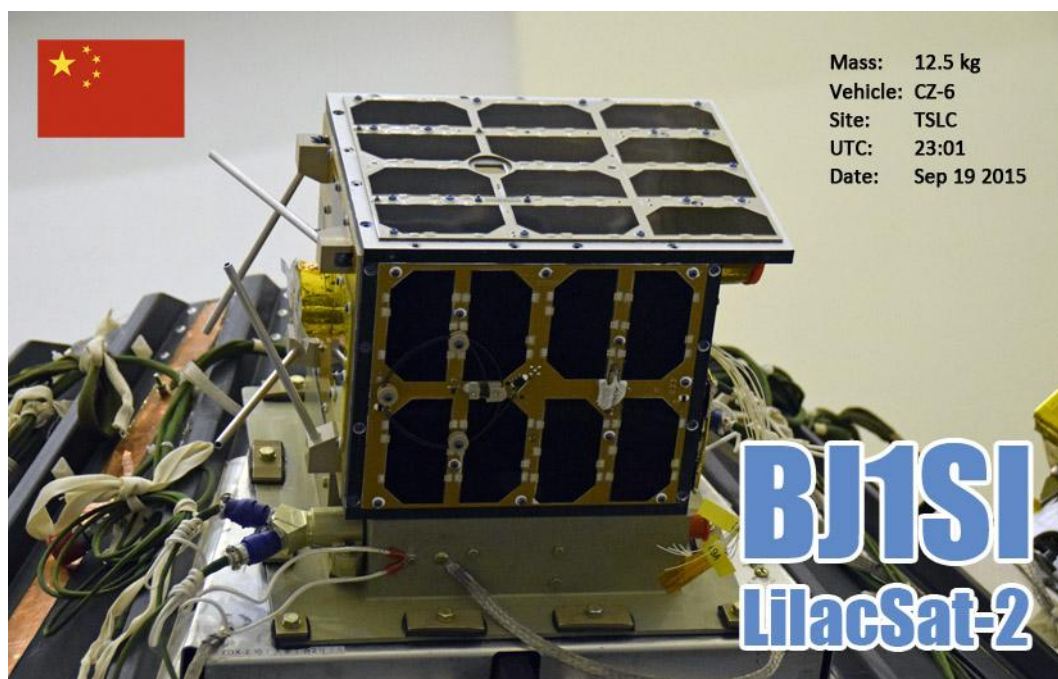


紫丁香 2 号 Live CD 用户指南

LilacSat-2 Live CD User Manual

Version 1.1



哈尔滨工业大学紫丁香 2 号团队

Harbin Institute of Technology LilacSat-2 Team

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1 概述 Overview

1.1 关于紫丁香 2 号 About LilacSat-2

紫丁香 2 号是一颗以学生培养、技术验证与业余无线电通信为主要任务的低成本微纳卫星，由哈尔滨工业大学一支 16 人的学生团队研制。卫星主体结构为立方体，外包络为 $23\text{ cm} \times 37\text{ cm} \times 20\text{ cm}$ ，质量 12.5 kg。

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 $23\text{ cm} \times 37\text{ cm} \times 20\text{ cm}$ satellite with a weight of 12.5 kg.

北京时间 2015 年 9 月 20 日 07:01，紫丁香 2 号随长征 6 号运载火箭由太原卫星发射中心一箭 20 星发射，进入 $520\text{ km} \times 520\text{ km}$ 、倾角 97 度的太阳同步轨道。

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 $520\text{ km} \times 520\text{ km}$ SSO orbit with an inclination of 97.

无线电信息与软件下载，请访问 http://lilacsat.hit.edu.cn/?page_id=257。

Visit http://lilacsat.hit.edu.cn/?page_id=257 for radio information and software download.

项目网站: <http://lilacsat.hit.edu.cn/>

Website: <http://lilacsat.hit.edu.cn/>

联系邮箱: lilacsat@163.com

E-mail: lilacsat@163.com

1.2 关于此 Live CD About This Live CD

本 Live CD 是一个可启动的 Ubuntu 软件无线电环境，使用 respin-gtk 制作，用于紫丁香 2 号卫星遥测的简易接收与 SDR 实验，且不必对计算机进行永久性更改。本 Live CD 不适用于安装。

This Live CD is a bootable Ubuntu SDR environment created with respin-gtk for quick and easy reception 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.

本 Live CD 以 ISO 镜像的形式发布，可烧录在 DVD 光盘或 U 盘中启动电脑，也可在虚拟机中运行。

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.

