ANALOGMAX QUICKSTART GUIDE

Featuring Jupyter

Revision 2.4

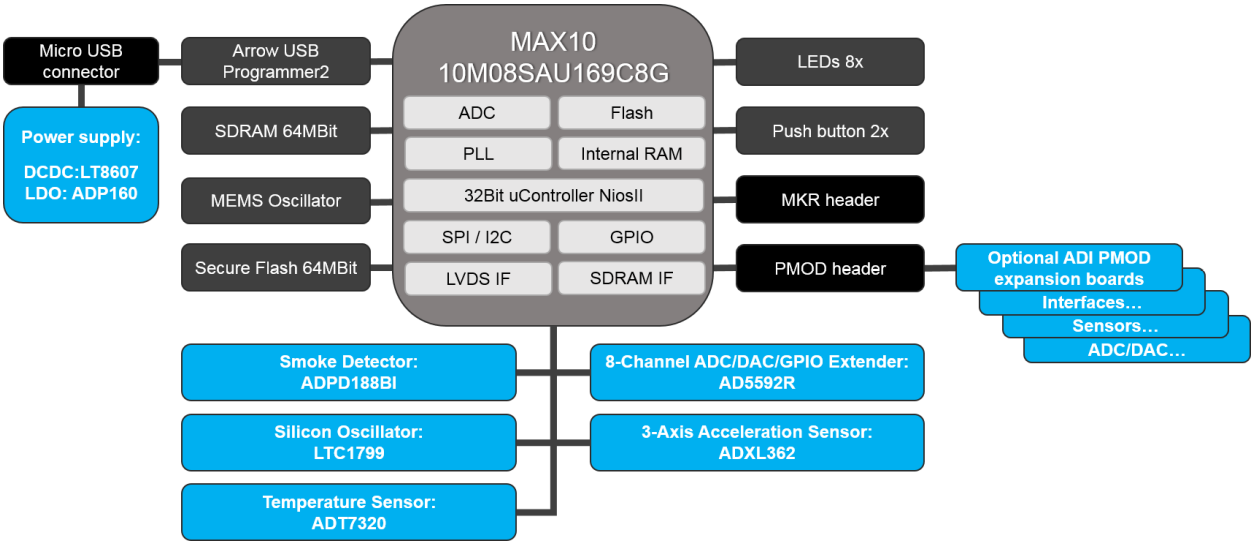
29 Jul 2019

Table of Contents

1. About the AnalogMAX

The AnalogMAX is multi-featured sensor fusion FPGA development platform targeting smart city and smart building applications.

It is based on the MAX10 Intel FPGA, including the brand-new Smoke & Aerosol Detector ADPD188BI from Analog Devices. The ADPD188BI is a complete photometric system for smoke detection utilizing optical dual-wavelength technology. The chip integrates a highly efficient photometric front end, two LEDs, and a photodiode. The board also includes a fully calibrated single-chip temperature sensor (0.25°C, 16-Bit), MEMS accelerometer (3-axis), and compact 8-channel ADC/DAC/GPIO extender. A soft core NIOS II processor and sample HDL code provides the means by which the sensors are configured and read via Python code running within a Jupyter notebook[1].



