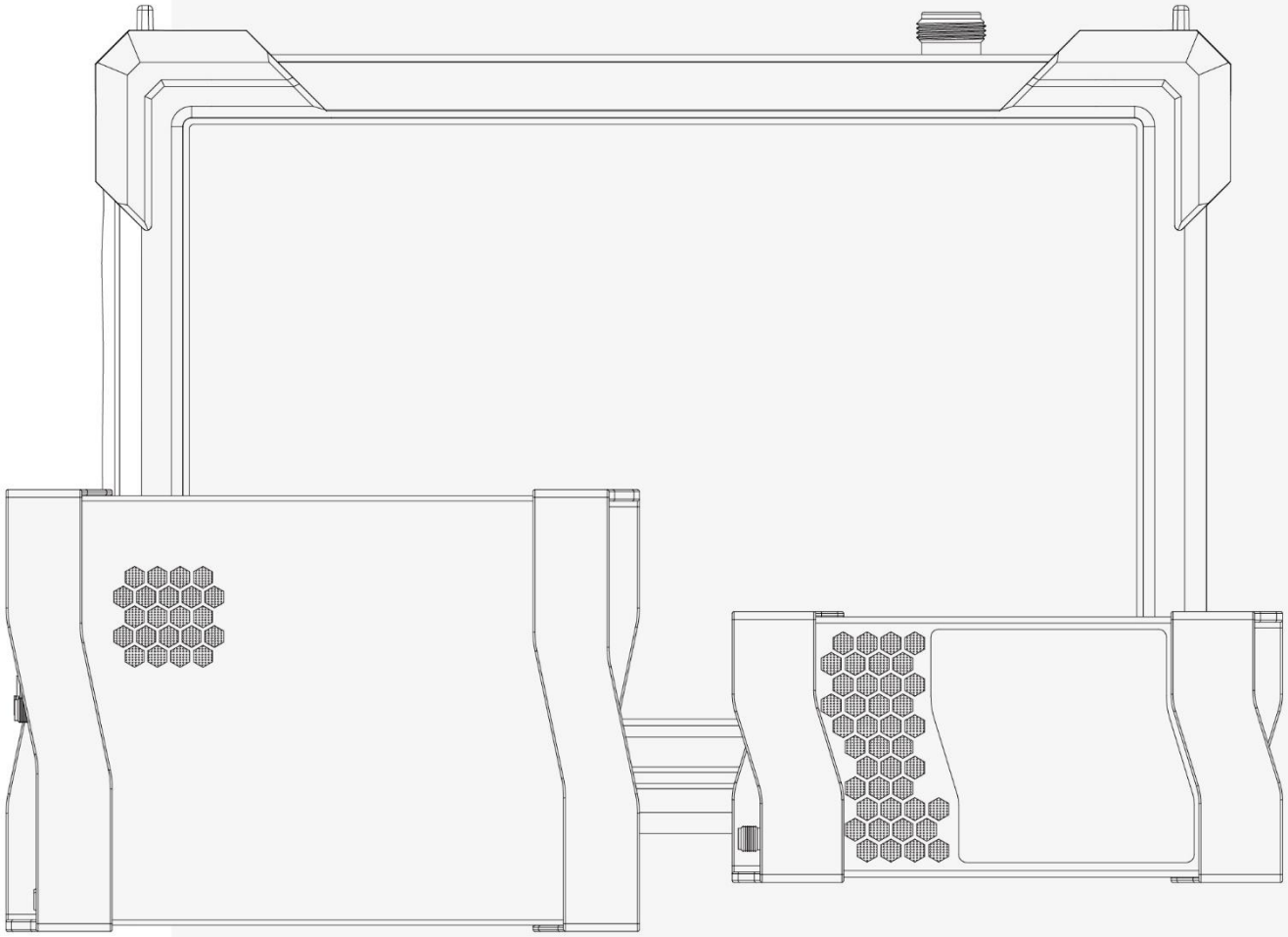
USER GUIDE

GNU Radio Examples Usage Guide



V2.0

05/18/2025

HAROGIC

CONTENTS

Version Management

Updated Description Sheet

Version	Description	Date
V2.0	1. Added: ADSB demodulation example	05/18/2026
V1.0	1. Initial Version.	12/05/2025

1 System Setup and Configuration

This section takes the installation of GNU Radio on Ubuntu 22.04 as an example.

1.1 Architecture and Operating System Requirements

- Architecture: x86_64
- Operating System: Ubuntu22.04 or later
- GNU Radio Version: 3.9 or later

Enter *uname -a* in the terminal to check whether your operating system and architecture meet the requirements for running the HAROGIC spectrum analyzer in GNU Radio. If they do not, please update to the required versions.

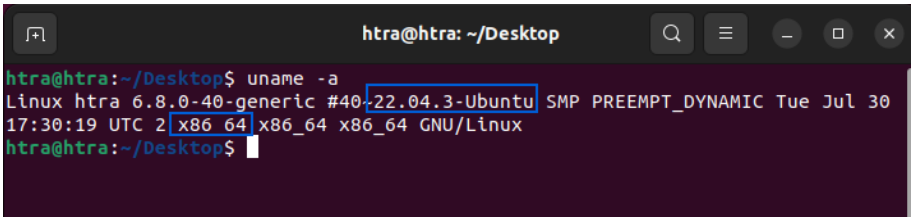


Figure 1 Check the system architecture and operating system version

1.2 Installing and Configuration GNU Radio

1. In the terminal, enter *sudo apt update && sudo apt-get install gnuradio* and wait for the installation to complete;
2. In the terminal, enter *gnuradio-config-info --version* to check the installed version and ensure that GNU Radio was installed successfully;

