Next Generation Beacon

Autumn 2011

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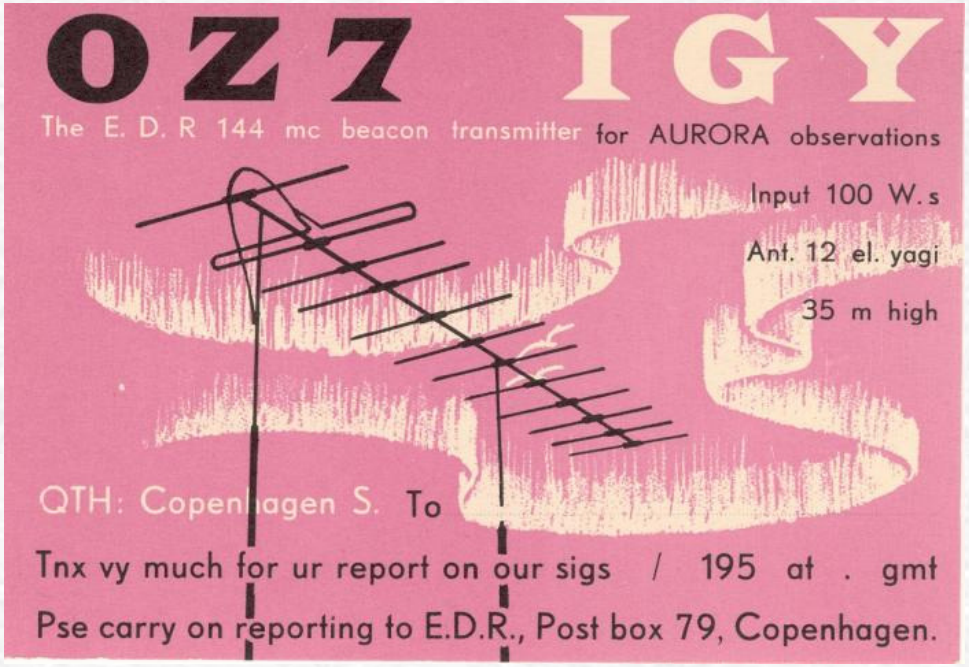
Contents

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

OZ7IGY historical status

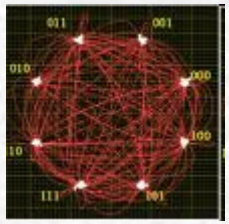
- QRV since 1957
- Using contemporary technology
- Everybody could participate but technically driven



Operating OZ7IGY

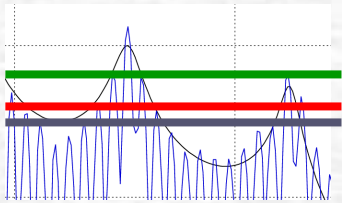
- Expenses ~2000 €/year, or using 800 W continuously
  - ~300 € from radio club memberships
  - ~1000 € form individual memberships
  - The rest
    - Member donations
    - The 70 MHz transverter project
- QRV
  - MHz: 28, 40, 50, 70, 144 and 432
  - GHz: 1, 2, 3, 5, 10 and 24
- How can we make OZ7IGY run another 50 years? The next generation beacon!

OK!
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



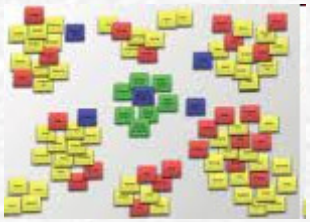
- Automated monitoring of conditions and comparison to **average** → **alarm** when x dB better than average → **possible** human communication

- 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?

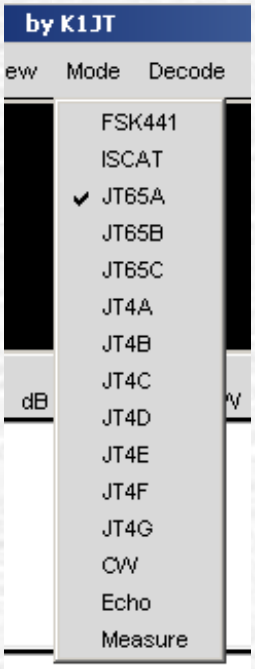


- What do the users say and want?