此 Live CD 基于如下软件制作：

- Ubuntu Linux 14.04.2 LTS;
- GNU Radio and GRC 3.7.8;
- gpredict （卫星跟踪）;
- gqrx （通用 SDR 接收机软件）;
- gr-fcdproplus;
- hamlib;
- gr-lilacsat 等。

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 关于 gr-lilacsat About gr-lilacsat

gr-lilacsat 是紫丁香 2 号卫星遥测接收使用的 GNU Radio 扩展模块。

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

examples 文件夹中的 frontend_rx_*.grc 流程图可配合不同的 SDR 硬件使用：

- frontend_rx_fcdpp.grc 适用于 Funcube Dongle Pro Plus;
- frontend_rx_uhd.grc 适用于 USRP;
- frontend_rx_rtl.grc 适用于 RTL-SDR。

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.

frontend_rx_*.grc 也可经简单修改以适用于其它硬件。

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

examples 文件夹中的 demod_node*_*.grc 流程图可用于不同调制方式与速率遥测的解调：

- demod_node1_bpsk_9k6.grc 适用于 437.200 MHz 9600 bps RRC-BPSK 遥测；
- demod_node1_afsk.grc 适用于 437.200 MHz 1200 bps AFSK-FM 遥测；
- demod_node1_ccsds_fm.grc 适用于 437.200 MHz 300 bps FM 亚音频遥测；
- demod_node4_4k8.grc 适用于 437.225 MHz 4800 bps GFSK 遥测。

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.

卫星的默认复位状态为 437.200 MHz 9600 bps RRC-BPSK 遥测与 437.225 MHz 4800 bps GFSK 遥测。

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

下行代理服务器（proxy_publish）也包含在 examples 文件夹中，用于向服务器上传数据并做实时显示。

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

2 使用示例 Guided Tutorial

在本章中，我们将以使用 Funcube Dongle Pro Plus 接收机和卫星的默认遥测模式为例，介绍 Live CD 的使用。您可根据实际的硬件情况与卫星的工作模式选择合适的 GRC 流程图。

