

Practical applications of the Lime SDR Mini

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Lewisville 2019

Topics to be covered:-

Wideband SDR Transceivers

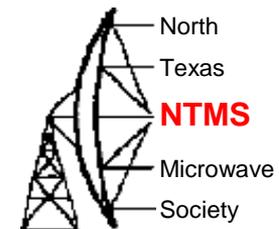
Microwave Narrowband

Eheilsat Narrowband

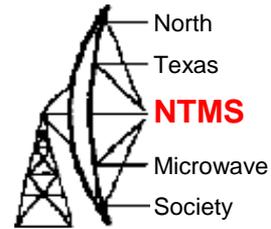
Portsdown

Eheilsat Wideband

Microwave DATV



Wideband SDR Transceivers



Past experience with SDR radios

1. Softrock
2. OPEN HPSSDR Mercury/Penelope/Atlas Bus
3. Anan-10

All above are HF radios

Requirements:-

1. Transmit capable
2. Coverage of microwave bands
3. Software available

Shortlist:-

LimeSDR USB
LimeSDR Mini
Adalm Pluto
HackRF

Adalm Pluto



325 to 3800 MHz

61.44 MSPS

20 MHz bandwidth

0.5mW out on a good Day!

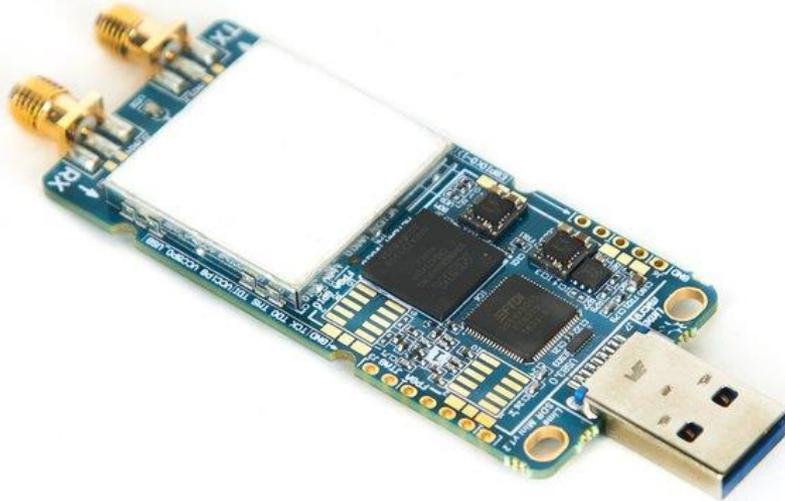
USB2 connection

HackRF



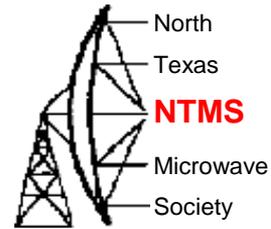
1MHz to 6 GHz
20 MSPS
20 MHz bandwidth
1mW out
8 bit
USB connection
\$300

LimeSDR Mini



10 to 3500 MHz
61.44 MSPS
30.7 MHz bandwidth
1mW output
12 Bit
2 antenna ports
USB3 connection
\$160

LimeSDR



100k to 3500 MHz

61.44 MSPS

61.44 MHz bandwidth

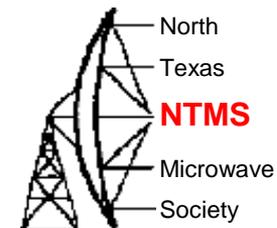
~1mW output

12 Bit

8 antenna ports

USB3 connection

\$300



BEWARE!

When changing frequencies/power levels the SDR does a calibration routine. This can result in large spurious signals in and out of band!

