Hamming it up on 24GHz...

...using Police Radars

Bertrand Zauhar, VE2ZAZ
ve2zaz@rac.ca
May 2012

Today's Program

- Why 24GHz for VE3WCC?
- Our 24GHz Police Radar Units
- The Police Radar Gunnplexer Application
- The Ham Radio Gunnplexer Application
- Proposed Electrical Implementations
- Test Results
- Improvements
- Hands on...

VE2ZAZ

Why 24GHz for VE3WCC?

- WCARC was given retired/defective K-band Police Radar heads.

- Possibility of adding the 24GHz Amateur band for Grid-Expeditions (June VHF Contest)

  – Payback is high in contest multipliers

    - **Each additional grid square worked on each band is a Multiplier,**
    - **Final Score: Total of QSO points** x **Multipliers.**

- Because it is cool!

- But how easy to put to use on the Ham band?

Our 24GHz Police Radar Units

- ## A typical M/A-Com Gunnplexer
  - ~ 5-10 mW RF output @ 24.125 GHz (Right within Ham band!)
  - Tx Gunn diode biased with 5 VDC @ 150mA
  - Standard cavity unit can support additional mixer diode(s)
  - Mechanically tunable. Covers several 100 MHz around 24GHz.
  - No electronic (varactor) tuning.

- ## Waveguide Assembly
  - Generates Circular Polarization. Designed for opposite sense of rotation Tx vs. Rx due to hard reflection (vehicle).
  - Has standalone Rx mixer diode, not part of Gunnplexer

- ## Horn
  - Funnel-shaped, no wave shaping feature inside horn, has focusing lens. 12-degree beam width.

- ## Complex electronics
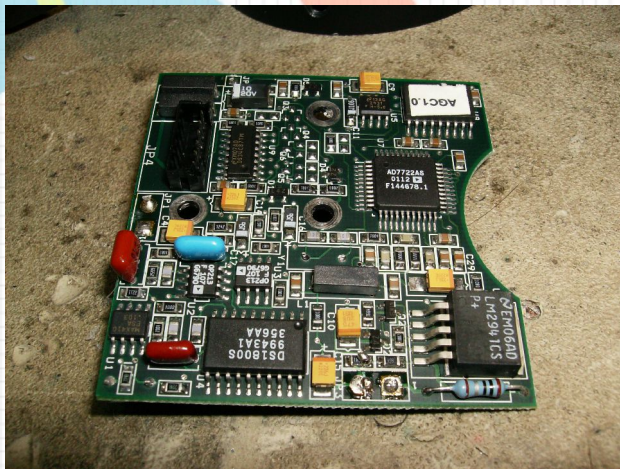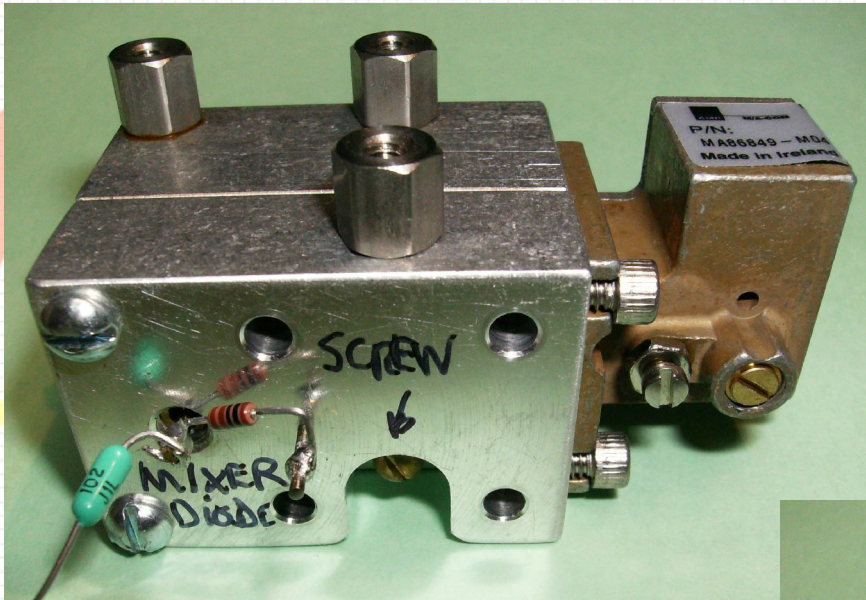 - To derive vehicle speed vs. doppler IF frequency. DC supplies