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 准备 Preparation

使用 Live CD ISO 文件制作 USB 启动盘，并启动电脑。

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

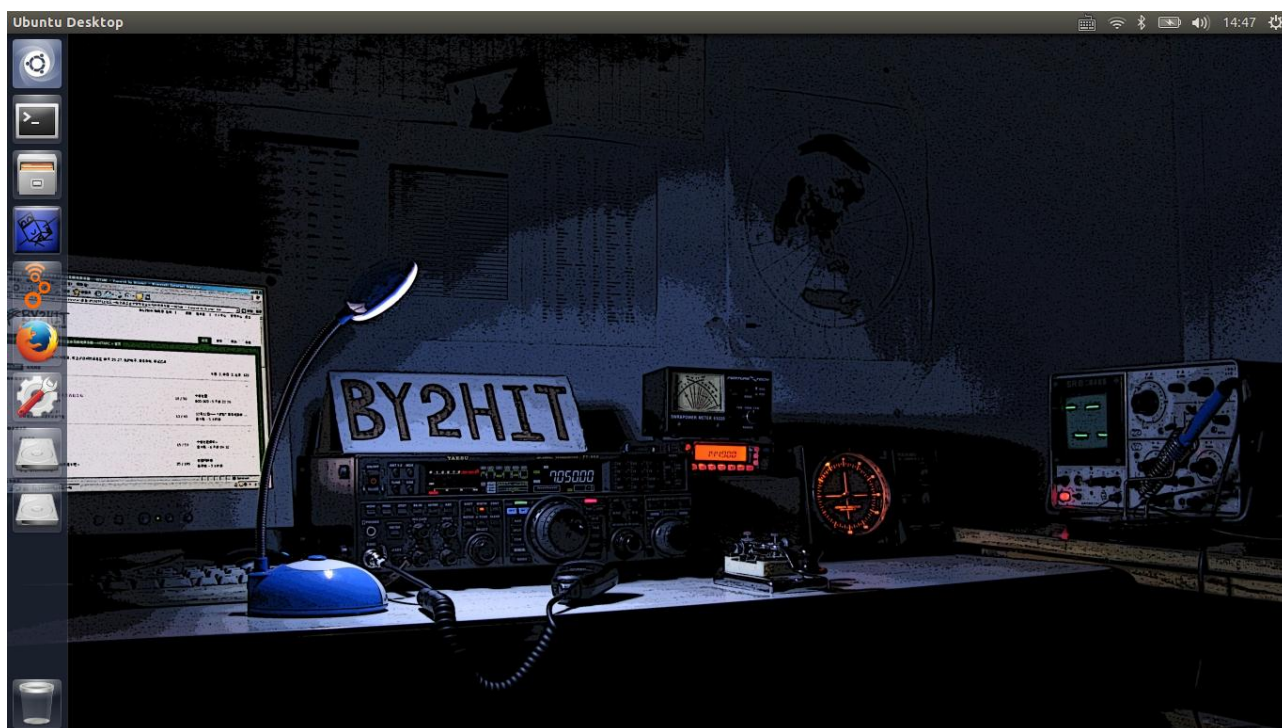


Figure 1

2.2 连接至 Internet Connect to the Internet

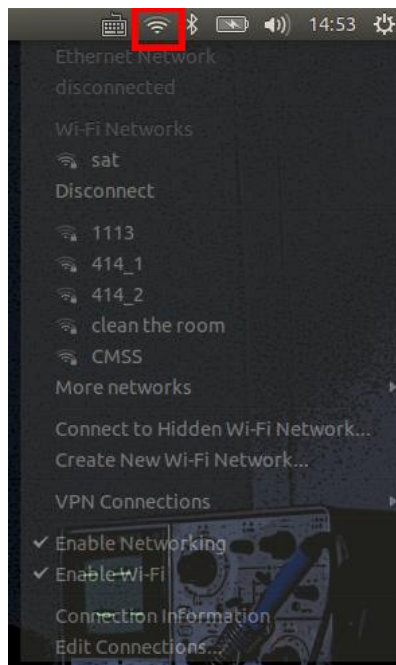


Figure 2

2.3 启动下行代理服务器 Start the Downlink Proxy

单击左边栏图标。

Single click the proxy icon.



Figure 3

在代理窗口中：编辑个人信息(1)；禁用备用服务器(2)；保存设置；(3)更新轨道信息(4)，在消息窗口(5)中可见成功信息；启动代理服务器(4)。

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

LilacSat2 Downlink Proxy

User Information




Nick Name: 9V1SV Position: 103.6953702
Lon: 1.337174
Lat: 80
Alt:

Server Information

Server URL: lilacsat.hit.edu.cn Server Port: 61161
BackUp Server URL: localhost ☐ Enable
TLE URL: http://lilacsat.hit.edu.cn/tle/lilacsat.txt

Status

Server: Not Connected
BackUp Server: Not Connected
Receiver A: Not Connected
Receiver B: Not Connected

Orbit Data Successfully Updated!

Figure 4

2.4 启动接收框图 Start the Receiver Sketches

单击图标启动 GRC。

Single click the GRC icon to start it.



Figure 5

选择 frontend_rx_fcdpp.grc (1), 编辑录音路径、文件名(2)并运行(3), 或将其禁用。推荐使用当前时间作为文件名。

Select frontend_rx_fcdpp.grc (1), edit record file name (2) and run (3), or disable it. It is recommended to use current time as the file name.

