

Experiments on 122 GHz

Mike Seguin, N1JEZ
44th Eastern VHF/UHF/Microwave Conference 2018

US Amateur Radio Bands

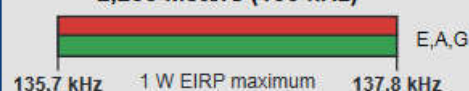
US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.



ARRL The national association for AMATEUR RADIO

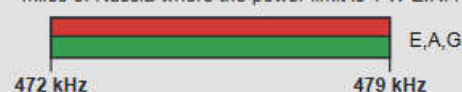
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at <https://utc.org/plc-database-amateur-notification-process/>. You need only register once for each band.

2,200 Meters (135 kHz)



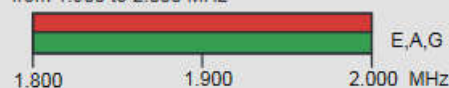
630 Meters (472 kHz)

5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

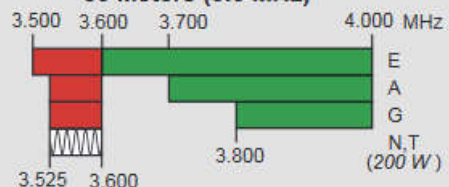


160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



80 Meters (3.5 MHz)

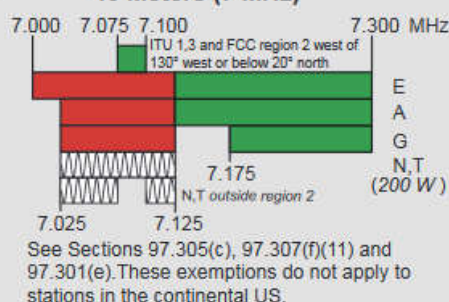


60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

40 Meters (7 MHz)

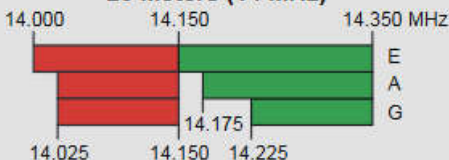


30 Meters (10.1 MHz)

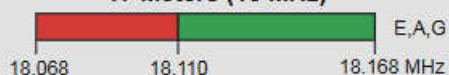
Avoid interference to fixed services outside the US.



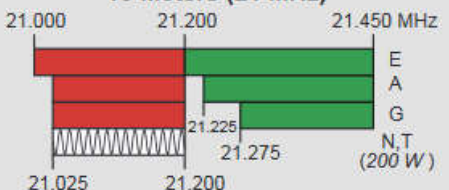
20 Meters (14 MHz)



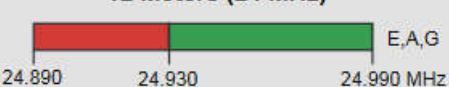
17 Meters (18 MHz)



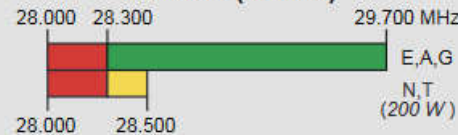
15 Meters (21 MHz)



12 Meters (24 MHz)



10 Meters (28 MHz)



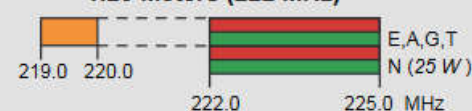
6 Meters (50 MHz)



2 Meters (144 MHz)

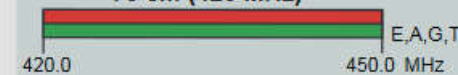


1.25 Meters (222 MHz)



*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

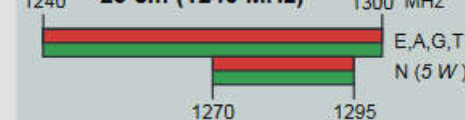
70 cm (420 MHz)*



33 cm (902 MHz)*



23 cm (1240 MHz)*



All licensees except Novices are authorized all modes on the following frequencies:

| | | |
|---------------|-----------------|-------------------|
| 2300-2310 MHz | 10.0-10.5 GHz ‡ | 122.25-123.0 GHz |
| 2390-2450 MHz | 24.0-24.25 GHz | 134-141 GHz |
| 3300-3500 MHz | 47.0-47.2 GHz | 241-250 GHz |
| 5650-5925 MHz | 76.0-81.0 GHz | All above 275 GHz |

‡ No pulse emissions

KEY

Note: CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz. Test transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW only
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems only

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See **ARRLWeb** at www.arrl.org for detailed band plans.

ARRL
We're At Your Service

ARRL Headquarters:
860-594-0200 (Fax 860-594-0259)
email: hq@arrl.org

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Membership/Circulation Desk:
www.arrl.org/membership
Toll-Free 1-888-277-5289 (860-594-0338)
email: membership@arrl.org

Getting Started in Amateur Radio:
Toll-Free 1-800-326-3942 (860-594-0355)
email: newham@arrl.org

Exams: 860-594-0300 email: vec@arrl.org

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First 122 GHz Contacts

KT1J – 8/22/2008

W1RIL – 7/11/2009

Henry Ingwersen
2936 Jersey Street South
Vergennes, VT 05491 USA

KT1J

Addison County
Vermont FN34ha

| Confirming QSO with | Day | Month | Year | UTC | Band | 2xMode | RST |
|---------------------|-----|-------|------|------|------|--------|-----|
| N1JEZ | 22 | AUG | 08 | 2045 | 122G | FM | 59 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

QSL Pse / Tnx

Email: kt1j@wcvt.com

73!

UX5UO print

Top Band
To

10 Gigs
122 GHz

W1RIL

Worcester County - Grid FN42ah

Ken Schofield
21 Forestdale Rd.
Paxton, MA 01612



Ex: KG6BT Guam - W6FIN CA

| TO RADIO | CONFIRMING QSO | | | | | | |
|----------|----------------|-------|------|-------|------|-------|-------------|
| | DAY | MONTH | YEAR | UTC | RST | 2-WAY | -MHz |
| N1JEZ | 11 | 7 | 09 | 1805Z | 5-9+ | SSB | 122.356 GHz |

THX MIKE - FIRST QSO ON 122 GHz -

Swot #2393

~1/4 MILE DISTANCE

Network QSL's 800-354-0530

☐ PSE QSL ☒ TNX

73' Ken



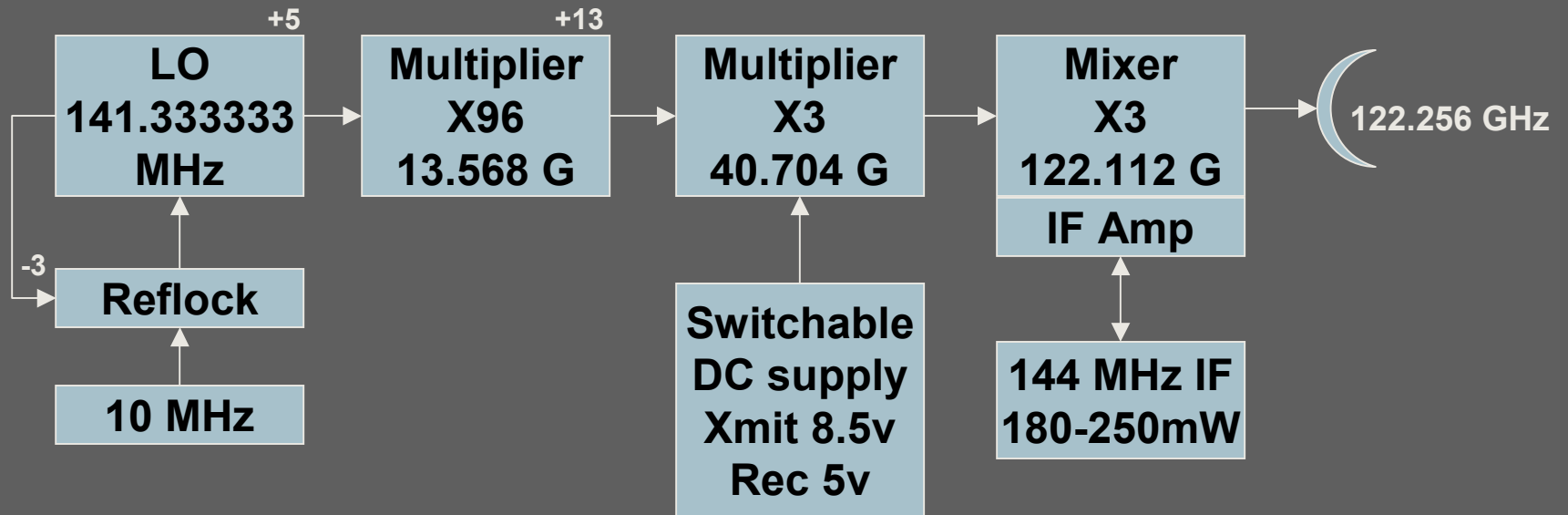
W1RIL/N1JEZ 2009



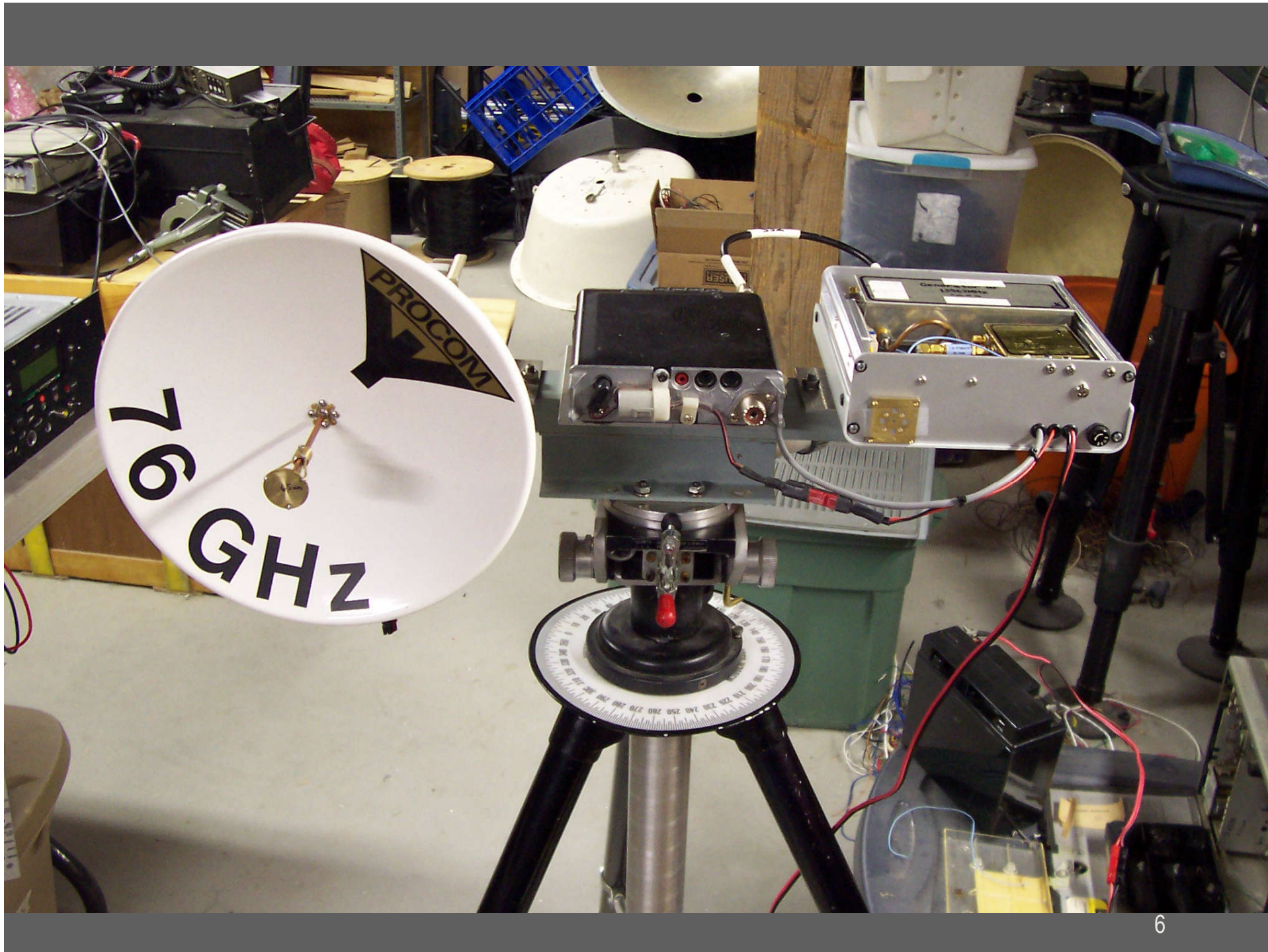
KT1J/N1JEZ first contact at ~ 200'