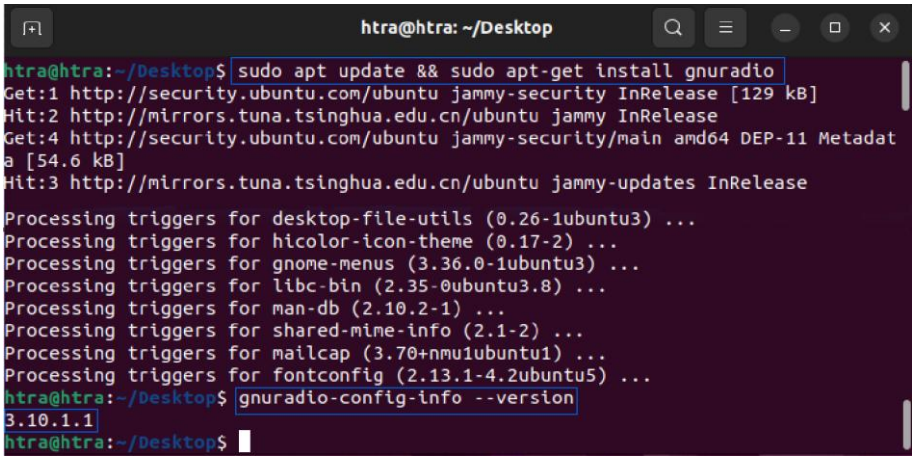


Figure 2 Installing and Checking the GNU Radio Version

1.3 Building the HRTA OOT Module

1. Open the terminal and enter: *sudo apt update && sudo apt install -y git cmake g++ libpython3-dev python3-numpy python3-pip python3-setuptools pybind11-dev*, this will install all the toolchains and dependencies required to build GNU Radio and third-party modules in one step.

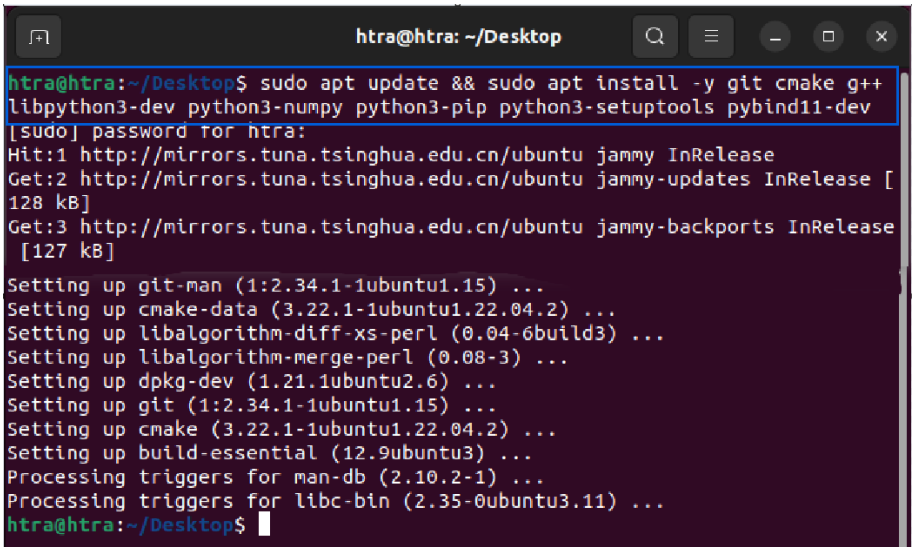


Figure 3 Configuring Dependencies

2. In the terminal, enter: *git clone* https://github.com/HAROGIC-Technologies/gr-htra.git to download the HTRA OOT module (The gr-htra folder can also be obtained directly from the attached data's Linux\HTRA_Gnuradio_Examples folder);

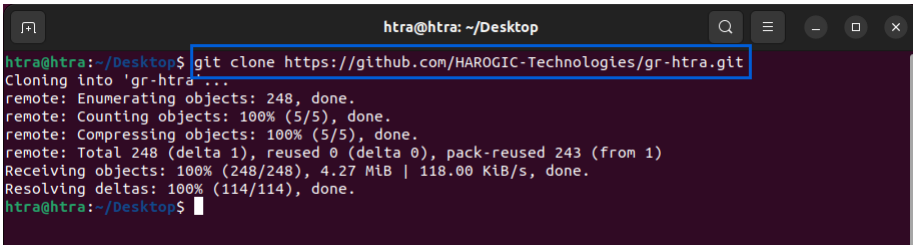


Figure 4 Downloading the HTRA OOT Module

3. In the terminal, enter *cd gr-htra* to navigate to the root directory of the HTRA OOT module;
4. Enter *mkdir build && cd build* to create a build directory under the project root and switch to it;
5. Enter *sudo cmake .. && sudo make install* to configure the project, compile the source code, and install the module to the system directory.

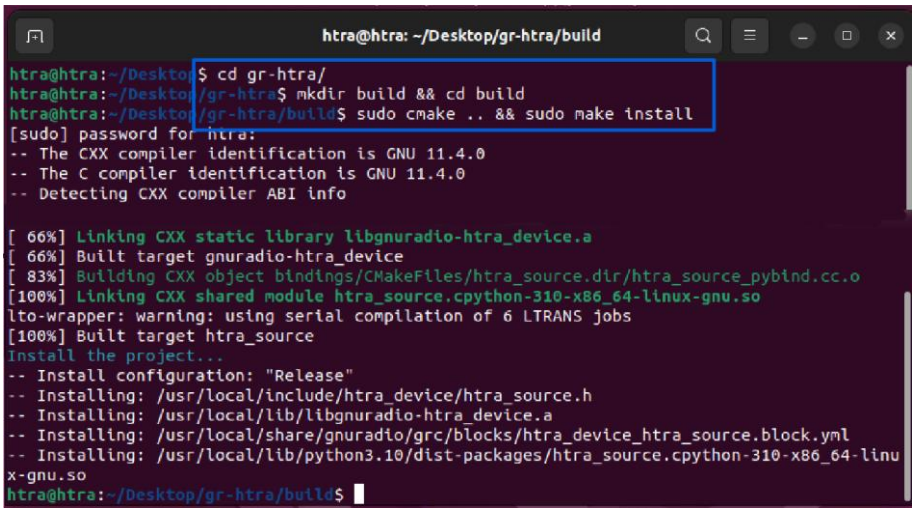


Figure 5 Building the Module

6. Copy the instrument's calibration files into the gr-htra/CalFile folder, then run *cd.. && sudo sh CopyCalFile.sh* to install the device calibration files.