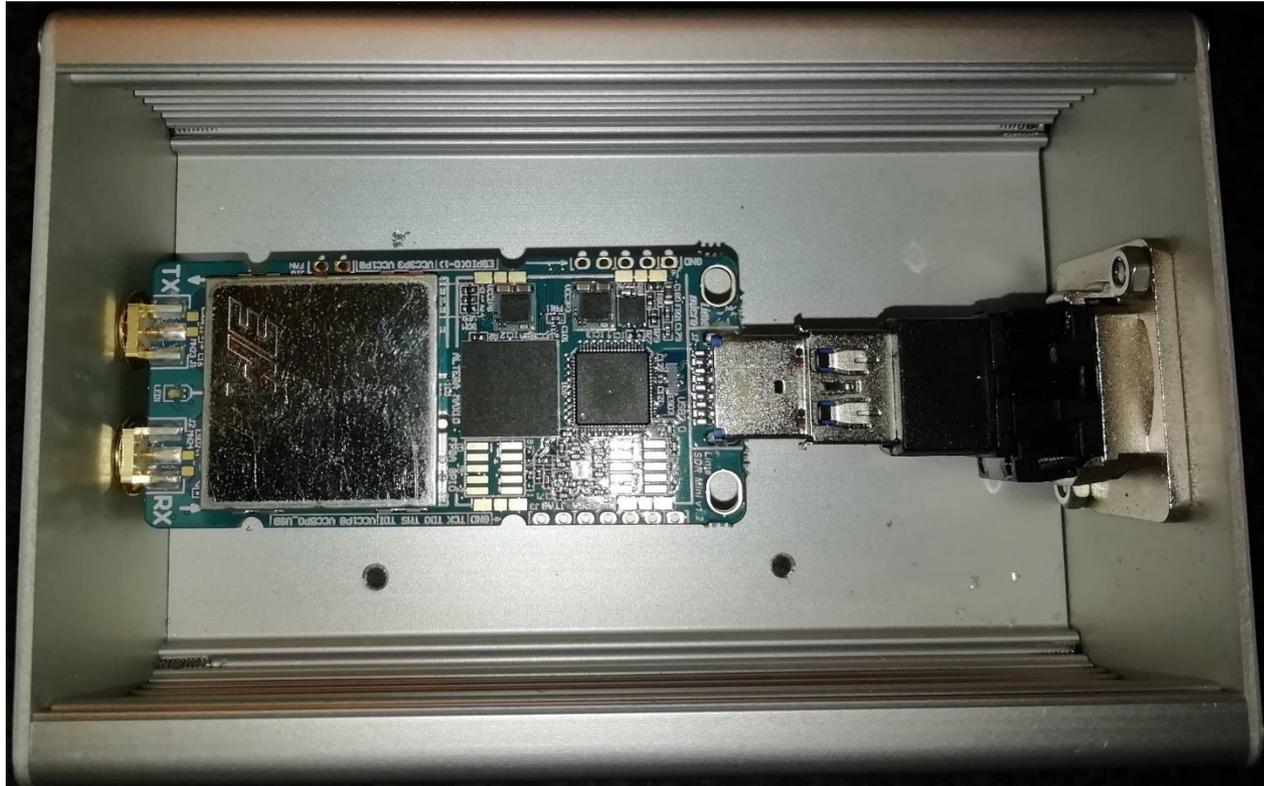
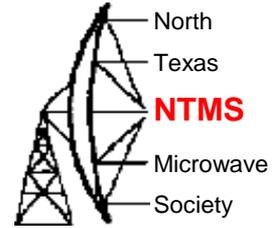
Example: Transmit carrier on 1296MHz

Adalm pluto generated a 10dbm signal randomly within its operating range

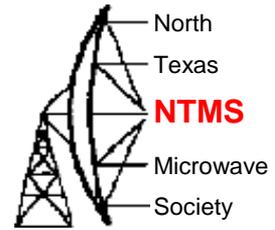
Lime SDR mini generated a 10dbm signal around 1296MHz before settling on desired power

Switch antennas and amplifiers appropriately!

