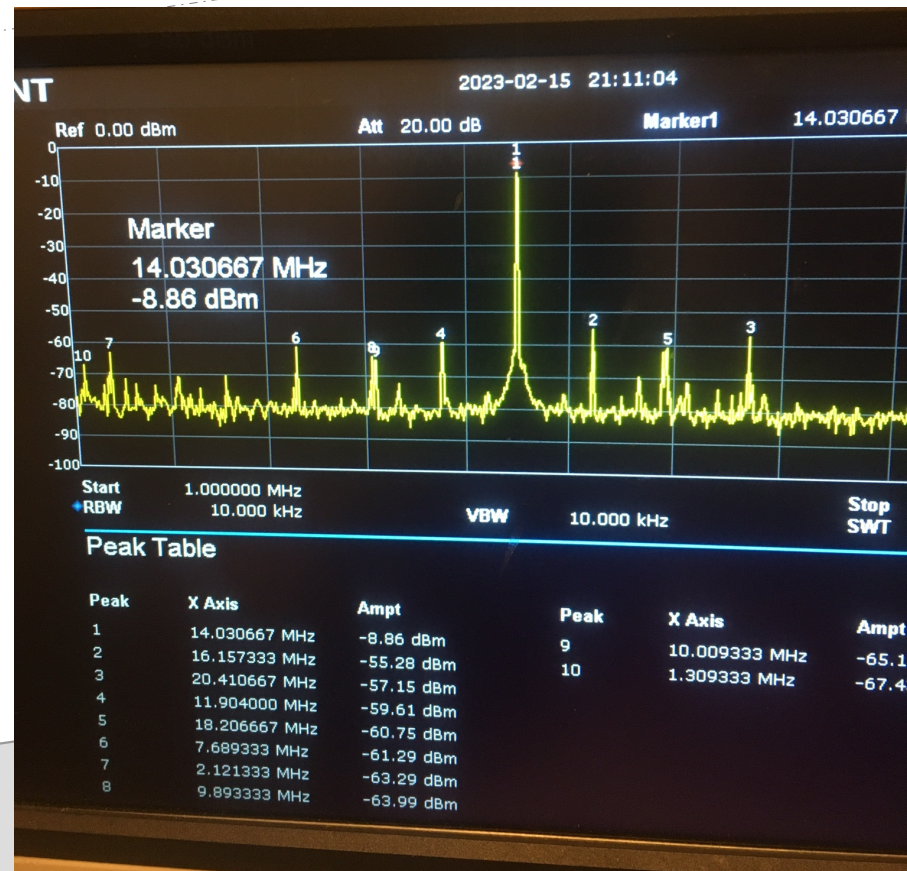# Massively Improved sBitx

Gordon Gibby KX4Z NCS521

Feb. 2024

MY Situation Last Year: Discouraging

- 500kHz Spurs (80 meters)

- Questionable Signal Purity...but close!

- Both my Raspberry 4's…..**toasted**.

REVIEW: Sbitx Introduction

- SDR architecture
- Modulation / demodulation performed in math
- Rpi4 processor
- Touch Screen
- Any mode you can mathematically describe possible
- FT8 built in
- PSK31 built in
- 10-20-30-40 watts
- Digital filtering

REVIEW: Hybrid SDR Overview

- Heterodyne low-pass filtered 3-30 MHz up to 40 MHz
- Then down to 0-48 kHz
- $4 WM8731 CD player codec
- (Full Duplex – one channel for receive, one channel for transmit)
- Center = 24 kHz
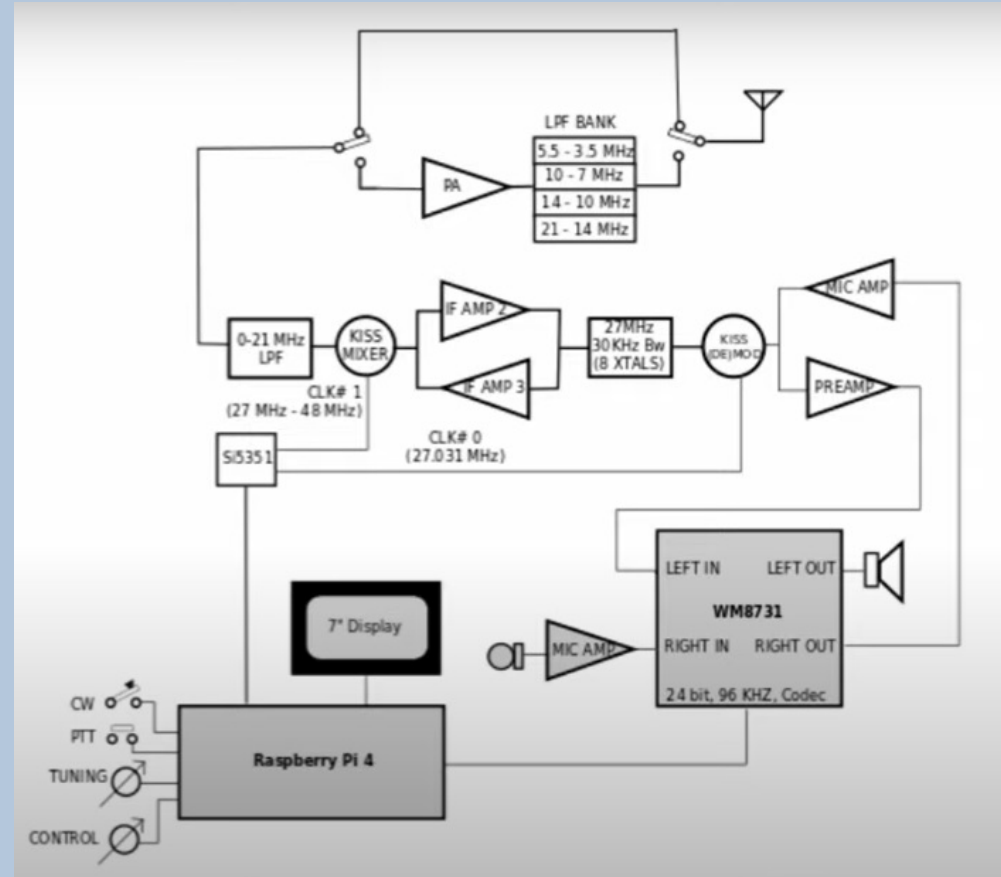
REVIEW: Blowing Finals

- Traced to PARASITIC OSCILLATIONS caused by direct feedback through the transmit/receive relay.

- Great Gnashing of Teeth: followed by development of a diode-switched T/R system that brought relay-less near full break-in!