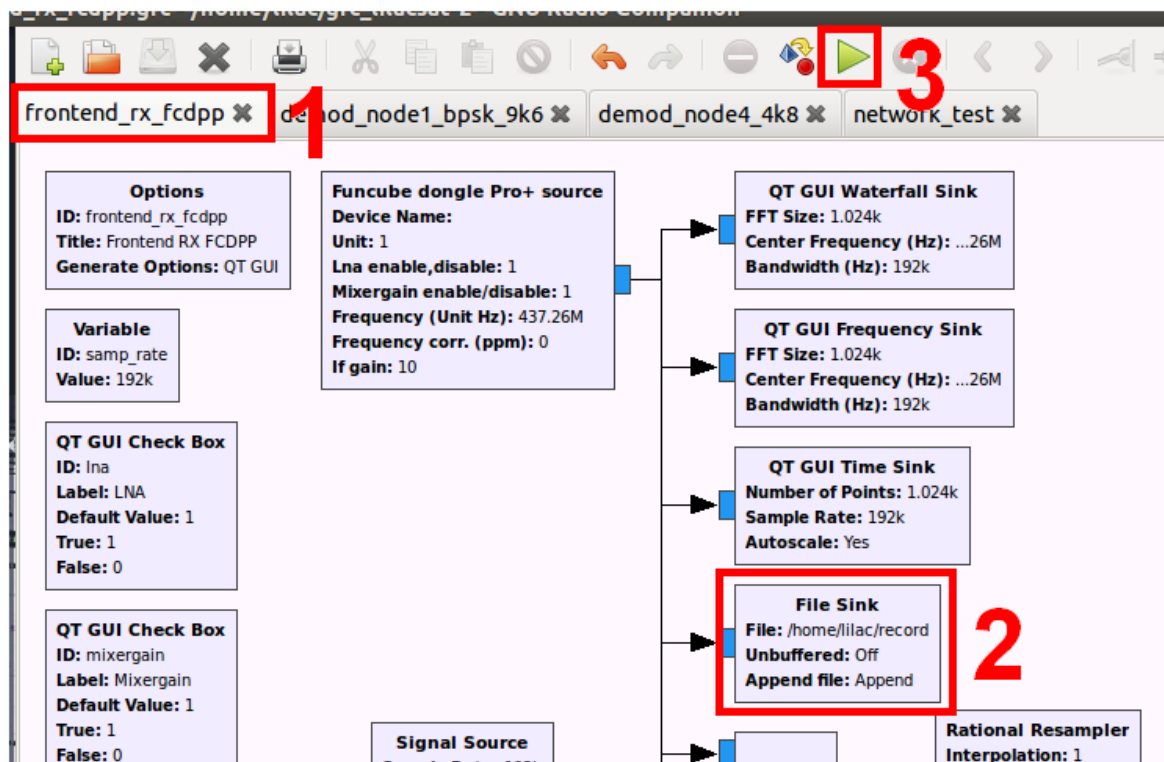


Figure 6

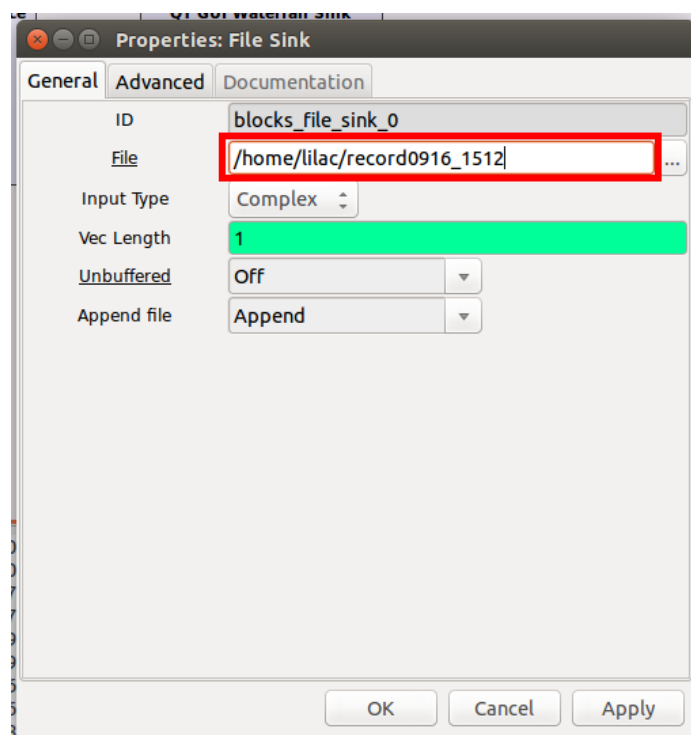


Figure 7

在新打开的窗口中，瀑布图(1)可用于监测是否曾收到信号。调整增益设置(2)以优化信噪比并保证不发生饱和。频谱图和波形图(3)也很有用。

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

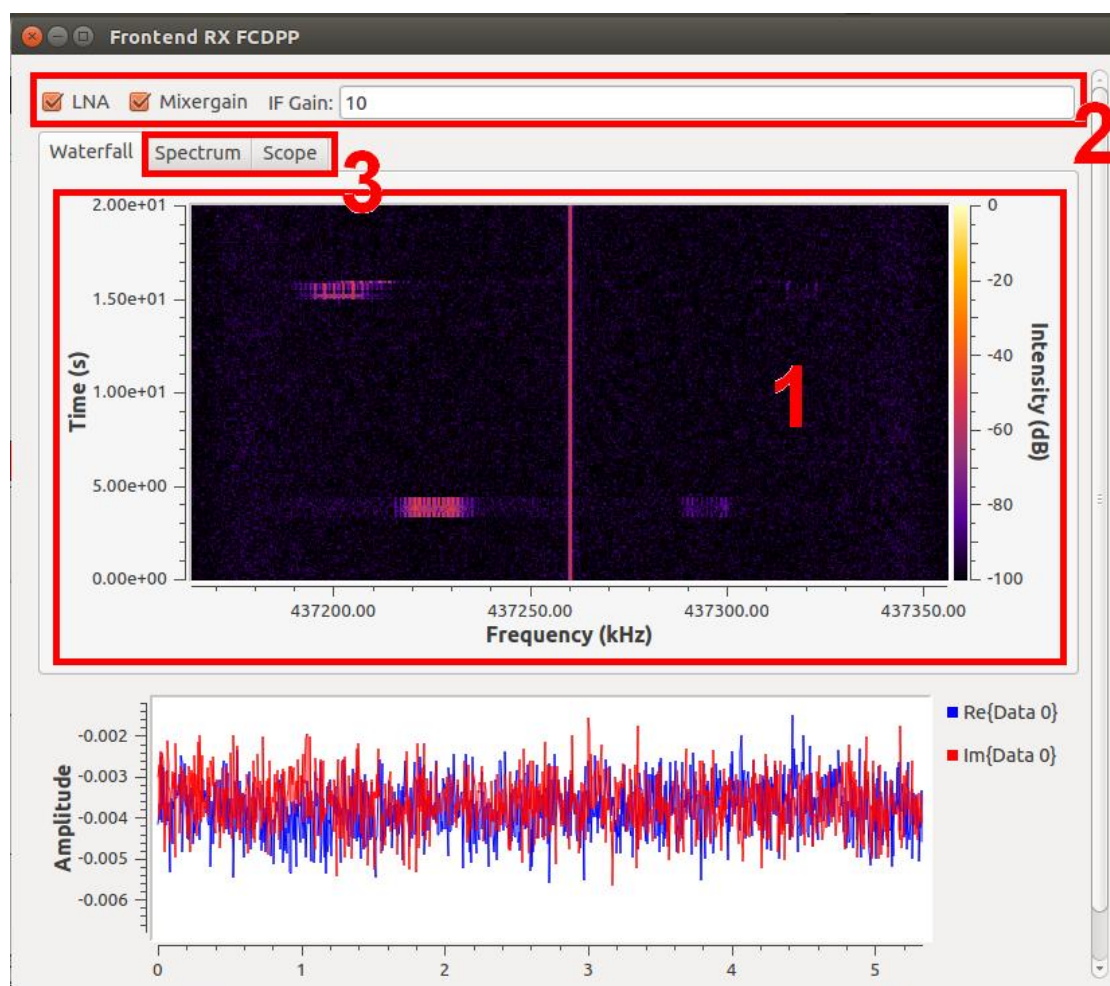


Figure 8