Both analog and digital modulations are the future

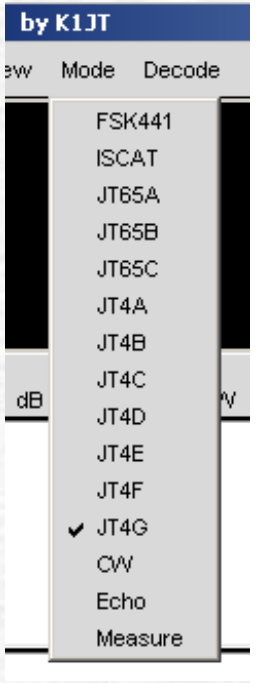
- Can be decoded both with and without a computer, like today
- Benefits from the digital capabilities
- Frequent ID to cope with QSB
- Possible to detect via unknown propagations
- Must be ”zero beatable”
- Must fit into existing beacon spacing(s)
- Same modulation and sequence on “all” bands
- The combination is possible using a smart sequence

Something exists, but ...

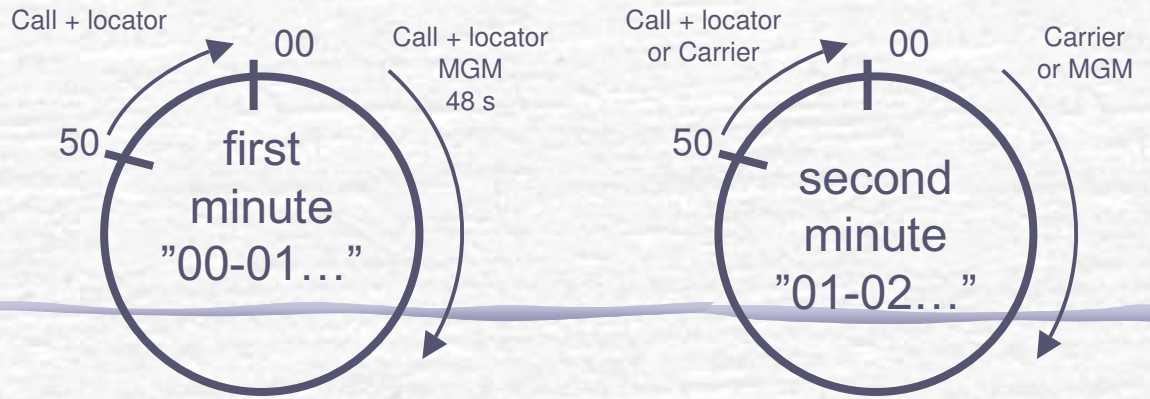


- WSPR
  - Designed for HF, OK for 6 m but not above
  - 2 min sequence and no CW ID
  - Not resistant to distortion or frequency jitter
- JT65
  - Designed for EME, tropo and ionoscatter
  - 1 min sequence and no CW ID, or 2 min with CW ID
  - Only somewhat resistant to distortion

