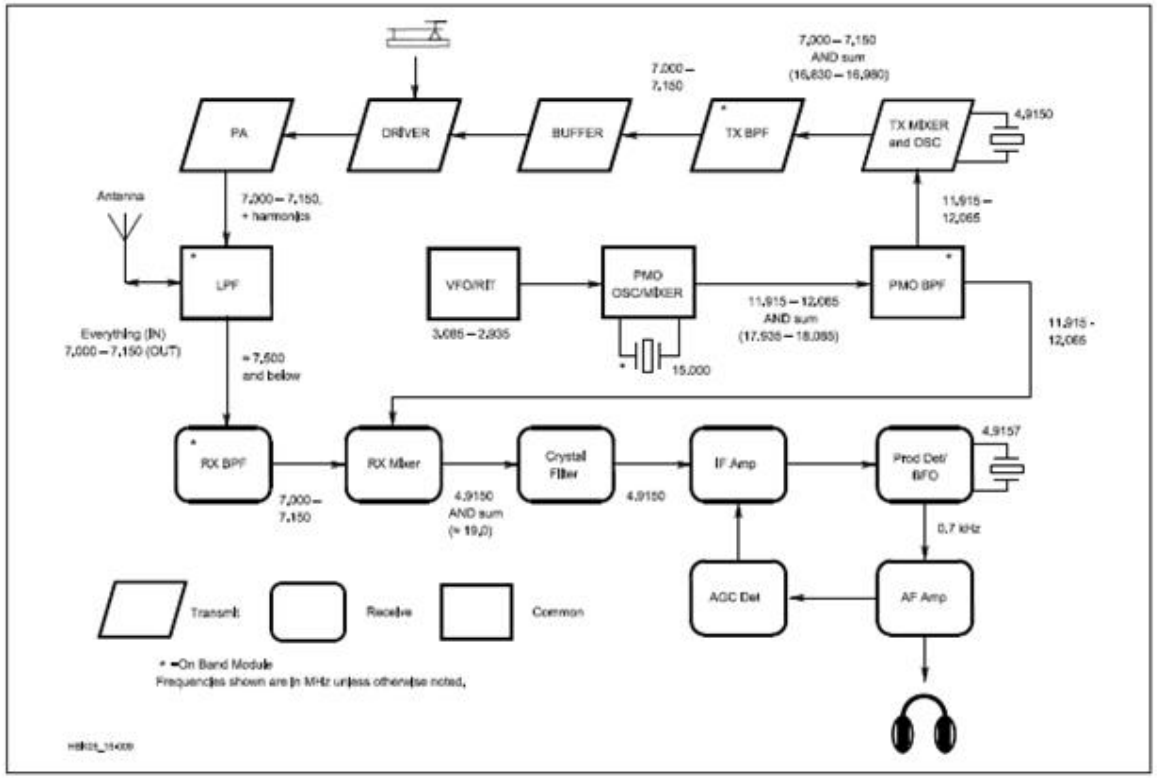
A homebrew QRP Transceiver

Lots of Fun
&
Lessons Learnt

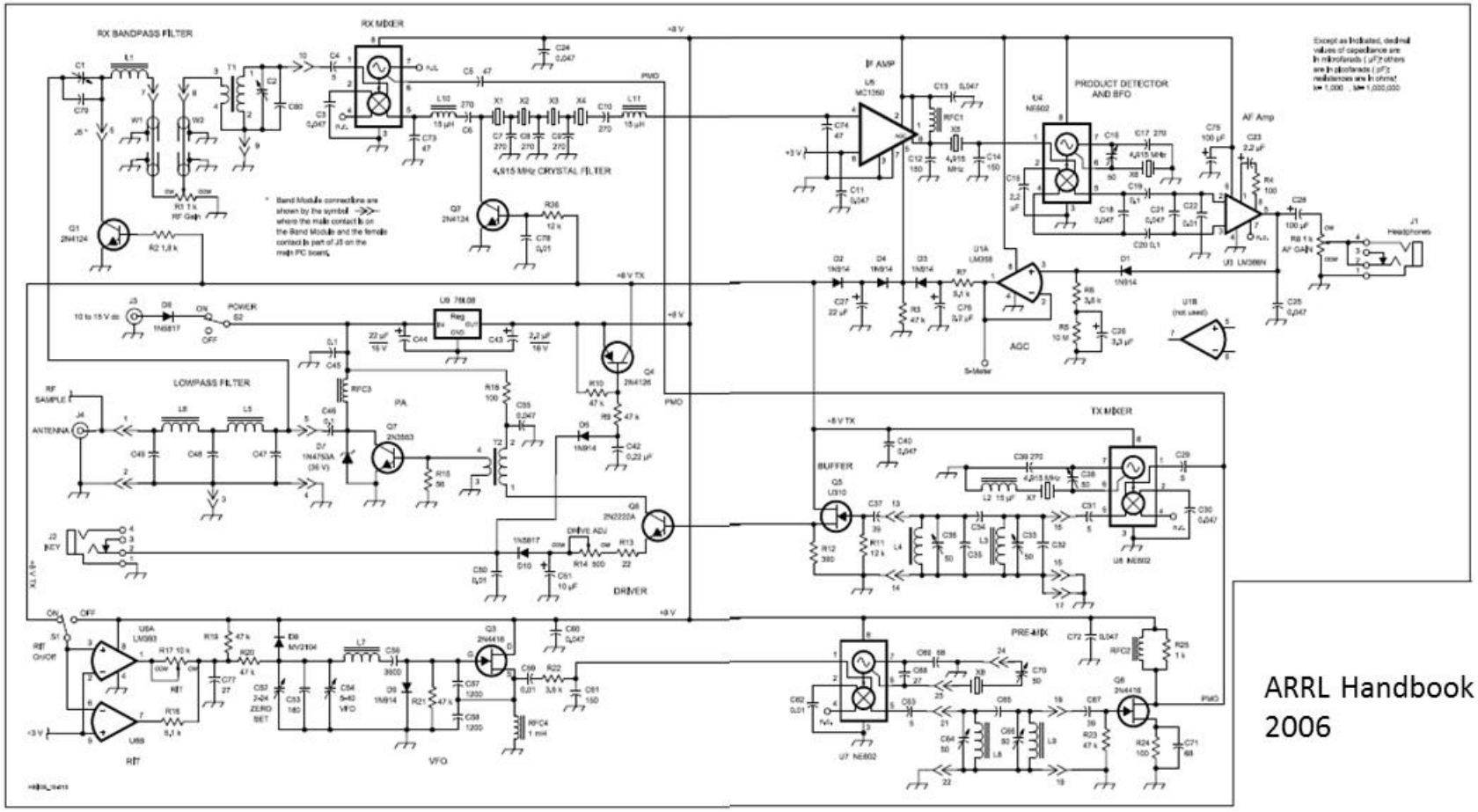
Background

- In 2008 I was transferred to a new location.
- I could bring 2 suitcases along and spent 5 months in an apartment until the container with all my stuff arrived. Finally!
- Enough time for reading though the complete ARRL handbook in detail.

