# Experiments on 122 GHz

*Mike Seguin, N1JEZ*

*44th Eastern VHF/UHF/Microwave Conference 2018*

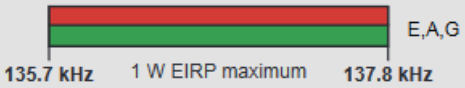
# US Amateur Radio Bands

**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®

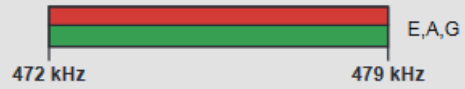
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

## 2,200 Meters (135 kHz)



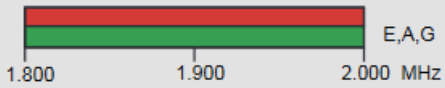

## 630 Meters (472 kHz)

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

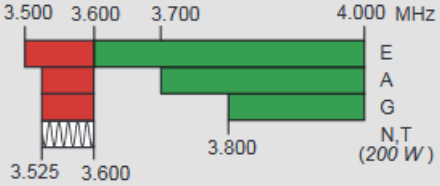



## 160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1.900 to 2.000 MHz




## 80 Meters (3.5 MHz)

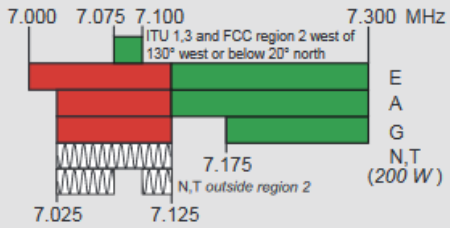



## 60 Meters (5.3 MHz)




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)



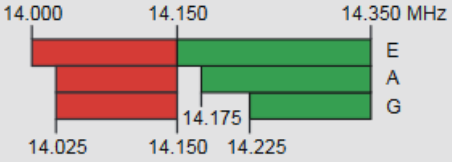

See Sections 97.305(c), 97.307(f)(11) and 97.301(e).These exemptions do not apply to stations in the continental US.

## 30 Meters (10.1 MHz)

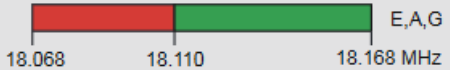
Avoid interference to fixed services outside the US.



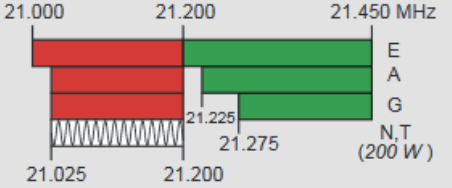

## 20 Meters (14 MHz)



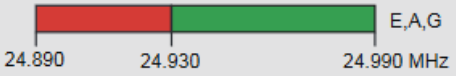

## 17 Meters (18 MHz)



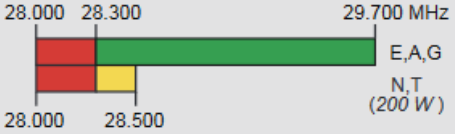

## 15 Meters (21 MHz)



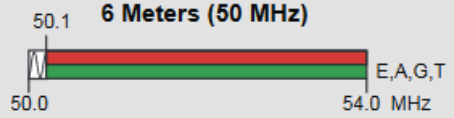

## 12 Meters (24 MHz)



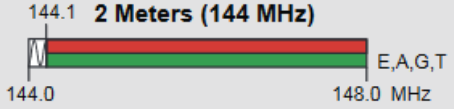

## 10 Meters (28 MHz)



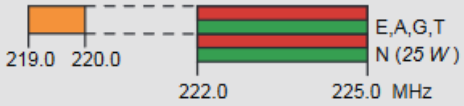

## 6 Meters (50 MHz)




## 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.

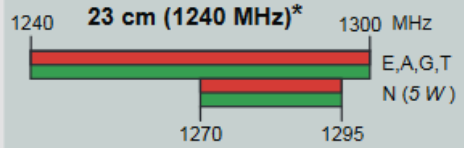
## 70 cm (420 MHz)*




## 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
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email: newham@arrl.org

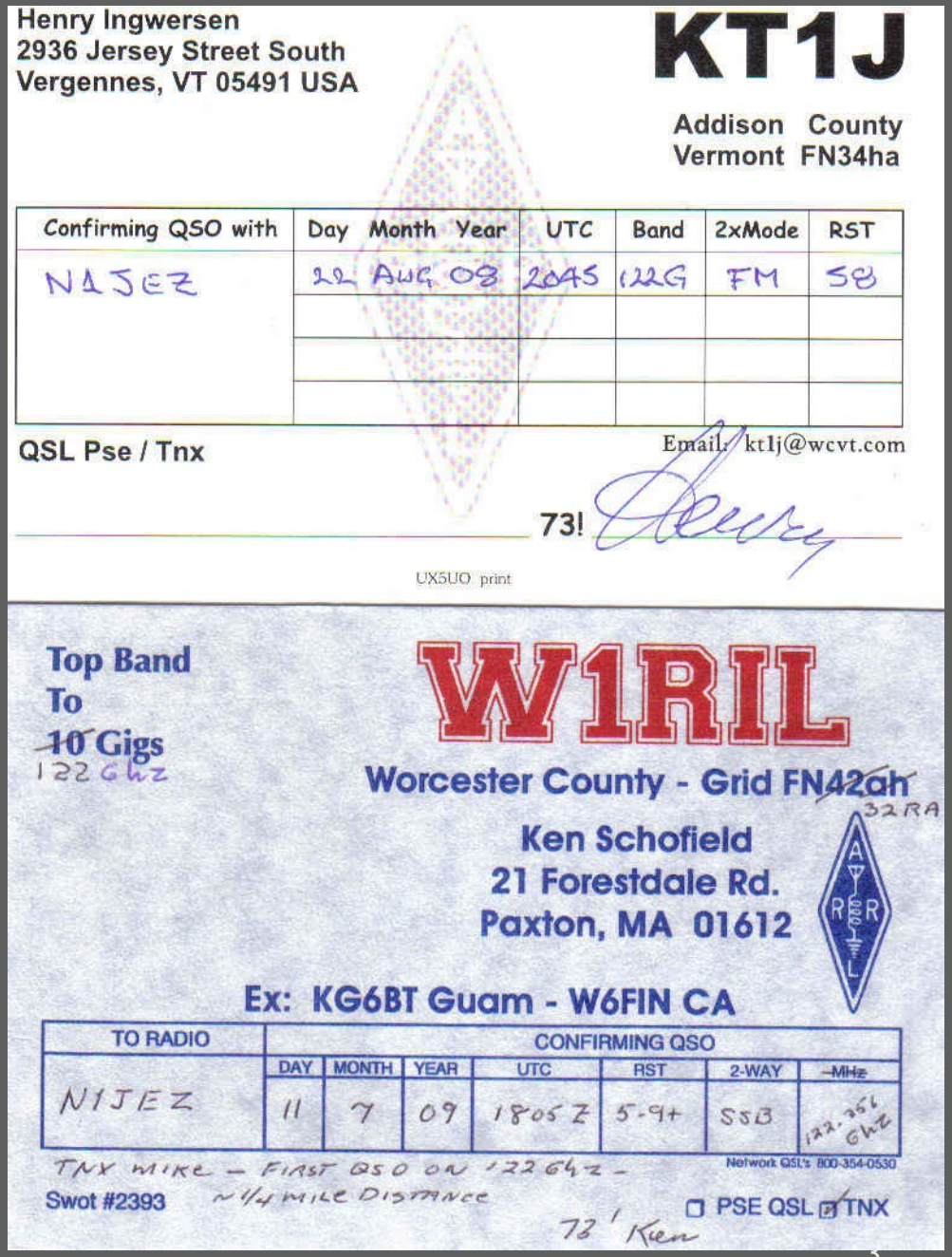
Exams: 860-594-0300 email: vec@arrl.org


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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 | 58 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

