Next Generation Beacons

Norsk Hammeeting 2013
(IARU Region 1 C5 Meeting)

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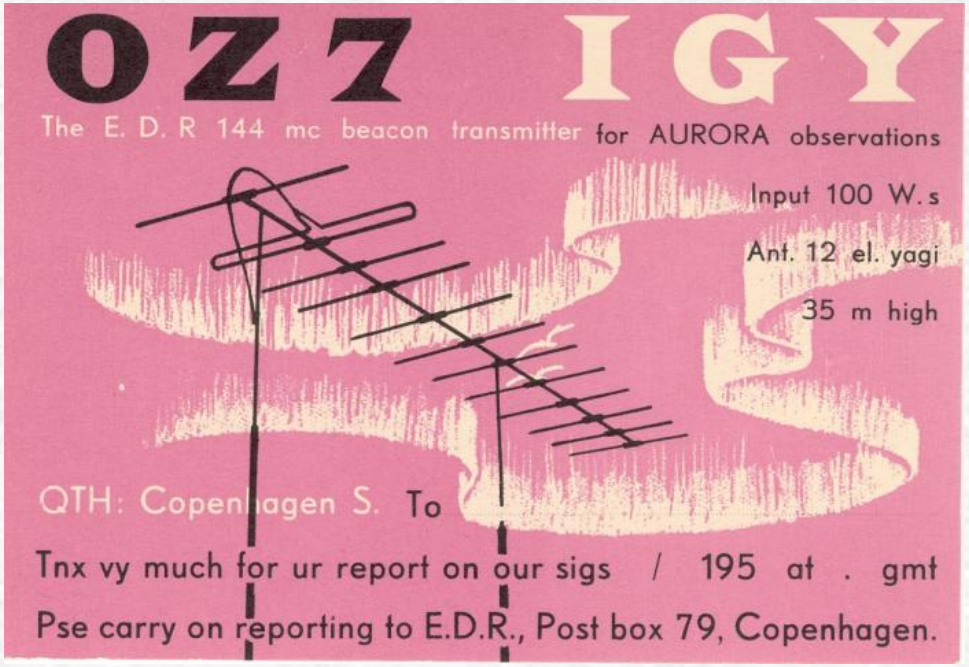
Contents

- OZ7IGY and why talk about next generation beacons?
- New technological advancements and possibilities in beacon designs
- Project ”Next Generation Beacons”

OZ7IGY historical status

- QRV since 1957
- Using contemporary technology
- Everybody could participate but technically driven



Operating OZ7IGY

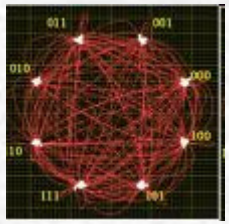
- Expenses 2300 €/year, i.e. 800 W continuously
  - ~300 € from radio club memberships
  - ~1100 € form individual memberships
  - The rest
    - Member donations
    - The 70 MHz transverter project
- QRV
  - MHz: 28, 40, 50, 70, 144 and 432
  - GHz: 1, 2, 3, 5, 10 and 24
- How can we make OZ7IGY run another 50 years? The next generation beacon!

Why beacons?

- To assess the conditions and compare with normal
- To control sensitivity and frequency of own receiver
- To let the authorities know that there is a signal on the air

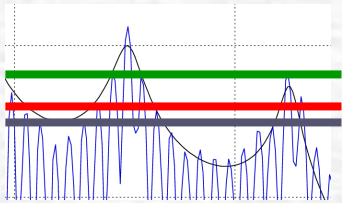
- Everything else is ego!
  - Discontinuous operation is useless
  - Irrelevant modulation vs band and propagations

Well !
So what?



Digital modulation is the future - today

- Sensitivity >10 dB better than CW
  - G4JNT: For easy copy CW at 18 WPM in 30 Hz bandwidth 10 dB S/N is needed

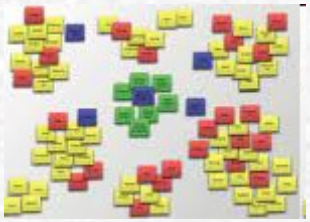


- Automated monitoring of conditions and comparison to average → alarm when x dB better than average
- Modulation/sequence can be changed when improvements are available

Choosing modulation and sequence

- Should it be based on ideology or users' need?

- Digital for the sake of digital?



- What do the users say and want?

