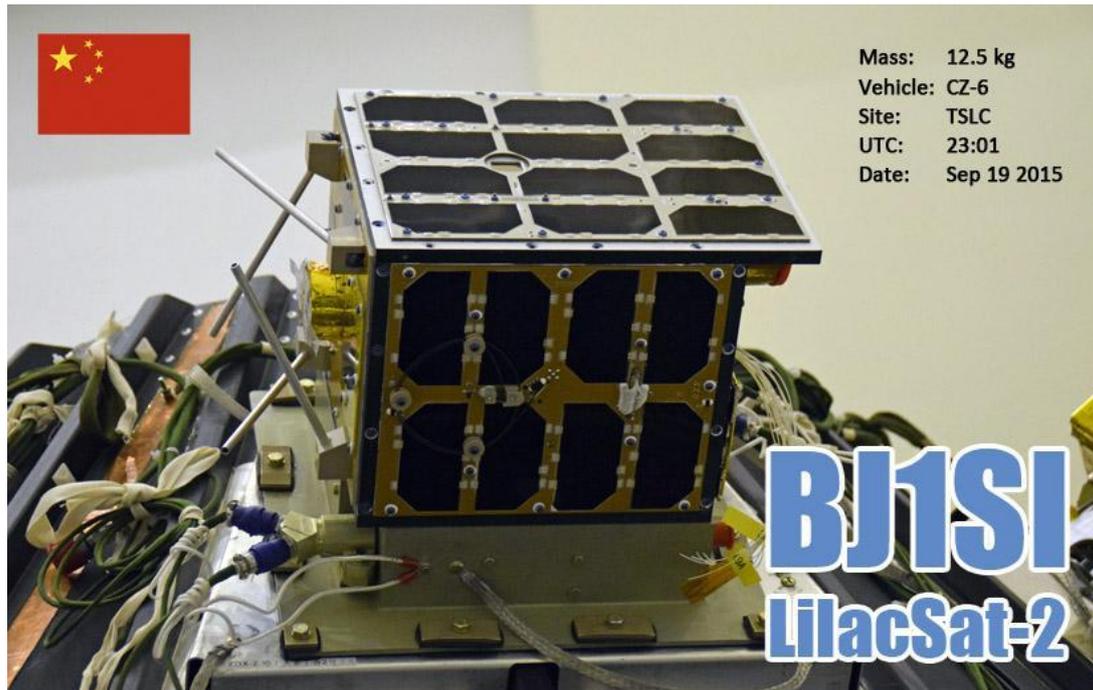# LilacSat-2 Live CD User Manual

Verson 1.1



Harbin Institute of Technology LilacSat-2 Team

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Edited by JE9PEL

# Contents

# 1   Overview

## 1.1   About LilacSat-2

LilacSat-2 is a low-cost, nano-satellite for education, technology demonstration and amateur radio communication, built by a team of 16 students of Harbin Institute of Technology (HIT). It is a cube-shaped 23 cm $\times$ 37 cm $\times$ 20 cm satellite with a weight of 12.5 kg.

LilacSat-2 was launched in a cluster of 20 satellites on the maiden flight of the CZ-6 rocket from Taiyuan Satellite Launch Center (TSLC) at 23:01 Sep 19 2015 UTC into a 520 km $\times$ 520 km SSO orbit with an inclination of 97.

Visit http://lilacsat.hit.edu.cn/?page_id=257 for radio information and software download.
Website: http://lilacsat.hit.edu.cn/
E-mail: lilacsat@163.com

## 1.2   About This Live CD

This Live CD is a bootable Ubuntu SDR environment created with respin-gtk for quick and easy recption of LilacSat-2 telemetry and SDR experiment without having to make any permanent modifications to a PC or laptop. It does not, however, provide for permanent installation.

It is supplied as an ISO image to be downloaded and burned onto a recordable DVD disc or copied to a USB flash drive using a utility such as the Ubuntu Startup Disk Creator (Ubuntu Linux OS) or Unetbootin (Windows, MacOS, Linux). Creating a USB drive from the image will provide much faster booting and operation, and allow making changes and storing files. Finally, the ISO image may be booted within a virtual environment such as VirtualBox, QEMU/kvm, VMware, or Parallels.

