New Claimed World and North American Distance Record (79.6km) and VUCC #1 for the 241GHz Amateur Radio Allocation

17-Feb-2004

Hello everyone-

I'd like to claim what should be a new World and North American DX record for the 241GI band.

Last night, W2SZ/4 worked WA1ZMS/4 on 241GHz at a distance of **79.6km** using slow speed CW (QRSS).

Detais of the QSO
Date: Feb 17th, 2004
Time: 00:15z
W2SZ/4 in FM07fm (37-31-00N 79-30-35W)
WA1ZMS/4 in EM96wx (37-59-28N 80-07-17W)
Distance: 79.6km

The weather at the W2SZ/4 QTH was:
Temp: -8C
Dew Point: -26C
Relative Humidity: 22%
Station pressure: 884mb
Atmospheric loss: 0.273dB/km

The weather at the WA1ZMS/4 QTH was:
Temp: -8C
Dew Point: -16.1C
Relative Humidity: 53%
Station pressure: 932mb
Atmospheric loss: 0.681dB/km

Pete, W4WWQ was the CW op at W2SZ/4. WA1ZMS/4 was the op of his own station at t EM96 QTH. Both ends of the QSO used Spectran software to aid in receiving the slow speed CW at a rate of approximately 1 second per "dot", 3 seconds per "dash".

The entire QSO took well over an hour to complete with both stations having to send the exchanges several times. Some portions of the CW were copied by ear, but the DSP

software came through in the end to help make the QSO happen.

Both stations used new Wenzel Ultra-Low-Noise 5MHz reference oscillators as the phase locking frequency references. Short-term stability on the order of 4 x 10-13 is required to keep the signals within a 1Hz filter bandwidth of the demodulating software.

The stations were keyed using Island Keyers with custom QRSS firmware from Charles Olsen, WB9KZY.

This QSO is also the 5th grid needed for the ARRL VUCC award for the 241GHz band fo W2SZ. This claim should be the very first VUCC for that band and has taken many month of hard work and many VERY cold-night DX-peditions to make it all happen. This latest D record of 79.6km occurred on our fourth attempt, so we were not without our failures.

73,
Brian Justin, WA1ZMS

For more information on Brian's 241GHz experiments you can also take a look at the following:

- **The original 1.1km DX effort**
- **The extension of the record to 7.3km**
- **34.9km and 61.8km on 241GHz**

241GHz Station Details

Here are some details of the 241GHz station as it has been modified for the latest DX record.

TRANSMITTER:
The transmitter is based on a 40mW 80.666GHz Gunn oscillator driving a anti-parallel Schotkey GaAs diode X3 multiplier (the original design of the multiplier was by Virginia Diodes Inc). The resulting 241GHz output power is a measured -1dBm.

RECEIVER:
The receiver is based on a modification of the X3 TX multiplier. By adding a DC/IF return port it converts the multiplier into a harmonic mixer. Each station's TX frequencies are offset which allows the use of a tunable RX IF of around 439MHz.

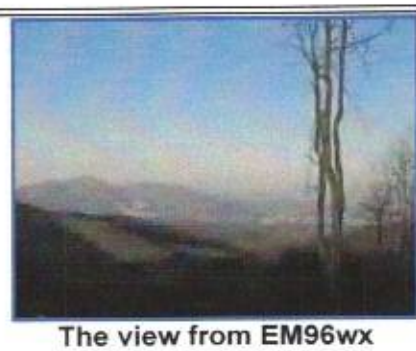
ANTENNAS:
New homebrew 30cm parabolic reflectors with Cassegrain feed system using true hyperbolic sub-reflectors. The machining of the curved surfaces was done with help from a local machinist. The feed is a W2IMU style dual-mode horn with a step transition from rectangular WR-3 waveguide. Antenna gain is around 53dB (rough measurement).

REFERENCE OSCILLATORS:
New homebrew direct synthesizers have replaced the former 5th over-tone VHF crystal oscillators. The direct synthesizers are now fed by 5MHz Ultra Low Noise reference OCXOs from Wenzel. CW keying is by FSK'ing the 5MHz OCXOs. The close-in phase noise of multiplied 5MHz OCXO is many times better than even the best VHF crystal oscillator.

Images and pictures

241GHz 30cm dish

The view from Apple Orchard, FM07fm in the direction of EM96.