- Brilliance: voltage doubler from the RF itself!
- Mosfets used to control DC biasing
- 2N7002
- Bias current only has to support RECEIVE
- Transmitter always connected to antenna
- Transmitter stages depowered when not transmitting
- Receiver only connected when receiving
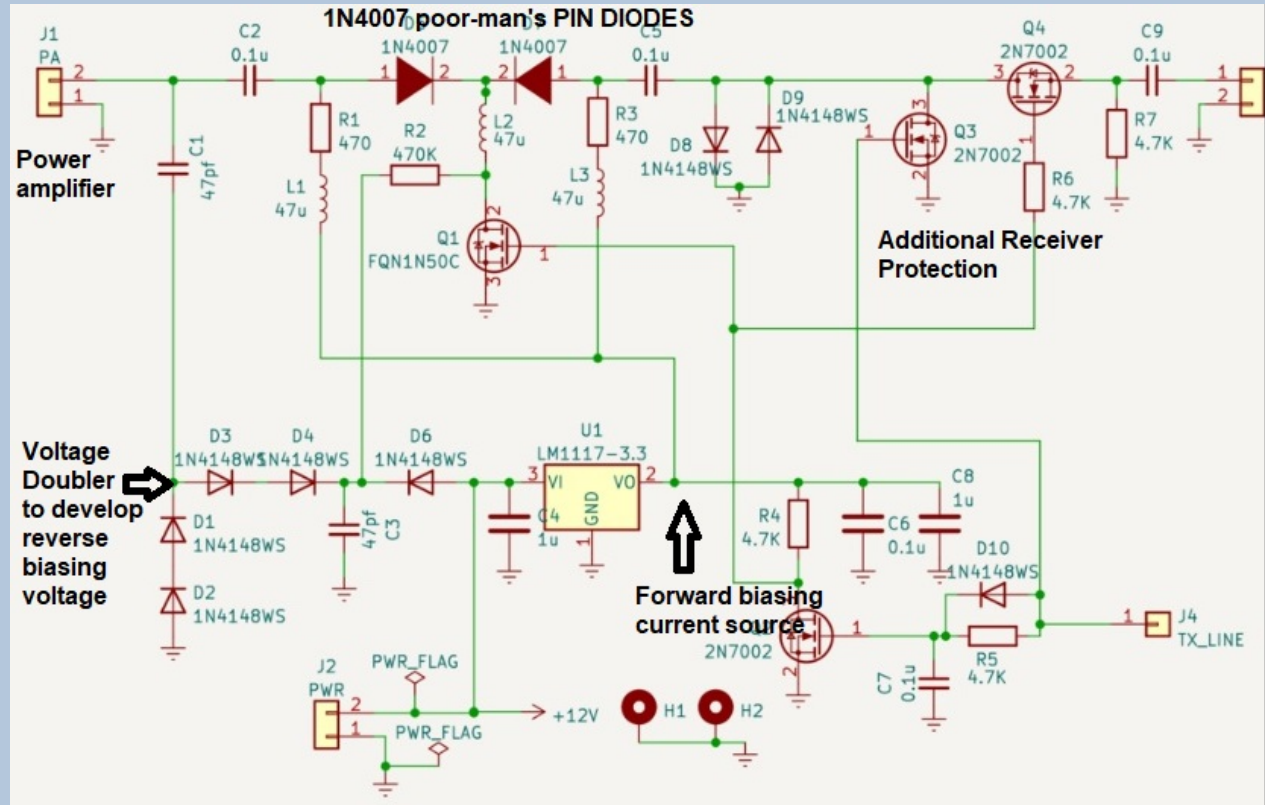
Things began to improve

- But only AFTER my talk of last year...

1. 500kHz spurs fixed by massive Cap on input to 5V switching regulator

2. Raspberry Pi price decrease

Raspberry Pi 4 Model B 2019 Quad Core 64 Bit WiFi Bluetooth (4GB)

Visit the Raspberry Pi Store

4.7 ★★★★☆ ⌄ | 17,893 ratings | Search this page

Amazon's Choice | Overall Pick

3K+ bought in past month

$61⁷⁹

Or **$11.41** /mo (6 mo). Select from 1 plan

✓prime Overnight

FREE Returns ⌄

May be available at a lower price from other sellers, potentially without free Prime shipping.

Eligible for Return, Refund or Replacement within 30 days of rece
⌄ | Product support included ⌄

Size: **4GB**

- Was finally able to purchase replacement Pi's for burned out units

- Gave up on +5VDC internal supply and went with stock wall wart MADE for the Raspbery Pi4 –

- Finally able to turn the unit back on!!

3. Raised PA idle from 0.25 to 0.36 A

- Single digit improvement in IMD responses, but helpful.

"tunable" spur!

DEVELOPER EDITION:

- **11ᵗʰ harmonic of operating frequency beating with Local Oscillator-- only observed on 80 meters**
- Here are the observed data from before and now some math that explains it:
-
- Operating　　　Spur　　　　　11th harmonic　　Local Oscillator　　Implied Bandpass
- Frequency　　　Frequency　　　of operating　　that goes with　　　Filter (should be constant)
- (MEAS)URED) (MEASURED)frequency　　　　making that spur
- 3.500　　　　　5.008 MHz　　　38.5 MHz　　43.508 MHz　　　40.008 MHz
- 3.510　　　　　4.912 MHz　　　38.61　　　　43.522 MHz　　　 40.012
- 3.520　　　　　4.816 MHz
- 3.600　　　　　4.012　　　　　39.6 MHz　　43.612 MHz　　　 40.012 MHz
- 3.620　　　　　3.808 MHz　　　39.82　　　43.628 MHz　　　40.008 MHz
- 3.640　　　　　3.640 MHz
- SOLUTION:　 Increasing PA idle to 0.360 Amps and decreasing Si5351 drive significantly reduced this….

- (red boxes in photo)
- All seemed to help except the one in the +V line to the PA finals – which hurt
- I added one additional 0.1 uF chip capacitor in parallel with
- C73 to filter the +V to the FSA3157 better
- C74 to filter the midpoint adjustment better
- C8 and 9 to filter the +V to the Si5351
- That made what appeared to be even further improvements to the 11th-harmonic/LO IMD mixing product such tht they were in the -44 to -50 dBcarrier range and of little further concern between 3.5 and 3.620 MHz. !

6. Removed ALL circuitry from +12 Analog Line

- +12VDC feeds all stages of Transmitter Amplifiers – switched ON/OFF for T/R

- **ANY** signal coupled to these stages via +V gets MIXED through their non-linearities-- ***and I had connected to that to run my circuit for external relays...***

- FAR better to make modifications that connect to the DIGITAL outputs directly from the Raspberry Pi….than to add even a few cm of wire to the ANALOG +12 lines

- With all these improvements, the DE was reasonably FCC-compliant.

Pull Ext PTT control from DIGITAL

- Completely avoid the +12 analog line!

- Solder to available Digital TX signal from Raspberry going to a CMOS switch.

- Opto-isolators have very little, if any, current gain!

