Real-time packet reception with software defined radio

Maria Raftopoulou 4620100 M.Raftopoulou@student.tudelft.nl

Salman 4593413 salman@student.tudelft.nl

Omer Zareen 4625919 M.O.Zareen@student.tudelft.nl

Wireless Networking, Quarter 3, 2017

1 Steps

The first step that we had to do, was to become sure that the SDR was connected and configured properly. To do that, we installed the software SDRSharp and tried to capture FM signals as it shows in figure 1.

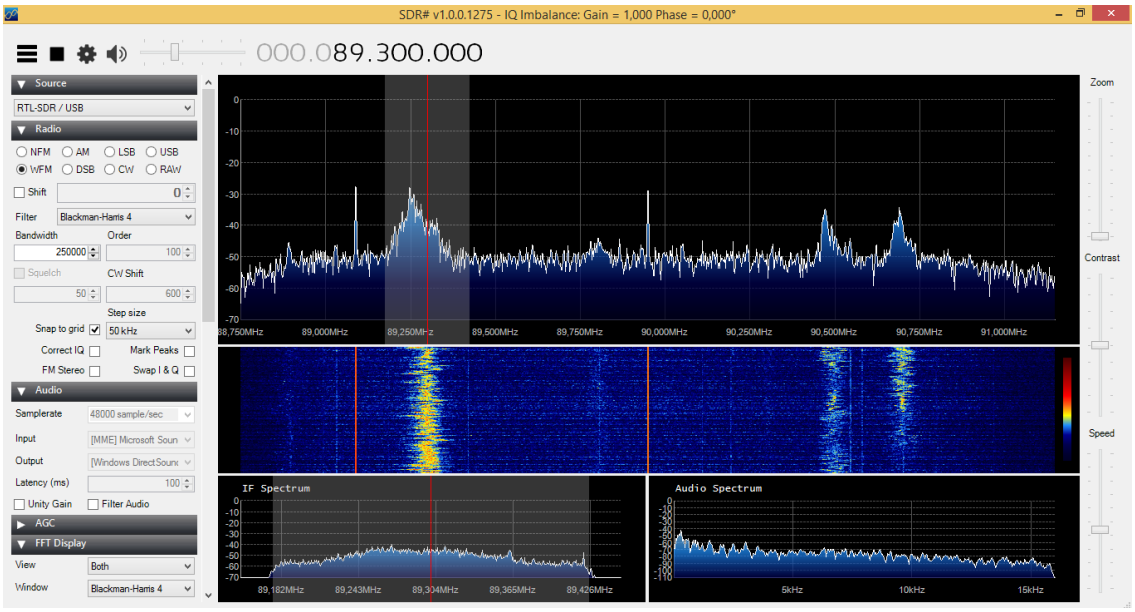

Figure 1: FM signal with SDRSharp

Knowing that the SDR is configured properly, we were able to tune to the pager frequency which is 169650kHz and capture a pager signal as it is shown in figure 2.