This Live CD is based on the following software:

- Ubuntu Linux 14.04.2 LTS,

- GNU Radio and GRC 3.7.8,

- gpredict,

- gqrx,

- gr-fcdproplus,

- hamlib,

- gr-lilacsat, etc.

## 1.3   About gr-lilacsat

gr-lilacsat is a GNU Radio OOT module for LilacSat-2 telemetry decoding.

frontend_rx_*.grc in examples folder for different SDR devices:

- frontend_rx_fcdpp.grc for Funcube Dongle Pro Plus,

- frontend_rx_uhd.grc for USRP,

- frontend_rx_rtl.grc for RTL-SDR.

It is not hard to edit frontend_rx_*.grc to support other devices.

demod_node*_*.grc in examples folder for different modulation and rate:

– demod_node1_bpsk_9k6.grc for 437.200 MHz 9600 bps RRC-BPSK telemetry,

– demod_node1_afsk.grc for 437.200 MHz 1200 bps AFSK-FM telemetry,

– demod_node1_ccsds_fm.grc for 437.200 MHz 300 bps FM subaudio telemetry,

– demod_node4_4k8.grc for 437.225 MHz 4800 bps GFSK telemetry.

On reset, the satellite will operate 437.200 MHz 9600 bps RRC-BPSK telemetry and 437.225 MHz 4800 bps GFSK telemetry by default.

proxy_publish is also included in examples folder for upload telemetry for display.

# 2 Guided Tutorial

In this chapter we will take Funcube Dongle Pro Plus and default telemetry mode as an example to show how to use this Live CD. Select the correct GRC sketches depend on your hardware and operating mode of the satellite.

## 2.1 Preparation

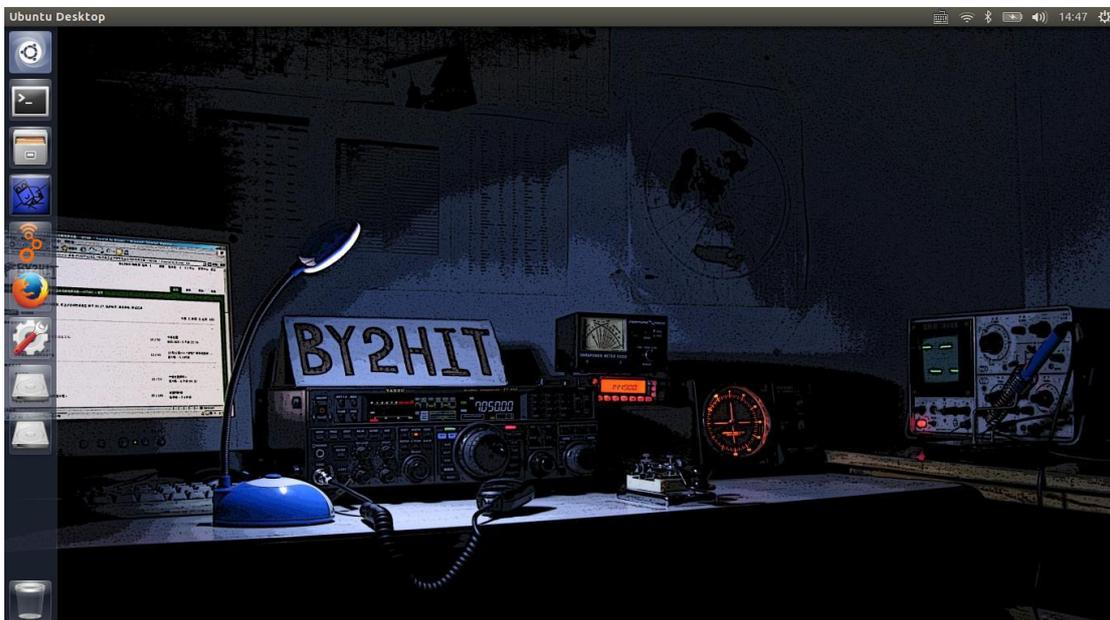Make a USB boot disk from the Live CD ISO file, then boot your computer with it.



Figure 1

## 2.2   Internet Connect to the Internet



Figure 2

## 2.3   Start the Downlink Proxy

Single click the proxy icon.