I chose the LimeSDR Mini

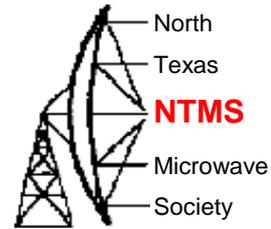


USB Connector Very Fragile. Needs to be boxed



Microwave Narrowband

Microwave Narrowband Considerations



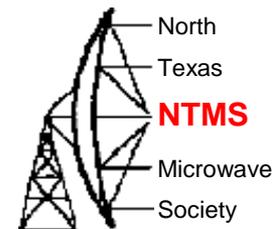
Can be used as a Beginners Transceiver covering 902, 1296, 2304 and 3456 MHz bands

Need to add Preamps / Filters / Amplifiers along with associated RF Switching

Use SDR console by G4ELI or SDR Angel by F4EXB Software

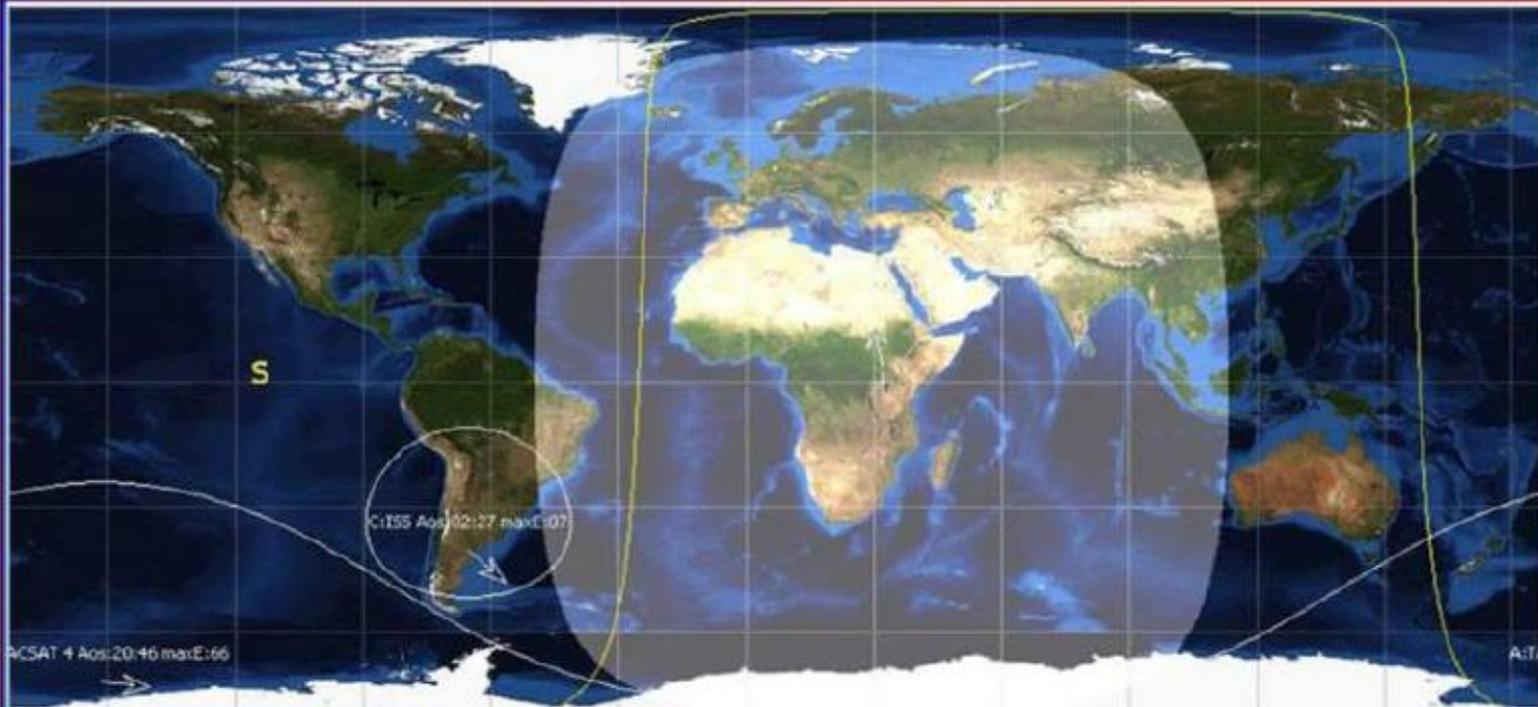
Phase noise and strong signal handling can be an issue in high activity areas

My barefoot pair of Limisdr mini have worked 33km on 13cm!