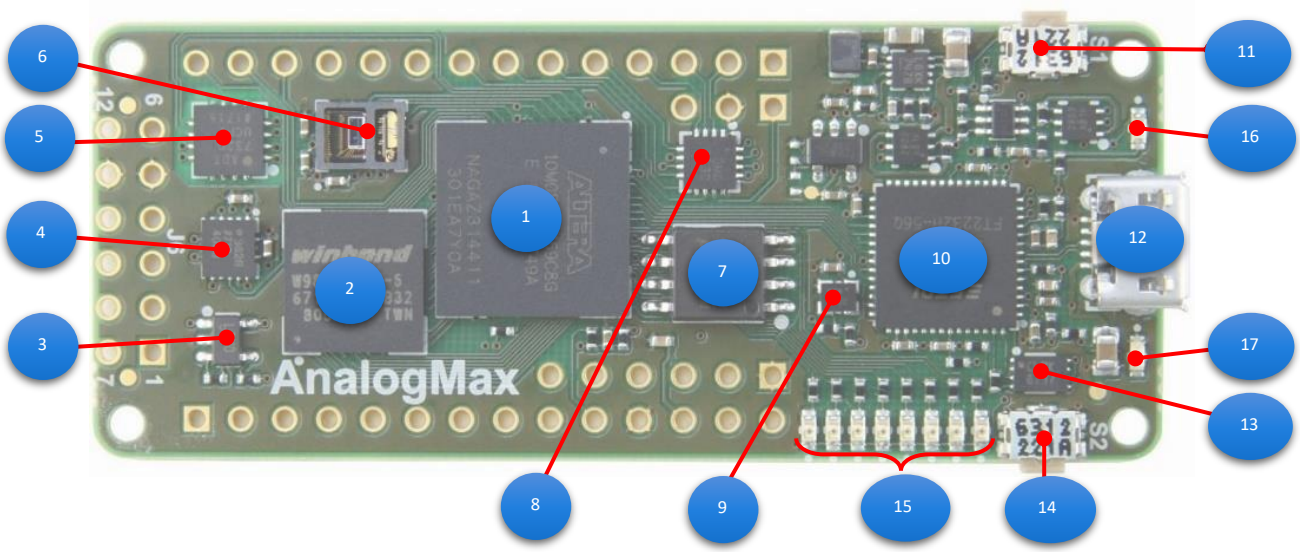
2. Purpose

This platform is a demonstration vehicle that requires zero FPGA expertise! Use this guide to get the AnalogMAX running with sensor-fusion packed fun within a few minutes.

Want more information? See the References section for additional helpful links.

[1] See Appendix A

3. AnalogMAX main components



1. Intel MAX 10 10M08 FPGA SoC[2]
2. Winbond 8 Mbyte SDRAM 166MHz
3. LT LTC1799 oscillator[3]
4. Analog Devices ADXL362BCCZ MEMS 3-axis accelerometer[4]
5. Analog Devices ADT7320UCPZ temperature sensor[5]
6. Analog Devices ADPD188BI optical module[6]
7. Winbond W74M64FV QSPI Flash memory
8. Analog Devices AD5592RBCPZ 8-channel ADC/DAC/GPIO[7]
9. Microchip 12.0000 MHz MEMS oscillator
10. FTDI USB2 to JTAG/UART adapter
11. Push button (reset)
12. Micro USB2 B socket (receptacle)
13. Configuration EEPROM for FTDI chip
14. Push button (user)
15. 8x red user LEDs
16. Red LED (Conf. DONE)
17. Green LED (indicating 3.3V supply voltage)

Visit the site (https://wiki.trenz-electronic.de/display/PD/TEI0010+TRM#TEI0010TRM-Overview) to get more information on the AnalogMAX.

[2] https://www.intel.com/content/www/us/en/products/programmable/fpga/max-10.html
[3] https://www.analog.com/en/products/ltc1799.html
[4] https://www.analog.com/en/products/adxl362.html
[5] https://www.analog.com/en/products/adt7320.html
[6] https://www.analog.com/en/products/adpd188bi.html
[7] https://www.analog.com/en/products/ad5592r.html

4. Downloads/Installation

4.1 Download Support files

Add support files directly into Jupyter[8].

1. Go to the following link https://github.com/ArrowElectronicsESC/AnalogMAX
2. Click on “Clone or Download” to download the files
3. Unzip the folder into C:/Users/username

4.2 Install Anaconda

1. Go to the following link http://docs.anaconda.com/anaconda/install/
2. Click on the proper operating system[9] (this guide is using Windows)
3. Click “Download the Anaconda installer.”
4. Click on the Windows icon
5. In the Python 3.7 version * box click on “64-Bit Graphical Installer “ **under** the download button
6. Run the installer
    a. Do not change the Install Location
    b. Leave the PATH variable **unchecked**
    c. Skip Visual Studio

4.3 Install pySerial

The python serial port support library pySerial needs to be added. It provides backends for Python running on Windows, OSX, Linux, BSD (possibly any POSIX compliant system) and IronPython to access a serial port.

1. Open the Anaconda command prompt
    a. Press the Windows key and type “Anaconda prompt”
2. *(2 min install)* In the command prompt type “`conda install -c anaconda pyserial`”
3. *(5 min install)* Type “y” to proceed with the install
    a. “Executing transaction: done” means the install is complete