The view from EM96wx looking back to Apple Orchard Mtn. Distance is 79.6km.

Ice on the tripod at Apple Orchard the night of the 79.6km DX QSO. Temp outside was 17degs F.

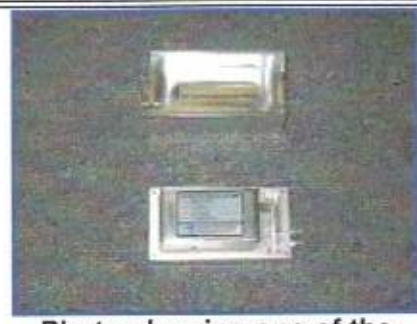
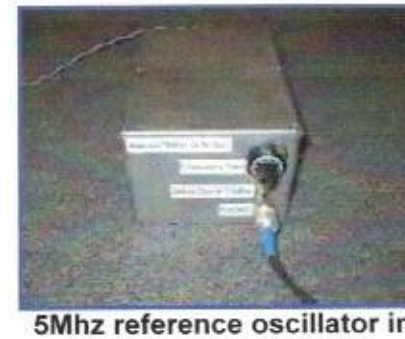


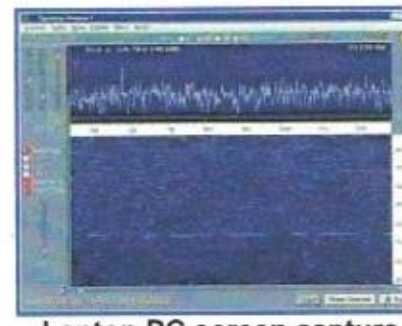
Photo showing one of the new Wenzel Ultra-Low-Noise 5Mhz reference oscillators before being installed in custom milled sub-chassis. Phase noise of this oscillator is -120dBc/Hz at 1Hz offset, and -150dBc/Hz at 10Hz offset!



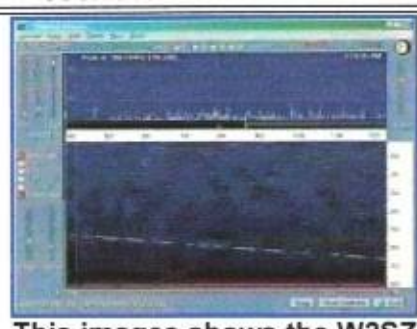
5Mhz reference oscillator in its final outer chassis.

G8ACE @ 10Hz -86dBc

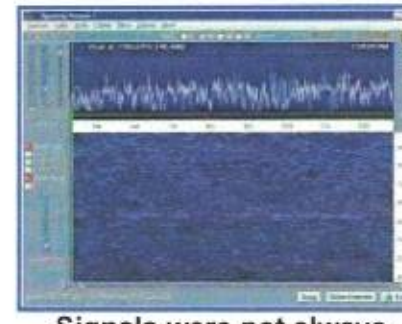
Coleman brand cooler that housed Wenzel reference oscillator and gell cell batteries. These oscilaltors are always kept running and have never been powered down over the past several months. This helps reduce oscillator re-trace issues.



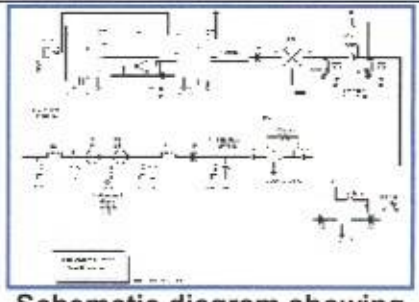
Laptop PC screen capture showing the signal as "heard" in EM96. You can see Morse characters "W" and "A" of WA1ZMS being received. DSP filter bandwidth set to 1.3Hz.



This images shows the W2SZ end of the QSO as viewed with Spectran. CW text of "2SZ" can be seen. The 75Hz of frequency drift shown is due to the Icom R-7000 IF receiver having hot air blown on it while Pete, W4WWQ, was operating inside his vehicle.