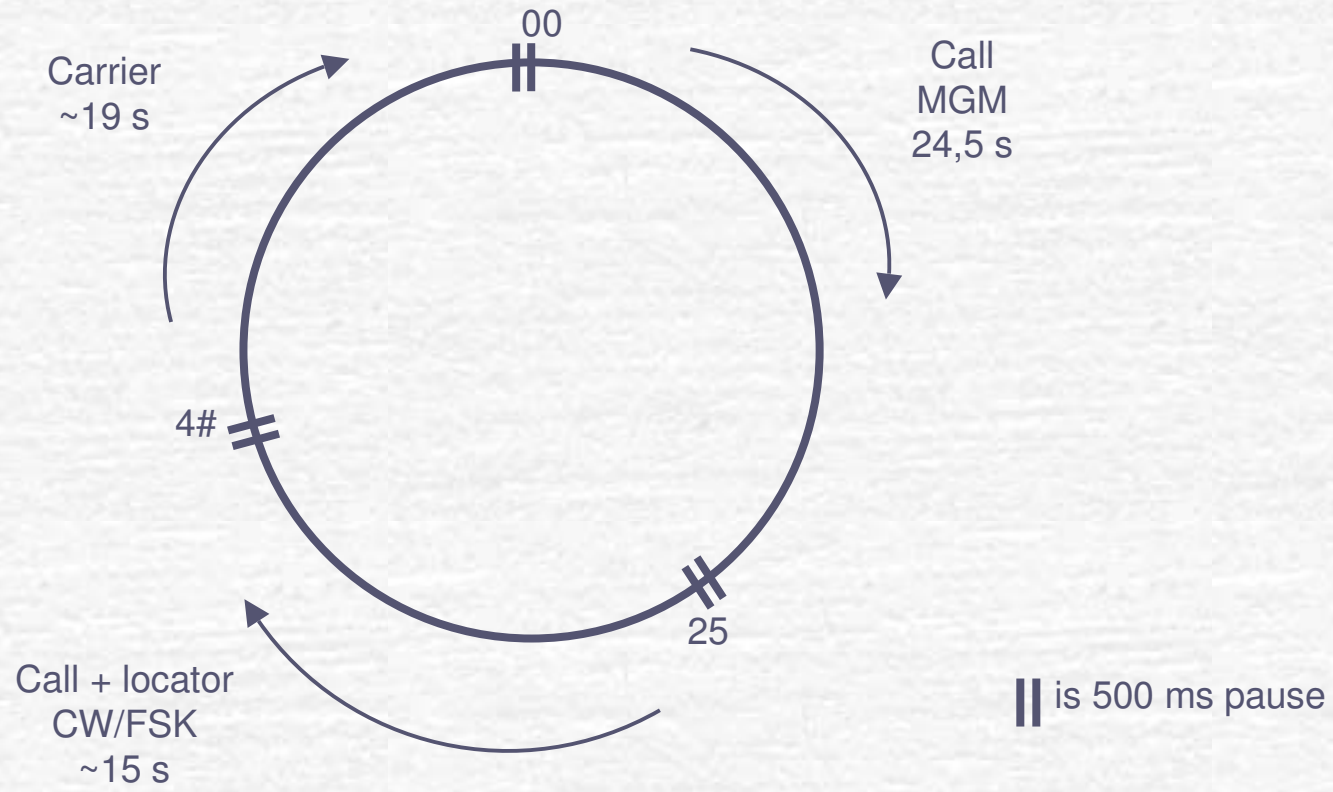
How about JT4x then?



- 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
  - E.g.:

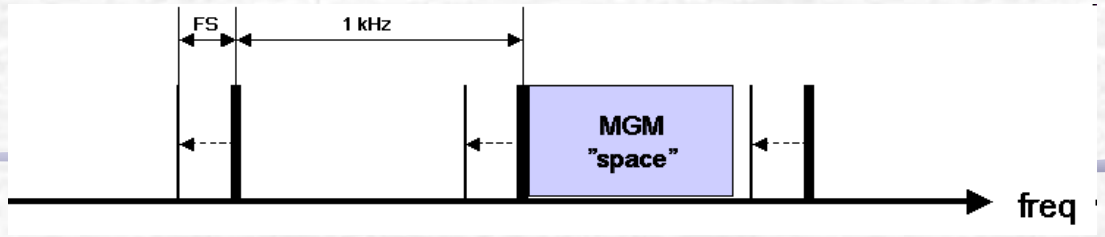


Here is what we want
1 min MGM + CW ID + Carrier



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 ~238 Hz, or ~715 Hz wide
    - Leaves guard space for above beacon using CW FSK
    - Wider spacing possible if needed, e.g. SHF bands
  - Open source



Comparing

JT4

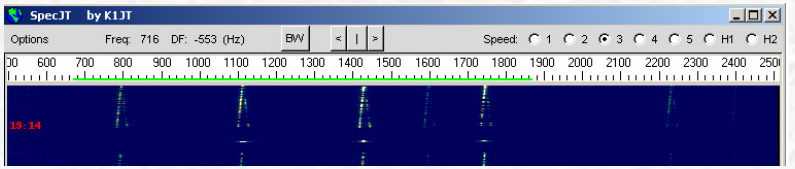
- Duration is 47,3 s
- 2 min sequence
- 13 char. message
- Call and locator
- “A”-“Z”, “0”-“9”, “/+-.?<space>” in total 42 chars
- ~F narrow, ~G wide
- S/N 23,6 dB
- Already in WSJT