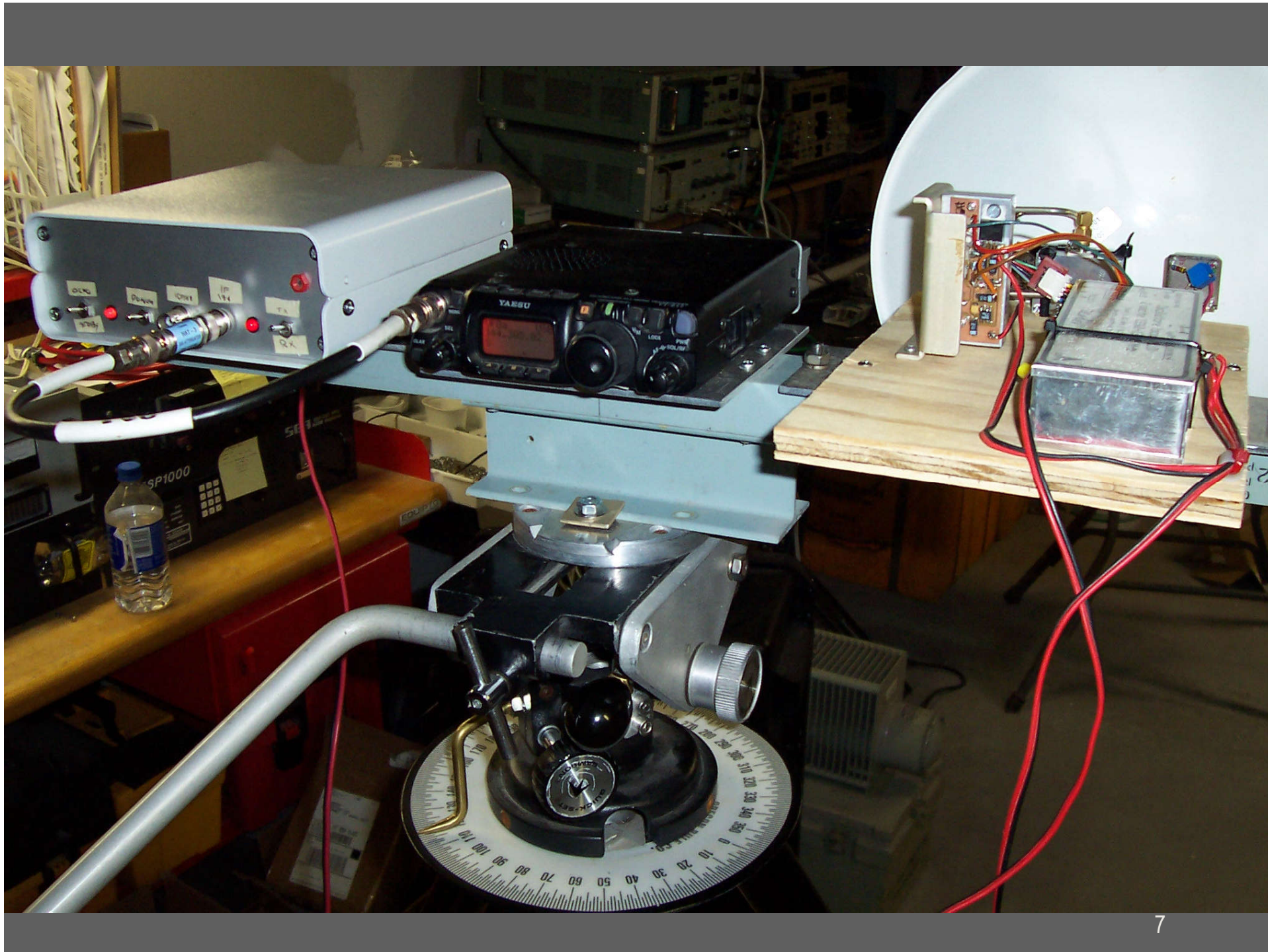


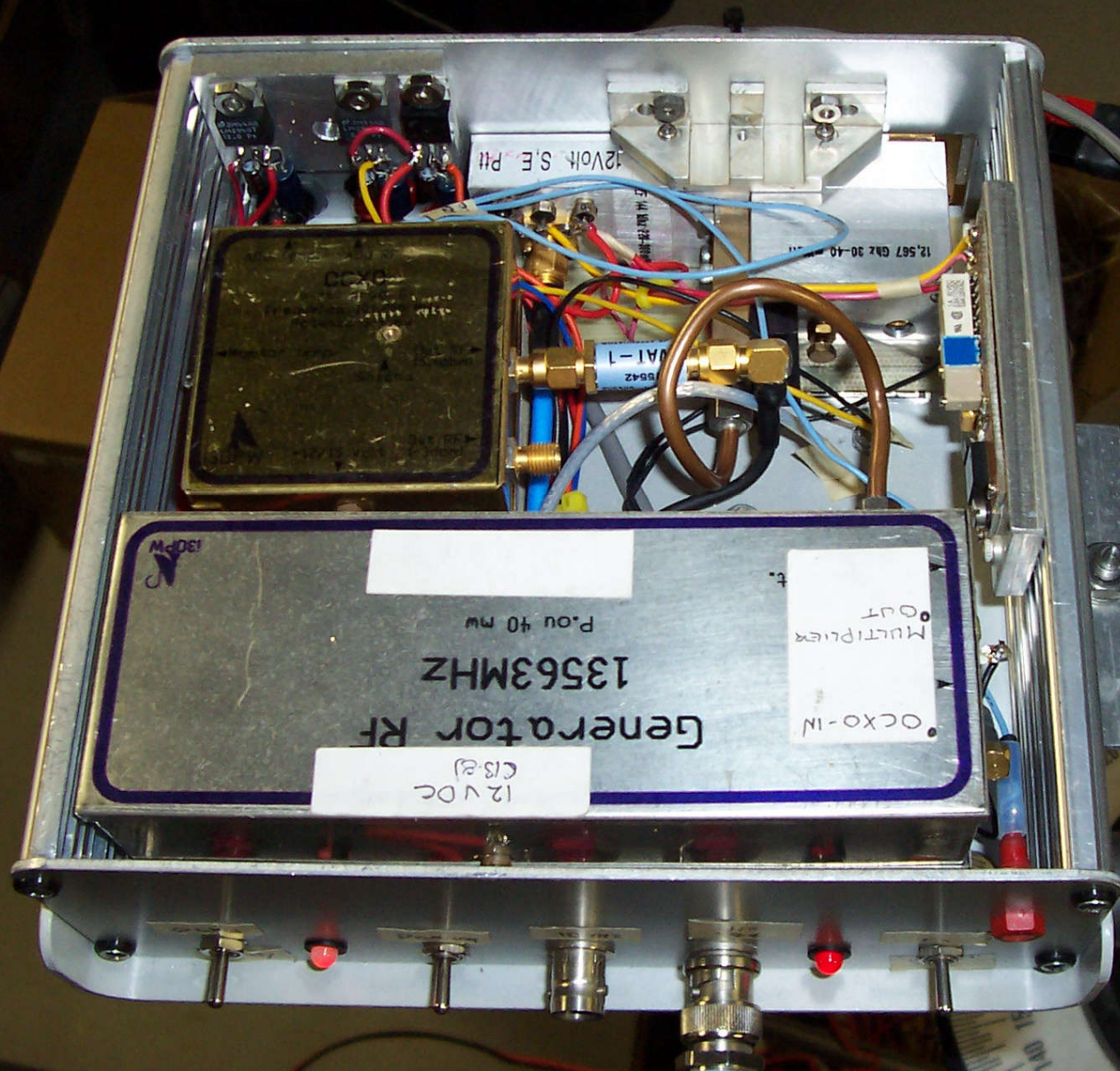
122.256 GHz Mixer

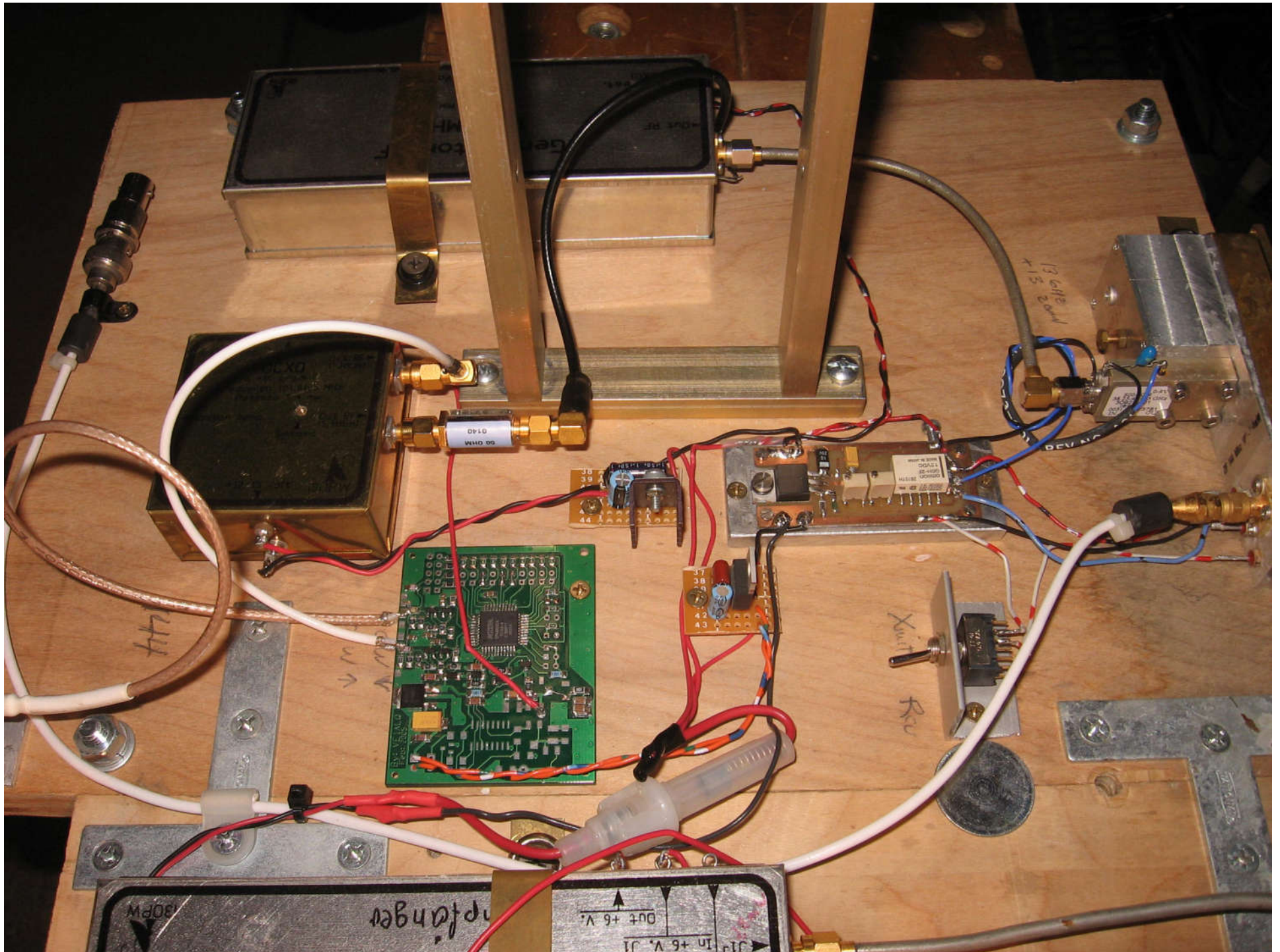


Reflock 141.333333 MHz LO
R = 60
N = 847 (848 calculated)
LO Multiplication = x 864

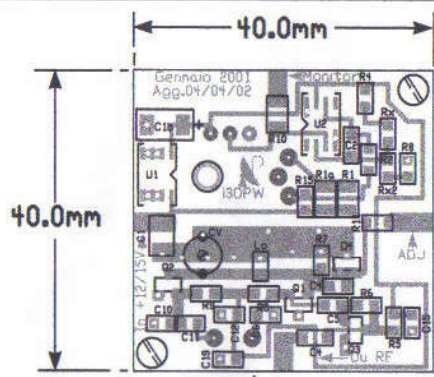




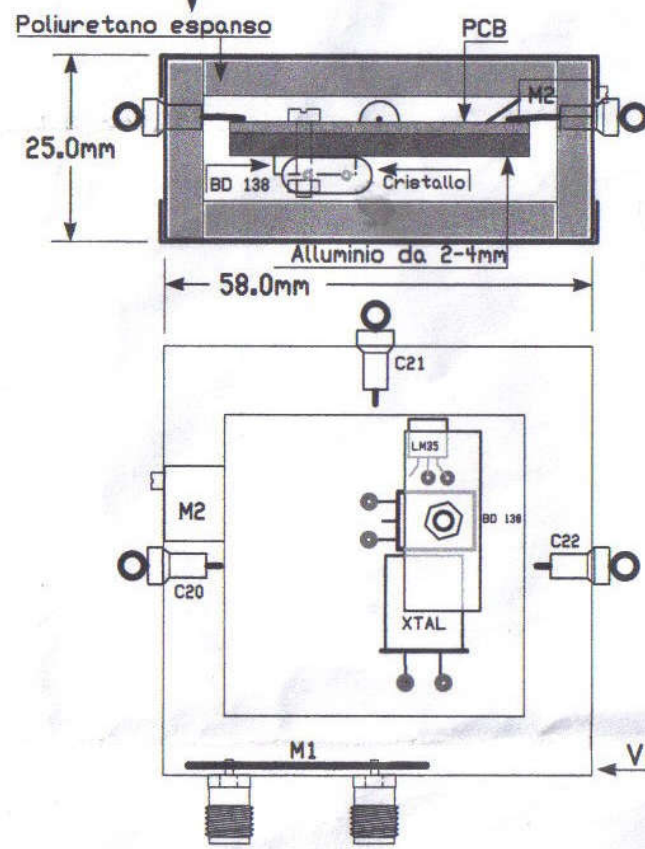




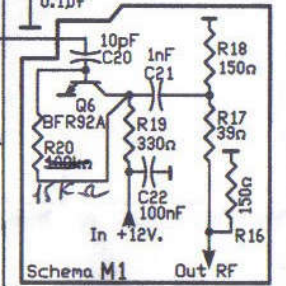
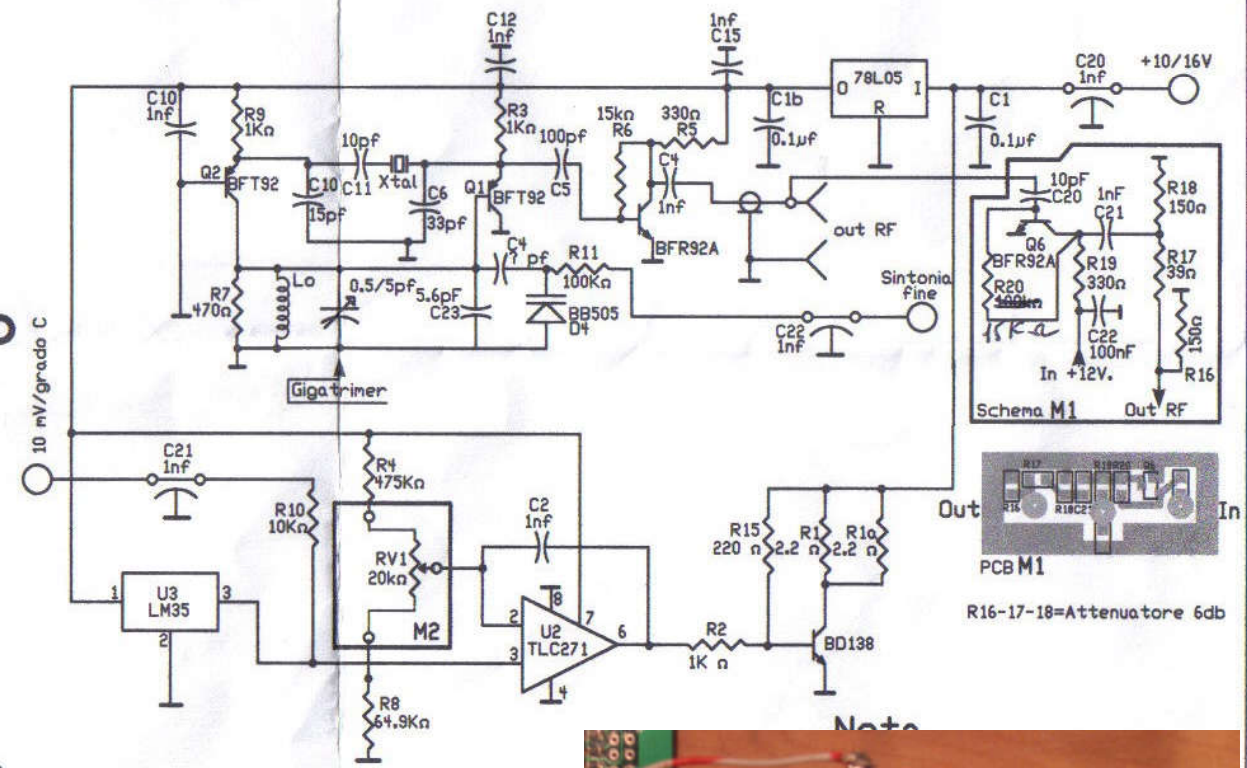
LO - 141.333 MHz



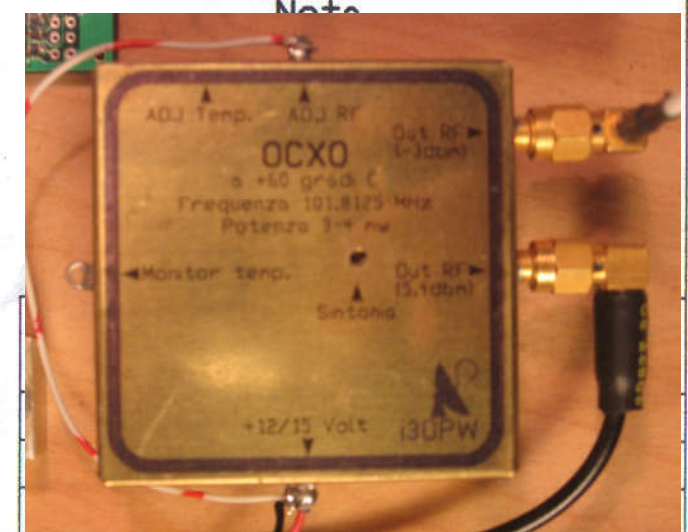
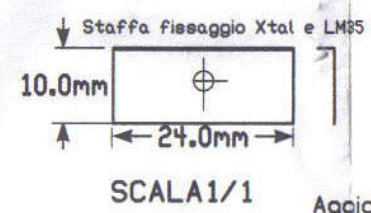
Vista lato componenti SMD