+5 available 74LS08 pin 14
GND avail 74LS08 pin 7
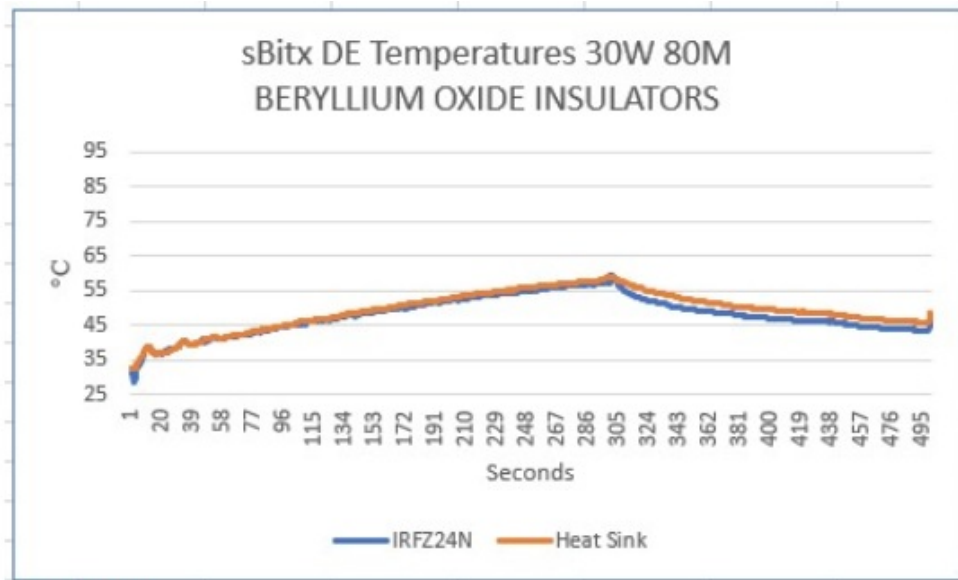TX avail 74LS08 2,5,10,13
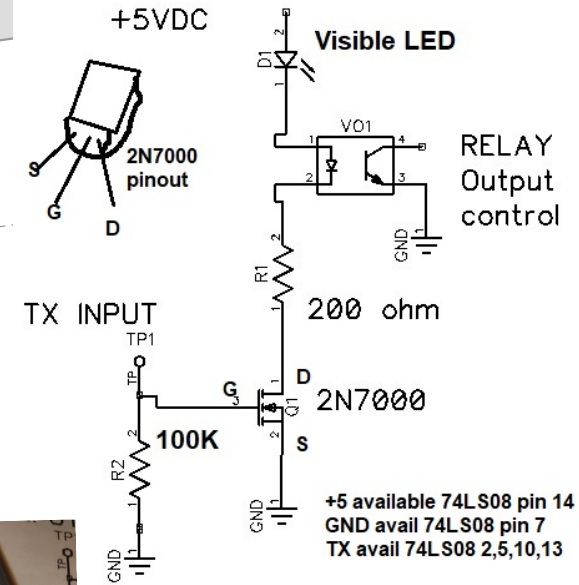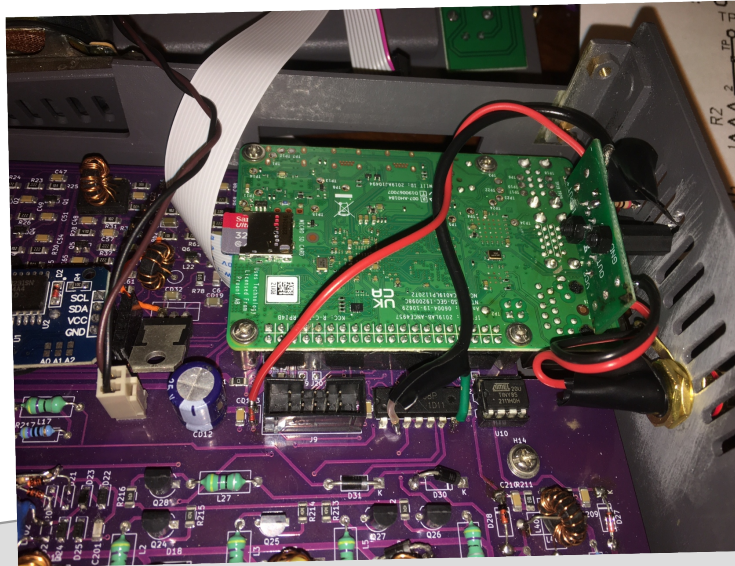
During DE installation

(Not connected up…. Just Positioned...
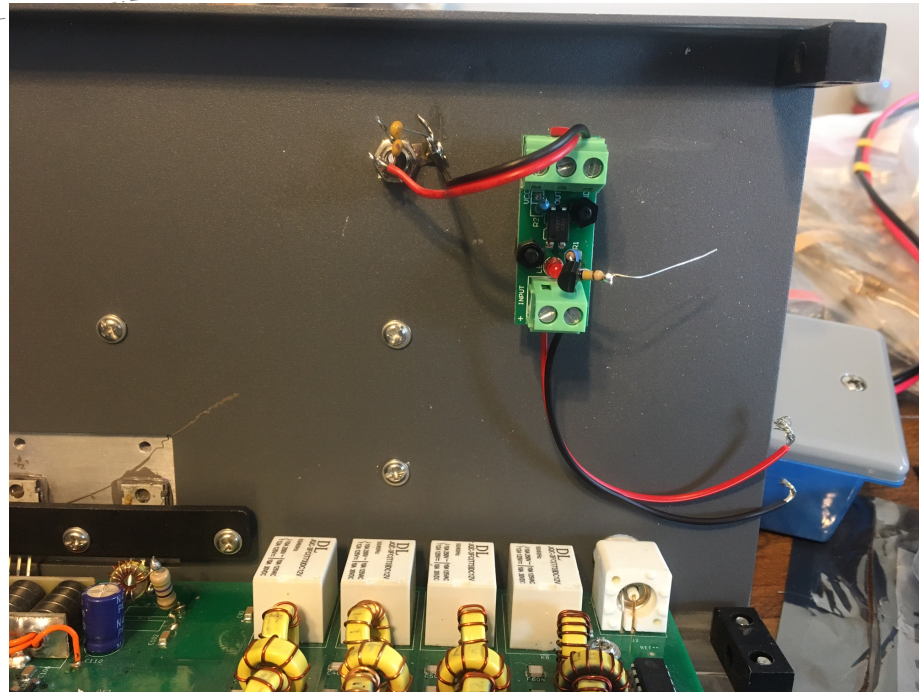
Aluminum Nitride Insulators

FAR better heat conduction from the MOSFET PA devices.

Work by Jack, N6LN. AlN about as good as beryllium oxide and less toxicity conccern.

sBitx DE Temperatures 30W 80M BERYLLIUM OXIDE INSULATORS

sBitx DE Finals Temperature, CW 30 watts 80M MICA INSULATORS

Jack, N6LN
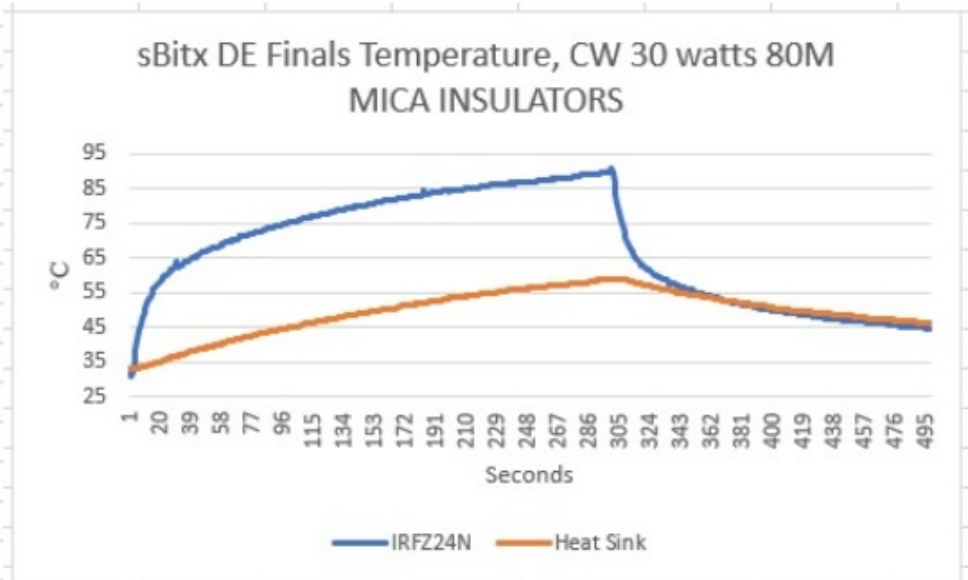
Version 2 hardware released!!

