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RF0

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May 10th, 2025

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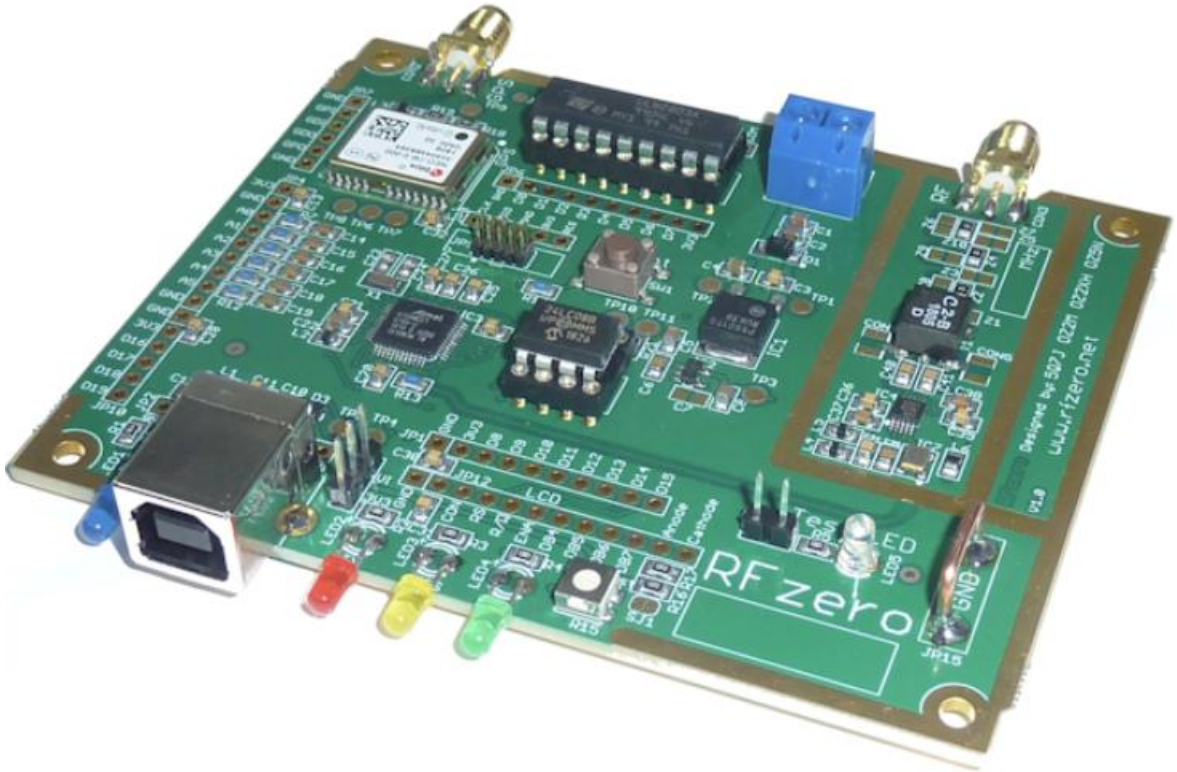
RFzero!



RFzero!

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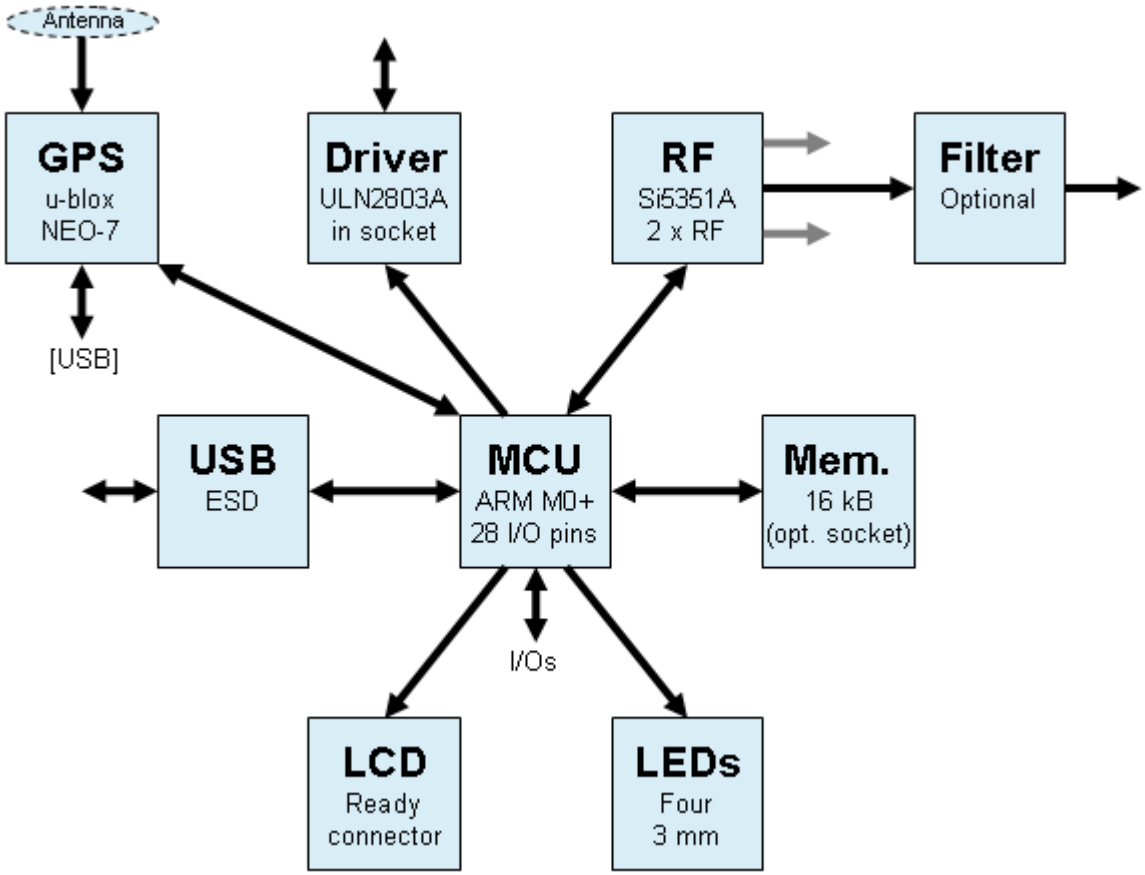


