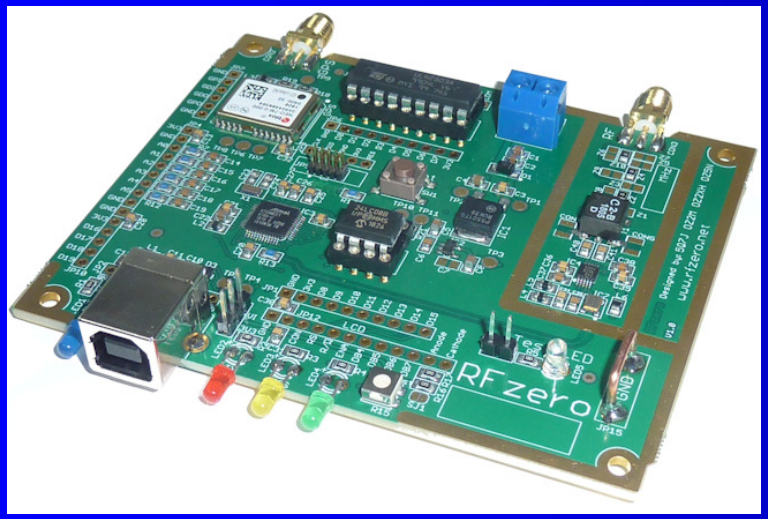
RFzero™

where it all starts



Learn to use
GPS, Arduino
and RF, use it
as a beacon driver
or ...

2022-12-20

RFzero™ “prefab” S/W

- GPSDO 10 MHz for lab., 49,152 MHz for IC-9700, …
- Signal generator (two-tone, I/Q, H3A, sweep, spread spectrum)
- WSPR and FST4W transmitters
- Beacon exciter (CW, FST4, FST4W, FT4, FT8, JS8, JT9, PI4, WSPR, ModeX, …)
- VFO with A/B, split RIT and XIT
- Frequency counter up to 90 MHz
- QO-100/Es’Hail fixed + TX/RX LO source
- Extensive open source library
- and …

- … or the one that you design

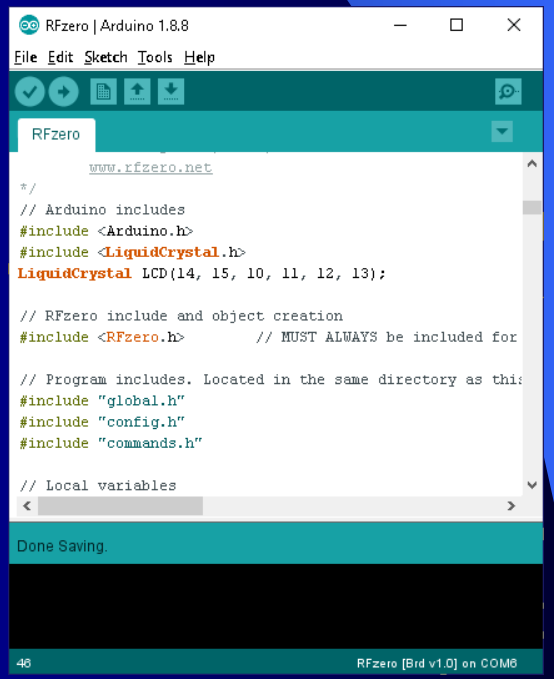
and all are GPS controlled

- Easy interface for LCD, rotary encoders, serial, I^2C, SPI and ULN2803A for power control and other devices

