ASU LoCo Lab
ECHO Project

On Off modulation with the RC Chopper

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Edit History
First Draft - 29 Aug 2022

Drones can cause backgrounds which are difficult to distinguish from the transmitter. If the transmitter is sufficiently narrow band, one could use nearby channels to a similar effect. But if the signal is being compressed, correlation between channels will upset that apple cart. If the signal is broadband, abandon all hope. Enter the chopper. This note summarizes experimental efforts to date.

A Chopper turns the signal RF off and on. How fast should it switch? Moving at ~.5m/s is about the slowest one can go and beat the weeds growing. The shortest range we've yet operated is at about 100m. At that range our speed amounts to about 0.3 degrees/second. A map resolution of about 1 degree will be better than most EM simulations I know about. This will amount to about 3 seconds pixel. Ten samples per second (10Hz) will get us 30 samples per pixel. This is a nice sampling count! A switch time of 100ms would nicely sub-sample that time period. Ideally the switching happens at a rate faster than anything else in the system, so our sample of "off" states is the same as the "on" state.

Power Chop

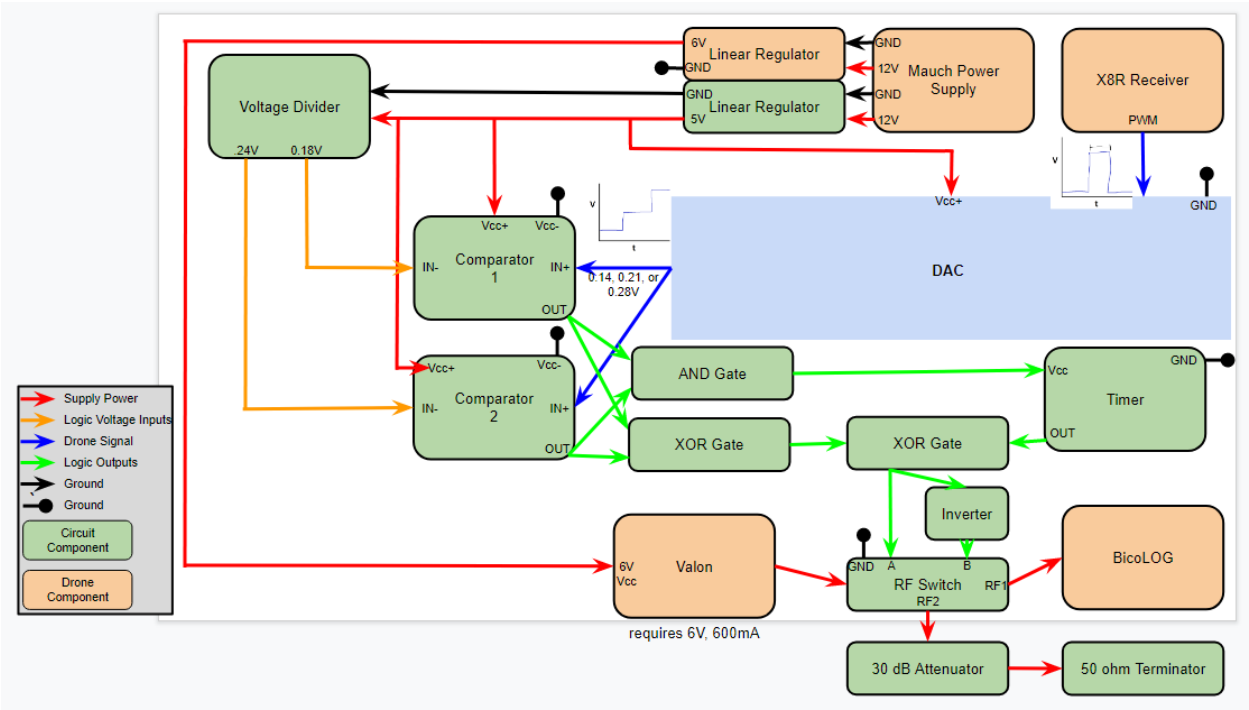
Could we turn the valon off and on? We found that the valon took almost half a second to start transmitting after power on. This would mean at least a half-second difference between off and on. This is a bit slow compared to the 10Hz estimate we came up with above. Lets leave this option for later.