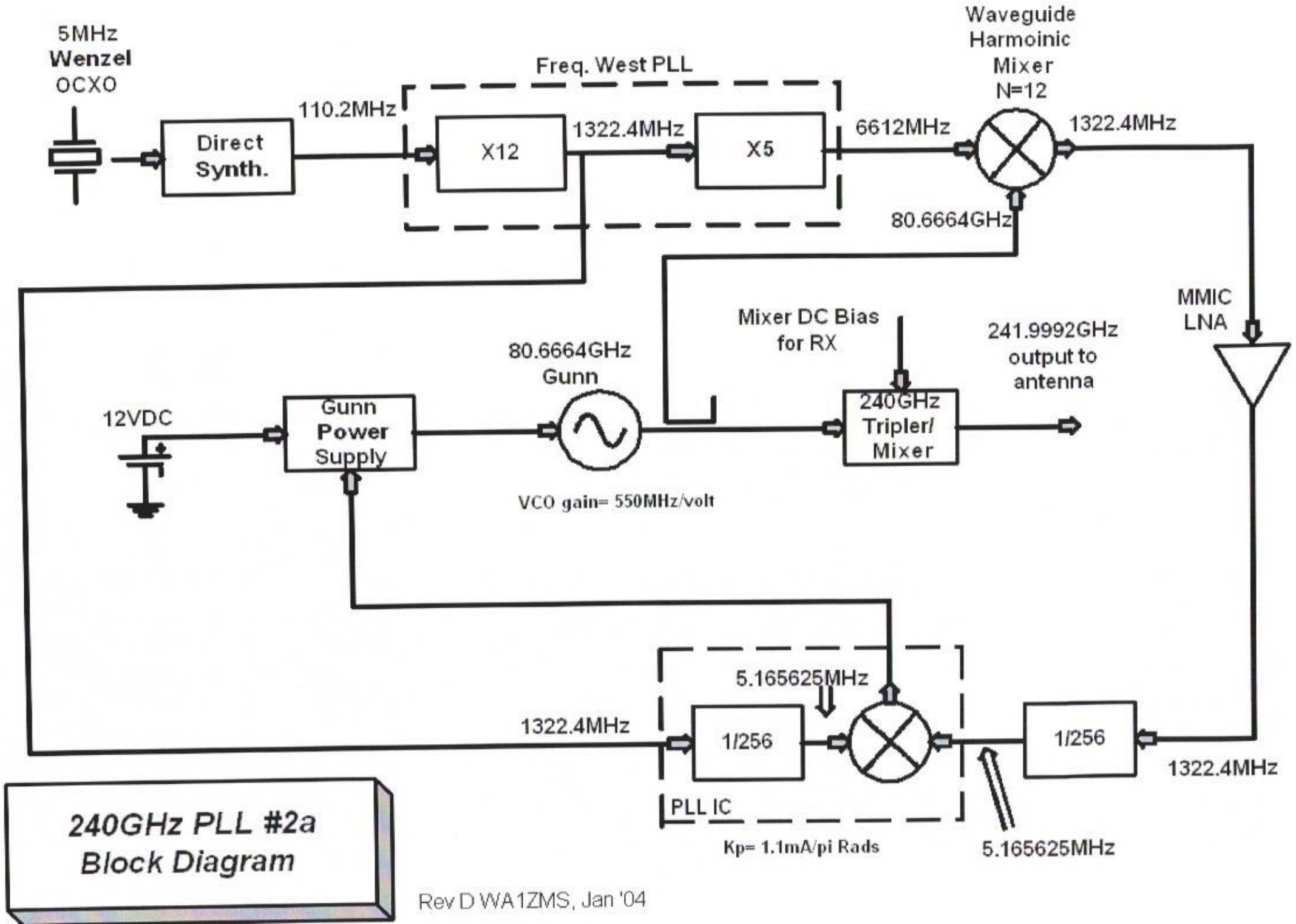


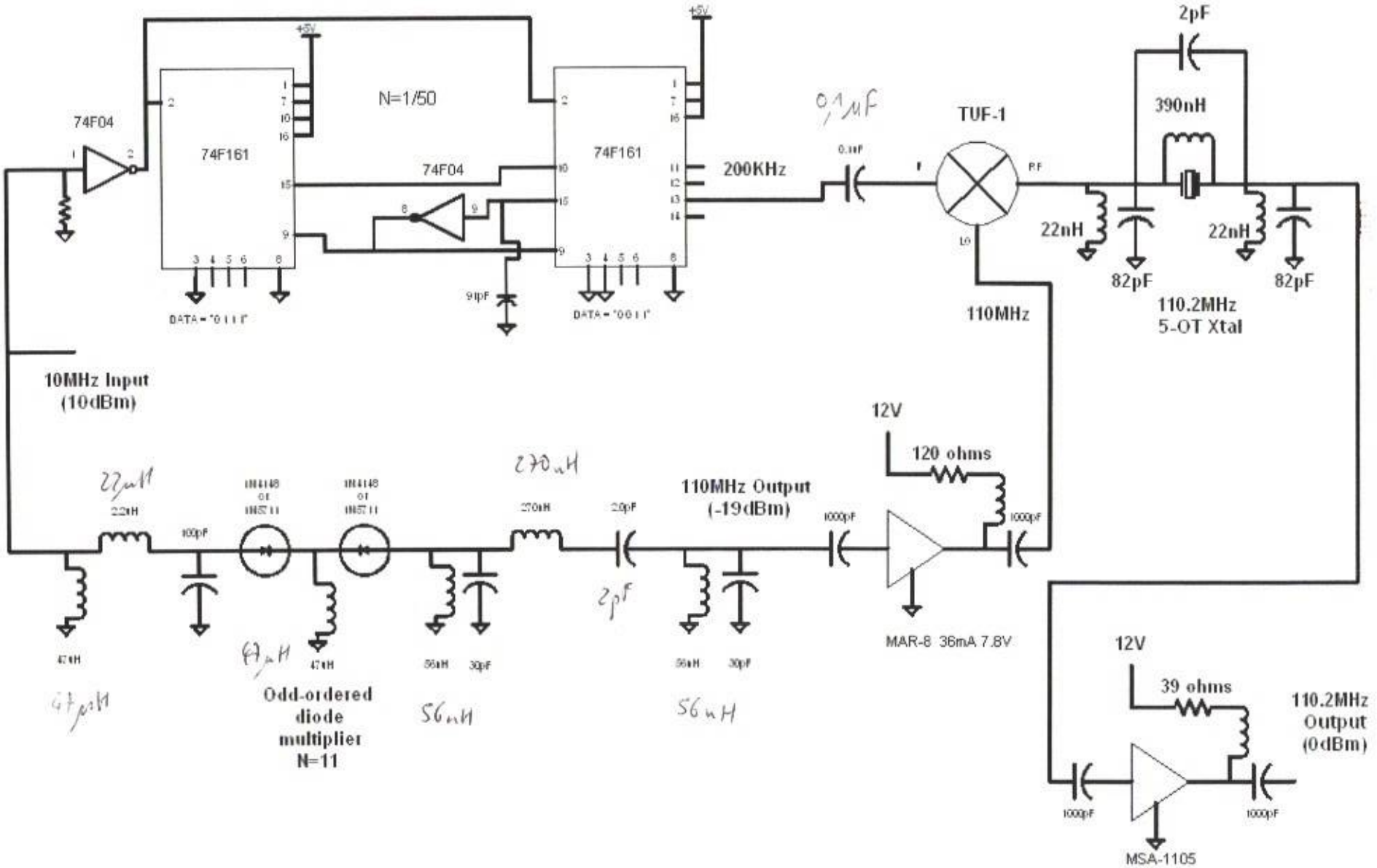
Signals were not always good. It took over 1 hour to make a valid two-way QSO.



Schematic diagram showing design of direct synthesizer used in the station LO chain. This circuit replaces the typical VHF crystal oscillator used in the Freq. West PLL block.

Page last updated: 20-Feb-2004 by K2JJB


5MHz
Wenzel
OCXO
Direct
Synth.
110.2MHz
Freq. West PLL
X12
1322.4MHz
X5
6612MHz
Waveguide
Harmoinic
Mixer
N=12
1322.4MHz
80.6664GHz
MMIC
LNA
Mixer DC Bias
for RX
241.9992GHz
output to
antenna
80.6664GHz
Gunn
12VDC
Gunn
Power
Supply
240GHz
Tripler/
Mixer
VCO gain= 550MHz/volt
5.165625MHz
1322.4MHz
1/256
1/256
1322.4MHz
PLL IC
Kp= 1.1mA/pi Rads
5.165625MHz
240GHz PLL #2a
Block Diagram
Rev D WA1ZMS, Jan '04



110.2MHz Direct Synthesizer

Rev. C WA1ZMS, Oct '03