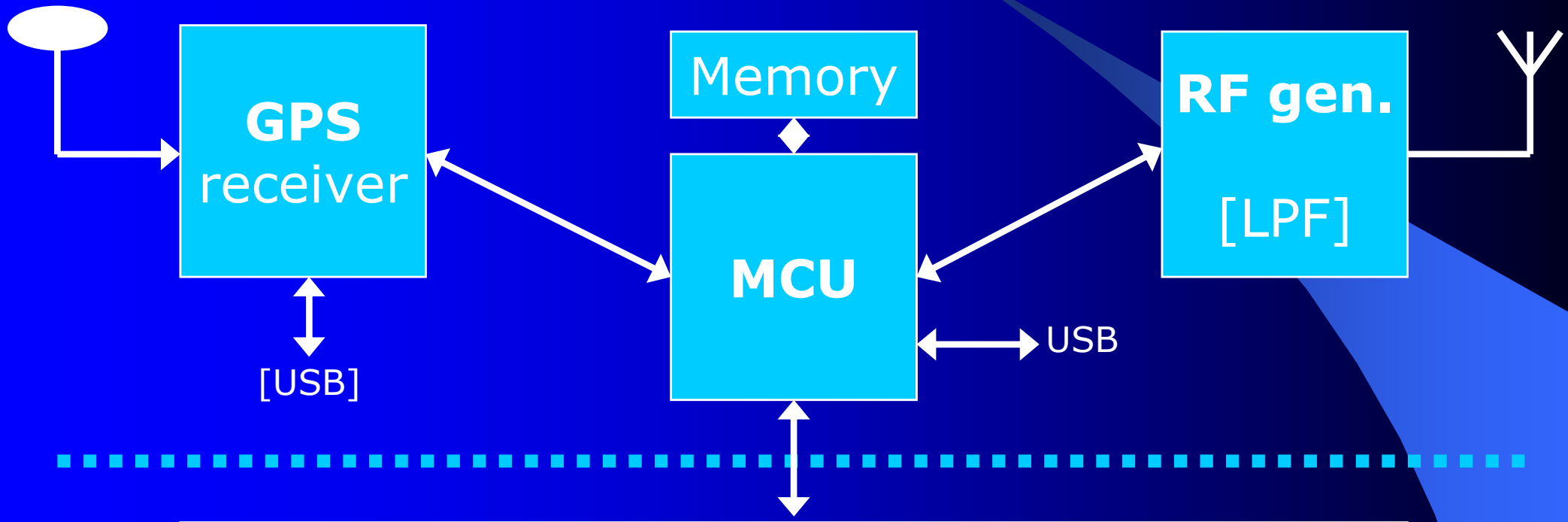
- Learn how to program a RF source and roll your very own RF-app using the RFzero library and other Arduino programs and libraries

RFzero™ key components

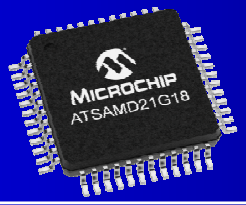
- MCU
  - Cortex ARM M0 Microchip ATSAMD21G (Atmel)
  - Same as used in Arduino Zero/M0/M0+
  - Program development in the free Arduino IDE
- RF
  - SiLabs Si5351A
  - ~2 kHz to ~300 MHz (or harm.)
  - 1 mHz resolution in full range
- GPS
  - u-blox NEO-7M

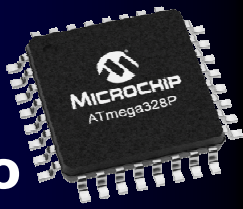


RFzero™ block schematic



RFzero™, Arduino Zero/Uno/Nano



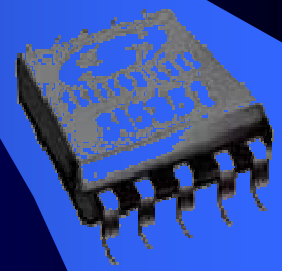


	RFzero™	Arduino Zero	Uno/Nano
Clock frequency	48 MHz	48 MHz	16 MHz
Clock type	crystal, 10 PPM	crystal, 20 PPM	ceramic, ½%
Architecture	32 bits ARM	32 bits ARM	8 bits RISC
Program memory	256 kB	256 kB	32 kB
EEPROM	16 kB (opt. in socket)	none	1 kB
SRAM	32 kB	32 kB	2 kB
ADC	12 bits	12 bits	10 bits
DAC	10 bits	10 bits	none
I/Os free* (max analog)	28 (8)	13 (6)	11 (6/8)

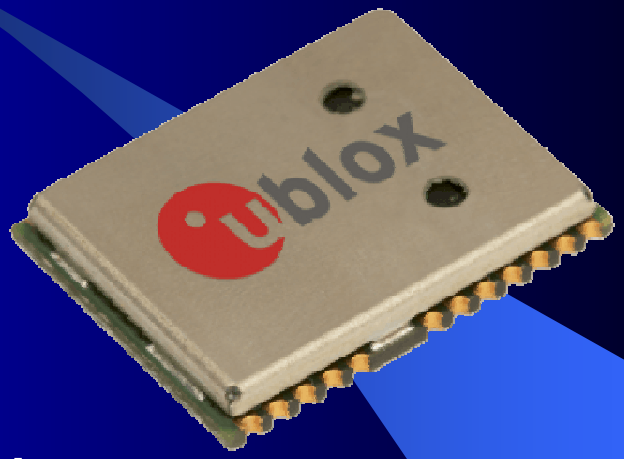
*: already used by GPS (3), I2C (2), LEDs (2) and USB (2)