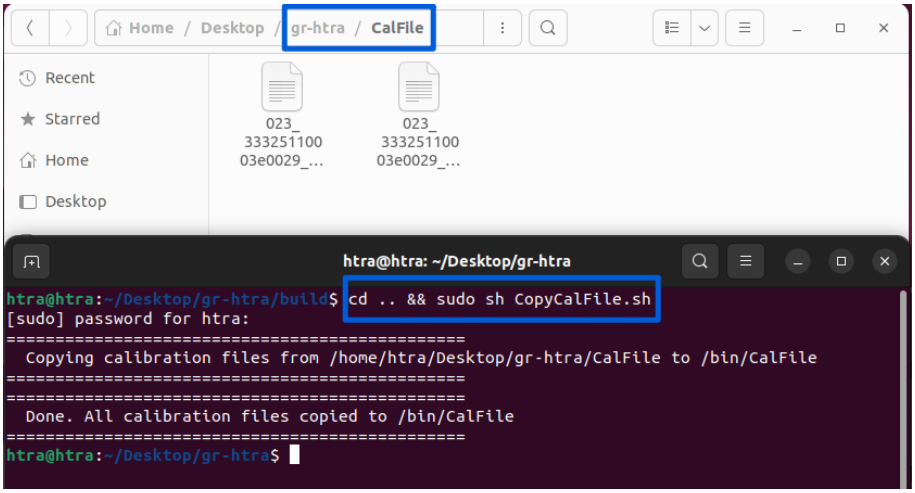


Figure 6 Copying and Installing Calibration Files

1.4 Uninstalling the HTRA OOT Module

To uninstall the HTRA OOT module along with its related configuration files, run the following command in the gr-htra folder: *sudo sh uninstall.sh*.

2 Running the HTRA OOT Module

The following text takes the USB model device as an example to run the HTRA OOT module.

1. Connect the device to the host computer, then enter *lsusb* in the terminal. If the output shows IDs 6430, 3675, 04b5, or 367f, it indicates that the instrument is correctly connected to the host.

   (If the host is a virtual machine, after a successful connection, you can check the hardware device icon at the bottom-right corner of the VM interface. Hovering the mouse over the icon should display the HTRA logo, confirming that the device is connected to the VM. Also, ensure that the USB compatibility setting is set to USB 3.1 to guarantee proper device operation.)

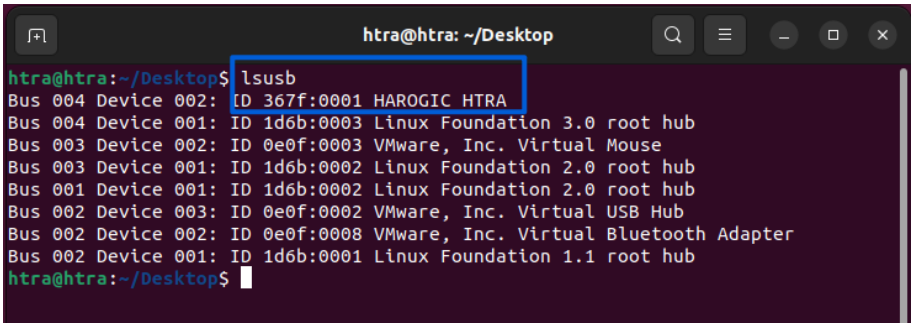


Figure 7 Checking Device Connection on Linux

2. In the terminal, navigate to the built gr-htra folder and enter *gnuradio-companion* to launch the graphical interface;

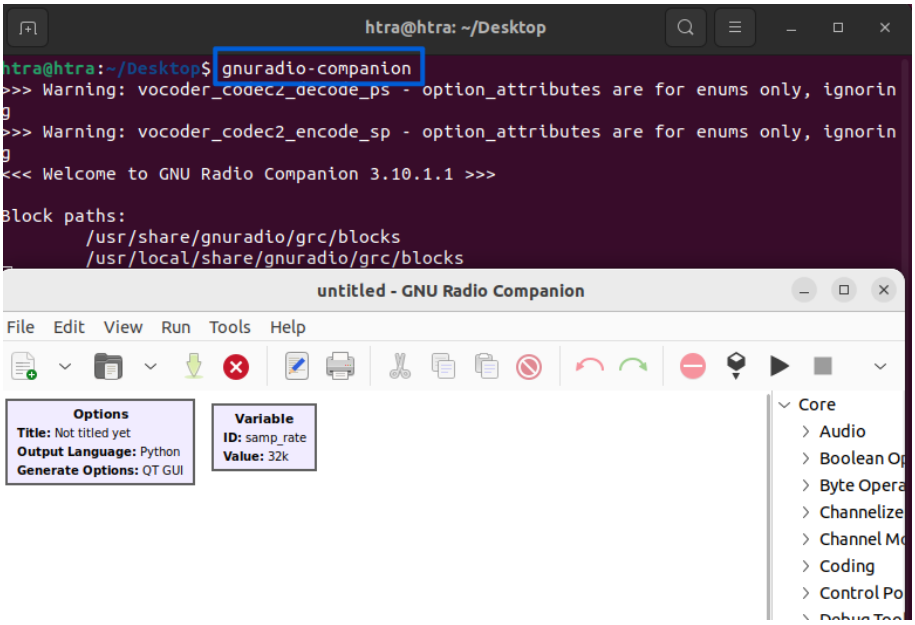


Figure 8 Launching GNU Radio

3. In the GNU Radio Companion graphical interface, press Ctrl+F to open the search box. Enter "HTRA:IQ Source" in the top-right corner and press Enter to load "HTRA: IQ Source" into the flowgraph;