Figure 3

In the proxy window,
- (1) edit your user information
- (2) disable the backup server
- (3) save settings
- (4) update orbit information
- (5) and if this is successful you can see message in message window
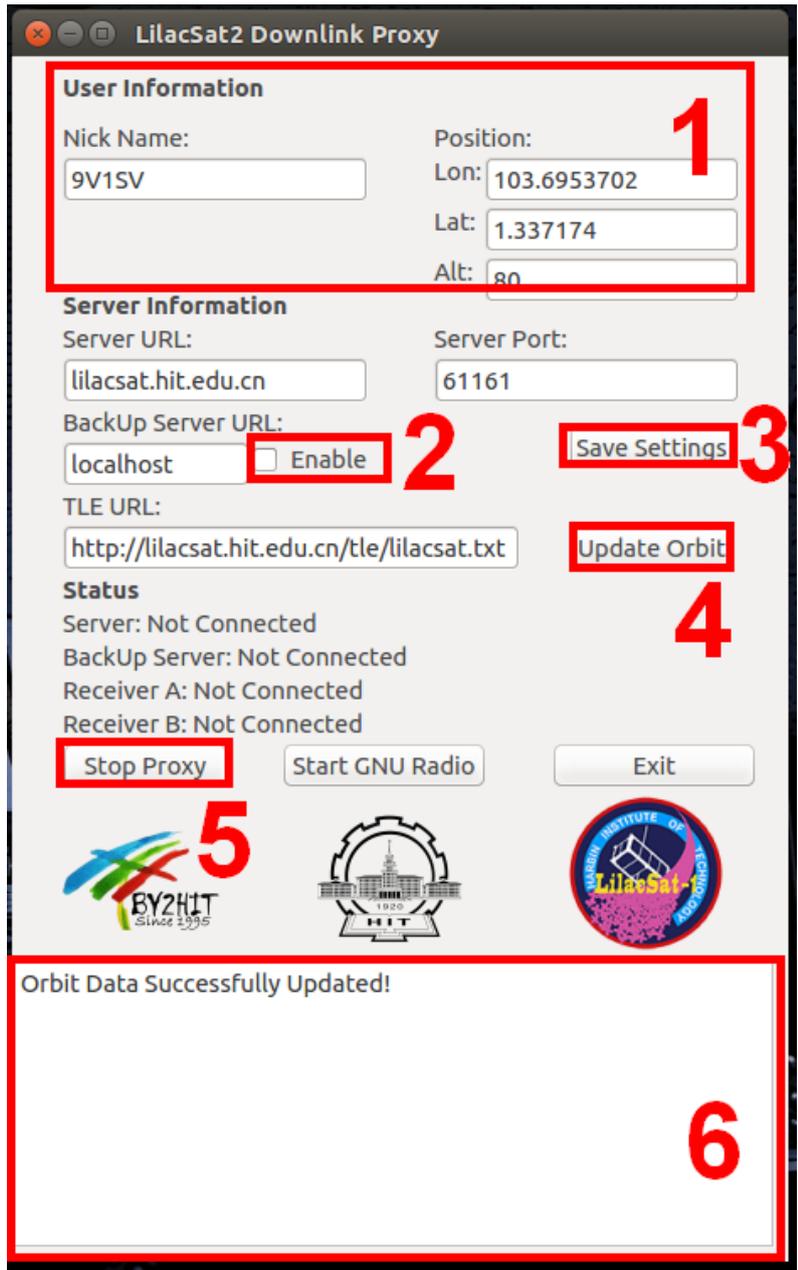- (6) and start the proxy

Figure 4

## 2.4    Start the Receiver Sketches

Single click the GRC icon to start it.



Figure 5

(1) Select frontend_rx_fcdpp.grc

(2) edit record file name

(3) and run

(4) or disable it.