选择并运行 `demod_node1_bpsk_9k6.grc` 和 `demod_node4_4k8.grc`。在代理窗口中，接收机 A 和 B 的状态以绿色字体显示为“已连接”。

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.

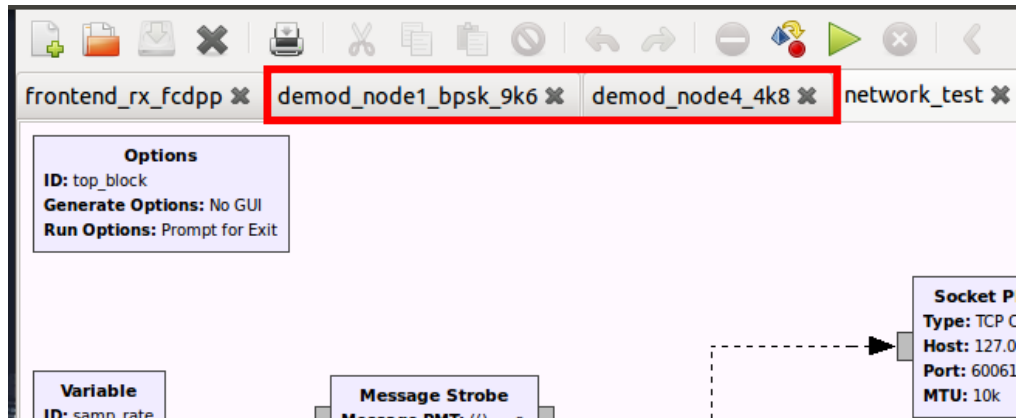


Figure 9

demod_node4_4k8.grc 是 437.200 MHz 上 4800 bps GFSK 信号的解调模块。在频谱图(1)中，蓝线为流程图的输入信号，红线为经多普勒修正后的信号。波形图(2)中显示解调输出的数据位。

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.