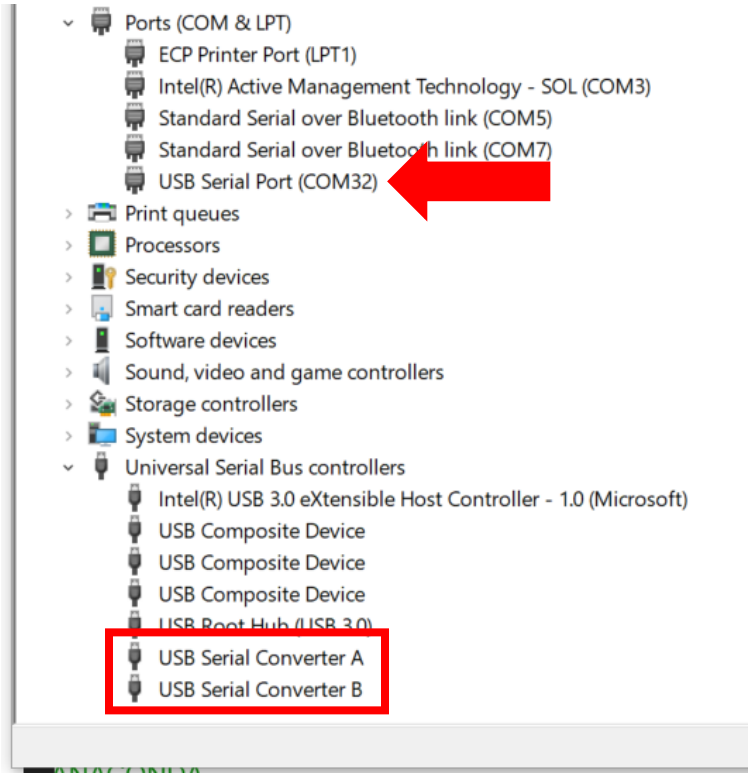
[8] See Appendix A
[9] See Appendix B

4. Close the window

4.4 Check the AnalogMAX connection

1. Plug in the AnalogMAX using a micro USB cable
2. Open Device Manager
    a. Press the Windows key and type “device manager”
3. Check under Ports (COM & LPT) for “USB Serial Port (COMx)”
    a. **Remember the COM port number!**
4. Check under Universal Serial Bus controllers for “USB Serial Converter A” and “USB Serial Converter B”

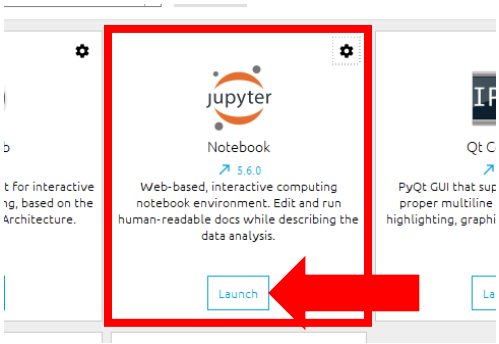
See Appendix B if you do not see these items.



5. Demos

5.1 Open Jupyter

1. Open Anaconda Navigator
    a. Press the Windows key and type “Anaconda Navigator”
2. Click “Launch” in the Jupyter notebook box



5.2 Access the demo files

Jupyter should now be open in a default browser.

See Appendix B if you do not see the “AnalogMAX..” folder.

1. Click on “AnalogMAX…” to access the demo files

6. Try a demo

In Jupyter files are called notebooks. Therefore, each demo file is a notebook. See below for some tips about the notebooks created to demonstrate the capabilities of the AnalogMAX.

Each demo consists of 2 sections:

- **The code**: which contains the functionality of the demo and works as a python code editor so that it is easy to implement new ideas
- **The graphs**: for which one graph displays the raw data during script execution and a second graph displays all the captured data after the script is done executing the code

Each demo also has a line at the beginning of the code that selects the COM port in use.

```
#
# Please change here to proper COM port name
#
ser = serial.Serial('COM5', 115200)
```

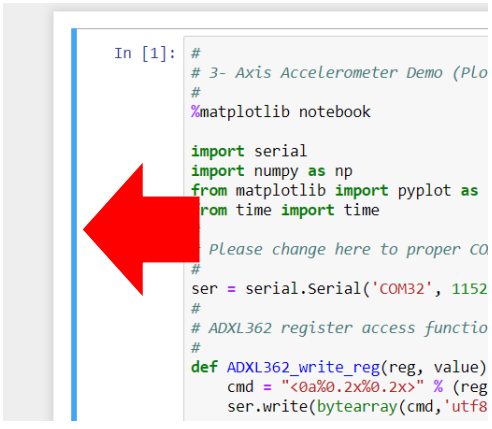
Each demo will require that 'COMx' be changed to the port that your computer is using.

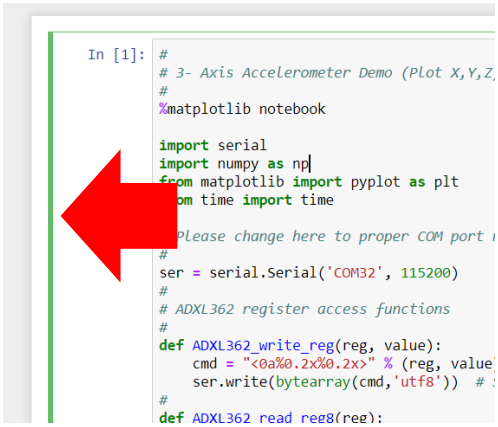
You have to change the port number in order for each demo to work. *Refer back to section 4.4.*