- BIG form factor change – much thinner!

- NO RELAYS AT ALL

- VERY IMPRESSIVE

- Possible concern over 80M IMDs (increase diode switching current)

- **Do I raise $$ and risk a purchase??**

Able to get a cast-off V2

- Owner: "Never transmitted"

- Received condition: Receiver works!

- Concluded careful study of the transmitter purity was in order

- CANNOT be certain what VOM measurements I made during this time…

- You'll understand why later...

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BIG PROBLEMS when measured

- HUGE spurs….. approx **-22dBc (way out of spec)**

- Weeks and Weeks of effort to figure out.

- Thread with hundreds of entries on BITX20

- Finally figured out

- IN PROCESS...learned a LOT about the design.
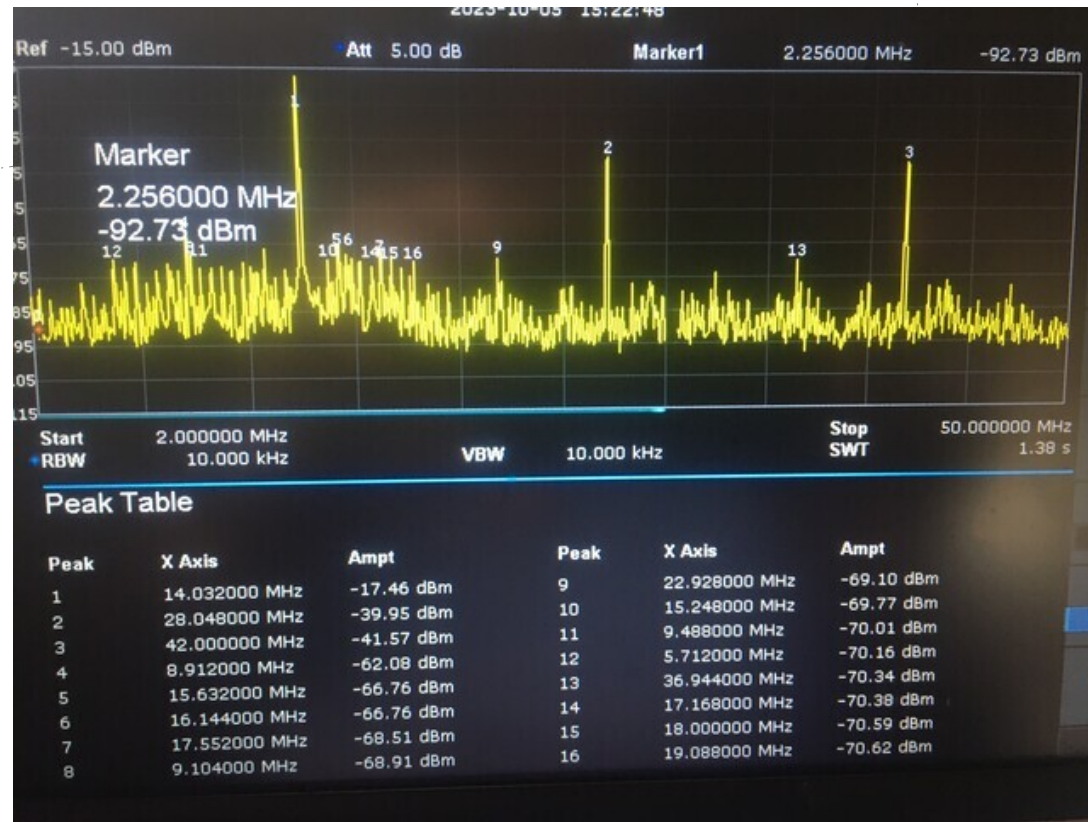
Divide and Conquer: Check Low Pass Filters

- First suspicion was inadequate low pass filtering.

- Opposite! Absolutely EXCELLENT!

- That's at least 55 dB of absolute isolation

- Would work even if harmonics SAME as fundamental!

- **Very impressive**
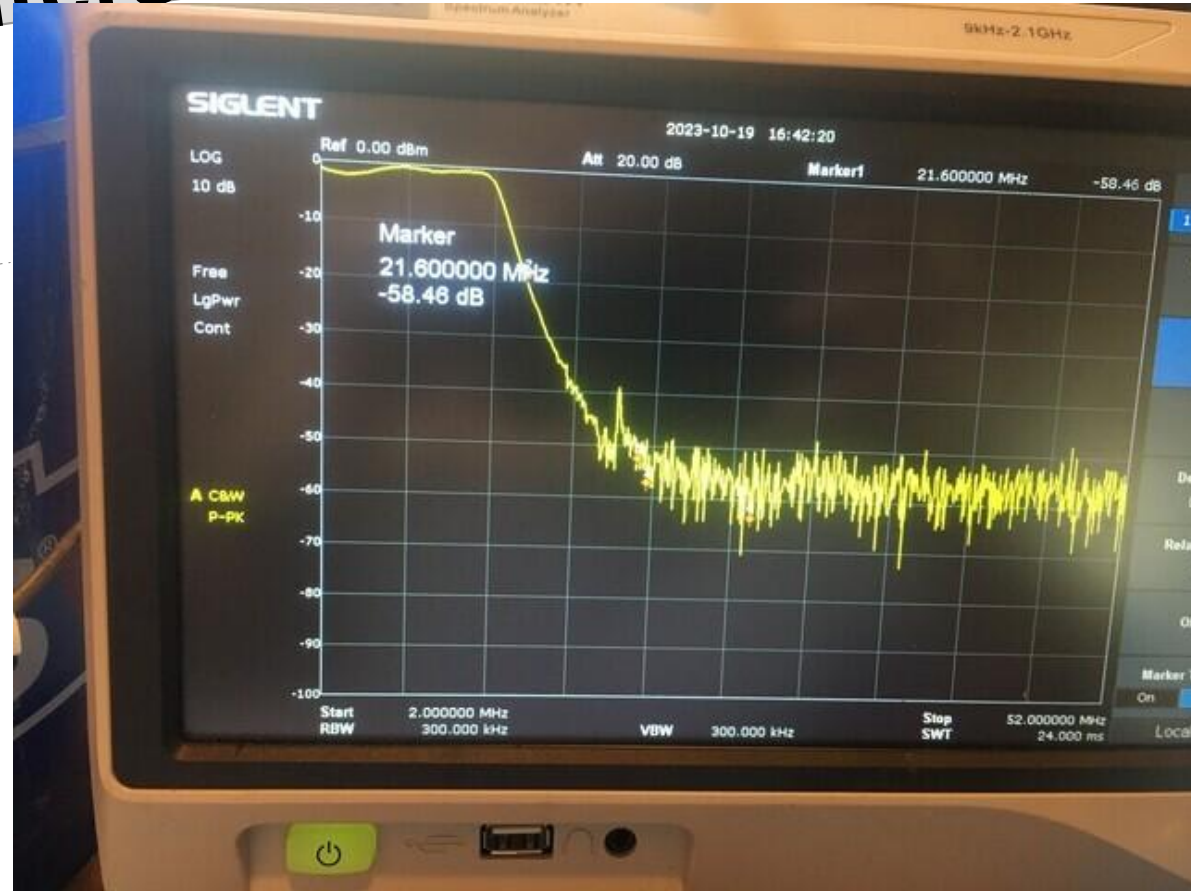
Check Direct Thru Filter