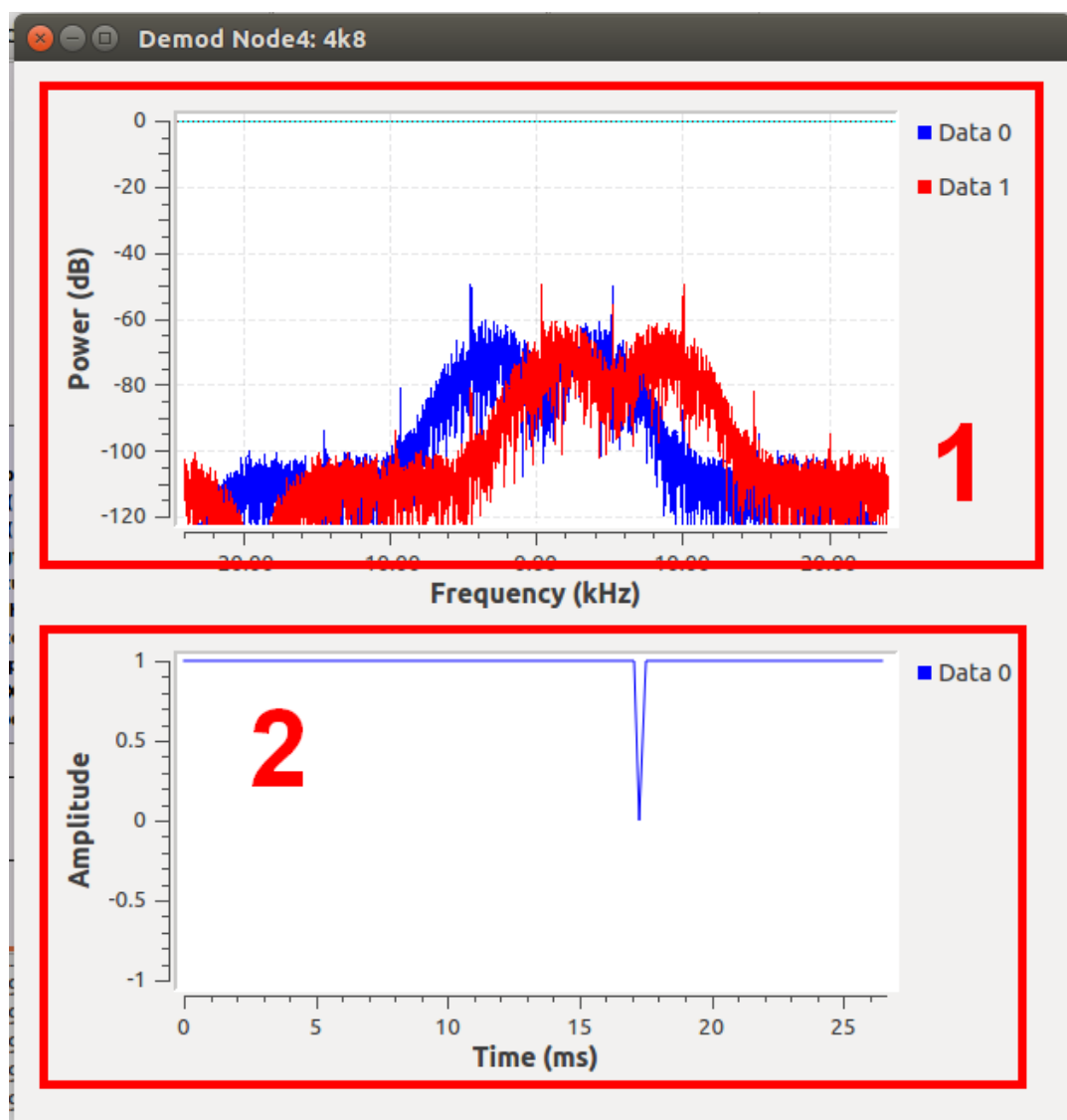


Figure 10

demod_node1_bpsk_9k6.grc 是 437.200 MHz 上 9600 bps RRC-BPSK 信号的解调模块。星座图可用于监测同步过程。在信号质量较好时，星座图应在(-1, 0)和(1, 0)位置出现两个点。如果星座图变为圆形，或出现了多个点，可能出现了问题，如接收到了干扰信号。

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 should 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.

