Pluto+ User Manual	Document ID	Version	Pages
	Pluto-01	2.0	24

Version	Author	Description	Completion Date
1.0	Signals and Systems Store	Initial version	2021.12.10
2.0	Signals and Systems Store	Rearranged the chapters and added the fourth chapter	2022.4.9

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Signals

1 Pluto+ Overview

Pluto+ is a product adapted from ADI's ADALM- Pluto Active Learning Module (PlutoSDR). Pluto+ has upgraded from 2-channel (1 send, 1 receive) to 4-channel (2 send, 2 receive), added a gigabit Ethernet port, and added an SD card slot compared to the original ADI PlutoSDR. The main hardware parameters for Pluto+ are:

RF chip with 12-bit ADC/DAC: AD9363 (Can hack to AD9361 or AD9364)

Rf Channel: 2 transmitting channels,2 receiving channels

Rf Band: 70MHZ to 6GHZ

Reference clock: VCTCXO 40MHZ 0.5ppm

FPGA: Zynq7010, 28K

RAM: 512 MB

FLASH: 32 m

USB: USB 2.0, supports OTG

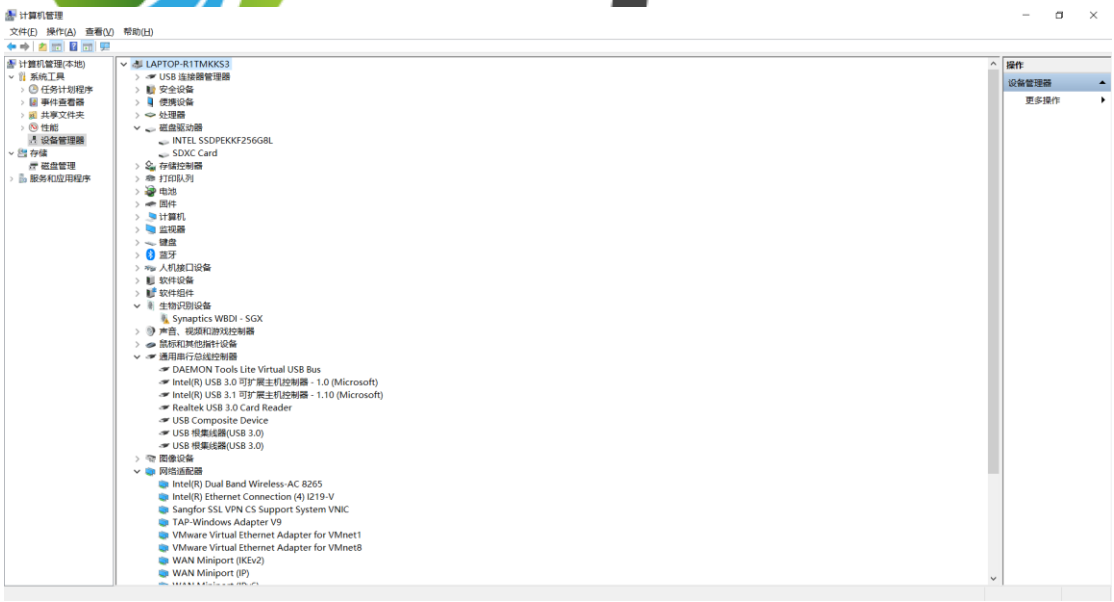
Ethernet: 1000 MB

Micro SD can use to boot

Dc power supply: 5V +-0.5V-2A, microUSB power supply

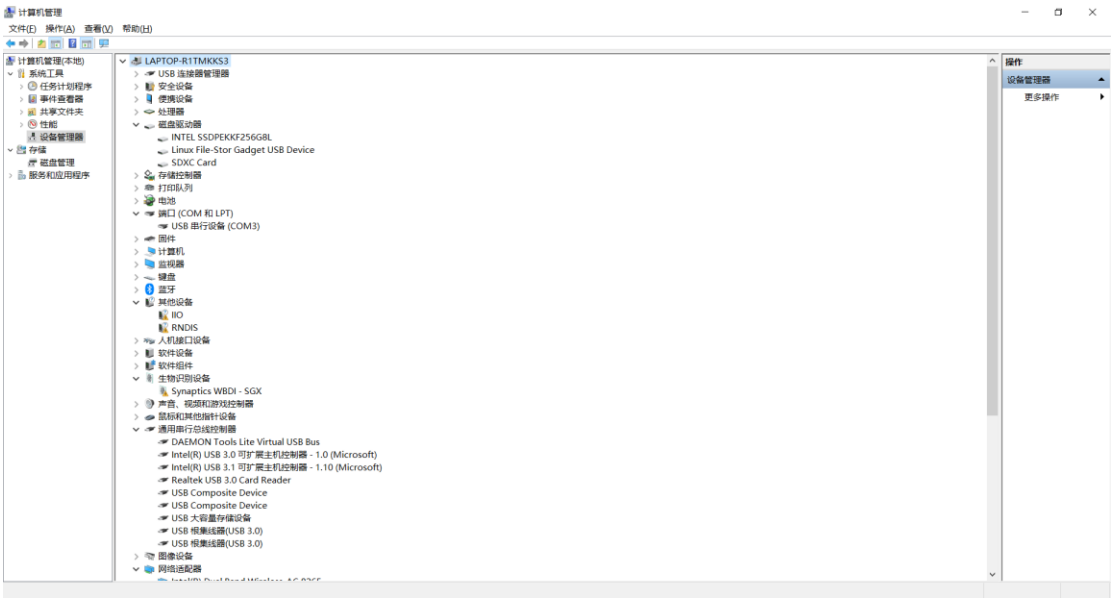
2 Windows User Manual

Before connecting the computer to Pluto+, the computer side [my computer]->[administration] ->[Device Manager], as shown in the picture below.



After the computer is connected to Pluto+ and before the driver is installed in Windows, the computer side [my computer]->[management]->[Device Manager], as shown in the picture below,

OpenSourceSDR Lab



2.1 Windows Driver Installation

2.1.1 PlutoSDR-M2k-USB-Drivers.exe Installation

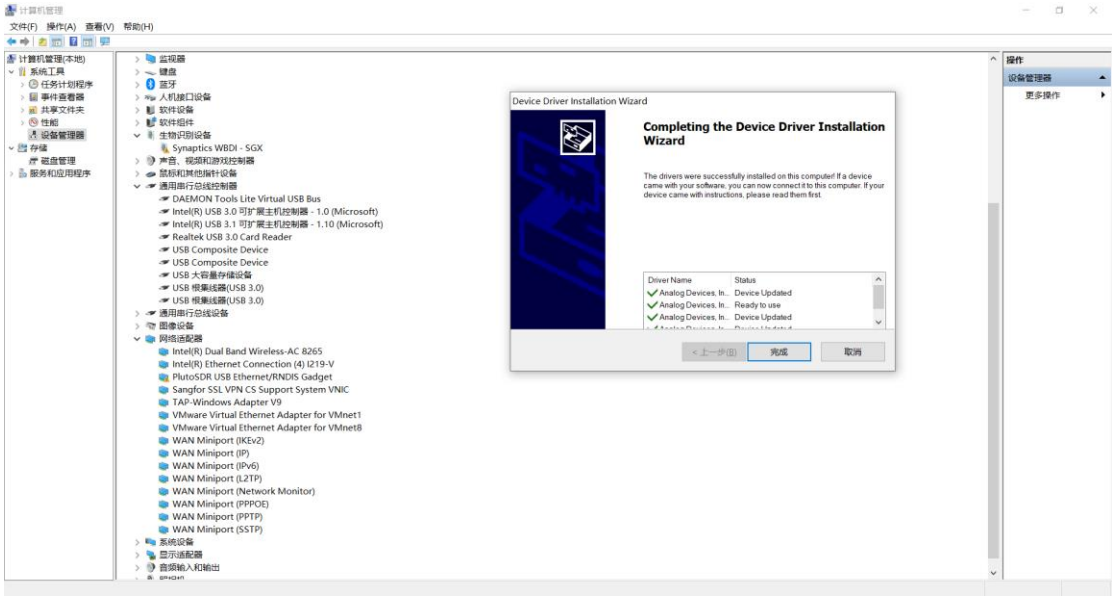
Install PlutoSDR-M2k-USB-Drivers.exe，Use the default for all options during installation.