SiLabs Si5351A

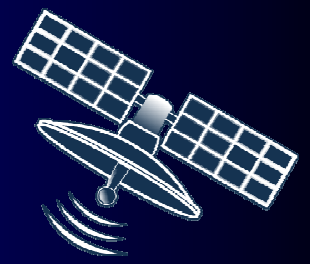
- 2289 Hz to ~300 MHz digital device used in a real RF design (harmonics usable beyond 1 GHz)
- 4 layers PCB, SMD and micro strip design for best RF performance
- Output balanced (factory), split or combined
  - More power,
  - better spectrum,
  - I/Q signals, or
  - two-tone generator
- Clock frequency measured continuously
- Separate power supply
- Stability better than 105 mHz (w/foam 13 mHz)



u-blox NEO-7M GPS/SBAS/QZSS



- 1 PPS accuracy
  - better than 30 ns RMS
  - 99% better than 60 ns
- On-board pre-amp voltage
- Cold start faster than 30 s
- Sensitivity better than -147 dBm
- 56 channels receiver
- Optional back-up bat. or super cap.
- Optional USB port e.g. PC time control
- Lots of documentation

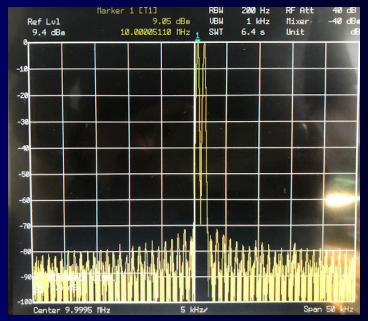


GPSDO reference

- Cheap GPSDO for home lab or radio
- 27 MHz oscillator measured
  - Stability better than 1 PPB (foam cover)
  - Frequency counter <2 Hz 99% of time
- Output power 13 dBm/20 mW
- Display showing UTC and local time

- Optional eight channel 10 MHz distribution amplifier

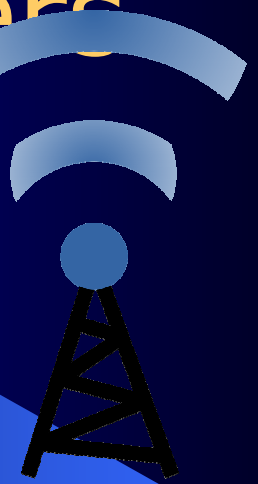
Signal generator



- Frequencies from 2289 Hz to ~300 MHz
- Frequency resolution 1 Hz
- Single, two-tone, I/Q, H3A, sweep and spread spectrum
- Output power 13 dBm/20 mW (>1 MHz)
- RF on/off
- Control also via USB

- Attenuator control
- Keypad or two rotary encoders can be used for freq. and attenuator control

WSPR and FST4W transmitters



- Configured via USB
- 5, 10, 12 or 15 time slots in transmission cycle
- Any frequency or skip in any time slot
- Two static or random plus day/night frequency sets with up to 15 frequencies in each set
- Auto fill of HF frequencies or manual configuration
- Filter management (digital or analog)
- WSPR Type 1, Type 2 and Type 3 messages
- Static or variable square (JO55) in message

- RF performance
  - Any frequency from 2289 Hz to >200 MHz
  - Harmonics usable beyond 1,3 GHz
  - Power >13 dBm/20 mW (50 MHz)
  - In-band spurii typically than -70 dBc (50 MHz)

CW or mixed mode beacons

- Beacons
  - CW + carrier
  - PI4 + CW + carrier
  - Synchronized Beacon Project
  - International Beacon Project
  - FST4 + CW + carrier
  - FST4W
  - FT4 + CW + carrier
  - FT8 + CW + carrier
  - JS8 + CW + carrier
  - JT9 + CW + carrier
  - WSPR
  - Frequency compensation for multiplier up to 72 GHz
- RF performance
  - Any frequency from 2289 Hz to ~300 MHz (or harmonic)
  - Power >13 dBm/20 mW (1 MHz to 200 MHz)
  - In-band spurious typically -70 dBc (50 MHz)