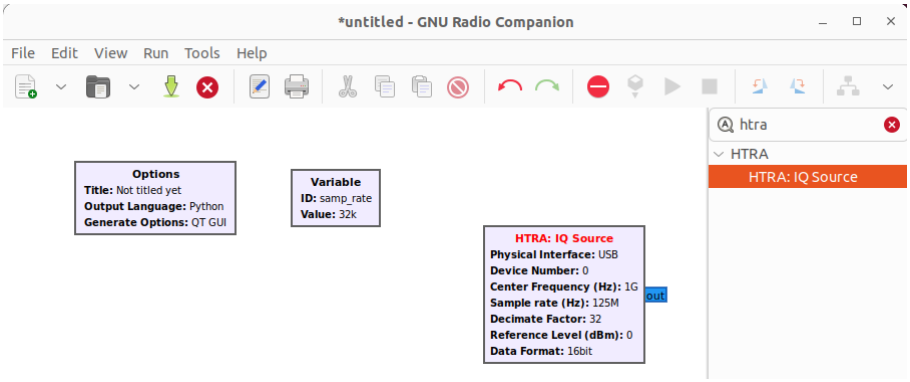


Figure 9 Loading the HTRA: IQ Source Module

4. The HTRA: IQ Source module is used to receive IQ data streams from the HAROGIC spectrum analyzer and process them within GNU Radio. You can double-click the HTRA: IQ Source module to open its configuration window, modify or select the desired parameter values, and then click OK at the bottom of the window to apply the changes;

- **Physical Interface**: Interface type: Select USB or Ethernet devices for connection using the drop-down menu.
- **Device Number**: Set different device IDs when multiple devices are connected simultaneously.
- **Center Frequency**: Center frequency, range: 9 kHz to Device Cutoff Frequency.
- **Sample rate**: Sample Rate: Default 125 MHz.
- **Decimate Factor**: Decimation Factor: Select from the drop-down menu under module parameters.
- **Reference Level**: Reference level, range: -50 to +23 dBm
- **Data Format**: Data Format: Set the data format of the captured IQ data.

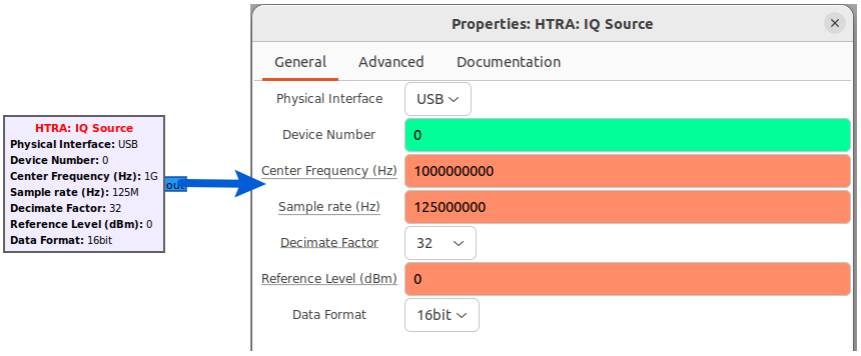


Figure 10 HTRA: IQ Source Module Parameter Description

5. In the search box, enter QT GUI Frequency Sink and press Enter to add the spectrum display module. Connect the input of this module to the output of the HTRA: IQ Source module to display the IQ signal spectrum in real time;

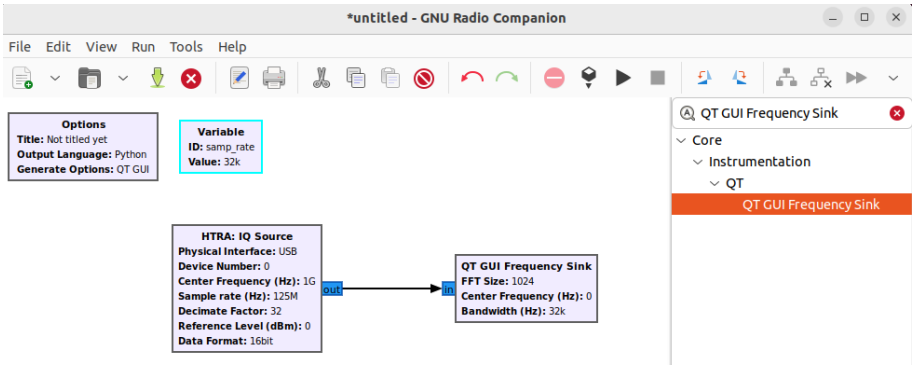


Figure 11 Connecting the Spectrum Display Module

6. Click "File" -> "Save" to save the file as Spectrum_display, then click the Run button at the top of the graphical interface to view the spectrum of the input signal.

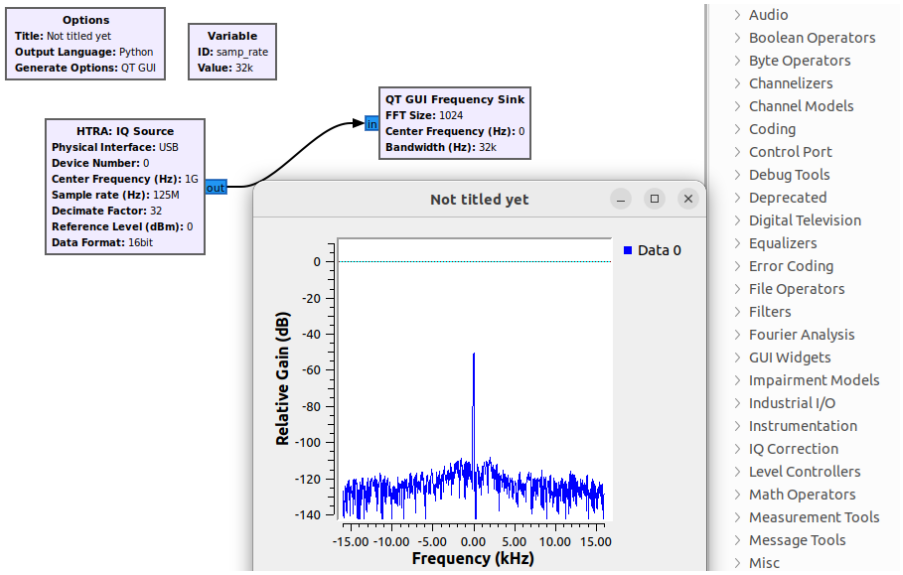


Figure 12 Viewing the Input Signal Spectrum

3 Acquiring IQ Stream

This example demonstrates how to acquire IQ data and provides the IQ data's time-domain waveform, frequency spectrum, and spectrogram.