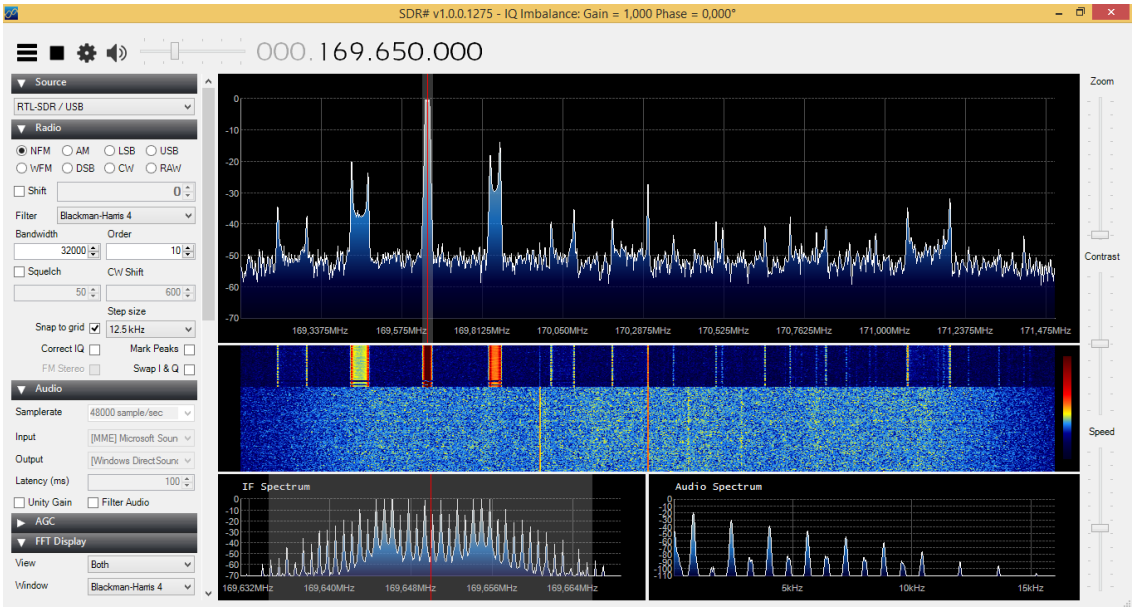

Figure 2: Pager signal with SDRSharp

The next step that we had to do, was to make sure that the signal that we were receiving was actually a pager signal. To verify that we installed the software PDW which decodes pager signals.

From the results we received (figure 3) we can see that the protocol used is FLEX-A with bit rate 1600bps.

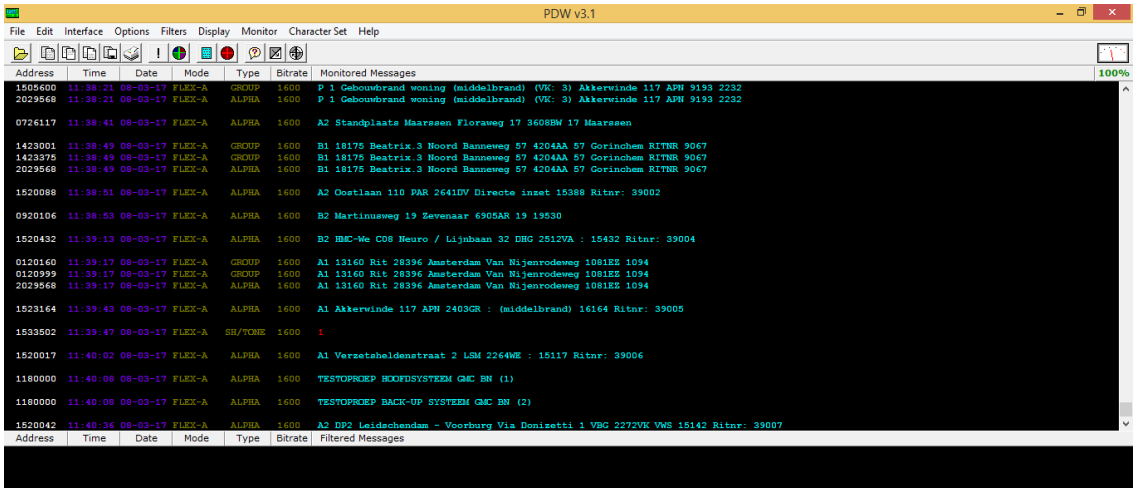

Figure 3: Decoded pager signal from PDW

It is known that the FLEX-A model is using a 2 level FSK modulation and therefore the next step that we need to get done is to receive the signal and demodulate it. At first we decided to record the signal from SDRSharp and try to demodulate it in MATLAB. Due to the big size of the recorded data and to the high default sampling rate of SDRSharp that cannot be changed, MATLAB was not able to perform any calculations. At that point, we decided that we should record the signal from MATLAB as MATLAB enables us to specify the sampling rate and then try to demodulate that signal.

First of all, we installed the required packets of SDR to MATLAB and we plotted a small part of the signal in order to check that our code and configuration was working. The signal we received is shown in figure 4.