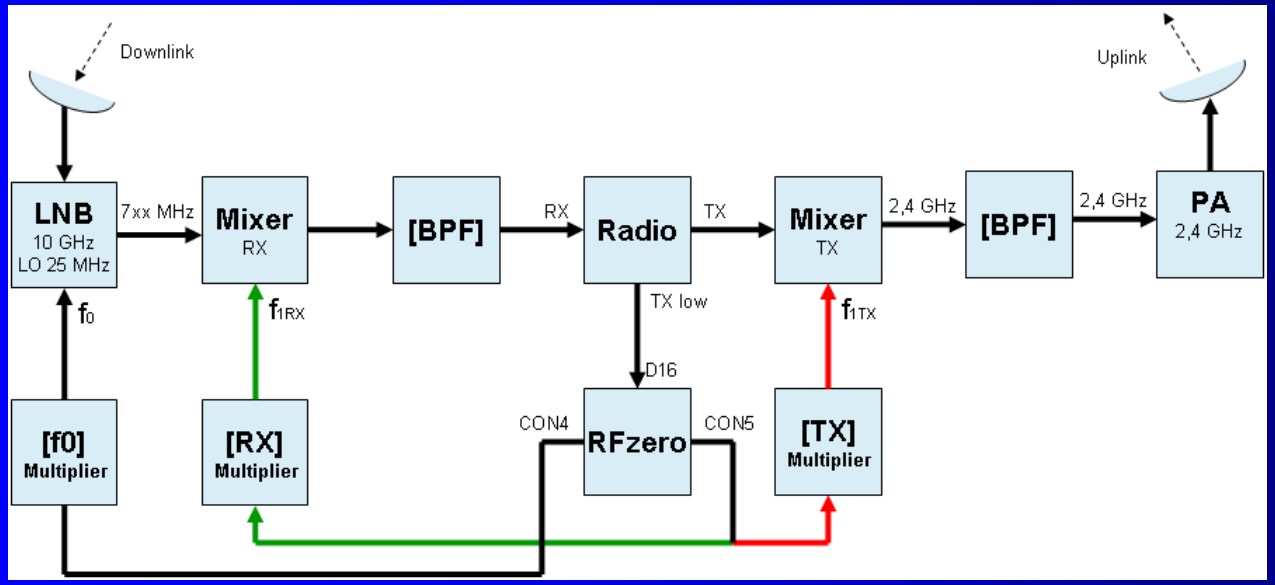
Frequency counter

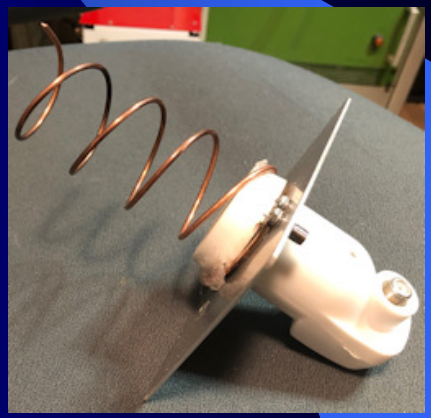
- Frequency counter up to 90 MHz

- 1 Hz resolution using 1 s gate time

QO-100/Es'Hail

- One fixed signal source, e.g. for LNB
- One dual TX/RX signal source, e.g. transverter LOs
  - Supports external multipliers
- TX/RX detection