The following uses viewing the IQ data of a 1 GHz, -20 dBm single-tone signal as an example.

1. In the terminal, navigate to the built gr-htra folder and enter *gnuradio-companion* to launch the graphical interface;
2. In the interface, click "File" -> "Open" -> "Examples" -> "IQ_streaming.grc" -> "Open" to load the example for IQ stream acquisition;
3. Keep the default parameters. Double-click the corresponding QT GUI Range module and Variable node at the top of the routine to modify the corresponding parameters in the HTRA: IQ Source module (the Decimate Factor must be consistent between the Variable and the module). Then, double-click the module to select the device and data type for the corresponding interface.

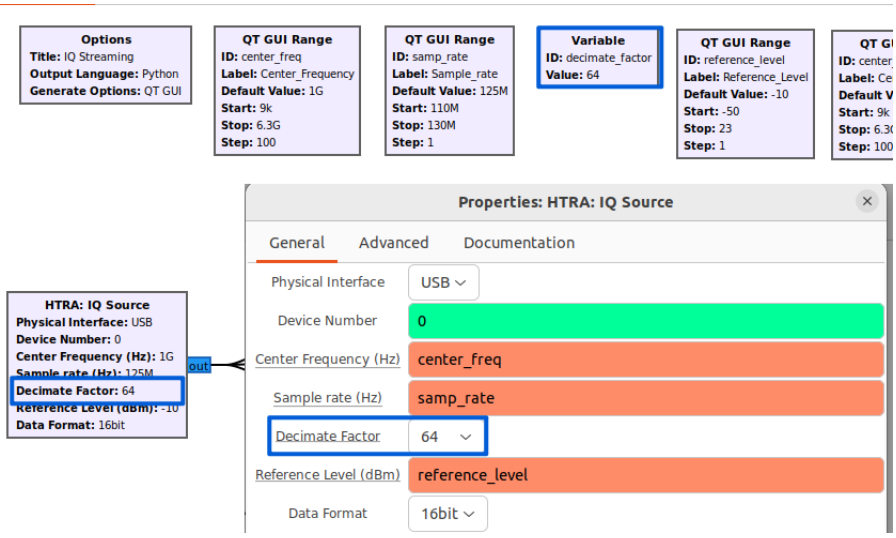


Figure 13 Configure parameters

4. Click the Run button at the top of the GNU Radio Companion graphical interface to view the spectrum, spectrogram, time-domain waveform, and constellation diagram corresponding to the IQ stream.

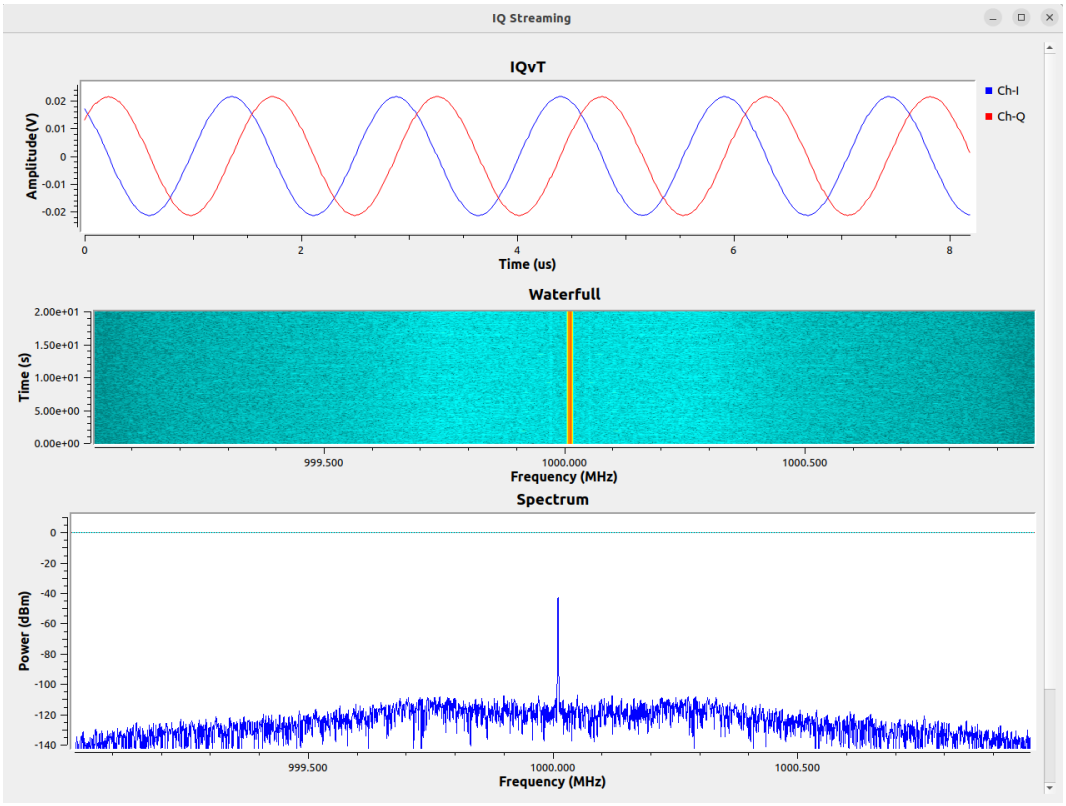


Figure 14 Run the IQ_Streaming example

4 AM Demodulation

This example demonstrates how to perform bandwidth limiting, automatic gain control (AGC), carrier synchronization, and amplitude demodulation on the actual output IQ data stream. It provides the time-domain waveform, spectrum, and the demodulated audio waveform of the AM signal. It is suitable for AM broadcast signals with typical audio bandwidth (≤15 kHz). If you need to demodulate AM signals with a larger bandwidth, you can design or adjust the demodulation chain according to your actual requirements.

