



SEMESTER PROJECT

Signal Processing for Software Defined Radio

ELEC4844/8844, S1 2024

INTRODUCTION

The RTL-SDR device can be used to receive a variety of RF signals transmitted over the air. In the Semester Project, you are going to nominate one practical application of RTL-SDR (other than AM/FM radio) that you are interested in, and build a MATLAB and/or Simulink program to realise the application. You are expected to demonstrate your program and application of choice during the Semester Project Defence & Demonstration in Week 13.

TIMELINE

You are expected to develop your design and execute it using MATLAB/Simulink progressively during the semester, with the following milestones:

1. Nominate your application by the end of Week 7.
2. Specify the scope and performance indicators for your design by the end of Week 8.
3. Ensure the progress is beyond halfway point by the end of Week 10.
4. Complete the project and submit your report and program by the end of Week 12.
5. Prepare your presentation to take the Project Defence during Week 13 practical session.

GUIDELINE FOR PROJECT REPORT

In the Project Report, you are required to describe the principle/workflow of the application of your choice. The relevant communication protocols/standards as well as key aspects of signal processing should be explained in sufficient detail to show how your program and RTL-SDR device are configured accordingly. Potential challenges for the nominated application with low-cost desktop SDR should also be discussed.

The following sections are required in your Project Report:

- **Introduction:** to introduce the application scenario, including a brief account of the past and the present;

- **Principle:** to explain how the application can be realised with RF signals, including a workflow diagram and relevant communication protocols and/or standards;
- **Design:** to illustrate how you realise the nominated application using RTL-SDR (or simulation), and to specify the aim of your design including a list of key parameters for consideration;
- **Implementation:** to describe how you process and analyse the signals in your program, with numerical and graphical results to verify that your design is functioning as expected;
- **Discussion:** to reflect on your design and implementation in terms of both successes and lessons, and perspectives for future development/improvement.

In Semester Project Oral Defence & Demonstration, you will present your project design, implementation, and results, and will be asked questions.

EXAMPLE TOPICS

The following topics are given as example applications suited for the Semester Project. You do not have to select one among them, but can nominate your own application of choice instead, as long as it is not about AM/FM radio.

Note that, if the application may be implemented using SDR in general but is beyond the capability of the RTL-SDR device at hand, you can choose to carry out your project purely based on simulation. However, in such cases you will be required to simulate both the transmitter end and the receiver end.

Example 1: Digital Audio Broadcasting (DAB)

Use RTL-SDR to receive and listen to a DAB channel.

Example 2: Navigation

Use RTL-SDR to find the location, for instance, of an aircraft (Automatic Dependent Surveillance–Broadcast, ADS-B), a ship (Automatic Identification System, AIS), etc. However, note that some navigation broadcasting may have been encrypted (e.g. FM Traffic Message Channel).

Example 3: Simulation of personalised telecom

Use a computer input (e.g. keyboard, microphone) to generate a signal (e.g. Morse code message, digital piano melody), modulate for RF transmission, and simulate its desktop SDR receiver to retrieve the signal.

ASSESSMENT & MARKING

The Semester Project must be your own work and is not a group project. Marks will be deducted for cases in which reports and/or programs from different students have noticeable similarity. If you have not originated the MATLAB code or Simulink program, references must be given to the source(s), including those published on the internet, books, journals, reports, thesis documents or have been originated by other students.

The Semester Project Report must be submitted in the form of an Adobe PDF file. You should include your name and student number at the top of every page as well as page number at the bottom. The MATLAB/Simulink program must be turned-in separately alongside the Report.

The following aspects will be marked:

- How appropriate is the nominated application for SDR;
- Understanding and explanation of the operational principles;
- Originality, as you may be assessed on a competitive basis if the topic is similar to other's;
- Overall design from the perspective of signal processing;
- How well you implement your design and ensure it functions as expected;
- How organised is your report, and how easily your program can be troubleshooted;
- It is desirable to demonstrate your application in real time during the Defence.