BEng (Hons) Electronic Engineering

Author: Callum Pickering

Supervisor: Dr Marc Molinari

Smart RF Test Source

SOLENT UNIVERSITY SOUTHAMPTON

Background Information

As a part-time student of Solent University, I am employed by Defence Science and Technology Laboratories (DSTL) Porton Down as an Engineering Technician for the Underwater Systems, Special Fit team. My team's role is to build, test, deploy and provide the continued support of specialist RF communications equipment suites (GTK) for Royal Navy platforms.

Currently in order to carry out an Integrated Function Test on the RF suites, they must be deployed onto a platform and tested in situe. This is due to the location of our build site not having suitable RF emission sources nearby to test from.

Initial market research into RF Test sources were either too expensive or did not support the frequency ranges required by the customer, therefore the final proposal was to build our own Test Source.

Aims and Objectives

- Conduct research into multiple solutions for an RF circuit and Digital controller, with a chosen solution by mid-end December 2020.

- Produce a working prototype analogue RF emitter by mid-end January 2021.

- Program a digital controller to control the parameters of the RF circuit by mid-end February 2021.

- Produce a fully functional physical prototype which passes the specification acceptance tests required for DSTL end March – mid April 2021.

- Produce a technical report to document the research and development of the project.

Project Specification

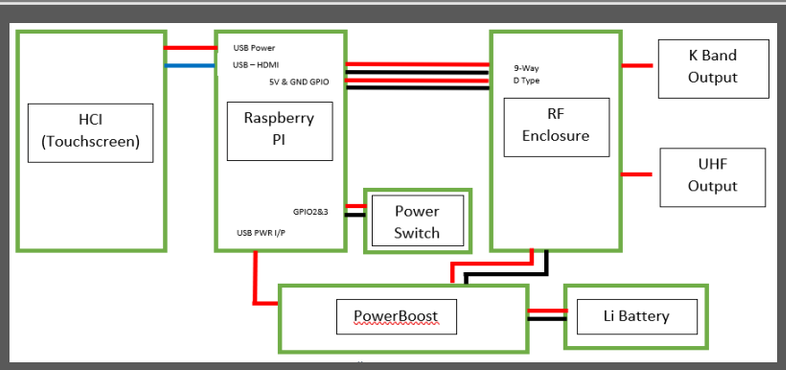
- Produce several frequencies (at least two) across the UHF band, with one optimally in the SHF band (IEEE K band (20GHz-40GHz)).

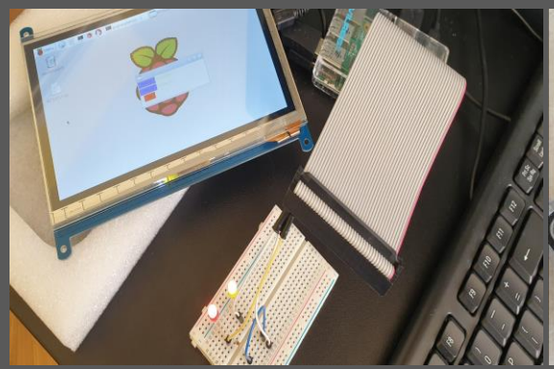
- Digitally configurable parameters such as Pulse Repetition Interval and Pulse Period using a suitable digital controller.

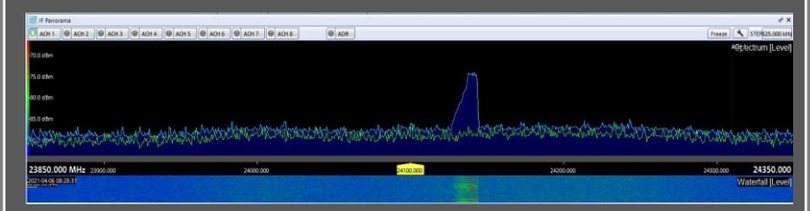
- Lightweight and portable (e.g., less than 10kg, 50mmx400mmx300mm maximum).

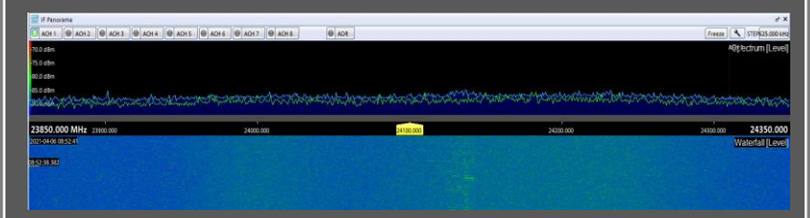
- Easy to use Human Control Interface (HCI).

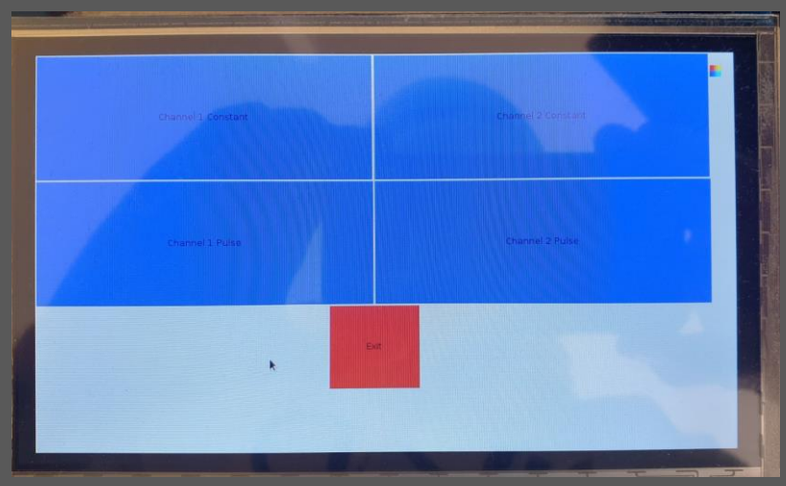
- Zero RF airborne emission.











Research

As per Project Specifications, research was carried out to establish the available technologies and methods to develop a working prototype RF Test source.

Various oscillator topologies, RF Emitters and Digital controllers were researched and evaluated for cost and viability to the project. After extensive analysis the consensus was the Raspberry PI and Microwave Sensor Module would best suit the needs for each portion of the project. The secondary components such as the HCI (Touchscreen), shielded enclosure and battery were researched and factored into the full assembly design.

Prototyping Development & Testing

The RF portion of the project was developed onto a Veroboard Circuit design and enclosed in a shielded enclosure, whilst the Digital Controller portion was written using Python 3 onto a Raspberry PI and tested using a simple LED set up.

Components such as the second MSM, Powerboost, battery, power switch and outer most enclosure were delayed and therefore did not reach the testing phase

Testing consisted of three phases, RF Portion, Digital Controller and Full Assembly.

The RF Portion tested the output of the RF Enclosure, which successfully emitted a signal at the correct frequency. However this frequency was far lower in power than anticipated and a small emissions leak was present through the shielded enclosure. The testing also displayed inconsistent results with low Pulse Repetition Intervals (<100ms).

The Digital Controller portion was tested for functionality of the GUI application, with the buttons correctly functioning as intended.

Unfortunately the full assembly test was unable to be carried out as the final components necessary did not arrive due to delays.

Conclusion & Recommendations

Overall the project proved the possibility of a SMART RF Test Source, however the prototype design requires further testing and refinement to fully meet customer specification. This includes a full assembly test .

The recommendations for future projects are further research into RF Emission methods, preferably a method which did not require the modification of an airborne transmitter such as a Dielectric Resonator Oscillator. The GUI on the digital controller could be improved for dynamic changes to PRI and Pulse Period parameters.