The following uses demodulating an AM signal with a carrier frequency of 1 GHz, a power of -20 dBm, and a symbol rate of 5 kHz as an example

1. Refer to steps 1 to 2 in the "Acquiring IQ Stream" chapter to open the "AM_demod.grc" example;
2. The Center Frequency and Reference Level maintain their default configuration. You can double-click the corresponding QT GUI Range block and adjust the "Default Value" in its properties window to adapt to AM signals of different frequencies and power levels.
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the IQ time-domain plot, spectrum, and demodulated audio waveform of the AM signal.

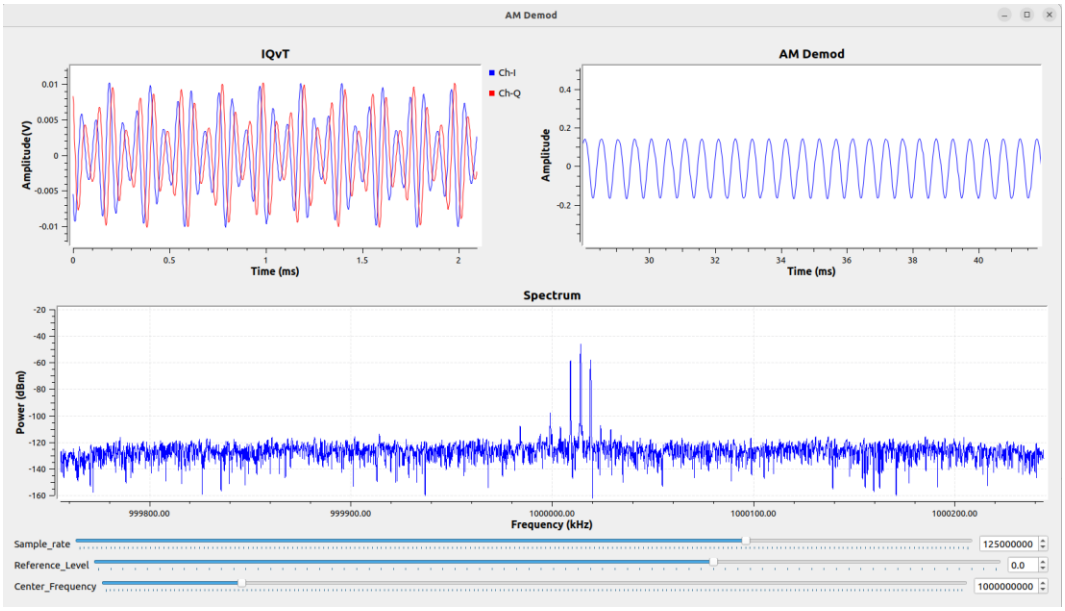


Figure 15 AM demodulation example

5 FM Demodulation

This example is used for demodulating FM broadcast signals and demonstrates the time-domain waveform, spectrum, and demodulated audio waveform of the FM signal. The following uses the demodulation of a 97.5 MHz broadcast signal as an example.

1. Refer to steps 1 to 2 in the "Acquiring IQ Stream" chapter to open the "FM_demod.grc" example;
2. The Center maintains its default configuration. You can double-click the QT GUI Range block corresponding to "center_freq" and adjust the "Default Value" in its properties window to demodulate FM broadcast signals at different frequencies.
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the IQ waveform, spectrum, and demodulated time-domain waveform of the FM signal.

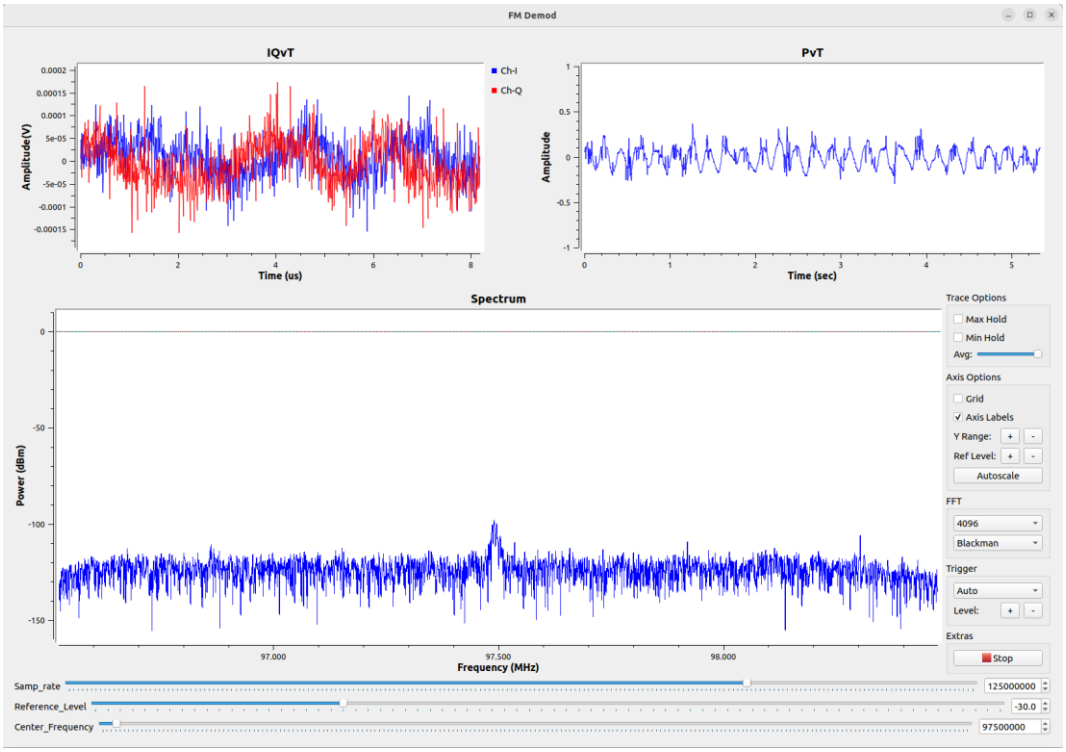


Figure 16 FM demodulation example

6 QPSK Demodulation

This example is used for demodulating QPSK signals and demonstrates the IQ time-domain waveform, spectrum, and demodulated constellation diagram of the QPSK signal, facilitating real-time verification of symbol synchronization, carrier recovery, and signal quality for users.