Vista lato componenti discreti



R16-17-18=Attenuatore 6db

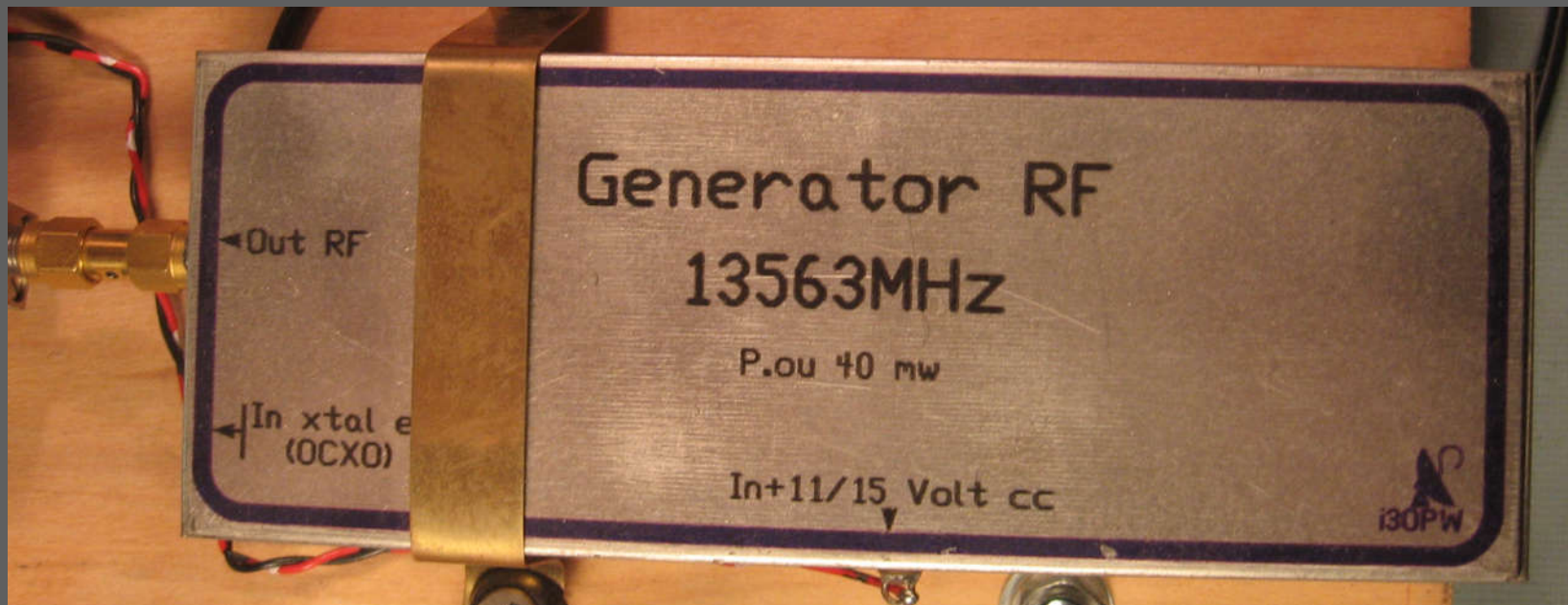


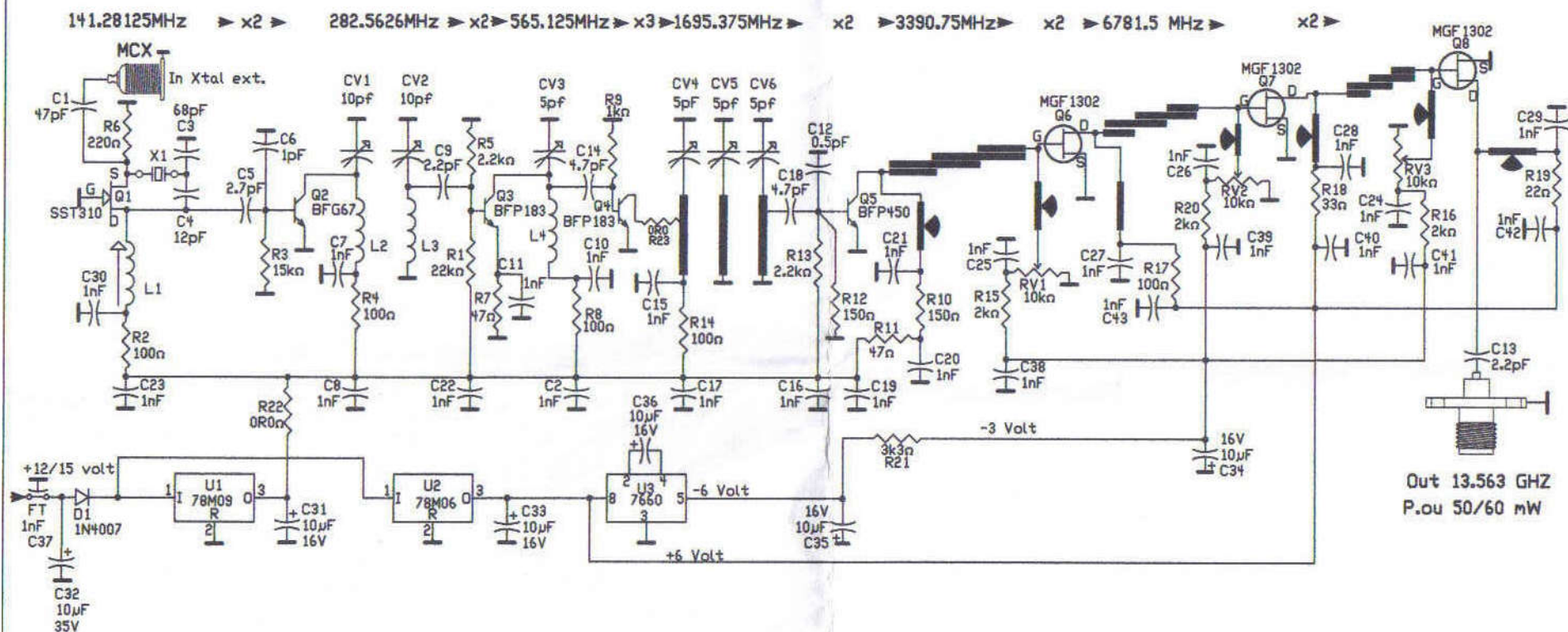
Pisciutti Armando
Viale della Resistenza,44/B
30020 Quarto d'Altino (VE)
Tel.0422823469-3493509975
E-MAIL:i3opw@inwind.it



Aggiornamento 2005

x96 Multiplier





L1-Neosid 5061 0.1 μ H
L2-3 spire su 3mm
L3-3 spire su 3mm
L4-1/2 spira su 3mm

Pisciutti Armando
Viale della Resistenza, 44/B
30020 Quarto d'Altino (VE)
Tel. 0422823469-3493509975
E-MAIL: i3opw@inwind.it



Title:

Schema generatore 13.563 GHz

Board:

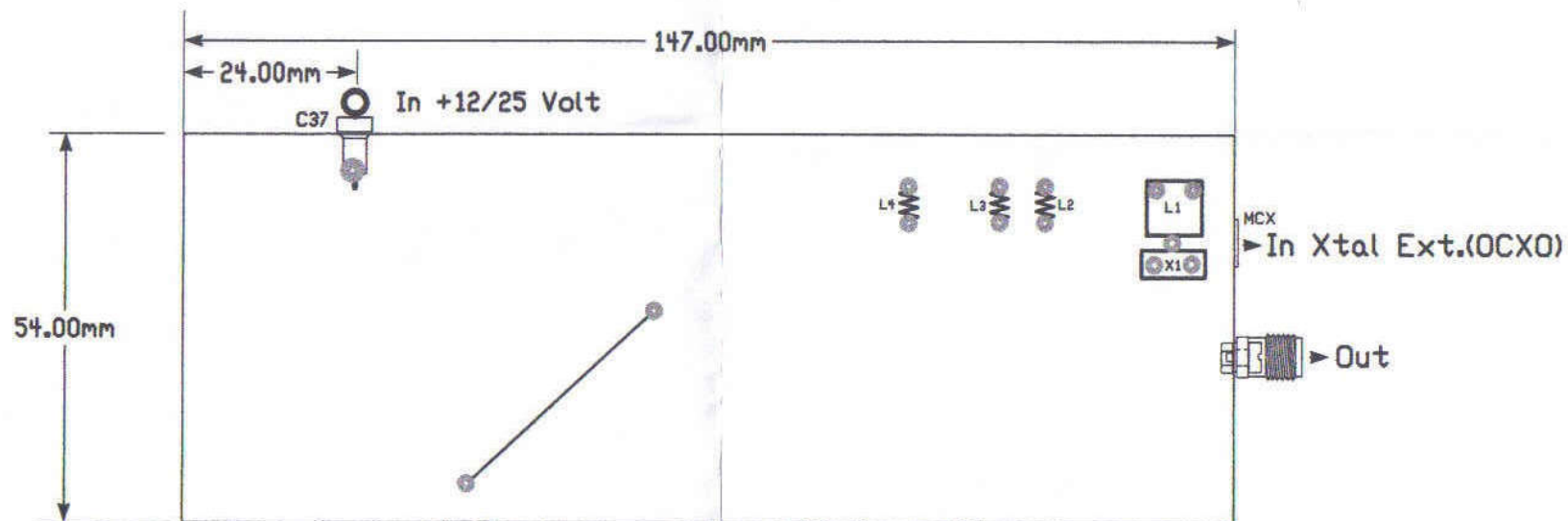
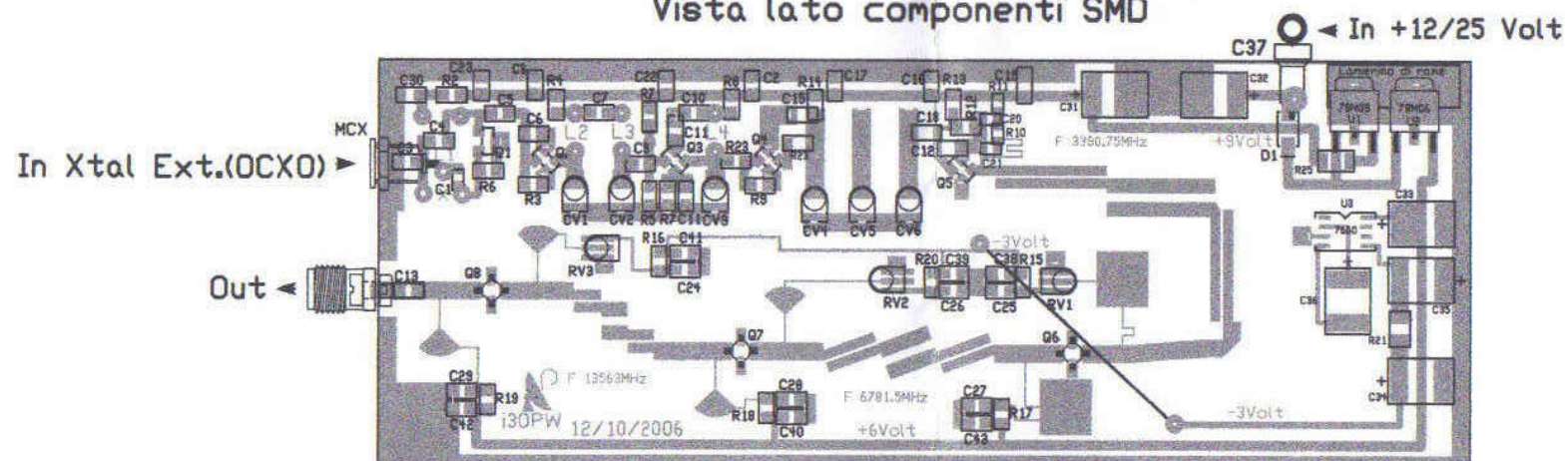
Revision:

Author:

Size:

Date: Aggiornamento del 10/10/06 Sheet 1 of 2

(Component SMD side)
Vista lato componenti SMD



Vista lato componenti discreti
(Discreet component side)

Pisciutti Armando
Viale della Resistenza,44/B
30020 Quarto d'Altino (VE)
Tel.0422823469-3493509975
E-MAIL:i3opw@inwind.it



Scala 1/1

Title:
PCB generatore RF 13.563 GHz

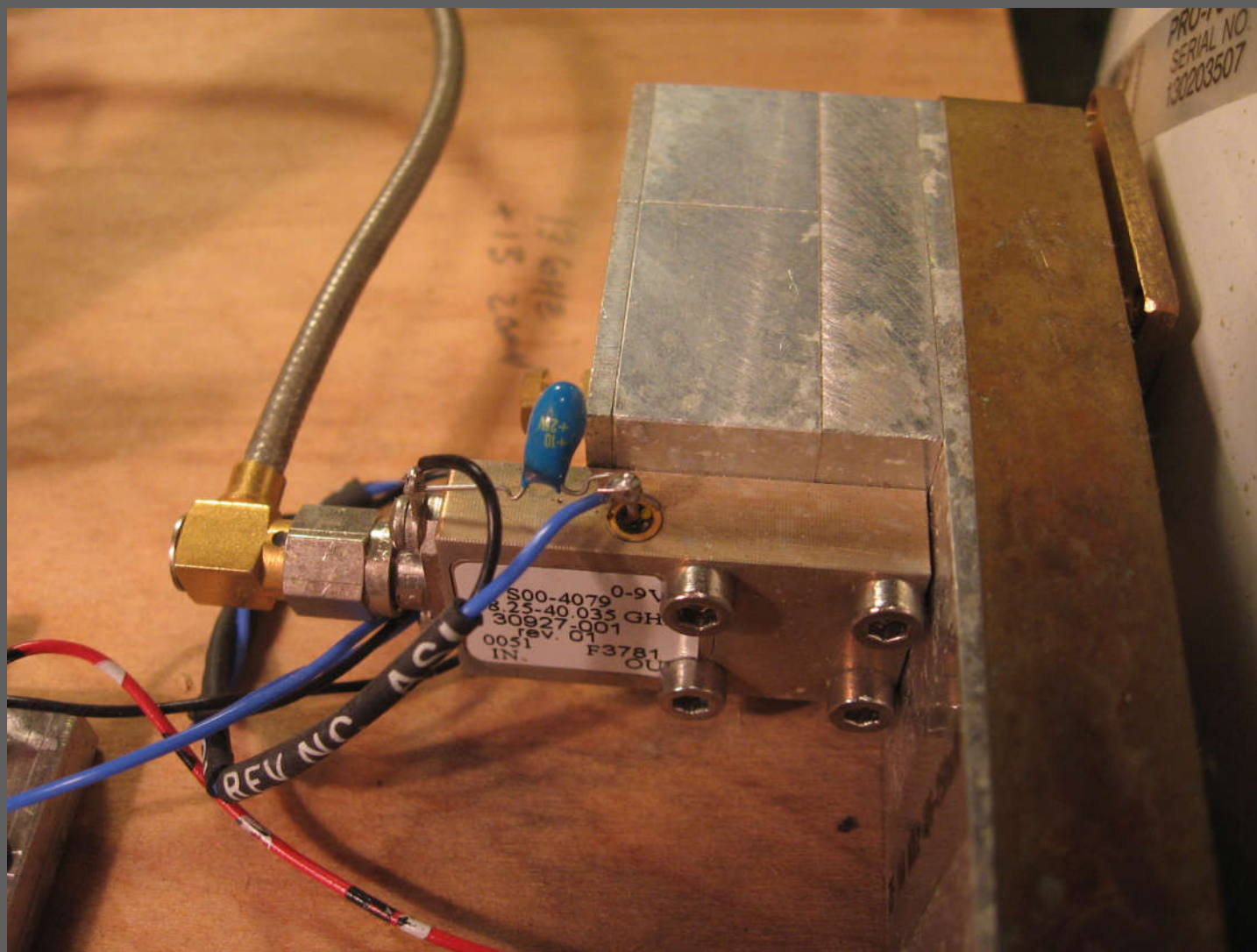
Device: Revision:

Author: Size:

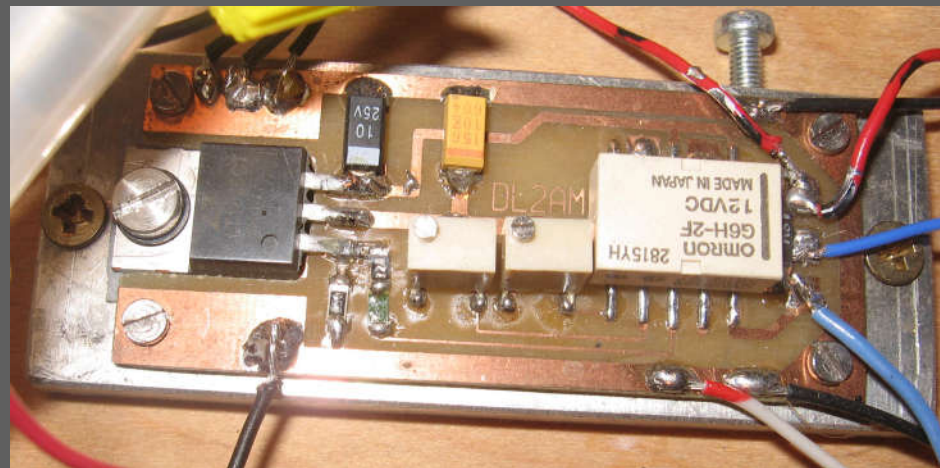
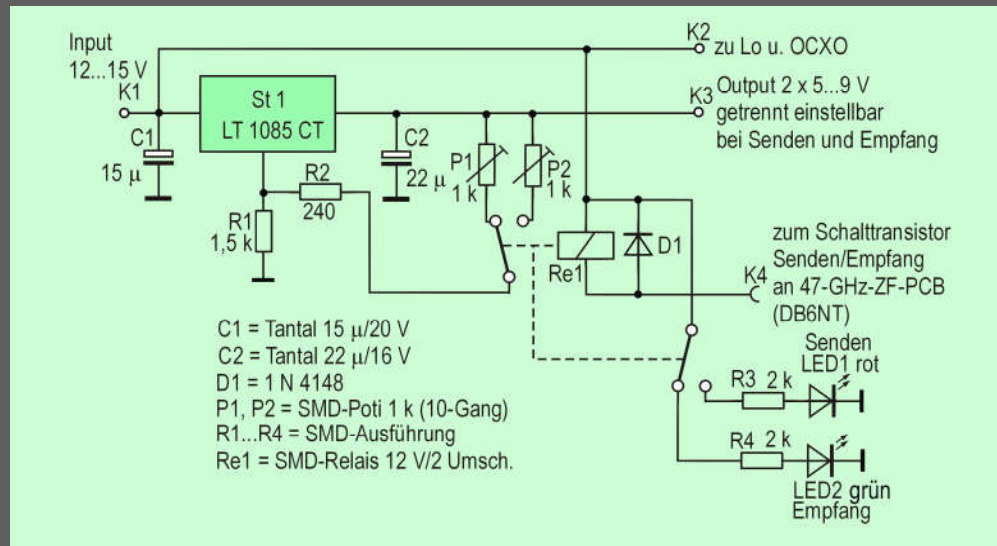
Date: 15/10/2006