Components

- GPSDO (u-blox NEO-7M) 10 MHz for local/shop usage
  - 1 PPS accuracy
  - On-board pre-amp voltage
  - Sensitivity better than -147 dBm
  - Output power 13 dBm
- RF generator (SiLabs Si5351A) ~2kHa to ~300 MHz + harmonics
  - Harmonics usable beyond 1 GHz
  - Output balanced, split or combined
    - More power,
    - Better spectrum,
    - I/Q signals or
    - Two-tone generator
  - Frequency resolution 1 Hz
  - Output power 13 dBm (>1 Mhz), Attenuator control
  - Separate power supply

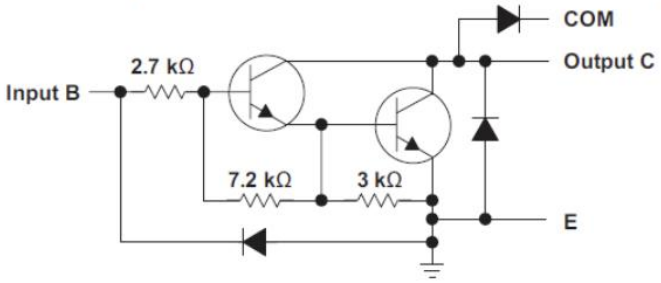
Processor comparison

- MCU (Cortex ARM M0 Microchip ATSAMD21G (Atmel)

	Rfzero	Arduino Zero	Uno/Namo
Clock	48 MHz	48 MHz	16 MHz
Clock type	crystal, 10 PPM	crystal, 20 PPM	Ceramic, ½%
Architecture	32 bits ARM	32 bits ARM	8 bits RISC
Program mem	256 kB	256 kB	32 kB
EEPROM	16 kB	None	1 kB
SRAM	32 kB	32 kB	2 kB
ADC	12 bits	12 bits	10 bits
DAC	10 bits	10 bits	None
I/Os free	28	13	11

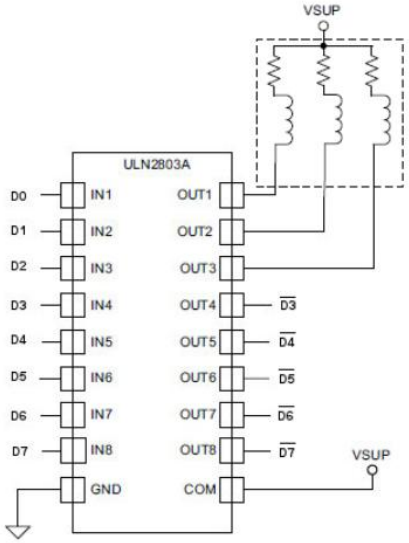
ULN2803A to drive loads

Functional diagram for one channel of the ULN2803A. Picture courtesy Texas Instruments.



When the COM pin is tied to the coil supply voltage the ULN2803A is able to drive inductive loads and suppress the kick-back voltage through the internal free wheeling diodes.

Diagram for connecting inductive loads, e.g. relays. Picture courtesy Texas Instruments and own work.