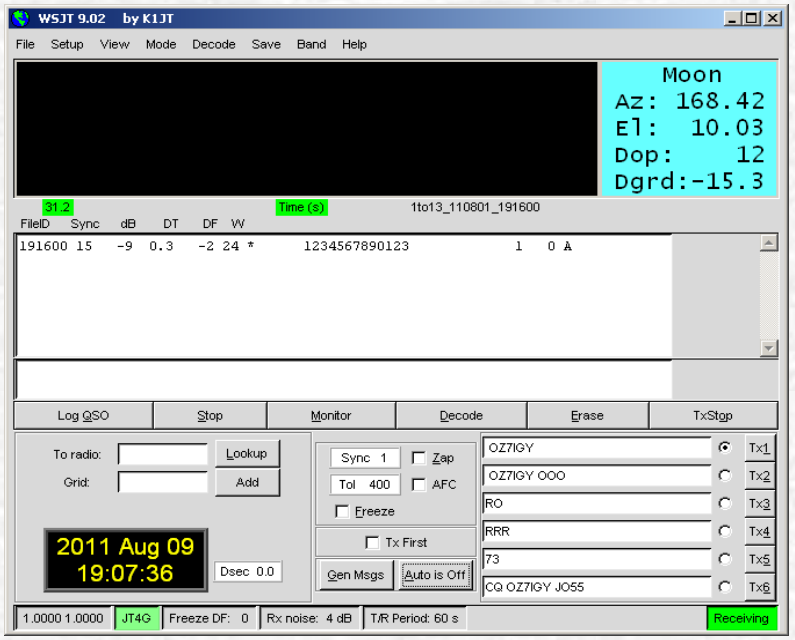
PI4

- Duration is 24,5 s
- 1 min sequence
- 8 char. message
- Call, or other msg.
- “A”-“Z”, “0”-“9”, “/<space>” in total 38 chars
- BW 715 Hz, just right
- S/N 22,3 dB
- IARU Reg. 1 standard

Decoding digital modulation

- The leading VUSHF digital modulation program is WSJT
- We are working on modifying WSJT
- To propose changes to Joe, K1JT



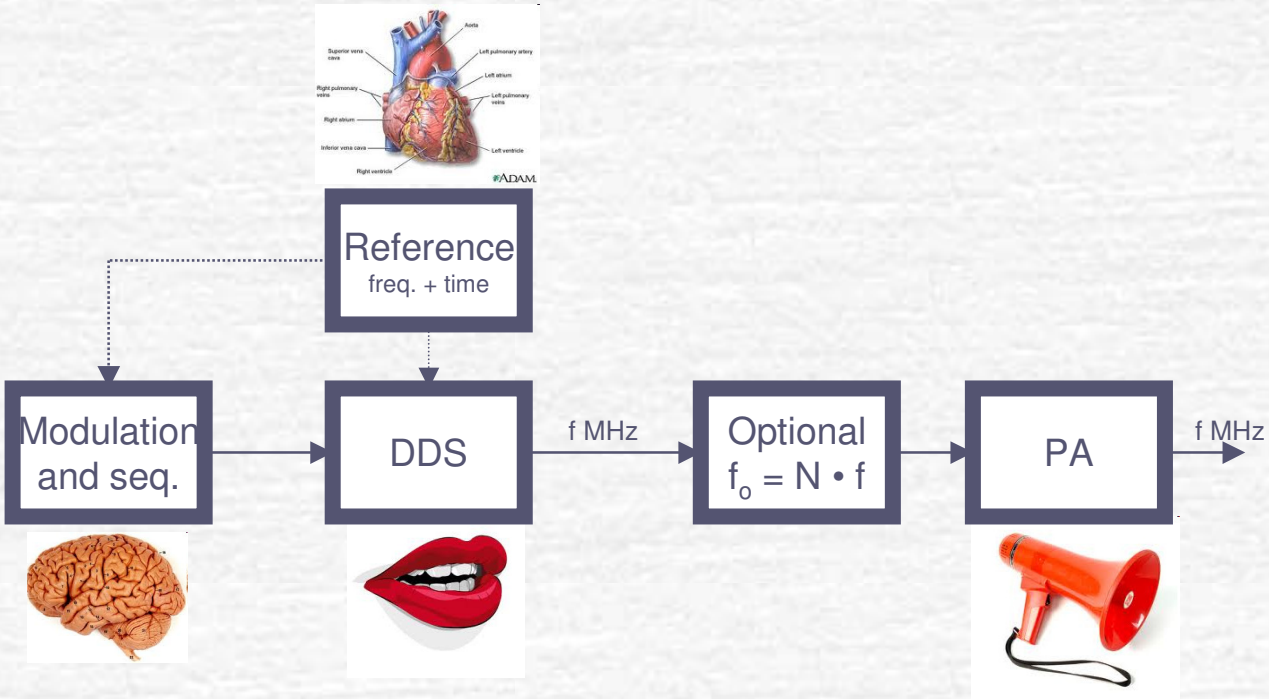


OK!
What do we do now?