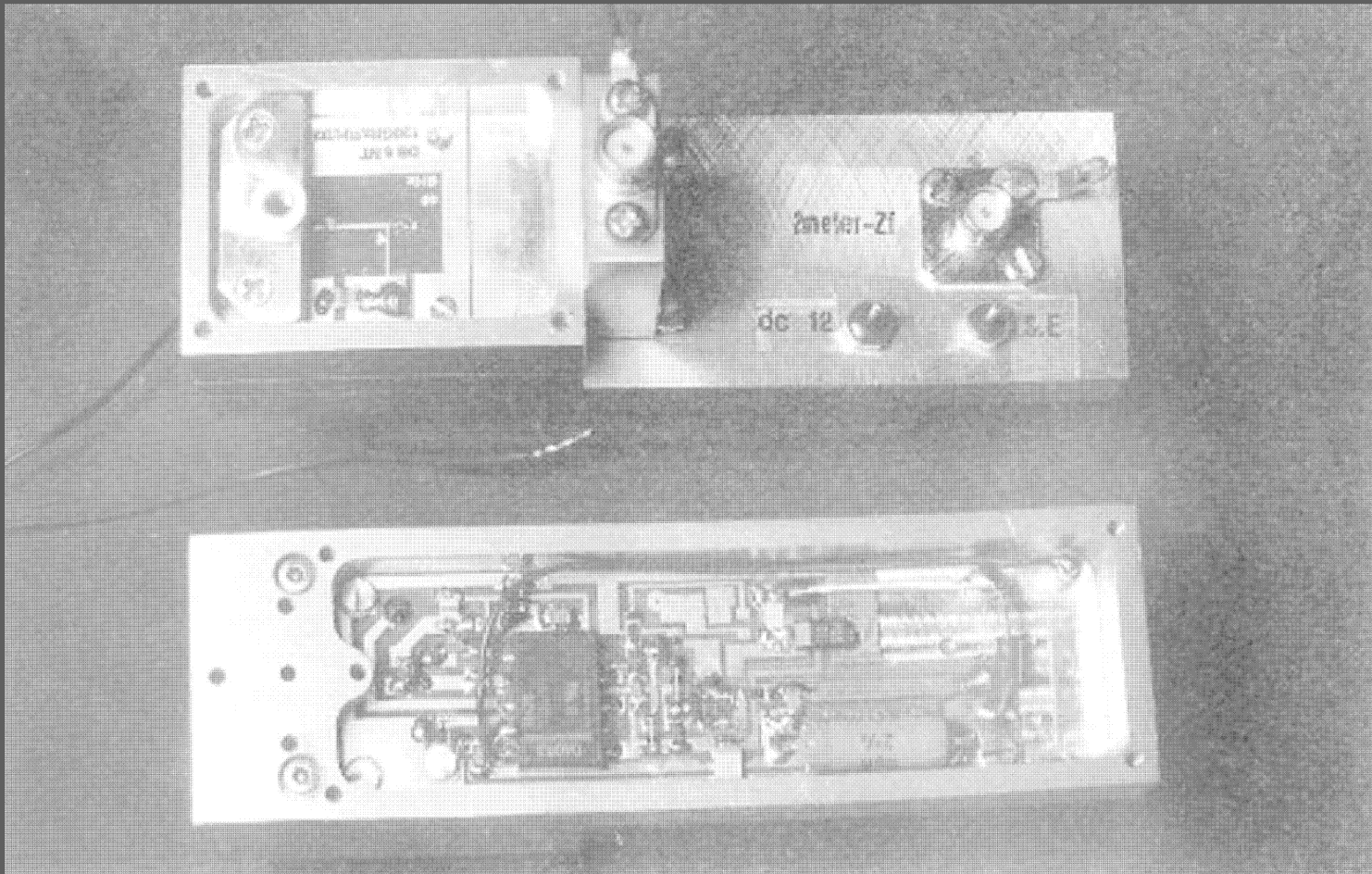
Sheet 2 of 2

40 GHz X3 Multiplier



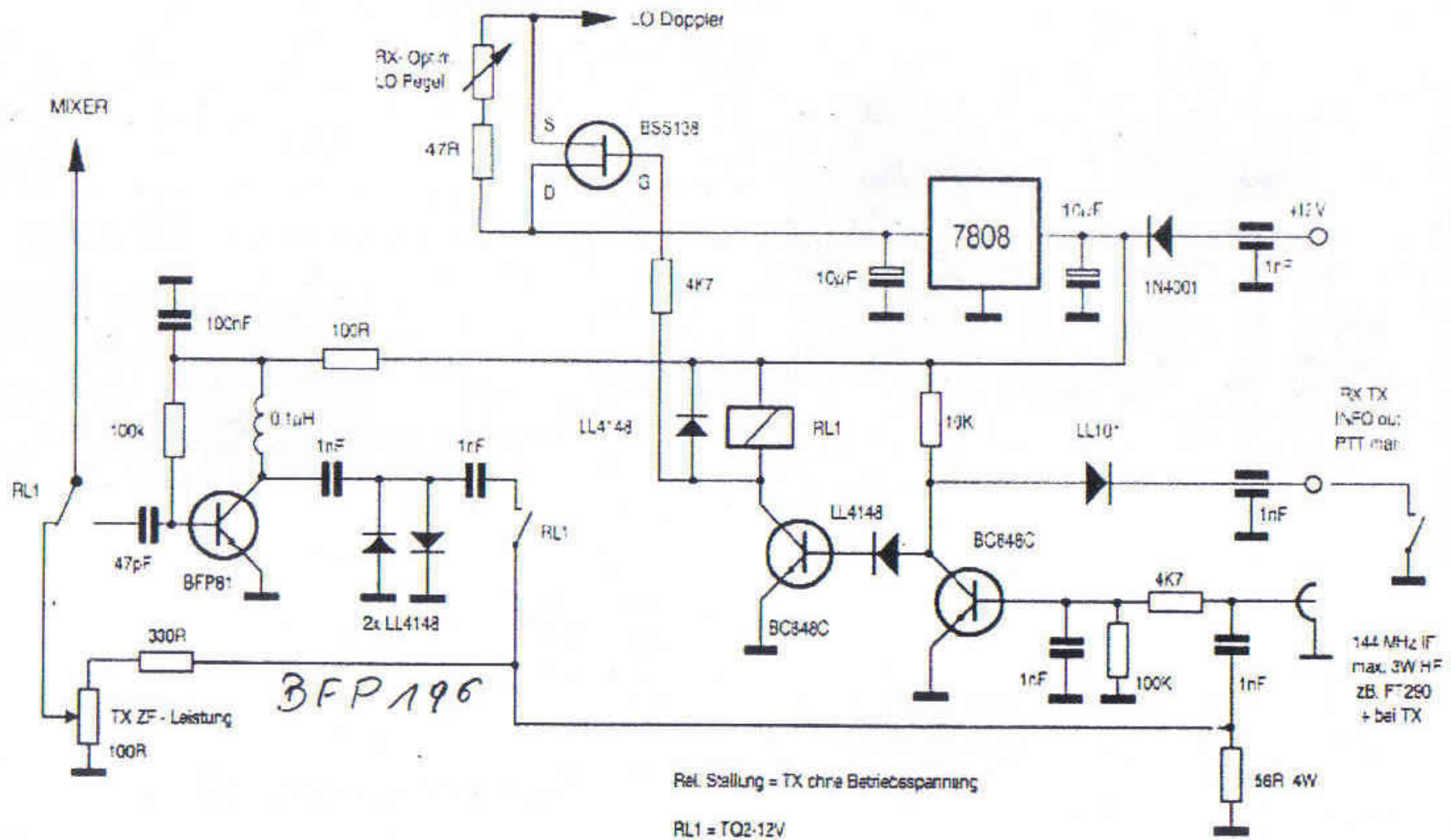
40 GHz X3 Multiplier Power Supply



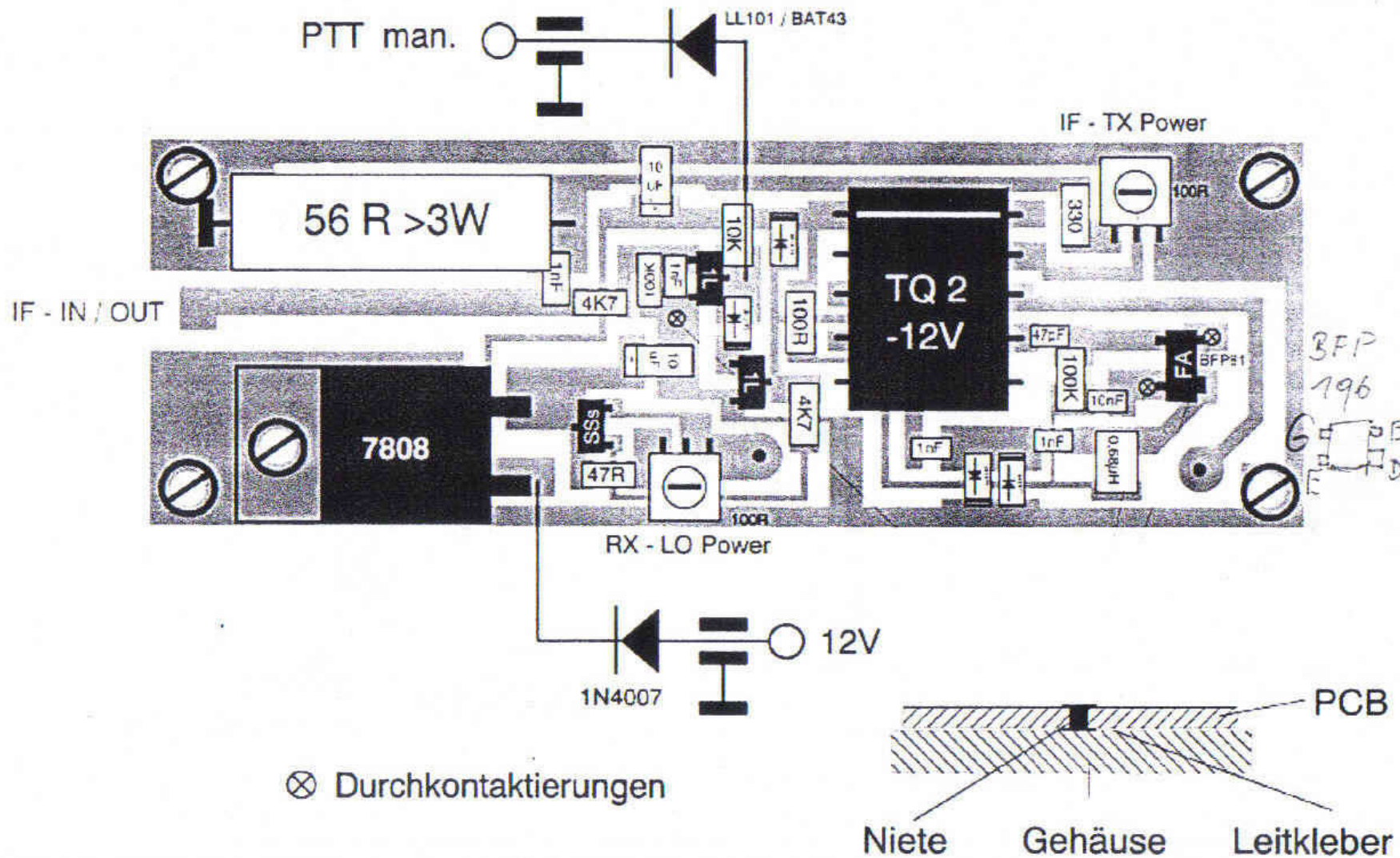


Single diode MA4E1317
DB6NT mixer board

IF Amp



IF Amp



Bild/Figure 9: 47 GHz Transverter IF/IF AMP NEU/NEU

W1RIL – 122 GHz

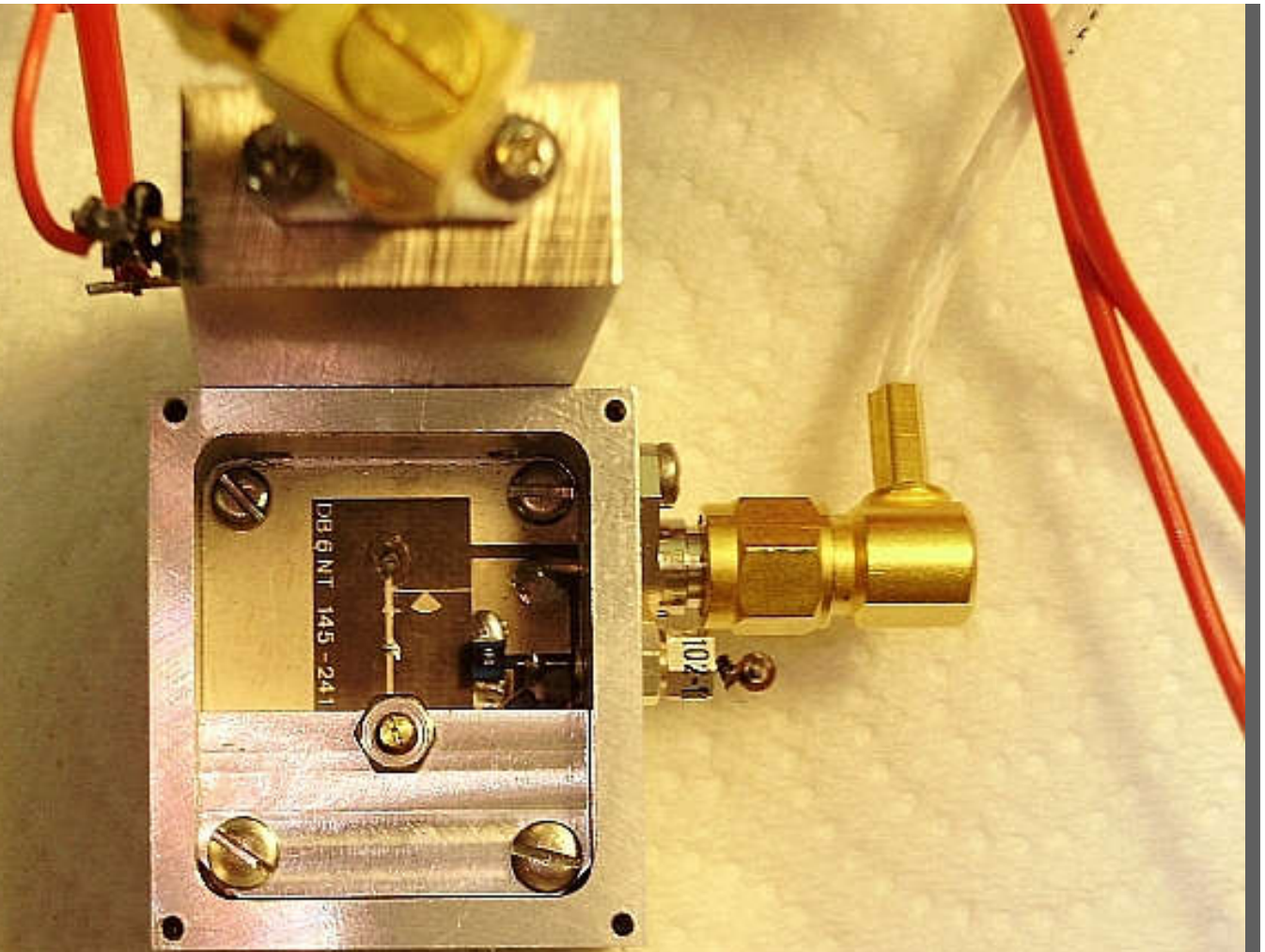


6 GHz brick osc into multiplier and pipe cap filter strip into multiplier strip to 40 GHz.
40 GHz injection into X3 harmonic mixer board. (board by DB6NT)

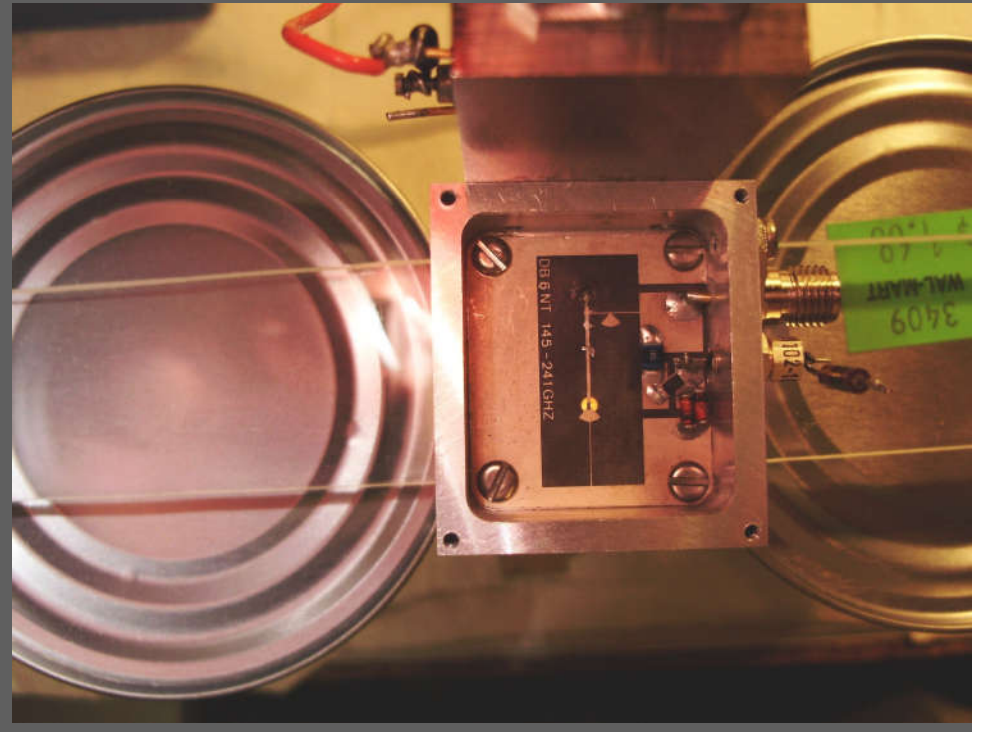
W1RIL – 122 GHz



Mixer assembly showing backshort

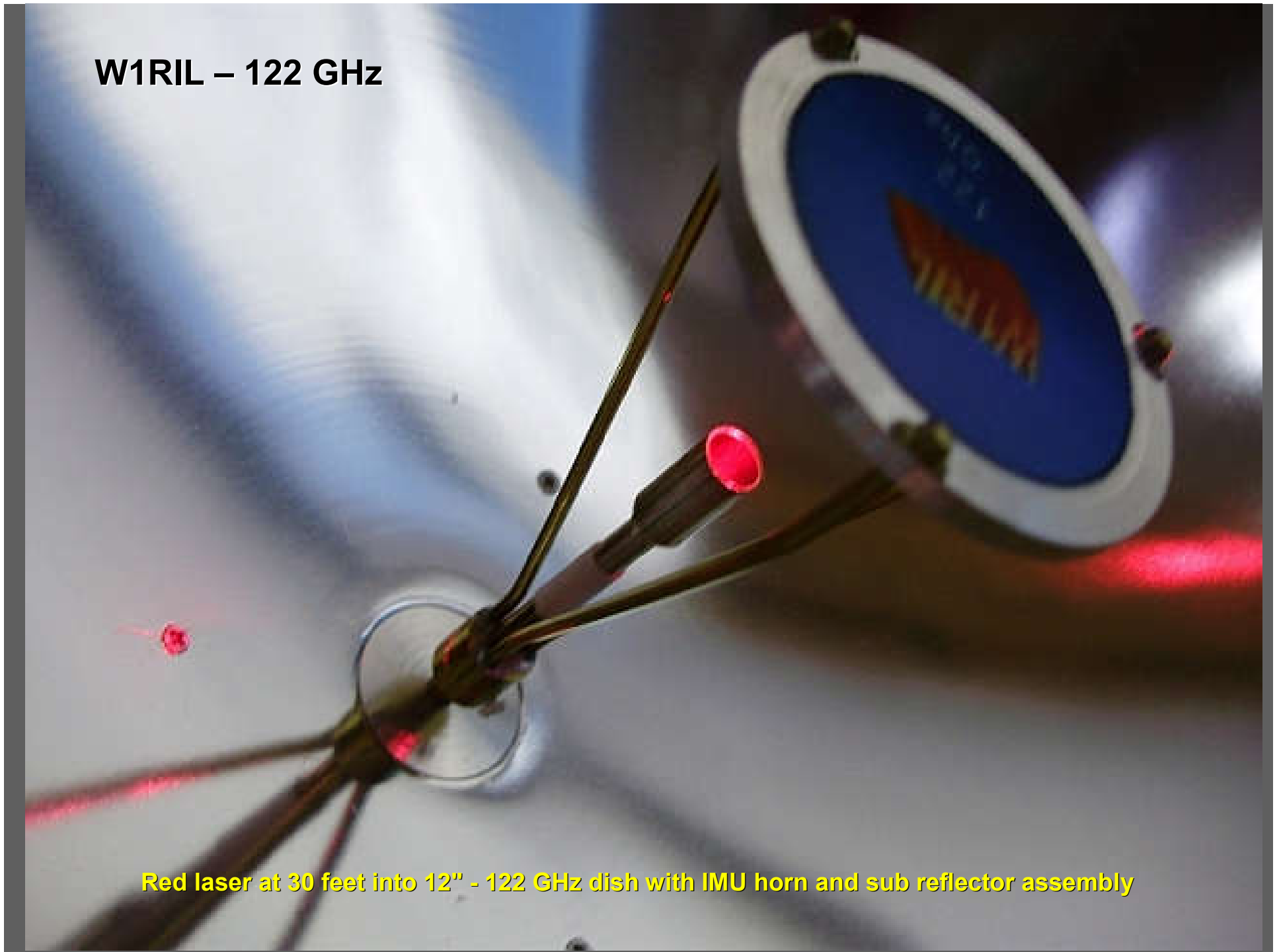


Diode Mounting



W1RIL – 122 GHz

Red laser at 30 feet into 12" - 122 GHz dish with IMU horn and sub reflector assembly

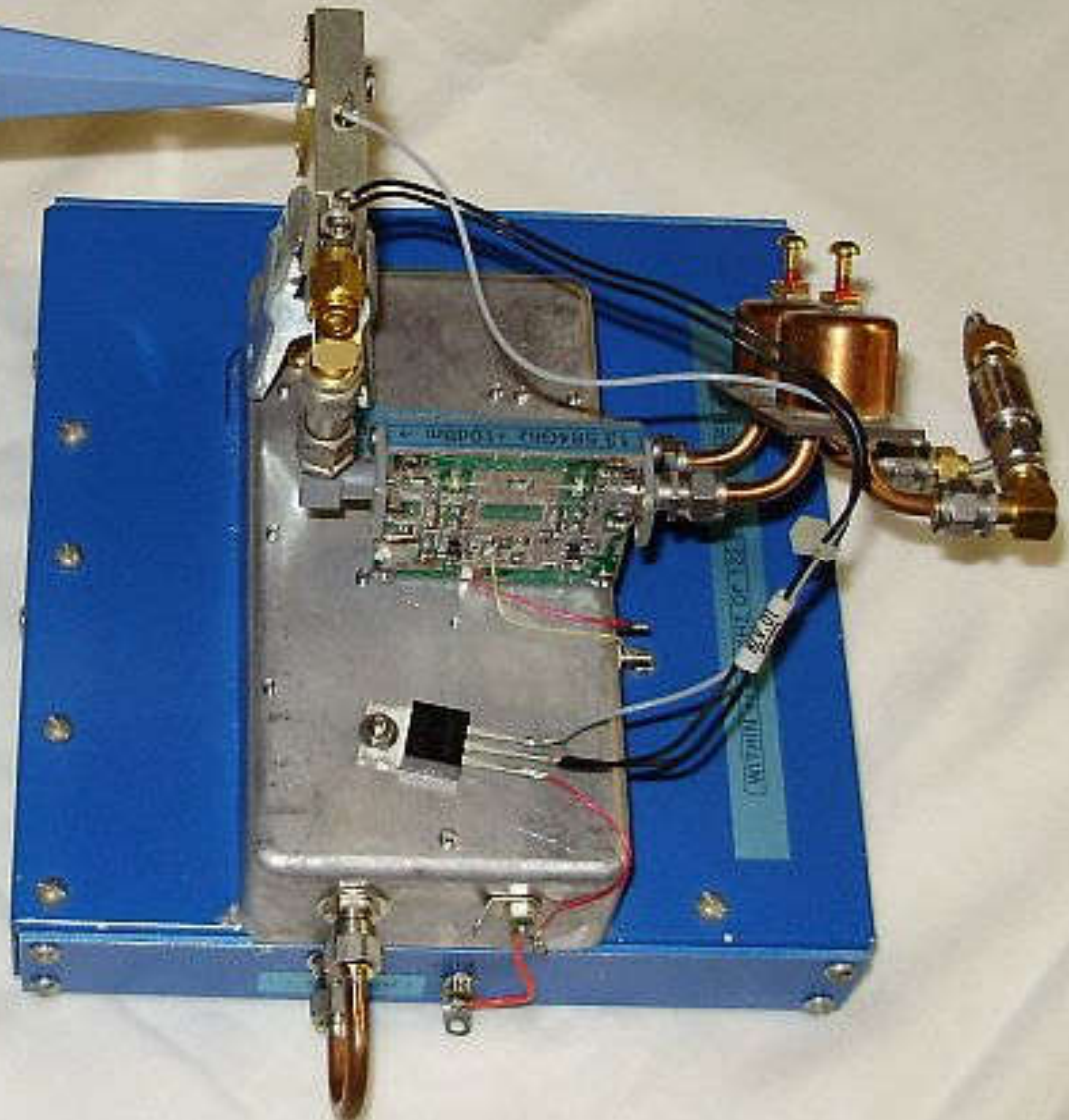


W1RIL – 122 GHz Marker

Qualcom Synth on 2.264 GHz feeding
+12.5 dBm into X6 multiplier with
output of +4.5 dBm into cascaded pipe
cap filters into a Qualcomm amp strip
with +10 dBm out at 13.584 GHz.

This drives a 38.85 to 39.48 GHz amp to
+10 dBm out feeding a WR-8 HB horn.

Results in signal on 122.256 within +/-
10 kHz when hot and S6-7 at 30 feet.