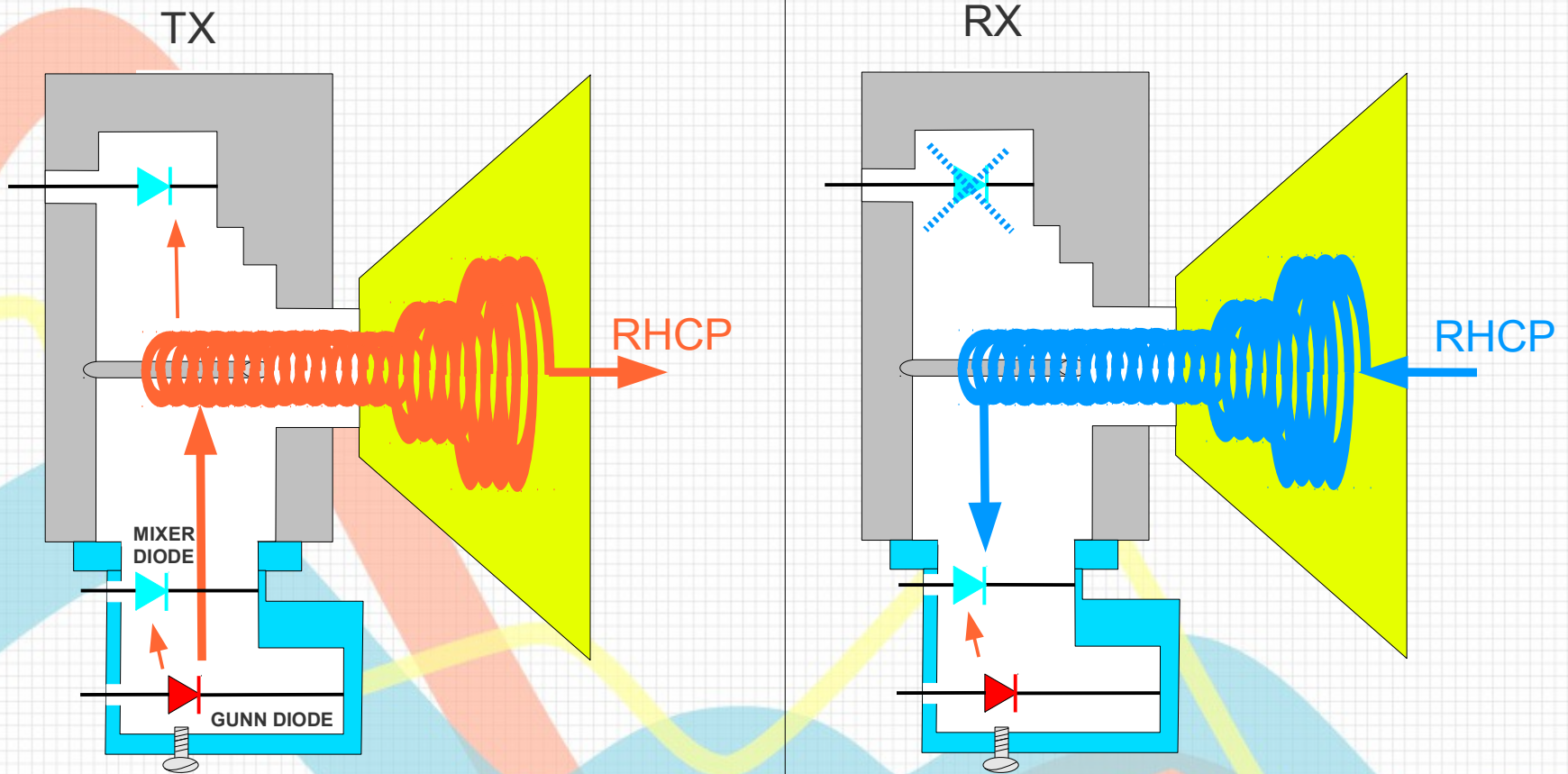VE2ZAZ

The Police Radar Gunnplexer Application

TX

RX

MIXER
DIODE

RHCP

LHCP

GUNN DIODE
