup is detailed from Princeton documentation, this section will deal with setup required to use the equipment after initial setup.

### 2.7.1 Setup

1. Ensure that the CCD and Spectrometer are connected to the computer.
2. Power on the CCD and Spectrometer by switching their power supplies on.
3. Open LightField and check that the devices are detected.

### **3 Software Operation**

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## 4 Troubleshooting

This section is intended to give general advice to troubleshooting problems which may arise.

### 4.1 General Advice

General device can be used to approach any problem which does not have a specific solution in the guide. These techniques are also useful when troubleshooting software and hardware outside of the lab.

- Check the all the power and data connections are properly secured, and try unplugging/re-plugging them back in.
- Try restarting the computer.
- Check in “Device Manager” that there are no yellow warning triangles for devices, and that the devices drivers are installed correctly.
- Attempt to reinstall the device drivers/programs as this can fix problems with the .dll’s which are used.

An exception to this is the Python installation. Unless there is a missing import error, there is no need to reinstall Anaconda or any packages.

### 4.2 Specific Error Solutions

Specific error solutions are errors which have come up in the lab which may arise in the future. This will not cover any problems arising from bugs in the program source code. If there is a bug in the source code, it is wise to make a backup before changing any code. If you fix the error, document the correction and source code change, and ensure that it doesn’t change the function of the program.

#### 4.2.1 thorlabs\_apr [WinError 126]

This error arises when thorlabs\_apr cannot find the “APT.dll” which is installed with the APT 32-bit for 64-bit installation. An example of this error can be seen in Figure 5.

```
Traceback (most recent call last):
  File "C:/Users/hione/OneDrive/Documents/Important/IQC/QuIN Lab Automation/Polarizer/polarization_experiment_automation.py", line 9, in <module>
    import thorlabs_apr as aprlib
  File "C:/Program Files (x86)/Anaconda3/lib/site-packages/thorlabs_apr/_init_.py", line 1, in <module>
    from .core import *
  File "C:/Program Files (x86)/Anaconda3/lib/site-packages/thorlabs_apr/core.py", line 1374, in <module>
    _lib = _load_library()
  File "C:/Program Files (x86)/Anaconda3/lib/site-packages/thorlabs_apr/core.py", line 1360, in _load_library
    lib = ctypes.windll.LoadLibrary(filename)
  File "C:/Program Files (x86)/Anaconda3/lib/ctypes/_init_.py", line 425, in LoadLibrary
    return self._dlltype(name)
  File "C:/Program Files (x86)/Anaconda3/lib/ctypes/_init_.py", line 347, in _init__
    self._handle = _dlopen(self._name, mode)
OSError: [WinError 126] The specified module could not be found

Process finished with exit code 1
```

Figure 5: [WinError 126] caused by thorlabs\_apr being unable to find “APT.dll”.

Solution:



1. Open Windows Explorer and navigate to “C:\Program Files (x86)\Thorlabs\APT\APT Server”.
2. Copy “APT.dll”.
3. Open the directory where the source code is running from, and paste these files into that directory.
4. Open “C:\Program Files (x86)\Anaconda3\Lib\site-packages\thorlabs\_apr”.
5. Paste the files in this directory.

The program should now run correctly.

## 5 Programming

This section of the guide is to provide tips on programming and documentation in Python for usage in QuIN Lab.

### 5.1 Documentation

All of the code which is created for usage within QuIN Lab should be documented use the NumPy documentation guidelines. These guidelines can be found [here](#).

### 5.2 Style

All of the code which is created for usage within QuIN Lab should follow the Python PEP8 Style guide. The PEP8 style guide can be found [here](#).

### 5.3 wxPython Phoenix

All of the wxPython Phoenix documentation is available [here](#). Additionally, it is recommended to try searching for your problem online, as wxPython and wxPython Phoenix are used quite commonly. There is likely a solution to your problem already.

When programming a GUI, it is important to use a different thread for the automation, which is a subthread of the GUI thread. To make this threading work, the GUIs use `_thread` to run the automation. It is very important that any calls to methods or objects which change the GUI appearance must use `wx.CallAfter(method, parameters)`, otherwise the automation and GUI will not work properly. It is also very important when programming, to make sure that objects have proper parents, otherwise the GUI can look very unusable.