NorCal Sierra: ARRL Handbook

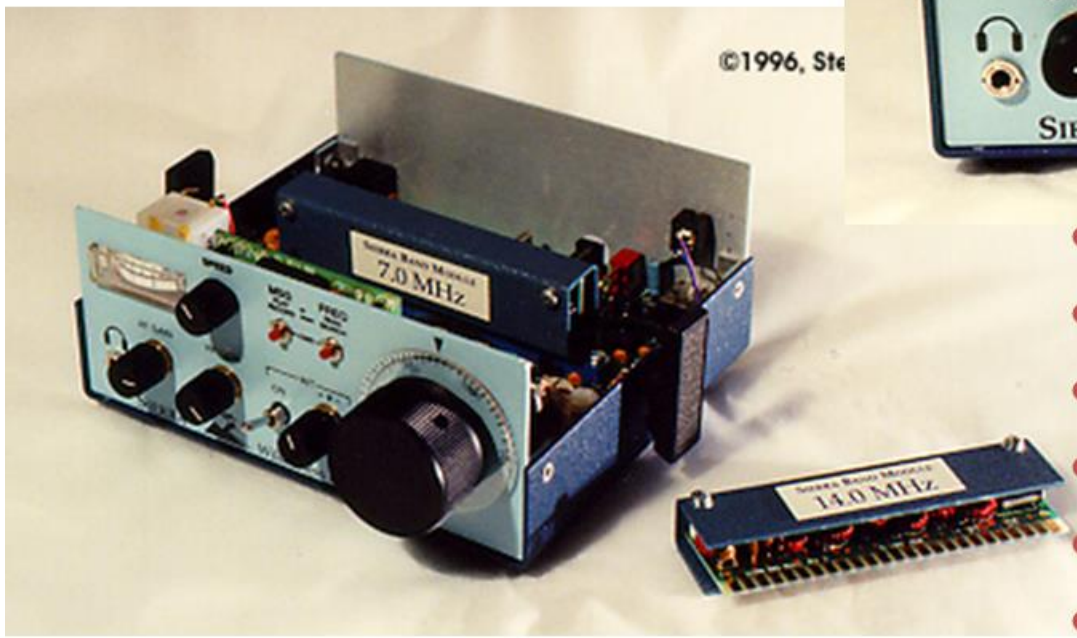


Sierra: Schematic



ARRL Handbook 2006

The “Sierra”
by Wilderness Radio



- All band CW transceiver
- Superhet, VFO
- Dig display & key options
- Removable band modules
- Rivals quality of rigs 5x $
- ARRL Hndbk cover ‘96

Idea: Why not make an own rig?

- Challenge: a homebrew TRX
  - No simple copy n paste approach
  - Some modifications of original circuit
  - Target: performance
  - No thrills n whistles (at least in first stage)
- 15 meter band
  - DX band
  - antenna size / performance

Some requirements

- Use of junk box parts
  - Chassis
  - Laptop power supply
  - Variable capacitor
  - DBM
  - Heat Sinks
- Construction techniques:
  - Manhattan, Dead bug, SMT..

Basic Design: simple

Direct Conversion	Superhet	
	single conversion	multiple conversion
(V)XO	VFO	Synthesizer
	CW only	SSB FM, AM
	MGC	AGC
	AF filtering	IF filtering
	-	NB, S-Meter
	-	digital display

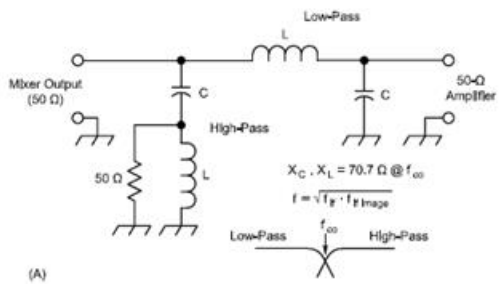
Modifications: some details

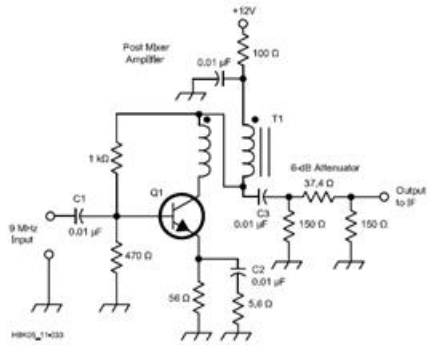
- Frontend : RF preamp / DBM / diplexer / IF amp instead of active NE602 mixer
- 3 pole Xtal filter
- audio filter: switchable bandwidth
- AF amplifier
- Frequency management: down conversion
  - VFO: 3.28-3.44 MHz
  - PMO-Xtal 12.8 MHz

