Designing and Building a Tuneable Comb Jammer

Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

School of
Applied Computing

Louise Caygill – 2110765 | Beng Embedded Electronic Systems | UWTSD, IQ Building, Swansea, SA1 8EW

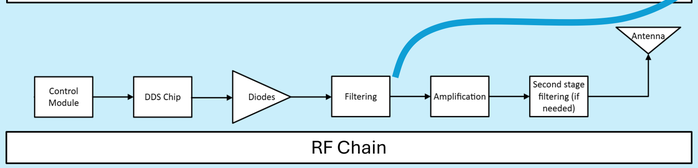
Conclusion

In conclusion the DDS chip specified had too large a bit-number for the PIC to be able to successfully complete the maths needed for the FTW.
As such, this work instead serves as a framework to guide future work.

Successful:
RF Chain
Antenna Selection
User interface and code
FTW maths – to a point
Filter bank select code

Unsuccessful:
Transmission of comb pattern
Integration as full system
Filter specification

Two tuneable RF generators from BAT-C [2], left and Elektor Magazine [3], right



RF Chain

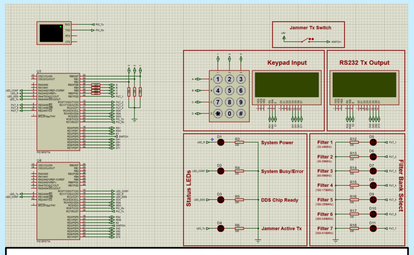
Literature Review Summary

In summary the key takeaways are that the best method of solving the problem is to design a tuneable comb jammer, utilising harmonics to create a pattern of interference. The simplest method of producing a tuneable RF transmitter without an SDR is using a PIC controlled DDS chip.

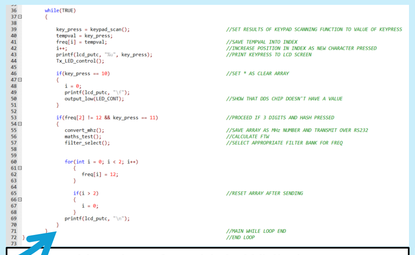
- DDS is a method of producing an analogue waveform
- Fast switching as digital
- Programmed through Frequency Tuning Word or through registers in ADF435x from Analogue Devices if using evaluation board ADF4351

$$FTW = F_{OUT} * \frac{2^{48}}{F_{REF}}$$

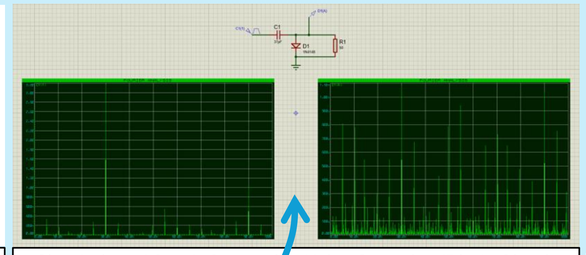
FTW Formula [1]



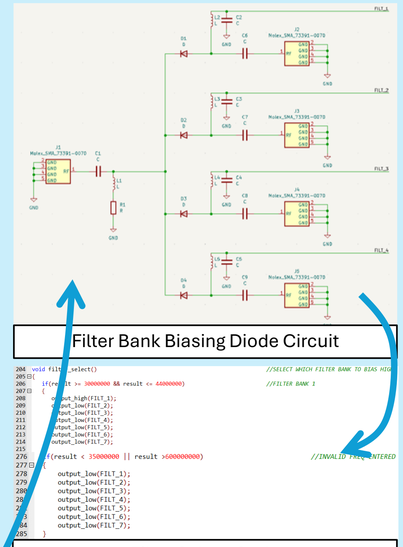
Proteus Schematic



User Interface Main While Loop



Simulation of Comb Generation Using Capacitor/Diode Circuit



Filter Bank Biasing Diode Circuit

Filter Select Code

Control Module

PIC16F877A [4]

- 2-5V supply
- Low power consumption
- 40 pins
- Multiple available in lab

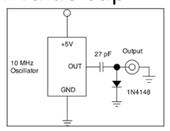
DDS Chip

- AD9956YCPZ [1]

- 0-2.7GHz
- 3V3 supply
- Low power consumption
- Low cost
- 48-bit FTW

Comb generator

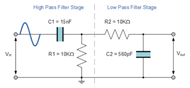
- 1N4148 Diode
- Small value cap



[5]

Filtering

- Passive bandpass filters bank with biasing diode select



[6]

Amplifier

- ZHL-20W-13SW+

[7]

1. Introduction

With the evolving state of Electronic Warfare (EW) the need for communications denial is ever present. With the range and capabilities of wireless communications devices evolving, this disruption is becoming harder to achieve. Especially with the ability to frequency hop over a wide frequency range.

2. Aim

Therefore, the overall aim of this report is to answer the question: How to best deny communications between devices that are capable of FHSS over a wide frequency range without the use of a Software Defined Radio (SDR), whilst remaining portable?

3. Method

Proteus along with CCS C language compiler were used to create a running simulation that would simulate the system functions. This allowed "real time" code development and debugging. ADF435x from Analogue Devices was used to prototype the ADF4351 synthesiser and breadboarding was used for the PIC user interface

4. Results

The results are a successful simulation of a comb pattern using the simple circuit from the literature review. A successful filter select code, and RF chain that encompassed all the necessary components. Plus a user interface code that takes the user input in MHz and converts to Hz to undertake the FTW maths operation.
The filters originally specified were incorrect, and as such this section needs more involved research

4. Future Recommendations

- Using a more advanced or recent PIC with a larger internal memory, more pins and smaller form factor to allow the PIC to undertake the maths needed for the DDS chip
- Use of a DDS chip with smaller FTW bit-number
- Utilising an SDR in place of a DDS chip and PIC solution, especially for a system that intends to be as agile as the one attempted during this project
- If utilising the ADF4351 further research into how the register values are calculated should be undertaken, so that they may be calculated by the microcontroller automatically without the need for user intervention
- Designing a bespoke antenna to cover entire range
- Having a clearer and more advanced system of project management to keep to task
- Better filter specification

References
[1] Analog Devices. *2.7 GHz DDS-Based AgileRFTM Synthesizer AD9956 Datasheet*. 2020. Available: https://www.analog.com/media/en/technical-documentation/data-sheets/AD9956.pdf
[2] British Amateur Television Club. ADF435x PIC – BAT-C Wiki. Available: Available: https://wiki.batc.org.uk/ADF435x_PIC
[3] Elektor Magazine. *A Simple DDS Signal Generator: DDS in Its Purest Form*. [Online] (April 2024). Available: https://www.elektormagazine.com/articles/simple-dds-signal-generator-direct-digital-synthesis
[4] Microchip. *PIC16F877A*. [Online]. Available: https://www.microchip.com/en-us/product/pic16f877a
[5] K. Wyatt. Harmonic Comb Generators Are Useful Tools. *EMC Directory & Design Guide* 2015. [Online] Available: https://interferencetechnology.com/wp-content/uploads/2015/02/WyattArticle.pdf
[6] Keysight. What is a Bandpass Filter. Available: https://www.keysight.com/used/gb/en/knowledge/glossary/oscilloscopes/band-pass-filter
[7] Mini Circuits. "*High Power Amplifier COAXIAL, BUILT-IN RF SWITCH" ZHL-20W-13SW+ Datasheet*. [Online]. Available: https://www.minicircuits.com/pdfs/ZHL-20W-13SW+.pdf