RF Chop

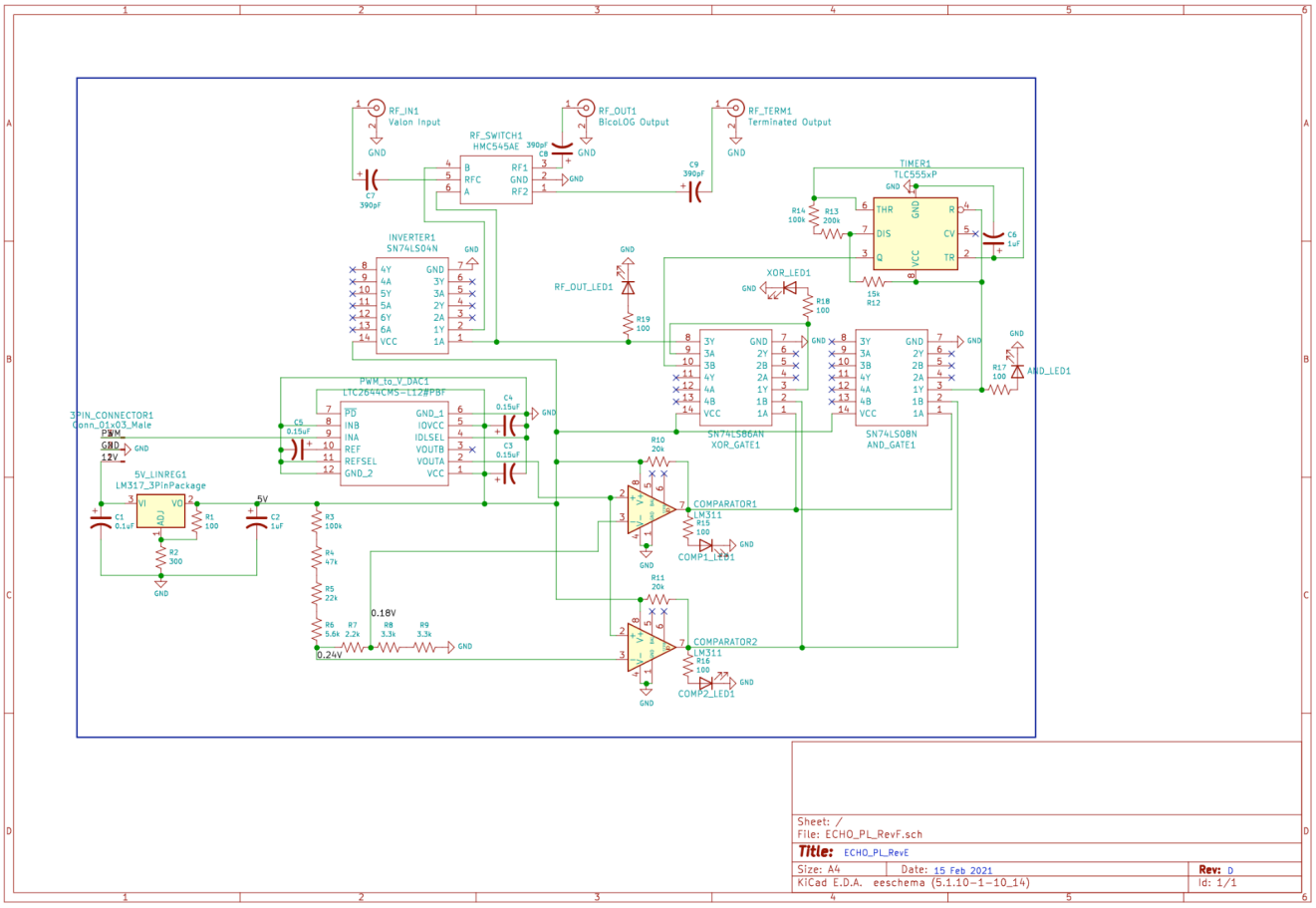
This option turns the RF output off and on. It does this by switching the RF signal back and forth between the antenna and a dummy load. When routed to the dummy load, some signal will inevitably leak out. This level must be below the level of the drone background which we are trying to characterize. This is the design we'll start with.