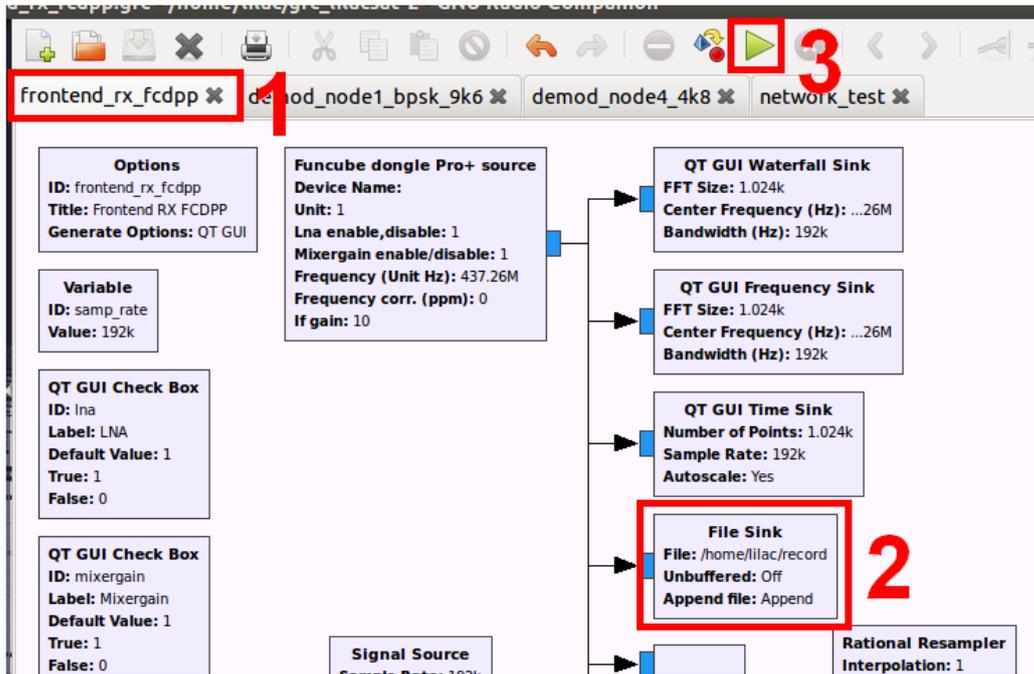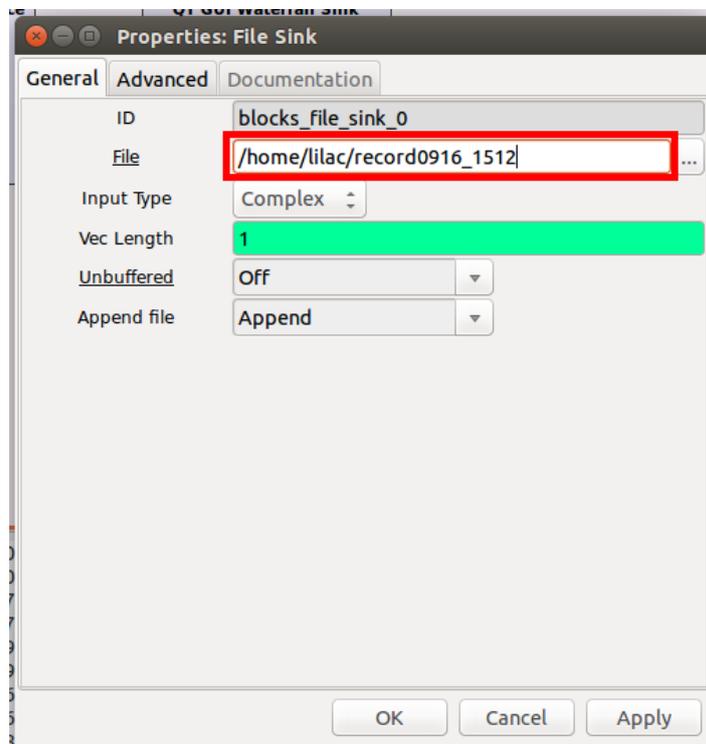It is recommended to use current time as the file name.