Es'HailSat-2

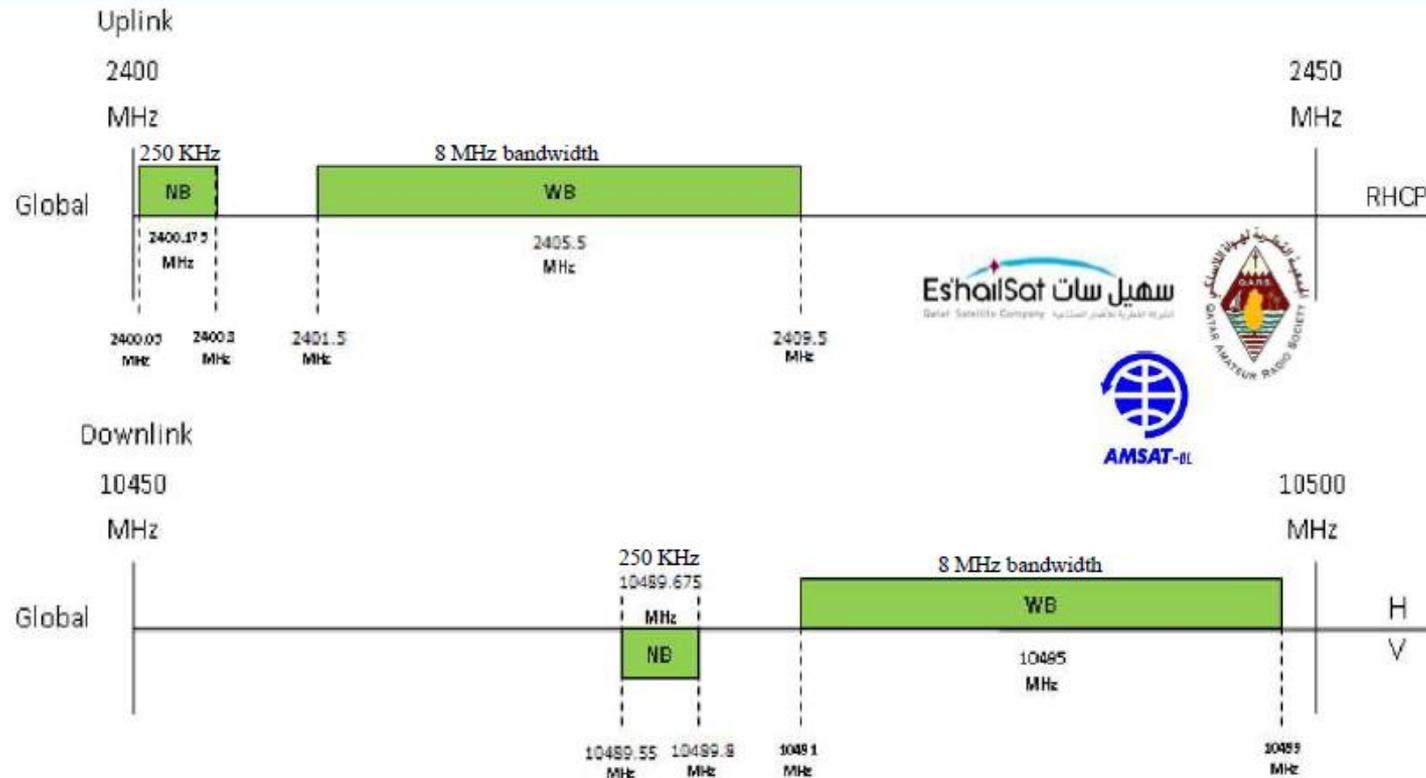
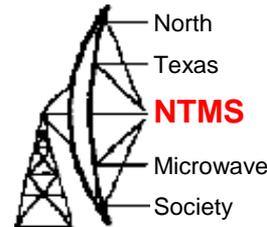
Earth Coverage Es'HailSat-2



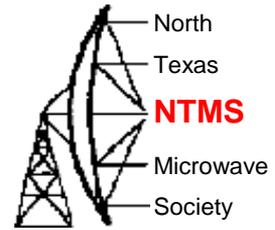
| Azimat | Elevation | HA | Hohe | Entf. | L SSP | B | Orbit | Squint | Azs | Low | MaxE | A | B | C |
|--------|-----------|-------|-------|-------|-------|---|-------|--------|-------|-------|-------|---|---|---|
| 149,0 | 26,9 | 112,4 | 35788 | 38892 | 32 | 0 | 21 | -- | ----- | ----- | ----- | | | |

