Modulation and Coding – labolatory

Digital Modulation

Phase Shift Keying (PSK)

The aim of the exercise is to develop algorithms for modulation and decoding for *Phase Shift keying* (PSK). The first part of the exercise will be to build a modulator and decoder PSK modulation.

Do you have a headphones? Use it for this exercise! (if not, then you can use a speakers from labolatory room).

1. PSK - Phase Shift Keying modulation

In the case of modulation method PSK (Phase Shift Keying) is changed the phase of the signal. Information is thus encoded in the phase of the signal changes. There are two basic methods of encoding digital information:

- By encoding the data directly **using the phase.** The demodulator **must have access** to a reference signal, to know the position of the symbol in time (Also it's can be use a *clock recovery* techniques).
- By encdoing the data **using a change of pshase.** The demodulator **not need access** to a refenrence signal.

In the case of PSK modulation is used a finite number of changes of signals phases. Each change of phase of signal is assigned for a unique arrangement of bits. Each phase decodes the same number of bits. Each sequence of bits represented by a symbol formed a single phase. Figure 1 shows the principle of modulation using phase shift keying.

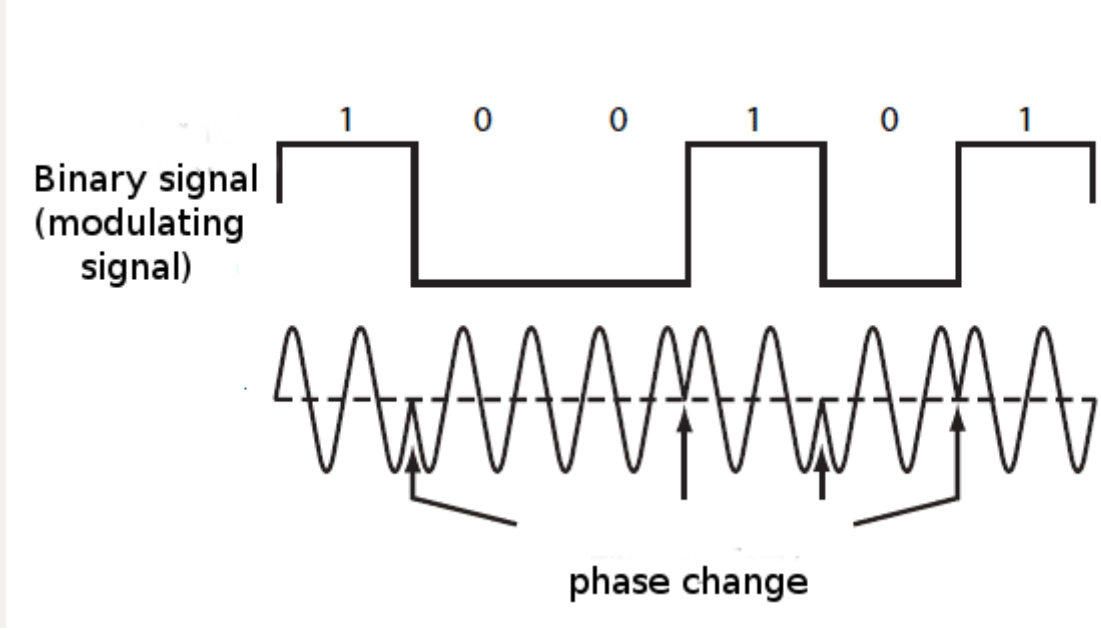

Fig. 1. Example of PSK (phase shift keying)

2.1 Prepare audio signal using a audio codec (for signal audio compressig).

- Prepare audio file. Read audio file by "*Wave file source*" component.
- Set “sampl_rate” variable to sample rate of audio source file.
- Prepare audio file. Read the audio file to "Wave file source". Generate a digital signal (via the codec G.723.1 - speech codec used in VoIP bandwith 5-6 kbit / s), build the diagram as shown below:

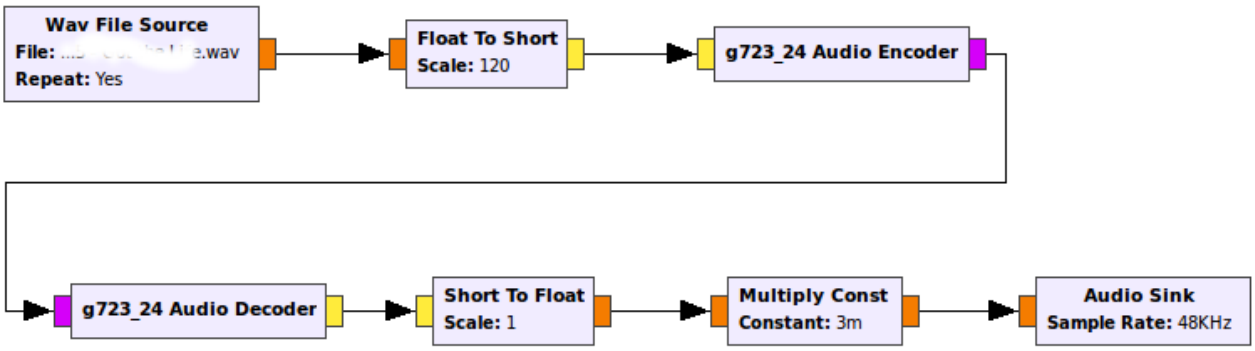

Fig. 6: Audio signal compresing and decompresing by G.723.1 codek.