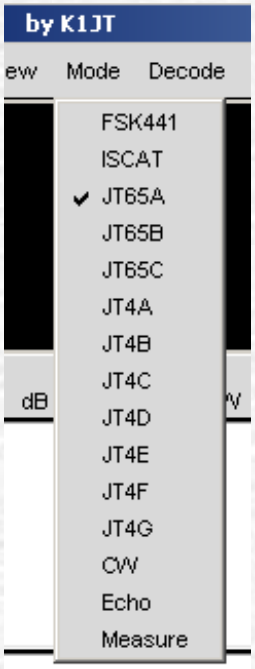
Both analog and digital modulations are the future

- Can be decoded both with and without a computer, like today
- Benefits from the digital capabilities
- Frequent ID to cope with QSB
- Possible to detect via unknown propagations

- Must be ”zero beatable”
- Must fit into existing beacon spacing(s)
- Same modulation and sequence on “all” bands
- “Short” sequence

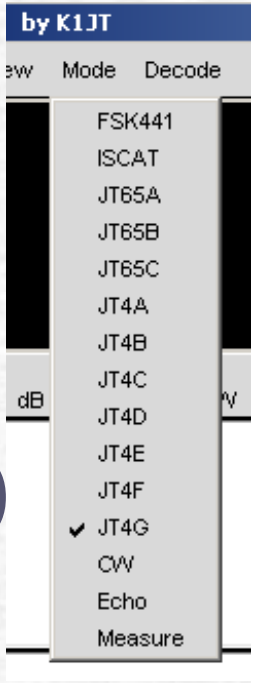
- The combination is possible using a smart sequence

Something exists, but ...

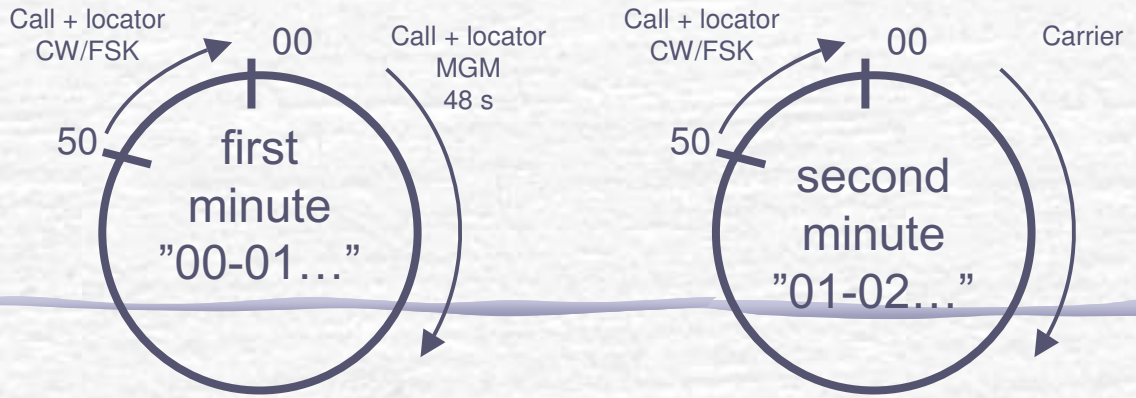


- WSPR/JT9
  - Designed for MF, HF, OK for 6 m but not above
  - 2 min sequence and no CW ID
  - Not resistant to distortion or frequency jitter
  - "Birdie-like"
  - Nominal frequency of 1500 Hz
- JT65
  - Designed for EME, tropo and ionoscatter
  - 1 min sequence and no CW ID, or 2 min with CW ID
  - Somewhat resistant to distortion, but low intra-tone spacing
  - Nominal frequency of 1270 Hz