Figure 6



Figure 7

In the new window, the waterfall plot (1) is useful to see if some signals have been received. Adjust the gain settings (2) for optium SNR and no saturation. Spectrum plot and scope plot (3) may also be useful.
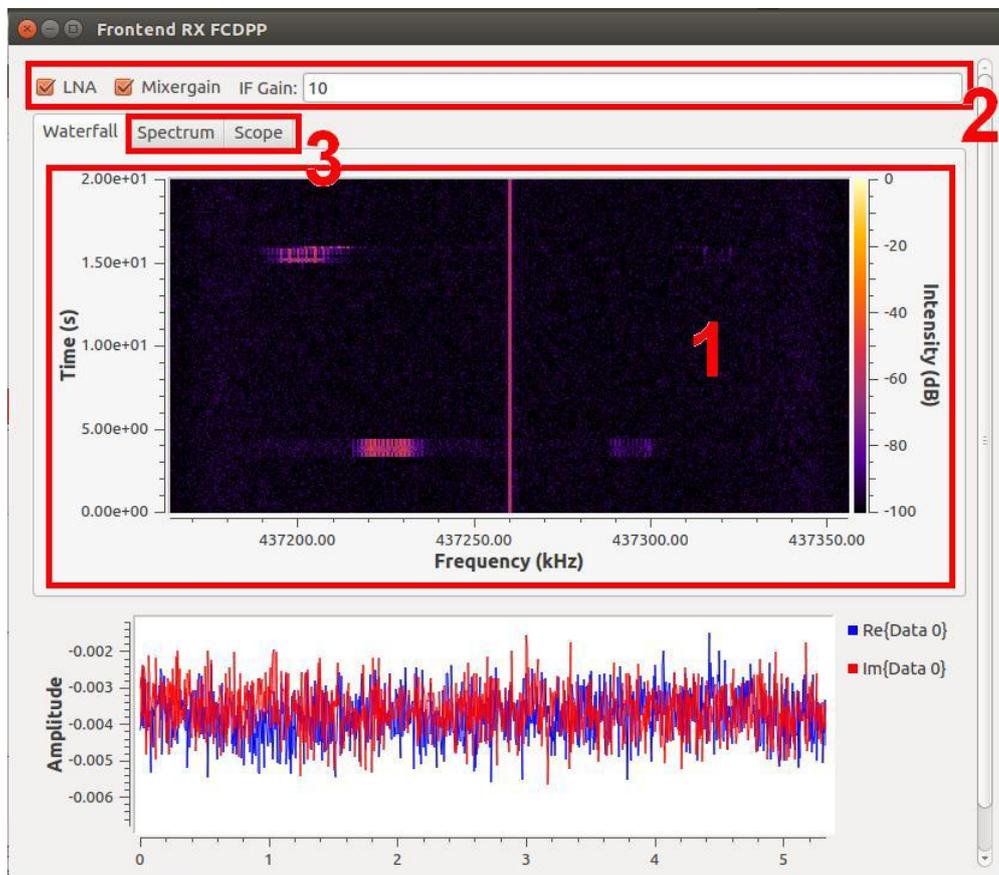


Figure 8

Select and run demod_node1_bpsk_9k6.grc and demod_node4_4k8.grc. In the proxy window, the status of receiver A and B should become "Connected" in green letters.
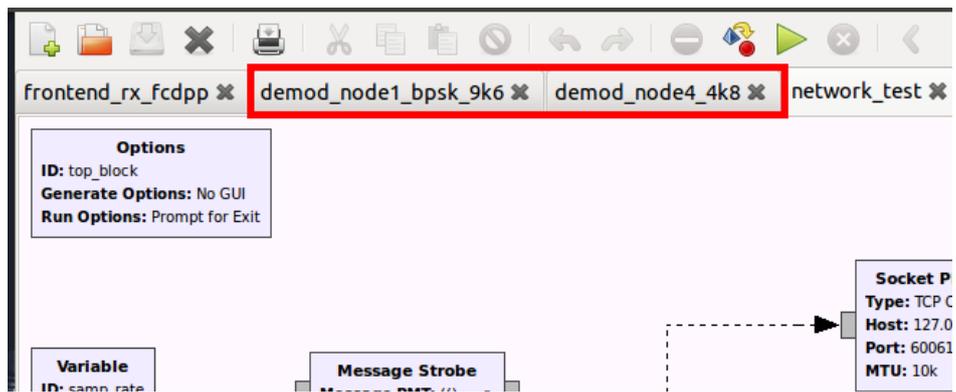
Figure 9

