# Installation Instructions

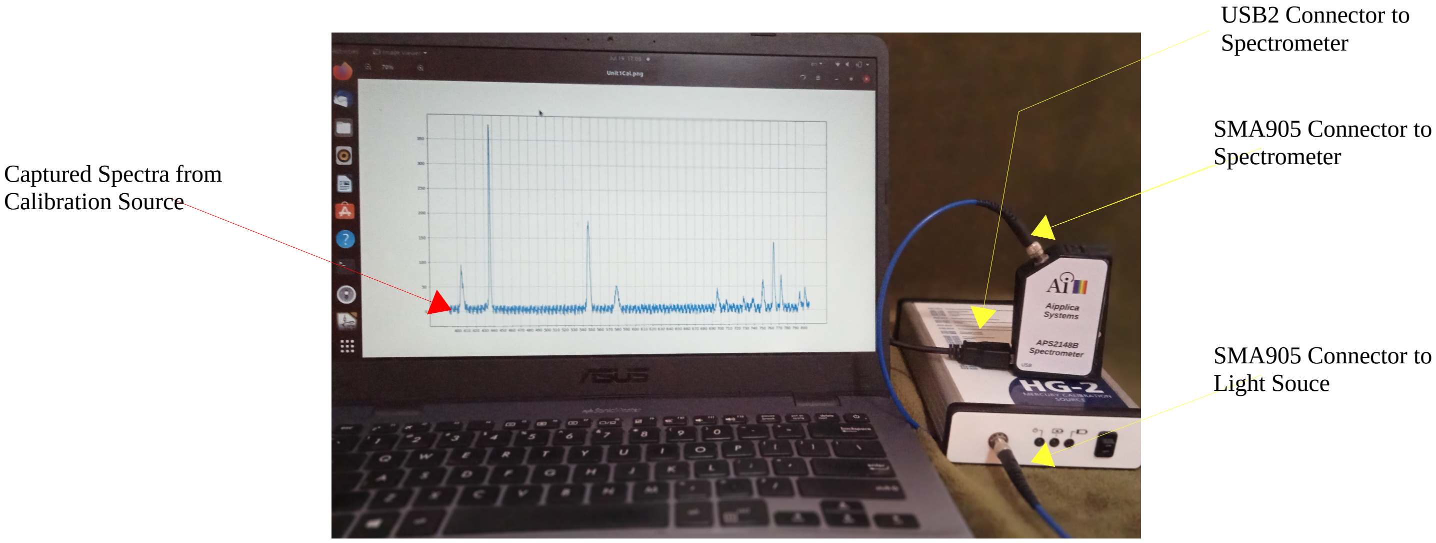
Congratulations on purchasing you Aipplica Spectrometer !

Purpose of this installation Guide is to walk you through the process of connecting your spectrometer and installing necessary drivers, libraries, 3rd party or Aipplica provided, and capturing a spectra with a test source of your convenience.

You should have received a Spectrometer module along with i) an SMA905 connector 50um Core optical fiber cable with black dustcaps and ii) a USB2 (Male) to USB2 (Female) connector cable. Your Spectrometer module has a USB port for communicating with the Laptop/Desktop PC and an Optical port with SMA905 connector for Optical signal input.

Plug in one end of your USB Cable into you computer and the other end into USB2 port of the Spectrometer.

Remove the dustcap from one end of the SMA905 Optical fiber cable. Do not touch the open end with your bare hands. Connect it to the Spectrometer SMA905 port. Do not apply excessive force and only tighten it lightly. Connect the other end of SMA905 Optical cable to an optical light source or calibration source with an SMA905 port or just point it to a light source, like an LED, LED light, for coarse observation.



USB2 Connector to Spectrometer
SMA905 Connector to Spectrometer
Captured Spectra from Calibration Source
SMA905 Connector to Light Souce
Ai
Aipplica Systems
APS2148B Spectrometer
HG-2

*Setup showing Aipplica Spectrometer and Calibration light Source*

From Aipplica website Download APSpec library for Python/Linux and follow the DemoA.ipynb jupyter notebook or DemoA.py to capture Spectral data.

If you are working with C language, a C library (libAPSpec.a and libAPSpec.h) with an example MyApp.c (using gnuplot) is provided. Following pages have further instructions. These examples are created with Hg-Ar calibration light source. If you have questions, you may write to contact.aipplica.com or refer to www.aipplica.com

**NB:** *Do not try to disassemble or unscrew the Unit or subject it to high mechanical stress or higher temperature than rated as it will disturb the alignment and render the calibration void and in worst case render the unit inoperative due to misalignment.*

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**APSpec2148 driver python3 installation instructions.**

APSpec interacts with PC through USB bus. To work with APSpectrometers in python/Ubuntu environment, you may install opensource pyftdi user space driver for popular FTDI devices. Please go through the installation section of pyftdi driver and install pyftdi package.