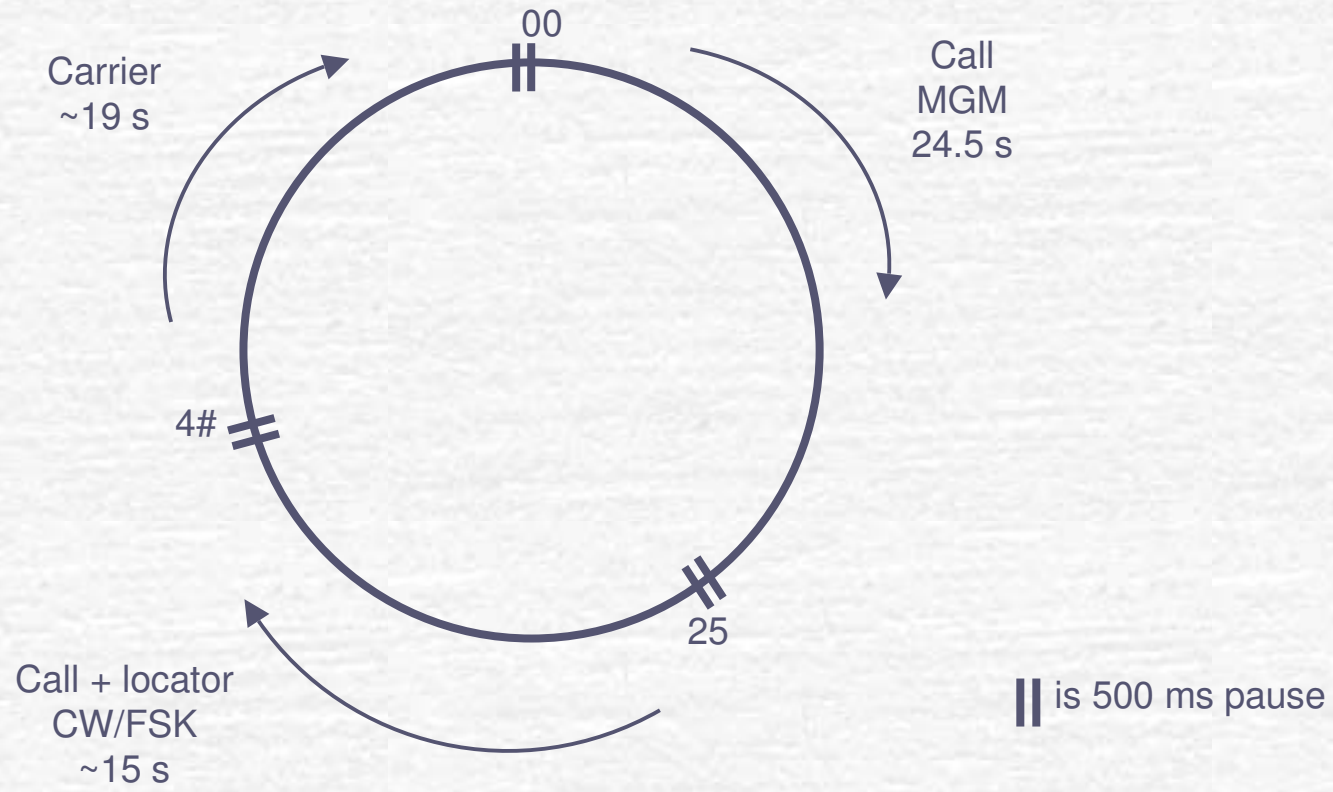
How about JT4x then?



- Designed for VUSHF communications
- Robust modulation and S/N –23.6 dB
- Can be used for 10 GHz EME (JT4F/G)
- Sequence
  - 1 min native (48 s)
  - 2 min with CW ID and carrier

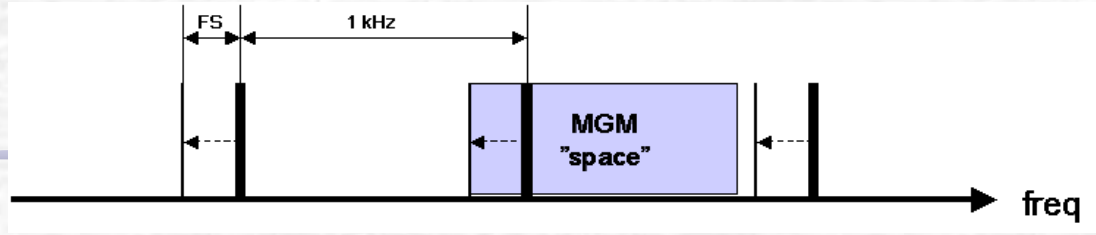


Here is what we want
1 min MGM + CW ID + Carrier



PI4 - PharusIgnis4

- A digital modulation (MGM) for beacons
- Maximum reuse of K1JT's JT4 modulation
  - Class C transparent
  - Omit locator from message, i.e. faster message
  - 4 tone FSK designed for beacon spacing
    - Tones spaced ~234 Hz, or ~703 Hz wide
    - Leaves guard space for above beacon using CW FSK
    - Wider spacing possible if needed, e.g. SHF bands
  - "Open source"