When it was the time to do the demodulation, we decided to first try to demodulate a known signal in order to check that our code is correct. Once, we will be sure that the demodulation code is working we will apply the code to the signal we receive from MATLAB. We know that our SDR dongle does the frequency shifting and filtering by itself and therefore we will be able to do the demodulation of the signal right after we receive it on MATLAB.

At this point we try to implement the MATLAB code for the demodulation. We were able to create a known signal with the known preamble 101010. This signal we generate, consists of the 6 preamble bits and 5 more random bits which represent the code. We use such a small signal size, as we want to see in detail what happens in every step of the demodulation and spot easily any errors. Also, we expect that the real signal will have 576 bits at the preamble. Before implementing the MATLAB code for the modulation and demodulation, we designed the FSK demodulation in simulink as shown in figure 5 . The output of this shown in figure 6. After getting the results, we implemented this scheme in MATLAB via coding.

At the same time, we created a GNU file with all the steps that need to be done in order to achieve our final goal. The purpose of this file is to make us sure that if we follow all the steps that we included there, we will actually be able to get the data from the signal. The GNU radio is an interactive platform in Linux used for simulating communication systems using modular approach. It has a vast library containing various signal processing blocks. We first successfully interfaced RTL-SDR with GNUR radio and received and record the signal through it as shown in figure 7.