OZ5N: LNB and uplink helix

VFO with enhanced control

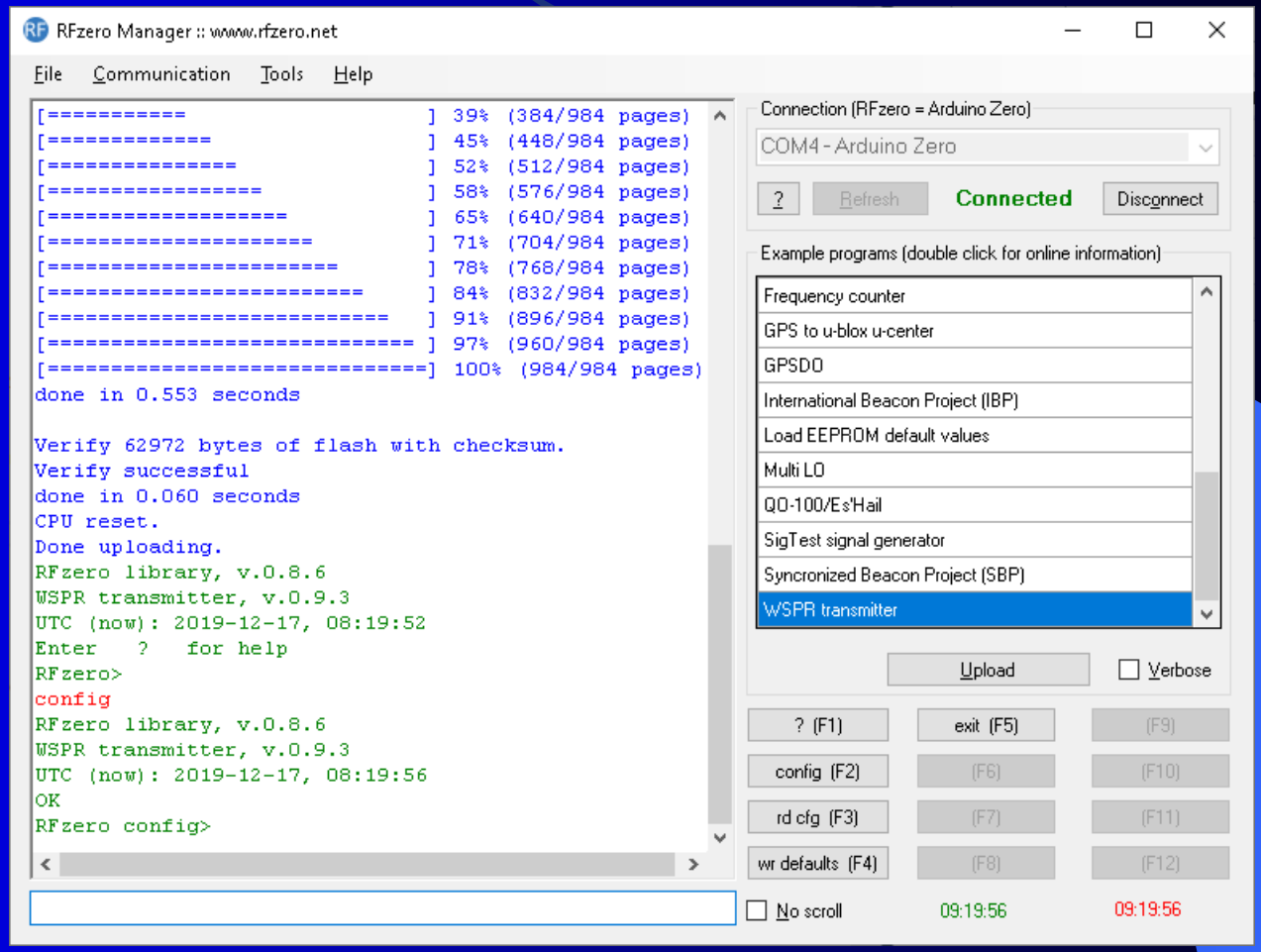
- Frequencies from 100 kHz to 268 MHz
- Frequency resolution 1 Hz
- Tune with rotary encoder
- RIT with rotary encoder

- Lots of pins free for enhanced control and monitoring of radio functions
- Optional I/Q outputs