Comparing

JT4

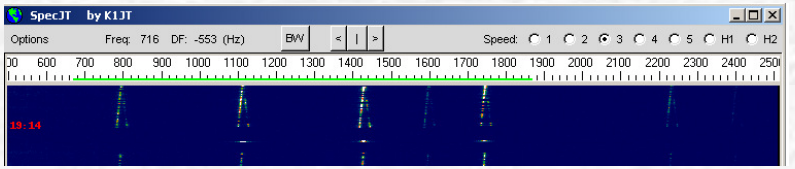
- Duration is 48 s
- 2 min sequence
- 13 char. message
- Call and locator
- “A”-“Z”, “0”-“9”, “/+-.?<space>” in total 42 chars
- ~F narrow, ~G wide
- S/N 23,6 dB
- 798 Hz nominal AF
- Already in WSJT

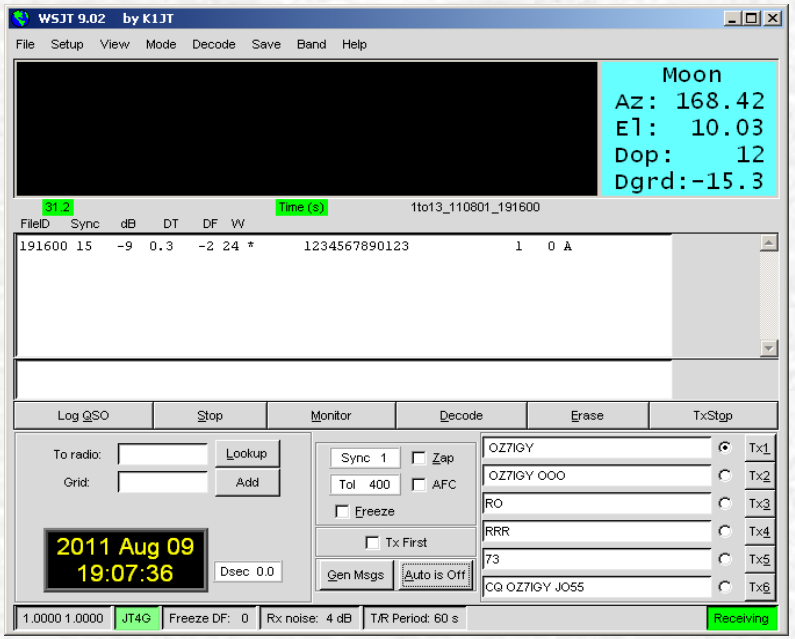
PI4

- Duration is 24.5 s
- 1 min sequence
- 8/14 char. message
- Call, or other msg.
- “A”-“Z”, “0”-“9”, “/<space>” in total 38 chars
- BW: 703 Hz
- S/N: 22,2 dB. Perfect averaging possibilities for even better S/N
- 800 Hz nominal AF
- New decoder · full control

Decoding digital modulation

- The leading VUSHF digital modulation program is WSJT
- Initial plan was to persuade Joe, K1JT but …