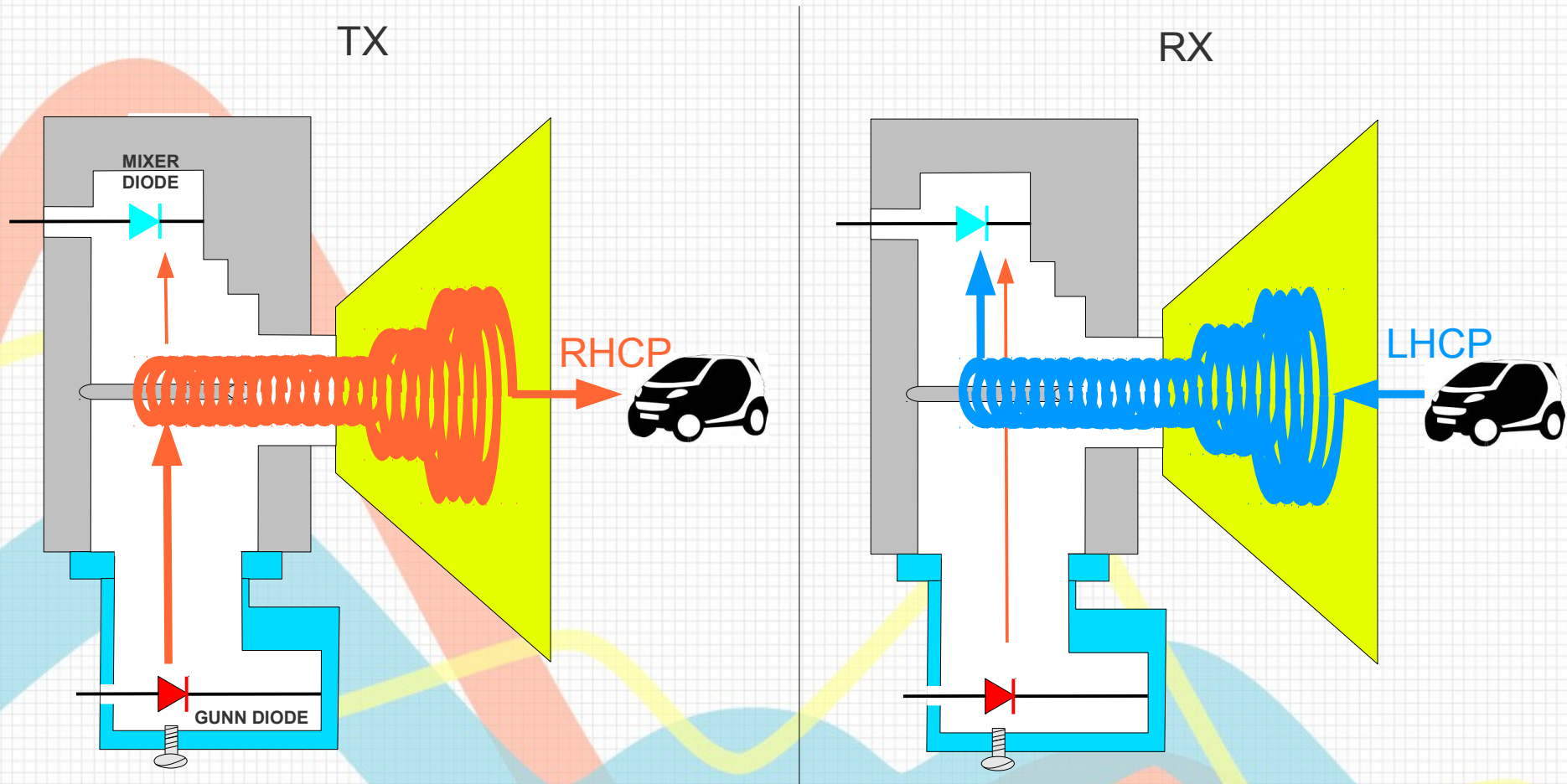
- Opposite senses of rotation on circular polarization
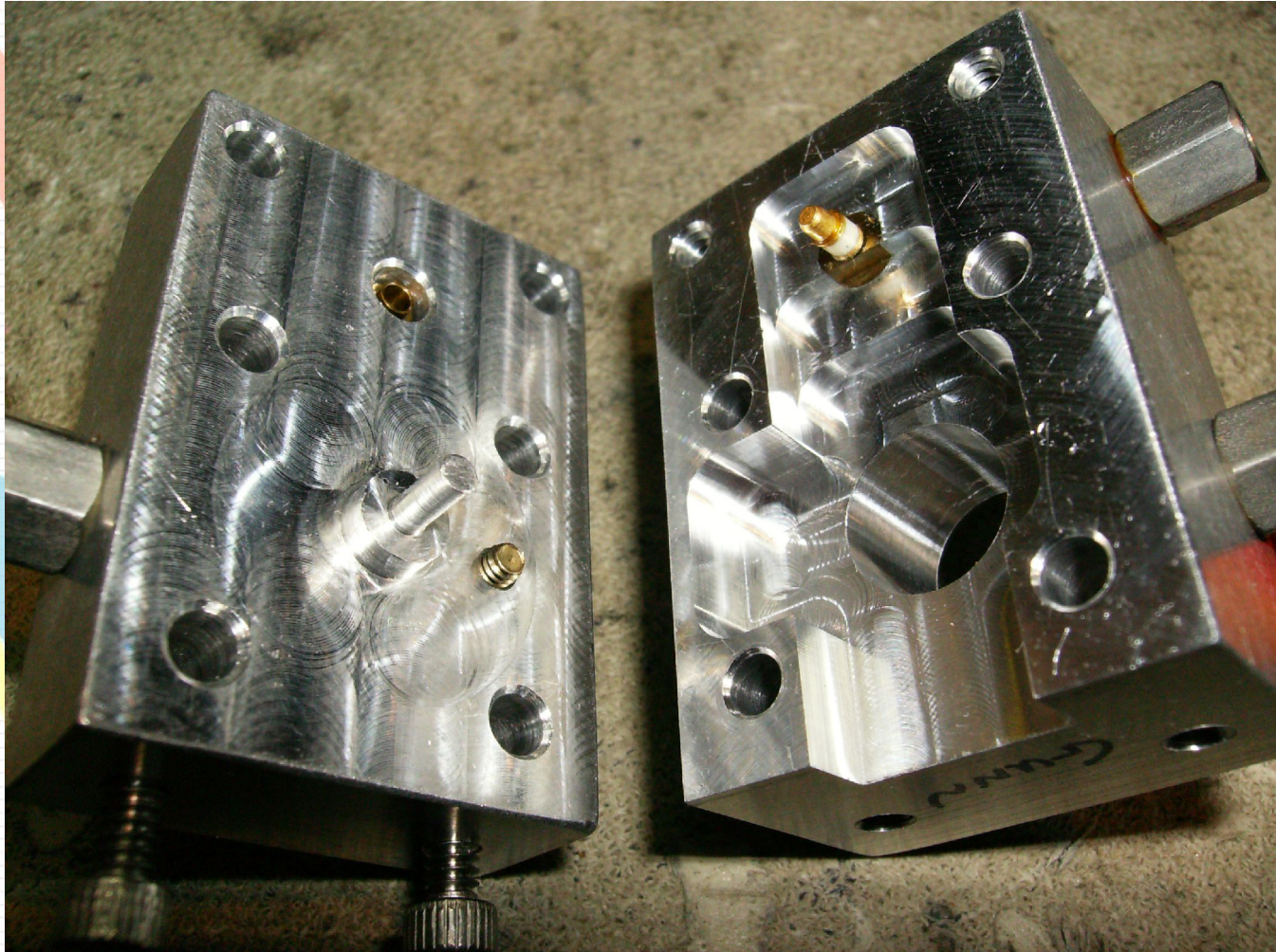
VE2ZAZ