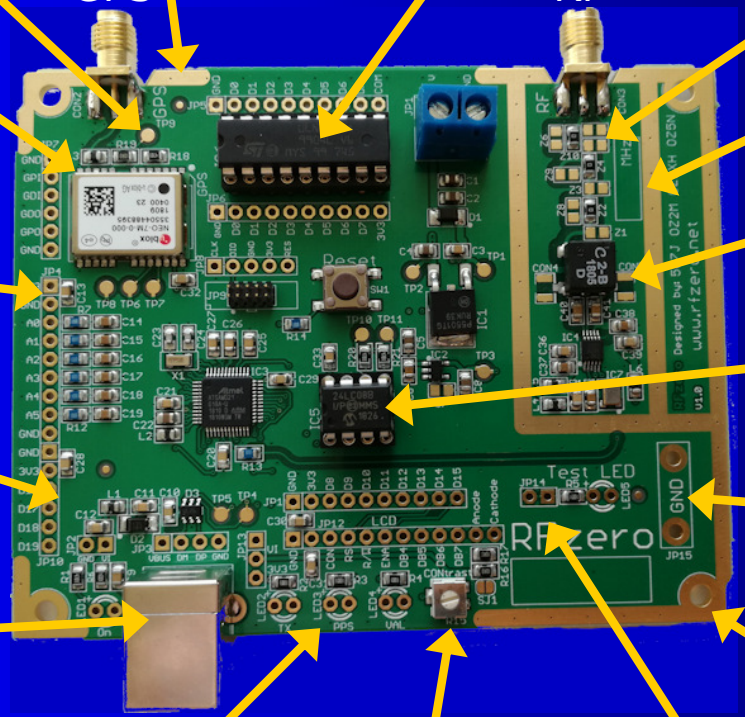
RFzero Manager

Using the RFzero Manager you don’t need to know anything about Arduino

Windows program but runs also under Wine and Parallels Desktop



RFzero™ is really easy to use



Immersion gold surface

Power control IC in socket

12 test point

GPS optional back-up

Optional GPS USB interface

On-board RF decoupling

PCB shield ready

USB is ESD protected