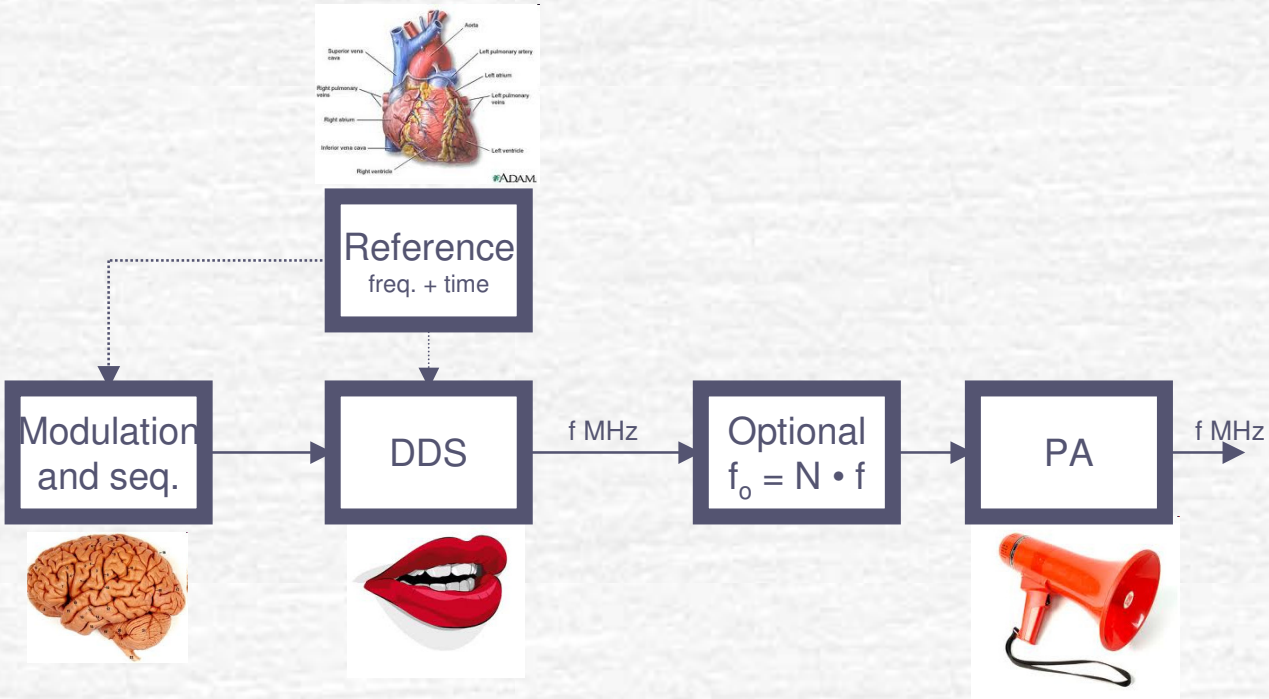


OK!
What have we done?