Beob.: 6,7 / 51,2 Konfg. 1 Grp. Es'HailSat Keys: obs1.txt 16.09.2013 Doppl.Korr.: Up/Down

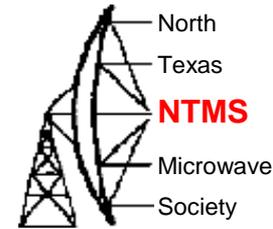
Es'HailSat-2 Transponder Frequency Plan



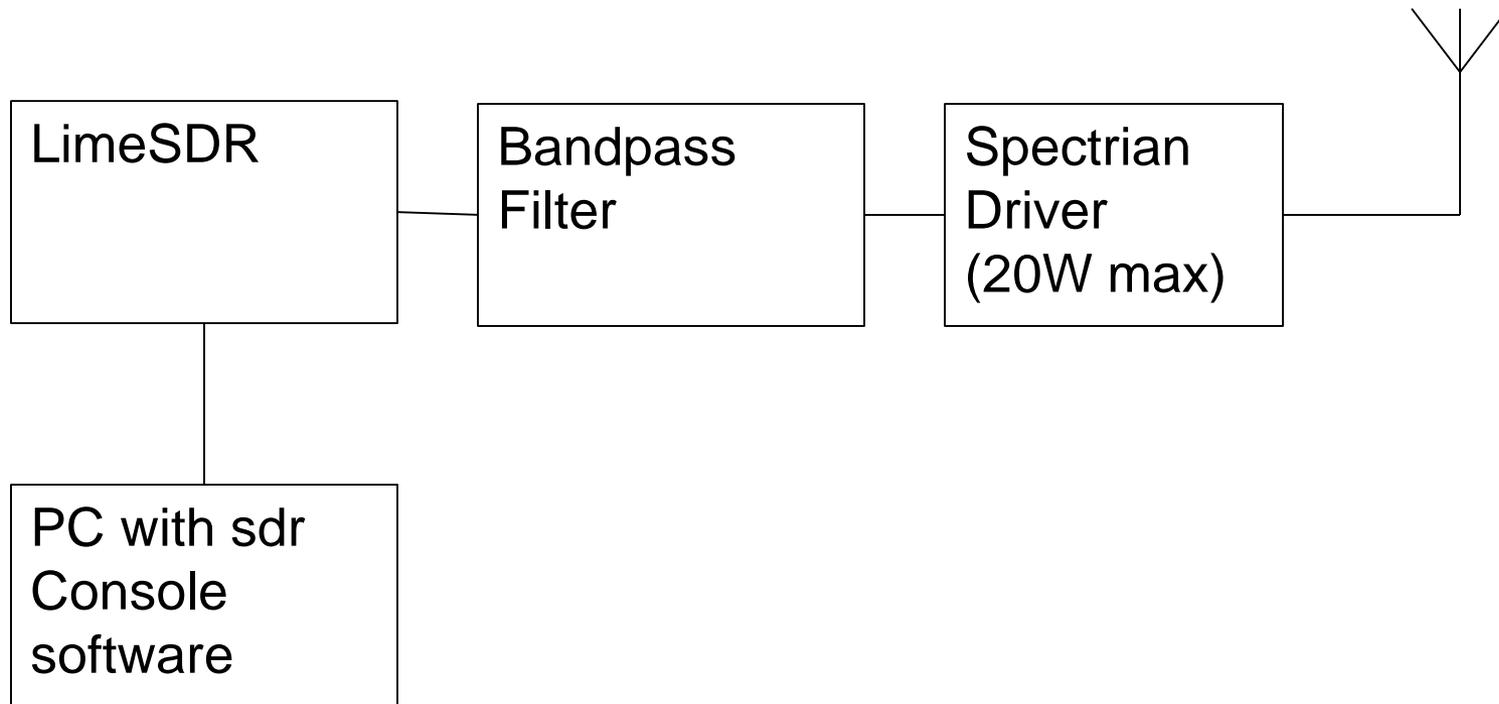
| Xpdr | U/L FREQUENCY (MHz) | | | | D/L FREQUENCY (MHz) | | | | LO (MHz) | BW (MHz) | |
|------|---------------------|------|---------|----------|---------------------|-----|----------|-----------|----------|----------|------|
| | No | Pol | Begin | Center | End | Pol | Begin | Center | | | End |
| NB | | RHCP | 2400.05 | 2400.175 | 2400.3 | V | 10489.55 | 10489.675 | 10489.8 | 8089.5 | 0.25 |
| WB | | RHCP | 2401.5 | 2405.5 | 2409.5 | H | 10491 | 10495 | 10499 | 8089.5 | 8 |