  PMO: 16.08- 16.24 MHz
  IF: 4.9152 MHz (Sierra, K2)
- PA: IRF 510 FET 3.5 W output
- RX/TX switching with relay

Replacement - Complexity

- Replacement of active NE 602 mixer by a DBM
  - DBM: passive mixer with conversion loss
    i.e. additional amplifier stage needed
  - Resizing of filter / diplexer frequencies
    software simulation, experimental verification





Test gear

- Oscilloscope
- Receiver
  - detection of spurs, oscillator drift...
- and some homebrew equipment
  - Dummy load / power measurement
  - Oscillator for Crystal measurements (Xtal filter)
  - Sweep frequency generator (filter measurements)
  - Capacity and inductance meter

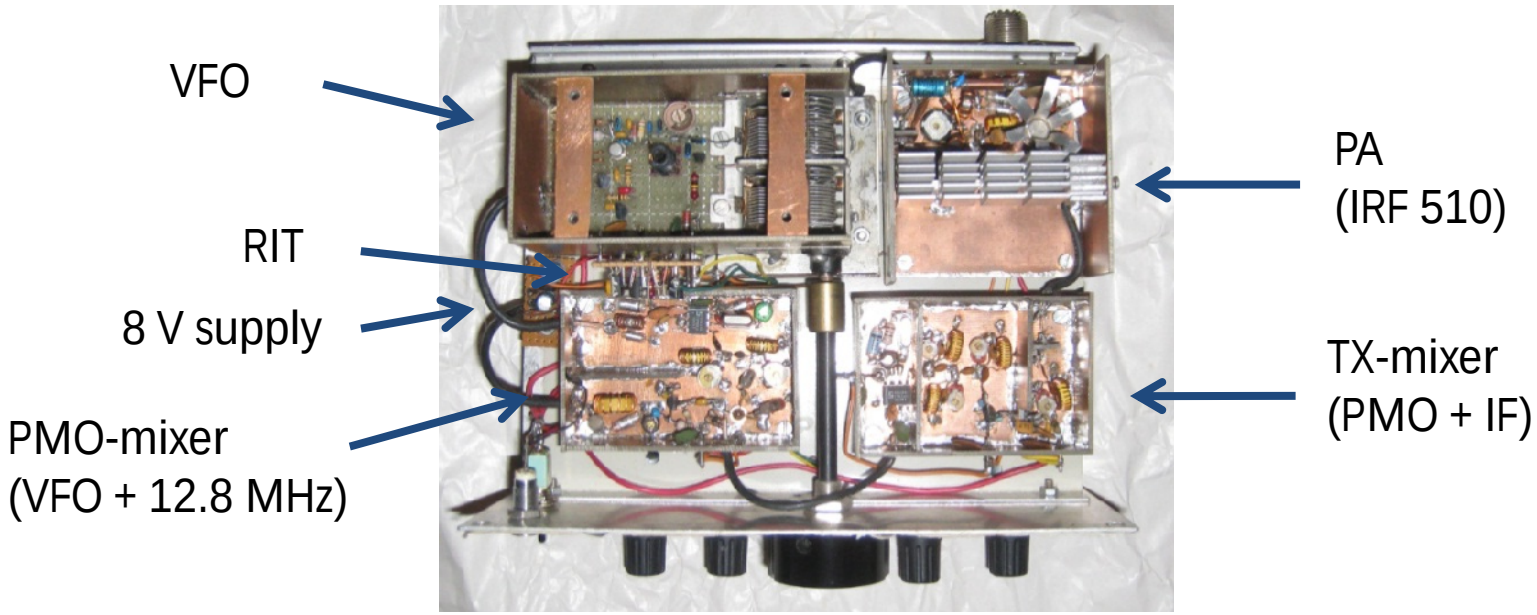
Summary

- What looks quite easy on paper too often turns out to be “somewhat” more complex in reality
- Combining circuit boards too often takes more time than soldering together the boards
- Grounding has an effect / some circuits don’t want to work ……..