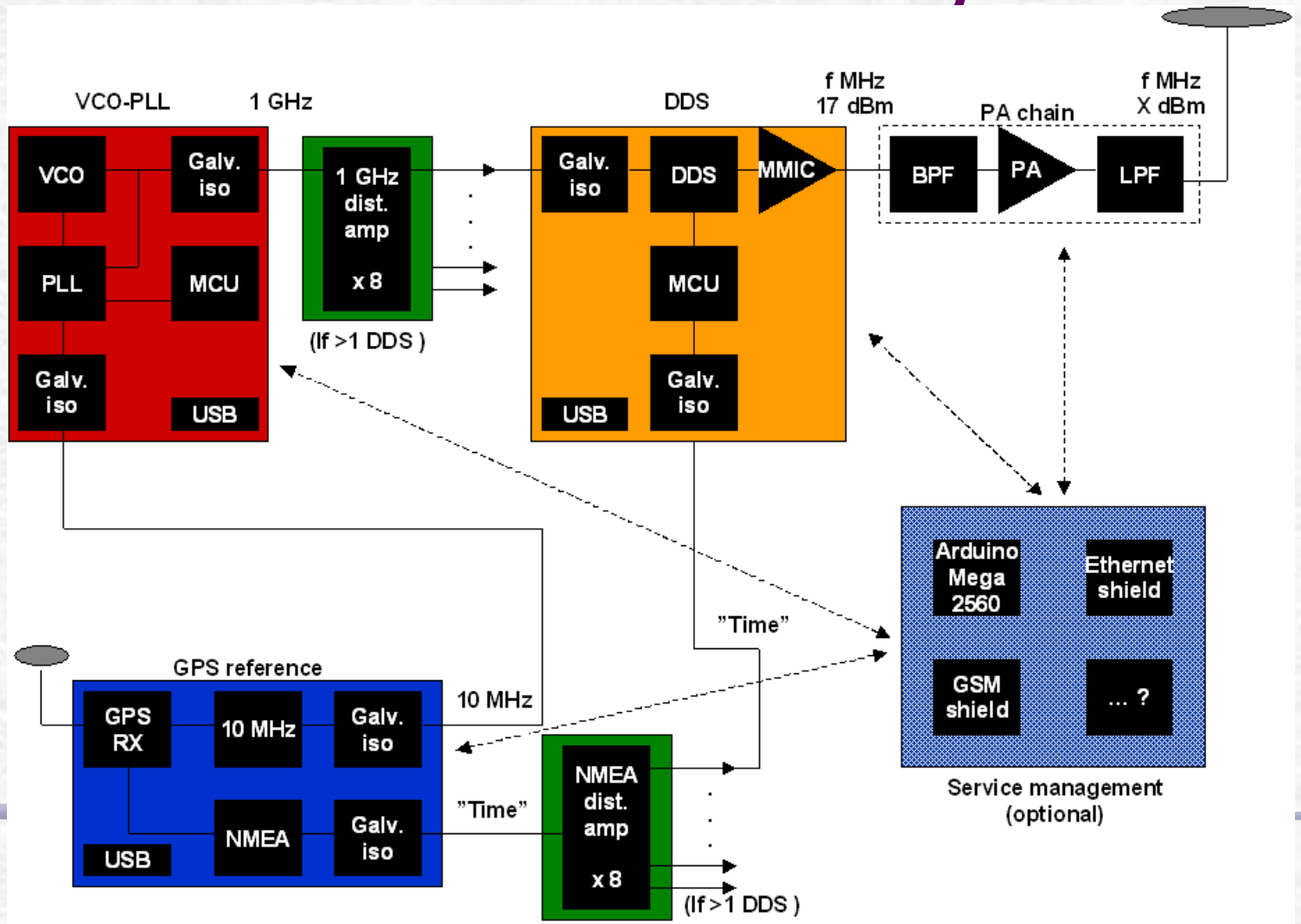
Project NGN Beacon

- The purpose of the project is
  - To start the discussion and identify the requirements
  - To develop the modulation (PI4), software and hardware to OZ7IGY
  - To make the platform available to others
- The project team
  - OZ1CKG, OZ2ELA, OZ2M, OZ5GQ, OZ9GE og OZ9ZZ
  - Partial participation OZ1BV, OZ2CPU and OZ8PG

