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Weekly Report #2 – CC1310 I/Q Debugging and RTL2832 SDR

Goals

- Group debugging of I/Q data extraction from the CC1310
- Project proposal revisions
- Coherent direction finding with SDRs research

Problem

The ADC on the CC1310 provides a sample rate much lower than the Nyquist frequency of the transmitted signal. Even though ideal sinusoidal waves can be reconstructed without error in an ideal environment, outside noise and imperfect transmissions (varying frequencies) will more adversely affect the reconstruction of a signal from undersampling. Justin and I spoke with Dr. Kan on Friday on this issue, and he confirmed our doubts on the CC1310 system.

General Approach

Research towards implementing an SDR or external mixer/demodulator for I/Q data extraction:

RTL2832 (SDR) Pros	RTL2832 (SDR) Cons	CMX970 Pros	CMX970 Cons
Greater wealth of information from online hobbyist blogs and forums.	No Formal Datasheet: https://www.rtl-sdr.com/wp-content/uploads/2018/02/RTL-SDR-Blog-V3-Datasheet.pdf (closest resource to one)	Formal Datasheet: http://www.cmlmicro.com/DesignSupport/resources/2013/03/05/EV9700UserManual	Less used in the online community. Limited forums and debugging resources online.
GNU Radio Software to capture IQ data and import it directly into Matlab.	2.56 MS/s Maximum Sampling Rate. This will make it difficult to implement phase interferometry on HF and UHF signals.	Analog to digital conversion takes place after IF mixing. 20 – 300 MHz RF intake.	Will have to learn how to use C-BUS to interface with the Host Microcontroller (GUI provided by manufacturer)
Clock selector jumper capability – Coherent RTL 2832 receivers with common clock.		Each board has a port for an external local oscillator.	

Code-level problems and solutions, and empirical testing

TI – RTOS has just been updated with a new patch for the CC1310. This patch was mostly implemented to take the main function outside of the rfPacketRx example code to allow for threading (multiple asynchronous execution).

When debugging the most recent code under this patch, Justin and I were able to obtain I/Q values from 0 to $\pi/2$. Additionally, the values printed to the console were different at each runtime. However, the code still only runs for one iteration of 300 samples on startup. Please note that this debugging happened late last week, before shifting our focus towards SDRs.

Because our efforts have shifted away from the CC1310, specific code description will not be included in the report. The most recent code will be sent by email regardless.

Research has commenced on the RTL-SDR, “often referred to as RTL2832U, DVB-T SDR, RTL dongle or the \$20 Software Defined Radio” (Source 4). Most notably, a protocol for clock synchronization for these SDRs (Source 2 and Source 6) has been found, as well as a software for directly extracting I/Q data into Matlab (Source 7).

More information can be found on a PowerPoint I have prepared for the weekly discussion (will be sent via email).

Resources and relevant Forum Posts

1. <http://superkuh.com/rtlsdr.html>: “Central Hub” source for RTL SDR Information
2. https://github.com/tejeez/rtl_coherent: Phase Interferometry Project using RTL SDRs
3. https://www.reddit.com/r/RTLSDR/comments/6n9hdk/welcome_new_visitors_a_little_info_about_rtlsdr/: Reddit Post detailing how RTL SDRs became popular
4. <https://www.rtl-sdr.com/about-rtl-sdr/>: General Information
5. <https://www.rtl-sdr.com/buy-rtl-sdr-dvb-t-dongles/>: Buying Location
6. <https://www.rtl-sdr.com/rtl-sdr-blog-v-3-dongles-user-guide/>: RTL_SDR Blog V3 Datasheet
7. aaron.scher.com/wireless_com_SDR/RTL_SDR_AM_spectrum_demod.html

“How to capture raw IQ data,” (Dr. Aaron Scher, 2015)