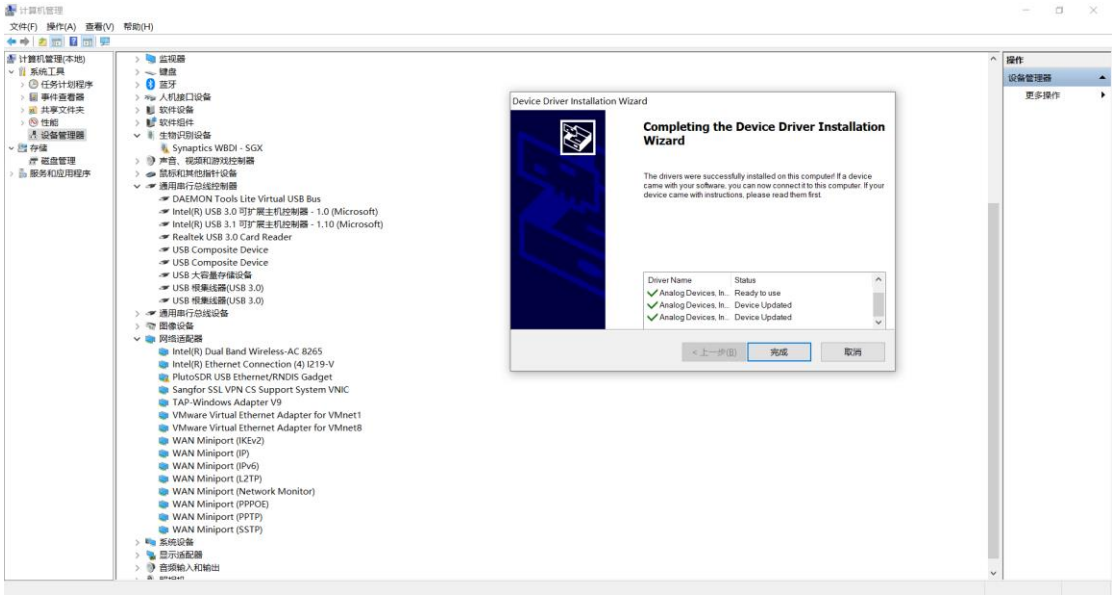
2.1.2 libiio-setup.exe Installation

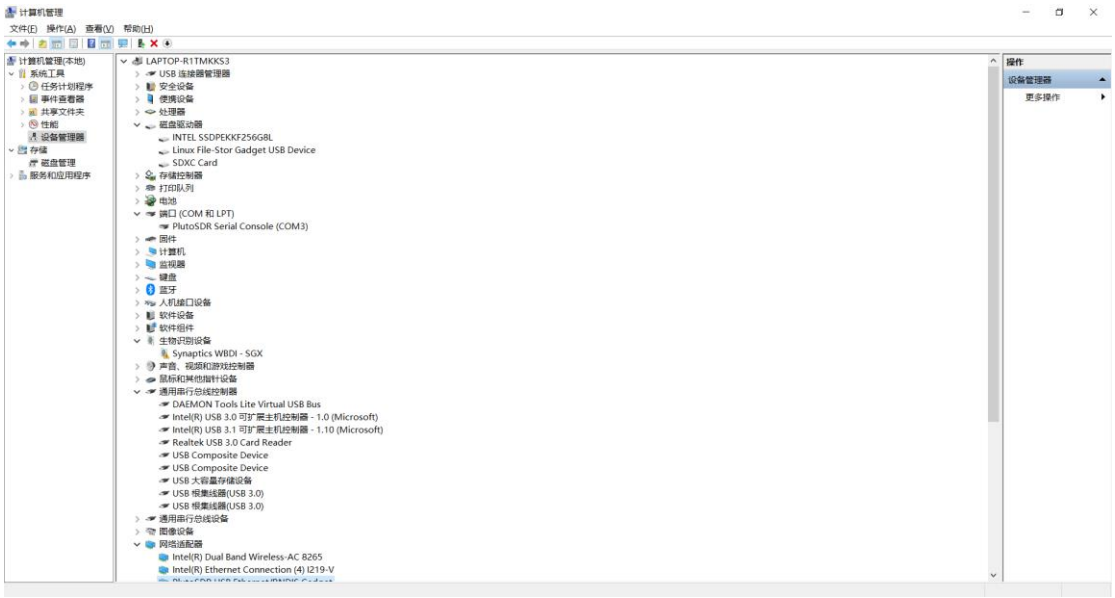
Install libiio-setup.exe，Use the default for all options during installation.

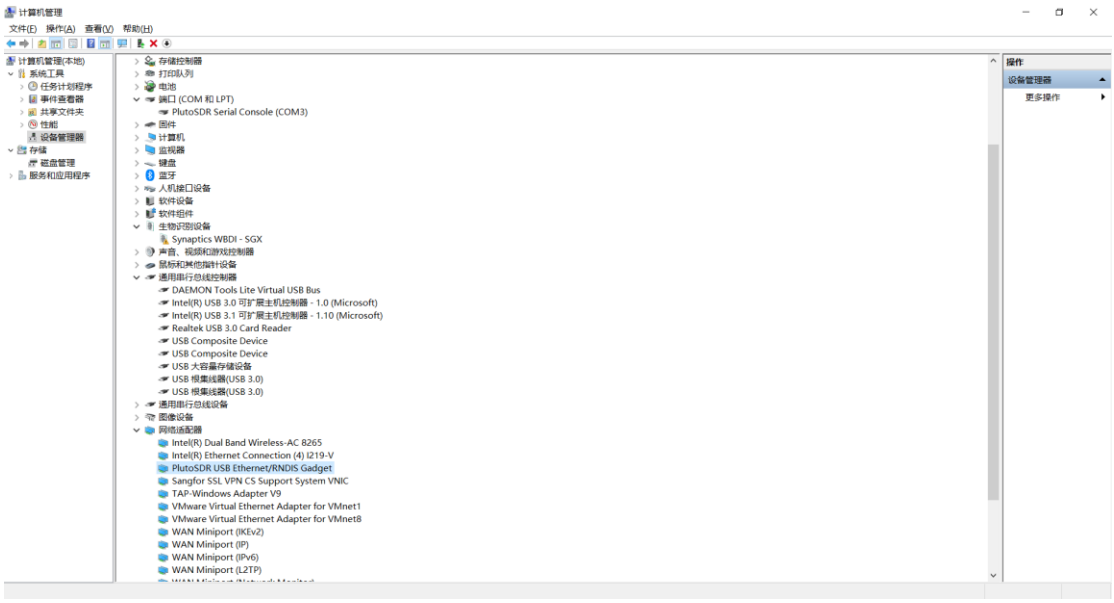
2.1.3 Check the Driver

After the computer is connected to Pluto+ (two USB cables are respectively connected to "DATA" and "5V-in" interfaces, where "DATA" is for DATA transmission and "5V-in" is for power supply input), and after the installation of plutoSDR-M2K-USB-drivers. exe driver in your Windows system, Computer side [my computer]->[Management]->[Device Manager], as shown in the picture below,

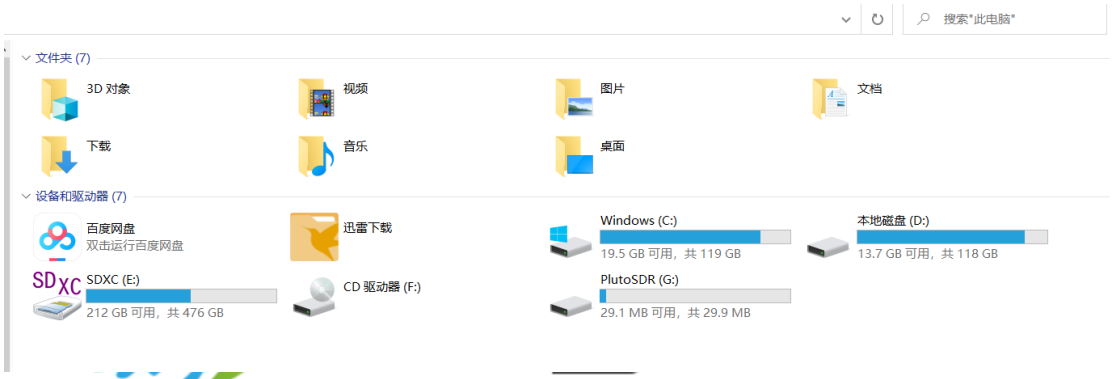

Device Driver Installation Wizard
Completing the Device Driver Installation Wizard
The drivers were successfully installed on this computer! If a device came with your software, you can now connect it to this computer. If your device came with instructions, please read them first.
Driver Name
Status
Analog Devices, In...
Device Updated
Analog Devices, In...
Ready to use
Analog Devices, In...
Device Updated
< 上一步(B)
完成
取消


Device Driver Installation Wizard
Completing the Device Driver Installation Wizard
The drivers were successfully installed on this computer! If a device came with your software, you can now connect it to this computer. If your device came with instructions, please read them first.
Driver Name
Status
Analog Devices, In...
Ready to use
Analog Devices, In...
Device Updated
Analog Devices, In...
Device Updated
< 上一步(B)
完成
取消





And your computer will have a PlutoSDR disk here.



Double click the PlutoSDR disk, enter it you can see the following files.

Double click the info.html，you can open the following web，

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Share PlutoSDR:

Get Started | Frameworks | Firmware ⇓ | Book ⇓ Devices | Help and Support | License | About Analog

Welcome to the ADALM-PLUTO Active Learning Module

Thank you for purchasing the ADALM-PLUTO Active Learning Module (PlutoSDR). The easy-to-use PlutoSDR helps introduce the fundamentals of software-defined radio (SDR), radio frequency (RF), and wireless communications to everyone. Designed for users at all levels and all backgrounds, the PlutoSDR can be used as:

- A learning module for instructor-led or self-directed learning to develop a foundation in real-world RF and communications in the pursuit of science, technology, or engineering degrees.
- A tool for practicing engineers and industry practitioners who are interested in mastering the design, implementation, and experimentation of communication systems. The PlutoSDR can be used to examine how well the communications system operates in terms of successfully transmitting or recovering intercepted signals.
- A tool for practicing RF engineers who use spectrum analyzers or vector signal generators to capture or create and analyze RF signals. The PlutoSDR with the appropriate software tool is capable of analyzing or generating digitally-modulated radio signals that may use any of a large number of formats used in modern communication systems.
- A complete reference design (hardware, HDL, embedded software, host software) for developers interested in creating their own products based on Analog Devices Wideband Transceivers.

Based on the AD9363, the PlutoSDR features independent receive and transmit channels that can be operated in full duplex. The PlutoSDR can generate or acquire RF analog signals from 325 MHz to 3800 MHz at up to 61.44 MegaSamples per second (MSPS). Small enough to fit in a shirt pocket, the PlutoSDR is completely self-contained and entirely USB powered with the default firmware. PlutoSDR is enabled by libiio drivers and supports macOS®, Windows®, and Linux®, allowing students and engineers to learn and explore on a variety of host platforms.

Getting Started

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The PlutoSDR online documentation provides instruction on how to set up the software on your Windows, Linux, or macOS based host to use the PlutoSDR. For those who do not read instructions, do the following steps:

1. Upgrade your Firmware
2. Install the Windows driver : Latest Windows Driver
3. Install the libiio Library: OS: Windows Type : .exe Version : Windows-setup : libiio-0.23.gc14a0f8-Windows-setup.exe

Test your installation:

Once everything above is installed, with your favorite console (Windows Linux or macOS), try these two commands (in bold below) to make sure the drivers and software is installed properly. It is expected that the serial number (specific to the PlutoSDR device) and usb uri (the three numbers after the 'usb:' field, based on your host) will be different than the examples below.

```
C:\> iio_info -s
Library version: 0.16 (git tag: 5cdeaaa)
Compiled with backends: local xml ip usb serial
Available contexts:
        0: 0456:b673 (Analog Devices Inc. PlutoSDR (ADALM-PLUTO)), serial=100000235523730700190030090216fd23 [usb:3.15.5]

C:\> iio_info -u ip:192.168.2.1
Library version: 0.16 (git tag: 5cdeaaa)
Compiled with backends: local xml ip usb serial
IIO context created with network backend.
Backend version: 0.15 (git tag: v0.15  )
Backend description string: 192.168.2.1 Linux (none) 4.9.0-10475-g2398d50 #269 SMP PREEMPT Mon Oct 15 20:18:34 CEST 2018 armv7l
IIO context has 8 attributes:
        hw_model: Analog Devices PlutoSDR Rev.A (Z7010-AD9363)
        hw_model_variant: 0
        hw_serial: 100000235523730700190030090216fd23
....
```

```
....
                    2 channel-specific attributes found:
                            attr  0: scale value: 6.433105468
                            attr  1: raw value: 778
```

If the 'iio_info -s' command cannot find the PlutoSDR on your host, you will need to do some reading and troubleshooting. If you are having issues installing the software, check out the on-line tutorials. Once the software is running, you can enable PlutoSDR in your communications framework like MATLAB, by following along the on-line tutorials.