Es'HailSat-2 Narrowband



Es'HailSat-2 Narrowband Transmit

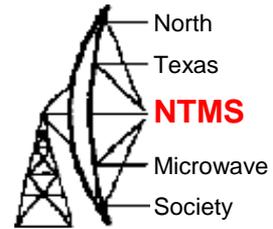


Uplink feed



Needed on 4w with antenna pointing out of window!

BATC Narrowband WebSDR



View: waterfall blind Allow keyboard: Waterfall: HTML5 Sound: HTML5 Narrowband listeners: 76

10489550 10489600 10489650 10489700 10489750 10489800

Low CW -> NB Digi -> Digi -> Mixed -> SSB -> Gu Upper Beacon

10489690.00 kHz labels

Filter: 2.70 kHz - +

squelch autonotch

Waterfall zoom

- +

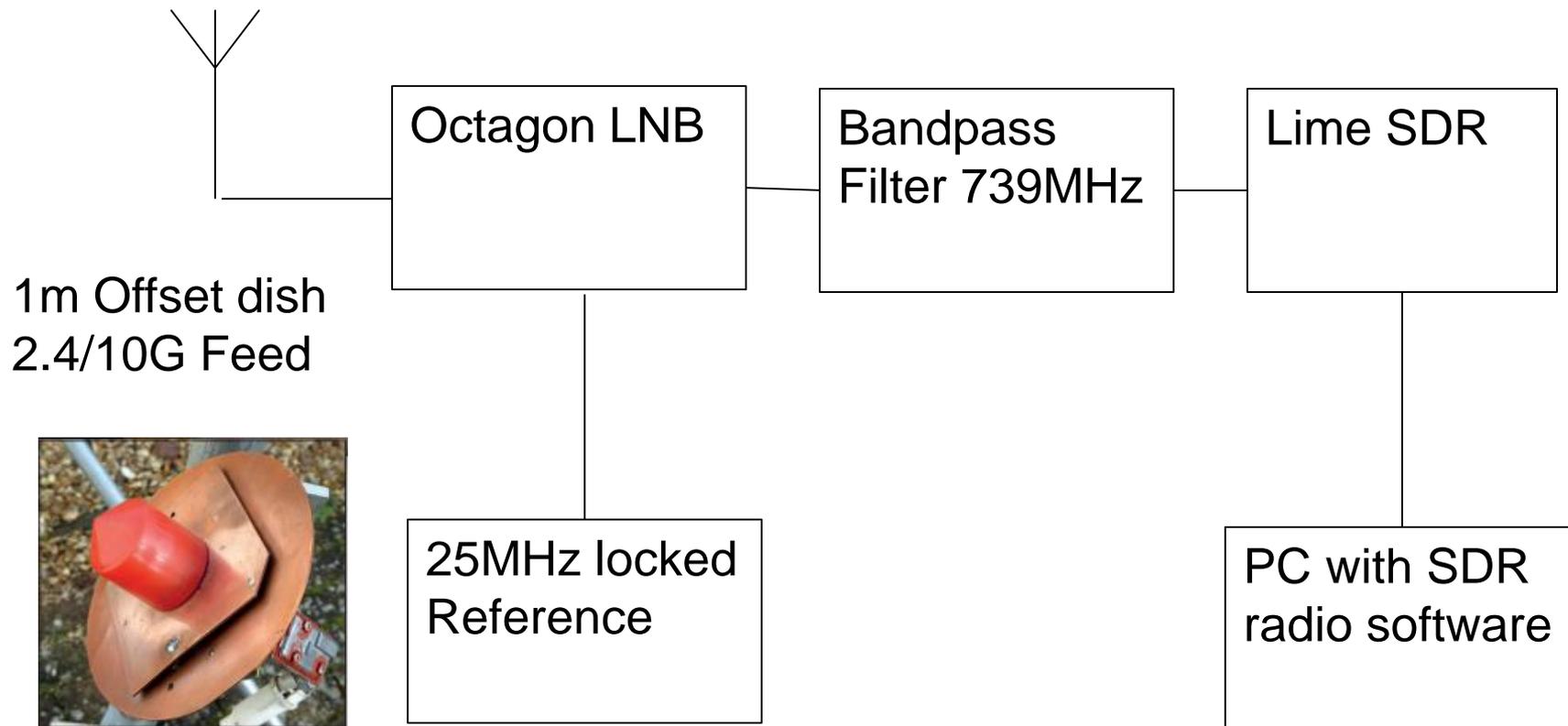
<< >>

\$1 \$3 \$5 \$7 \$9 +2.0dB +4.0dB +6.0dB

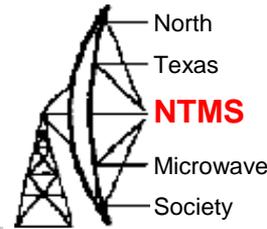
-88.2 dB; peak -88.1 dB;

<https://eshail.batc.org.uk/nb/>

Downlink Receive



SDR Console Software



PlutoSDR :: SDR Console v3.0.7

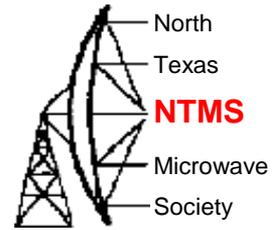
Home View Receive Transmit Rec/Playback Favourites Memories Tools Help

Select Radio Start Stop Bandwidth Calibration Frequency Previous History Screenshot Auto-mute: [Enable] [Options] Noise Blanker: [Enable] [Options]

Receive
RX 1 19749.9 MHz 100 - 2900 Hz
10.489.554.550
Default
F Display Mode
SAM CW-U
BPM NFM WFM