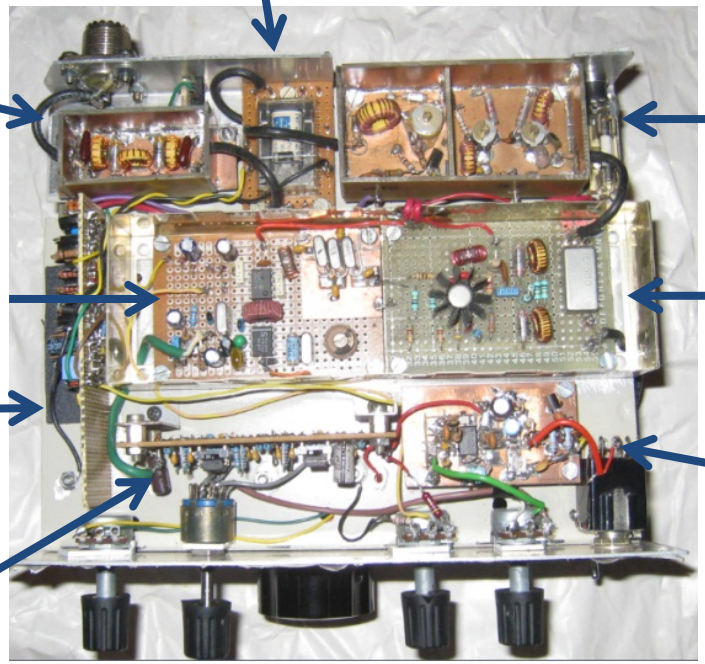
1 year later: the Outcome

Single band
CW Transceiver
21.00 - 21.16 MHz
Receiver:
Single conversion superhet
RIT
Variable RF gain
500 Hz IF Xtal filter
Switchable audio filter
Transmitter:
3.5 Watt output

Insights: The top



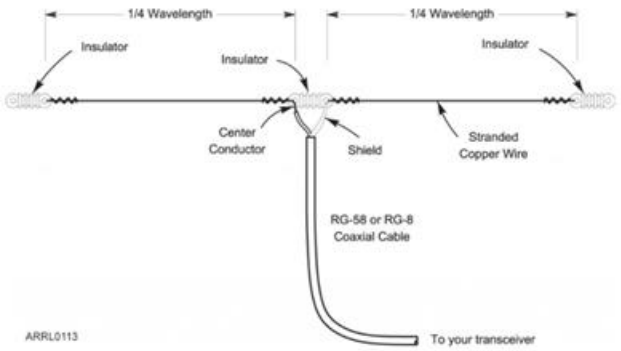
At the bottom



Crucial: Antenna

coax fed sloping dipole

- From 1st floor window (≈ 5.5 m)
- to bamboo stick (≈ 2.5 m)



What is “QRP?”

- A telegraphy Q-signal
  - “QRP” = To lower ones power
  - “QRP?” = Can you lower your power?
- QRP Operation
  - CW: 5 Watt RF output power (or less!)
  - SSB: 10 Watt PEP
- QRPP / miliwatting

  < 1 Watt output

Some theory: 5 % of 100 W.....