Frameworks

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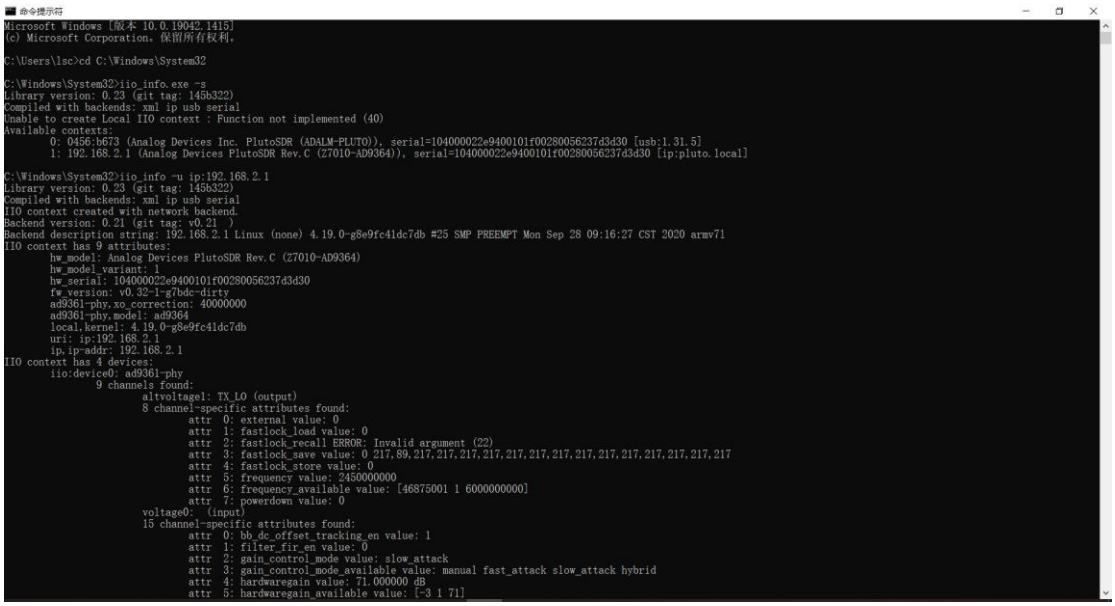
Use the PlutoSDR with your favorite communications framework, visualization, or signal processing tool.

Framework / Application	OS	Description
MathWorks	Windows, Linux, macOS	Communications Toolbox™ Support Package for Analog Devices PlutoSDR (doc) enables you to use MATLAB® and Simulink® to prototype, verify, and test practical wireless systems. Request a zero cost trial and then use, study, modify, and/or distribute a variety of MATLAB and Simulink examples.
GNURadio	Linux, macOS	GNU Radio is a Free and Open-Source Toolkit for Software Radio, primarily supported on Linux operating systems. It has both generic IIO blocks, and PlutoSDR specific blocks
IIO Command Line Tools	Windows, Linux, macOS	iio_info, iio_attr, iio_readdev, iio_writedev, iio_reg for interacting with the PlutoSDR from your favorite shell.
IIO Oscilloscope	Windows, Linux	The IIO Oscilloscope is an application, which demonstrates how to interface various IIO devices to different visualization methods on Linux and Windows
SDRangel	Windows, Linux	SDRangel is an Open Source Qt5 / OpenGL 3.0+ SDR and signal analyzer frontend to various hardware. Check the discussion group and wiki. While SDRangel seeks to be approachable, it is targeted towards the experienced SDR user with some digital signal processing understanding.

After the installation of libiio, in your windows computer path Windows\System32, there is a iio_info.exe. When the Pluto+ is connected in the windows computer via USB (two USB cables are respectively connected to "DATA" and "5V-in" interfaces), when run iio_info.exe –s and iio_info.exe -s，you will get the following similar results.



If you can see the above results, then it shows your driver installation is done successfully.

2.2 Updating AD9363 to AD9364

If you are using our Pluto+, you do not need to upgrade AD9363 to AD9364 according to this section. Because we have done it and test for you before shipping. This section only describes the method of how to upgrade AD9363. If you have the original ADI PlutoSDR, the default is probably AD 9363 with a frequency range of 325MHz to 3.8GHz (then in SDRSharp, you won't be able to adjust the frequency to FM broadcast band, so you'll need to upgrade).

https://wiki.analog.com/resources/eval/user-guides/ad-fmcomms2-ebz/ad9361

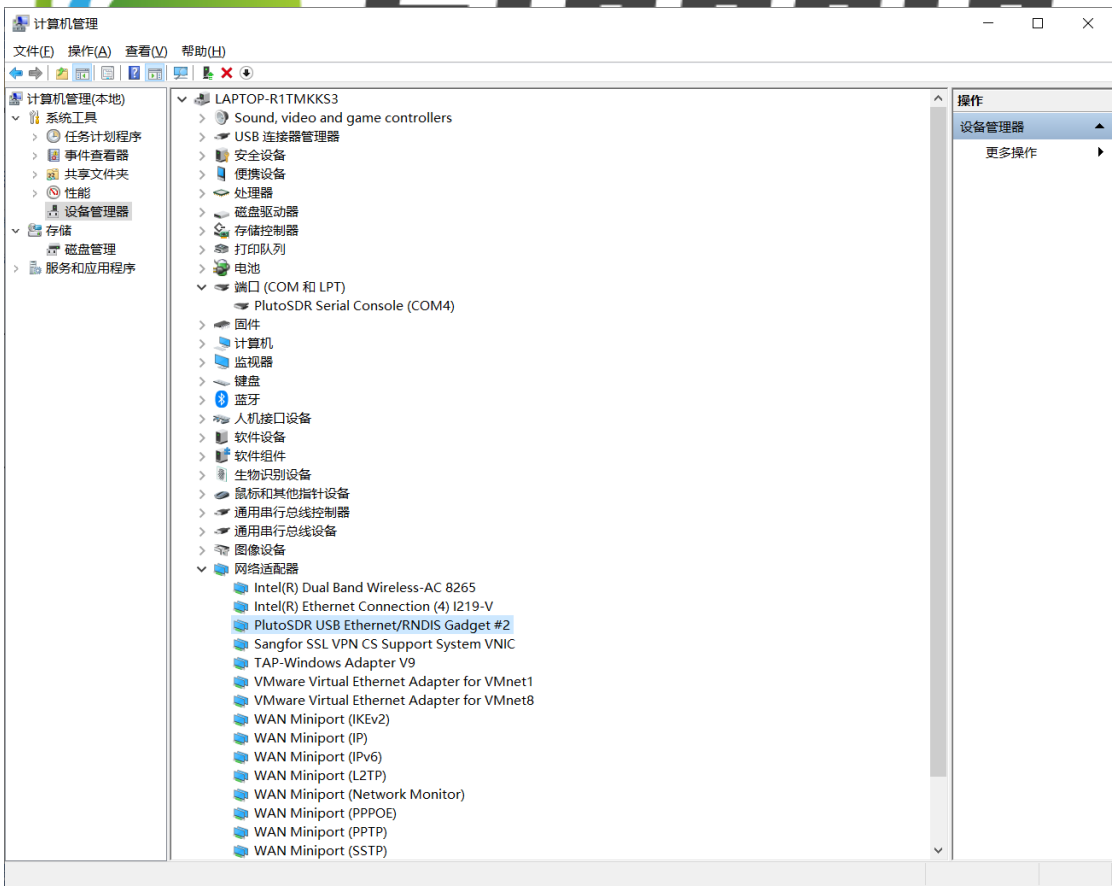
https://www.analog.com/en/products/ad9363.html#product-overview

https://wiki.analog.com/university/tools/pluto/users/customizing

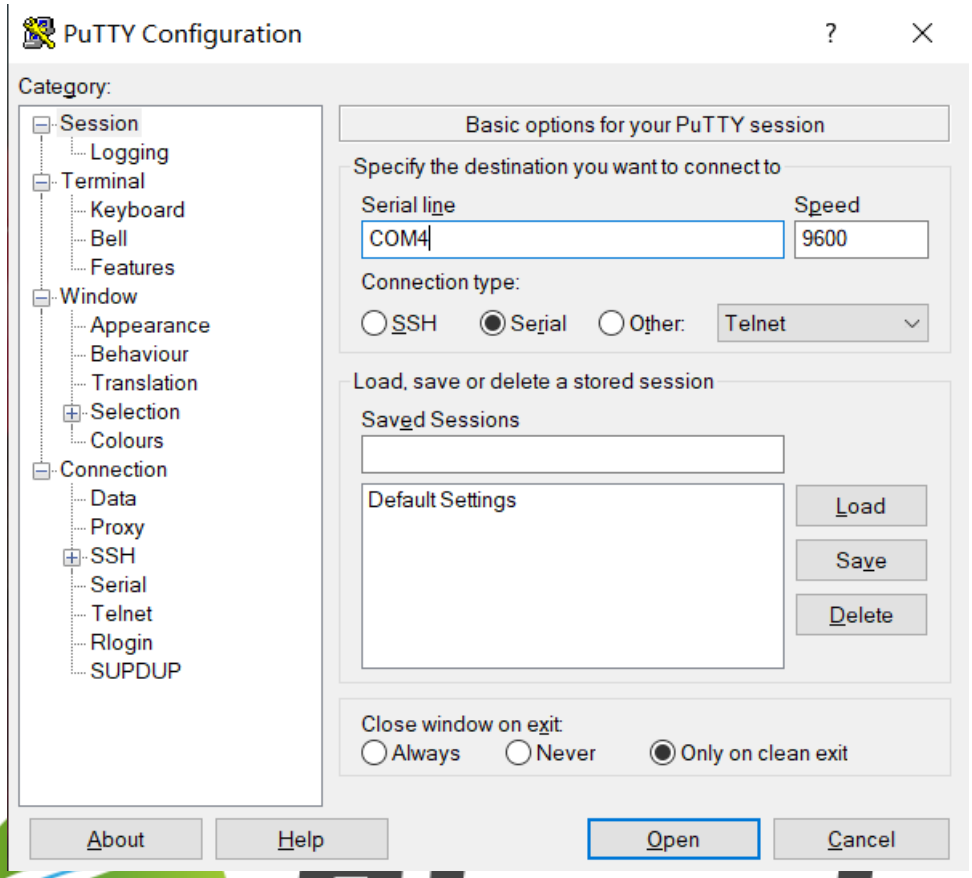
RF Transceiver	LO tuning range	Bandwidth	Number Channels
AD9363 (Default ADALM-PLUTO)	325 - 3800 MHz	20 MHz	2 Rx, 2 Tx
AD9364	70 - 6000 MHz	56 MHz	1 Rx, 1 Tx
AD9361	70 - 6000 MHz	56 MHz	2 Rx, 2 Tx

The AD9361 and AD9364 both support 70MHZ-6GHz bands, while the AD9363 only supports 325MHZ-3.8GHz bands. By default, the original ADI PlutoSDR works in the 325MHZ-3.8GHz band (AD9363), but it can be upgraded to AD9364 by command on Windows. After connecting to Pluto SDR through Putty, run the following command.