5

The Inner Guts...
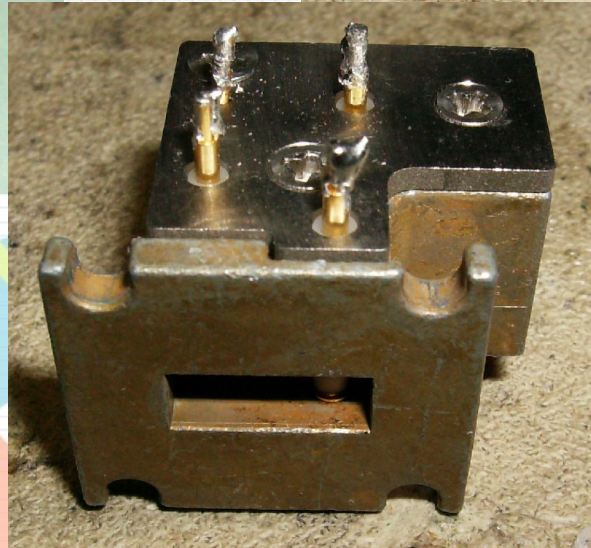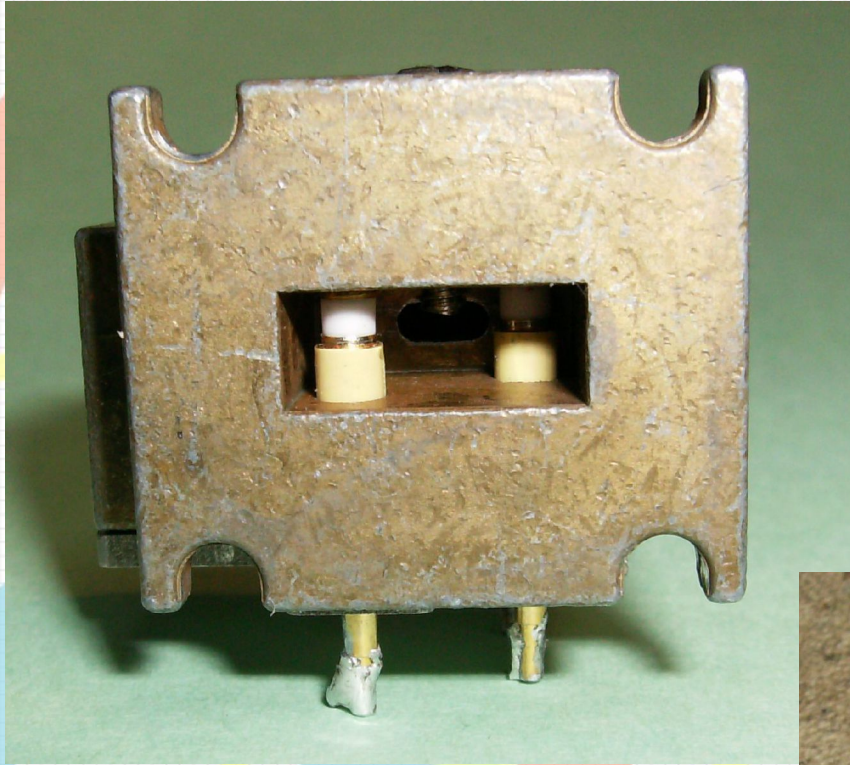
The Ham Radio Gunnplexer Application