Note

To run each demo:

1. Place the cursor into the python code editor (the line on the left of the editor will turn green)
    a. When the **cursor is <u>not</u> in the editor** the line on the left of the editor is blue





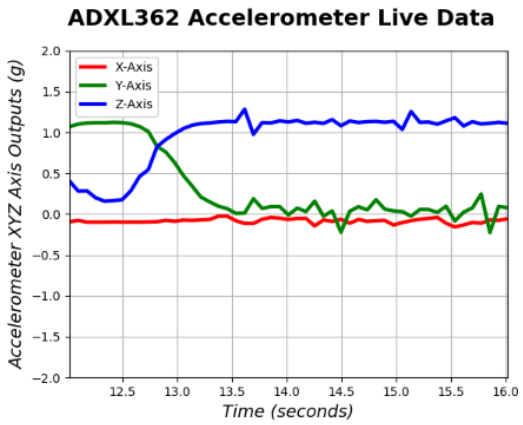
2. Click on the run button in the toolbar at the top of the notebook

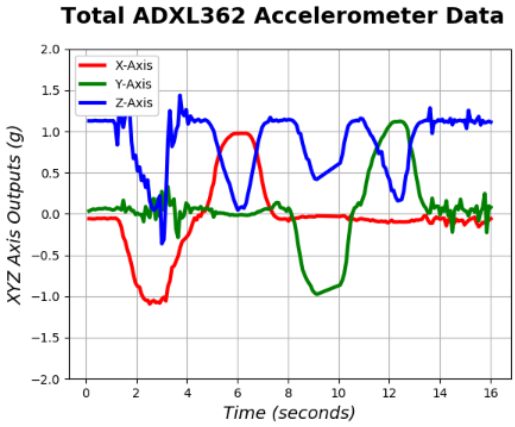
6.1 Accelerometer Demonstration

This demo shows the gravitational acceleration of the AnalogMAX. It is possible to normalize data to show g=9.8 m/s^2. **Click on "AnalogMax_Accelerometer_Demo".**

1. Change the COM port to the one you are using
2. Place the cursor in the code editor

3. Click the run button at the top of the notebook
4. Shake the AnalogMAX to generate data

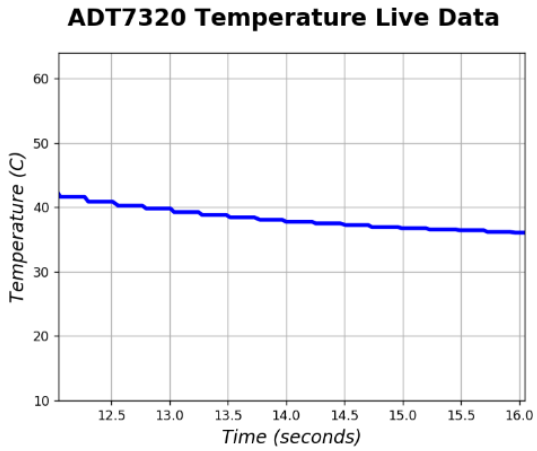


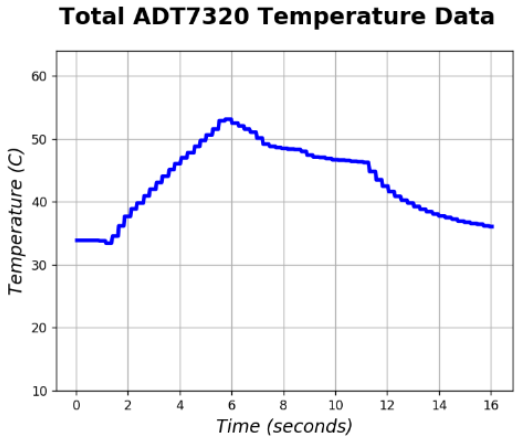


6.2 Temperature Demonstration

This sensor is a bit robust. To produce major changes in the data use materials with a big difference in temperature. The following graphs have been obtained using a hair blow dryer, then blowing on the sensor and then placing a finger on the sensor to rapidly cool it. **Click on "AnalogMax_Temperature_Demo".**

1. Change the COM port to the one you are using
2. Place the cursor in the code editor
3. Click the run button at the top of the notebook
4. Place your finger on the sensor or breathe on it (See **section 3** for where the sensor is)