First, Check the COM port for your Pluto SDR in Device Manager (for example, COM4 in my case).



In Putty, set the following parameters and click Open to connect to Pluto SDR.



After connecting to the Pluto SDR, the following interface is displayed. The user name is “root” and the password is “analog” (note without the “”). Enter the following commands and press Enter.

fw_printenv attr_name

fw_printenv attr_val

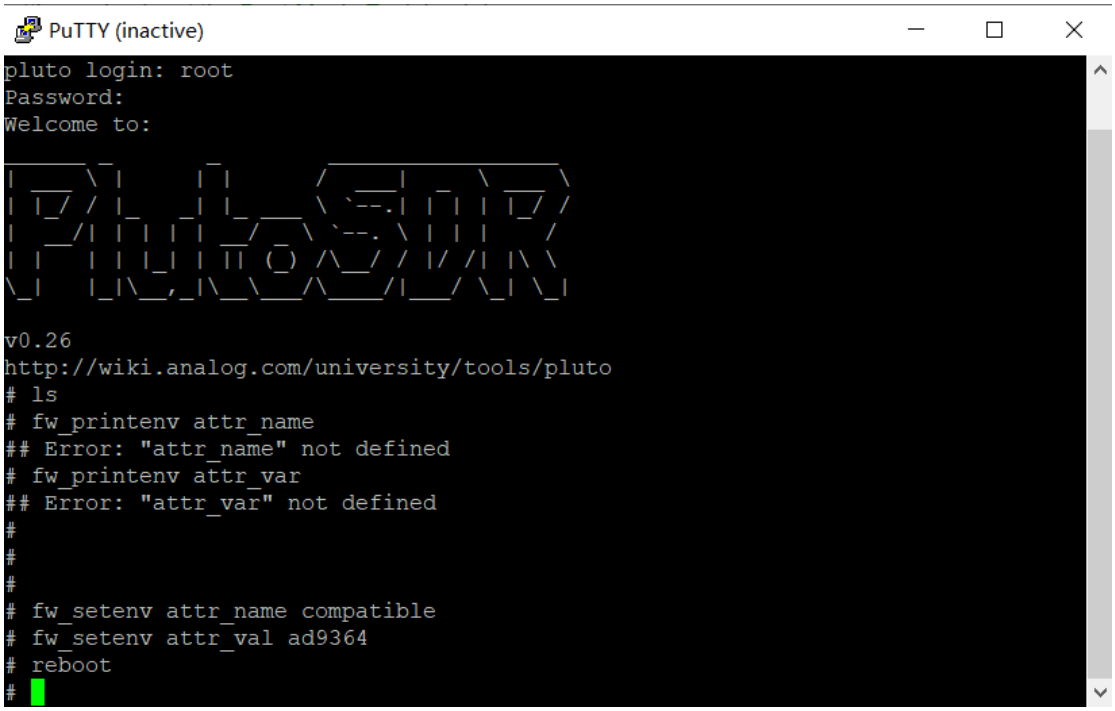
After executing these two commands, Error: "XXX" not defined, that's fine, don't worry about it.

To continue:

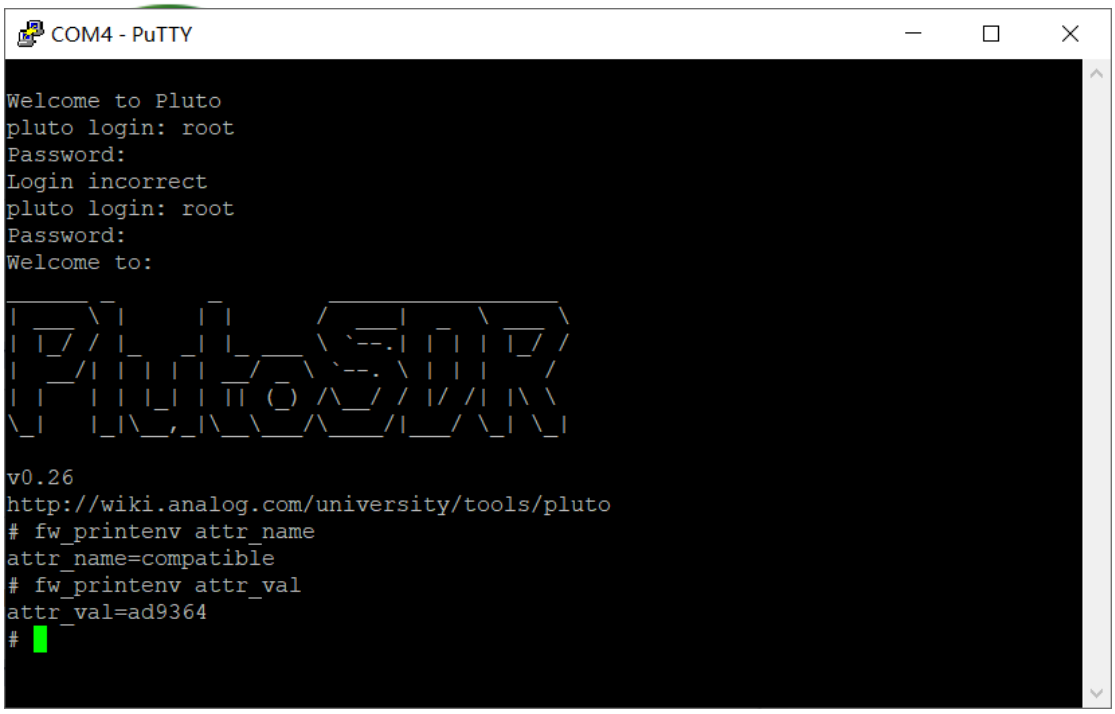
fw_setenv attr_name compatible

fw_setenv attr_val ad9364

reboot



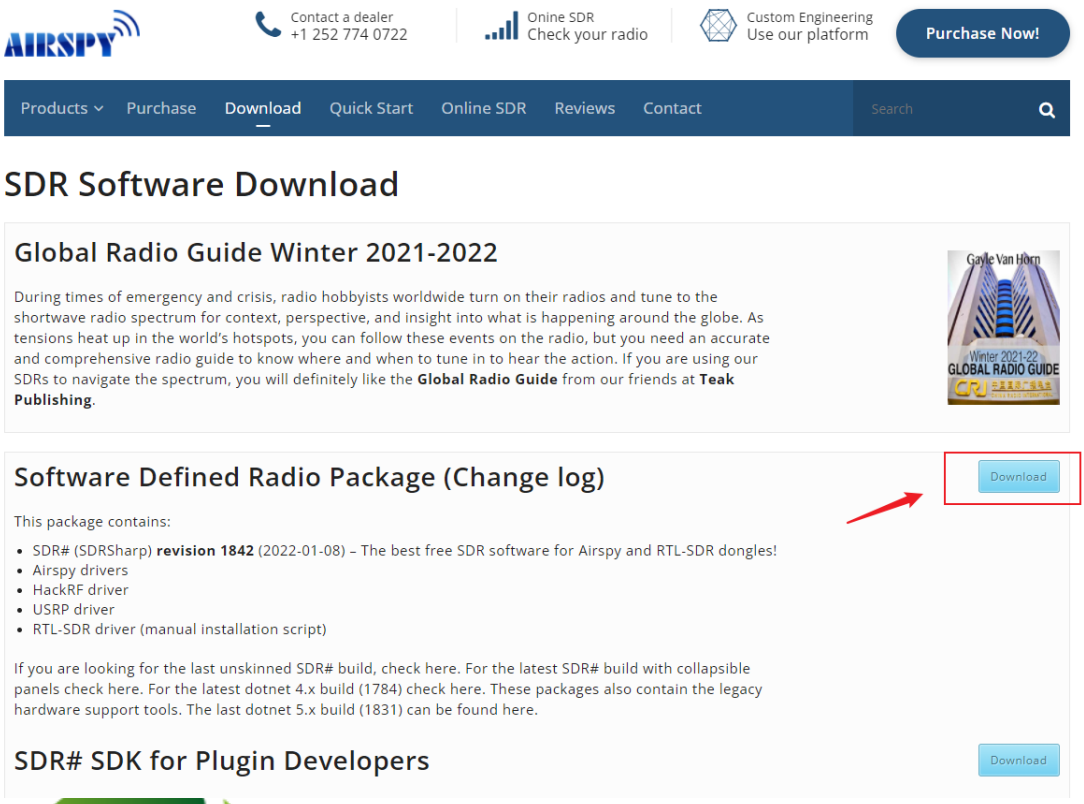
Now, when you run fw_printenv attr_name and fw_printenv attr_val，you will get:



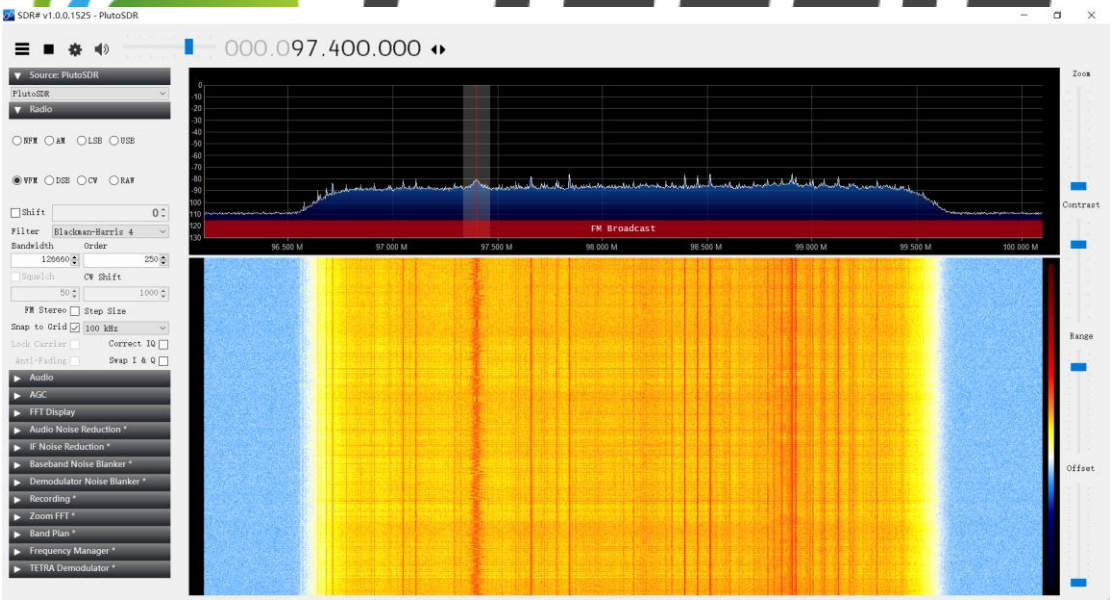
So far, the updating work is done.