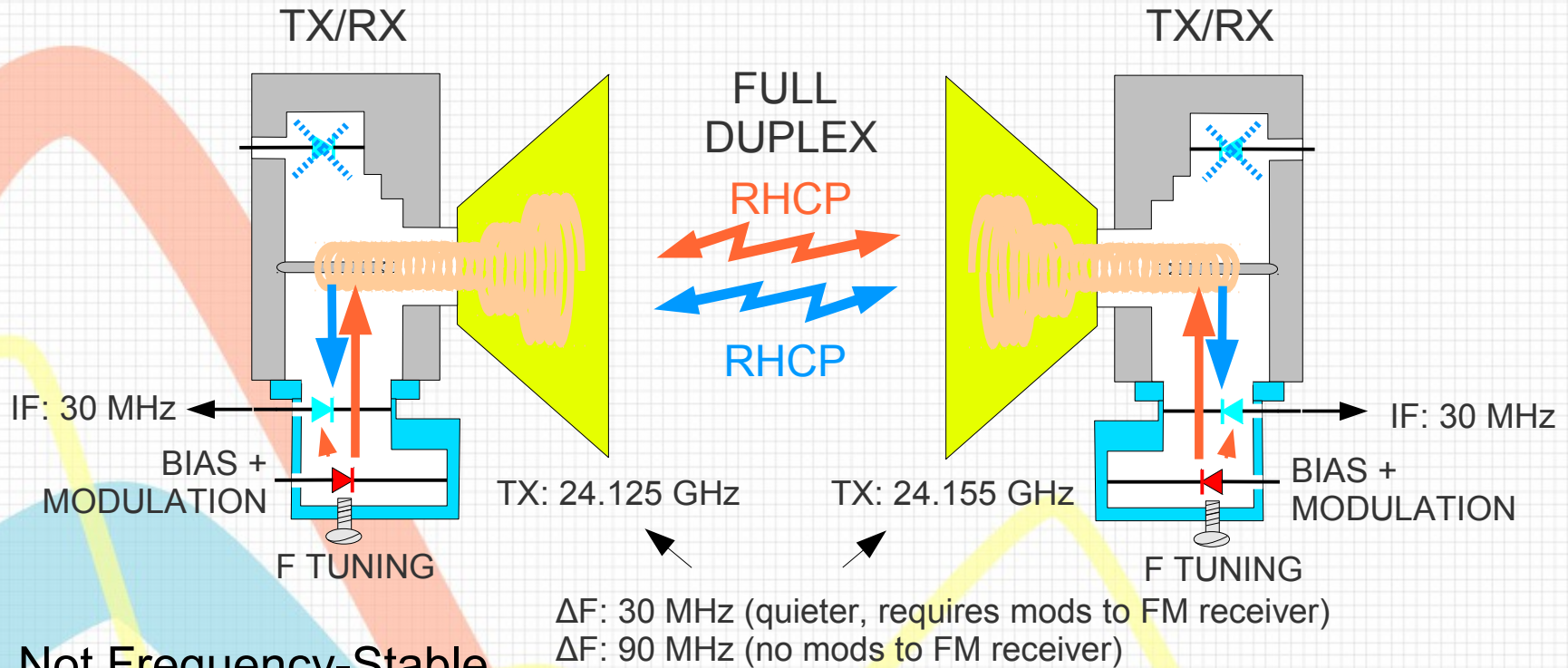- Same Sense of Rotation on Circular Polarization
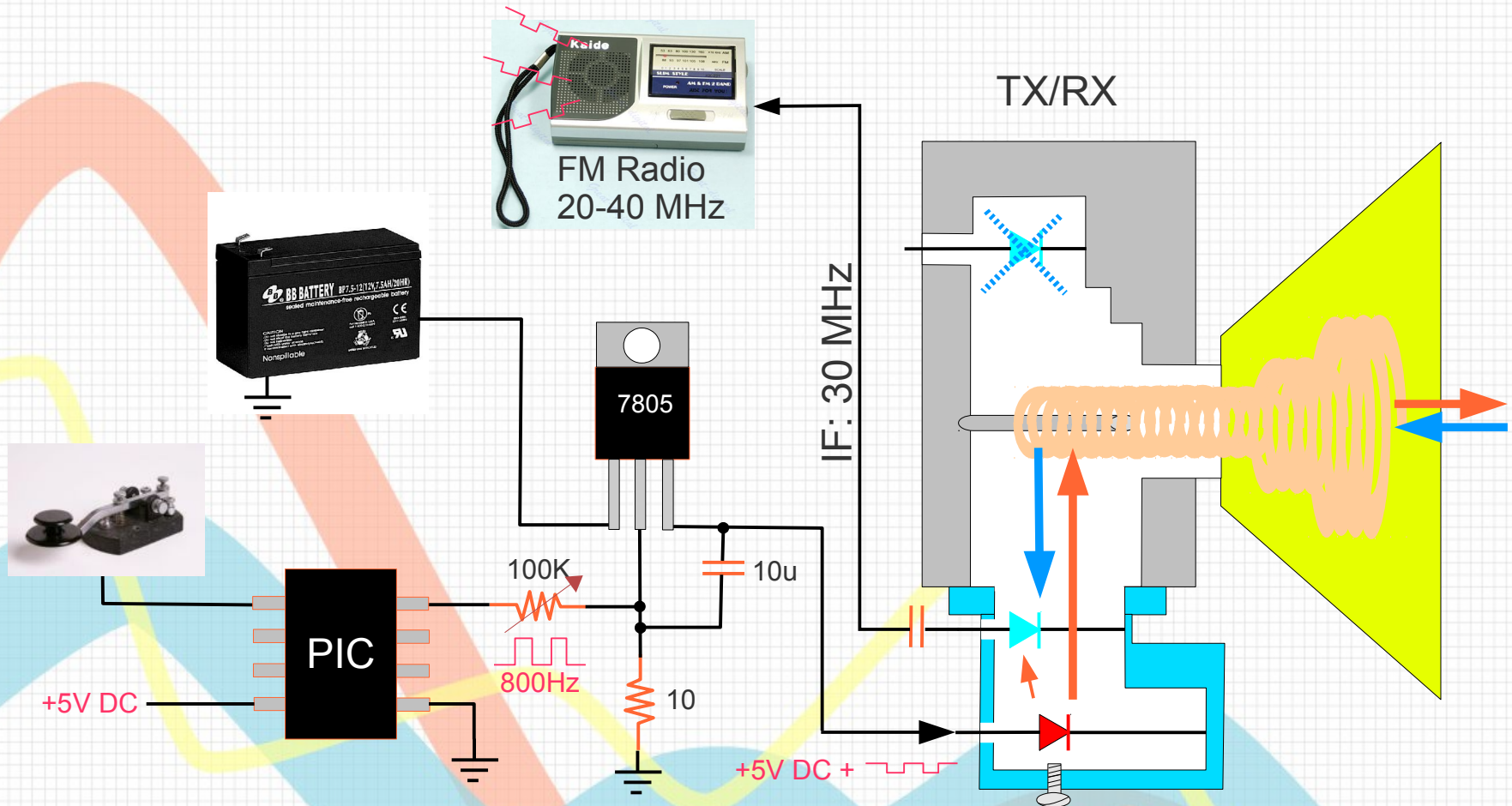
More Inner Guts...

Even More Inner Guts...