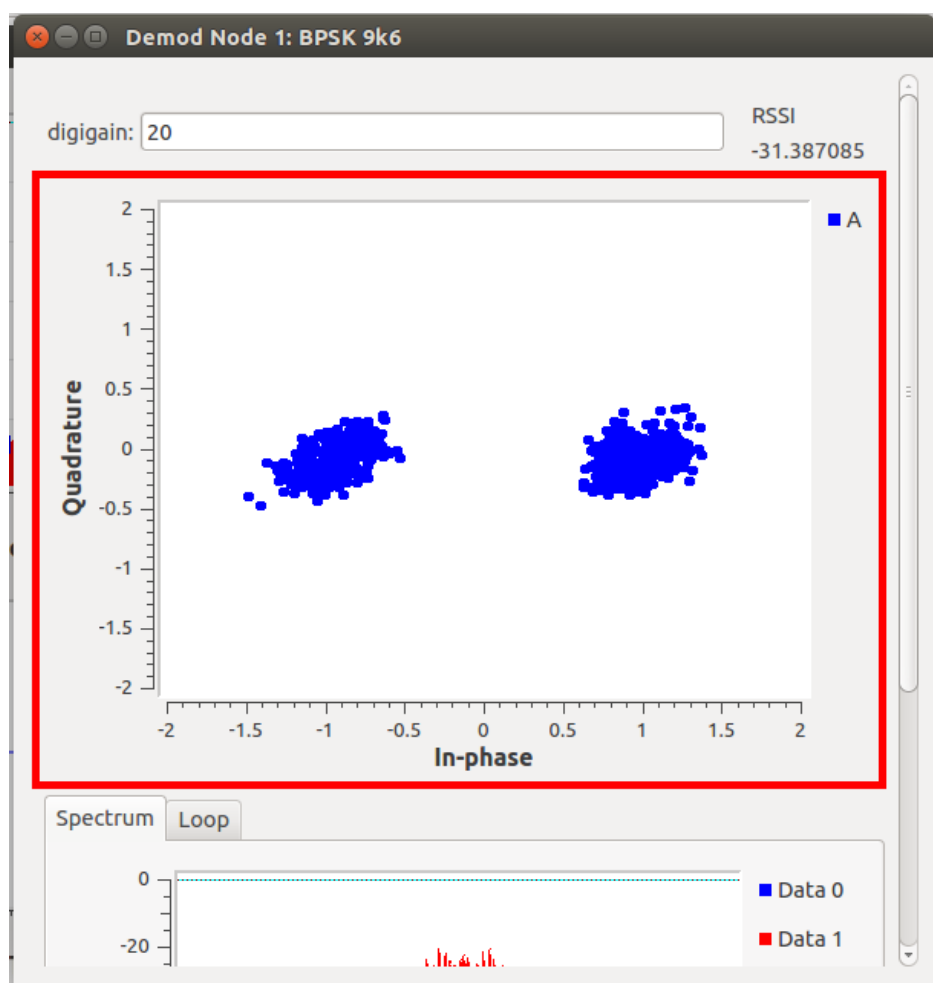


Figure 11

在频谱图中，蓝线为流程图的输入信号，红线为经多普勒修正、自动增益控制和锁频环后的信号。

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.