QSL Pse / Tnx

Email: ktlj@wcvt.com

73! Henry

UX5UO print

Top Band
To
~~10 Gigs~~
122 Ghz

**W1RIL**

Worcester County - Grid ~~FN42ah~~ 32RA

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 |

TNX MIKE – FIRST QSO ON 122 GHz – ~1/4 MILE DISTANCE

Network QSL's 800-354-0530

Swot #2393

☐ PSE QSL ☒ TNX

73 / Ken

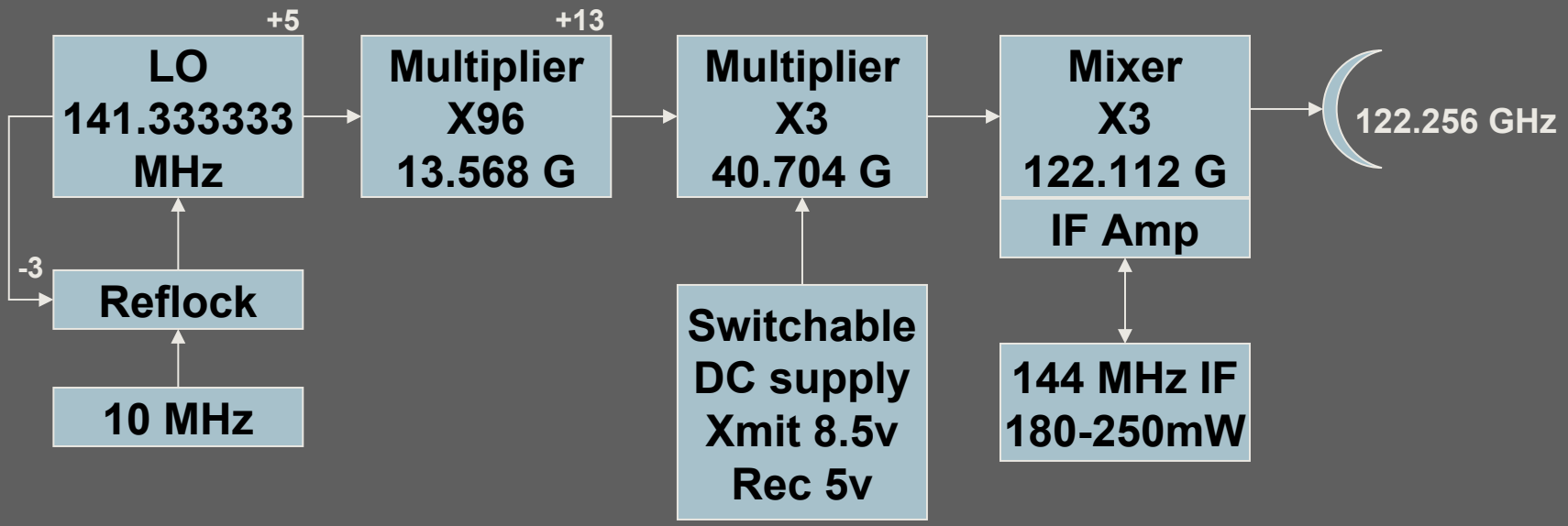


W1RIL/N1JEZ 2009

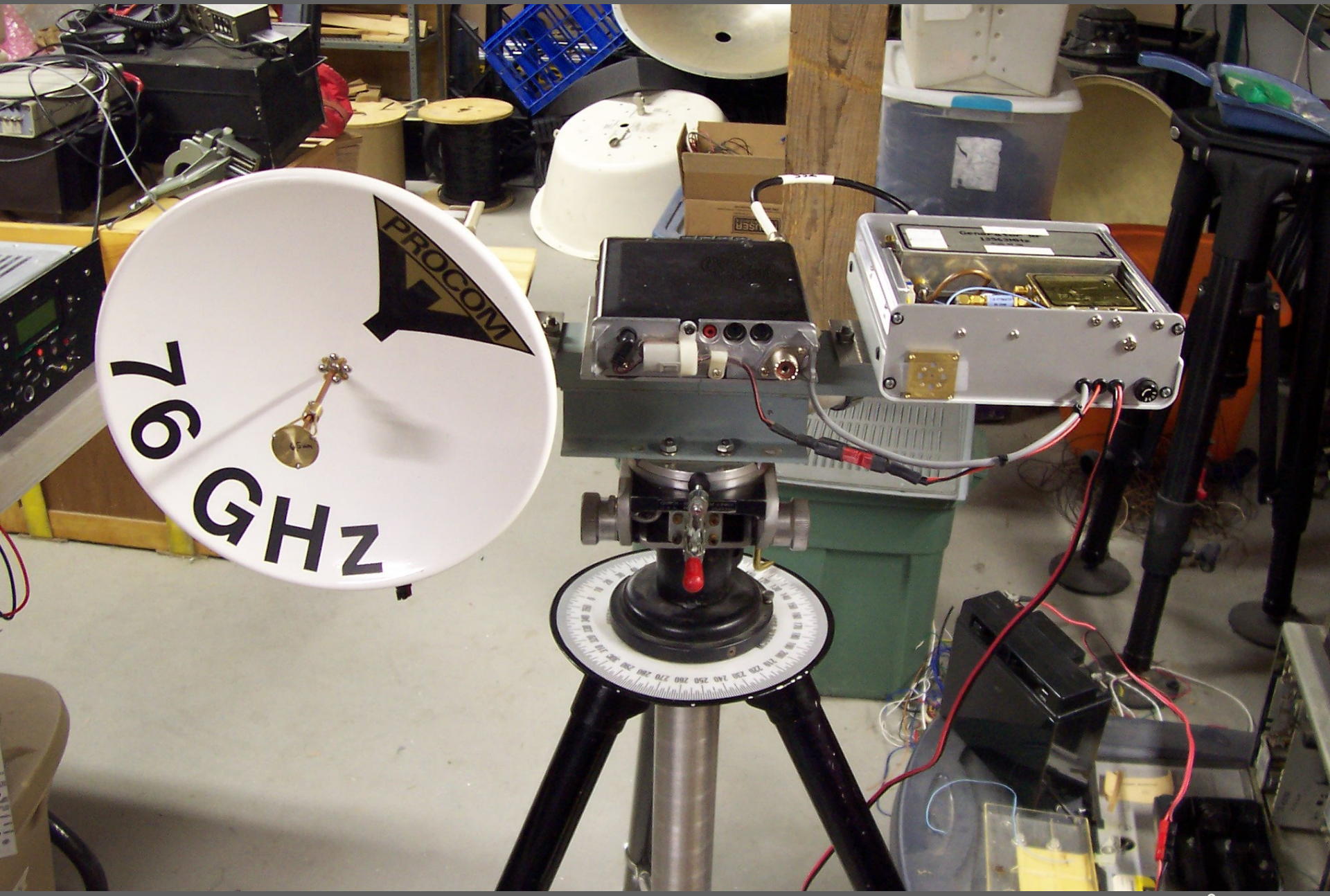


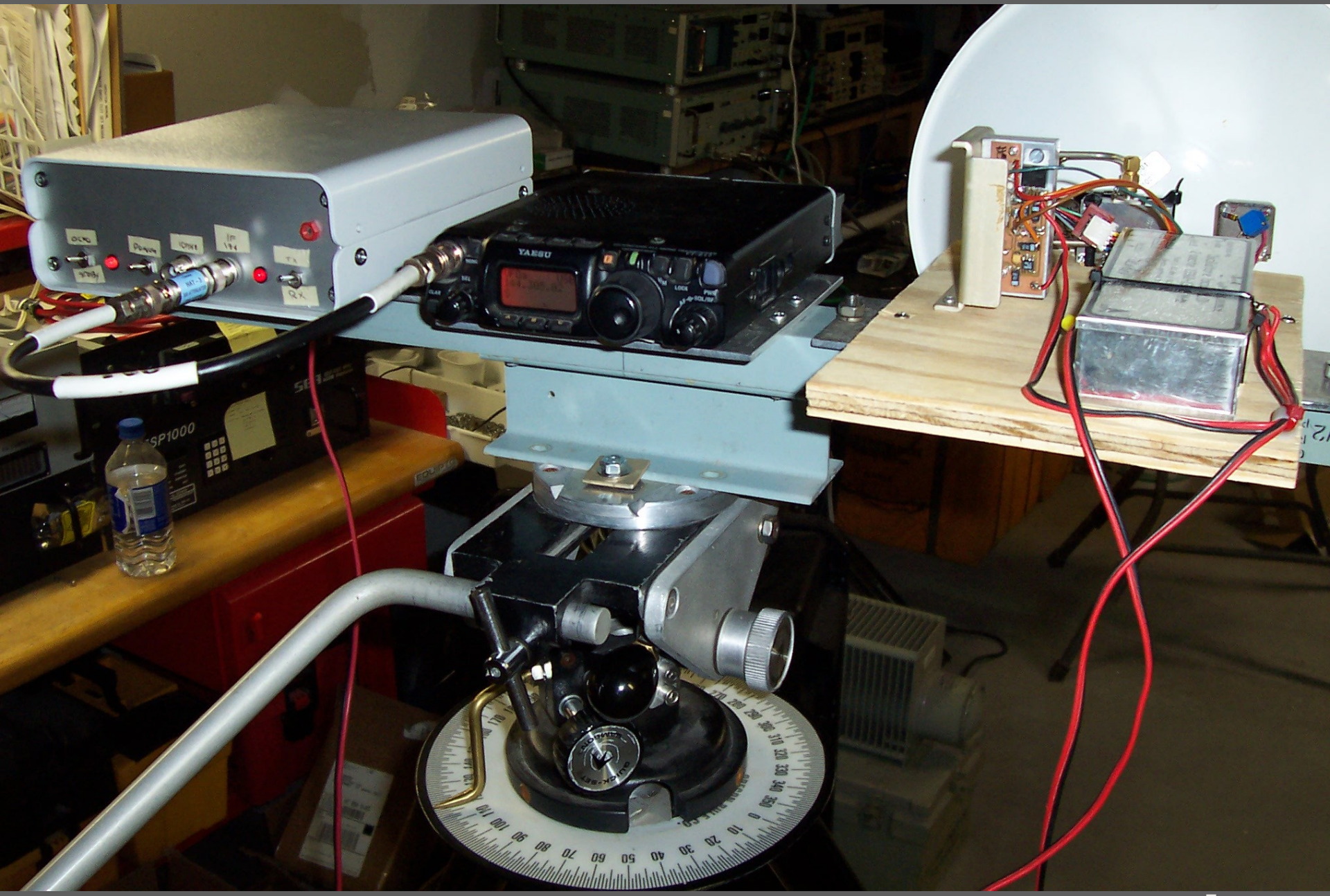
KT1J/N1JEZ first contact at ~ 200’

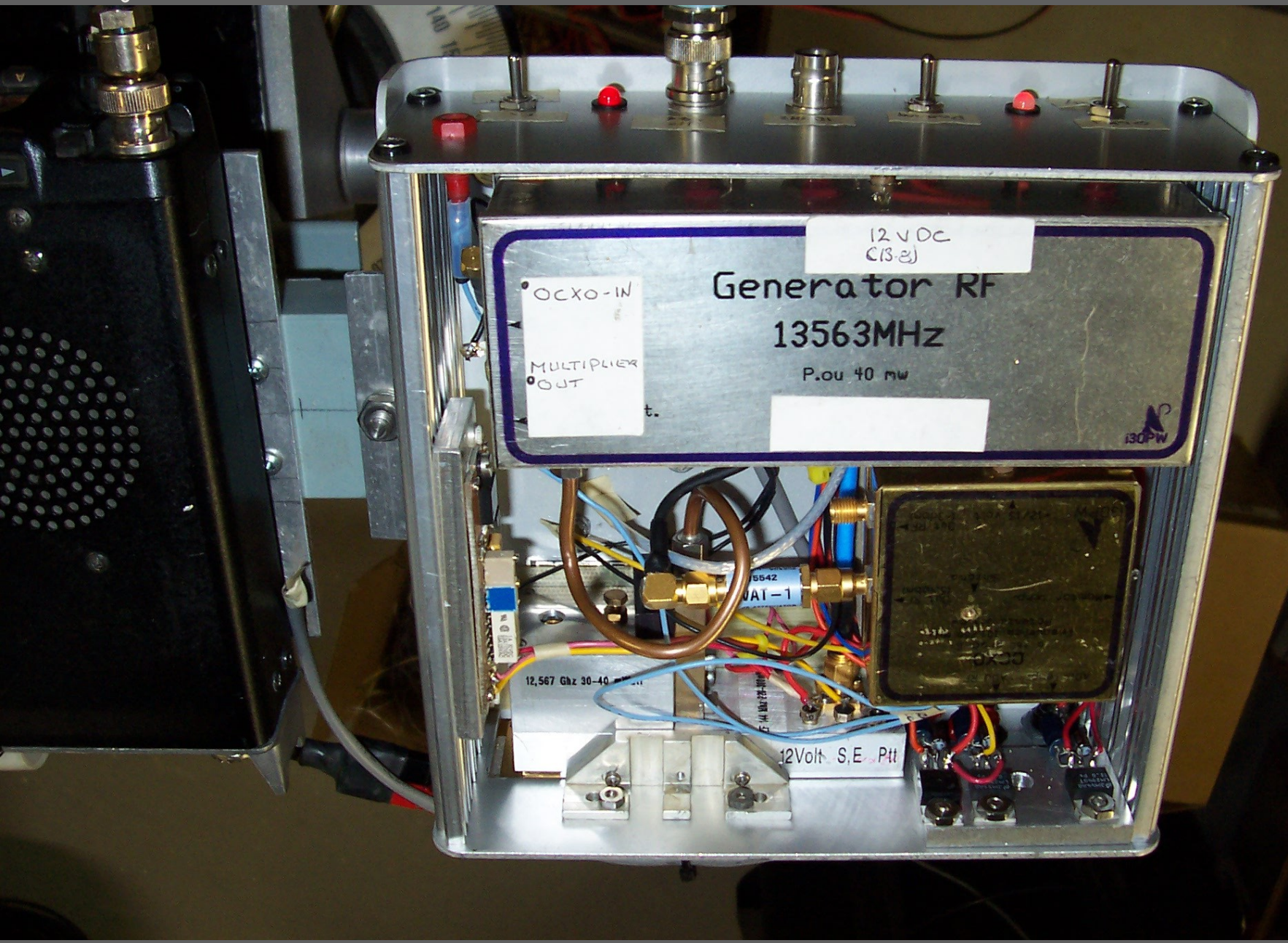
# 122.256 GHz Mixer

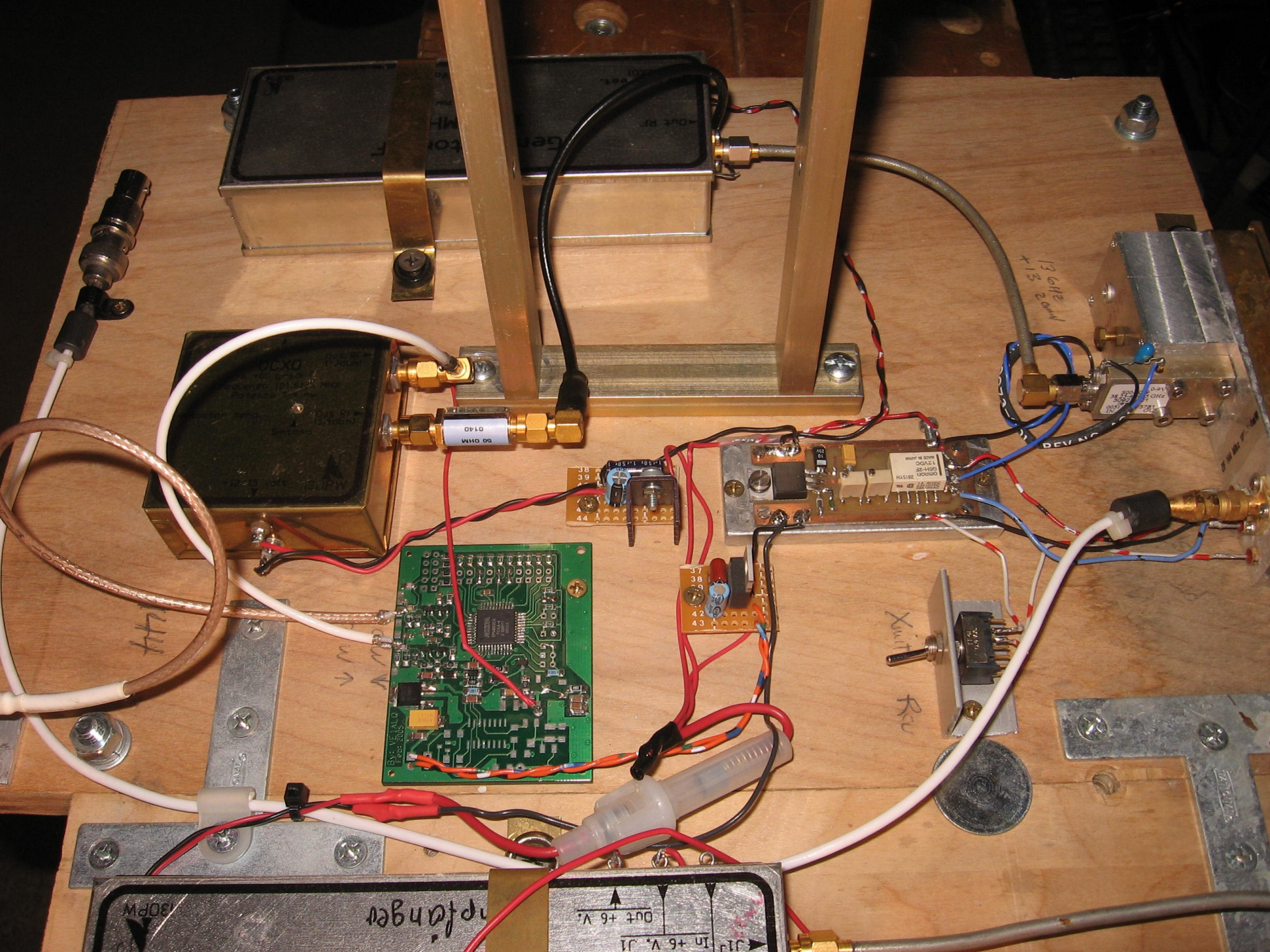



Reflock 141.333333 MHz LO
R = 60
N = 847 (848 calculated)
LO Multiplication = x 864