The Ham Radio Gunnplexer Application

TX/RX   TX/RX

FULL DUPLEX

RHCP

RHCP

IF: 30 MHz   IF: 30 MHz

BIAS + MODULATION   BIAS + MODULATION

F TUNING   TX: 24.125 GHz   TX: 24.155 GHz   F TUNING

ΔF: 30 MHz (quieter, requires mods to FM receiver)
ΔF: 90 MHz (no mods to FM receiver)

- Not Frequency-Stable
  - Gunnplexer not enough stable (Temp, Bias) to produce Narrowband RF
  - Will use F vs. Bias characteristics to our advantage
- Wideband FM
  - Target is 75 KHz deviation, 200 KHz bandwidth
  - Similar to broadcast FM radio

VE2ZAZ

Proposed Implementation

FM Radio
20-40 MHz

TX/RX

IF: 30 MHz

BB BATTERY

7805

100K

800Hz

10u

10

PIC

+5V DC

+5V DC +

- CW easier to implement than voice audio. No audio feedback problem.
- Warbler feature also included, easier to locate with the FM radio.
- Local CW sidetone through IF radio.

Alternate Modulation Injection

FM Radio
20-40 MHz

TX/RX

PIC

800Hz

+5V DC

7805

1000 Ohms

IF: 30 MHz

10u

10

+5V DC +
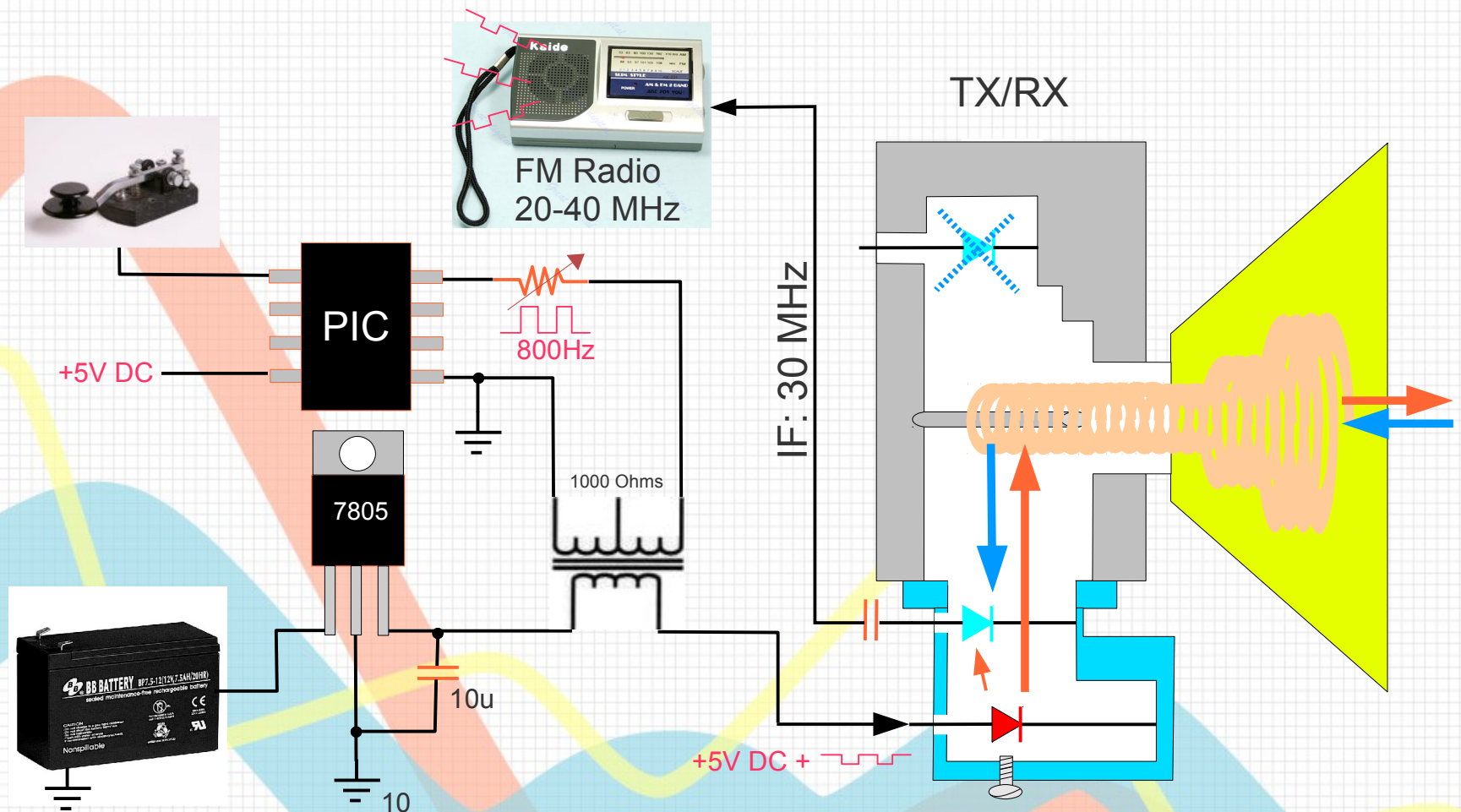
- Also works well using AF transformer. More $, more scarce, bigger.
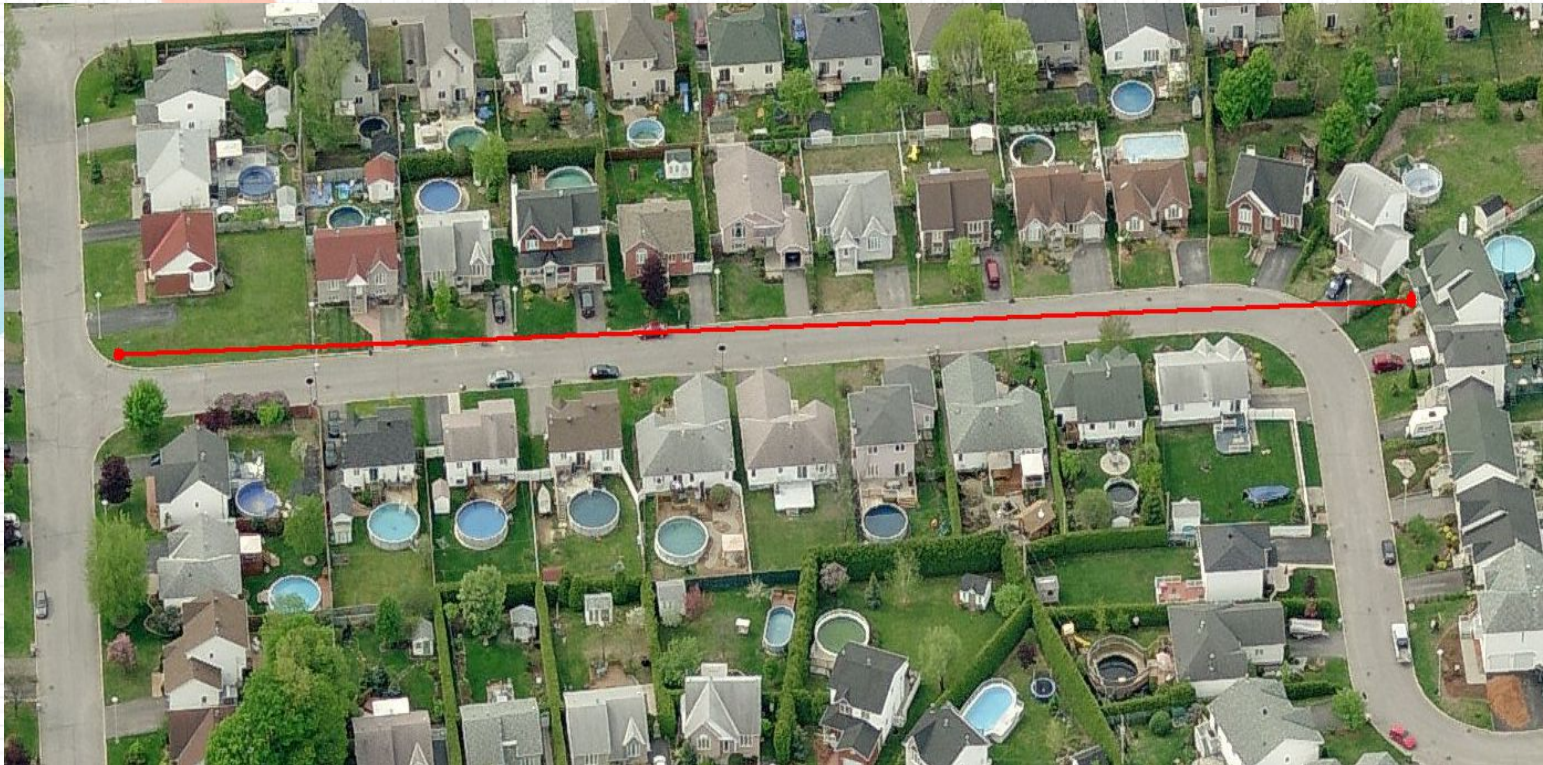
Implementation
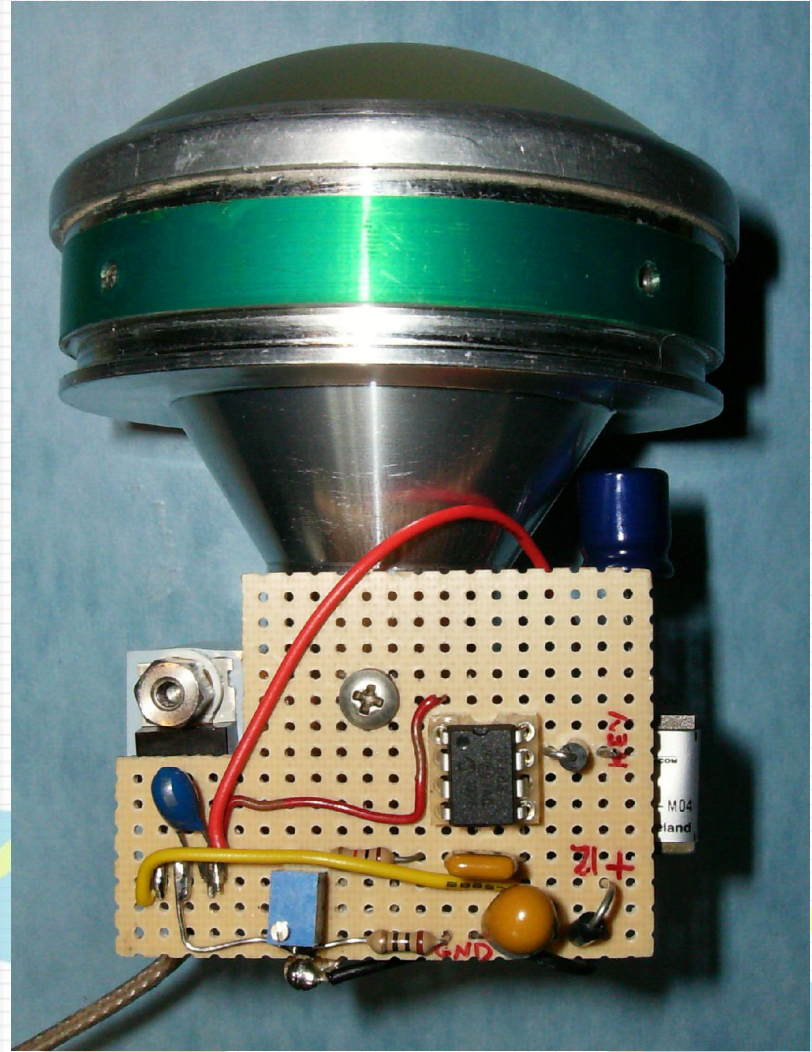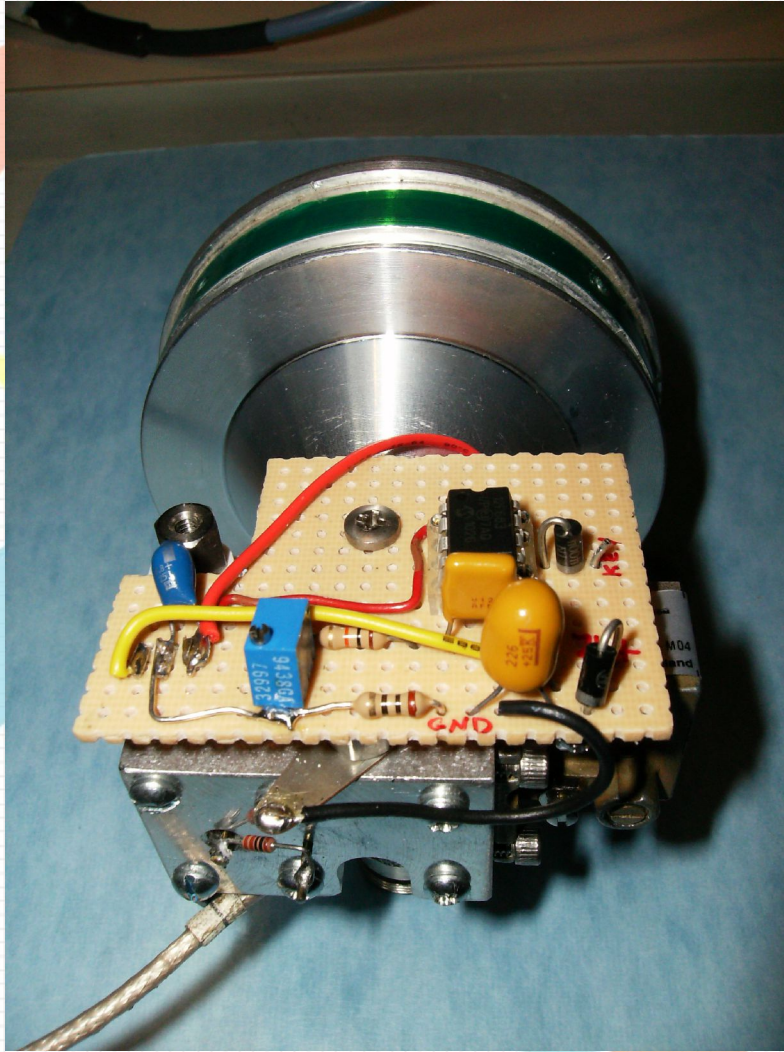
First Tests