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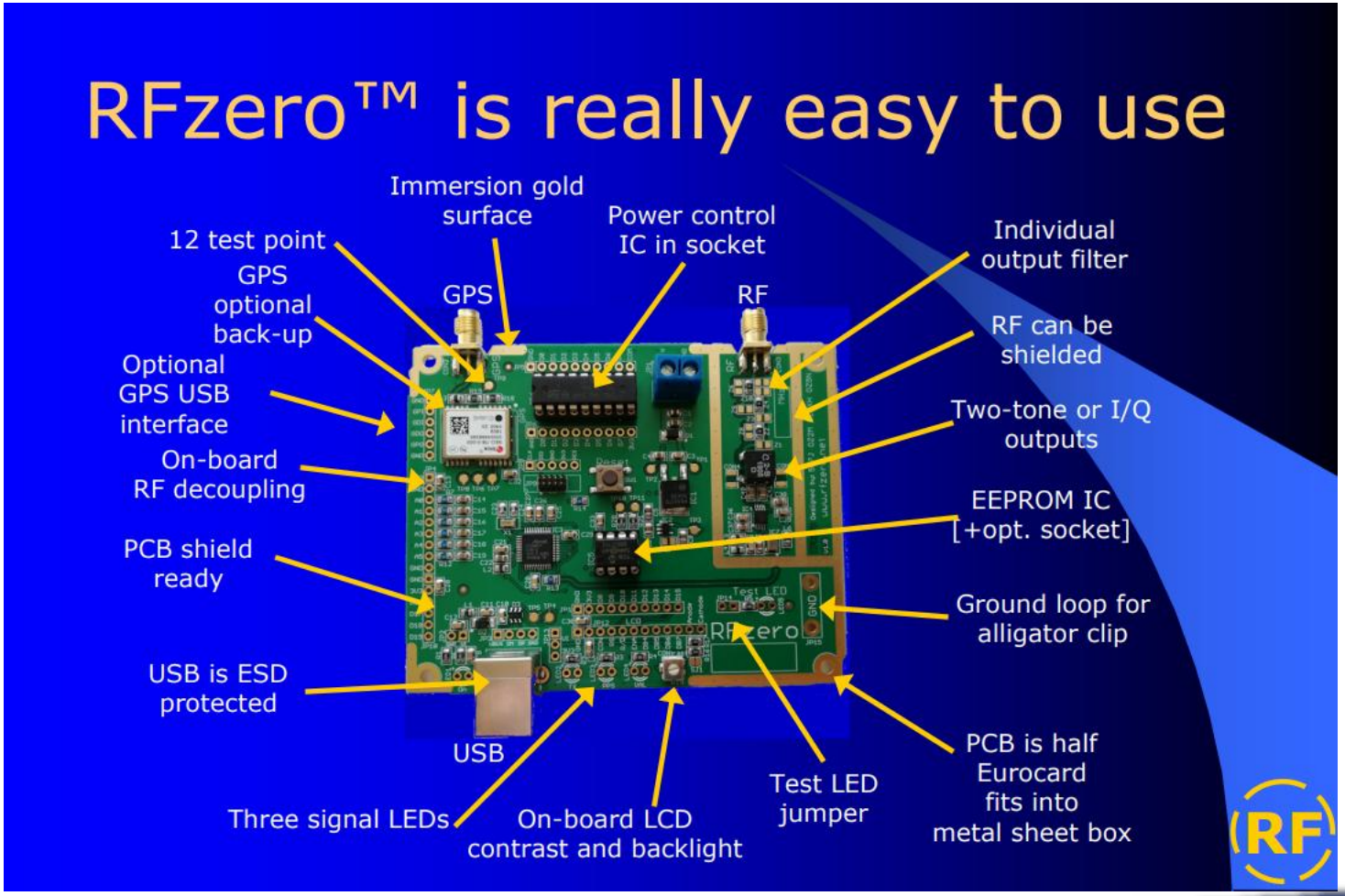
The RF0 board



CW or mixed mode beacons

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Frequencies from 2289 Hz to ~ 300 MHz (or harmonic)
CW + carrier
FT4 + CW + carrier
FT8 + CW + carrier
JS8 + CW + carrier
JT4 + CW + carrier
JT65 + CW + carrier
Q65 + CW + carrier
RTTY x 5 + CW + carrier
WSPR
Frequency compensation for multipliers up to 72 GHz

Configuration

- Use Arduino development environment
  - Access pre-written Arduino sketches and install them. Modify them.
- Use the RFzero Manager
  - Allows configuration of existing Arduino sketches and downloading them to the board.
- Use both!
  - Customize whatever you want.
  - Roll your own Arduino code.
  - For the beacon, use a mixed mode beacon sketch (pre-written), configure the sketch for our use and then modify this sketch to add the other stuff we need related to polling the Hologram card, setting DC control relays, etc. This eliminates the need for a separate Arduino!