- Run script. You should be able to hear a sound.

The advantage of this solution is relatively low *BitRate*, making it much easier to implement and test digital modulation in the environment GnuRadio Camponion. Obviously this is not the only audio compressor available in this environment.

2.2 Data transmitting using PSK modulation

Make the signal modulation through PSK modulator and decoding. Build a transmission system according to the following diagram (Figure 2):

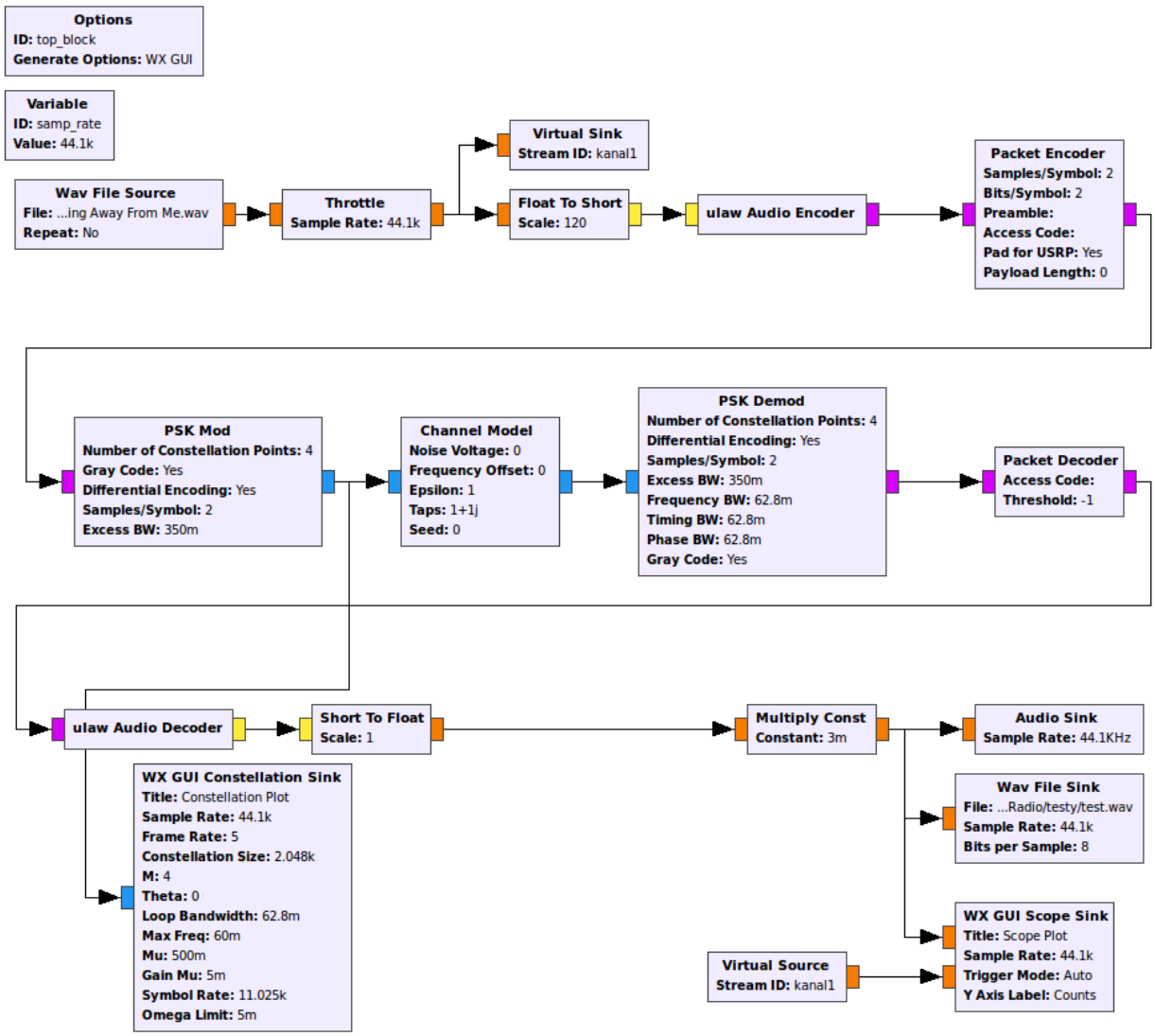

Fig .2: Flow diagram of system of data transmitted using a PSK modulation.