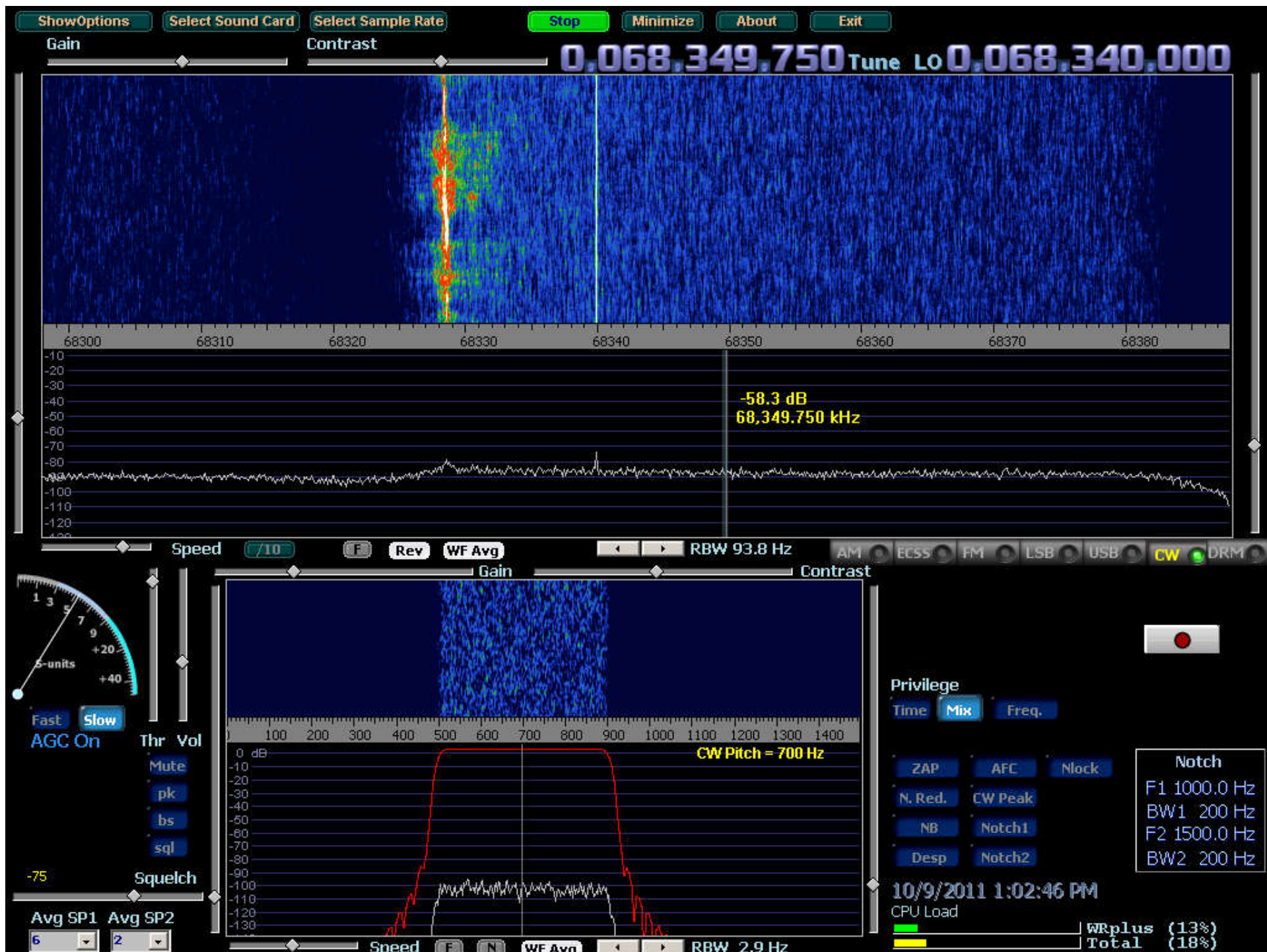


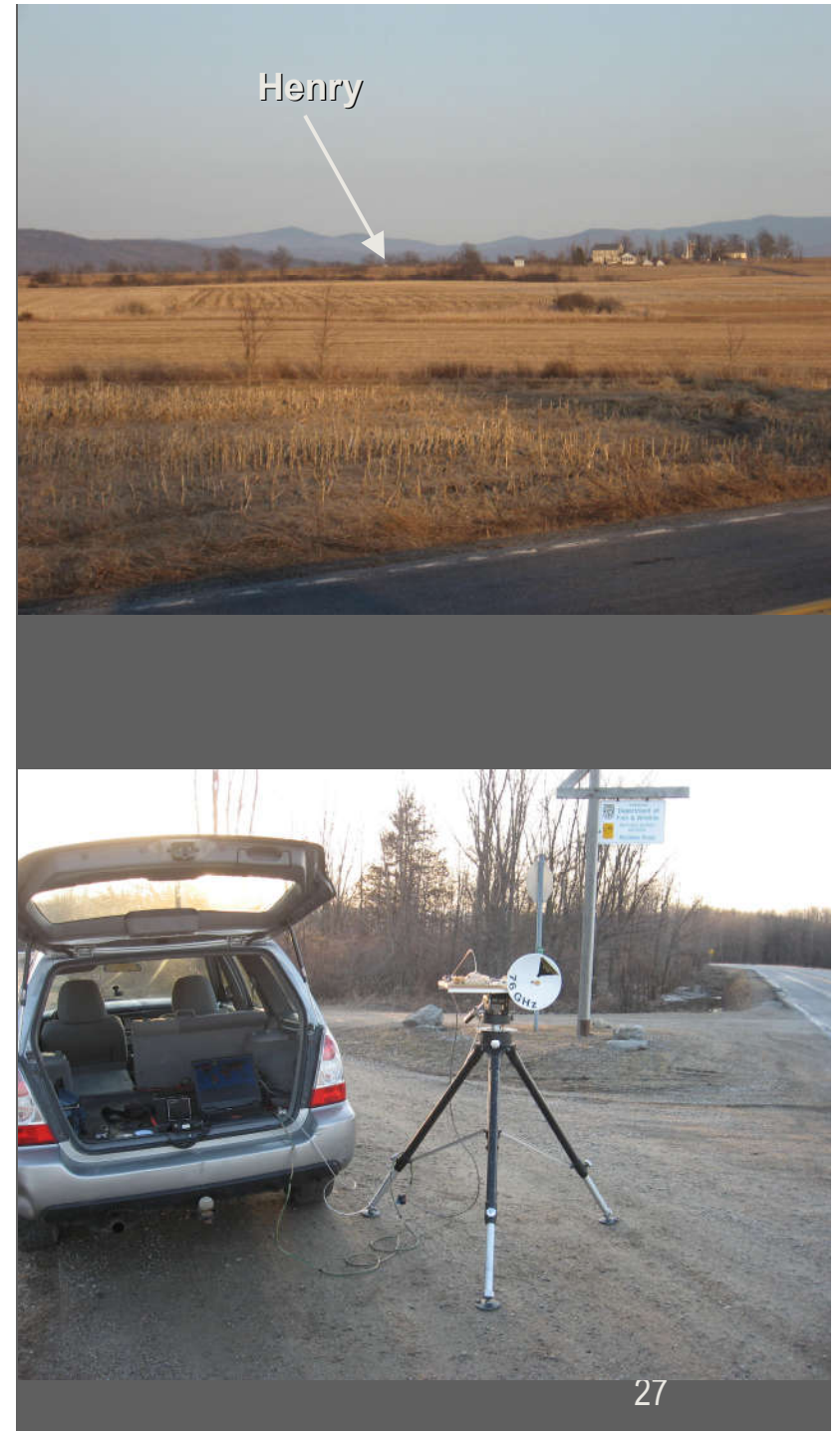
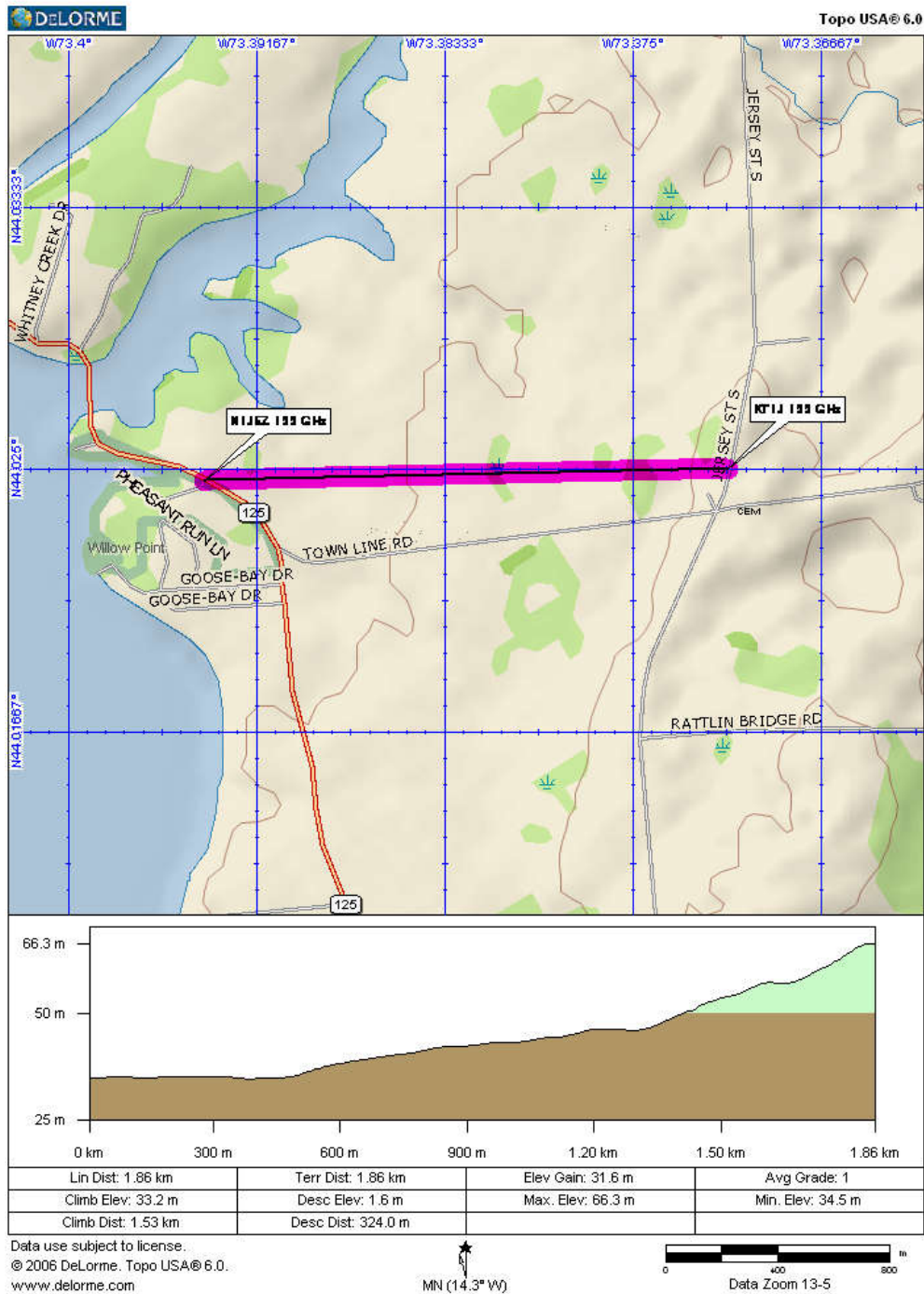
10/11/2011 - WAB