Configuration


```
config
config
Unknown command
RFzero config>
rd cfg
rd cfg

Software
========
RFzero library :: Beacon Q65 + CW + carrier :: v.1.8.0

Configuration
=============
T1: 0: transformer*, 1: combiner, 2: none        : 0
Display: 0: none, 1: 16x2, 2: 20x4*, ...         : 1
PCF8574 I2C addr: 0, 0x20 to 0x27, 0x38 to 0x3F  : 00
Warm up before transmitting: 0* to 255 s         : 0
Curr. level: 0: 2 mA, 1: 4 mA, 2: 6 mA, 3: 8 mA*: 3

Wait for valid GPS before TX: 0: no*, 1: yes     : 0
Echo GPS data to USB 0: off*, 1: on, 2: all      : 0

Nominal beacon frequency in Hz                   : 144360000
Calibration interval: 1 to 255, 5*               : 5
Keying style: 0: OOK, 1: FSK*                    : 0
CW speed: 1 to 255 ms, 100 ms* = 12 WPM/60 LPM   : 100
Call, max 15 characters                          : KM5PO/B
Locator, max AA00AA00                            : EM12IL56
MGM, max 13 characters in Q65                    : KM5PO Q65 BCN
Q65 mode: 0: 15A*, 1: 15B, 2: 15C, 3: 15D, ...   : 6

*: default value

RFzero config>
```

Configuration

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The RFzero Modes library

Constants and enums +

calculateTones() +

calculateTonesMulti() −

Usage

```
bool val = Modes.calculateTonesMulti(double fnom, CalcTones_t tones, uint8_t
multiplier);
```

Functionality

Calculates the register values for the tones for entire sequence relative to the nominal frequency and taking the multiplier value into account. The tones can be for the CW part only, the MGM part only, carrier with 800 Hz CW modulation tone offset and MGM tones or all of them.

Parameters

double fnom: the nominal frequency
CalcTones_t tones: the tones to calculate (TONES_ALL, TONES_CMM, TONES_CW or TONES_MGM)
uint8_t multiplier: the multiplier value from 1 to 255

calculateTonesReversed() +

Testing

Testing

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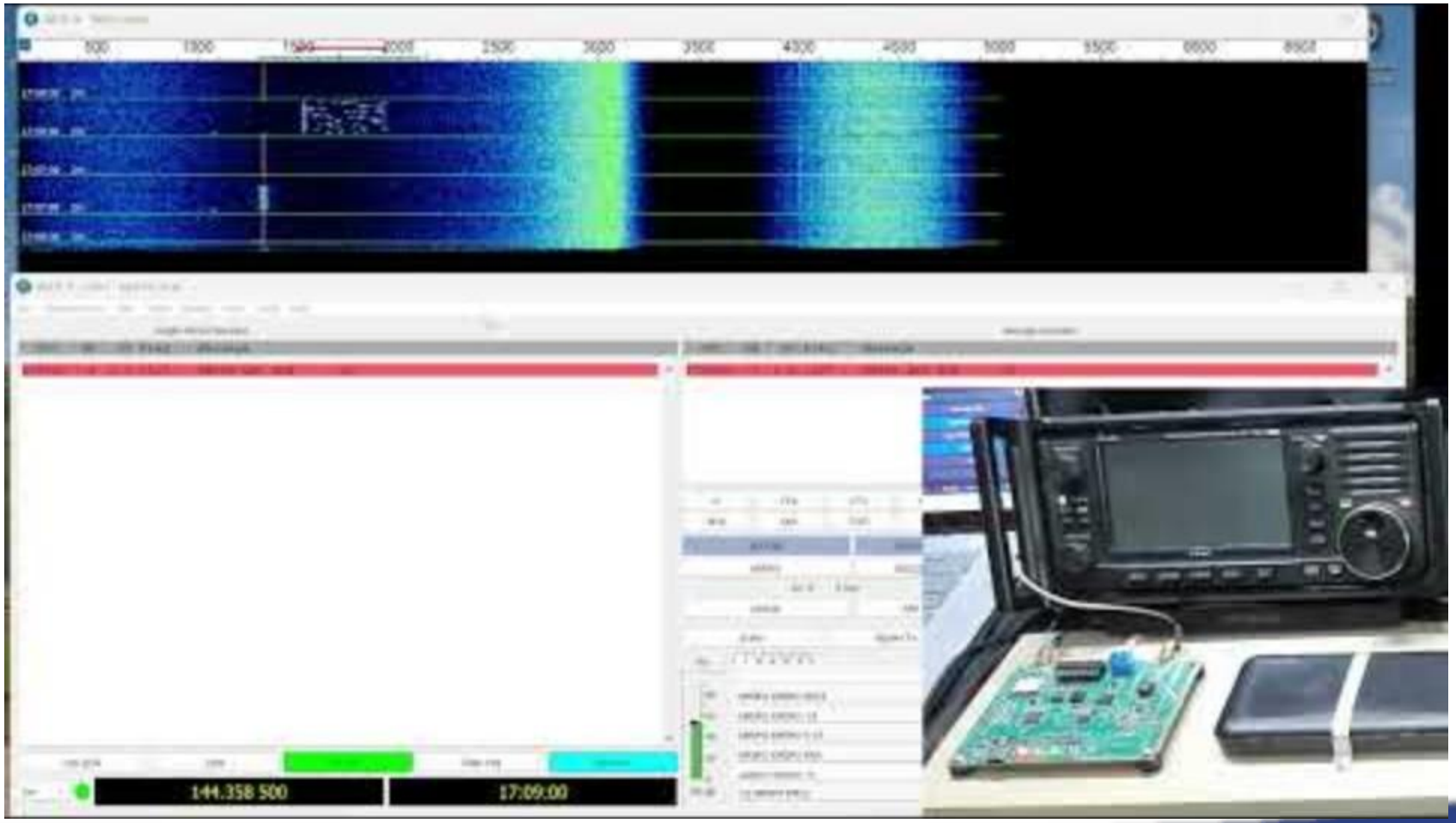