The following uses the demodulation of a 1 GHz, -20 dBm QPSK signal with a symbol rate of 1 MHz and a filter alpha (roll-off factor) of 0.35 as an example.

1. Refer to steps 1 to 2 in the "Acquiring IQ Stream" chapter to open the "QPSK_demod.grc" example;
2. Double-click the Variable parameter nodes corresponding to "decimate_factor" and "symbol_rate", and modify their respective "Value" in the properties window to set the Decimate Factor to 16 and the Symbol Rate to 1 MHz. Then, double-click "HTRA: IQ Source" and update the value of the Decimate Factor in the pop-up window. Keep other parameters at their default configuration. You can double-click other QT GUI Range or Variable nodes to adjust Center, Ref.Level, SampleRate, Decimate Factor, and Filter Alpha as needed to adapt to different signals.

   Note: Sample Rate / Decimate Factor ≥ 4 * Symbol Rate.
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the time-domain graph, spectrum, and demodulated constellation diagram corresponding to the IQ stream;

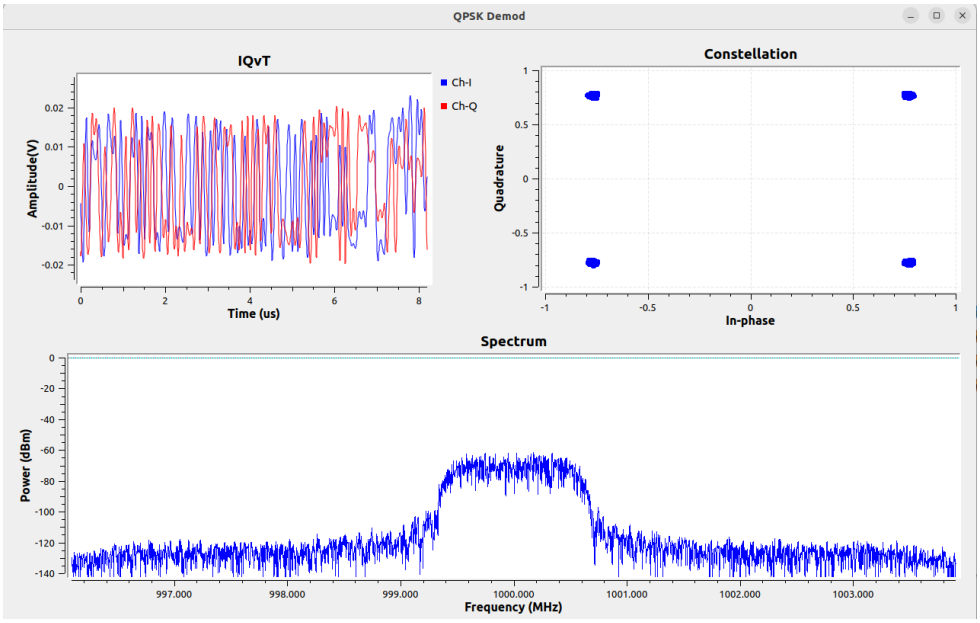


Figure 17 QPSK demodulation example

7 QAM Demodulation

This example currently supports demodulating QAM16 and QAM64 signals. It provides the IQ time-domain waveform, spectrum, and the demodulated constellation diagram. The following uses demodulating a QAM16 signal with a center frequency of 1 GHz, a reference level of -20 dBm, a symbol rate of 300 kHz, and a roll-off factor of 0.35 as an example.

1. Refer to steps 1-2 in the "Acquiring IQ Stream" chapter to open the "QAM_demod.grc" example;
2. Double-click the Variable parameter node corresponding to "symbol_rate", and modify its "Value" in the properties window to set the Symbol Rate to 300 kHz. Keep other parameters at their default settings. You can double-click other QT GUI Range or Variable nodes to adjust Center, Reference Level, SampleRate, Decimate Factor (setting rules refer to the QPSK Demodulation chapter), and Filter Alpha as needed to adapt to different signals;
3. Click the Run button at the top of the GNU Radio Companion graphical interface to view the time-domain graph, spectrum, and demodulated constellation diagram corresponding to the IQ stream.