100 Watt: S 9 signal

5 Watt: S 7

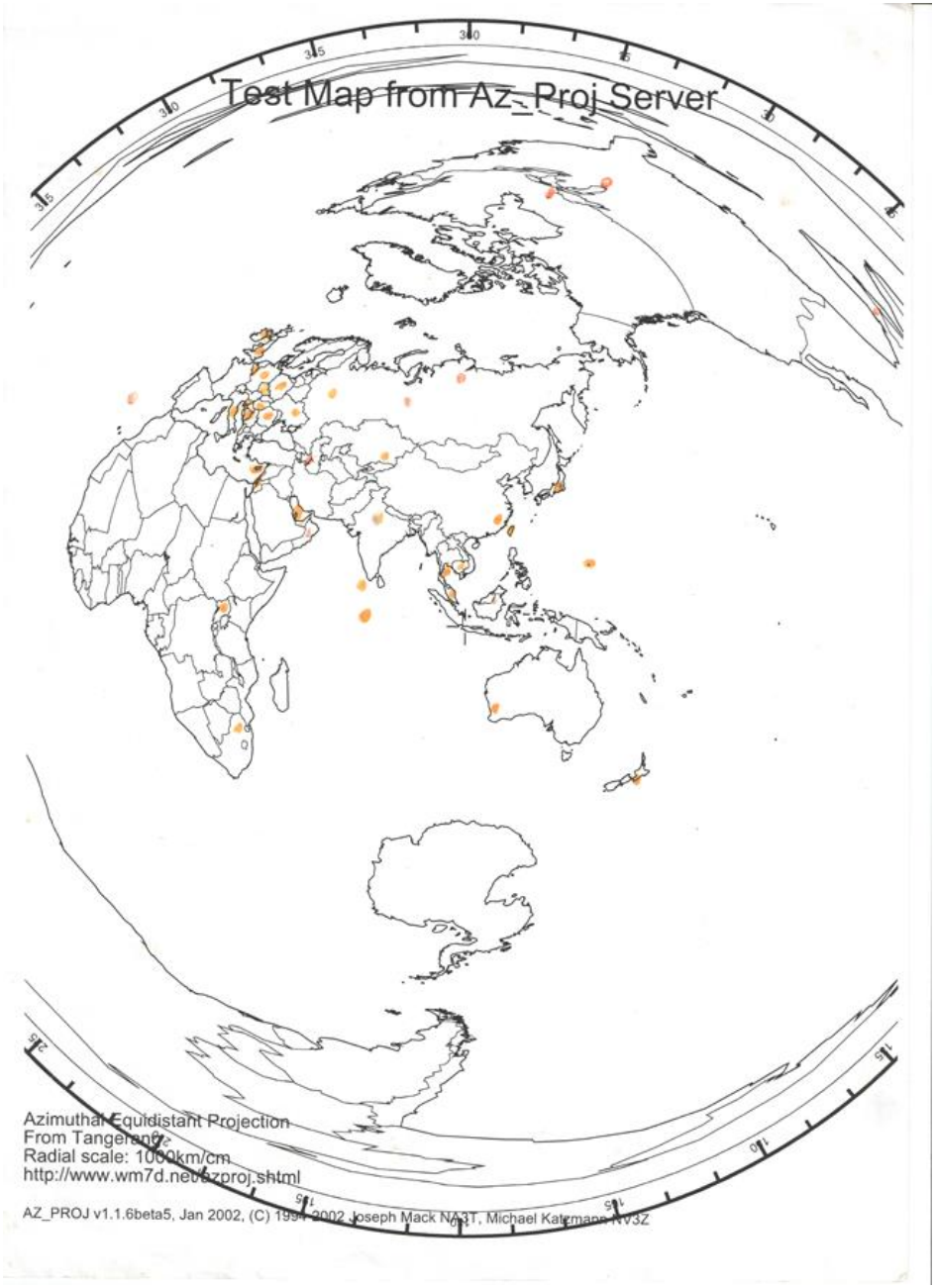
Only 5 watts? You must be kidding...

100 W	0 dB
10 W	- 10 dB
5 W	- 13 dB
1 W	- 20 dB

S-meter: 1 unit ð 6 dB

Operation with 3.5 W

- Within ½ year more than 50 countries from YB
- From “round the corner” to real DX
- HR, OY, 5X, CT3, ZC4, 4K, A6, A7, GI, VE3, K2, 5Z
  (No contest QSO’s!)
- Short band openings (3/4 h) to Europe almost every day
  i.e. 0.3-0.4 W / 1000 km
- Several 2 way QRP contacts
  A4, RA1, DL, JA
- Learning: Improved own operational skills



Have a Try – First steps

- Play with attenuator button:
  - 16 dB correspond to power reduction 100 W 4 W
- Listen on QRP frequencies
- Test: reduce transmitting power
  - Are you still heard?