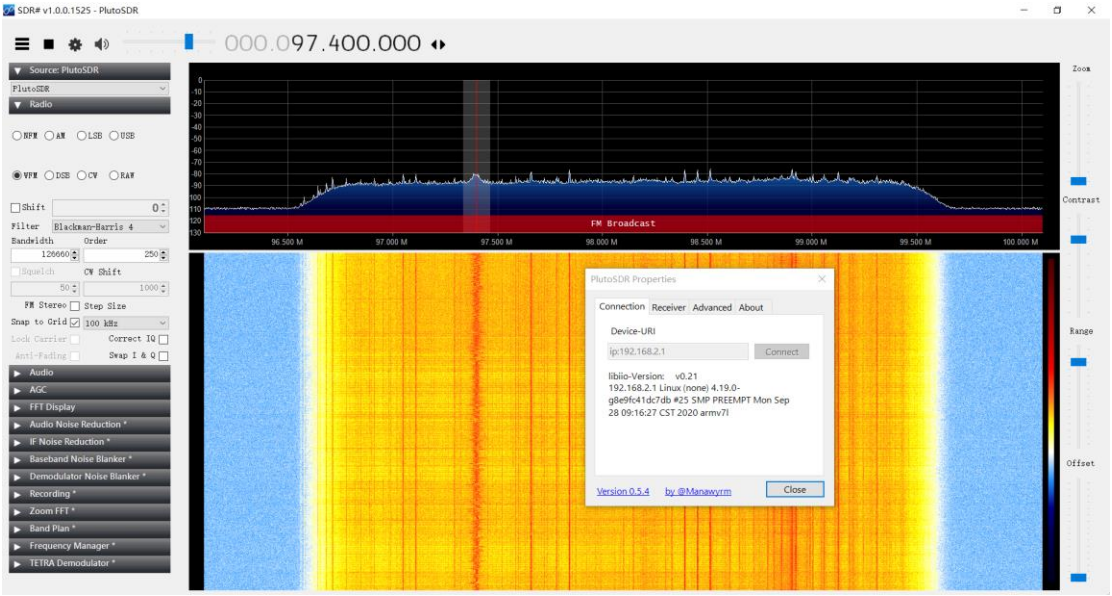
2.3 SDRSharp Receiving Signal

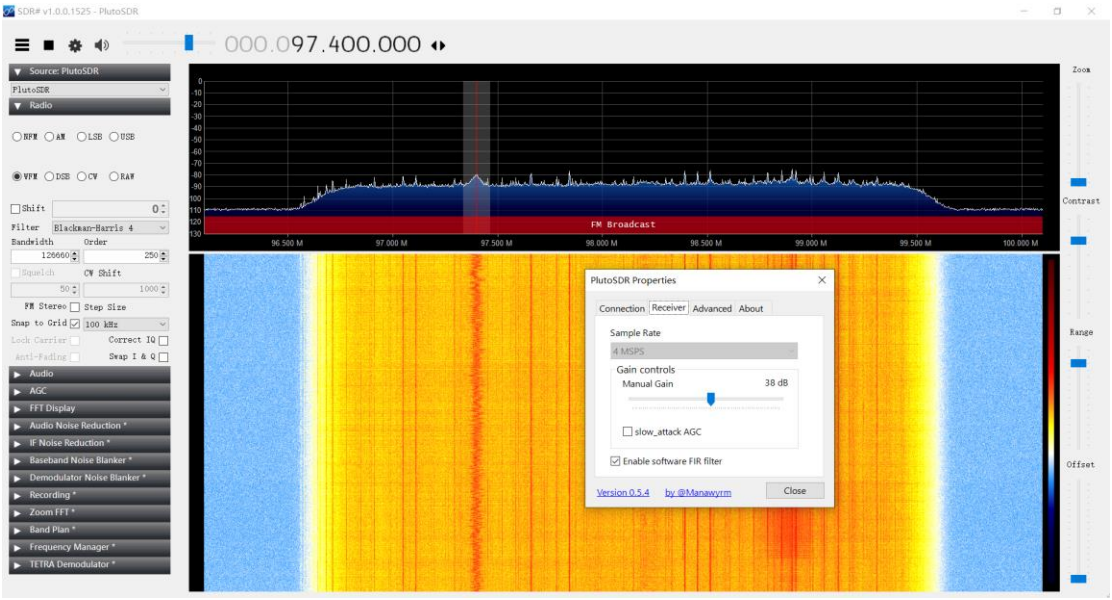
You can download and decompress the SDRSharp software on the following website,

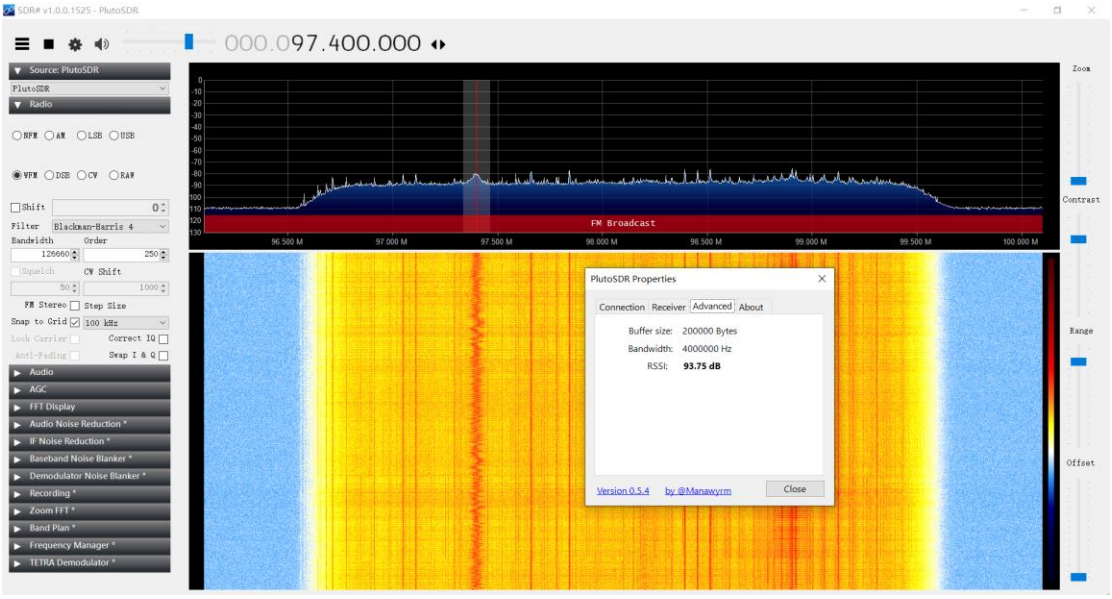


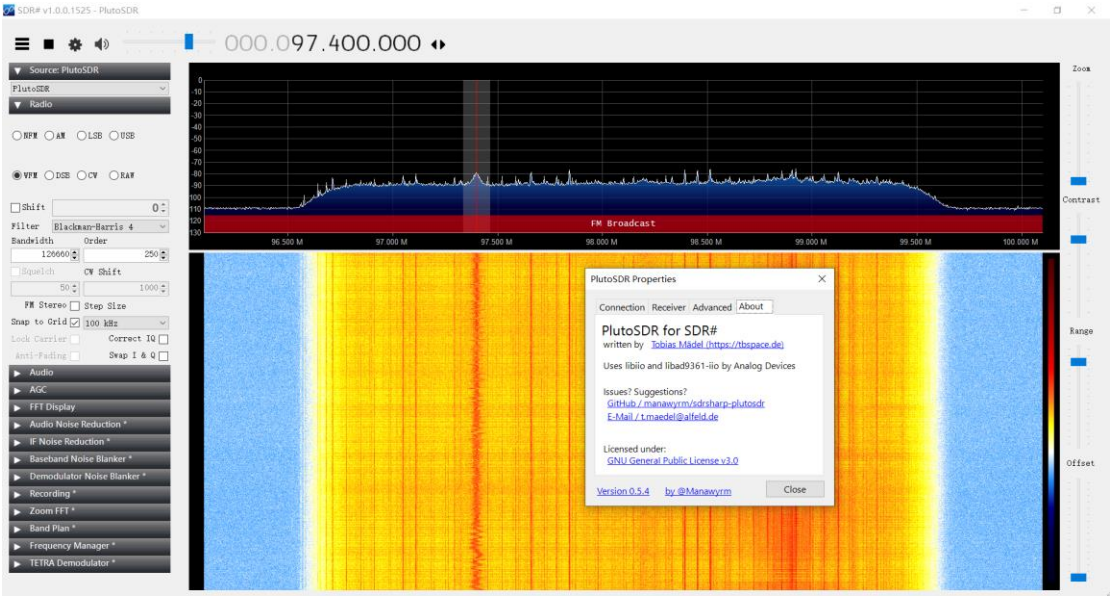
Decompress sdrsharp-plutoSDR-0.5.4. zip and copy the decompressed file to the directory where sdrSharp resides. If the same file is displayed during the replication, replace it.