Basic topology



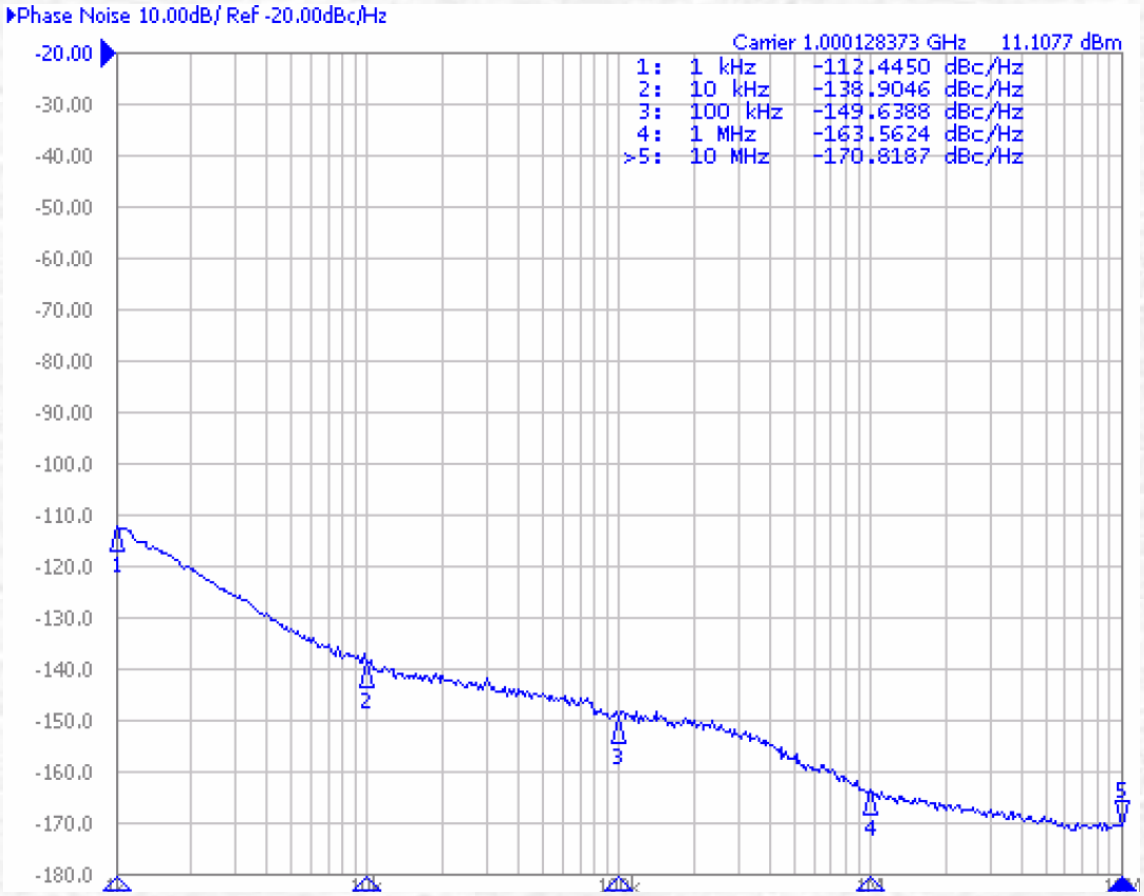
Functional block diagram



1 GHz VCO-PLL clock

- Different VCOs depending upon sideband noise needs, e.g. Crystek CVCO55CX-1000-1000
- PLL is Analog Devices ADF4107
- MCU is ATMEL ATMega48/88/168/328
- Reference is 10 MHz from GPS disciplined osc.
- Performance
  - Output power ~14 dBm
  - Input lock from -10 dBm
  - Power consumption 1,5 W

Crystek CVCO55CX-1000-1000



DDS freq. and modulation

- DDS is Analog Devices AD9912
- MCU is ATMEL ATMega128A
- Performance
  - Frequency range 137 kHz to 432 MHz, and 1,3 GHz†
  - Frequency resolution 4 µHz
  - Only frequency range specific components, e.g. same components for 28 MHz to 432 MHz
  - Harmonics <-20 dB rel. to carrier, BPF in PA chain
  - Output power ~17 dBm
  - Power consumption 2 W

†: Super Nyquist principle

DDS board

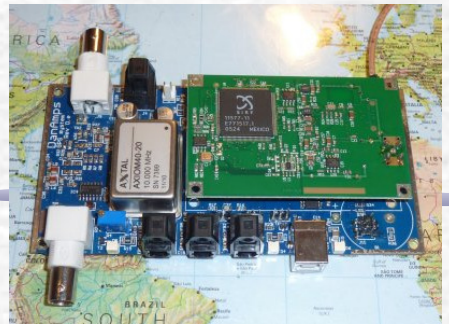
- Galvanically isolated inputs and outputs
- DIP switches, and auxiliary inputs and outputs for unplanned features
- USB interface for S/W downloading and management

Distribution boards

- Necessary if more than one DDS board
- Performance
  - 1 input to 8 outputs
  - Power spread across ports less than 1 dB
  - Power consumption 1,5 W
  - Port til port-isolation ~40 dB
- 10 MHz can also be used for lab-use