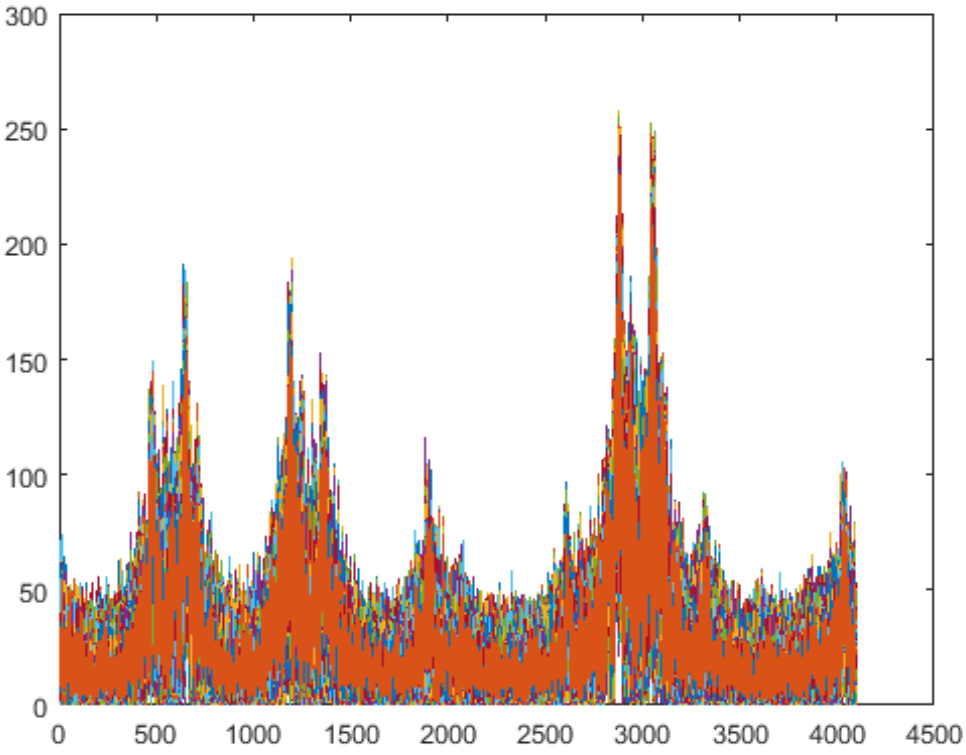

Figure 4: FFT of the received signal from MATLAB

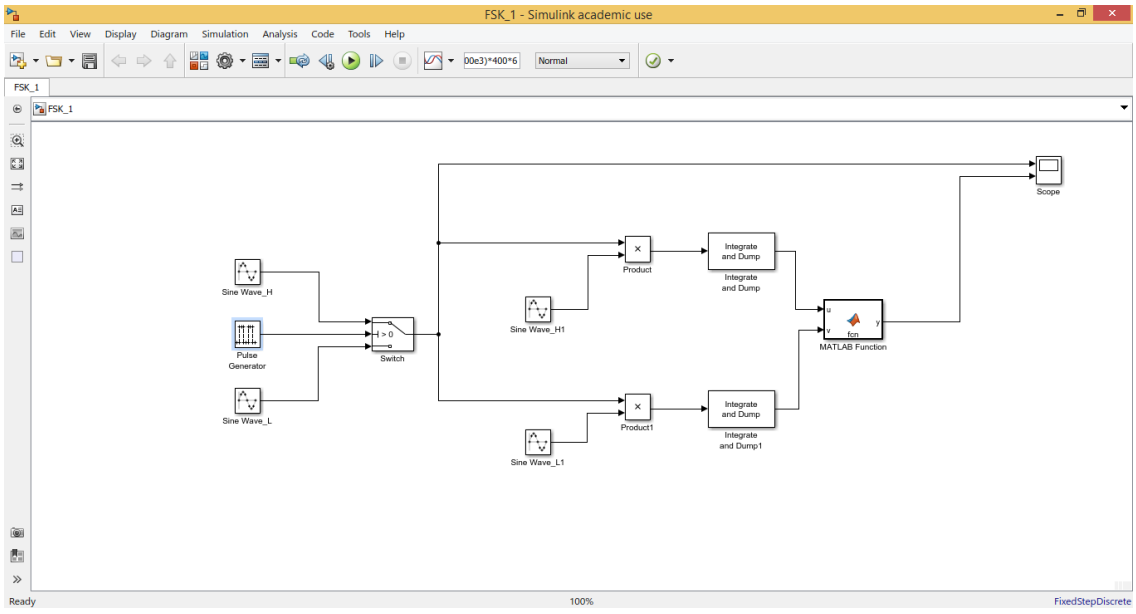

Figure 5: Diagram from Simulink

figure 8 represents the system used for demodulating the incoming signal. The recorded signal is first passed via low pass filter to select the desired frequency band. The filtered signal is