- Wired directly thru filter – good output!
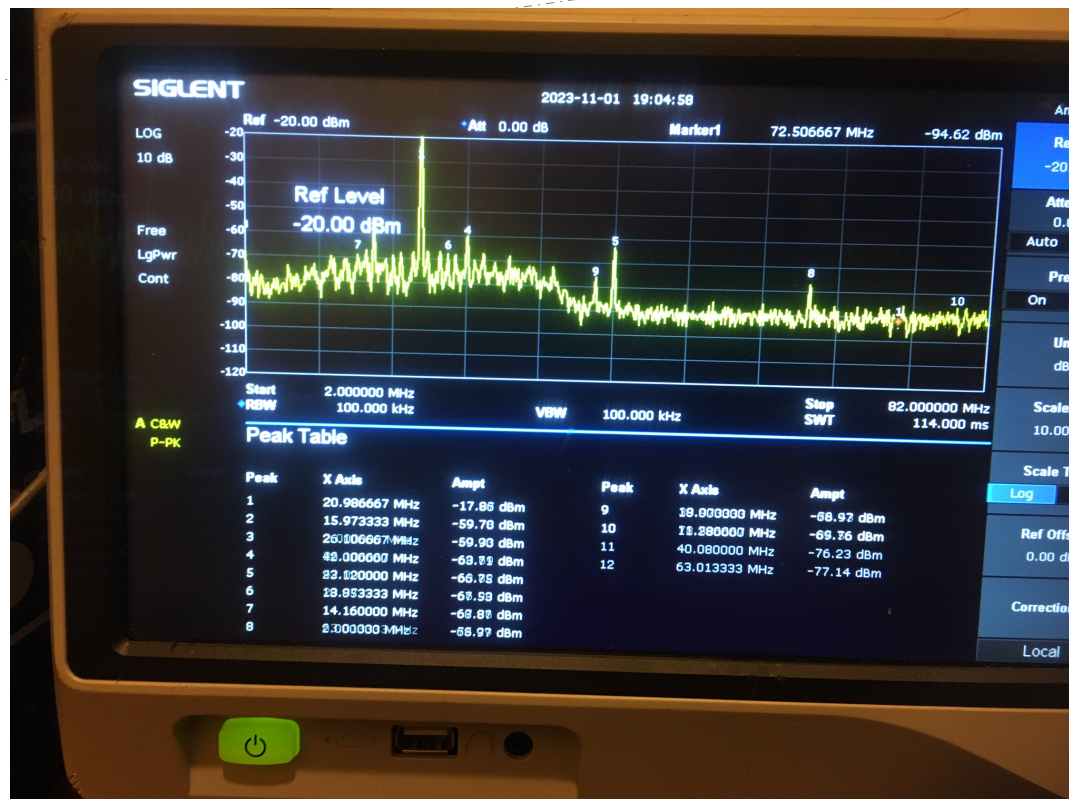
Blamed every diode in sight…

- Extensive testing to see which diodes added what spurs….relatively fruitless

- Tried with/without just about every switching diode posssible….

INPUT CONNECTED
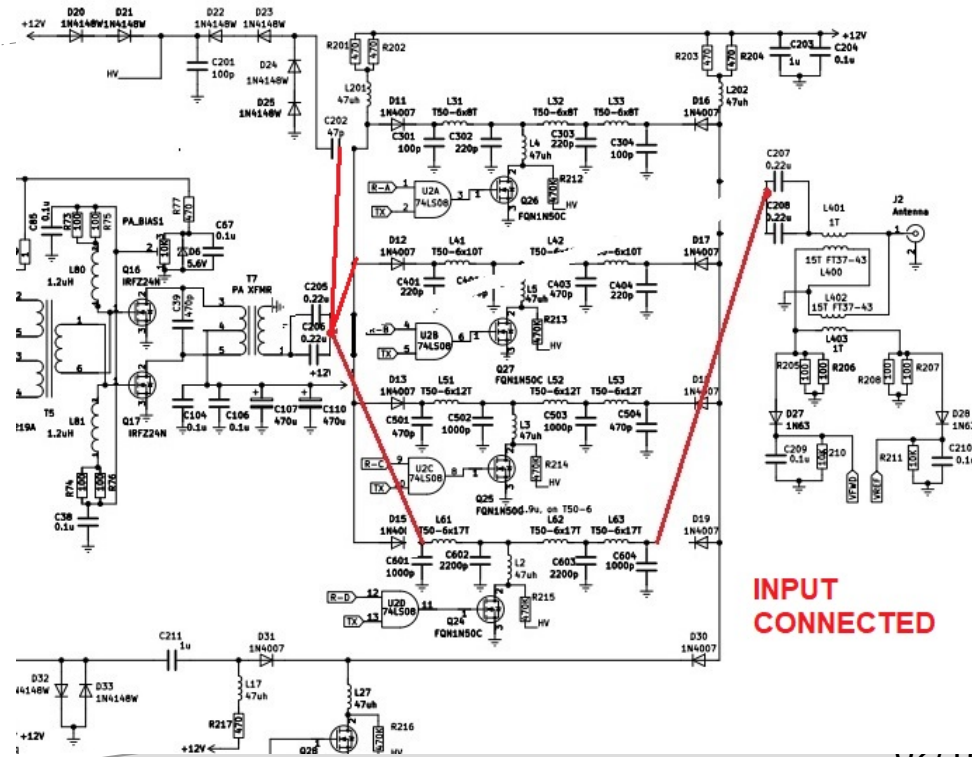
Finally:
signal is bypassing the filters
HOW?