Three signal LEDs

On-board LCD contrast and backlight

Test LED jumper

PCB is half Eurocard fits into metal sheet box

Ground loop for alligator clip

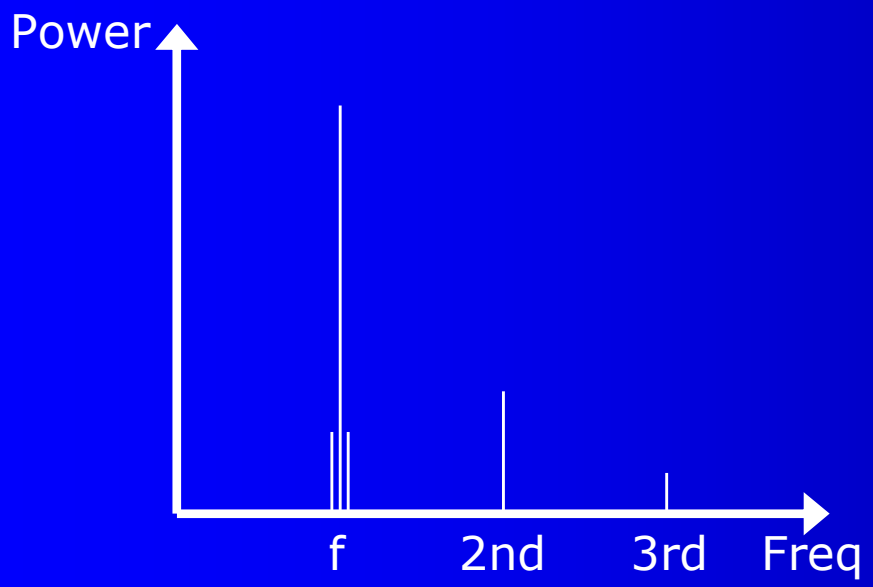
EEPROM IC in socket

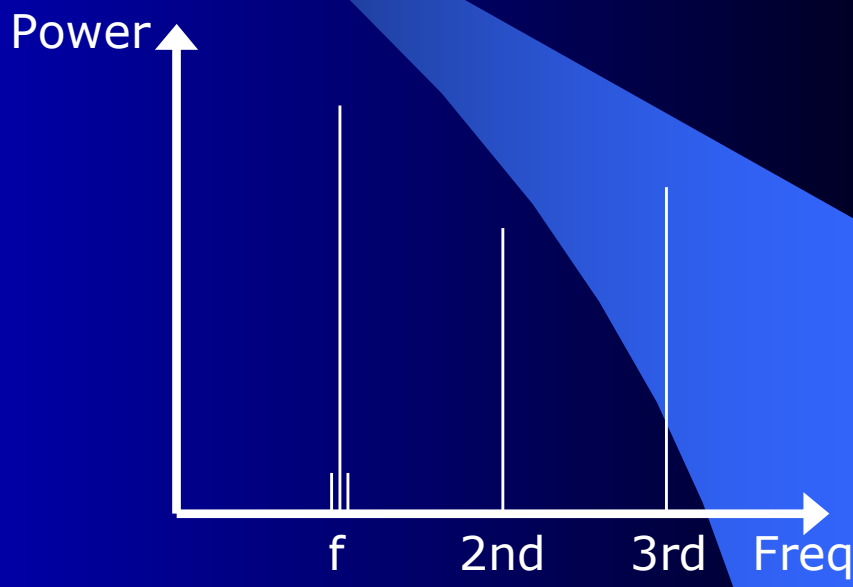
Two-tone or I/Q outputs

RF can be shielded

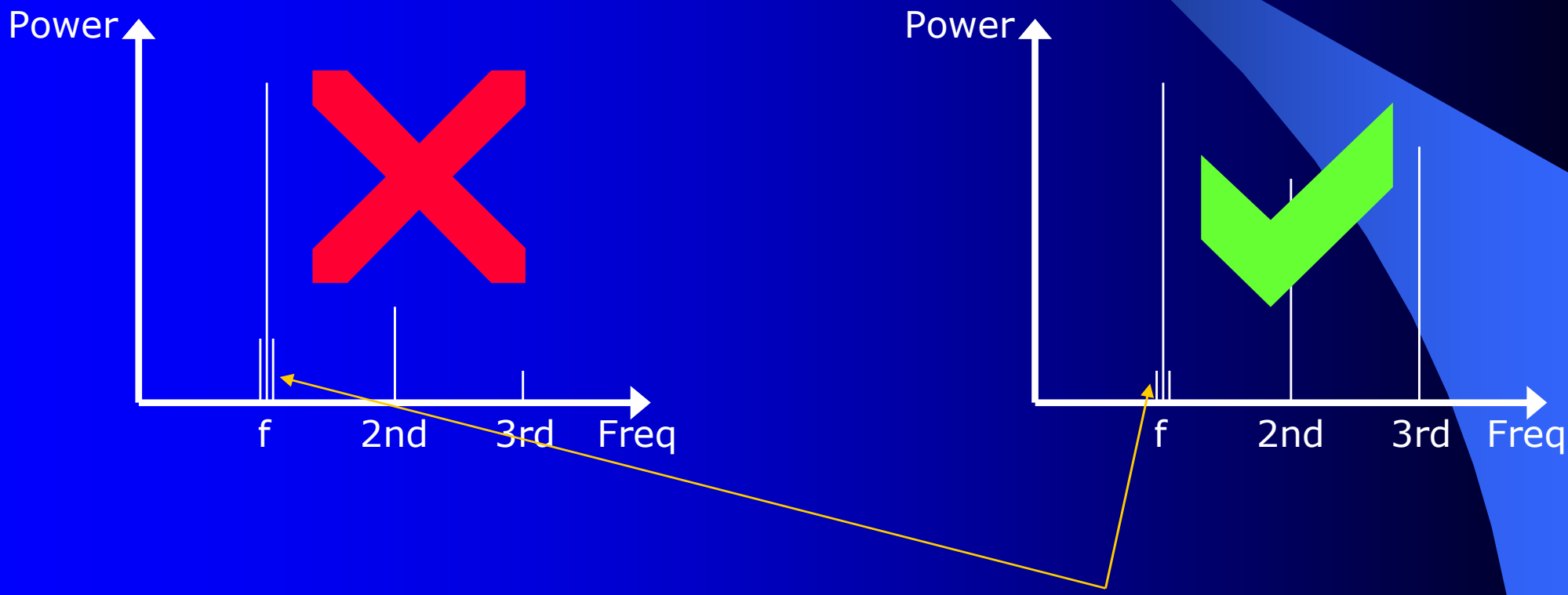
Individual output filter

Which spectrum do you prefer?