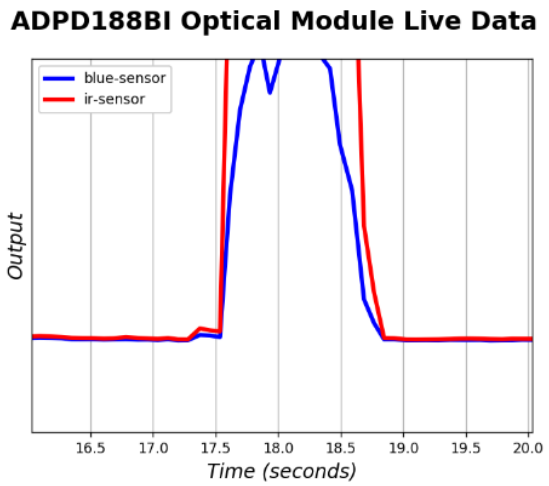


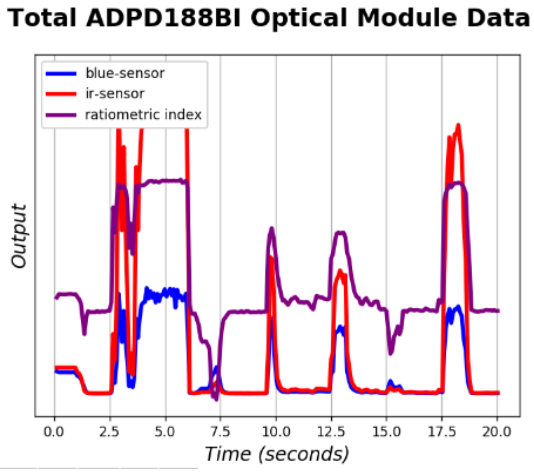
6.3 Smoke Sensor Demonstration

This demo uses two different spectra of light; infrared and blue light. Take note that the sensor reading will max out at 4. **Click on "AnalogMax_Smoke_Sensor_Demo".**

1. Change the COM port to the one you are using
2. Place the cursor in the code editor
3. Click the run button at the top of the notebook

4. Use your breath (or gas from another safe source such as an unlit lighter) and place various materials above the sensor (the following is from steam and smoke)