RF Chopper Design Parameters

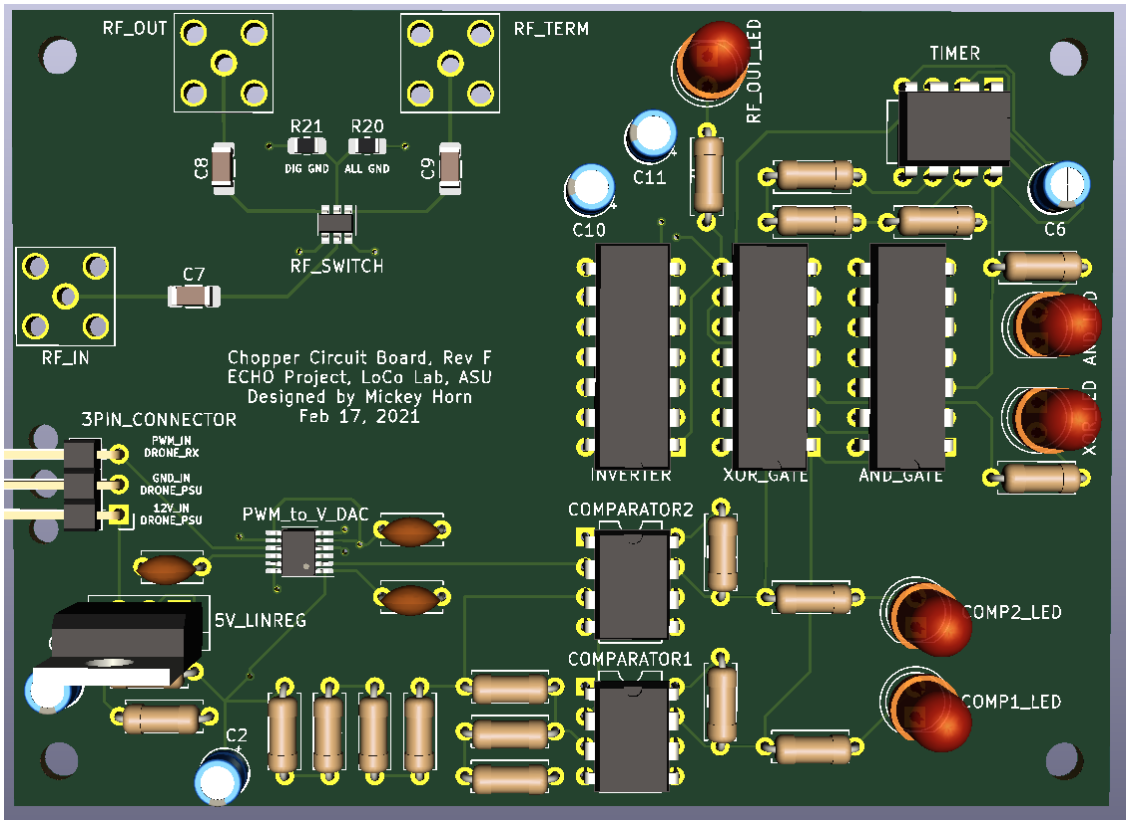
Control Input: PWM signal. from drone receiver or drone autopilot
RF input: Valon or similar low power transmitter
RF output 1: to antenna
RF output 2: to a dummy load
Power: 5V
Version documented here: Rev F
Files: see github.com/dannyjacobs/ECHO/hardware/chopper



Block diagram of RF Chopper Rev F, M. Horn 2020



Electrical schematic diagram ECHO RF Chopper, ref F.



Board Rendering

Lessons from initial testing

In initial bench testing using a valon and a fieldfox, we found that the off position isolates by at least 40dB. This could potentially be improved with better shielding around the board and better RF. (ECHO Memo 53, M. Horn)

During design there was some disagreement about how the RF switch ought to be grounded. One view is that the ground of digital systems should be kept isolated from the RF system. However, the datasheet shows an example wiring of the switch were the RF ground is connected to the ground. This version of the board has the chip grounded to a separate ground which can optionally be connected to the RF ground. Initially we set up the board with the RF ground separate. Initial drone-based measurements returned very strange results where, with the switch held firmly in the ON position, the beam pattern appeared to oscillate between two very different modes. This suggested some instability in the connection of the electrical path on. Bench tests seemed to confirm instability and showed that grounding the RF to the logic lines resolved the issue. (Memo 57, M. Gopalkrishna)

References

ECHO memo series at dannyjacobs.github.io/ECHO

ECHO Memo 53, Initial testing of ECHO RF Chopper. M. Horn 2021
ECHO Memo 57, Additional characterization of ECHO RF Chopper, M. Gopalkrishna 2022