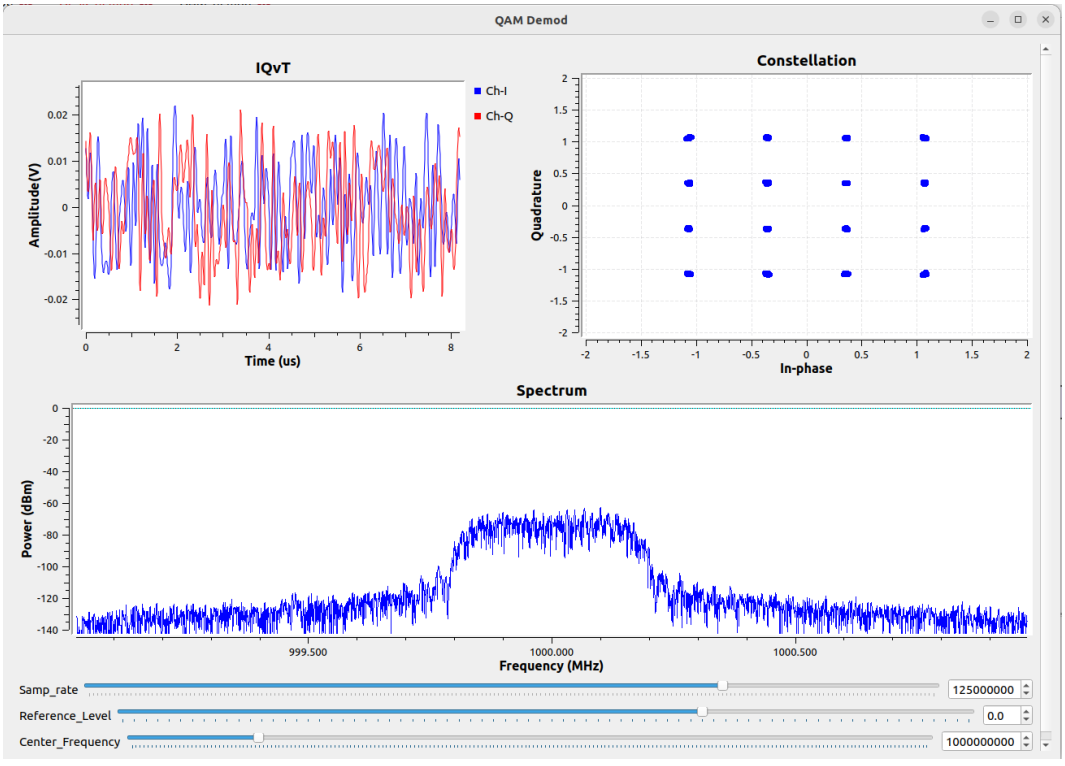


Figure 18 QAM demodulation example

8 WLAN Signal Demodulation

The WLAN demodulation example relies on the open-source projects gr-ieee802-11 and gr-foo. Please install these projects according to the following chapter before running it.

8.1 Install gr-ieee802-11 and gr-foo Project

Enter the following commands in the terminal, in sequency, to install gr-foo:

```
git clone https://github.com/bastibl/gr-foo
cd gr-foo
mkdir build
cd build
cmake ..
make
sudo make install
sudo ldconfig
```

Enter the following commands in the terminal, in sequency, to install gr-ieee802-11:

```
git clone https://github.com/bastibl/gr-ieee802-11
cd gr-ieee802-11
mkdir build
cd build
cmake ..
make
sudo make install
sudo ldconfig
sudo sysctl -w kernel.shmmax=2147483648
```

8.2 Run the WLAN Demodulation Example

This example is used to demodulate WLAN signals and displays the IQ time-domain waveform, spectrum, and demodulated constellation diagram of the WLAN signal.

The following section uses the demodulation of an IEEE 802.11a signal with a Center frequency of 1 GHz, a Reference Level of -20 dBm, and a symbol rate of 200 MHz as an example.

1. Refer to steps 1 to 2 in the chapter "Acquiring IQ Stream" to open the "WLAN_demod.grc" example;

2. Click the Run button at the top of the GNU Radio Companion graphical interface. Set the "freq" parameter in the result display window to 1|2412.0|11g to view the corresponding time-domain graph, spectrum, and demodulated constellation diagram of the IQ stream.

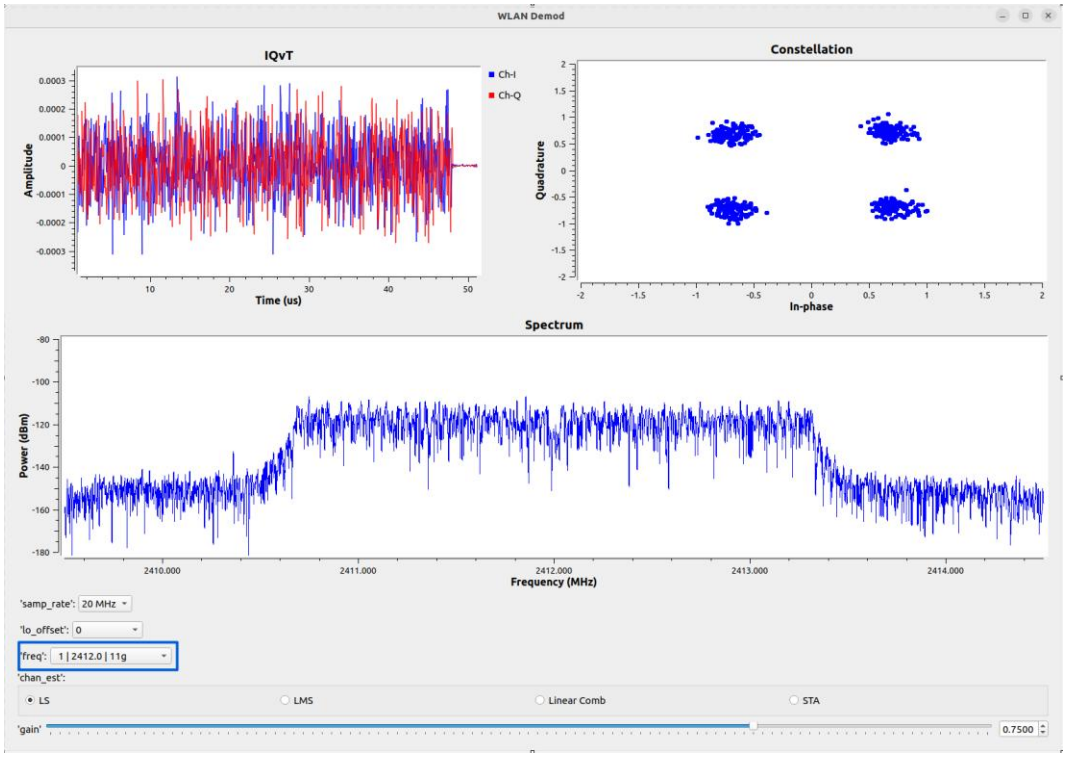


Figure 19 WLAN demodulation example

9 ADSB Demodulation

The ADSB demodulation example depends on the open-source project gr-adsb. Before running it, please follow the instructions in the following sections to install the project. Enter the following commands in the terminal one by one to install gr-adsb:

```
git clone https://github.com/mhostetter/gr-adsb.git
cd gr-adsb
mkdir build
cd build
cmake ..
make
sudo make install
sudo ldconfig
```

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