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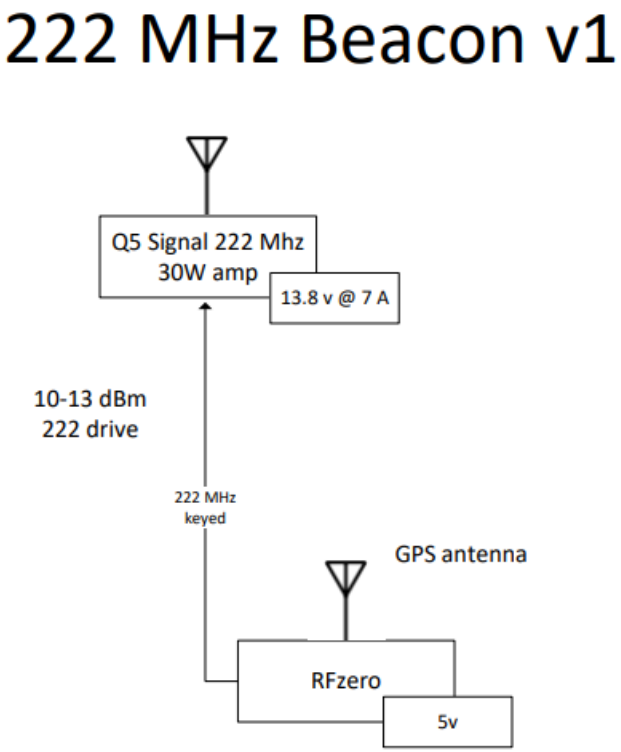
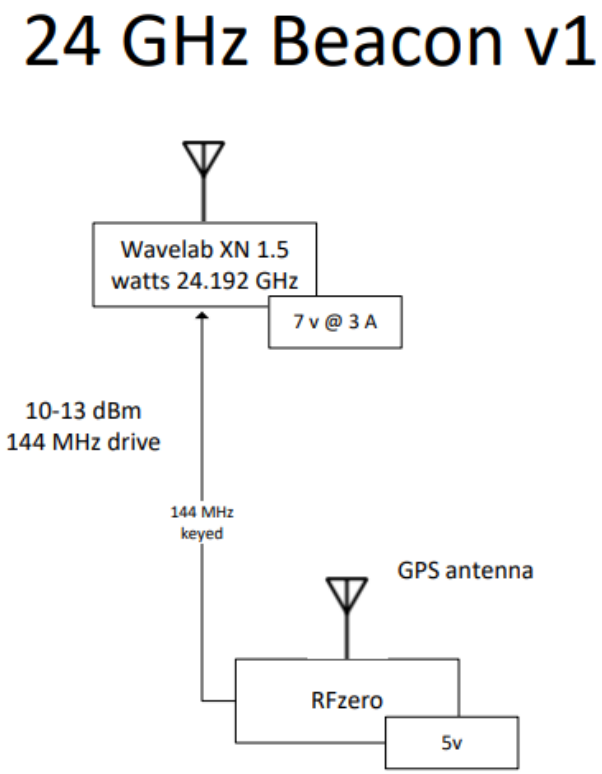
Implementation