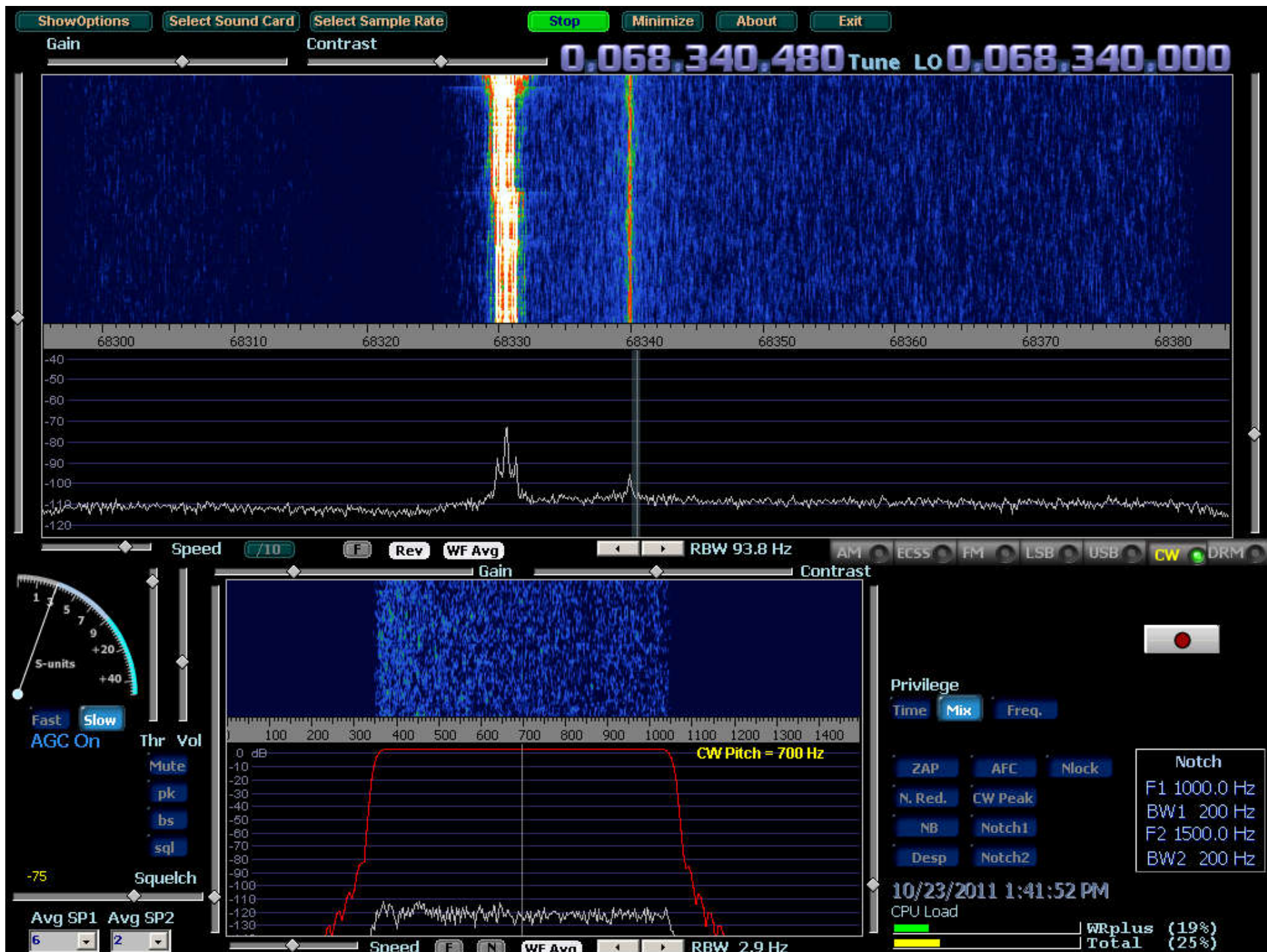


Henry









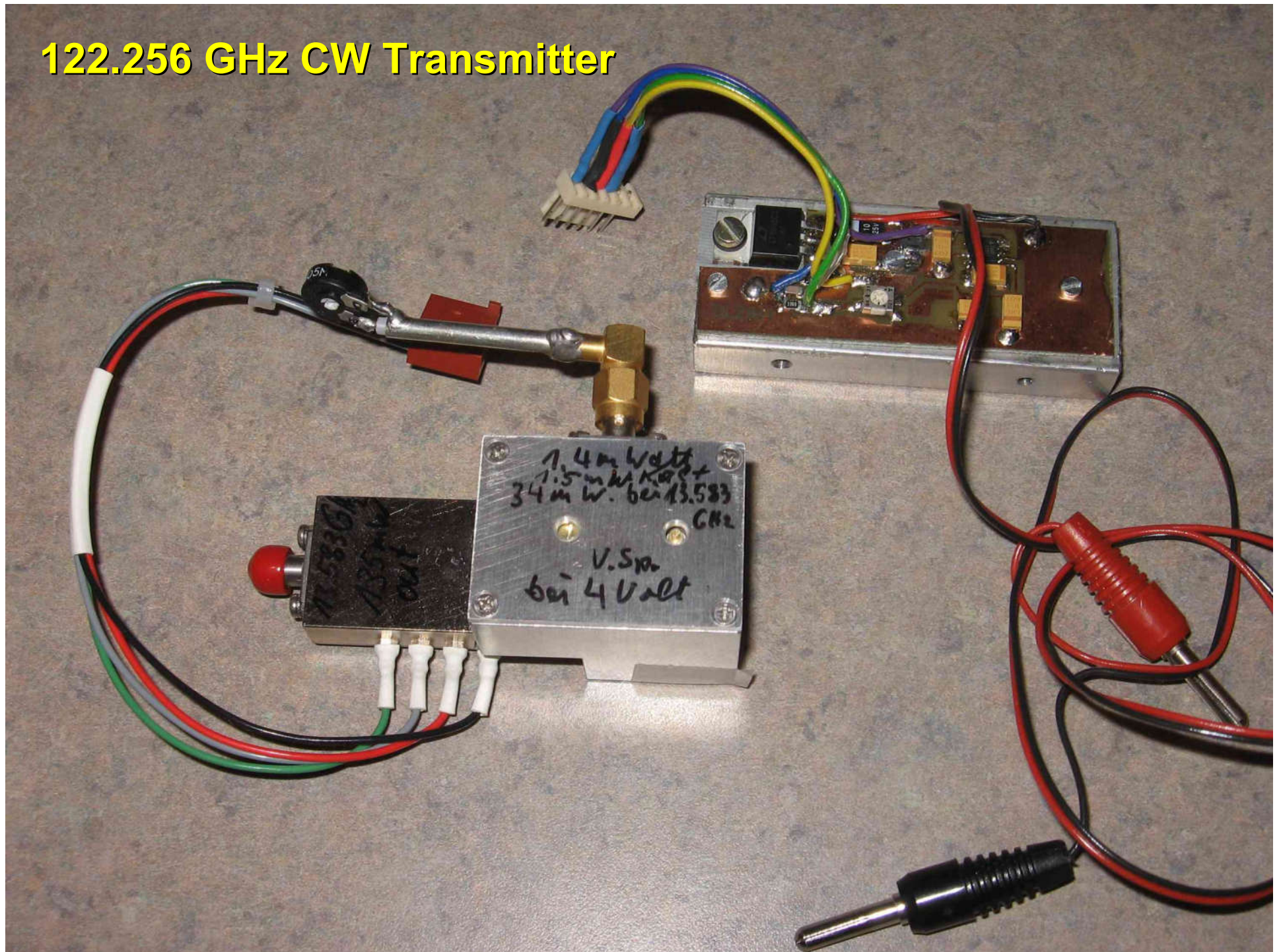
What's Next?

CW Transmitter

New LO's

VE2UG on 122 GHz

122.256 GHz CW Transmitter



F = 122.256 GHz

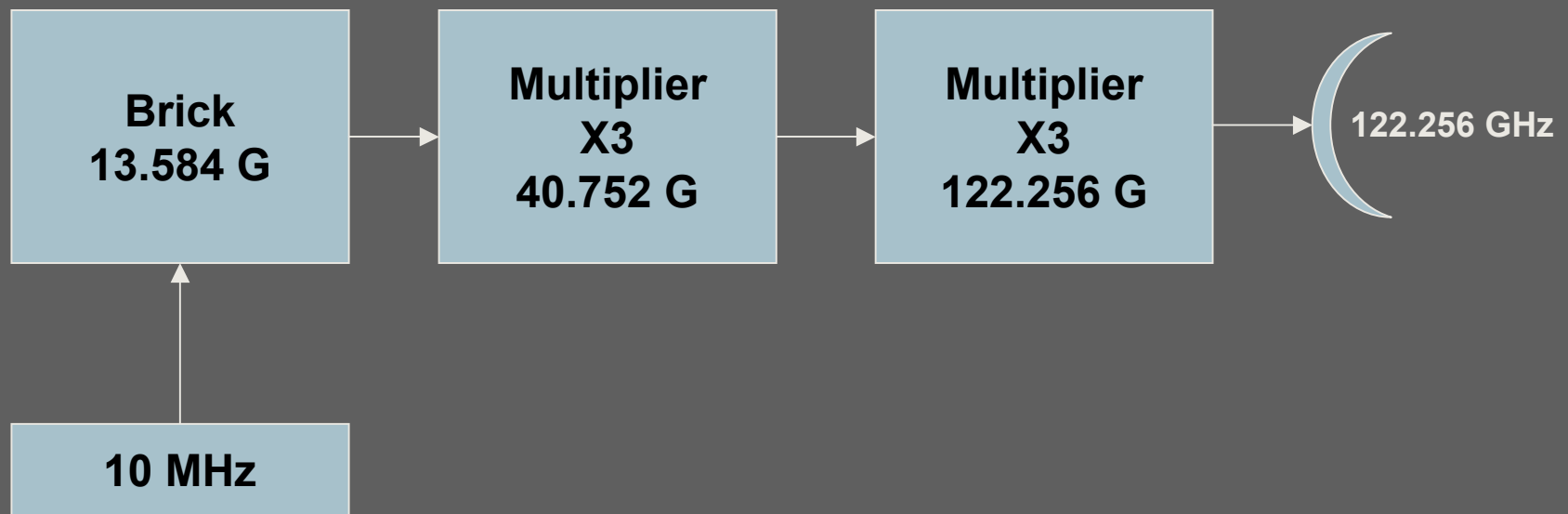
Output = 1.5 mW

Output w/g: WR8

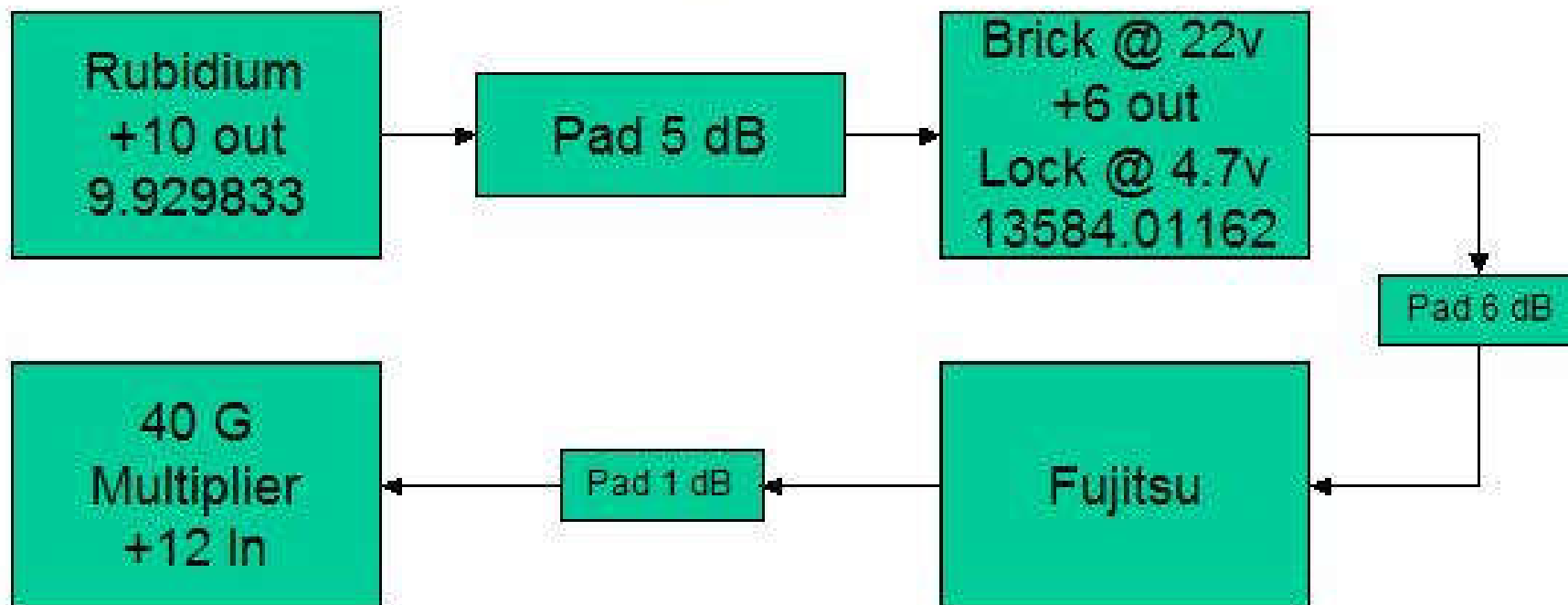
Multiplier input at 13.584 GHz: 34 mW

Multiplier output at 40.752 GHz: 140 mW
(a selected unit; most of them are 20 -30 mW)

122.256 GHz CW Transmitter



9/1/2014



Is There a Better Way?

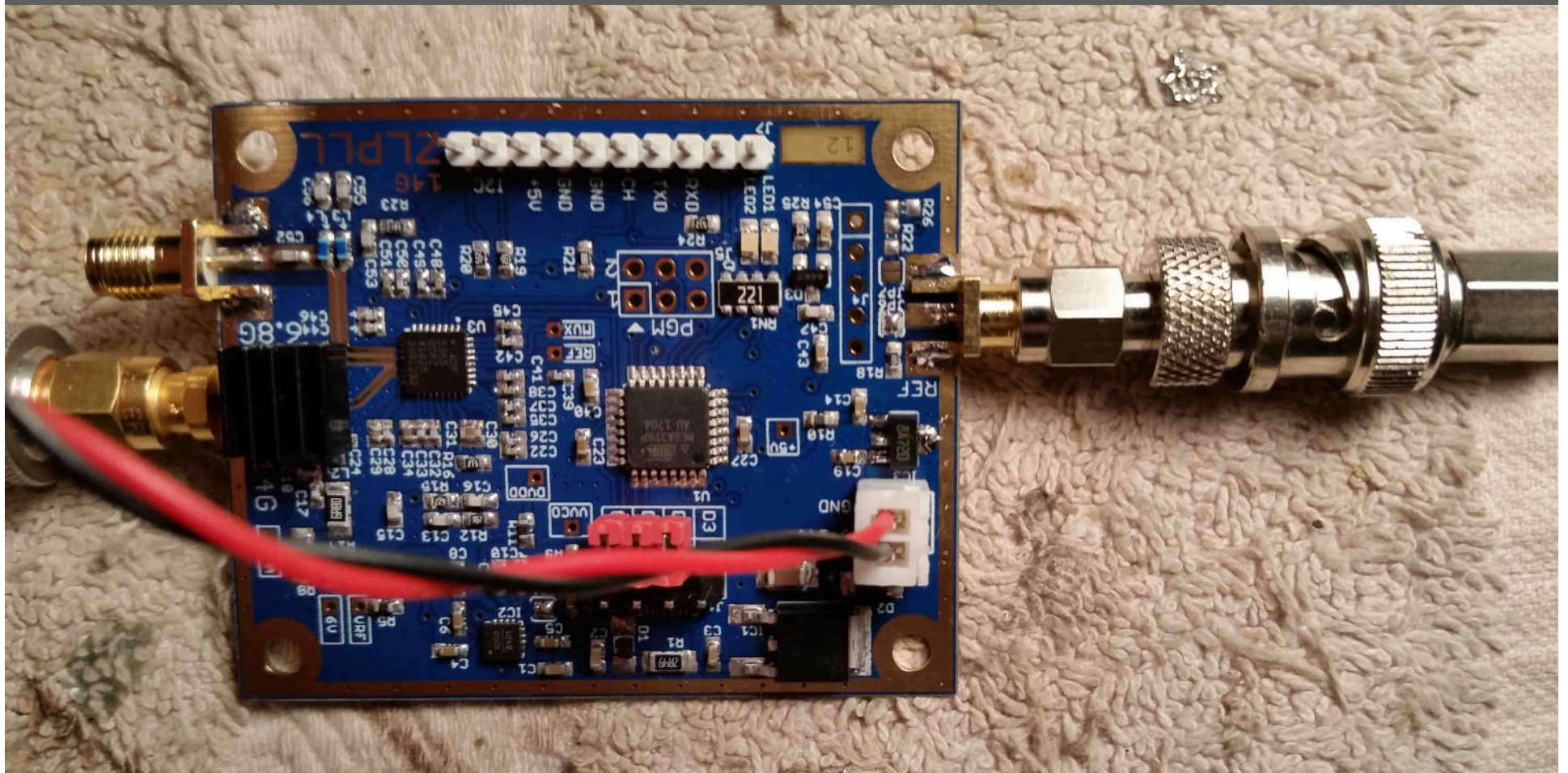


MKU LO 8-13 PLL - 54 MHz to 13.6 GHz \$408 plus shipping



GUI

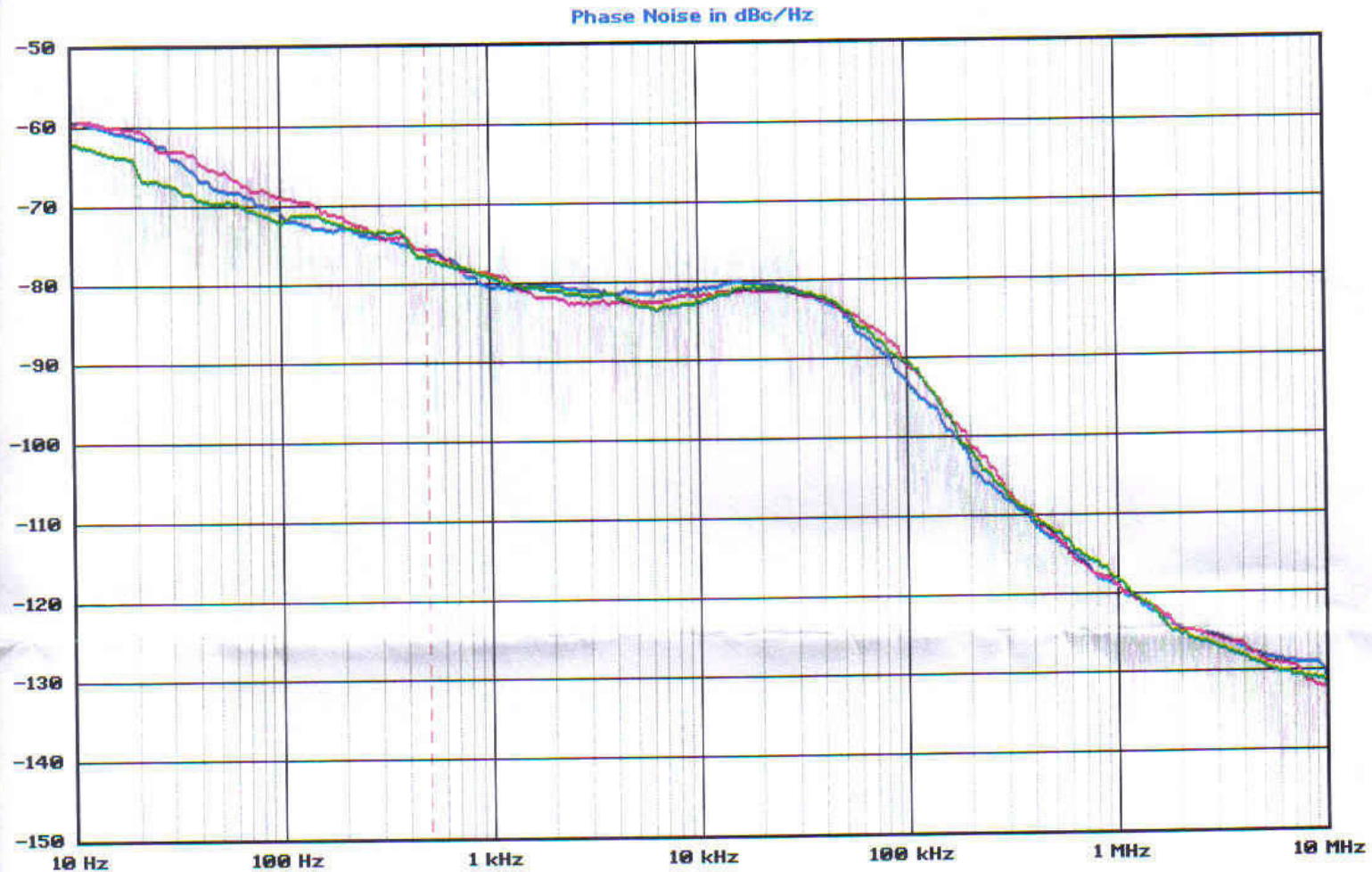
ZL-PLL-14G - 54MHz to 13.6 GHz
\$186 delivered (with optional programming cable)