- Multiple paths of control of switching diodes

- +12 can bias

- RF HV can bias

- Band control can bias

- On and on
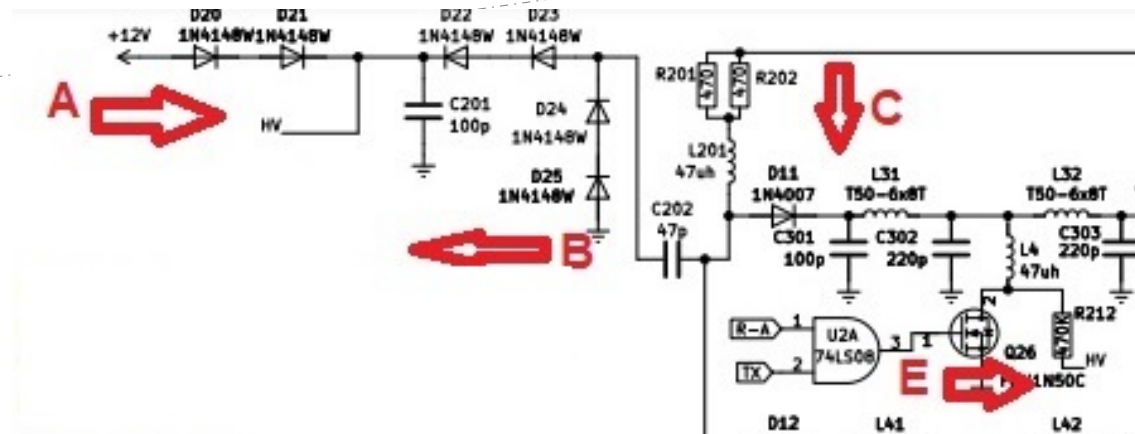
How is signal getting around?
Extremely complicated T/R Switching

- Multiple paths to control.

- Days and days of testing and adjusting different parts of the switching controls of the diodes….

- Hunting for how energy is bypassing the excellent filters...

Both D20 & D21 were shorted and thus badly loading down the RF Voltage Doubler - the "HV" signal was hobbled.
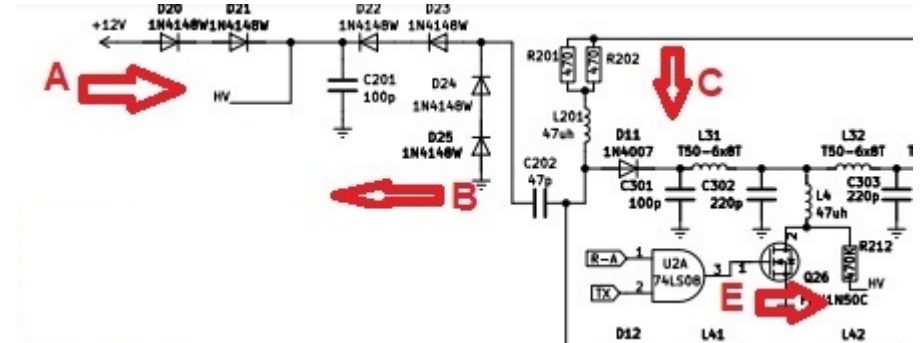
- No resistive current limit on D20 and D21. Direct connect to +12VDC

- An errant VOM lead could have fried them at any point.

- Added ~150 ohms in series as protective for them after repair.

- Works FINE

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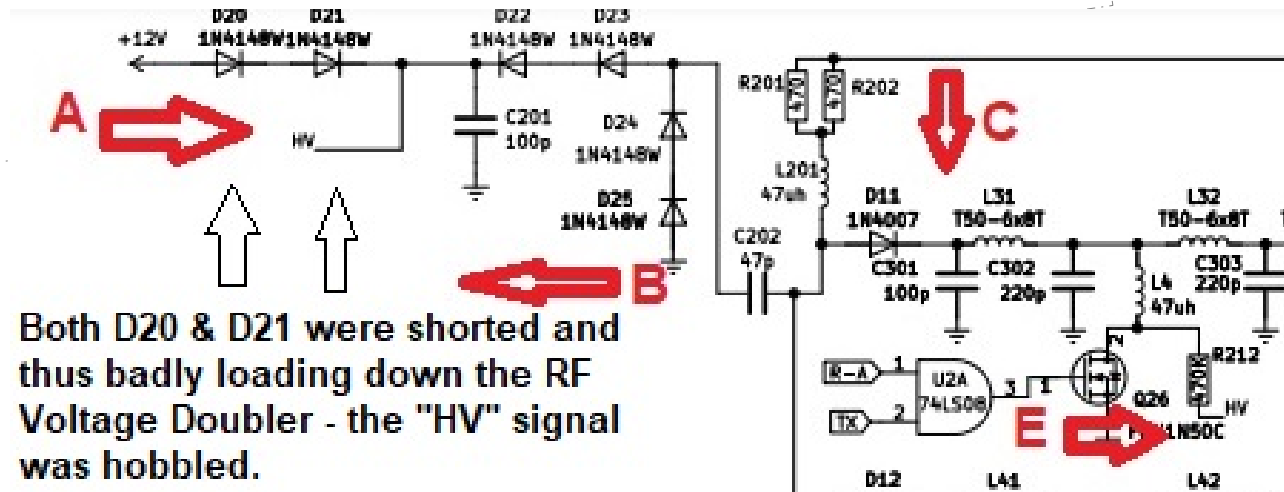
In the process… discovered Q101 was fried…. Somewhat risky MOSFET switching

Q9 and Q101 can potentially BOTH be on – a short across the power supply. One of the two will be toasted. And Q101 is much smaller!

Q9 is a powerful IRF4905
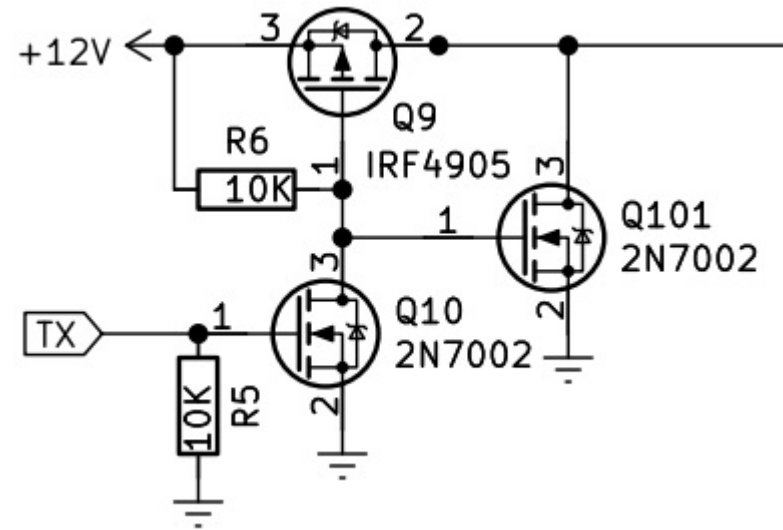
Fixes

- Allison had fixed it with RC delay

- I recommended 150-200 ohms in the drain of Q101 - protective
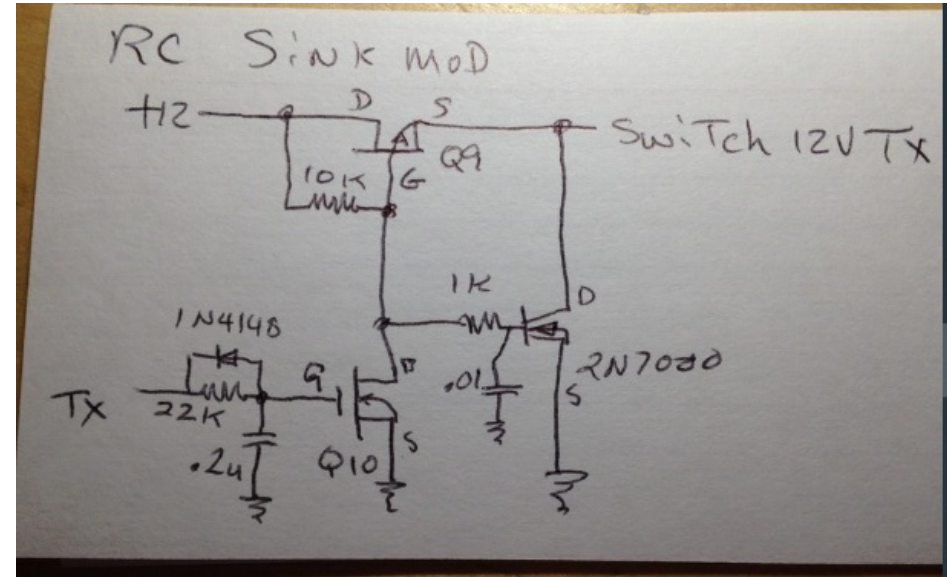
Software now includes HTML interface Remote operation easy.