- 222 MHz beacon – To prove some things



Implementation

- 24 GHz beacon



Simplifies current 24/47 GHz beacon design

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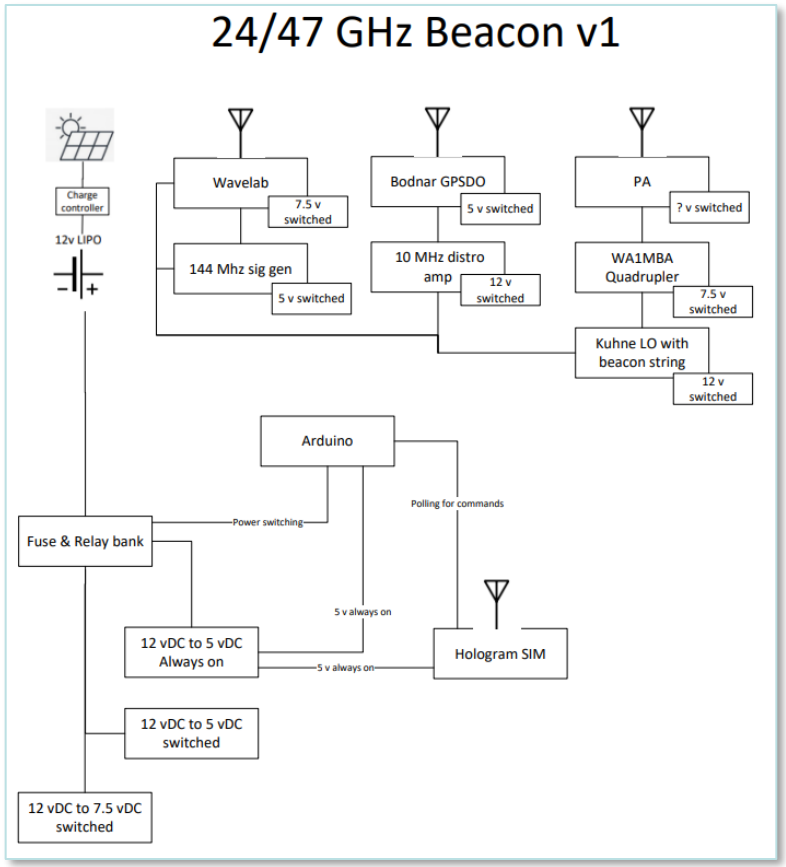
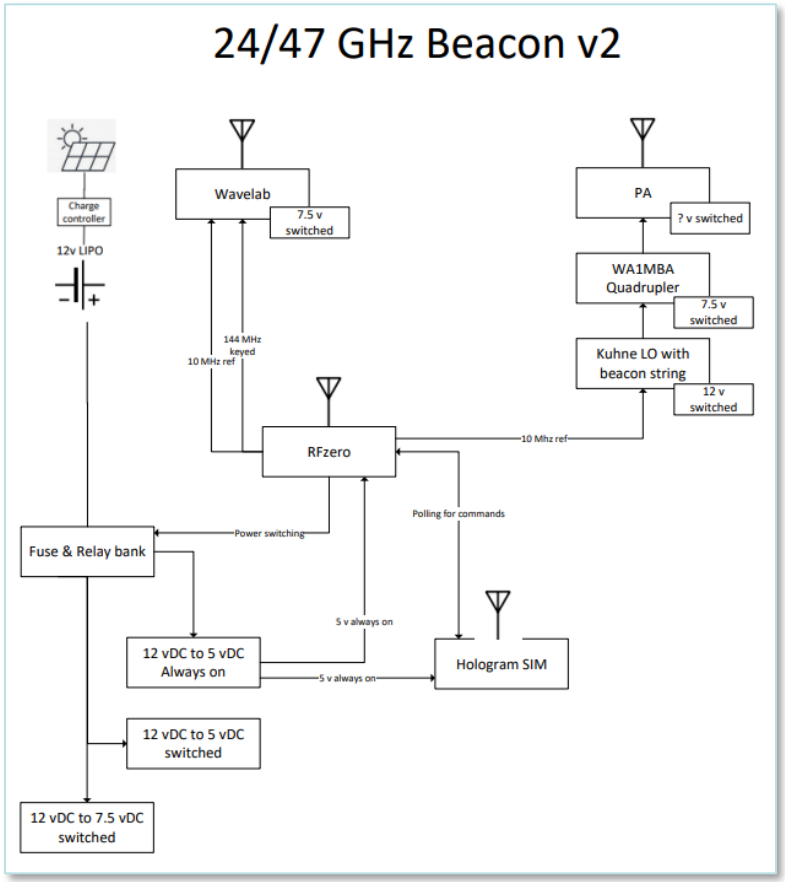
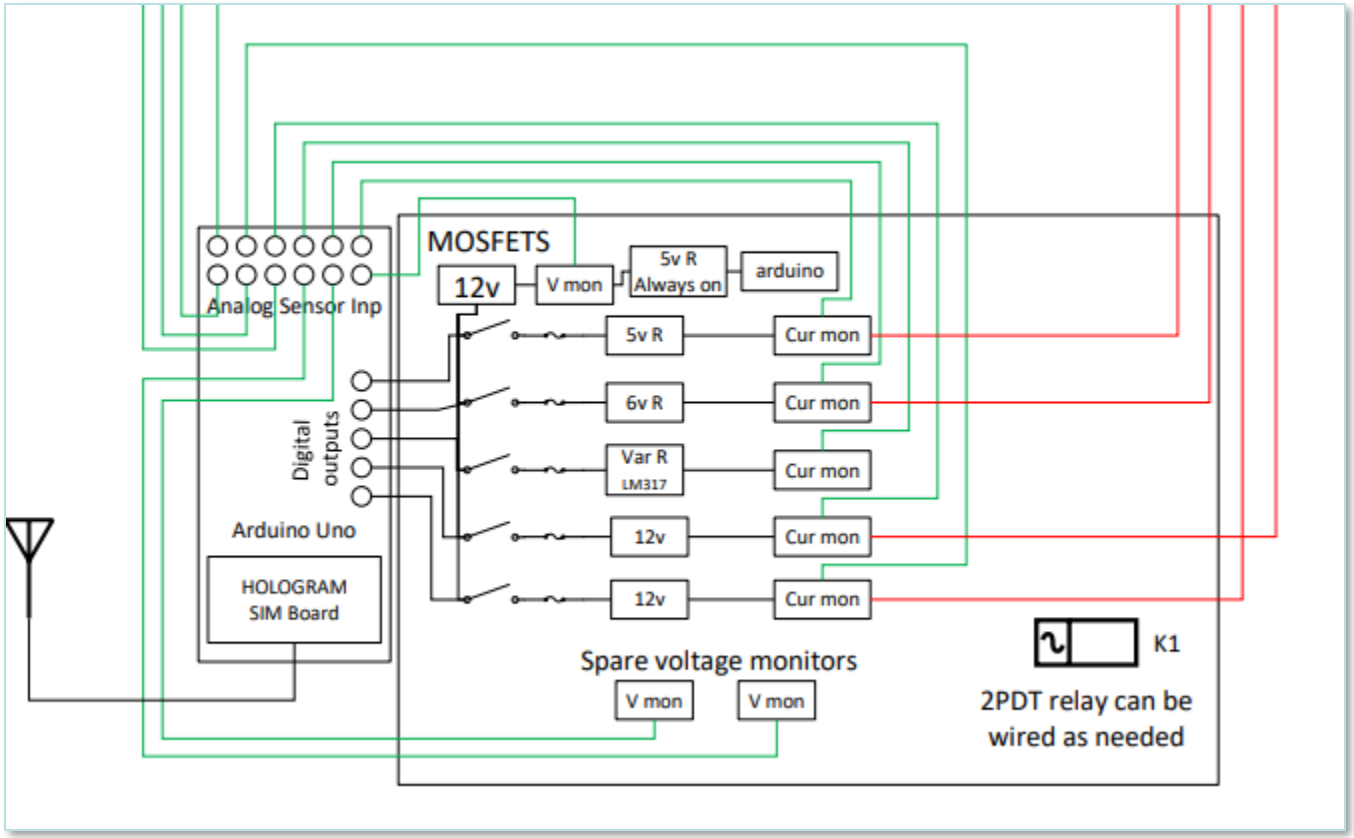