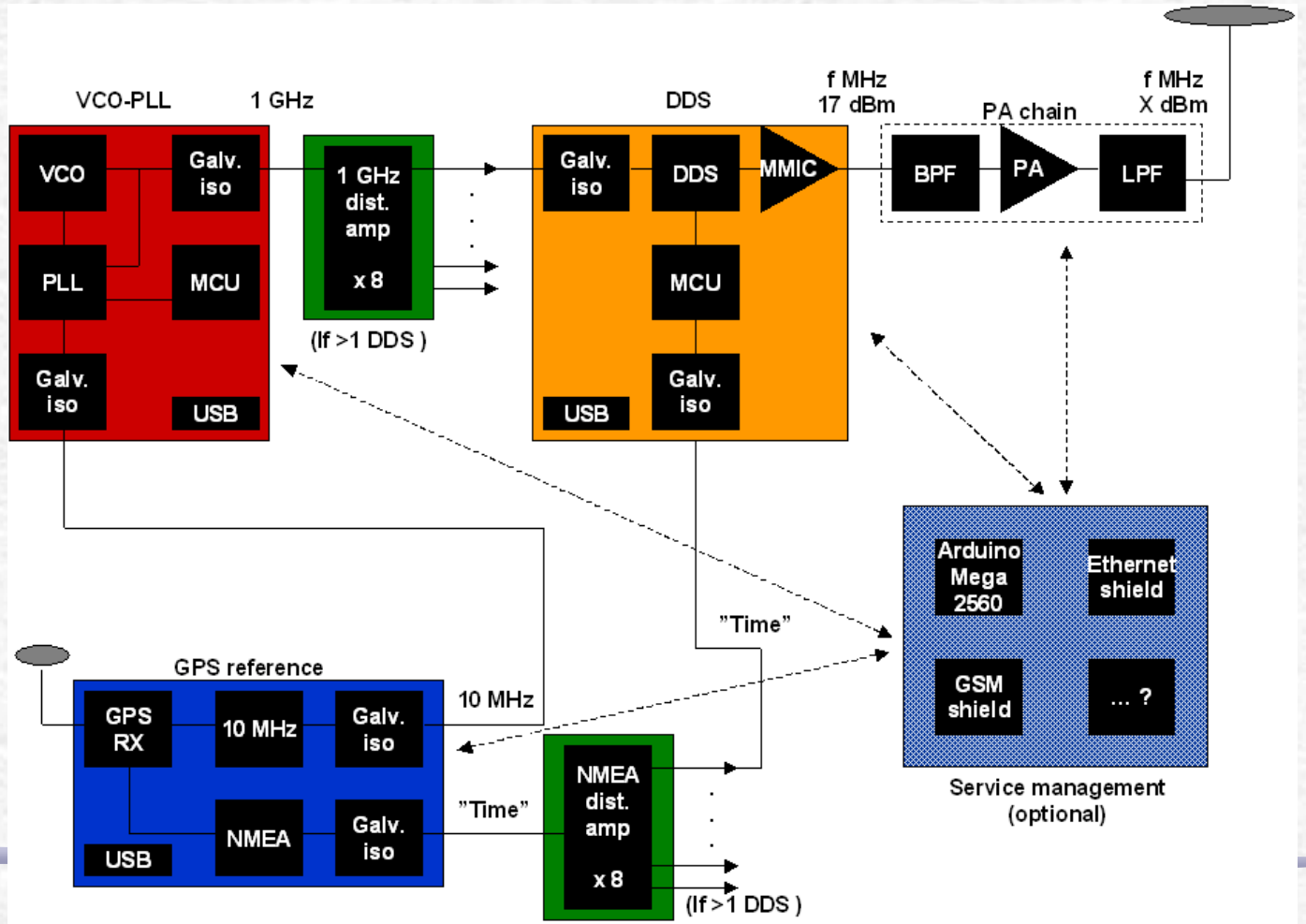
Project NGN Beacon

- 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, OZ9GE and OZ9ZZ
  - Partial participation OZ1BV and OZ2CPU