Really working Unit now!

- Started using for various nets

- Created my own desktop mic for it

- (Hi-output electret, -24dB)

- Works FB into SB-200 vacuum tube amp

"Goal-directed microphone FFT filtering to improve intelligibility in the face of noise"

- Take advantage of the FFT representation of voice to add treble, cut bass and see if better intelligibilty in the face of added noise in the received signal...

MIC → FFT → FILTER: emphasize treble; cut bass → ⊗ → MODIFIED RF

CARRIER
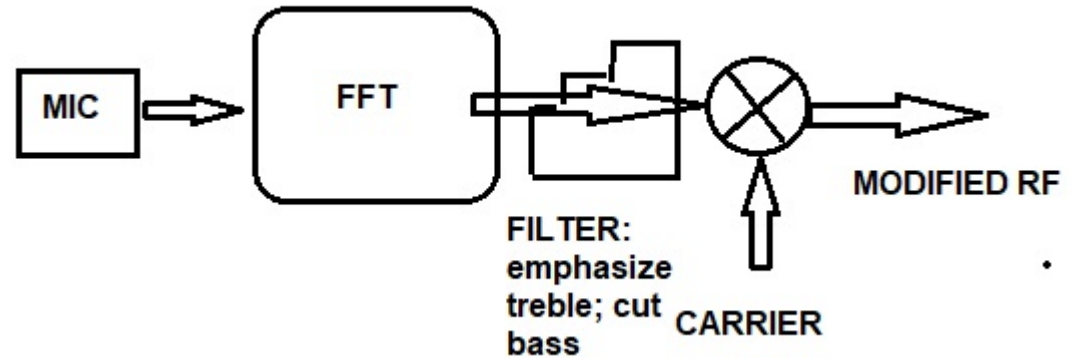
V3 Hardware/software

- December 14, 2023

- Improved software in many ways

- Better connection to CODEC

- Went down in power to IRF510, more stable, more resilient 25W

- Better documentation

02/18/24
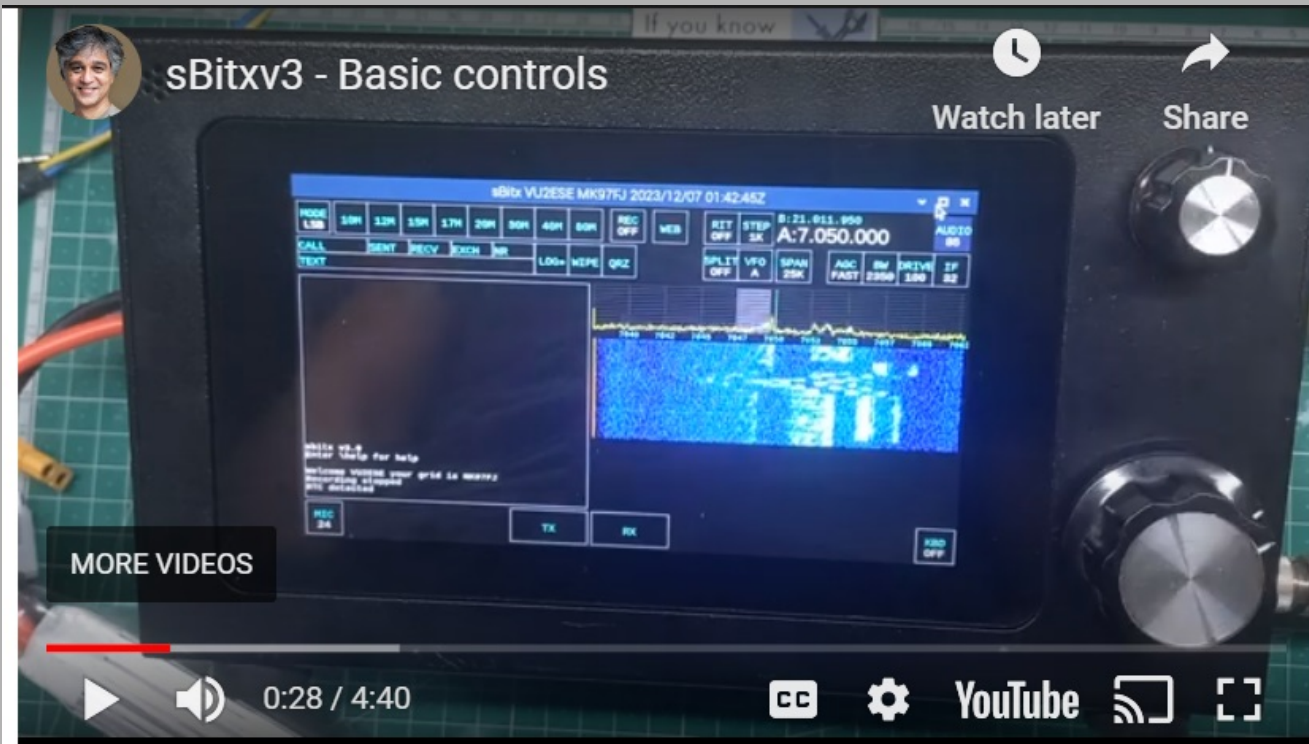
TELNET PORT API

- V3 addition from Ashhar

- Unidirectional: controls radio

- Port 8081

- ~ 56 commands

- Well documented.