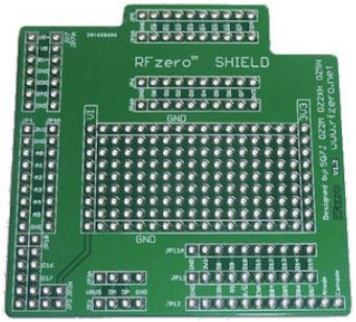


Custom board for DC control will be simplified



Accessories

- Shield



Many other PCBs available

- Filters

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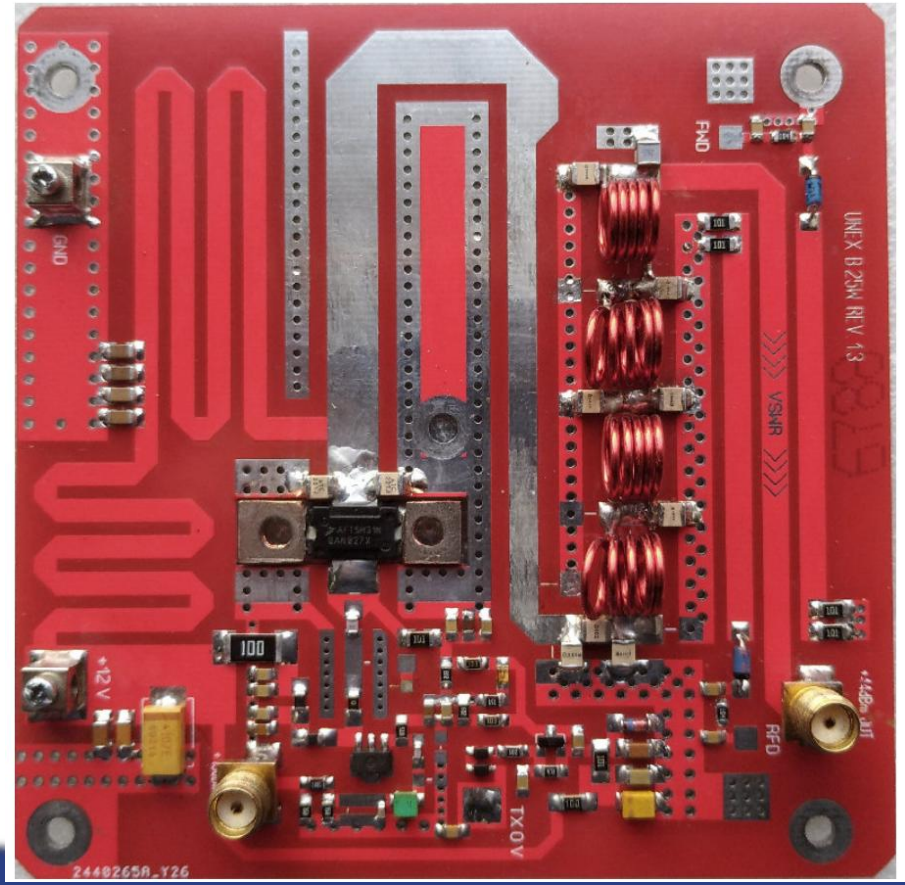
Amplifiers