demod_node4_4k8.grc is the demodulator for the 4800 bps GFSK signal on
437.225 MHz. In the spectrum plot (1), the blue line is the input of the sketch,
and the red line is the output of doppler correction. The scope plot (2) shows
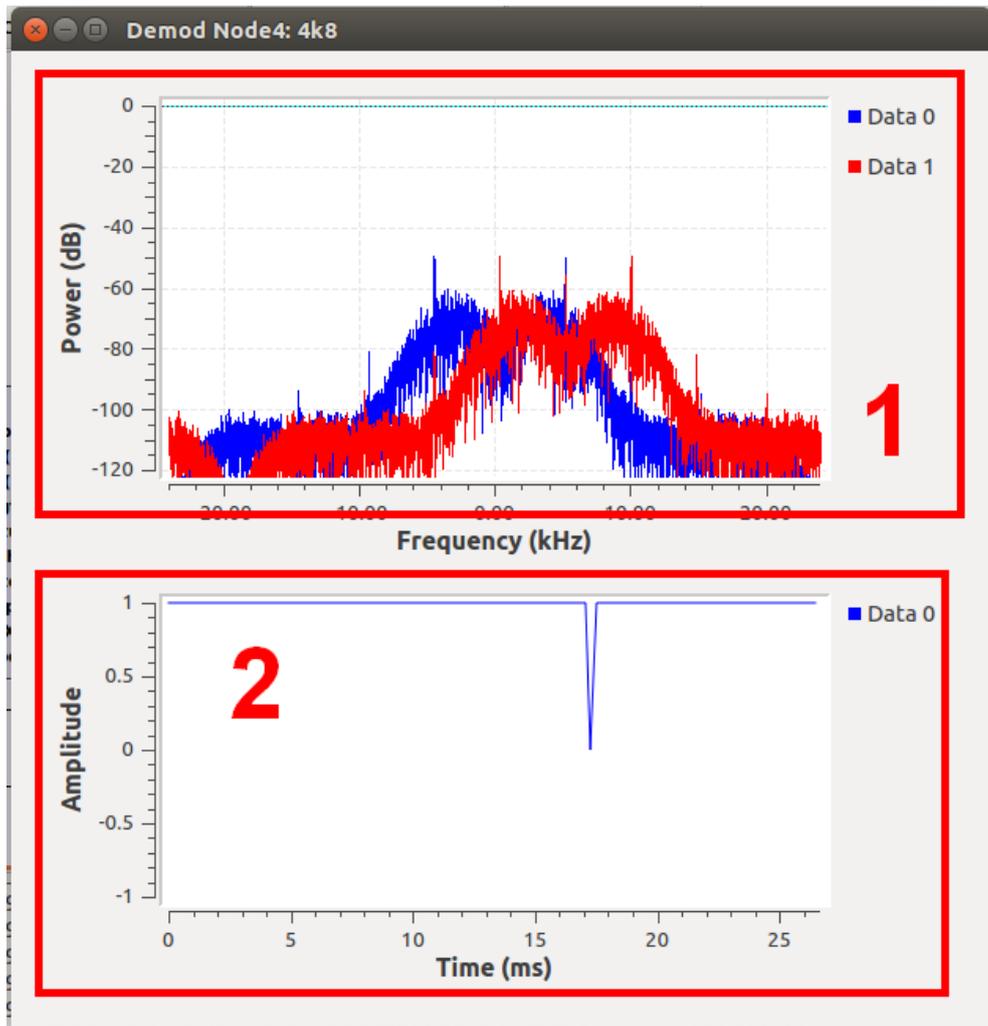the demodulated bits.