CW	SSB
1810	---
3560	3985
7040 (7030)	7285
10106 (10116)	---
14060	14285
21060	21385
24900	24950
28060	28885
50060	50885

- Less interference -> happy neighbours

Another toy of my shack

- rather simple design
- nevertheless High Performance
- several options: 100 W PA, tuner, digital filter

Some References/Links

www.gqrp.com
www.qrparci.org
www.qrpproject.de (also in English!)
www.qrp.pops.net

Frank W. Harris, KØIYE 2006: CRYSTAL SETS TO SIDEBAND
A Guide to Building an Amateur Radio Station
W1FB's QRP Notebook

ARRL Handbook
Experimental Methods in RF Design

High End Homebrew

160-2 m, QEX 1999
Mark Mandelkern, K5AM

HBR-2000, QST 03/2006
Markus Hansen VE7CA

Table 1
HBR-2000 Test Measurements

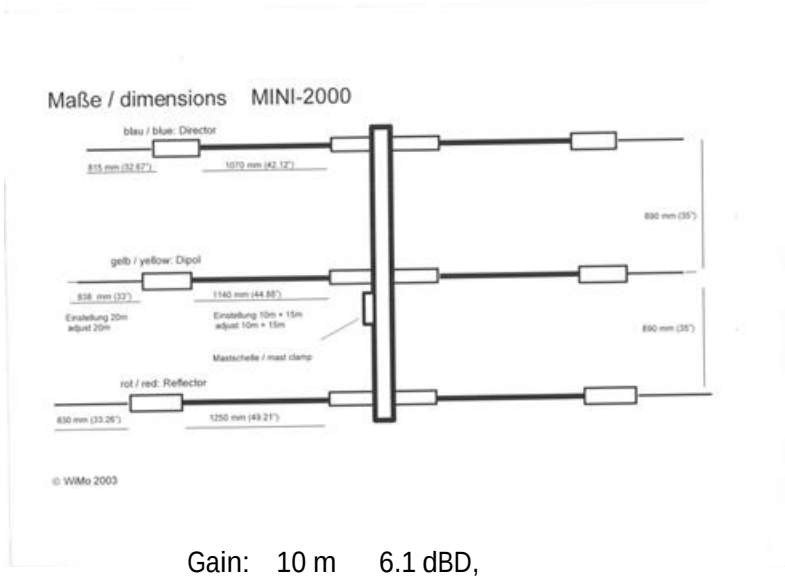
Image rejection all bands:	>135 dBm.		
Spacing:	*20 kHz*	*5 kHz*	*2 kHz*
Two-tone blocking dynamic range:	>126.0 dB	124.0 dB	122.0 dB
Third-order intermodulation dynamic range:	103.5 dB	102.5 dB	93.0 dB
Third-order intercept:	25.5 dBm	24.0 dBm	14.5 dBm

Next on the agenda

- August/September: QRT in 9V
- Later on: QRV from YB land


YB1RGK
YB1RGK
YB1RGK
YB1RGK

Garage Sale



Gain: 10 m 6.1 dBD,
15 m 4.2 dBD,
20 m 3.5 dBD
ca. 3 dB below full size 3 ele Yagi (ca. ½ S-meter level)
Front/Back ratio 8 dB
Boom length 2 m
Element length 5 m
Turn radius 2.6 m
Weight 8 kg
Max power 1000 W PEP

Heathkit SB 221
2 x 3-500Z Triodes
80, 40, 20, 15 m bands
Drive: 90 W
Output: > 1 kW