\$170

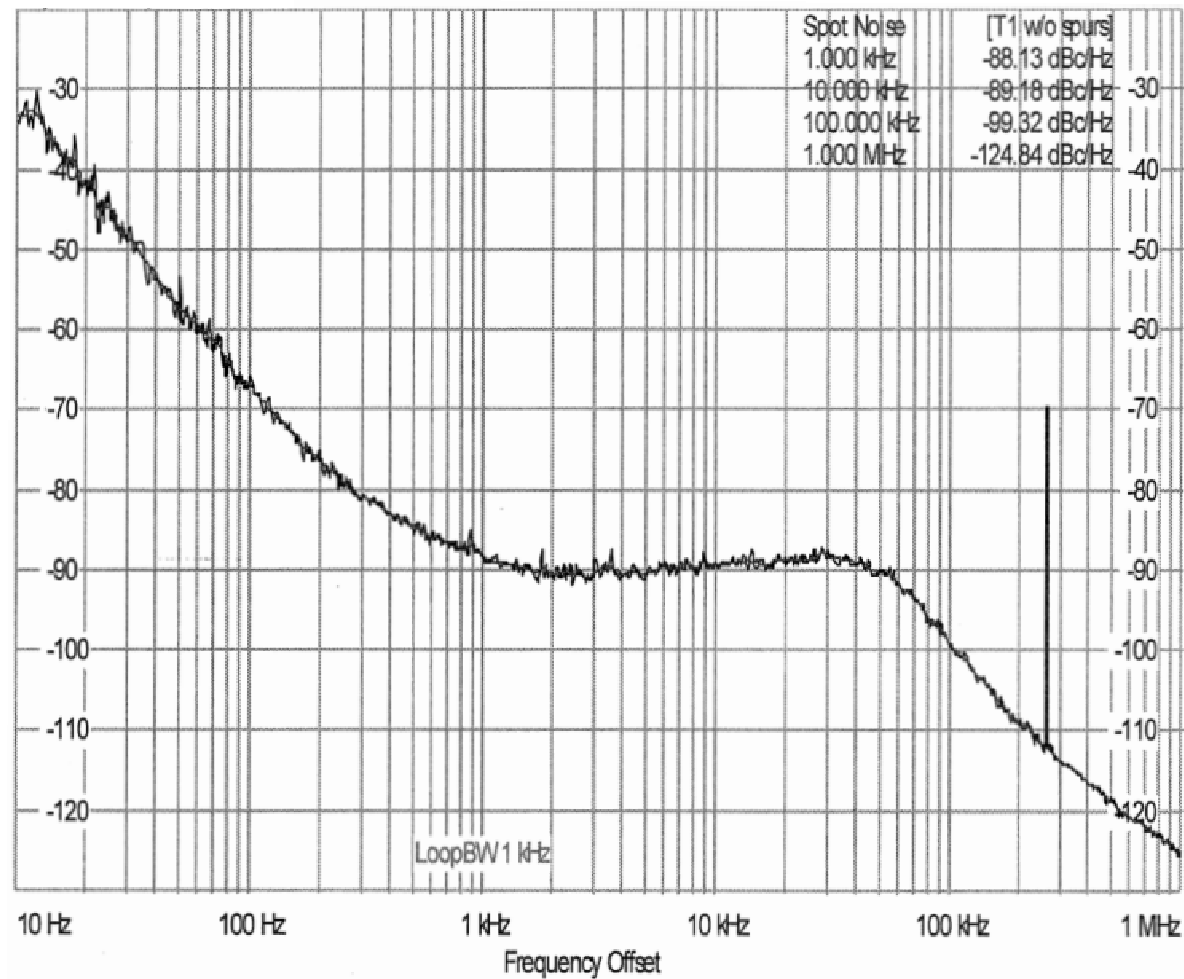


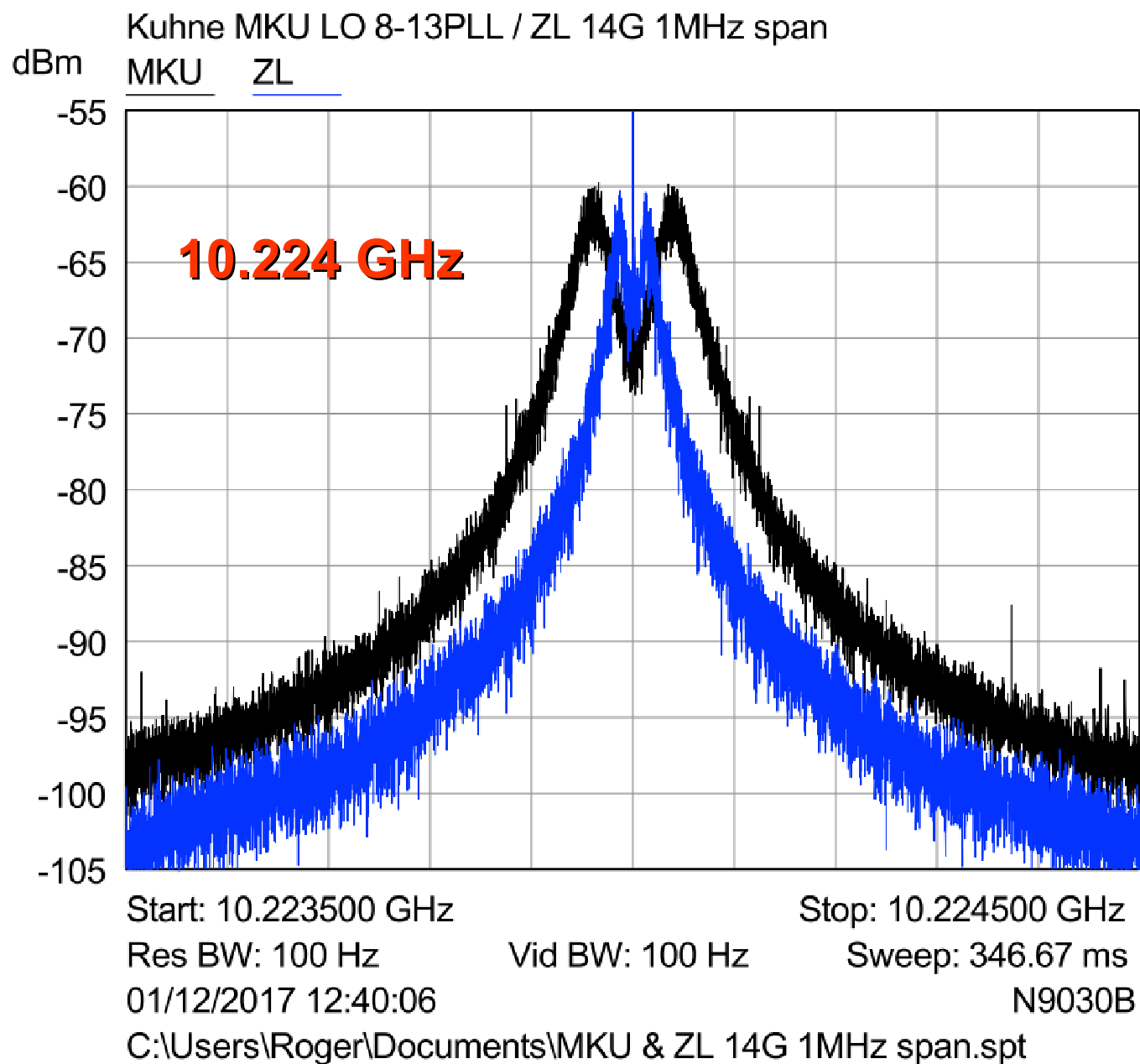
ADF5355

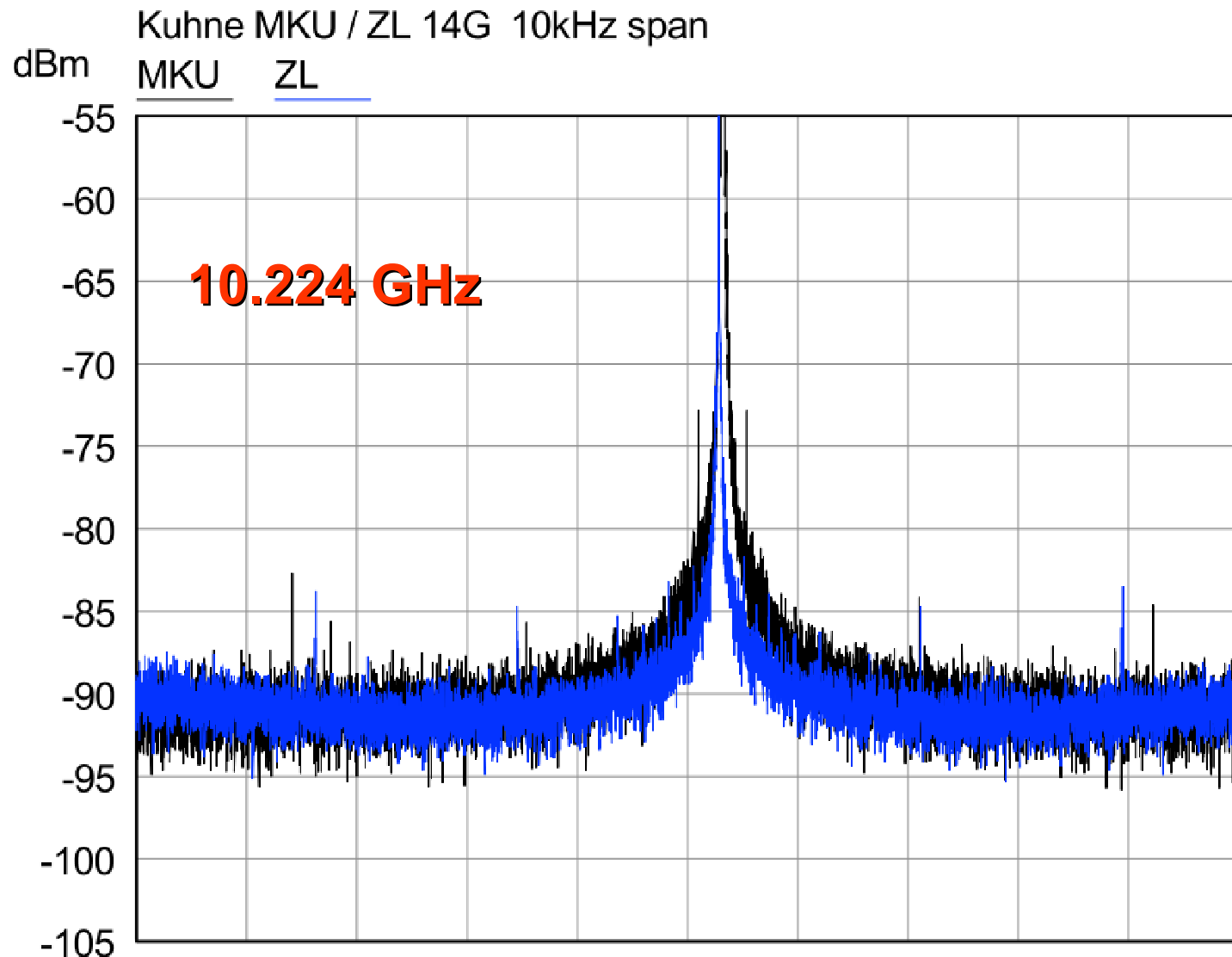


| Trace | Carrier Hz | Carrier dBm | dBc/Hz at 500 Hz | RF Atten dB | Instrument |
|--------------------------|----------------|-------------|------------------|-------------|-------------------------|
| ZLPLL A013 CP=2 Bleed=20 | 13 365 000 000 | 6.00 | -75.7 | 10 | HP8563E,005,007,008,8ZE |
| ZLPLL A014 CP=2 Bleed=20 | 13 365 001 070 | 6.17 | -76.3 | 10 | HP8563E,005,007,008,8ZE |
| ZLPLL A020 CP=2 Bleed=20 | 13 365 001 003 | 6.83 | -76.9 | 10 | HP8563E,005,007,008,8ZE |

ADF4355







Start: 10223995.000000 kHz Stop: 10224005.000000 kHz
Res BW: 1 Hz Vid BW: 1 Hz Sweep: 1.84 s
01/12/2017 12:24:04 N9030B
F:\Phase noise\Kuhne MKU _ ZL 14G 10kHz spanA.spt

ZL-PLL-14G

| Command | Description |
|----------------|----------------------------------|
| cw speed # | Set the CW Speed in WPM |
| cw text | Update CW message text |
| channel # | Load channel for reconfiguration |
| save # | Save channel |
| freq ##.### | Set RF frequency |
| level # | Set RF Level (0=Off to 4=High) |
| multiplier # | Set external multiplier factor |
| config param # | Setup PLL Parameters |
| ref_int #.## | Reference frequency - Internal |
| ref_ext #.## | Reference frequency - External |
| diag | Display PLL data for channel |
| debug # # | Display debugging information |
| test | Enter RF Test mode |
| init | Reload PLL Setup |
| i2c_addr | Set I2C Slave address |
| show | Display current config |

ZL-PLL-14G

```
> show
Frequency: 11952.000000
Level: 3
Step Size: 25000.000000 Hz
Ref Div: 1

Internal Ref: 10.000 MHz
External Ref: 10.000 MHz (level >= 20)
Doublor Max: 50 MHz
Config: cp=2, bleed=20
Config: mtlid=1, csr=0, gcd=1, spur=0
I2C Addr: 0x00

CW Text=_ZLPLL_
CW Speed=12 WPM Gap=0 T1=0ms T2=5ms

0: Freq 10224.000 level=3 mode=1 rdiv=1
1: Freq 11952.000 level=3 mode=1 rdiv=1
2: Freq 11736.000 level=3 mode=1 rdiv=1
3: Freq 12648.000 level=3 mode=1 rdiv=1
4: Freq 9936.000 level=3 mode=1 rdiv=1
5: Freq 11808.000 level=3 mode=1 rdiv=1
6: Freq 5616.000 level=3 mode=1 rdiv=1
7: Freq 5328.000 level=3 mode=1 rdiv=1
8: Freq 0.000 level=0 mode=0 rdiv=1
9: Freq 0.000 level=0 mode=0 rdiv=1
10: Freq 0.000 level=0 mode=0 rdiv=1
11: Freq 0.000 level=0 mode=0 rdiv=1
12: Freq 0.000 level=0 mode=0 rdiv=1
13: Freq 0.000 level=0 mode=0 rdiv=1
14: Freq 0.000 level=0 mode=0 rdiv=1
15: Freq 0.000 level=0 mode=0 rdiv=1
>
```

VE2UG
10 inch dish
WR12 feed



Questions?