

AUFGABE DER MASTERARBEIT

im Studiengang „International Studies in Engineering“

für: Xuan LIU

gestellt von: **Prof. Dr.-Ing. Andreas Czylik**

Thema: Time, Phase and Frequency Synchronization of Low-Cost DVB-T
USB Receivers Acting as Software Defined Radios in a
Multi-Channel Coherent Receiver

Low-cost DVB-T USB dongles based on the *Realtek RTL2832U* demodulator chip and the *Rafael Micro R820T* tuner chip can be used with a particular driver to act as *Software Defined Radios (SDRs)* with a frequency range from 24–1850 MHz, a resolution of 8 bit and a sampling rate of up to 3 MS/s. This property has in recent years led to their widespread use in amateur radio and academia under the name *RTL-SDR*. Lately, these receivers are also supported by MATLAB/Simulink through the Communication System toolbox, allowing simplified control and digital signal processing.

While the *RTL-SDRs* lend themselves as components for multi-channel coherent receivers – e.g. for digital beamforming – due to their extremely low cost, they exhibit a number of properties that impede this application. That includes an unstable local oscillator frequency and random phase and time offsets between different receivers.

In this thesis a multi-channel coherent receiver consisting of several *RTL-SDRs* shall be developed. The channels in this receiver shall be synchronized in time, phase and frequency through hardware modifications and software algorithms. One possible approach is the use of a common clock and the evaluation of suitable reference signals that are switched into the signal path.

The task entails the following steps:

- creating a time and work plan,
- getting familiar with the use of multiple *RTL-SDRs* in MATLAB,
- investigating the severity and causes of the frequency, phase and time offsets,
- investigating suitable reference signals,
- developing suitable circuits for the generation and distribution of reference signals as well as matching the inputs of the *RTL-SDRs* to 50Ω ,
- design of a PCB layout in EAGLE and assembling the circuits after production at the in-house PCB workshop,
- measuring all developed hardware components,
- developing algorithms for time, phase and frequency synchronization,
- demonstrating the coherent reception of signals and possible applications,
- documentation of the work,
- final presentation of the work, and
- submitting a digital copy of documentation and presentation in PDF format.

Zweitgutachter: Prof. Dr.-Ing. I. Willms

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