- Un-modified FM receivers – Tuned to 88 MHz.

- 20 feet in basement through full bookshelf, wall and glass insulation mats. Q5 copy.

- 100 feet outdoors, direct path. Q5 copy

More Testing...

- Modified FM receivers – 20 to 40 MHz Tuning.

- 622 feet outdoors, still Q5 copy.

- Significant frequency drift when exposed to sun or high winds.

Improvements

- Add 30MHz IF preamplifier with input bandpass filter,
- Add Voice Modulation,
- Modify more units (we have 5 in total),
- Add a band spread control on FM receivers,
- Add FLL or PLL for longer term stability.

How I First Tested Gunnplexers at 24 GHz?
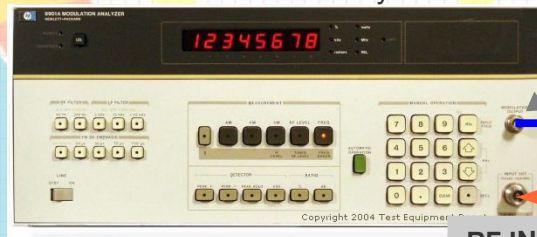
FLUKE 27 DDS Function Generator

MODULATION

Semi-Rigid, Center exposed
1/4 Wavelength = 3.1 mm

HP 5350B Microwave Freq. Counter

RF IN

IF OUT

MODULATION OUT

HP 8901A Modulation Analyzer

RF IN

AUDIO AMP

References

- The Gunnplexer Cookbook
  - 72.52.208.92/~gbpprorg/mil/radar/The_Gunnplexer_Cookbook.pdf
- The Gunn diode (Wikipedia)
  - http://en.wikipedia.org/wiki/Gunn_diode
- An Introduction to 10 GHz Wideband Operating in Ontario (KWARC, 1999)
  - http://www.kwarc.org/10ghz/10GHZ-4.htm
- An Introduction to 24 GHz (KWARC)
  - http://www.kwarc.org/10ghz/24g.html
- M/A-COM MACS-007802 24GHz Gunnplexer
  - http://www.macomtech.com/datasheets/MACS-007802-0M1RS0.pdf

Thanks...

Now Hands On!

VE2ZAZ