- 50 watt 6 meter amp designed for RFzero



AB5N/B

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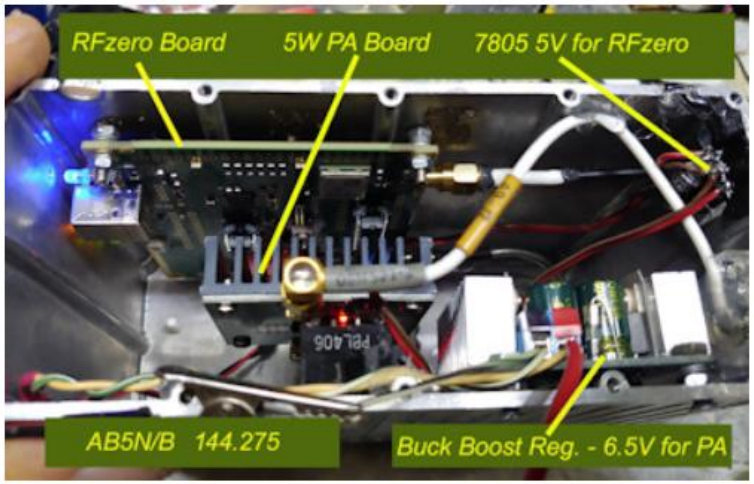
AB5N/B

Bob, AB5N, operates a 2 m beacon transmitting FT8 + CW + dashes on 144,257 MHz from EM34LM running 3,5 W. This is probably the first FT8 beacon globally on any band.

Inside view of the compact AB5N/B 2 m beacon. Picture courtesy Bob, AB5N.



GI0GDP/B

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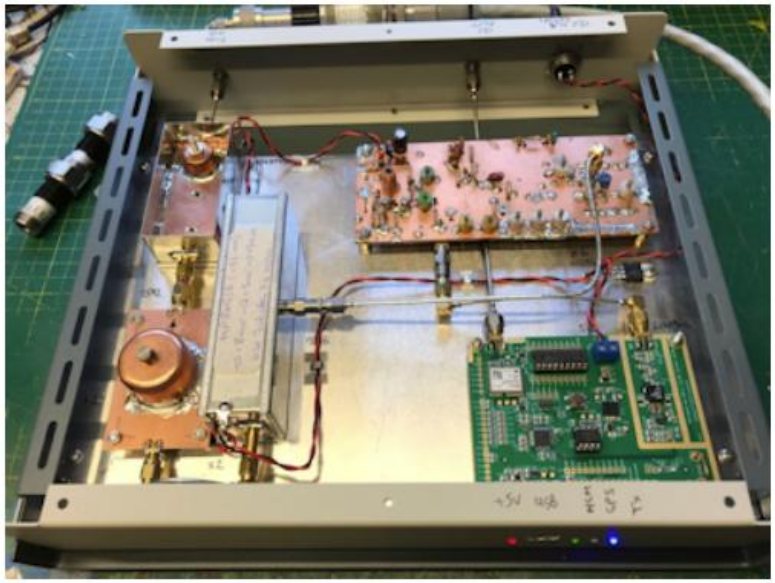
GI0GDP

Geoff, GI0GDP, is using an RFzero as beacon driver for his 10 GHz personal beacon. The RFzero generates 216 MHz that is multiplied 48 times to reach 10 GHz.

The 10 GHz personal beacon with x6, x2 and x4 multipliers. Picture courtesy Geoff, GI0GDP.



KH6HME/B by Chip N6CA

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KH6HME/B

Chip, N6CA, has built a new 2 m WSPR beacon to operate from Hawaii using the call KH6HME/B. The power is 40 W (max) WSPR which is split between Southern Japan and the West coast of the US with seven element yagis.

The KH6HME/B RFzero inside a heavy duty box. Picture courtesy Chip, N6CA.

Reference

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- Rfzero home page

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Questions?