Basic topology

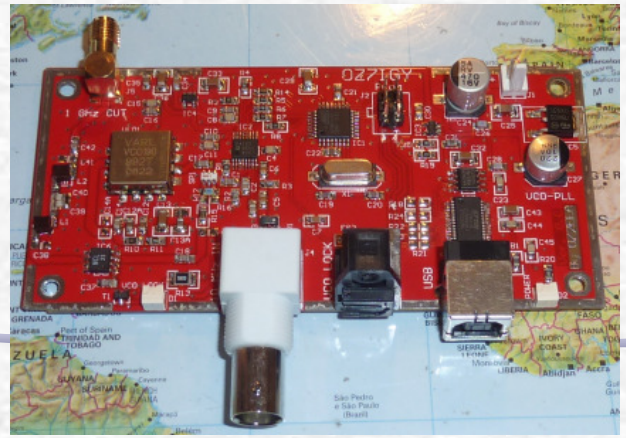


Functional block diagram

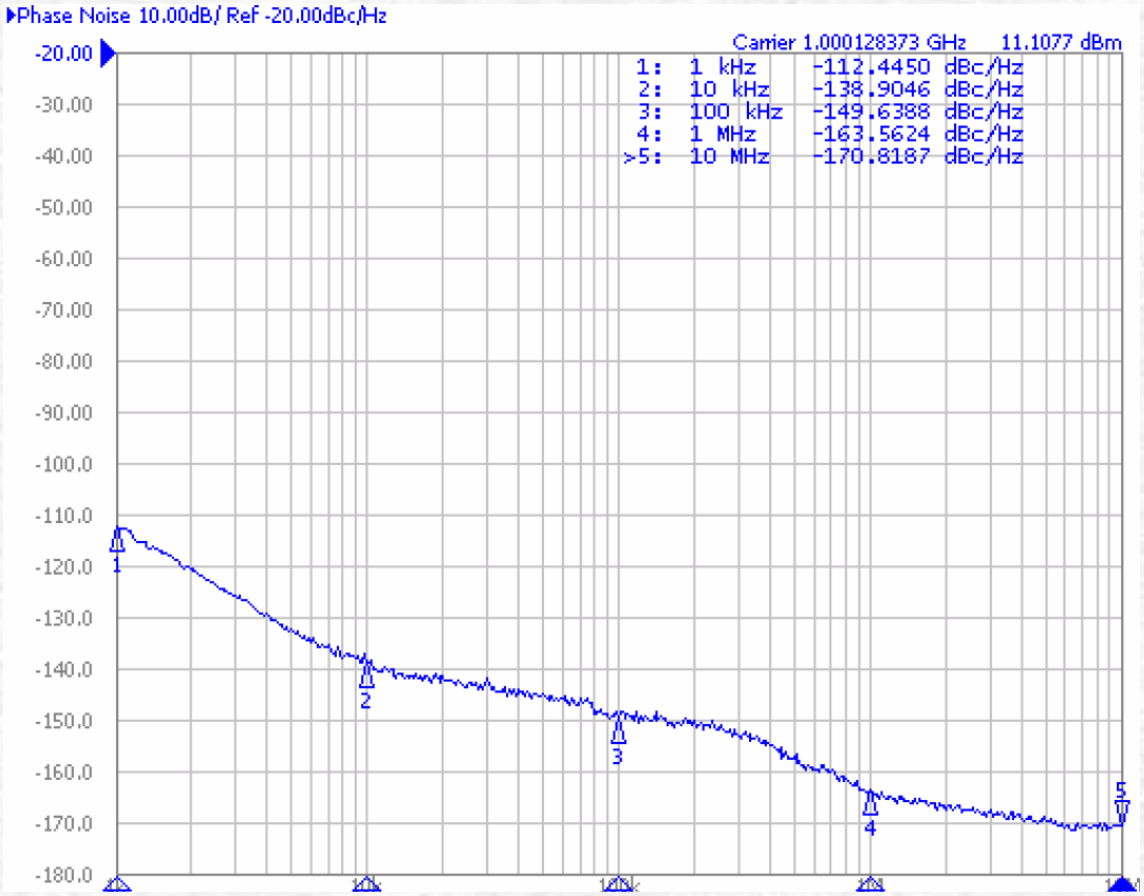


1 GHz VCO-PLL clock

- 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



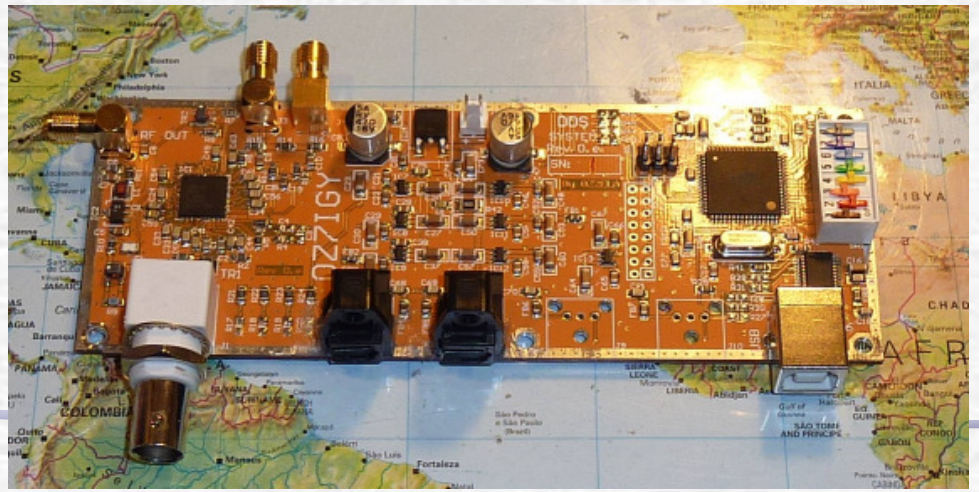
DDS freq. and modulation

- 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

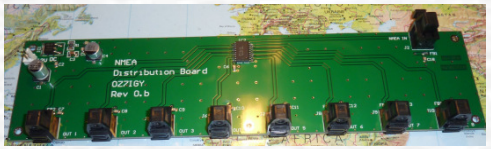
DDS board

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



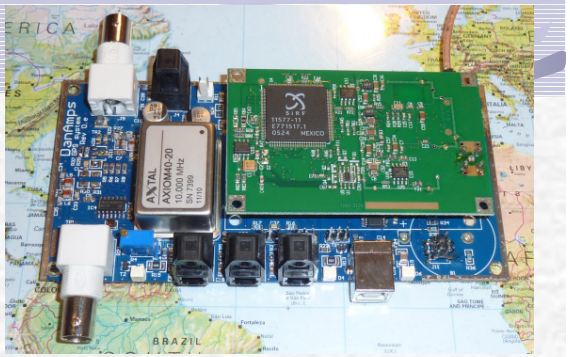
Distribution boards

- Necessary if more than one DDS board
- 1 GHz distribution board performance
  - 1 input to 8 outputs
  - Port to port isolation ~40 dB
  - Gain ~3,5 dB
  - Power spread across ports less than 1 dB
  - Power consumption 1,5 W



NMEA

GPS reference



- The GPS reference provides 10 MHz, NMEA time signal and 1 PPS
- You can use any GPS that has 10 MHz and NMEA for the OZ7IGY 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

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

The real world

- The first OZ7IGY next generation beacon on air in autumn 2011 on 50 MHz
- Other beacons from 28 MHz to 1,3 GHz will follow during autumn and winter as time permits
- Live demonstrations in 2011
  - Nordic VHF Meeting, June
  - Weinheim UKW-Tagung, September
  - RSGB Convention, October

Conclusion

- The next generation beacon platform that is frequency and time locked is on the air
- A one minute mixed mode (MGM, CW ID and carrier) sequence has been developed that meets the requirements
- “Any” modulation and sequence is possible, e.g. IBP, JT4, JT65, PI4, WSPR or classic CW ID and carrier

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.oz7igy.dk
  - Ivan, OZ7IS, oz7is yahoo dk