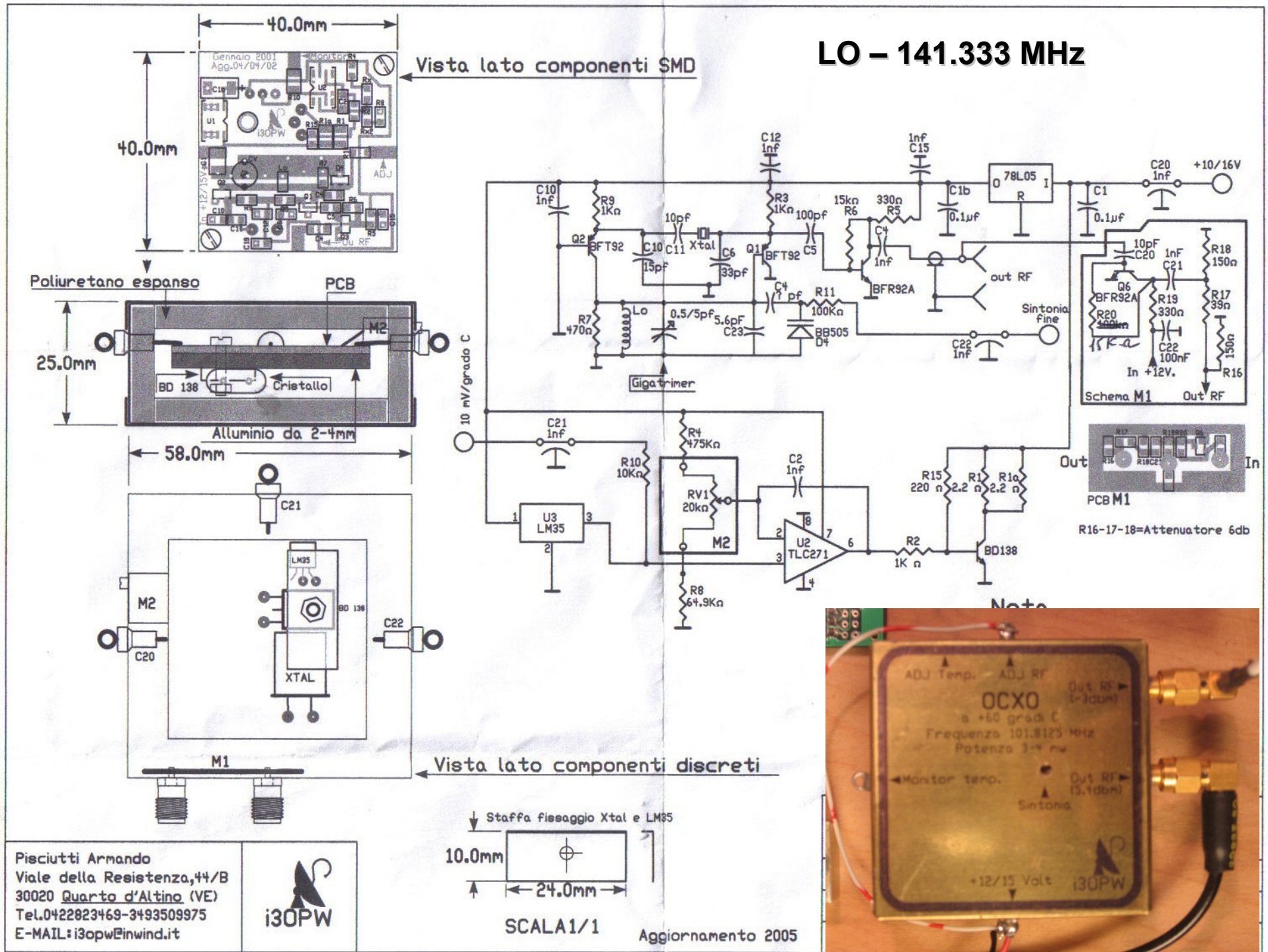

PROCOM
76 GHz


YAESU


12 V DC
Generator RF
13563MHz
P.ou 40 mw
OCXO-IN
MULTIPLIER
OUT
12,567 Ghz 30-40
12Volt S.E. Ptt


50 OHM
0140
Out +6 V.
In +6 V. J1
J1

# LO – 141.333 MHz



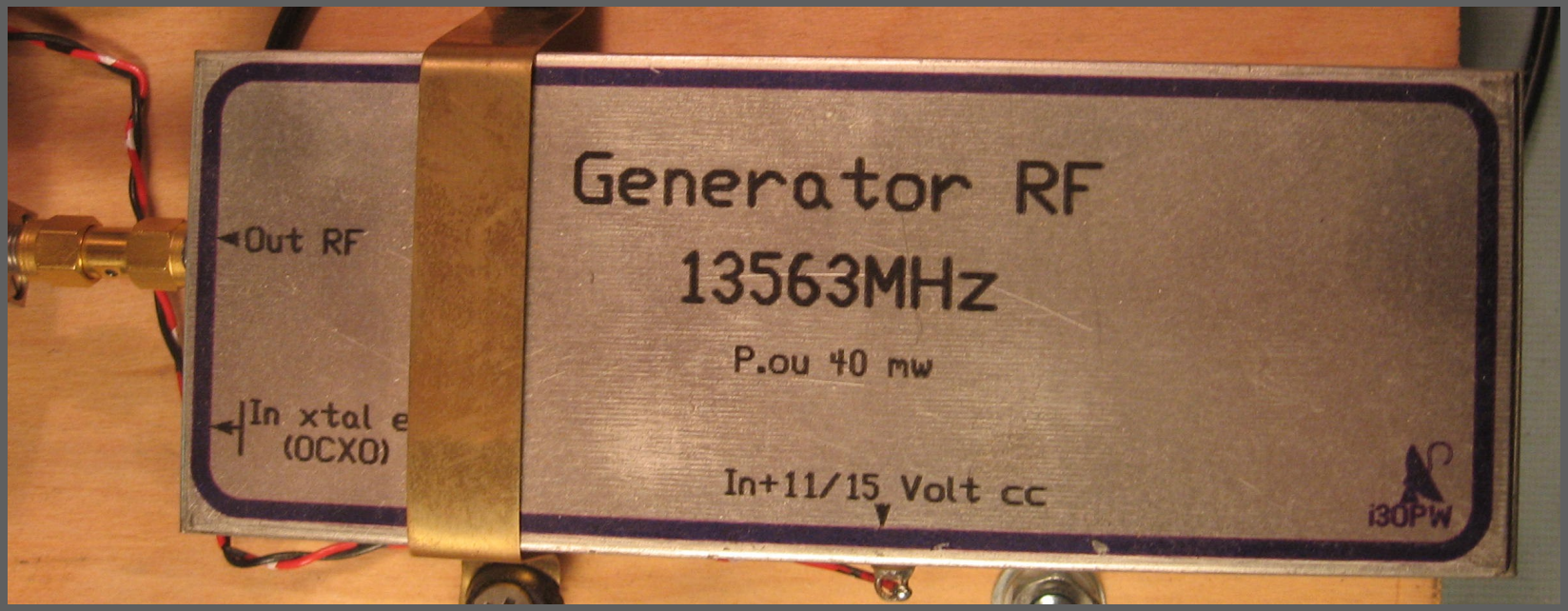


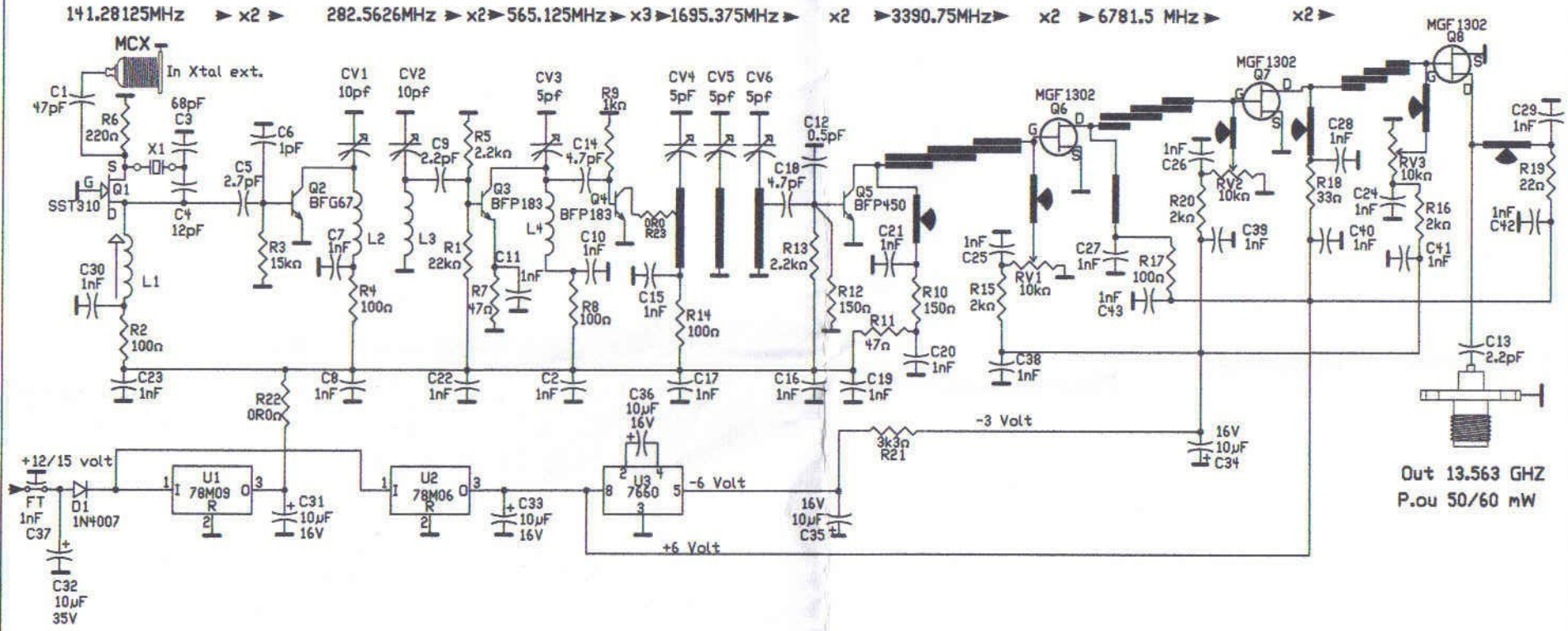



Pisciutti Armando
Viale della Resistenza,44/B
30020 Quarto d'Altino (VE)
Tel.0422823469-3493509975
E-MAIL:i3opw@inwind.it


i3OPW

# x96 Multiplier






L1-Neosid 5061 0.1 µH

L2-3 spire su 3mm

L3-3 spire su 3mm

L4-1/2 spira su 3mm


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


i3OPW

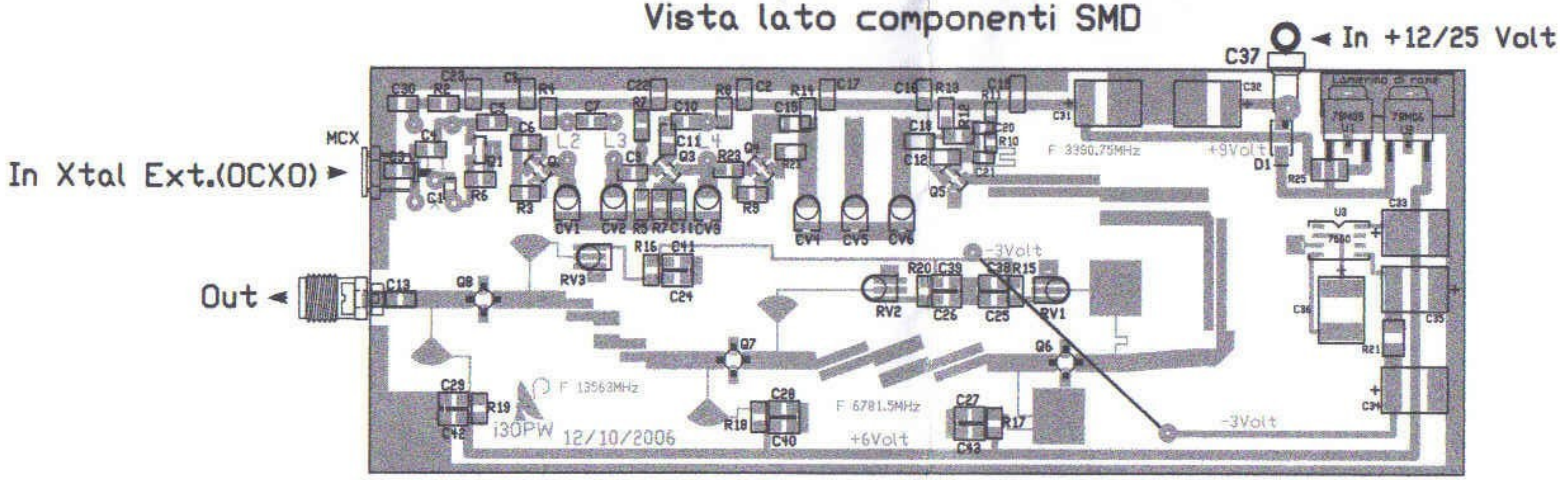
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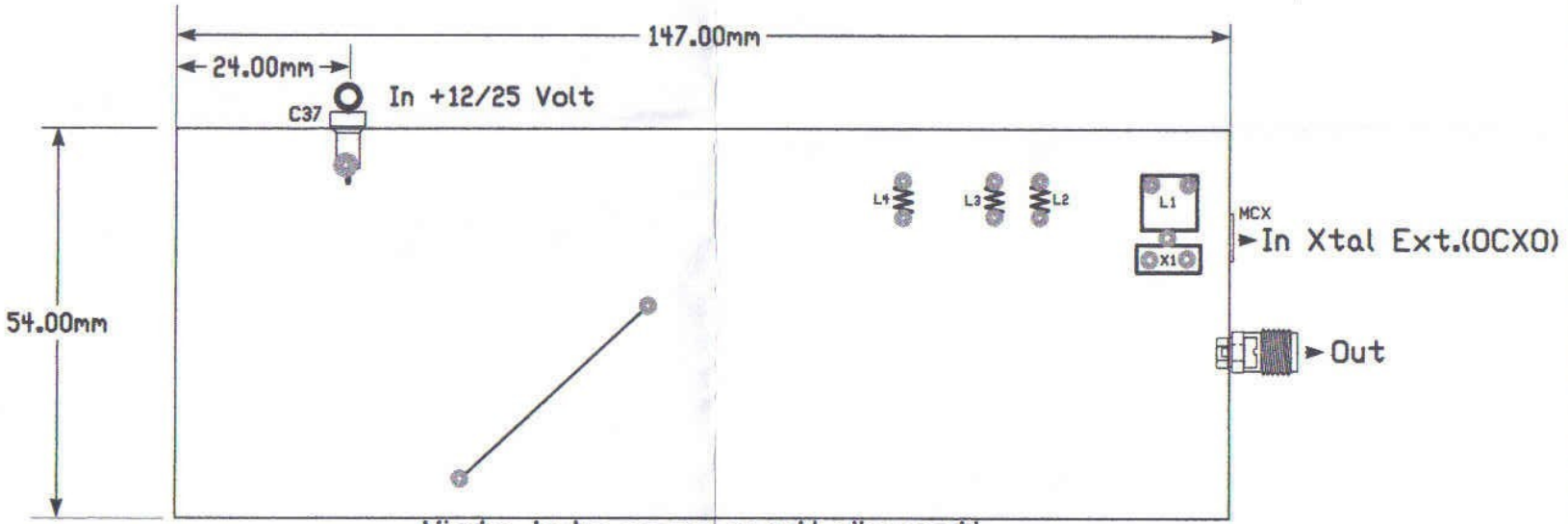
Board: Revision:

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

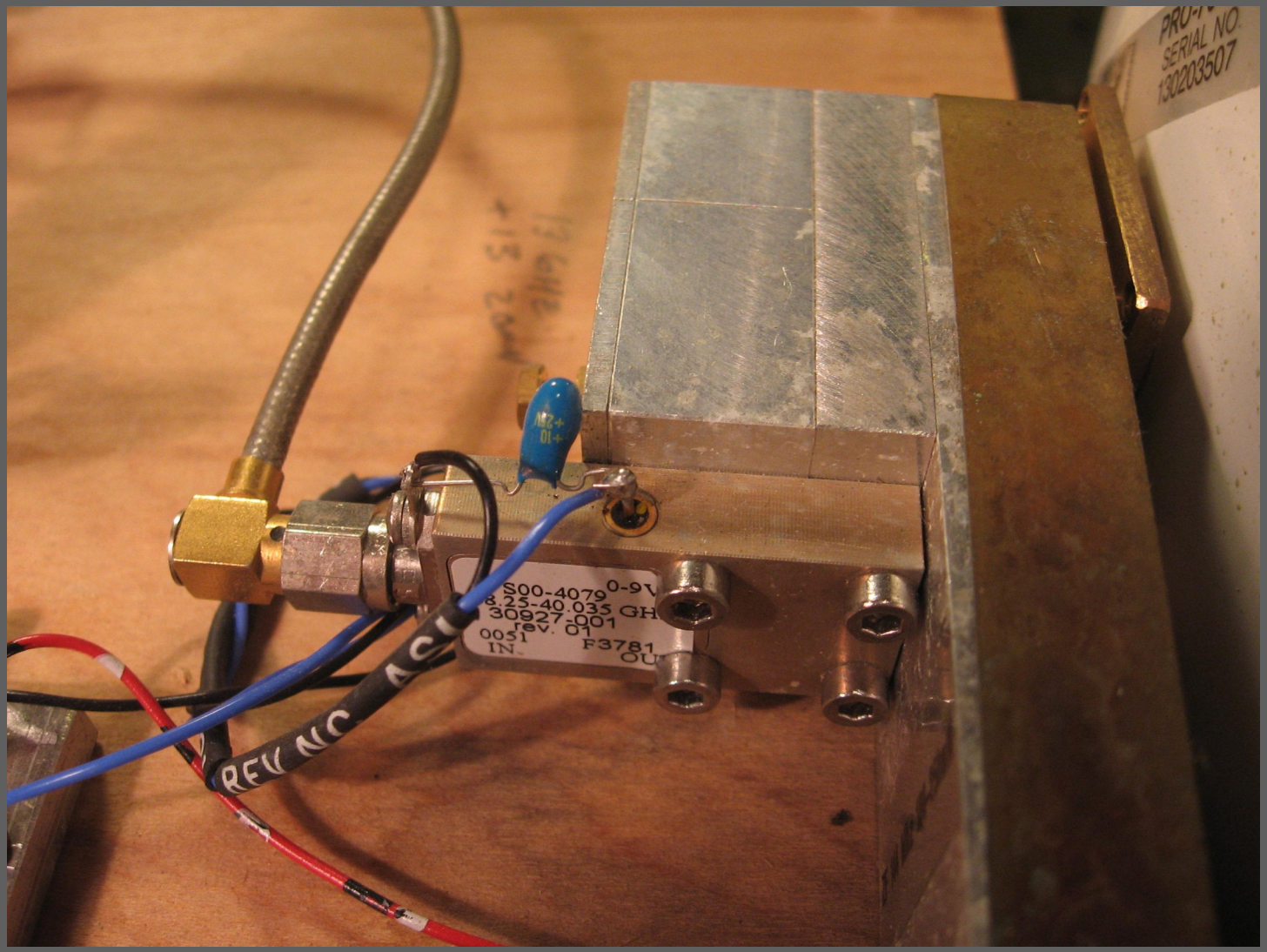

i30PW

Scala 1/1

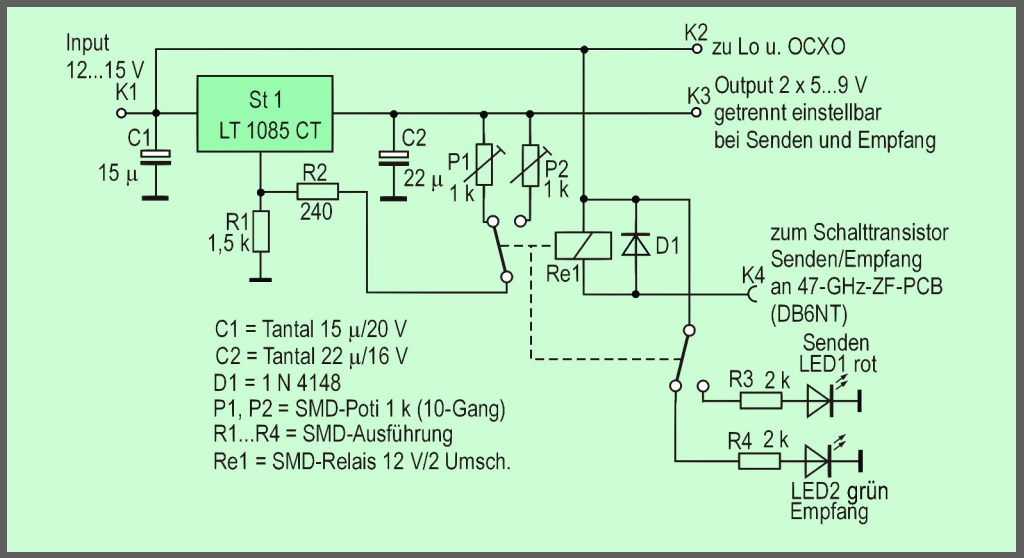
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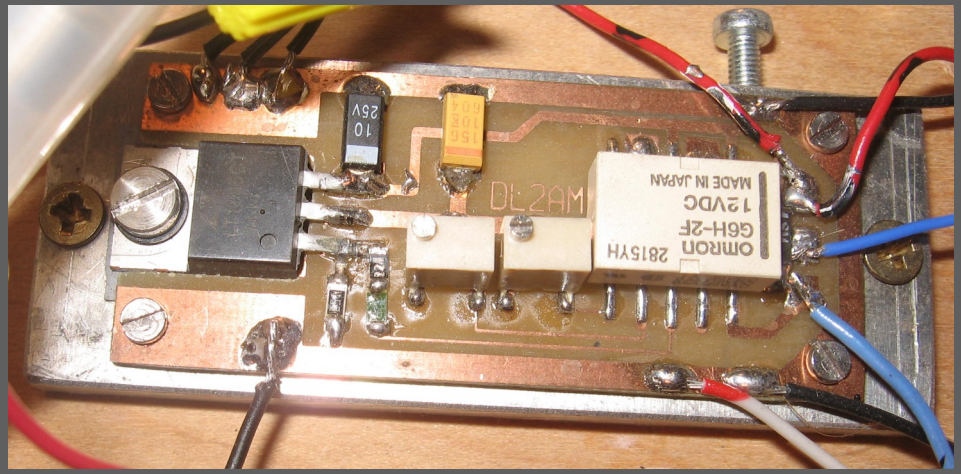
| | |
|---|---|
| Device: | Revision: |
| Author: | Size: |
| Date: 15/10/2006 | Sheet 2 of 2 |

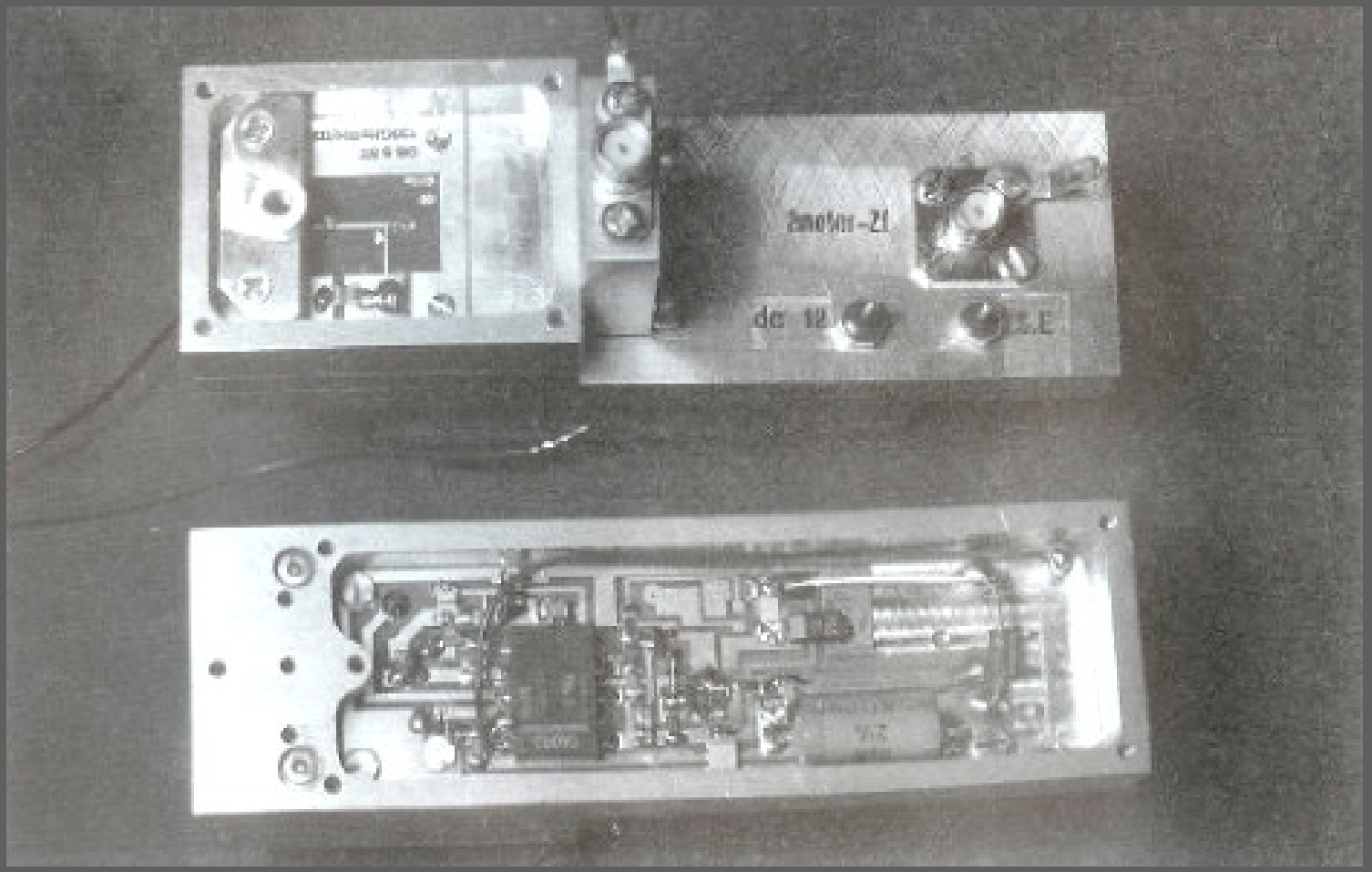
# 40 GHz X3 Multiplier



# 40 GHz X3 Multiplier Power Supply

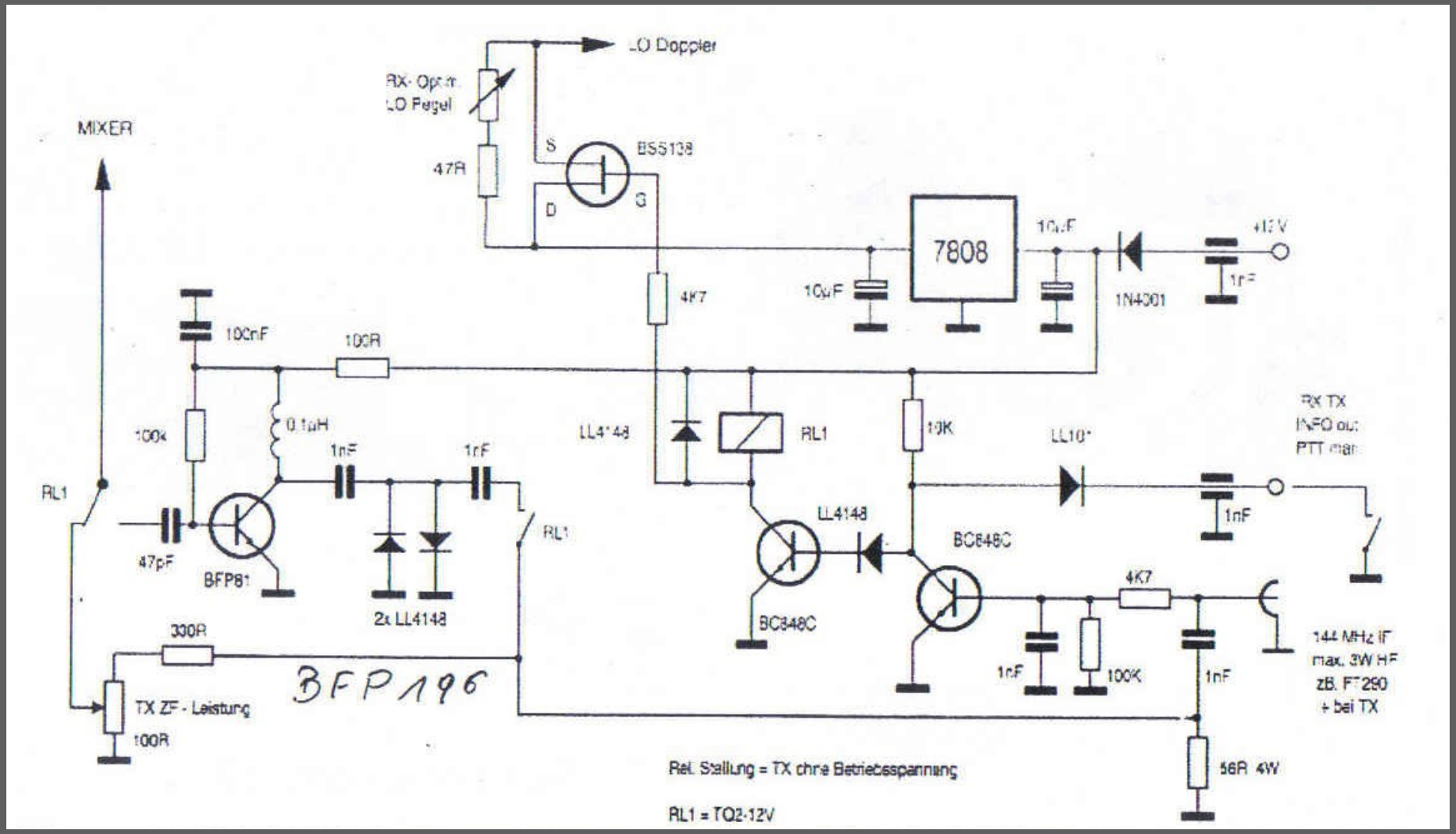


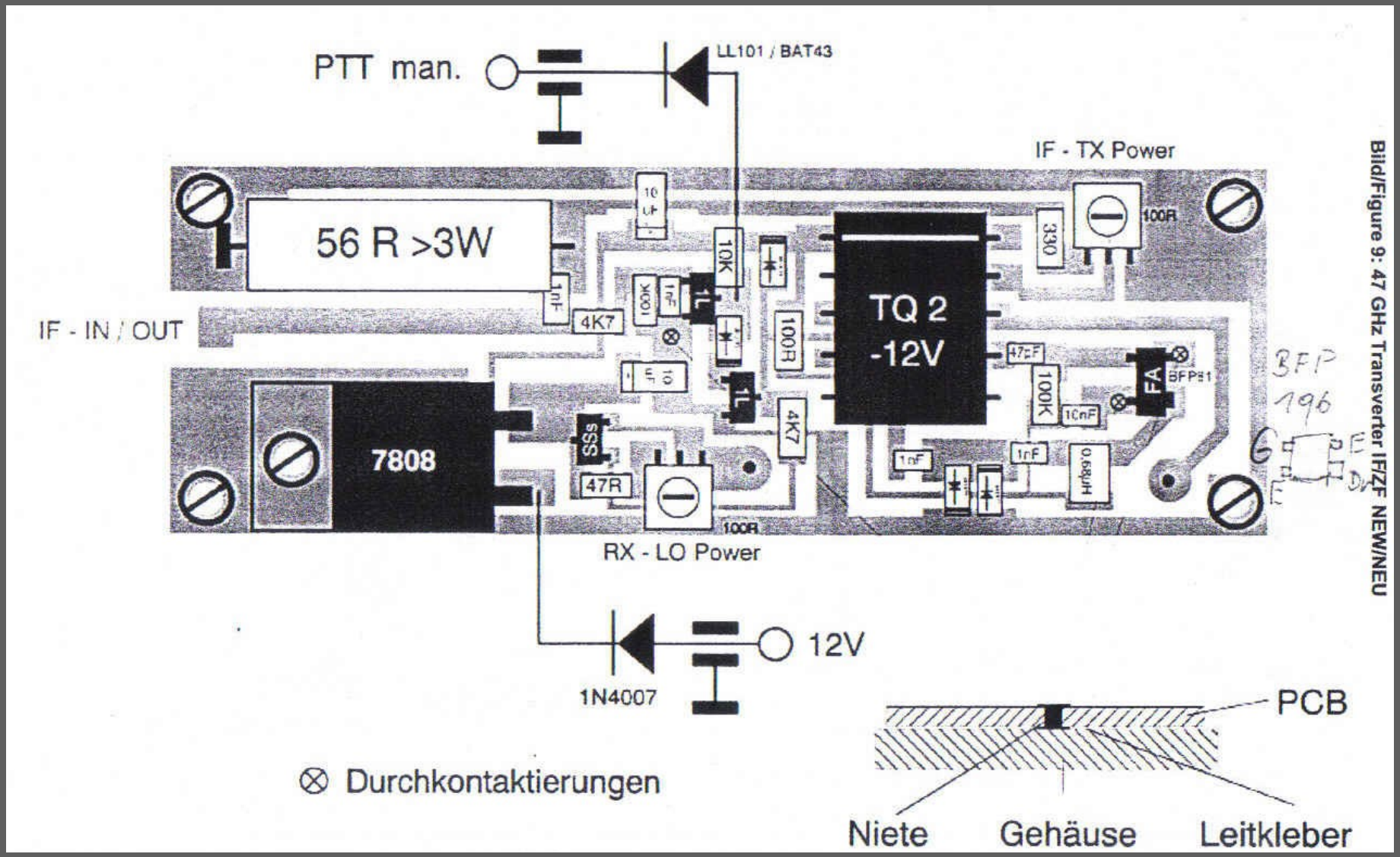


Single diode MA4E1317
DB6NT mixer board

# IF Amp


MIXER
LO Doppler
RX- Opt.
LO Pegel
47R
S
D
G
BS138
7808
1N4001
4K7
100nF
100R
100k
0.1µH
1nF
47pF
BFP81
2x LL4148
330R
TX ZF - Leistung
100R
BFP196
RL1
LL4148
BC848C
10K
LL10
4K7
100K
56R 4W
Rel. Stellung = TX ohne Betriebsspannung
RL1 = TQ2-12V
144 MHz IF
max. 3W HF
zB. FT290
+ bei TX