Alternatively you may write your own C/C++ application code and interact with Aipplica Spectrometers via FTDI's D2XX API drivers (Windows) or libftd2xx (Linux) & FTDI's MPSSE library and Aipplica Spectrometer library, libAPSpec. Go to the next section for instructions.

### For Python/Linux Environment:

```
>pip3 install pyftdi
```

Please note, as outlined in the pyftdi installation section, On Linux, you also need to create a *udev* configuration file to allow user-space processes to access to the FTDI devices. After you have successfully installed pyftdi.

Download APSpec2148 latest APSpec_*.whl from www.aipplica.com/downloads.html

```
>pip3 install APSpec-0.2-py3-none-any.whl
```

Now you are ready to use the APSpectrometer. For plotting and viewing captured spectral data, these scripts use matplotlib. Please ensure matplotlib is installed.

```
$pip3 install matplotlib
```

Invoke Python3 and follow the sequence of commands as provided in **DemoA.py** or if you use jupyter notebook, invoke jupyter notebook with **DemoA.ipynb** These files are provided in Download section on Aipplica website.

For DemoA.py executable file you may invoke the python3 executable as follows,

```
>./DemoA.py
```

but first read through the comments. Do block the optical input with the dustcap when collecting the dark signal and illuminate/connect the slit/fiber when collecting the light spectra at the right steps. The script will open the plot and display the captured signal. It will proceed to the next step after you close the graphics plot. Once you are familiar with the script, you may customize/modify as needed.

For DemoA.ipynb you may execute in jupyter notebook, Please read through the comments to understand the flow.

```
>jupyter  notebook DemoA.ipynb
```

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By this point you have instantiated a spectrometer module and captured the dark signal data. You may turn on the light source of your choice (Colour LEDs,LED torch light,light bulb and capture its spectra a plot it and process the captured spectrum  as you please.

### **<u>For C/C++ & Linux Environment</u>**

### FTDI driver installation instructions.

APSpec uses FTDIs USB interface IC with Multi Protocol Synchronous Serial Engine (MPSSE) hardware. The MPSSE is a hardware block found in several FTDI chips which communicates with a PC over the USB interface. Applications on a PC communicate with the MPSSE in these chips using the D2XX USB drivers and the LibMPSSE library and the libAPSpec wrapper library.

Please install FTDI’s libftd2xx drivers in Linux ( D2XX API drivers for Windows) Please refer to FTDIs website for additional details. The following Application Note on FTDIs website may be helpful:  *AN_220_FTDI_Drivers_Installation_Guide_for_Linux-1.pdf*

Next Download the LibMPSSE.zip library from FTDI’s website: You will need the libMPSSE.h and libMPSSE.a files from here.

*<u>https://ftdichip.com/software-examples/mpsse-projects/libmpsse-spi-examples/</u>*

Download “APSpec C Library Programmer’s Guide” and libAPSpectra.a & APSpectra.h from Aipplica website Download sections and compile with the libraries as follows

```
>gcc MyApp.c -o MyApp.o  ./libAPSpec.a ./libMPSSE.a ./libftd2xx.a -lpthread -ldl -lrt -Wall -Wextra
OR
>g++ MyApp.cpp -o MyApp.o  ./libAPSpec.a ./libMPSSE.a ./libftd2xx.a -lpthread -ldl -lrt -Wall -Wextra
```

(Temporarily remove ftdi_sio & usbserial drivers as they are not compatible with D2XX. You can restore those later with [sudo modeprobe ftdi_sio; sudo modeprobe usbserial] commands)

```
>sudo rmmod ftdi_sio; sudo rmmod usbserial
```

Plug in the APSpectrometer module and Run MyApp.o

```
>chmod +x MyApp.o
>./MyApp.o
```

If you used MyApp.c Ver 0.1 from the Aipplica Website, you may see the program throw some output messages and a gnuplot of captured spectra from the light source.

```
Initalized USB Chip
Read ID  Successful 7
Verification passed 0
1 1 1 2
```