SDR# v1.0.0.1525 - PlutoSDR
000.097.400.000
Source: PlutoSDR
Radio
FM Broadcast
PlutoSDR Properties
Connection
Receiver
Advanced
About
Device-URI
ip:192.168.2.1
Connect
Close
Version 0.5.4
by @Manawyrm


SDR# v1.0.0.1525 - PlutoSDR
000.097.400.000
Source: PlutoSDR
Radio
FM Broadcast
PlutoSDR Properties
Connection
Receiver
Advanced
About
Sample Rate
4 MSPS
Gain controls
Manual Gain
38 dB
slow_attack AGC
Enable software FIR filter
Close
Version 0.5.4
by @Manawyrm


SDR# v1.0.0.1525 - PlutoSDR
000.097.400.000
Source: PlutoSDR
Radio
FM Broadcast
PlutoSDR Properties
Connection
Receiver
Advanced
About
Buffer size: 200000 Bytes
Bandwidth: 4000000 Hz
RSSI: 93.75 dB
Close
Version 0.5.4
by @Manawyrm



3 Ubuntu User Manual

3.1 Using DragonOS ISO

If you have not used Ubuntu before, or are not familiar with how to install software in Ubuntu, you are strongly advised to directly use dragonOS_Focal_publicr21.iso. This ISO image is a system image that has been installed with Pluto, Gnuradio and other common SDR softwares. You can use it to create a vmware virtual machine or install a physical machine. Ubuntu virtual machine and physical machine installation method, you can google and search it, there are many tutorials online.

3.2 Ubuntu 20.04 Softwares Installation

If you are familiar with the Ubuntu system and software installation method, refer to the installation method described in this section. Ubuntu 20.04 is used in this manual. Please search for installation tutorials online. The rest of this chapter requires that you install Ubuntu 20.04 on a clean version, meaning that you have no other software installed.

3.2.1 GNU Radio Installation

Open the terminal (shortcut key is press these three keys of ctrl\alt\T at the same time) and enter the following three commands to install GNU Radio V3.8.

```
sudo add-apt-repository ppa:gnuradio/gnuradio-releases-3.8
sudo apt update
sudo apt install gnuradio
```

3.2.2 PlutoSDR Driver Installation

3.2.2.1 Dependency Installation

sudo apt install -y gnuradio-dev libxml2 libxml2-dev bison flex cmake git libaio-dev libboost-all-dev swig libusb-1.0-0-dev libavahi-common-dev libavahi-client-dev liborc-0.4-dev python3-setuptools

3.2.2.2 libiio Installation

Decompress the file “libiio-master.zip”, run the following commands.

```
cd libiio-master
mkdir build && cd build
cmake -DPYTHON_BINDINGS=ON -DCMAKE_INSTALL_PREFIX:PATH=/usr ..
make
sudo make install
sudo ldconfig
cd ../..
```

3.2.2.3 libad9361-iio Installation

Decompress the file “libad9361-iio-master.zip”, run the following commands,

```
cd libad9361-iio-master
mkdir build && cd build
cmake -DCMAKE_INSTALL_PREFIX:PATH=/usr ..
make
sudo make install
sudo ldconfig
cd ../..
```

3.2.2.4 gr-iio Installation

Decompress the files “gr-iio-upgrade-3.8.zip”, run the following commands,

```
cd gr-iio-upgrade-3.8
mkdir build && cd build
cmake -DCMAKE_INSTALL_PREFIX:PATH=/usr ..
make -j`nproc`
sudo make install
sudo ldconfig
cd ../..
```

3.3 GNU Radio GRC Test

3.3.1 Check the USB descriptor of Pluto+

After the computer is connected to Pluto+ (two DATA cables are respectively connected to the "DATA" and "5V-in" interfaces, where "DATA" is for DATA transmission and "5V-in" is for power input), input the iio_info -s command in the terminal to query the USB descriptor of Pluto+. This descriptor is used for the following "IIO Context URI" parameter in the Pluto Source and Sink modules of GNU Radio.

```
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$ iio_info -s
Library version: 0.23 (git tag: 145b322)
Compiled with backends: local xml ip usb
Unable to create Local IIO context : No such file or directory (2)
Available contexts:
        0: 0456:b673 (Analog Devices Inc. PlutoSDR (ADALM-PLUTO)), serial=104000022e9400101f00280056237d3d30 [usb:2.9.5]
        1: 192.168.2.1 (Analog Devices PlutoSDR Rev.C (Z7010-AD9364)), serial=104000022e9400101f00280056237d3d30 [ip:pluto.local]
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$ iio_info -s
Library version: 0.23 (git tag: 145b322)
Compiled with backends: local xml ip usb
Unable to create Local IIO context : No such file or directory (2)
Available contexts:
        0: 0456:b673 (Analog Devices Inc. PlutoSDR (ADALM-PLUTO)), serial=104000022e9400101f00280056237d3d30 [usb:2.10.5]
        1: 192.168.2.1 (Analog Devices PlutoSDR Rev.C (Z7010-AD9364)), serial=104000022e9400101f00280056237d3d30 [ip:pluto.local]
opensourcesdrlab@opensourcesdrlab:~/Downloads/SDR/gr-iio-upgrade-3.8/build$
```

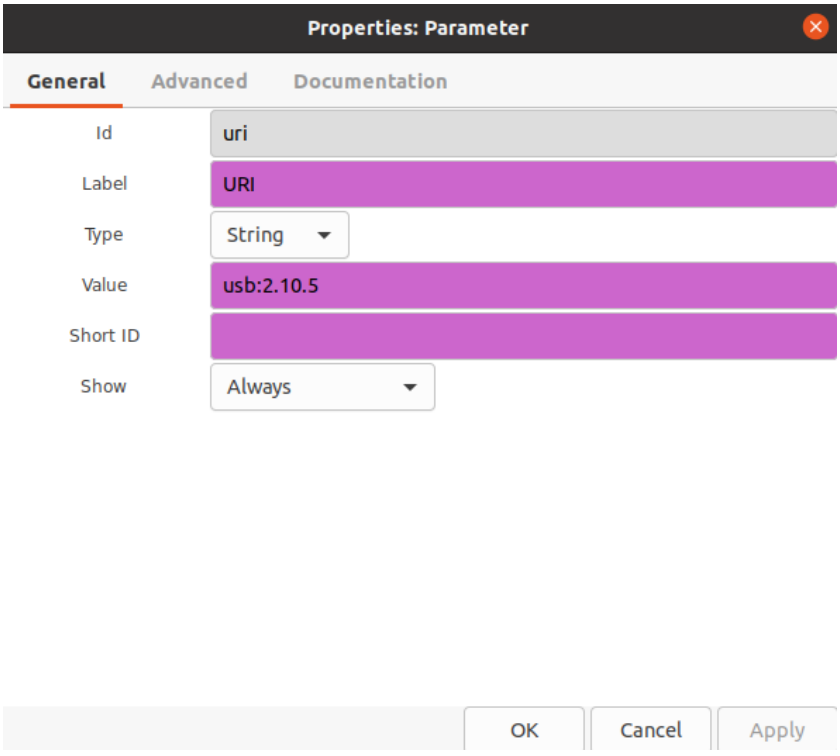
About the details of command iio_info, please see:

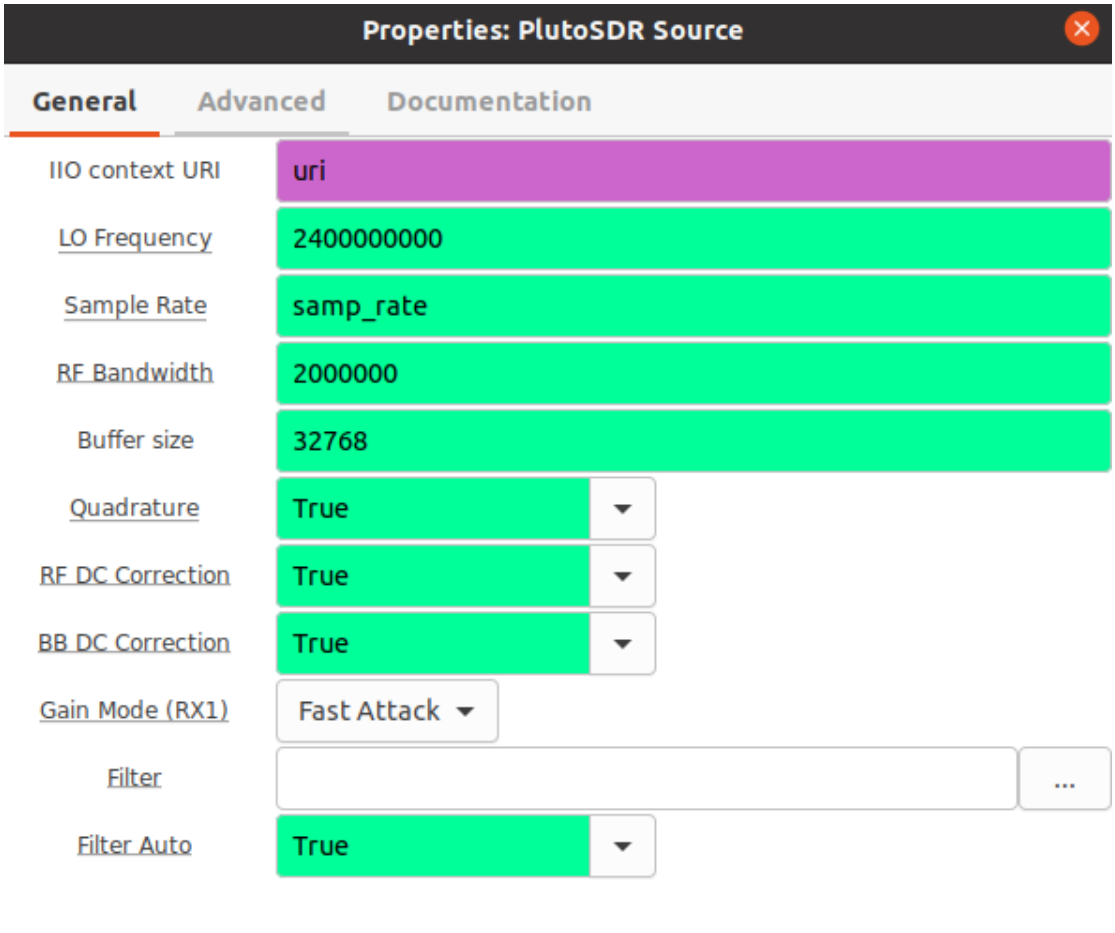
https://wiki.analog.com/resources/tools-software/linux-software/libiio/iio_info