# IF Amp

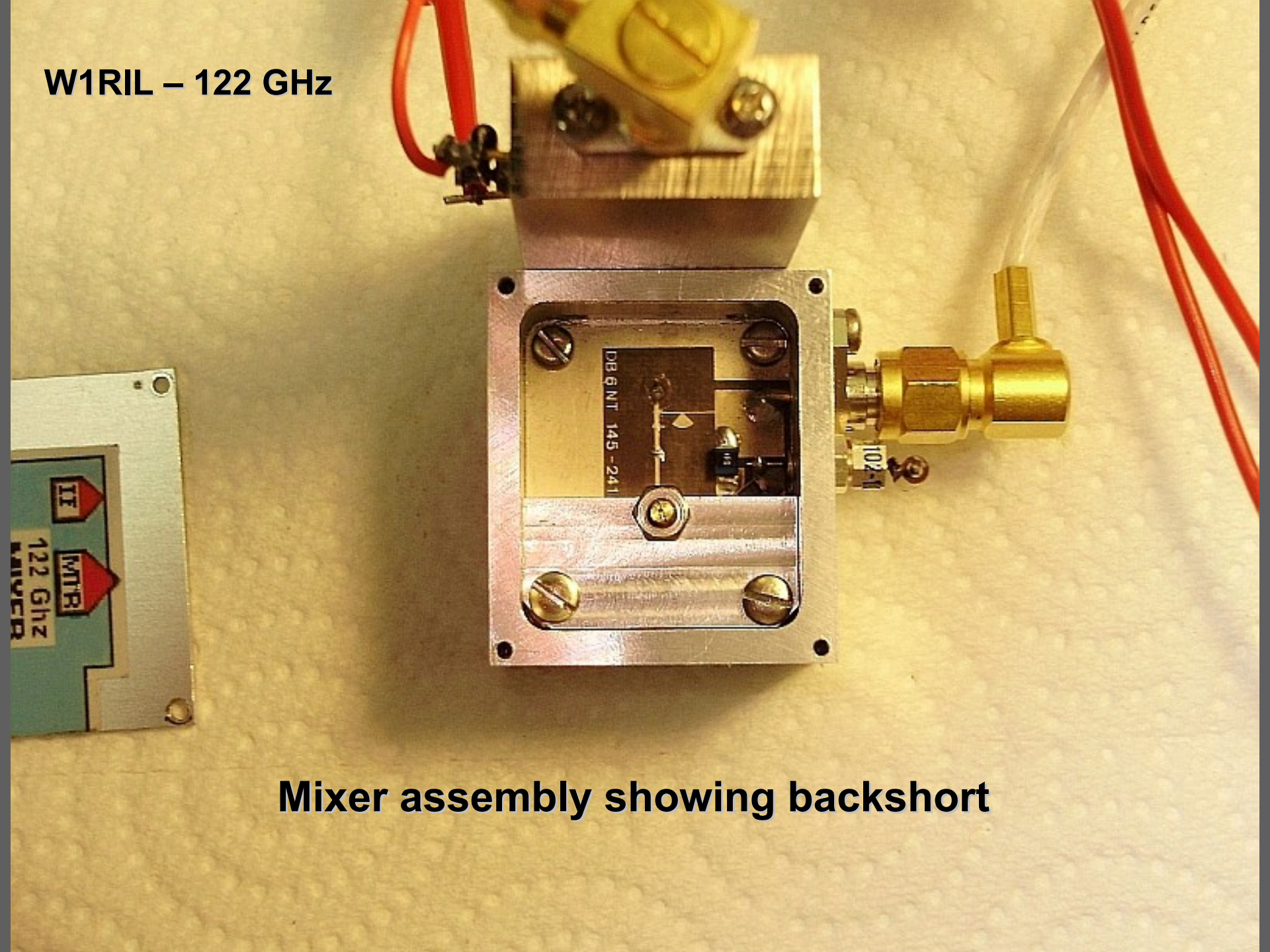

PTT man.
LL101 / BAT43
IF - TX Power
56 R >3W
IF - IN / OUT
TQ 2
-12V
7808
RX - LO Power
12V
1N4007
⊗ Durchkontaktierungen
PCB
Niete
Gehäuse
Leitkleber
BFP
196
Bild/Figure 9: 47 GHz Transverter IF/ZF NEW/NEU