GPS reference

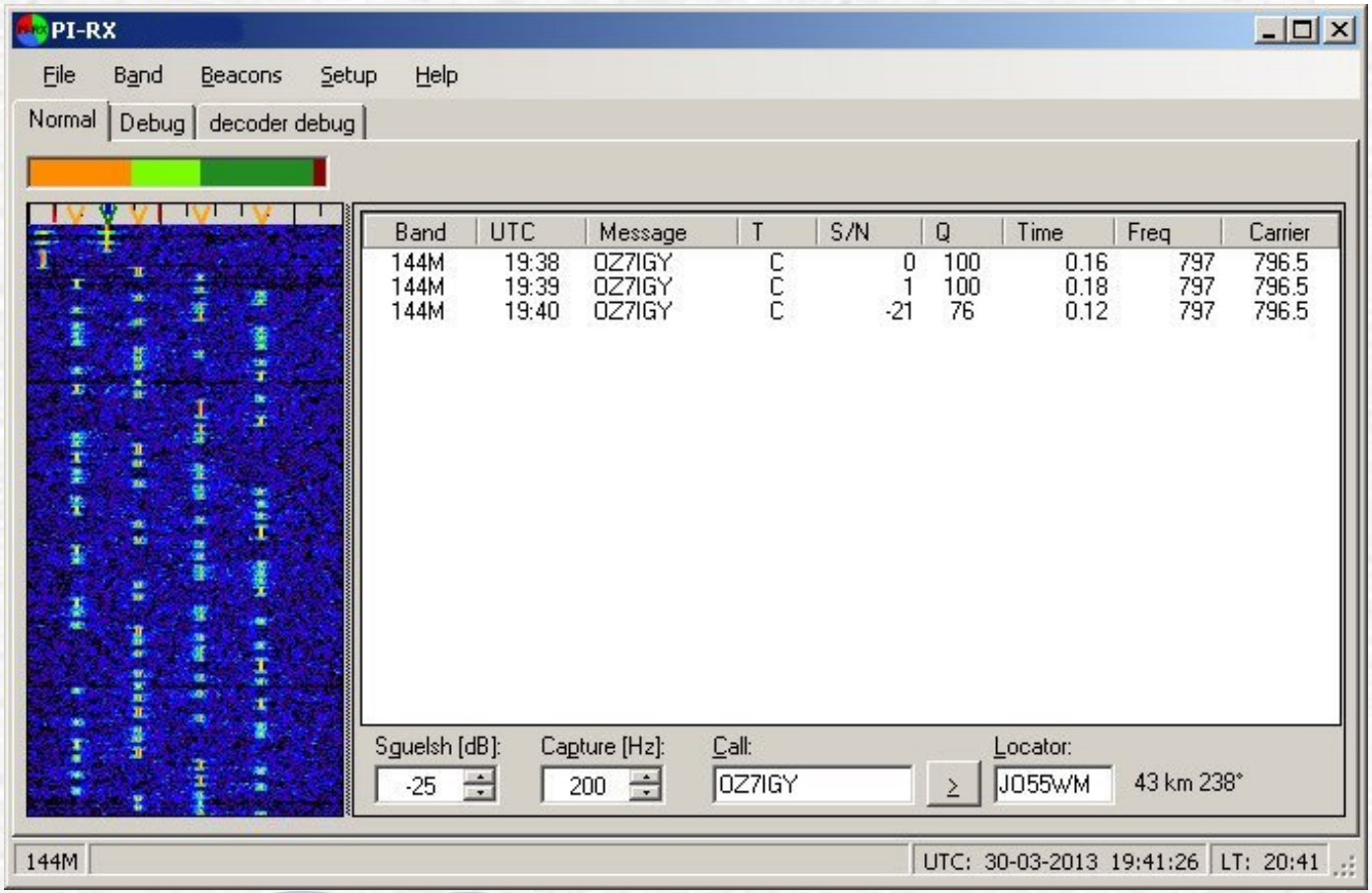
- The GPS/GPSDO reference provides 10 MHz and NMEA time signal
- You can use any GPS that has 10 MHz and NMEA for the NGNB platform
- A NGNB GPS reference will be developed with 10 MHz outputs and station clock features so you can use it at home too



Service management

- Service management is optional
- We suggest to use Arduino's open source hardware and software platform
- Arduino is easy to use and others develop generic hardware and libraries e.g. GSM and Ethernet interfaces for remote access and monitoring

PI-RX • PI4 decoder



PI-RX features

- Waterfall with up to 100 dB resolution and carrier and PI4 tone markers
- Carrier measurement with 0,1 Hz resolution
- Signal strength and quality measurements
- Beacons list with frequency and locator
- Online manual
- Sensitivity will be improved 3-4 dB and more robust to multi-path propagation/distortion
- The ambition is to decode PI4 via aurora

What do the users say?

- Perfect with a beacon spot on!
- I am now using OZ7IGY for calibration purposes!
- Exciting new concept – interesting vision!
- Looking forward to the fully developed decoder!

- What a load of junk – the old beacons were much better!

Next generation SHF beacons

- Next generation SHF beacons can be made in two ways,
- either multiplying RF or LO → sideband noise is multiplied, or
- the Reverse DDS principle is excellent for retrofitting, XO clocks DDS and compares output with reference driving a varicap tuning the xtal → frequency specific

Conclusion

- OZ7IGY Next Generation Beacons QRV 30 October 2012, 70 cm to 10 m are QRV. 23 cm before the summer vacation
- Developed a 1 min. mixed mode sequence (PI4, CW ID and carrier) fulfilling the user requirements
- Developed PI4 decoder - PI-RX
- "Any" modulation and sequence is possible e.g. : IBP, 6 m coordinated, FSK441, ISCAT, JT4, JT6M, JT65, JT9, Opera, PI4, WSPR or CW ID and carrier
- Soon also QRV from Central- and South Europe, USA and Oceania

More information

- The NGNB project
  - www.rudius.net/oz2m/ngnb
  - Bo, OZ2M, oz2m rudius net
  - PCBs, partial kits and plug-n'-play boards
- OZ7IGY
  - www.rudius.net/oz7igy
  - Ivan, OZ7IS, oz7is yahoo dk