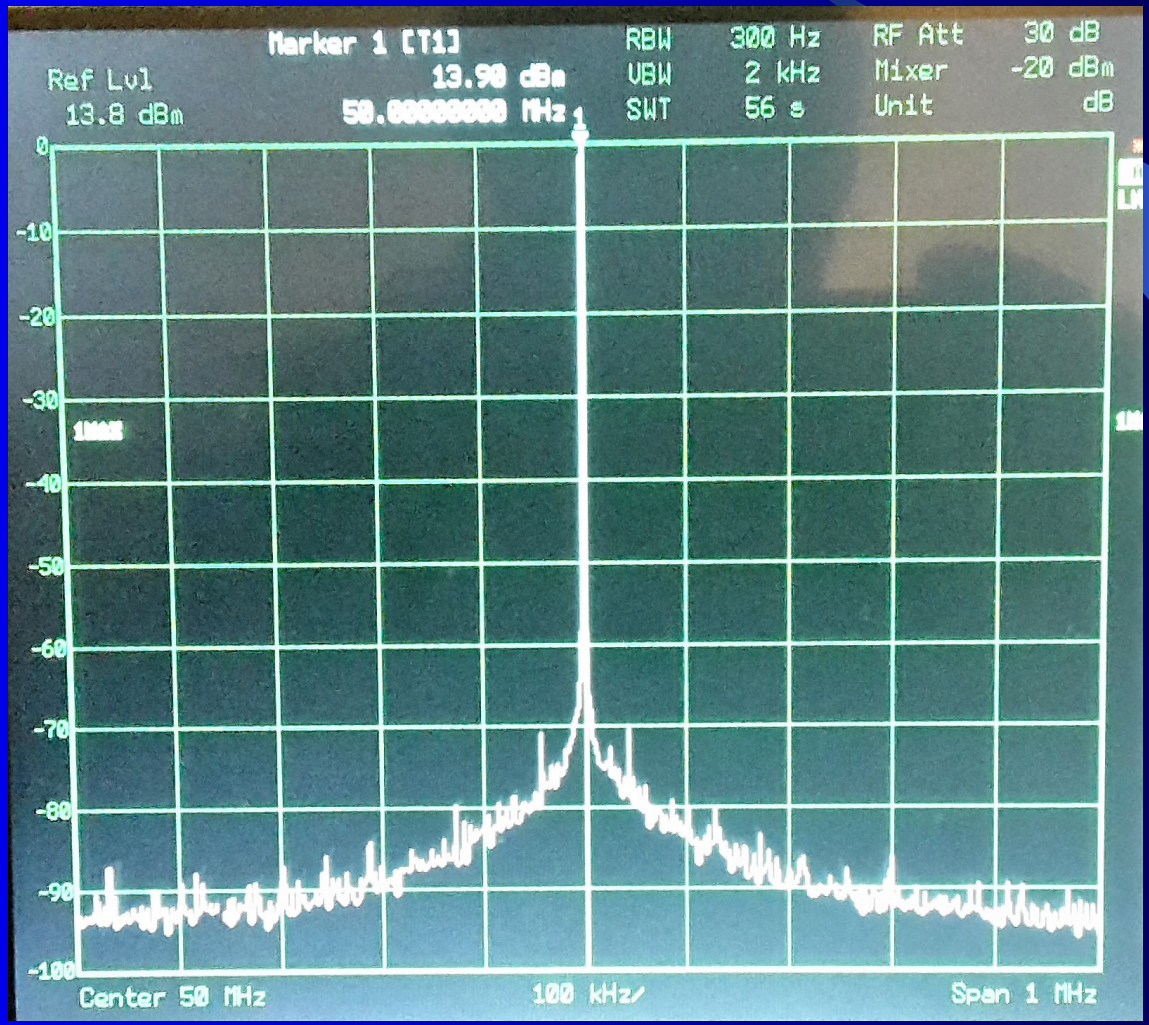


The right one of course!



Attenuating harmonics with a low pass filter is easy but in-band spurious is not

50 MHz in-band spectrum



VUSHF beacons using RFzero™

- SK3SIX QRV since 4 Jan. 2019 followed by a 15 W PA, see QRZ.com

- AB5N/B, EI0SIX, EI1KNH, EI4RF, GB3MAT, GB3MCB, GI0GDP, KH6HME/B, KH7Y, OZ1FYR, PI7ALK, PS8RF/B, RB1CA, SK3SIX, SK3VHF, SV3BSF, …

More information

- www.rfzero.net data and shop
- www.groups.io/g/RFzero user group

- or ask
  - Bo, OZ2M
  - Hans, OZ2XH
  - Steen, OZ5N