# 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)

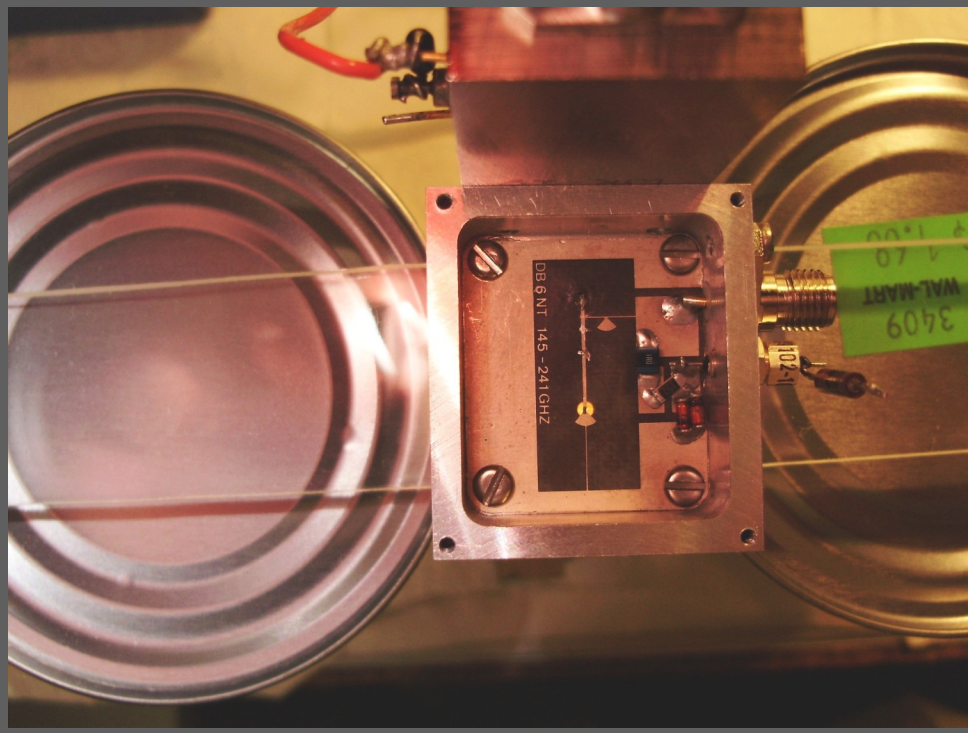
W1RIL – 122 GHz



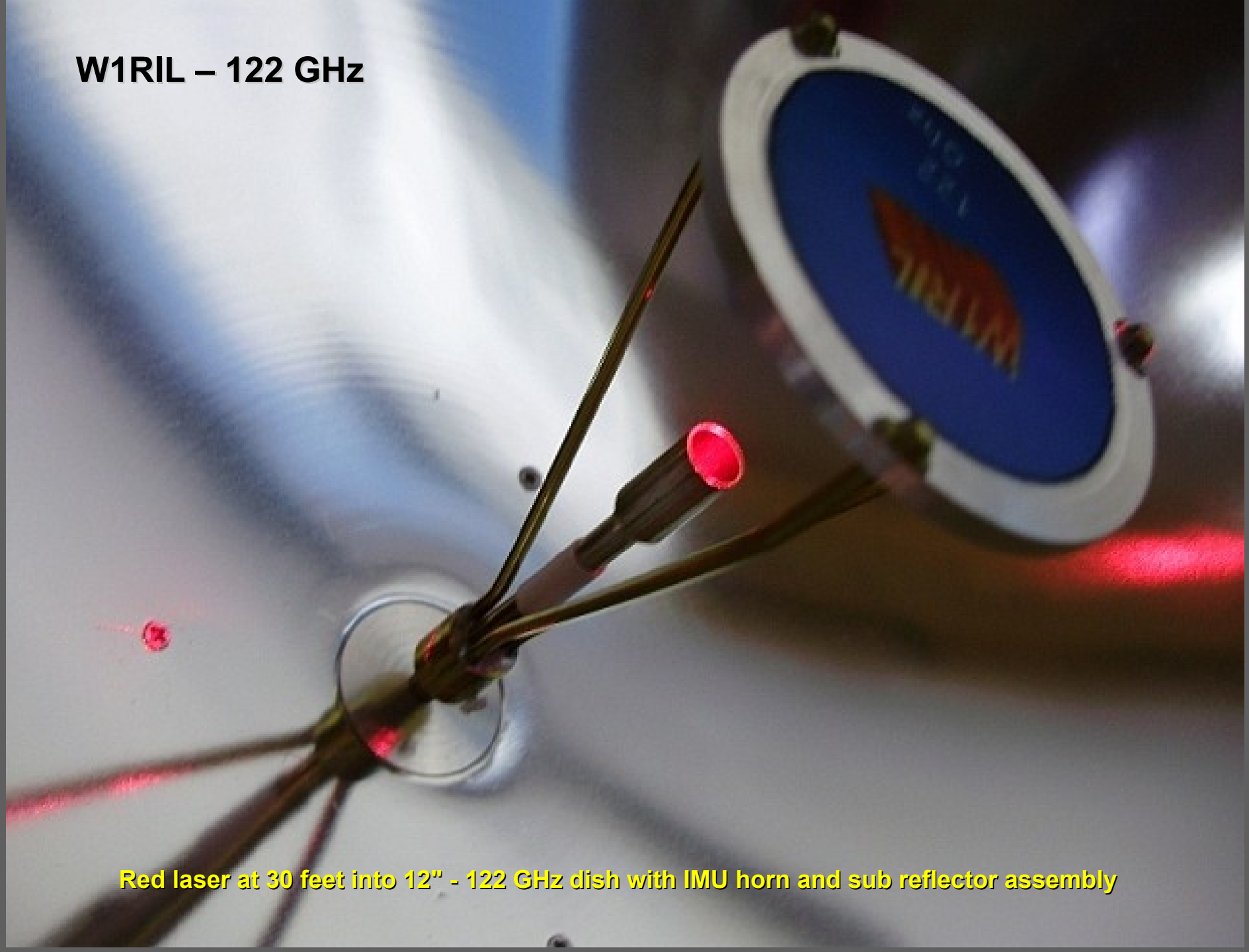

Mixer assembly showing backshort




# Diode Mounting

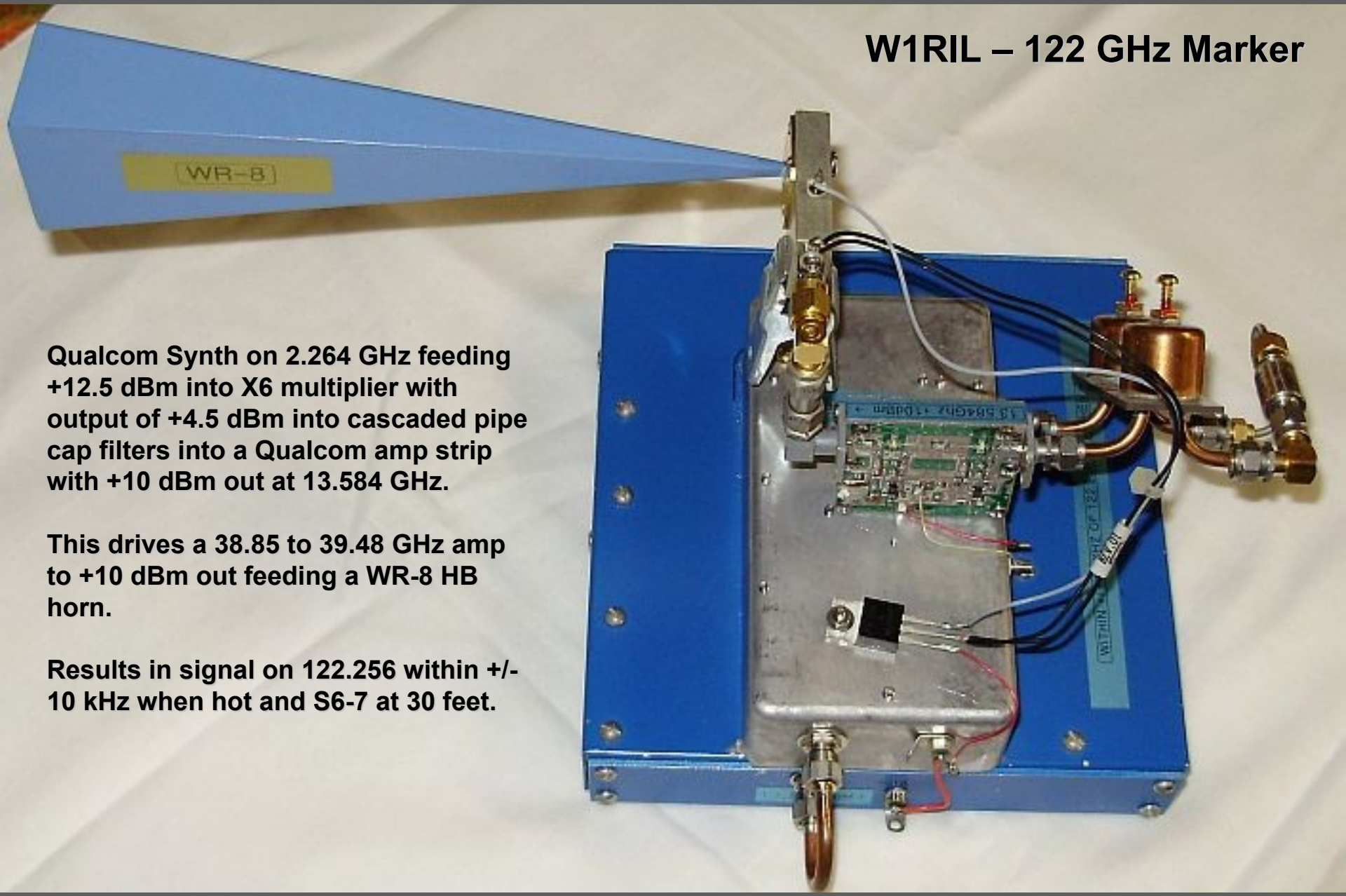


# W1RIL – 122 GHz



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

# W1RIL – 122 GHz Marker



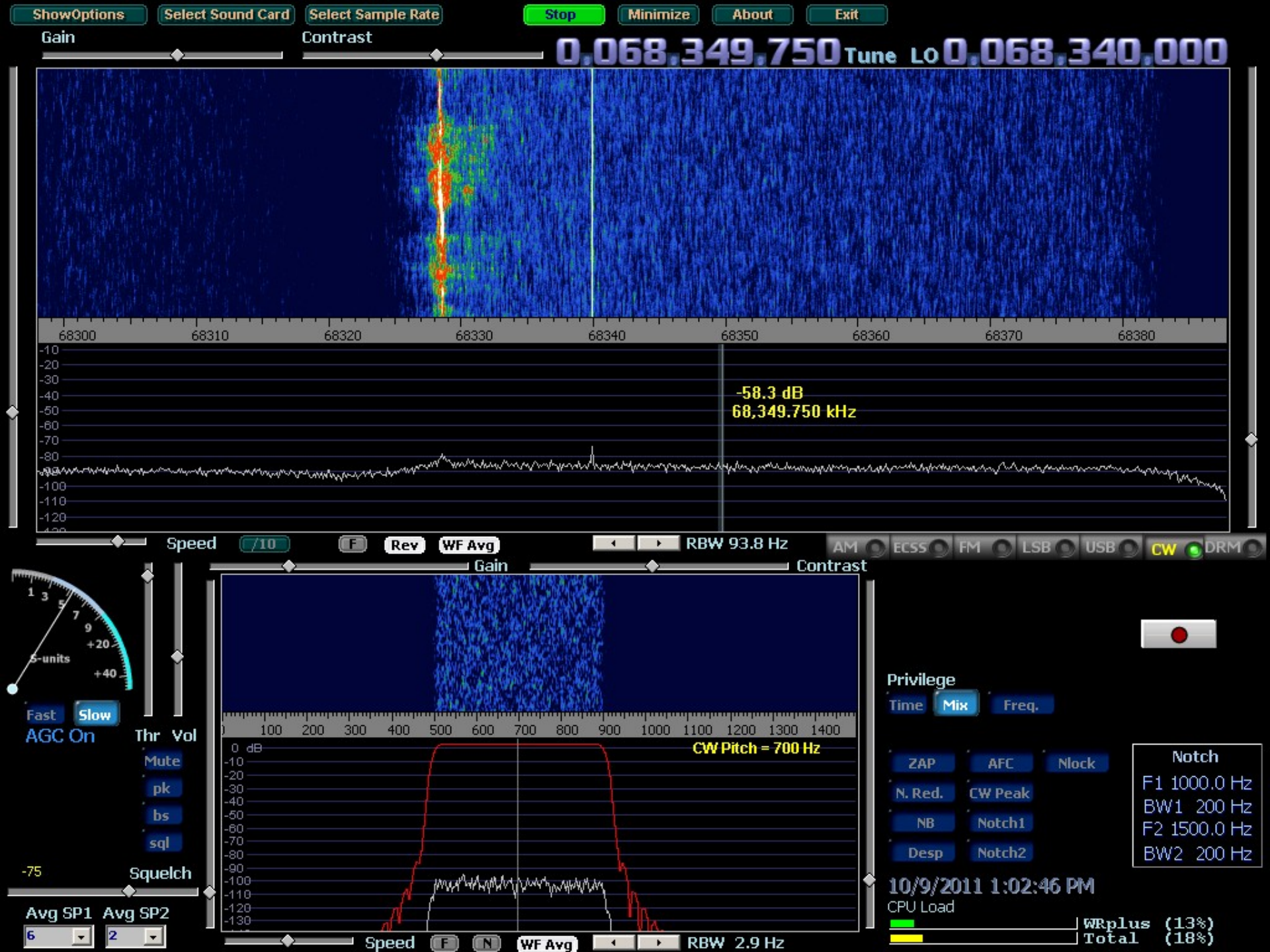

**Qualcom Synth on 2.264 GHz feeding +12.5 dBm into X6 multiplier with output of +4.5 dBm into cascaded pipe cap filters into a Qualcom amp strip with +10 dBm out at 13.584 GHz.**

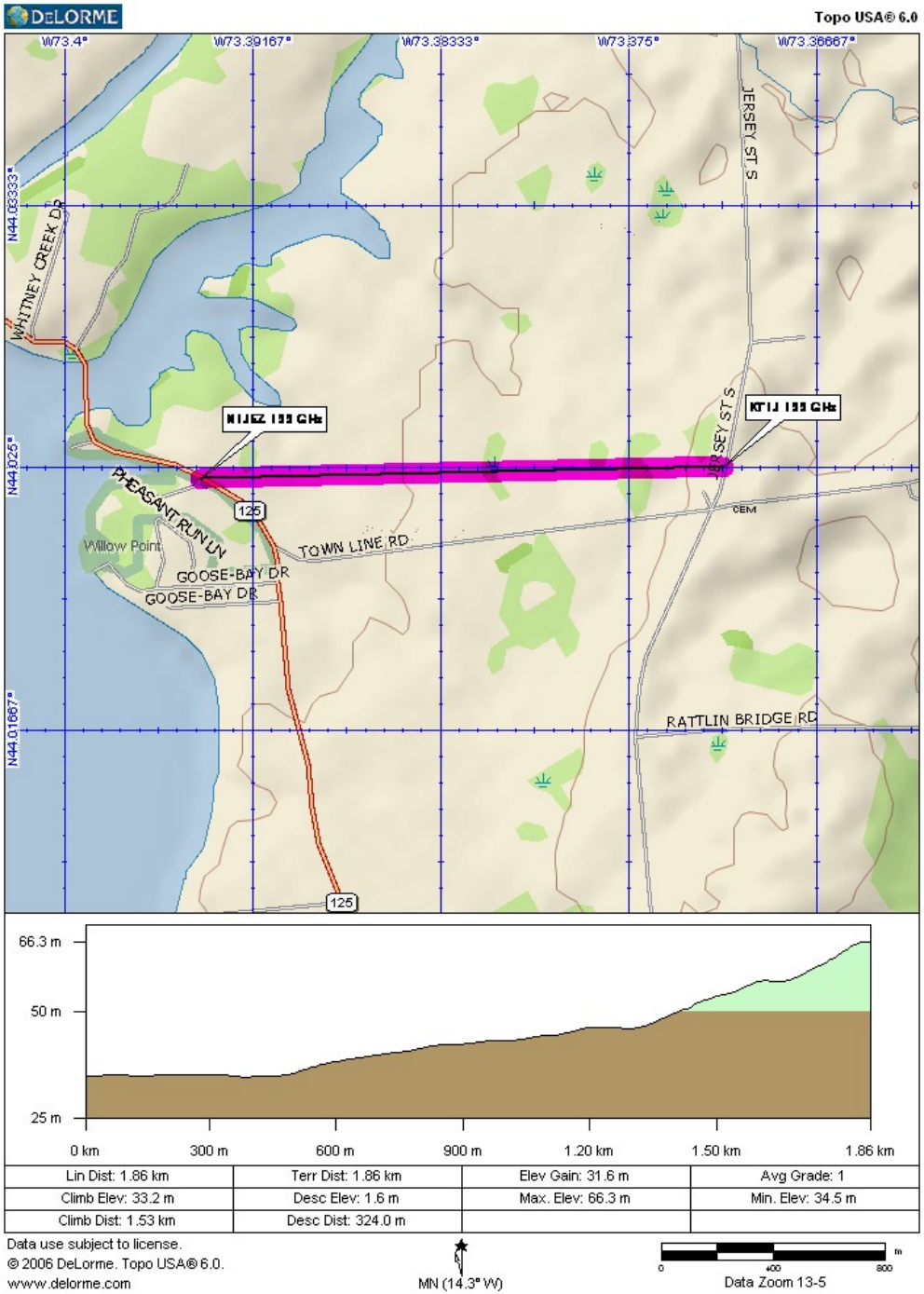
**This drives a 38.85 to 39.48 GHz amp to +10 dBm out feeding a WR-8 HB horn.**

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


10/11/2011 - WAB

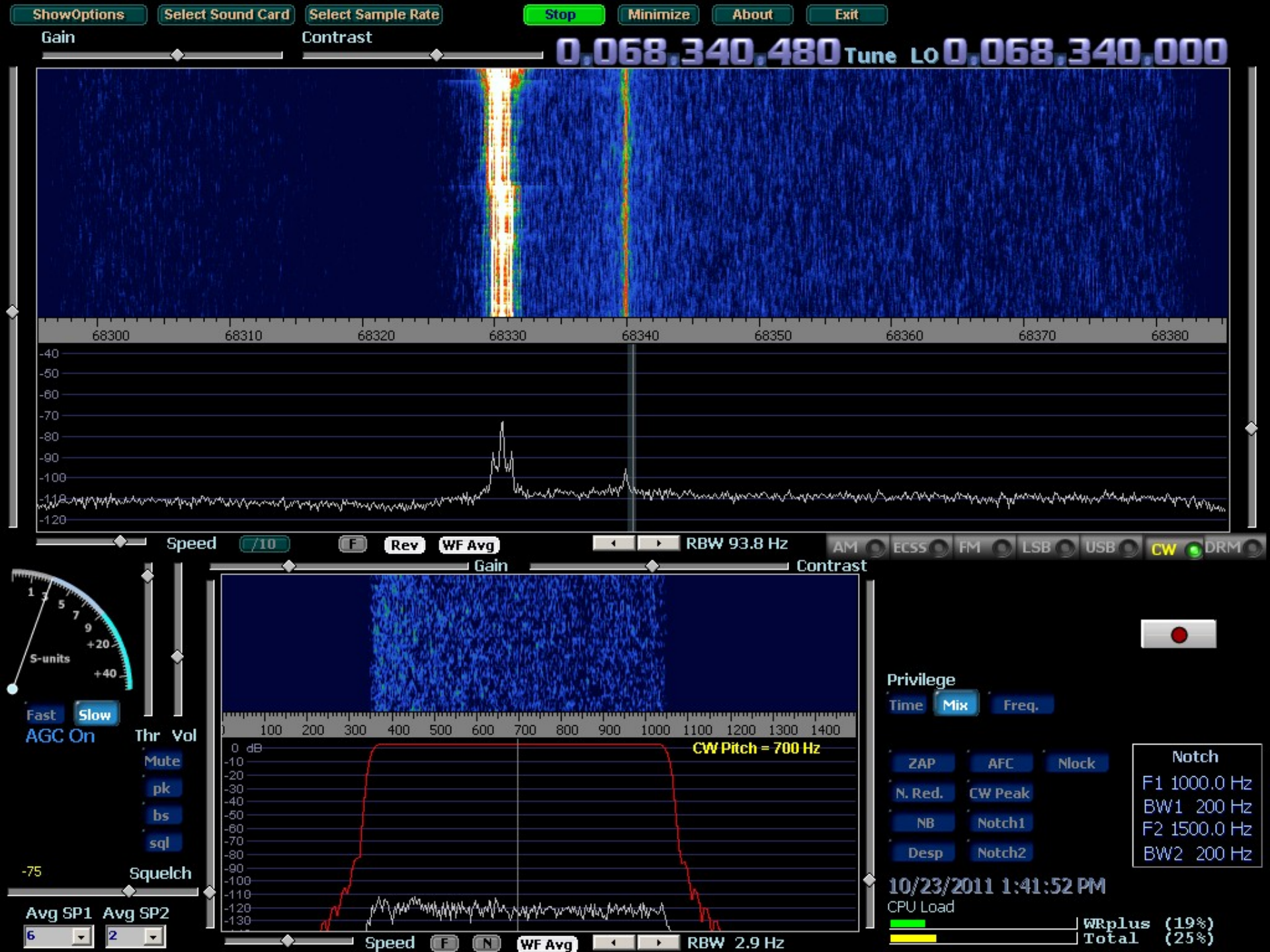

Henry


ShowOptions
Select Sound Card
Select Sample Rate
Stop
Minimize
About
Exit
Gain
Contrast
0.068.349.750 Tune LO 0.068.340.000
68300
68310
68320
68330
68340
68350
68360
68370
68380
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-58.3 dB
68,349.750 kHz
Speed
/10
F
Rev
WF Avg
RBW 93.8 Hz
AM
ECSS
FM
LSB
USB
CW
DRM
Gain
Contrast
1
3
5
7
9
+20
+40
S-units
Fast
Slow
AGC On
Thr
Vol
Mute
pk
bs
sql
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
0 dB
CW Pitch = 700 Hz
-75
Squelch
Avg SP1
Avg SP2
6
2
Speed
F
N
WF Avg
RBW 2.9 Hz
Privilege
Time
Mix
Freq.
ZAP
AFC
Nlock
N. Red.
CW Peak
NB
Notch1
Desp
Notch2
Notch
F1 1000.0 Hz
BW1 200 Hz
F2 1500.0 Hz
BW2 200 Hz
10/9/2011 1:02:46 PM
CPU Load
WRplus (13%)
Total (18%)


DeLORME
Topo USA® 6.0
W73.4°
W73.39167°
W73.38333°
W73.375°
W73.36667°
N44.03333°
N44.025°
N44.01667°
WHITNEY CREEK DR
JERSEY ST S
PHEASANT RUN LN
125
Willow Point
TOWN LINE RD
GOOSE-BAY DR
GOOSE-BAY DR
CEM
RATTLIN BRIDGE RD
66.3 m
50 m
25 m
0 km
300 m
600 m
900 m
1.20 km
1.50 km
1.86 km
Lin Dist: 1.86 km
Terr Dist: 1.86 km
Elev Gain: 31.6 m
Avg Grade: 1
Climb Elev: 33.2 m
Desc Elev: 1.6 m
Max. Elev: 66.3 m
Min. Elev: 34.5 m
Climb Dist: 1.53 km
Desc Dist: 324.0 m
Data use subject to license.
© 2006 DeLorme. Topo USA® 6.0.
www.delorme.com
MN (14.3° W)
0
400
800
m
Data Zoom 13-5


Henry




ShowOptions
Select Sound Card
Select Sample Rate
Stop
Minimize
About
Exit
Gain
Contrast
0.068.340.480 Tune LO 0.068.340.000
68300
68310
68320
68330
68340
68350
68360
68370
68380
-40
-50
-60
-70
-80
-90
-100
-110
-120
Speed
/10
F
Rev
WF Avg
RBW 93.8 Hz
AM
ECSS
FM
LSB
USB
CW
DRM
Gain
Contrast
1
3
5
7
9
+20
+40
S-units
Fast
Slow
AGC On
Thr
Vol
Mute
pk
bs
sql
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
0 dB
CW Pitch = 700 Hz
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-75
Squelch
Avg SP1
Avg SP2
6
2
Speed
F
N
WF Avg
RBW 2.9 Hz
Privilege
Time
Mix
Freq.
ZAP
AFC
Nlock
N. Red.
CW Peak
NB
Notch1
Desp
Notch2
Notch
F1 1000.0 Hz
BW1 200 Hz
F2 1500.0 Hz
BW2 200 Hz
10/23/2011 1:41:52 PM
CPU Load
WRplus (19%)
Total (25%)