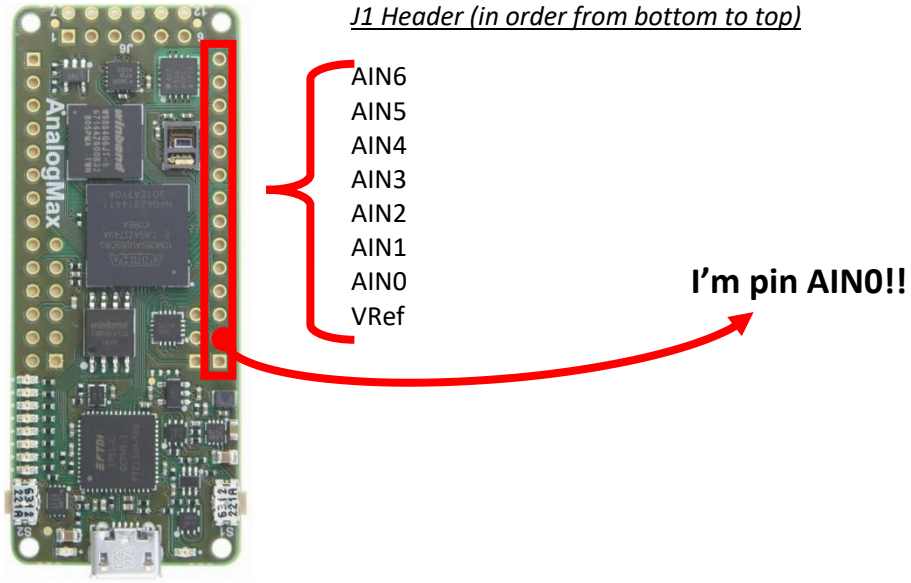


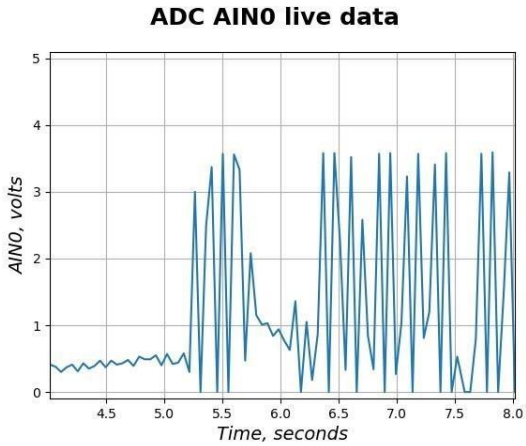


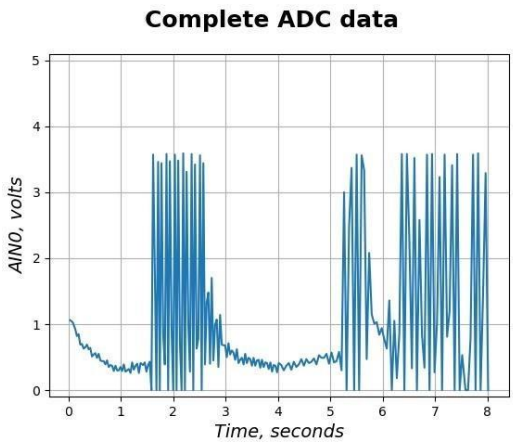
6.4 ADC/DAC/GPIO Demonstration

This demo configures pin IO7 as a DAC with a midscale output, IO0 as an analog input, IO1 as a digital input and pints IO2 to IO6 as digital outputs with high values. The AIN0 input pin is being sampled in this demonstration. **Click on "AnalogMax_ADC_DAC_GPIO_Demo".**

1. Change the COM port to the one you are using
2. Place the cursor in the code editor
3. Click the run button at the top of the notebook
4. Touch the AIN0 pin via a 20kΩ resistor







References

pySerial Overview: https://pythonhosted.org/pyserial/pyserial.html#overview

Anaconda Overview: https://www.anaconda.com/

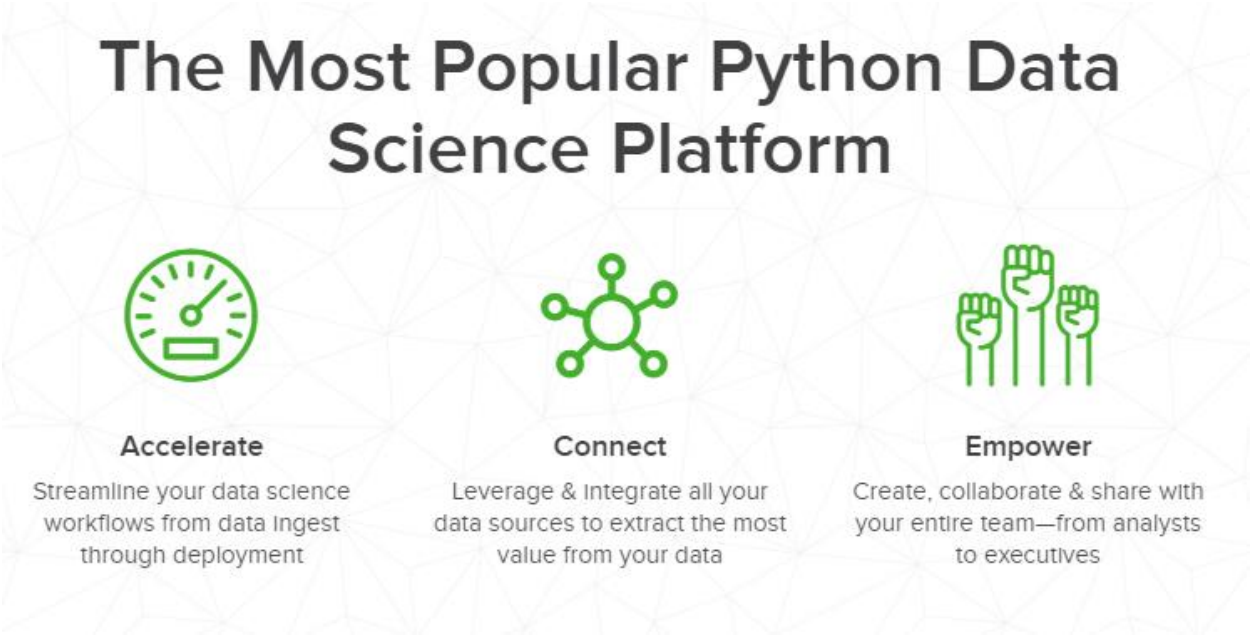
AnalogMAX Overview: https://wiki.trenz-electronic.de/display/PD/TEI0010+TRM#TEI0010TRM-Overview

