Down converter with Adalm-Pluto

Overview

For satellite reception with normal amateur radio equipment, you often need a mixer to shift the transmission frequency of a satellite into an amateur radio band. Instead of a hardware mixer, this software allows the use of an Adalm Pluto for frequency conversion.

This configuration can be described as a "Simplex Crossband Repeater". The spectrum received at the RX connection is sent out again without any change at the TX output. The choice of RX and TX frequency is arbitrary.

System Requirements

- any Linux computer. E.g. a Raspberry or a PC with any Debian (Ubuntu) based Linux distribution. The computer has to be fast enough to achieve the sample rate, which will usually work with a Raspberry PI 4.
- an Adalm Pluto. Can be connected to the computer via USB or Ethernet adapter.
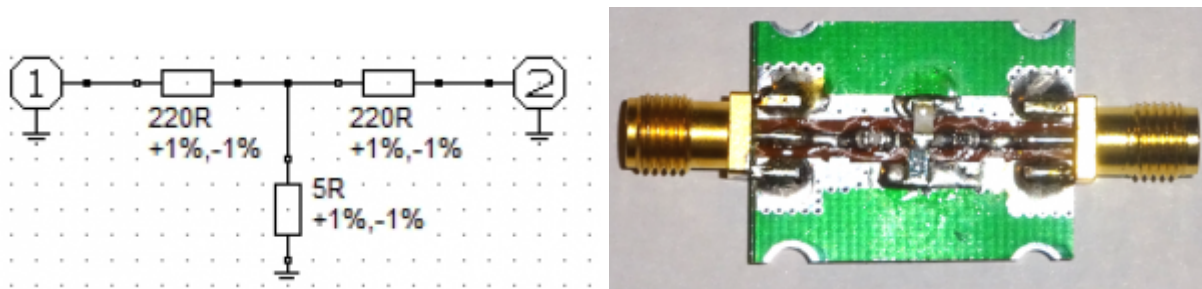
Connection

the RX input of the Pluto is connected to the signal source to be received.

the TX output of the Pluto is connected to the amateur radio via a 40dB attenuator.

the attenuator has two jobs. Firstly, it reduces the Pluto's output signal so that the radio receiver is not overdriven. On the other hand, it prevents damage to the Pluto if you mistakenly "send into" Pluto

Such an attenuator can easily be built from three SMD resistors. Alternatively, the connection cable can be separated and the inner conductors left at a distance of 1 cm from each other. The exact value of the damping is irrelevant.

Example:

this attenuator has just under 40dB and deliberately no match to 50 ohms, because the focus here is on safety in case of accidental transmission, which would not be guaranteed with a 50-ohm

attenuator.

Installation

On the Linux computer, open a terminal and enter the following:

```
git clone https://github.com/dj0abr/Pluto
cd Pluto
./prepare_ubuntu_pluto
make
```

The program is now complete, we only have to configure it to our requirements.

Configuration

in the same directory (Pluto) you will find the file pluto_config.txt, all settings are made here and the various parameters are described in it.

Here is an example how to set the configuration for receiving QO100:

UDP_IPADDRESS

this setting is meaningless as it is not used in Crossband Repeater mode.

PLUTO_ID

this ID is used to identify Pluto. There are three possible settings for this:

- a single Pluto is connected via USB. This specification is meaningless here, since a single Pluto is automatically found on USB. Example:

```
PLUTO_ID 12345
```

- multiple Plutos are connected to USB. In this case, the Pluto's ID number must be specified. This can be printed out with the command: iio_info -s and then entered here. Example:

```
PLUTO_ID 1044730a199700191f001800f3647c5341
```

- Pluto is connected via Ethernet adapter and has a fixed IP address. Sample (using Pluto's actual IP address, of course):

```
PLUTO_ID ip:192.168.1.2
```

TX_FREQ

This is Pluto's transmission frequency, here the NB transponder of QO100 should be output in the 70cm band (any other frequency in Pluto's working range is possible)

```
TX_FREQ 435.450
```

RX_FREQ

this is the receiving frequency of Pluto, the NB transponder is downconverted to 739 MHz by an LNB if the LNB has the usual reference frequency of 25 MHz.

```
RX_FREQ 739.450
```

TX_GAIN

the output power of the Pluto, adjustable from -40 to 0 dBm. If you have installed a PTT switch via GPO0 and GPO1, this value must be between -25 and 0 dBm, otherwise the PTT will not be switched.

```
TX_GAIN 0
```

SAMPLERATE

this is the RX and TX sample rate. This must be slightly larger than twice the desired reception area. The NB transponder is 0.5MHz wide, so we choose 2 * 0.5 + 0.2 (reserve) = 1.2MHz for QO100.

```
SAMPLE RATE 1.2
```

TX_BANDWIDTH and RX_BANDWIDTH

the bandwidth is relatively uncritical, of course it has to be large enough to let the entire range through, we choose 1 MHz here

```
TX_BANDWIDTH 1
RX_BANDWIDTH 1
```

CROSSBAND REPEATER

this setting must always be set to 1.

```
CROSSBAND REPEATER 1
```

Summary:

The file pluto_config.txt has the following (example) content for QO100:

```
UDP_IPADDRESS 127.0.0.1
PLUTO_ID 12345
TX_FREQ 435.450
RX_FREQ 739.450
TX_GAIN 0
SAMPLE RATE 1.2
TX_BANDWIDTH 1
RX_BANDWIDTH 1
CROSSBAND REPEATER 1
```

Normally only the settings TX_FREQ and possibly RX_FREQ and possibly PLUTO_ID are to be changed, the rest is already optimal for QO-100.

RX and TX frequency:

the lower beacon appears at the LNB output on the frequency 739,500 MHz. However, we set the receiving frequency of Pluto 50kHz lower (739.450) for the following reason: The Pluto has a whistle (residual carrier) on the set frequency. We lower this by 50 kHz, which means that the whistle is outside the reception range and is no longer annoying.

Program start

to start the program, type (still in the "Pluto" directory):

```
./pluto
```

The configuration data displayed on the screen should be verified. If there is no error message, the Pluto downconverter is active and you should have reception.

The first QSO with a Pluto downconverter and an IC9700 took place on April 3, 2022 between PA0EKE and DJ0ABR.

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