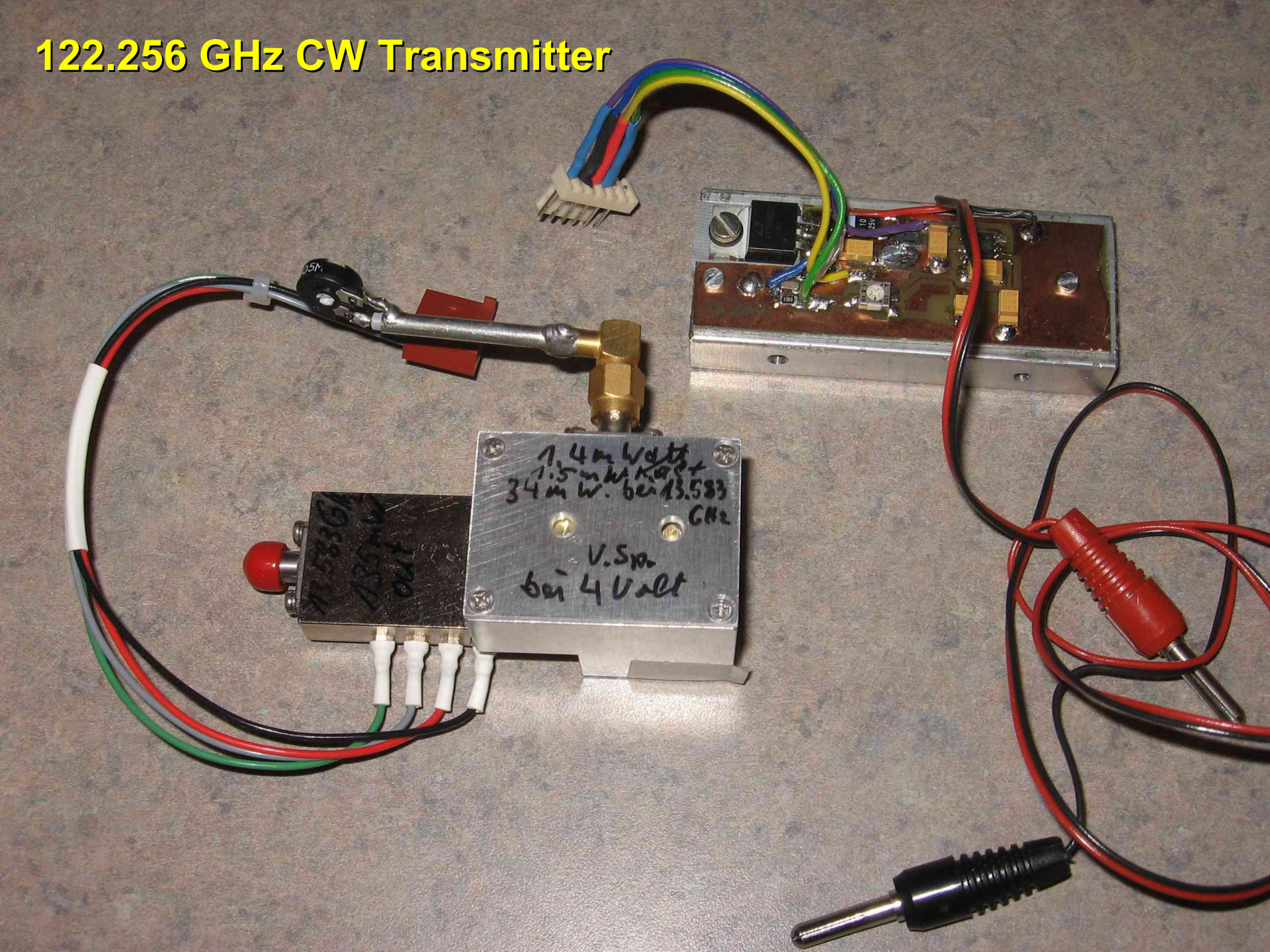
# What's Next?

# CW Transmitter

# New LO's

# VE2UG on 122 GHz

# 122.256 GHz CW Transmitter

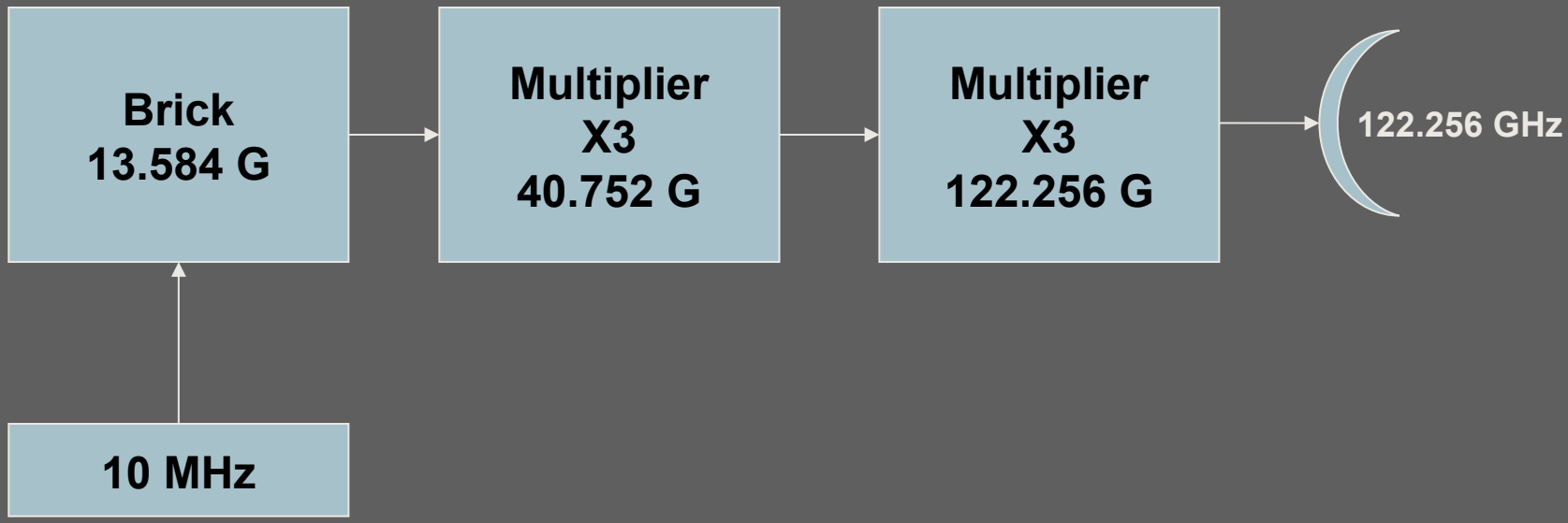


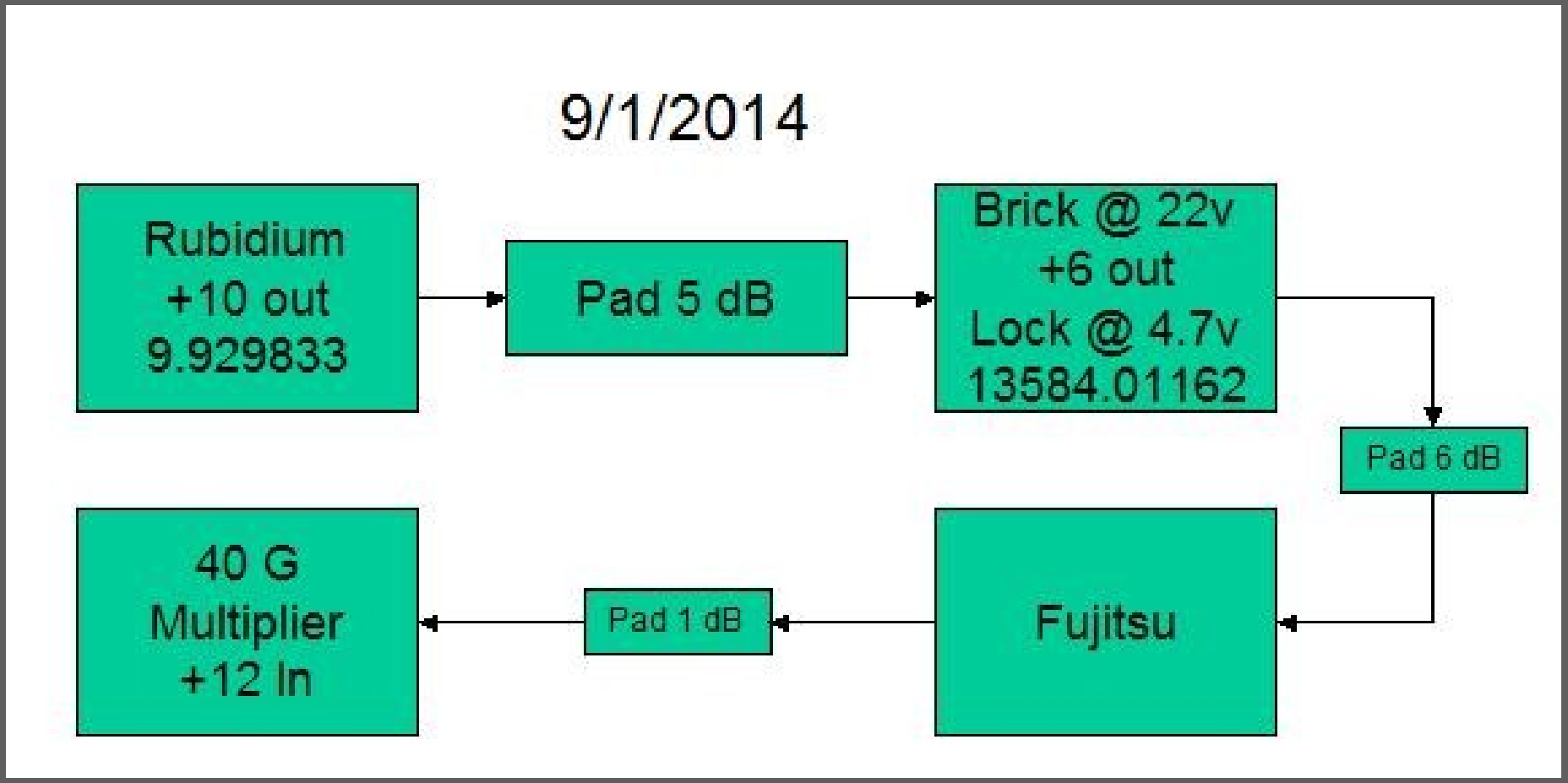
**F = 122.256 GHz**

**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



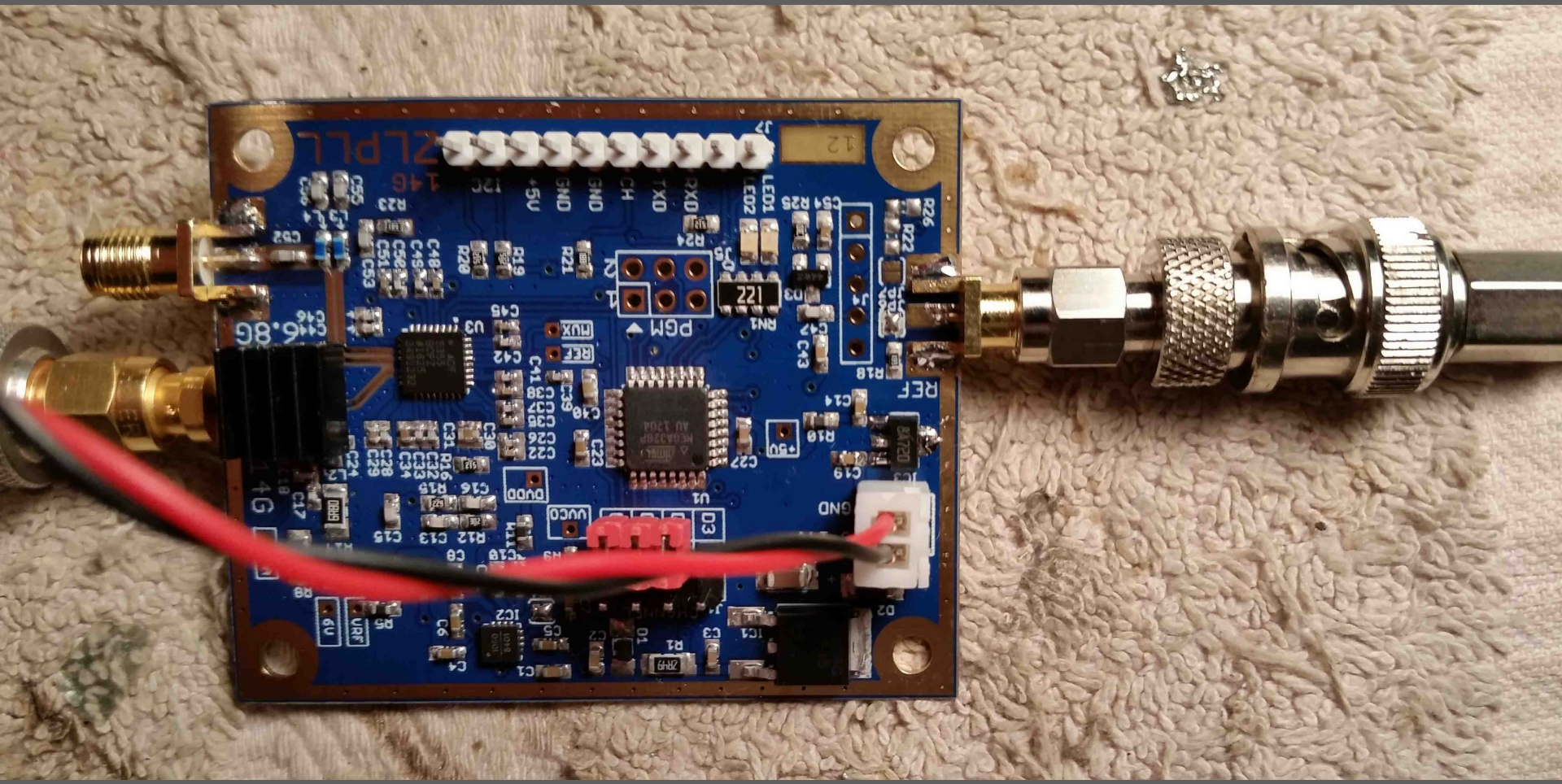

9/1/2014
Rubidium
+10 out
9.929833
Pad 5 dB
Brick @ 22v
+6 out
Lock @ 4.7v
13584.01162
Pad 6 dB
40 G
Multiplier
+12 In
Pad 1 dB
Fujitsu


Is There a Better Way?
FREQUENCY ELECTRONICS, INC.
55 CHARLES LINDBERGH BLVD.
MITCHEL FIELD, NY 11553
IRIDIUM FREQUENCY STANDARD