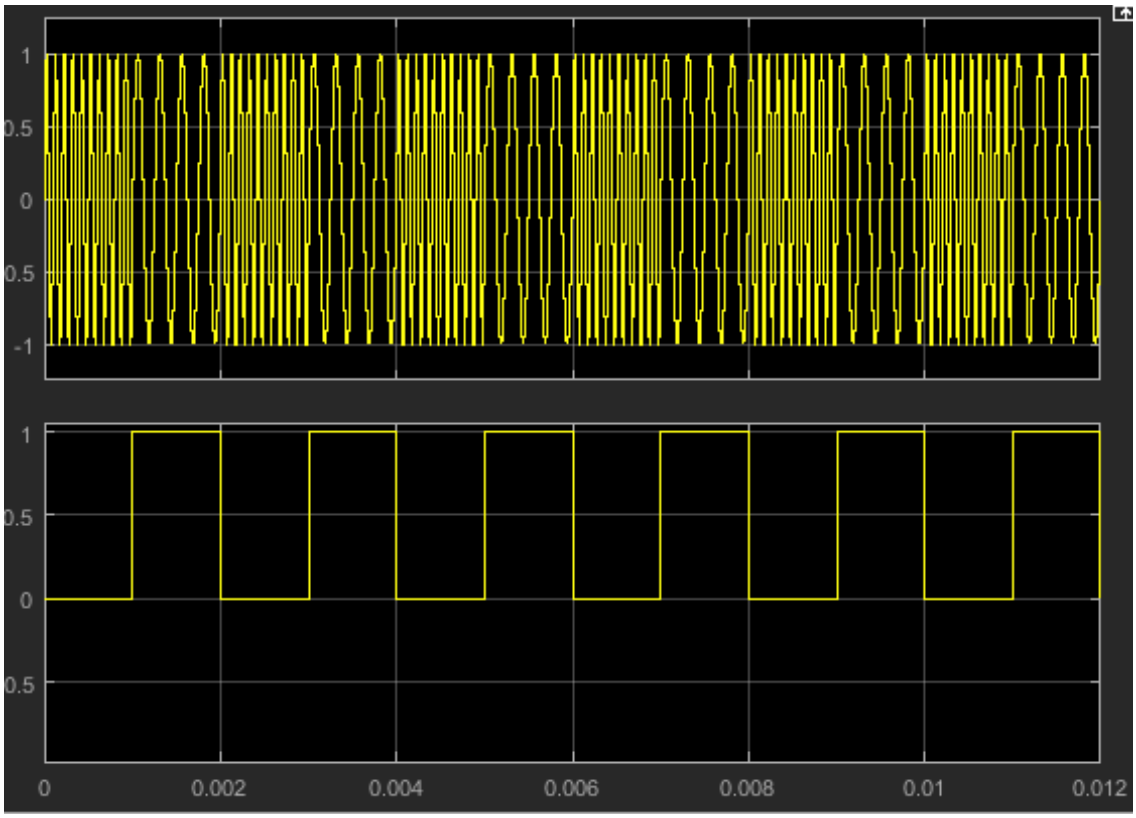

Figure 6: Output of FSK Modulator and De-modulator in Simulink

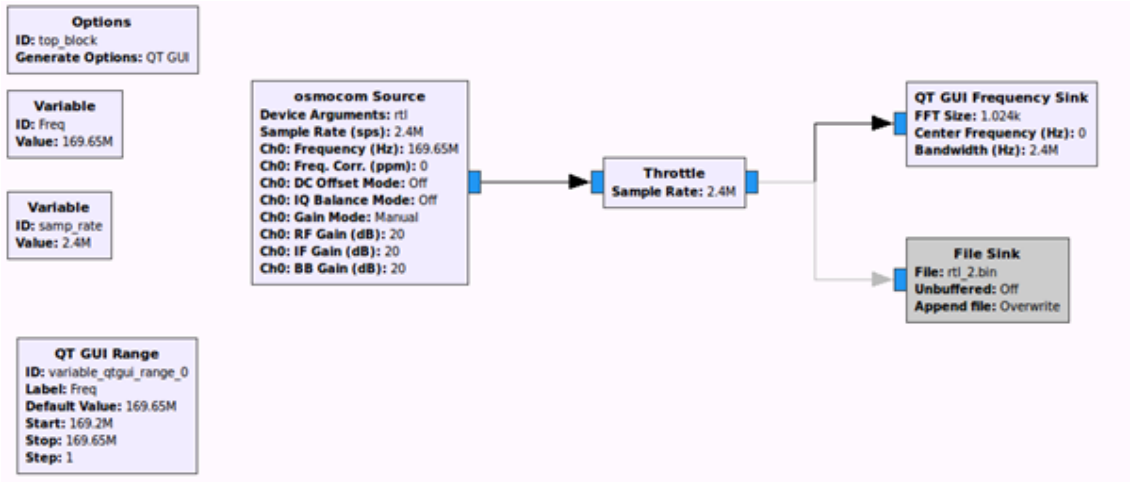

Figure 7: RTL-SDR Interface with GNURadio

then supplied to Quadrature demodulator block which is used to demodulate the FSK signal in GNUradio. The demodulated signal is then filtered to remove the noise from the signal. Then the clock recovery is performed using Clock recovery MM block. The output data is viewed via QT GUI Time sink block is shown in figure 9.