- Allows 3rd party control, without having to edit sBitx code!
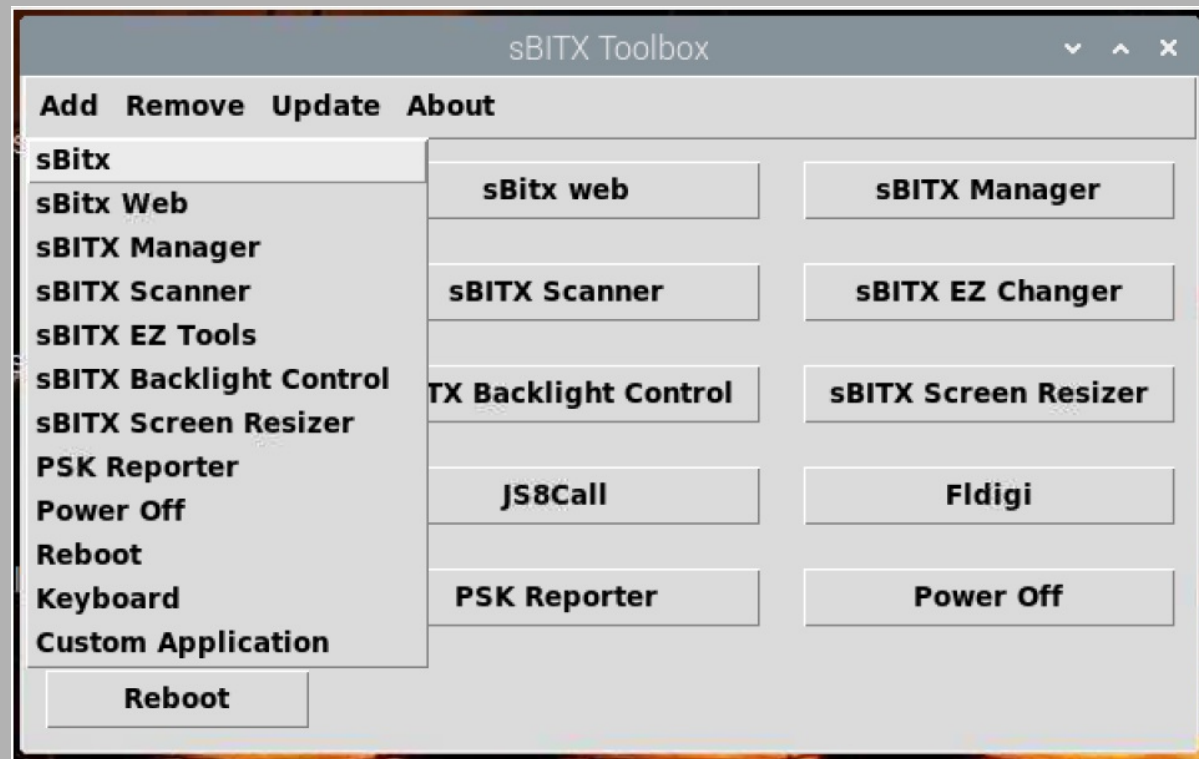
USER COMMUNITY AWAKENS

- Moves from fixing problems...to creating new utilities.
- JJ W9JES Creates sBitx Toolbox

ICOM EMULATOR

- Despite the BITX20 / Farhan efforts, unlikely to replace ALL extant ham radio software with Linux-compatible code on the Raspberry Pi

- Waste of effort?

- Legacy code doesn't normally connect over Internet ports….uses serial ports / USB

- Best to provide an EMULATOR

ICOM Emulator

Fascinating different views of what is actually important and useful in a new radio….

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Physical Layer: RS232 via UARTs

- UARTS provide in-built driver provision of Windows COM ports, and Linux / dev USB0

- Reliable at 115200 without handshaking
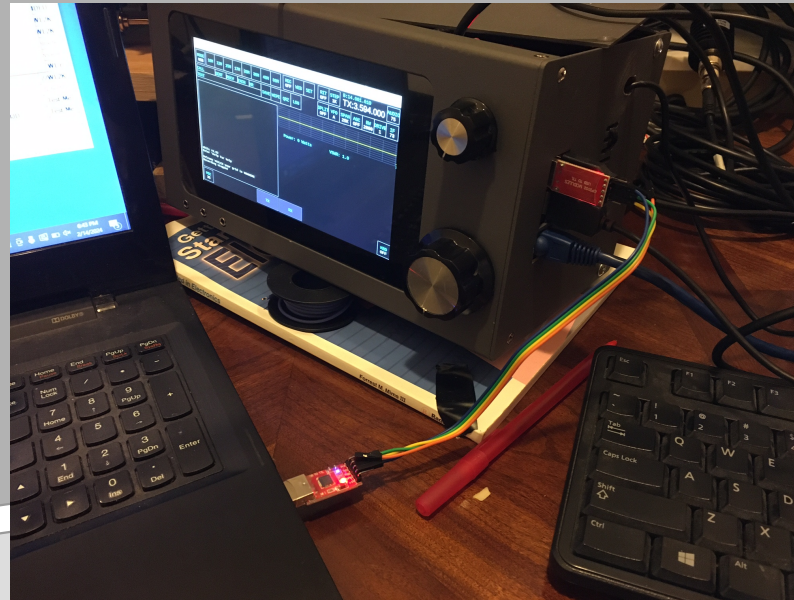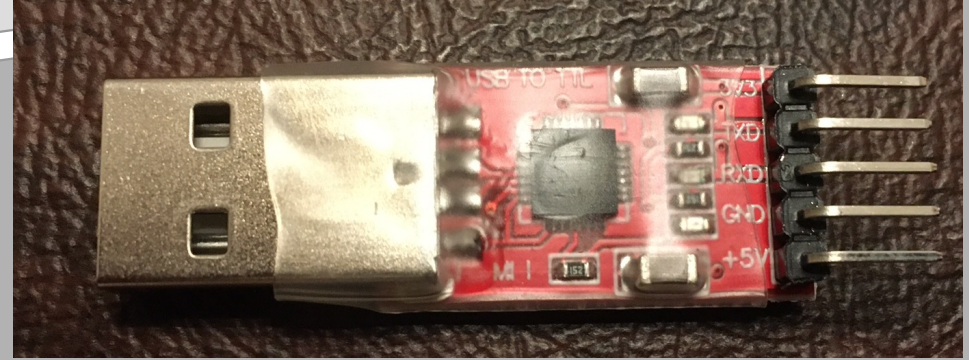
Ver 0.1 Interface Software

- Fixed / dev/ttyUSB0

- 115200 baud

- Unidirectional

- Implements FREQ control

- Implements TX

- Implements RX

- Adequate for WINLINK Client

- Adequate for WINLINK Server

- Adequate for ION2G ALE

Software:
https://qsl.net/nf4rc/Tech/icomemulator.zip

Groups.io wiki page:
https://groups.io/g/BITX20/wiki/36021

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```c
int main (void)
{
    fd_set    readfds, testfds;
    ssize_t rd;

    struct termios new_termios, old_termios;
    struct serial_struct sstruct;
        FILE *fp1;   // file pointer for capture file
        int    command, bytectr;  // GLG use
        printf("Hello, world!\n");
    printf ("SimpleTerm\n(c) 2005-2012 SCS GmbH & Co. KG, Hanau, Germany\npress CTRL-C to end program\n");
    if (lock_device (serdev) < 0)
    {
        // error
        fprintf (stderr, "Could not lock %s\n", serdev);
        return EXIT_FAILURE;
    }


    if ((ser = open (serdev, O_RDWR | O_NOCTTY)) == -1)
    {
        // Error
        fprintf (stderr, "Could not open %s\n", serdev);
        unlock_device (serdev);
        return EXIT_FAILURE;
    }

    if(socketstart()!=0 )
        {
            printf ("Could not open telnet socket \n");
```

My V2 Go-Box

- Radio

- 150W $50 power supply with no discernible RF hash

- Auto antenna tuner

- External soundcard system

- Custom power/current meter

My DE Go-Box (unfinished)

- Power supply and little else at time of writing.

Possible Demo of Winlink RMS (Server software)

VARA Winlink RMS Stations

Fascinating and working radio!

- $399 – in many ways, for hams who want to experiment, this is now a STEAL.

The END

"

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