AnalogMAX files: https://github.com/ArrowElectronicsESC/AnalogMAX

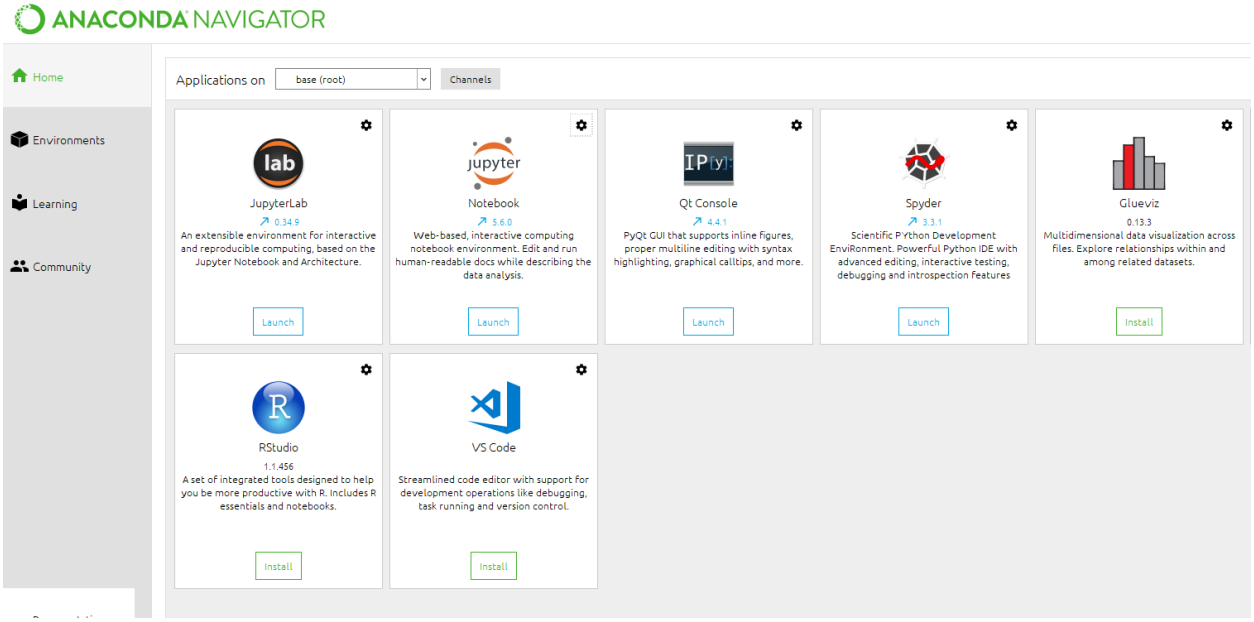
Install Anaconda: http://docs.anaconda.com/anaconda/install/