The bits are recovered but there are issues related to timing of the incoming bits. The time scale

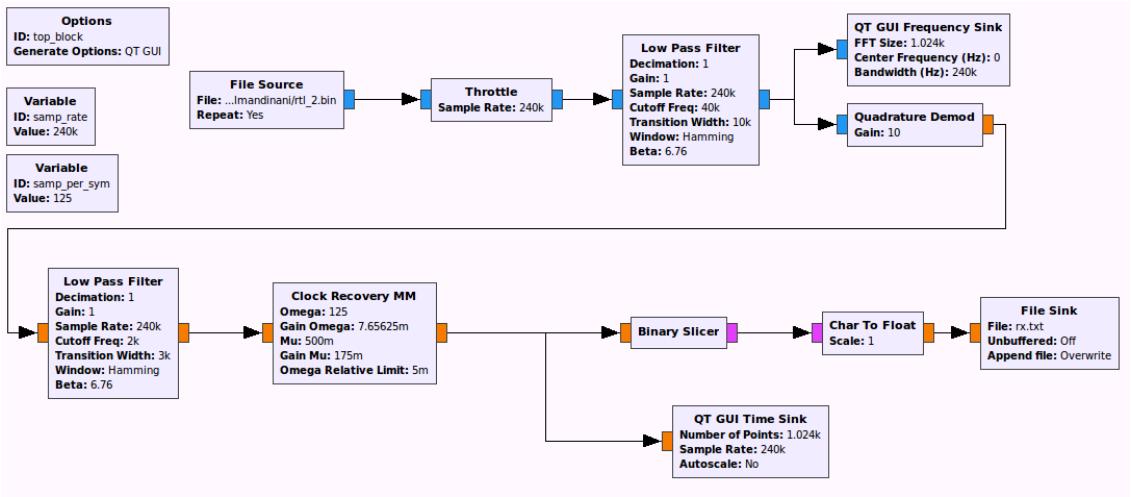

Figure 8: FSK demodulator for Pager signal

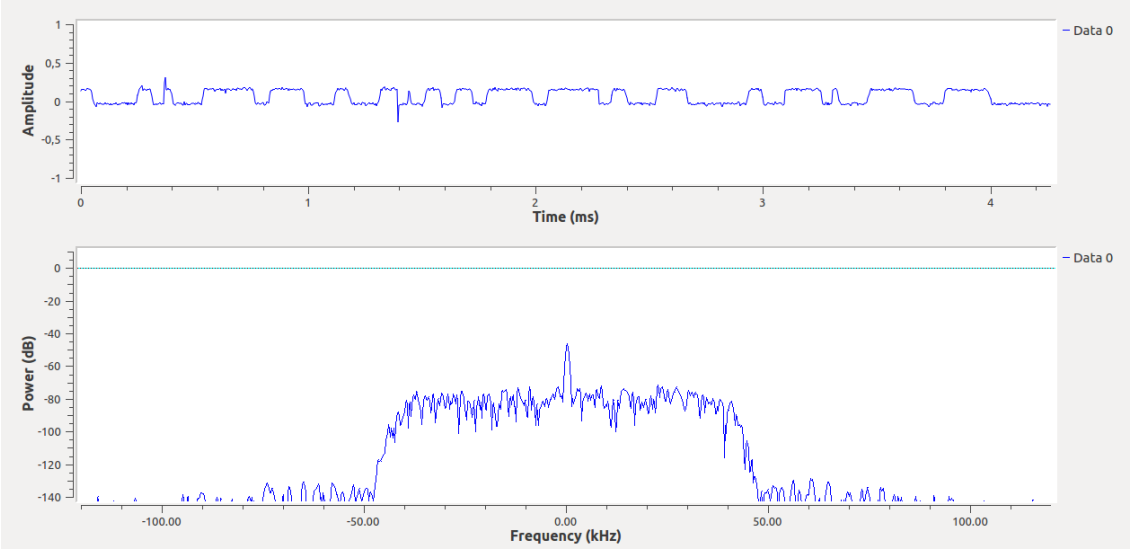

Figure 9: Output Data

in figure doesn't correspond to the data rate of FLEX signal which is 1.6 kbps. We are currently working on it to solve this issue.

Now that we are sure that the demodulation code we have is working, we should apply the code to the signal we receive from SDR to MATLAB. The difficulties that we expect to face during this step, is the noise from the signal and the unknown frequencies used for the modulation.

Once we demodulate that signal, we will then have to decode it. The challenging point to the decoding process will be understand which is the preamble.