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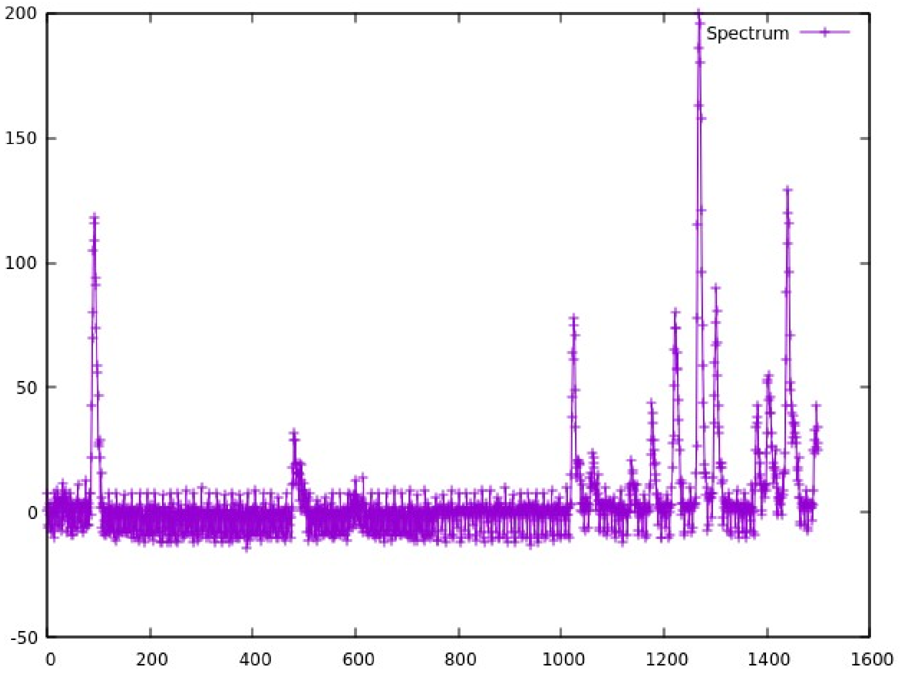
```
Read ID  Successful
NumofCalCoeff: 03
C[0] -0.000003
C[1] 0.282167
C[2] 409.736694
Read Cal Successful
Setting Integration Time
Reading Dark Signal
Verification passed 7
Turn ON the light source and Type a character

Reading Spectral Signal
Verification passed 0
Turn OFF the light source and Type a character

Type Ctrl+d to quit..
```



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## <u>ForWindows Environment</u>

In this illustration we will use Visual Studio (VS). We assume that you have some familiarity with it, else please download Visual Studio and familiarize yourself with it. You should be able to open a project in Visual studio and run a simple “hello world” application in C/C++. [ Use an online tutorial if you are new to VS ]

We use gnuplot for this illustration. You may install it in your windows environment or comment it out from the sample code [MyAppW.cpp] and modify MyAppW.cpp if you prefer other means of displaying the data.

APSpec uses FTDIs USB interface IC with Multi Protocol Synchronous Serial Engine (MPSSE) hardware. The MPSSE is a hardware block found in several FTDI chips which communicates with a PC over the USB interface. Applications on a PC communicate with the MPSSE in these chips using the D2XX USB drivers and the LibMPSSE library and the libAPSpec wrapper library.

Please install FTDI’s D2XX API drivers for Windows. Please refer to FTDIs website for additional details. The following Application Note on FTDIs website may be helpful:
*AN_119_FTDI_Drivers_Installation_Guide_for_Windows-7.pdf OR*
*AN_234_FTDI_Drivers_Installation_Guide_for_Windows-8.pdf OR*
*AN_396_FTDI_Drivers_Installation_Guide_for_Windows-10/11.pdf*

Next Download the LibMPSSE.zip library from FTDI’s website:

https://ftdichip.com/software-examples/mpsse-projects/libmpsse-spi-examples/

Unzip the archive. You will need the WinTypes.h, libMPSSE_spi.h and libMPSSE.lib and ftd2xx.h files from …. Release/samples/SPI/SPI folder in the unzipped archive.

Edit WinTypes.h and change the following include statement

*Change #include <sys/time.h> to #include <time.h>*

Later we will move the aforementioned four *.h as well as two *.lib files to your visual studio project folder [ where *.vcxproj file resides.]. We will create this folder in subsequent steps.

Download “APSpec C Library Programmer’s Guide” and libAPSpec.lib & libAPSpecW.h from Aipplica website Download section. We will move these two files to same folder as above.

Start Visual Studio (VS) and click on Create a New Project.

Choose Console Application with C++, Windows and console options in pull down tabs.

Choose Project name (say, NewProject) and SolutionName (say, NewSolution) and click next

VS will create a NewSolution Folder with NewProject subfolder.

NewProject contains template NewProject.cpp as well as NewProject.vcxproj file.

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As mentioned earlier, move all the *.h header files, *.lib library files and MyAppW.cpp to NewProject folder.

Go to solution explorer tab, left click on Source files and then right click, a drop down menu will appear, choose ***Add*** then choose ***Existing item*** and Navigate to NewProject Subfolder where all the files are.

Select MyApp.cpp and click on ***Add*** button. File MyAppW.cpp will appear under Source files

Alternatively left click on Source files and press ***Shift+Alt+A***, a file explorer window will open Navigate to NewProject Subfolder and select MyApp.cpp and click ***Add***.

Remove existing NewProject.cpp template by left clicking on it and the pressing ***Del.***

In the same manner Add ftd2xx.h, libAPSpecW.h, libMPSSE_spi.h and WinTypes.h under Header files in Solution explorer.

Also Add libAPSpec.lib and libMPSSE.lib under Resource files in Solution explorer.

You are now ready to Build the application. Hit he ***F5*** button for debug or choose ***Build Solution*** from Build pulldown tab. The .exe file NewProject.exe will be found in NewSolution/x64/Debug.

Double click to run it and capture spectral signature of light source.