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



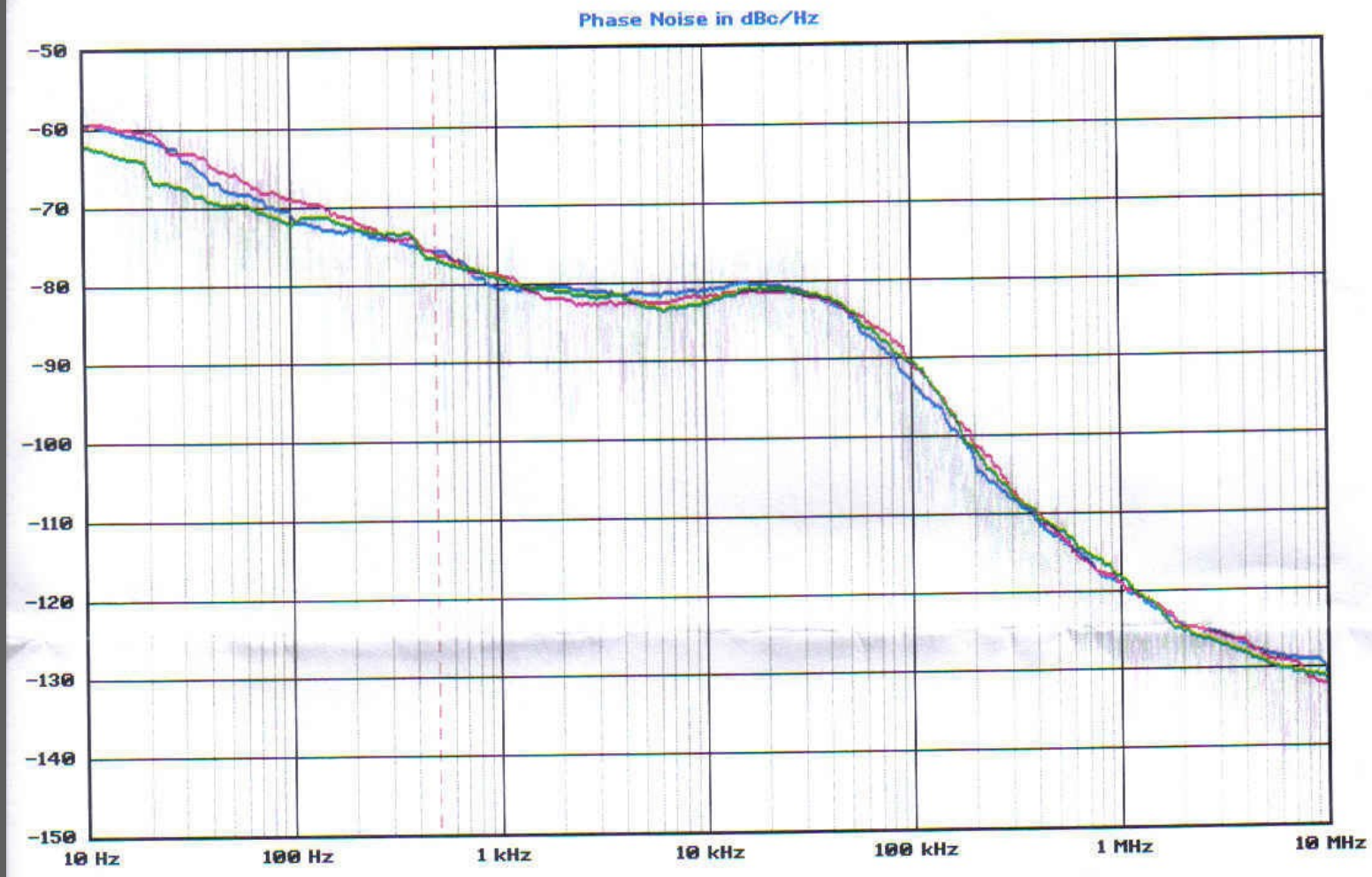
# ZL-PLL-14G - 54MHz to 13.6 GHz
# $186 delivered (with optional programming cable)



# $170


USB
DCIN:9-12V
OLED
FB=07,000,000KHz
FA=03,500,000KHz
频率显示
OK
USB
前显示面板
按键操作

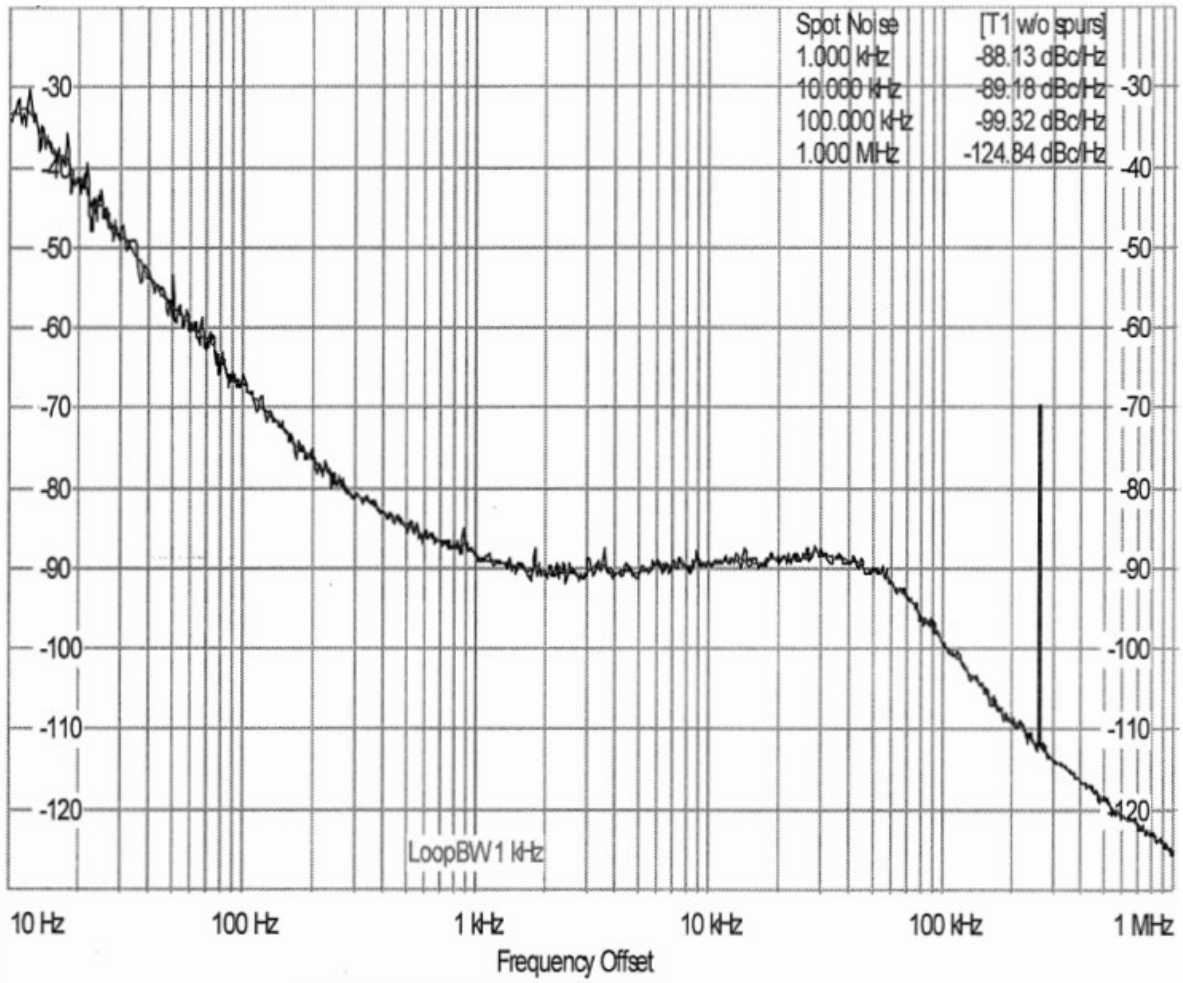
# ADF5355

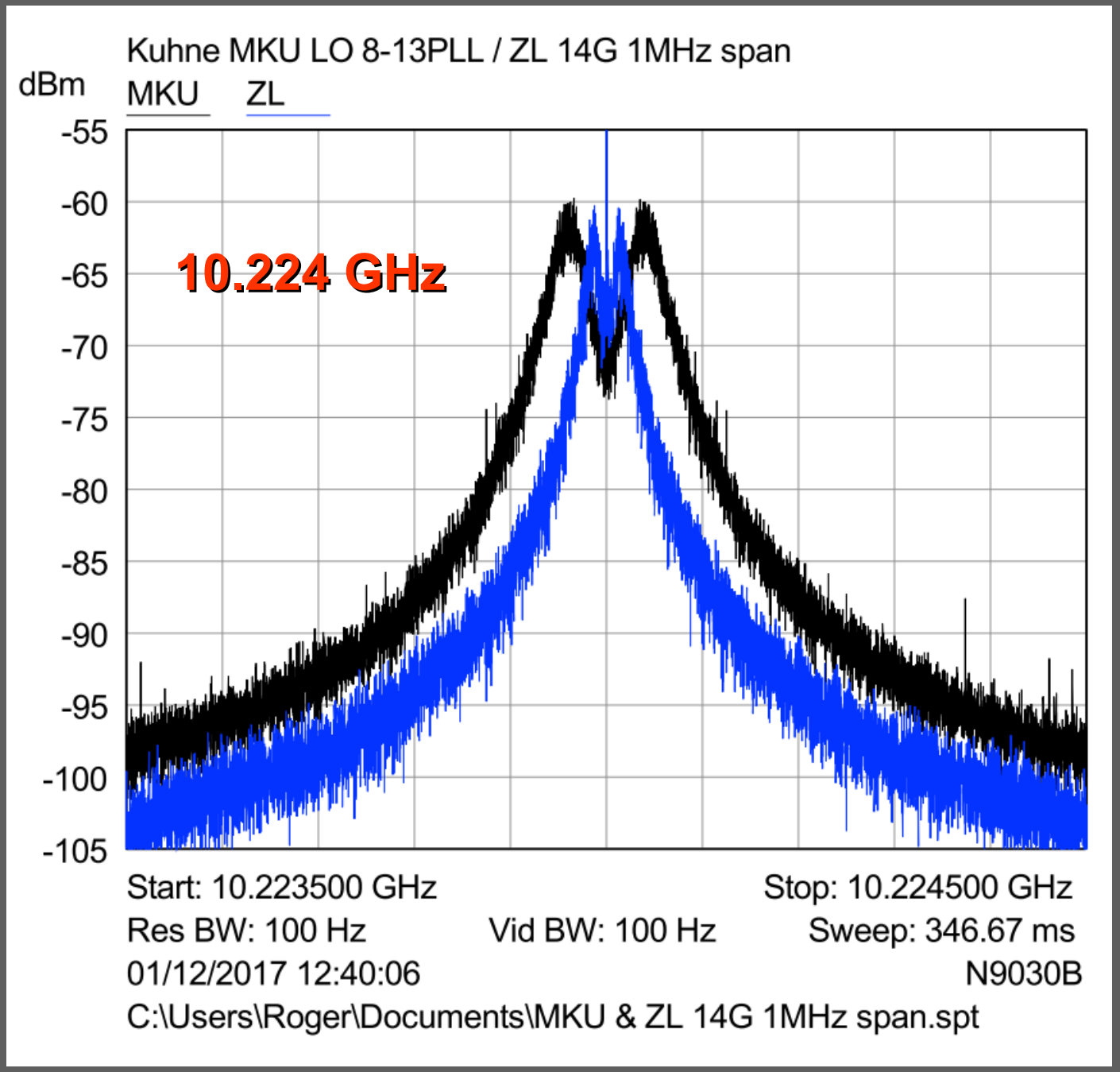


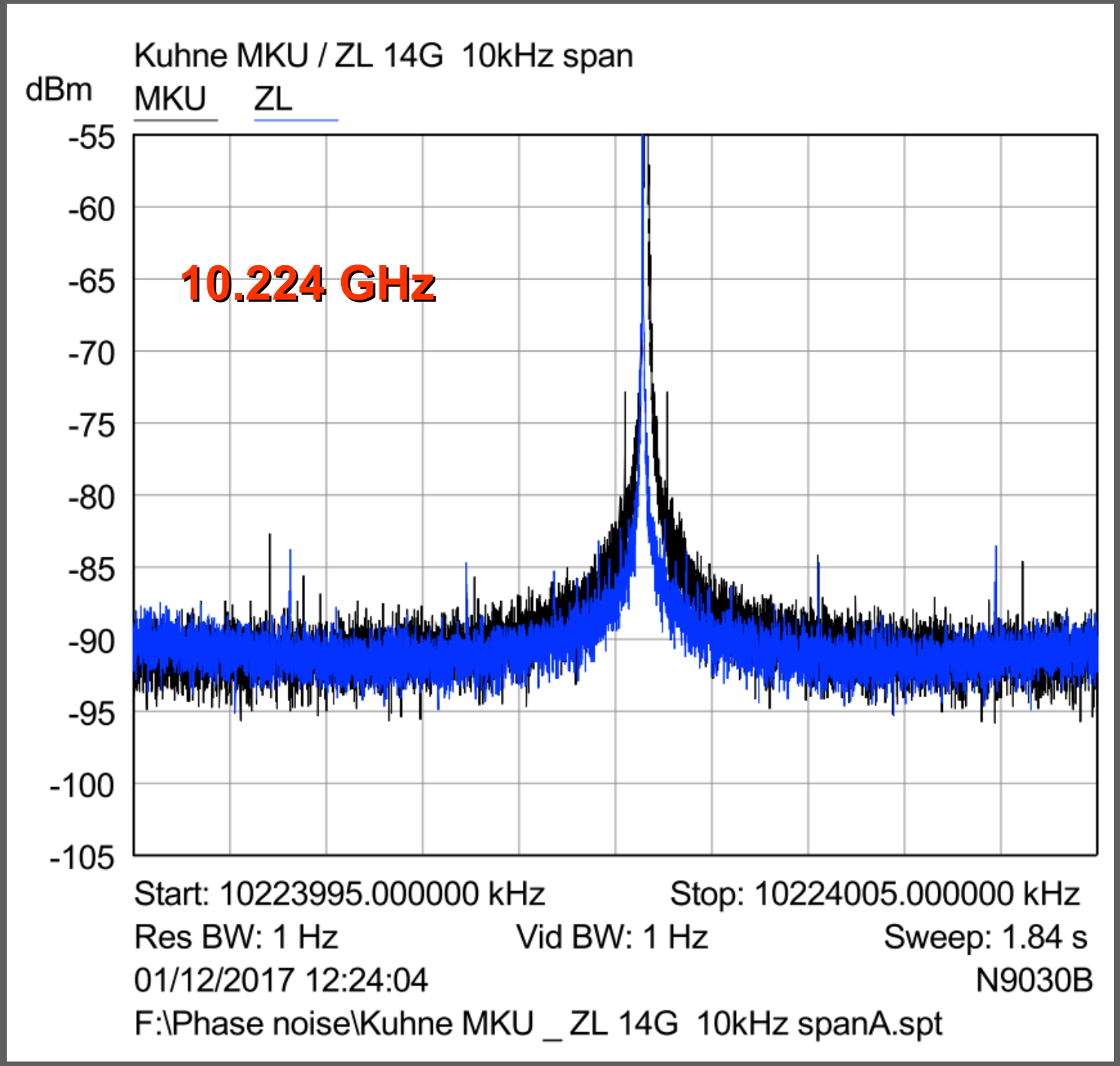

| Trace | Carrier Hz | Carrier dBm | dBc/Hz at 500 Hz | RF Atten dB | Instrument |
|---|---|---|---|---|---|
| ZLPLL A013 CP=2 Bleed=20 | 13 365 000 000 | 6.00 | -75.7 | 10 | HP8563E,005,007,008,8ZE |
| ZLPLL A014 CP=2 Bleed=20 | 13 365 001 070 | 6.17 | -76.3 | 10 | HP8563E,005,007,008,8ZE |
| ZLPLL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

Phasenrauschen @ 12024 MHz / Phasenoise @ 12024 MHz

# ADF4355




Kuhne MKU LO 8-13PLL / ZL 14G 1MHz span
dBm
MKU
ZL
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
10.224 GHz
Start: 10.223500 GHz
Stop: 10.224500 GHz
Res BW: 100 Hz
Vid BW: 100 Hz
Sweep: 346.67 ms
01/12/2017 12:40:06
N9030B
C:\Users\Roger\Documents\MKU & ZL 14G 1MHz span.spt


Kuhne MKU / ZL 14G 10kHz span
dBm
MKU
ZL
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
10.224 GHz
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)
Doubler Max:  50 MHz
Config:       cp=2, bleed=20
Config:       mtld=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?***