- Virtual Source "and" Virtual Sink "is used to build a *virtual channel*, but can also be used to create connections between the different components. It's very useful when making a large project with a lot of number of components. It could be use a many *virtual channels* on one GnuRadio project. Each channel consists of an input ("Virtual Sink") and output ("Virtual Source"). Each channel has its own ID. So, the pair of components: "Virtual Sink" and "Virtual Source which have the same ID we called a virtual channel (see example in Fig. 3):

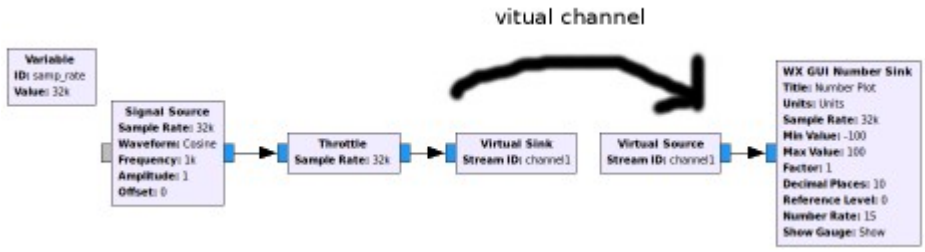

Fig. 3: Example of virtual Channel.

In our project virtual channel is used for connecting input signal with WX component (at the bottom of the diagram).

- sample rate must be equal sample rate of audio input file.
- sample rate in „A*udio sink*" and „*Wav file Sink*" must be equal sample rate of audio input file.
- Component "*Encoder Packet*" is used for forming a signal in the form of a byte. Decoding is done using the "*Packet Decoder*". Set the "*Samples / symbol*" 2 and "*bit / symbol*" to 2.
- Set parameter „*Number of connstelation points*" to *4* (*PSK Mod* and *PSK Demod* component).
- Run script. You should be able to hear a sound.
- The sound generated by the component "*Audio Sink*" will not always be correct, because all signal processing operation (audio compression, modulating, demodulating, audio decompression) are doing in real time. If your sound isn't clear, try to listen a sound file (generated by „W*av File Sink"* component).
- Look at constellation diagram. What do you see?

- Add „*WX Scope Sink*" between modulator and demodulator. Look at chart. What do you see?

You should see the signal characteristic of the PSK modulation. Should be similar to signal presented in fig. 4:

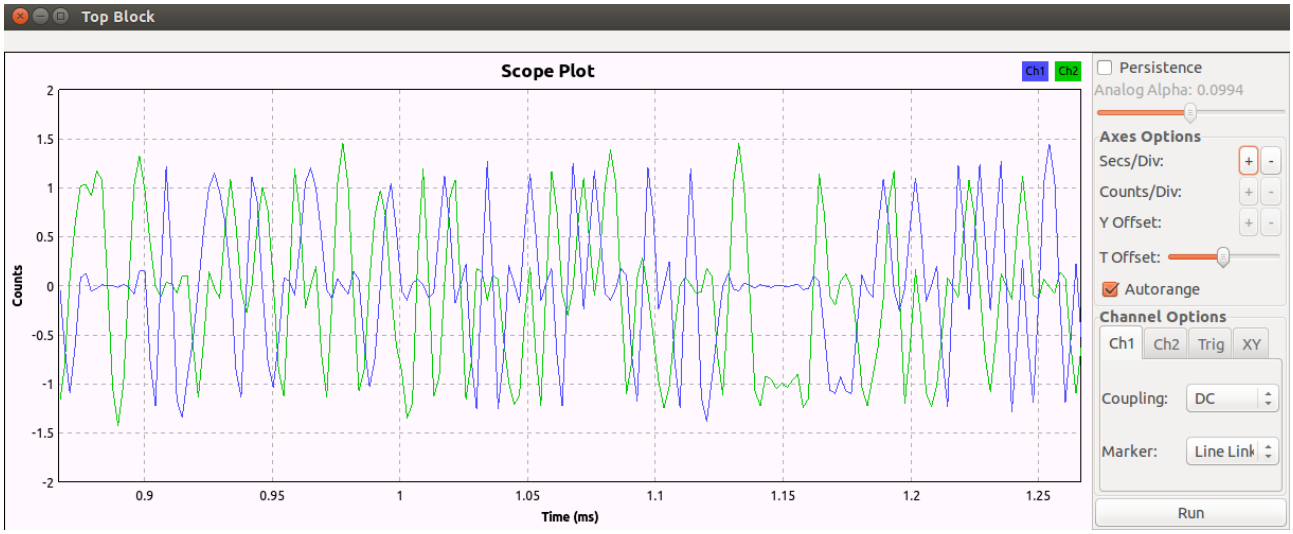

Fig. 4: The signal modulated by PSK (complex variable, ch1 – real part of signal, ch2 – imaginary part of signal).

2.3 PSK Digital transmission using SDR devices (not obligatory exercise part):

- Use the SDR device (transmitter and receiver) for digital signal transmission. A carrier frequency can be adjusted over a wide range (100MHz ... 5GHz). Use a ISM frequency (e.x. 433 or 868 MHz)
- Modulated signal can be directly sent to SDR device (*OsmoSink* Component).
- Signal received from the SDR may be directly decoded or after filtration of the signal with low pass filter.
- Try to use "*PolyPhase clock Synch*" and "*CMA Equaizer*" to sinchronize your tramsmission.
- The "*Freq. Corr*." (*OsmoSource* component) is used to correct the frequency of the internal hardware clock of SDR device.