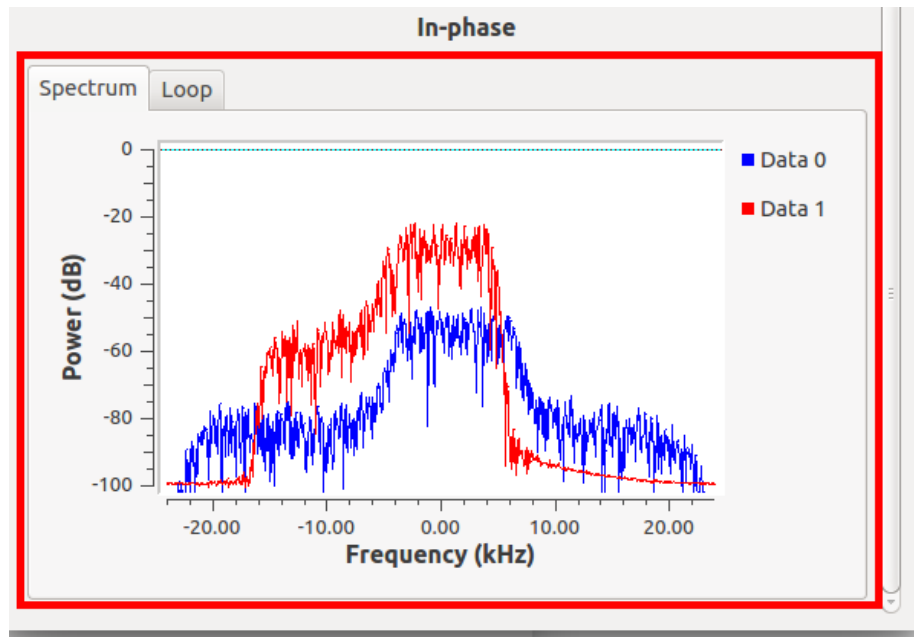


Figure 12

成功解码的信息将被打印在 GRC 的消息窗口中。byte_corr = -1 说明同步字被检测出但误码过多，纠错编码无法纠正，数据包无效。

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.

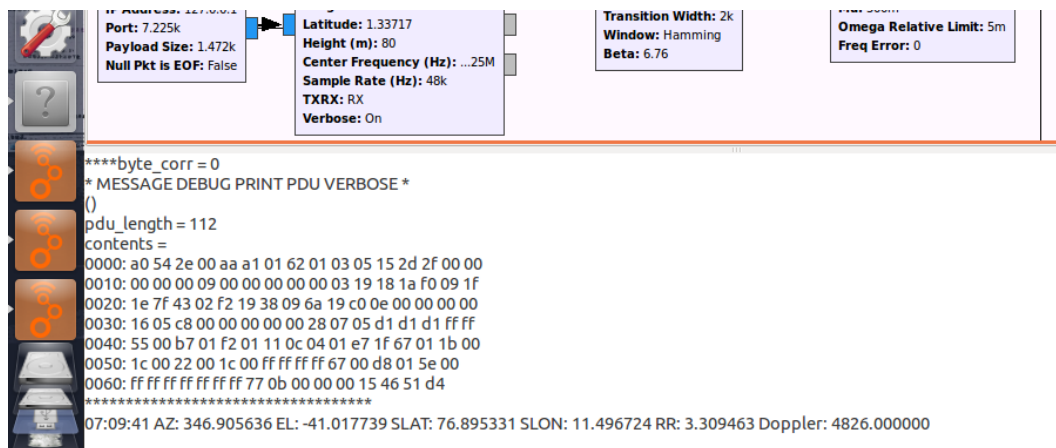


Figure 13

2.5 查看网络与本地日志 View Internet and Local Logs

遥测数据解析可前往 http://lilacsat.hit.edu.cn/lilac_back/Dashboard.html 查看。

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

贡献者列表可前往 http://lilacsat.hit.edu.cn/lilac_back/pages/newCon.html 查看。

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

可在 /home/lilac/gr-lilacsat/examples/proxy_publish 文件夹下查看本地日志文件，其中 ChannelADownlink.log 对应 437.200 MHz，ChannelBDownlink.log 对应 437.225 MHz。

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 注意事项 Notes

3.1 用户名与密码 User Name and Password

User Name: lilac

Password: lilac

3.2 RTL-SDR 电视棒的使用 Use of RTL-SDR

接入电视棒后，在终端中运行如下命令：

```
$ sudo rmmod dvb_usb_rtl28xxu rtl2832
```

After plug in RTL-SDR, type and run the following command in a terminal:

```
$ sudo rmmod dvb_usb_rtl28xxu rtl2832
```

双击 frontend_tx_rtl.grc 中的 RTL-SDR Source，在 Ch0: Freq.Corr. (ppm)中填入频率校准值。若数值未知，使用 gqrx 与频率已知的本地 FM 广播电台进行校准。

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 存储空间耗尽问题 File Sink Out of Memory

frontend_rx_*.grc 中的 File Sink 可能造成存储空间耗尽，可在 File Sink 上右键单击并选择 Disable 禁用。

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 本地安装 Install Locally

为方便使用，您可能希望将解调软件安装在本地。可按照如下步骤进行。

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

安装 Ubuntu 系统。

Install the Ubuntu operating system.

安装 GNU Radio，推荐使用脚本安装。

```
$ wget http://www.sbrac.org/files/build-gnuradio && chmod a+x ./build-gnuradio && ./build-gnuradio
```

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
```

安装 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
```

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
```

安装代理服务器。根据 gr-lilacsat/examples/proxy_publish/readme.md 中的步骤进行。

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

根据硬件情况，可能需要安装其它软件。

Other softwares may be required depending on your hardware.

3.5 其他问题 Other Problems

若出现其他异常，如网络中断，关闭所有程序，按步骤重新启动。

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