Figure 10

demod_node1_bpsk_9k6.grc is the demodulator for the 9600 bps RRC-BPSK signal on 437.200 MHz. The constellation plot is useful for monitoring the sync process. It shold be two points at (-1, 0) and (1, 0) while the signal is good. If it becomes a circle or more than 2 points, something may be wrong, for example an undesired signal appears.
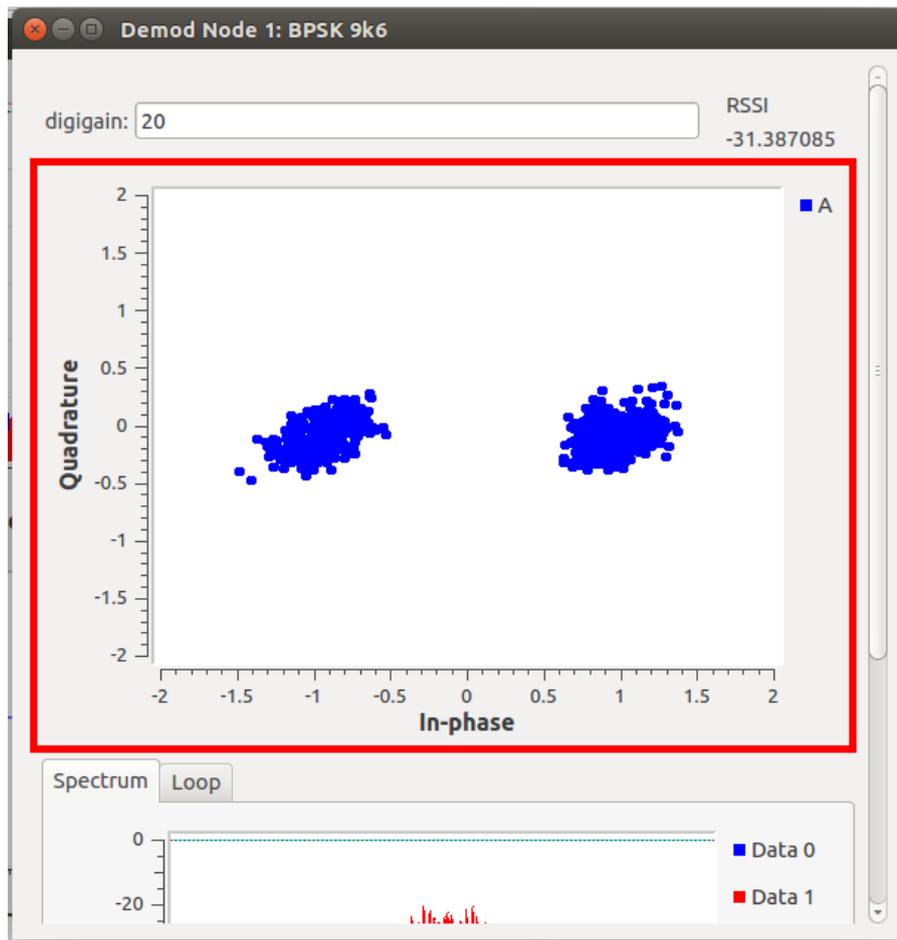
Figure 11

In the spectrum plot, the blue line is the input of the sketch, and the red line is the output of doppler correction , AGC and FLL.
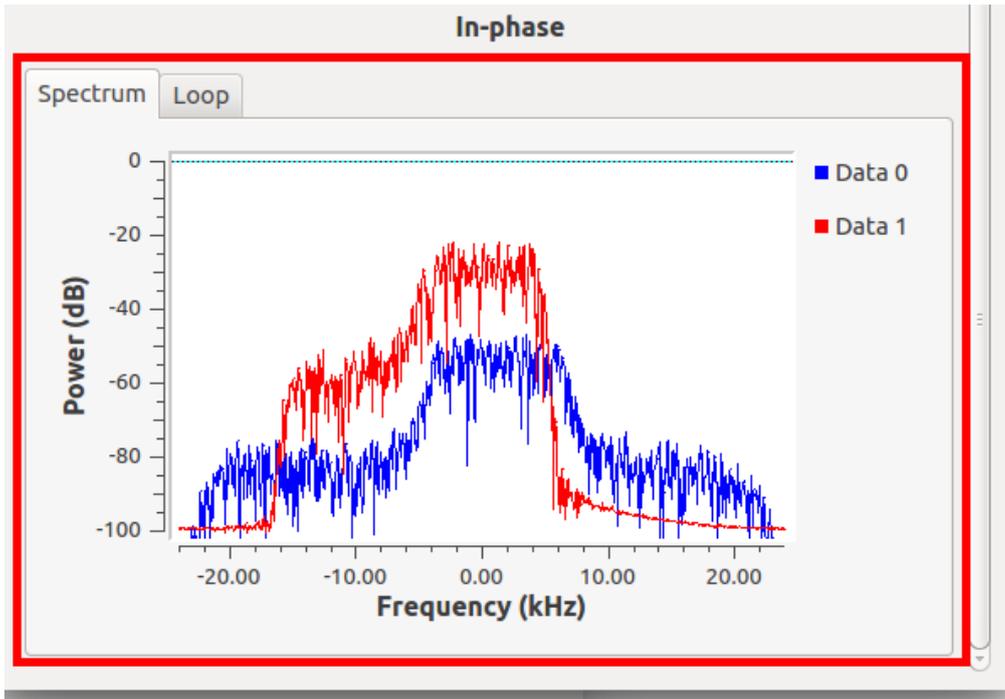
Figure 12