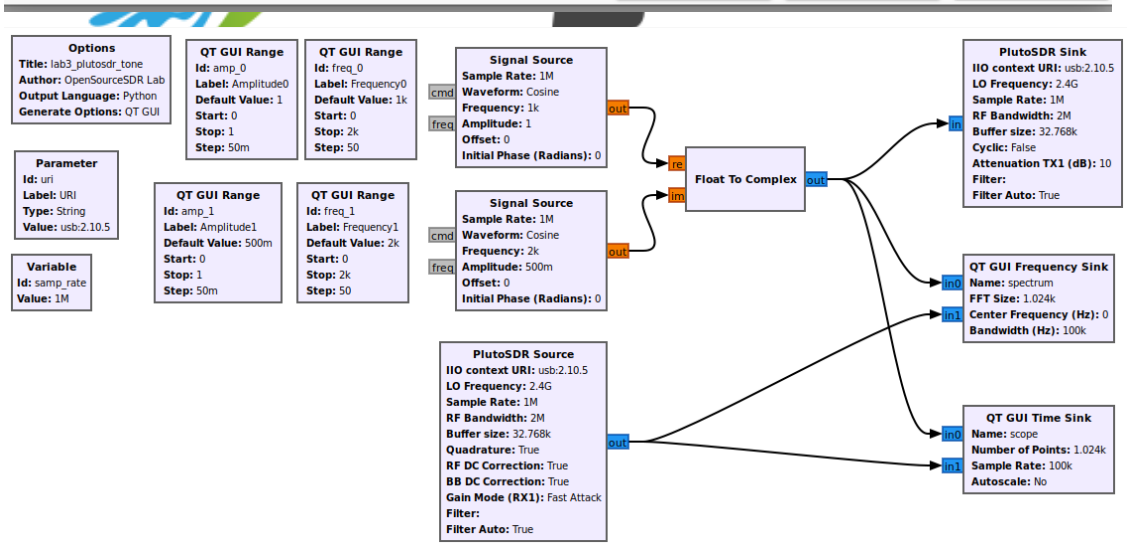
https://wiki.analog.com/resources/tools-software/linux-software/libiio/cmd_line

3.3.2 Basci Transceivers GRC Test

The normal operation of equipment transmission and reception is verified by establishing the following basic transmitting and receiving flow diagram. Notice that the USB descriptors of the device "DATA" change after each insertion and removal of the USB cable used for DATA transmission. You need to replace the USB descriptors in the flow diagram in time; otherwise, an error message indicating that the device cannot be created will be displayed in the GRC message printing window.

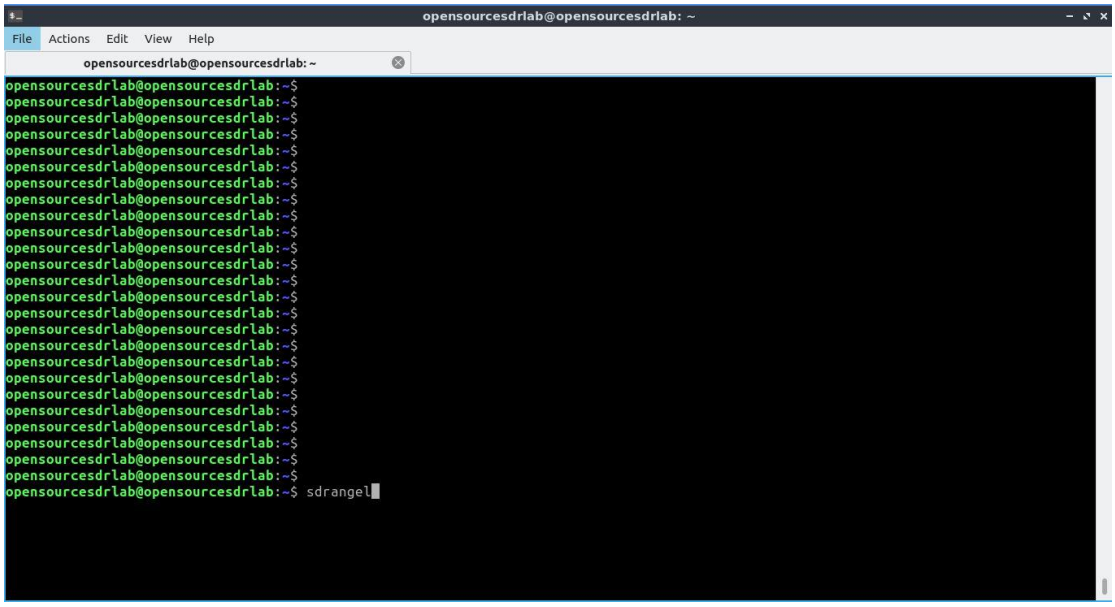




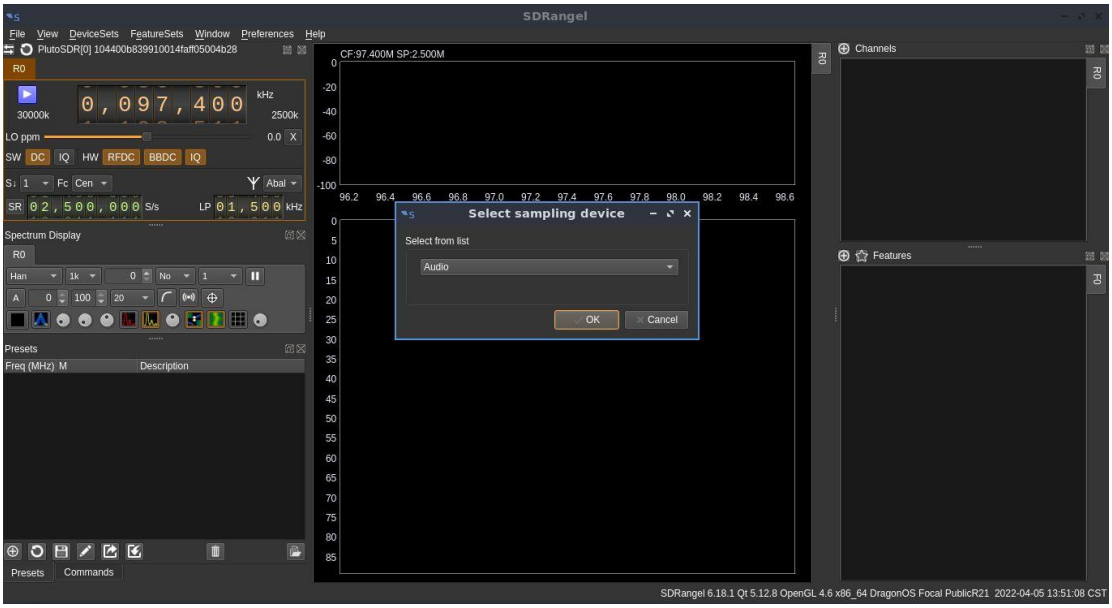


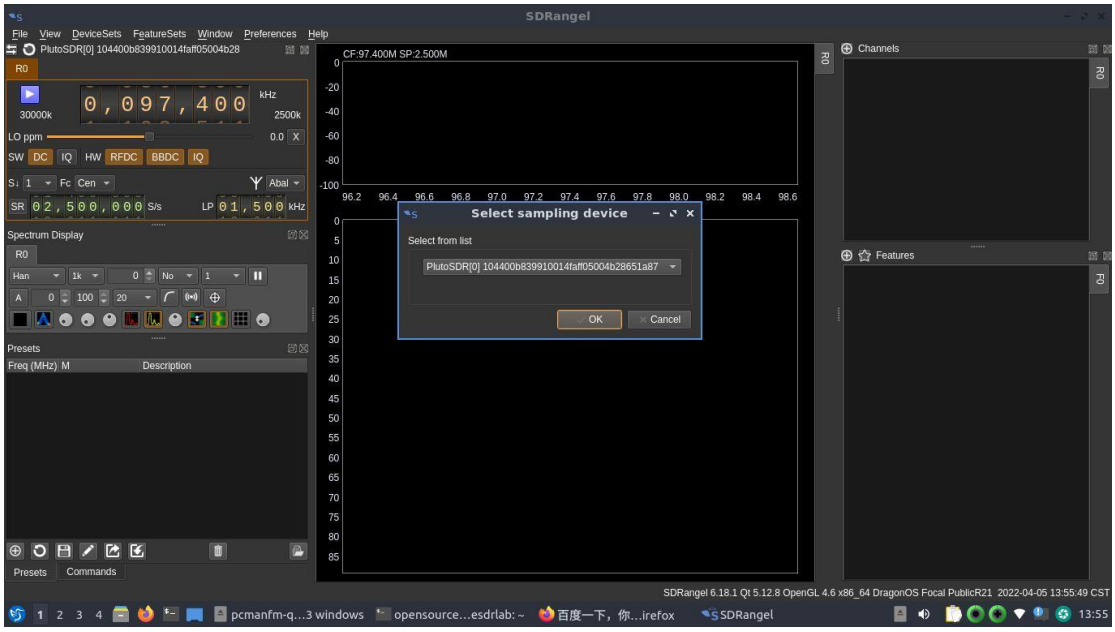
3.4 SDRangel WFM Receiving

In Ubuntu, open a terminal (the shortcut is to press three keys simultaneously, CTRL, Alt, and the letter T). Enter the command: sdrangel, enter the command and click Enter to open the sdrangel software.