Appendix A: Integrated Development Environments

About Anaconda



Quick Tour

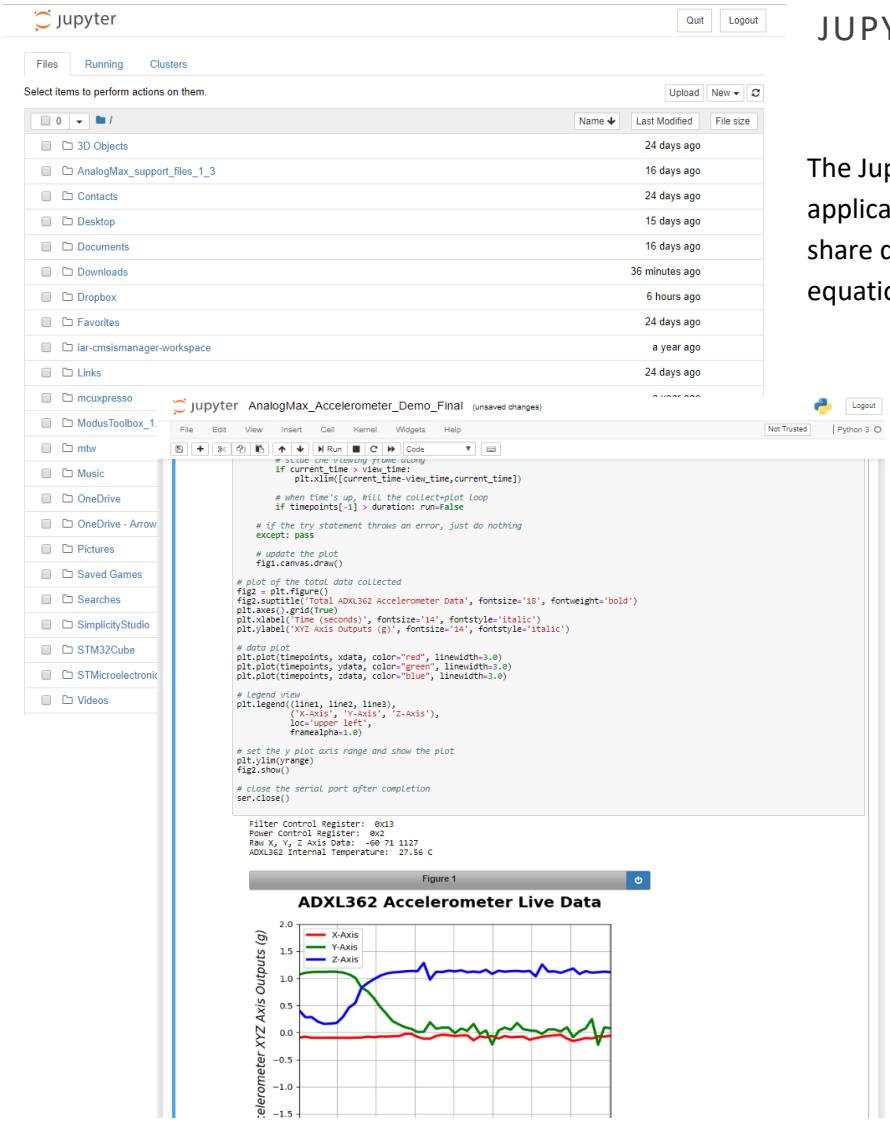


Anaconda Navigator is the Desktop Portal to Data Science

- Install and launch applications and editors including Jupyter, RStudio, Visual Studio Code, and Spyder
- Manage your local environments and data science projects from a graphical interface
- Connect to Anaconda Cloud or Anaconda Enterprise
- Access the latest learning and community resources

About Jupyter

Jupyter exists to develop open-source software, open-standards, and services for interactive computing across dozens of programming languages.



JUPYTER NOTEBOOK

The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text.

Uses include:

- data cleaning and transformation
- numerical simulation
- statistical modeling
- data visualization
- machine learning

and much more

Appendix B: Troubleshooting

Anaconda installation for all Operating Systems

1. Visit this link http://docs.anaconda.com/anaconda/install/
2. Under “System requirements” select the Operating System you are using
3. Follow the instructions given
4. Return to section 4.3 of this guide

USB driver installation

1. Open device manager
2. Expand “Other devices”
3. Complete the steps for each “Arrow USB Programmer 2” listed
    a. Right click on “Arrow USB Programmer 2”
    b. Click “Update Driver”
    c. Click “Search automatically for updated driver software”
4. If the driver files could not be retrieved visit www.ftdichip.com/Drivers/D2XX.htm
5. Download the D2XX drivers based on your operating system
6. Complete the steps for each “Arrow USB Programmer 2” listed
    a. Right click on “Arrow USB Programmer 2”
    b. Click “Update Driver”
    c. Click “Browse my computer for driver software” to manually apply the drivers

Cannot Access Demo Code in Jupyter

1. Open the Anaconda command prompt
    a. Press the Windows key and type “Anaconda prompt”
2. Type in the following code to access the files
   `jupyter notebook --notebook-dir=/<path to dir>`
    a. Do not type in the parent directory
   ~~/C/<path to dir>~~ ✗
   /<path to dir> ✓

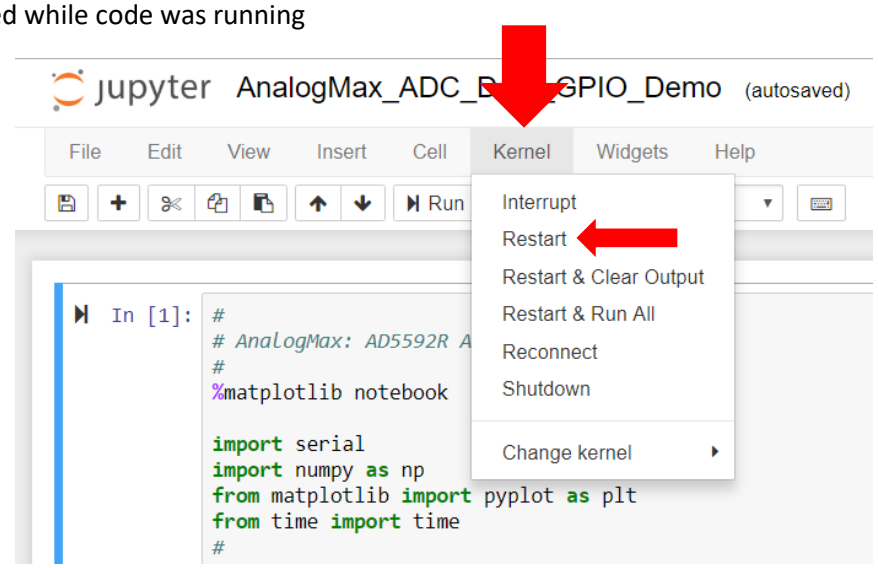
Error in code

The serial port will not close properly if:

- There is an error in the code
- The AnalogMAX has been unplugged while code was running

To reset the serial port:

1. Click on “Kernel” in the tool bar at the top of the notebook
2. Click on “Restart”
    a. “Restart & Clear Output” and “Restart & Run All” also reset the serial port



Test UART connection

Use any UART terminal emulator to test the UART connection of the AnalogMAX.

1. Open a serial connection to the COM port you are connected to
2. Set the Speed/Baud rate to 115200
3. Type in the command “<0b0f..>”
4. Check the result is “00”