If a message is successfully decoded, it will be printed to the message window of GRC. If byte_corr = -1, it means the sync word has been detected but too many errors happened that the FEC can not handle.
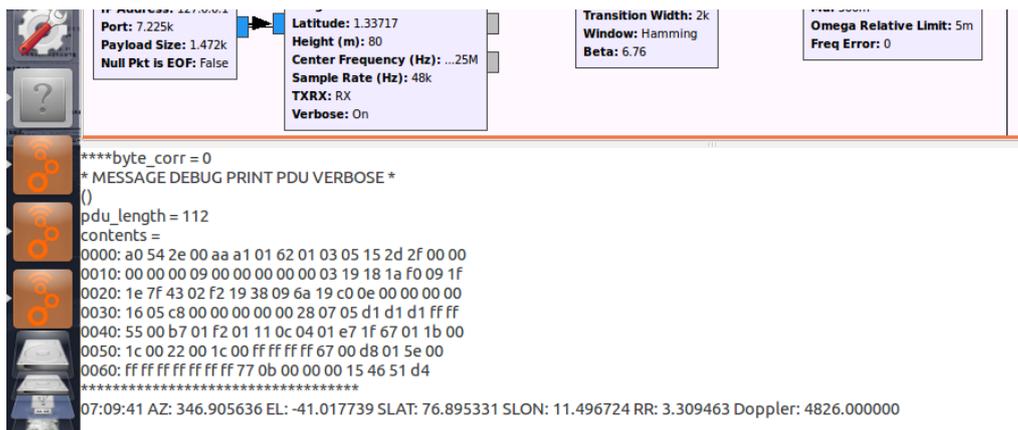


Figure 13

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## 2.5   View Internet and Local Logs

Visit    http://lilacsat.hit.edu.cn/lilac_back/Dashboard.html to see decoded telemetry.

Visit http://lilacsat.hit.edu.cn/lilac_back/pages/newCon.html for list of contributors.

Local log can be viewed under /home/lilac/gr-lilacsat/examples/proxy_publish folder.

ChannelADownlink.log is for 437.200 MHz, and

ChannelBDownlink.log is for 437.225 MHz.

# 3   Notes

## 3.1   User Name and Password

User Name: lilac Password: lilac

## 3.2   Use of RTL-SDR

After plug in RTL-SDR, type and run the following command in a terminal: $ sudo rmmod dvb_usb_rtl28xxu rtl2832

Double click RTL-SDR Source in frontend_tx_rtl.grc, type in Ch0: Freq.Corr. (ppm). If unknown, use gqrx and a local FM broadcast station to do a calibration.

## 3.3   File Sink Out of Memory

Sometimes File Sink in frontend_rx_*.grc may causes the memory to be out. Disable the File Sink by right click on it and press Disable bottom.

## 3.4   Install Locally

You may want to install the software locally for a better use. Follow the instructions below.

Install the Ubuntu operating system.

Install GNU Radio. It is recommended to use the build-gnuradio script.
$ wget http://www.sbrac.org/files/build-gnuradio && chmod a+x ./build-gnuradio && ./build-gnuradio

Install gr-lilacsat.
$ git clone https://github.com/bg2bhc/gr-lilacsat.git
$ cd gr-lilacsat
$ mkdir build
$ cd build
$ cmake ../
$ make
$ sudo make install
$ sudo ldconfig

Setup proxy.

Follow the instructions in gr-lilacsat/examples/proxy_publish/readme.md.

Other softwares may be required depending on your hardware.

## 3.5 Other Problems

If something else goes wrong, for example a network disconnection,
close everything and restart.