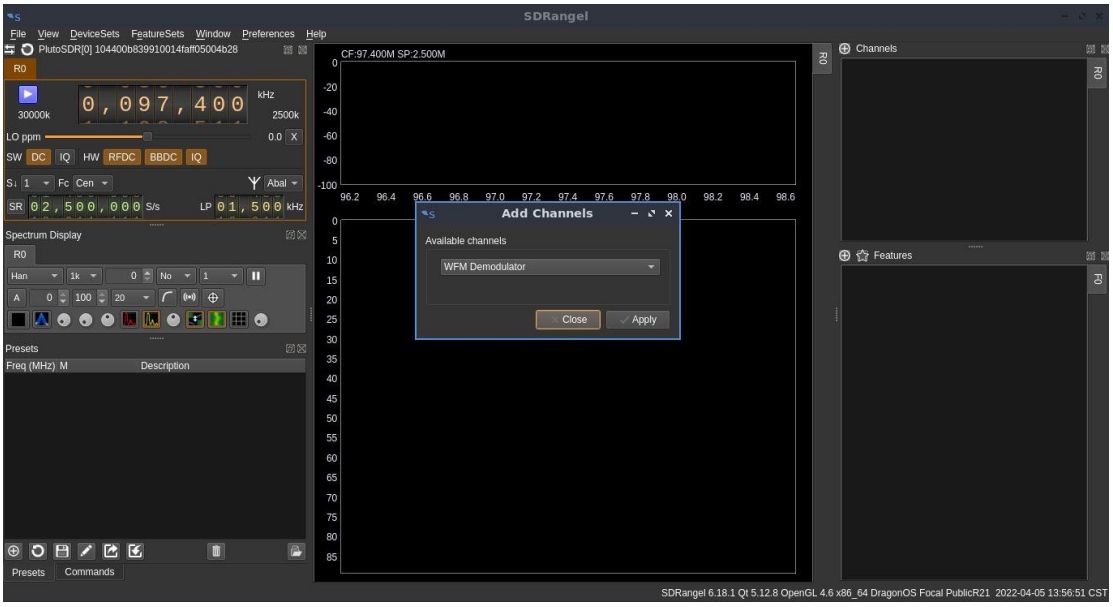


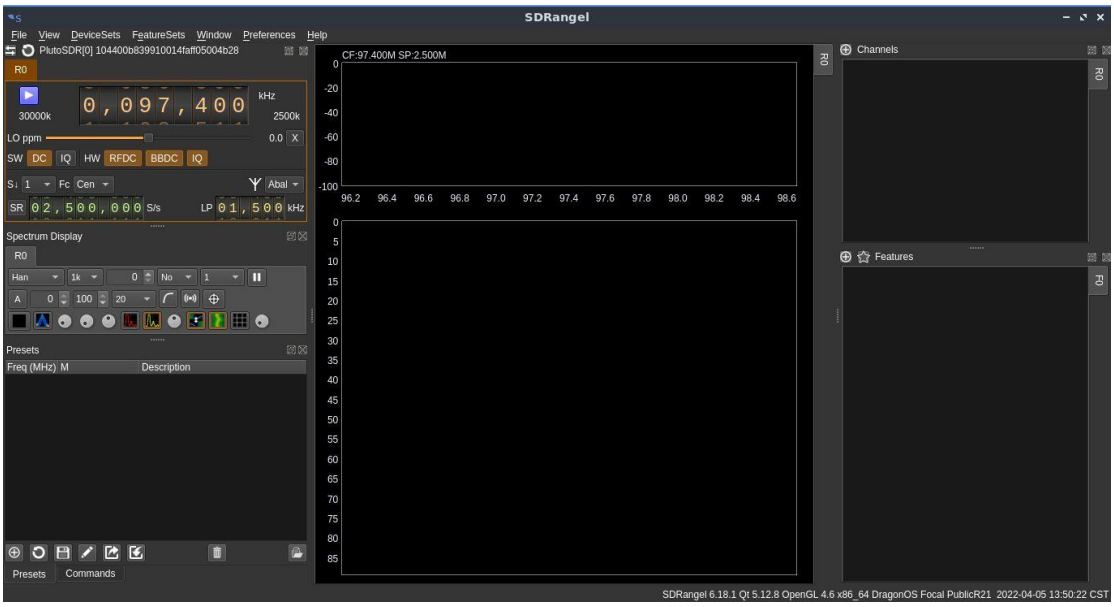
Setting the device, choose the PlutoSDR.

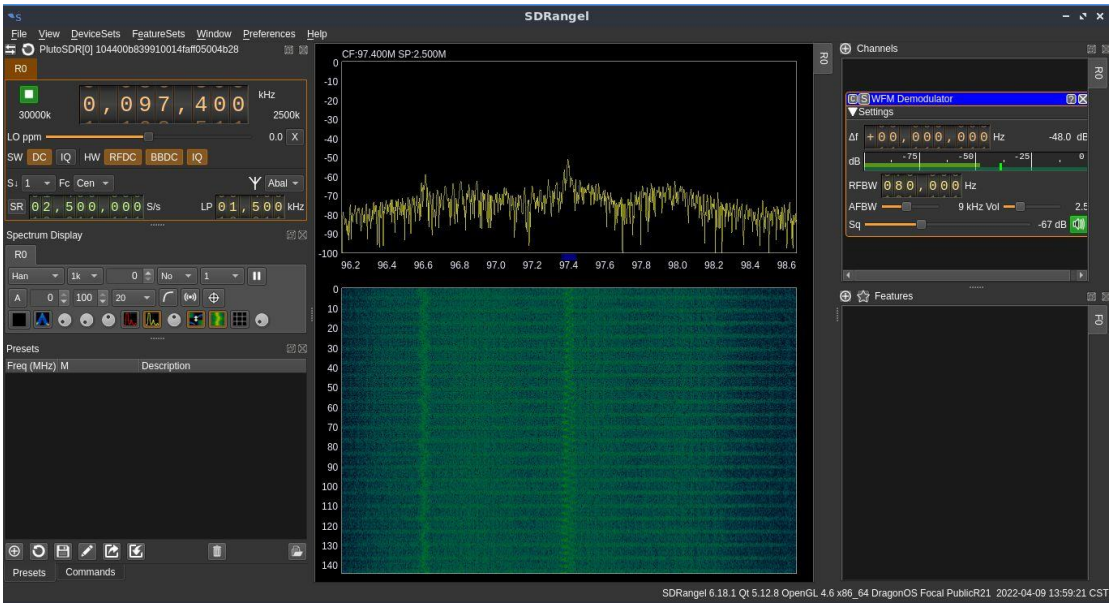




Then click the plus sign in the Channels on the right to add a WFM Demodulator. Click Apply to complete the setting of WFM receiving. But after setting up, you may encounter no sound, in this case, you need to adjust the squelch value (i.e., the “Sq” Value on the right Channels interface).







4 GNU Radio Pluto+ User Manual

4.1 PlutoSDR Source Block

https://wiki.gnuradio.org/index.php/PlutoSDR_Source

1、IIO context URI

For Pluto+ (or PlutoSDR) devices, it is recommended to use usb descriptors, such as USB :X.X.X. The X.X.X can be queried by typing iio_info -s on the terminal. If your Pluto+ is connected to your computer via a network cable, use network descriptors, such as IP :192.168.2.1.

2、LO Frequency

Selects the RX local oscillator frequency.

3、Sample Rate

Sample rate in samples per second, this will define how much bandwidth your SDR receives at once (the RF bandwidth parameter below just defines the filter). limits: >= 520833 and <= 61440000

4、RF Bandwidth

Configures RX analog filters: RX TIA LPF and RX BB LPF. limits: >= 200000 and <= 52000000.

5、Buffer size

Size of the internal buffer in samples. The IIO blocks will only input/output one buffer of samples at a time. To get the highest continuous sample rate, try using a number in the millions.

6、Quadrature

True/False.

7、RF DC Correction

True/False.

8、BB DC Correction

True/False.

9、Gain Mode (Rx1)

Selects one of the available modes: manual, slow_attack, hybrid and fast_attack. For most spectrum sensing type applications, use a manual gain, so that you actually know when a signal is present or not, and it's relative power.

10、Filter

Allows a FIR filter configuration to be loaded from a file.

11、Filter Auto

When enabled loads a default filter and thereby enables lower sampling / baseband rates.

4.2 PlutoSDR Sink Block

https://wiki.gnuradio.org/index.php/PlutoSDR_Sink

1、IIO context URI

For Pluto+ (or PlutoSDR) devices, it is recommended to use usb descriptors, such as USB :X.X.X. The X.X.X can be queried by typing iio_info -s on the terminal. If your Pluto+ is connected to your computer via a network cable, use network descriptors, such as IP :192.168.2.1.

2、LO Frequency

Selects the TX local oscillator frequency.

3、Sample Rate

Sample rate in samples per second, this will define how much bandwidth your SDR transmits (the RF bandwidth parameter below just defines the filter). limits: >= 520833 and <= 61440000. A FIR filter needs to be loaded or set to auto for values below 2.083 MSPS.

4、RF Bandwidth

Configures TX analog filters: TX BB LPF and TX Secondary LPF. limits: >= 200000 and <= 52000000.

5、Buffer size

Size of the internal buffer in samples. The IIO blocks will only input/output one buffer of samples at a time. To get the highest continuous sample rate, try using a number in the millions.

6、Cyclic

Set to “true” if the “cyclic” mode is desired. In this case, the first buffer of samples will be repeated on the PlutoSDR until the program is stopped. The PlutoSDR IIO block will report its processing as complete: the blocks connected to the PlutoSDR IIO block won't execute anymore, but the rest of the flow graph will.

7、Attenuation TX1 (dB)

Controls attenuation for TX1. The range is from 0 to 89.75 dB in 0.25dB steps. Note: Maximum output occurs at 0 attenuation.

8、Filter

Allows a FIR filter configuration to be loaded from a file.

9、Filter Auto

When enabled loads a default filter and thereby enables lower sampling/baseband rates.

4.3 AM

See《AM_dsb_tc.grc》、《AM_dsb_tc_Pluto.grc》、《AM_envelope_demod.grc》和《AM_envelope_demod_Pluto.grc》。

4.4 FM

See《WFM_mod.grc》、《WFM_demod.grc》、《WFM_transmitter_Pluto.grc》、《WFM_receiver_Pluto.grc》、《WFM_tx_rx_Pluto.grc》。

Note：《WFM_receiver_Pluto.grc》, the received sound quality is mediocre and cannot be compared with the special receiving software. There is still some room for optimization of the flow chart.

4.5 ASK

See《ASK_mod.grc》、《ASK_mod_demod.grc》、《ASK_file.grc》、《ASK_file_Pluto.grc》。

4.6 BPSK

See《BPSK_mod.grc》、《BPSK_mod_demod.grc》、《BPSK_File.grc》、《BPSK_file_Pluto.grc》。

4.7 QPSK

See《QPSK_mod_demod.grc》、《QPSK_file.grc》、《QPSK_file_Pluto.grc》。

4.8 To be continued

……

5 Useful links

https://www.rtl-sdr.com/adalm-pluto-sdr-unboxing-and-initial-testing/#:~:text=The%20PlutoSDR%20%28aka%20ADALM-PLUTO%29%20is%20a%20new%20RX,61.44%20MSPS%20sampling%20rate%20and%2020%20MHz%20bandwidth.

https://wiki.analog.com/university/tools/pluto/drivers/windows

https://github.com/analogdevicesinc/plutosdr-m2k-drivers-win/releases

https://wiki.analog.com/university/tools/pluto/prerequisites

The PlutoSDR supports USB 2.0 On-The-Go (OTG), and can be used in two different modes:

https://wiki.analog.com/university/tools/pluto

https://www.rtl-sdr.com/plutosdr-quickstart-guide/

https://wiki.analog.com/university/tools/pluto/users/quick_start

https://wiki.analog.com/university/tools/pluto/prerequisites

https://wiki.analog.com/resources/tools-software/linux-software/gnuradio

https://plutosdr.org/getting-started/

https://blog.csdn.net/goldenhawking/article/details/104072054

https://blog.csdn.net/weixin_42905573

https://blog.csdn.net/zhangxq0521/category_9812491.html

https://wiki.gnuradio.org/index.php/PlutoSDR_FMRadio