LSB USB Wide-U
Filter
2.2kHz 2.4kHz
2.6kHz 2.8kHz 3.0kHz
3.2kHz 3.4kHz 3.6kHz
Radio
Help Options
RIT +00.000
XIT +00.000
Filter: Analog: 80% Digital: 80%
RX Gain: Manual 50dB Visual: -10dB

Transmit
TX 100 - 3100 Hz
2.401.700.400
Sync RX RX TX TX RX
Sync RX LSB USB AM FM CW
TX Tone Tune
13cms Proc
Drive 64
Meter
PWR 0 2 W
SWR 1 2.5 2 3 4
DRV 0 25 50 75 100 mV
VDD 32 34 36 38 V
ALC 0 25 50 75 100 125
Microphone: Gain 98, Proc 90
Normal DX Other
Microphone (EasyCall Speakerphone ...)
Proc VOX 3.0kHz Record
Gain 98
Proc 90
VOX Gain 50

Geostationary Satellite Beacon
10489.760 10489.770 10489.780 10489.790 10489.800 10489.810 10489.820 10489.830 10489.840
Beacon: 10.489.781.585
PlutoSDR, BW = 900 kHz CPU: 1.7% GPU: 17.2% Audio: 30ms



Portsdown DATV Exciter

DATV Receiver

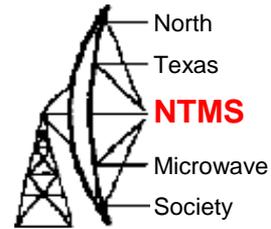
British Amateur Television Club (BATC) trying to promote Digital ATV (DATV)

Receiver design using wideband (146MHz to 2.4GHz) SATTV tuner integrated into Minituner Receiver hardware

Minituone software on PC by F5 takes receiver data via USB and displays DATV picture



Portsdown DATV Exciter



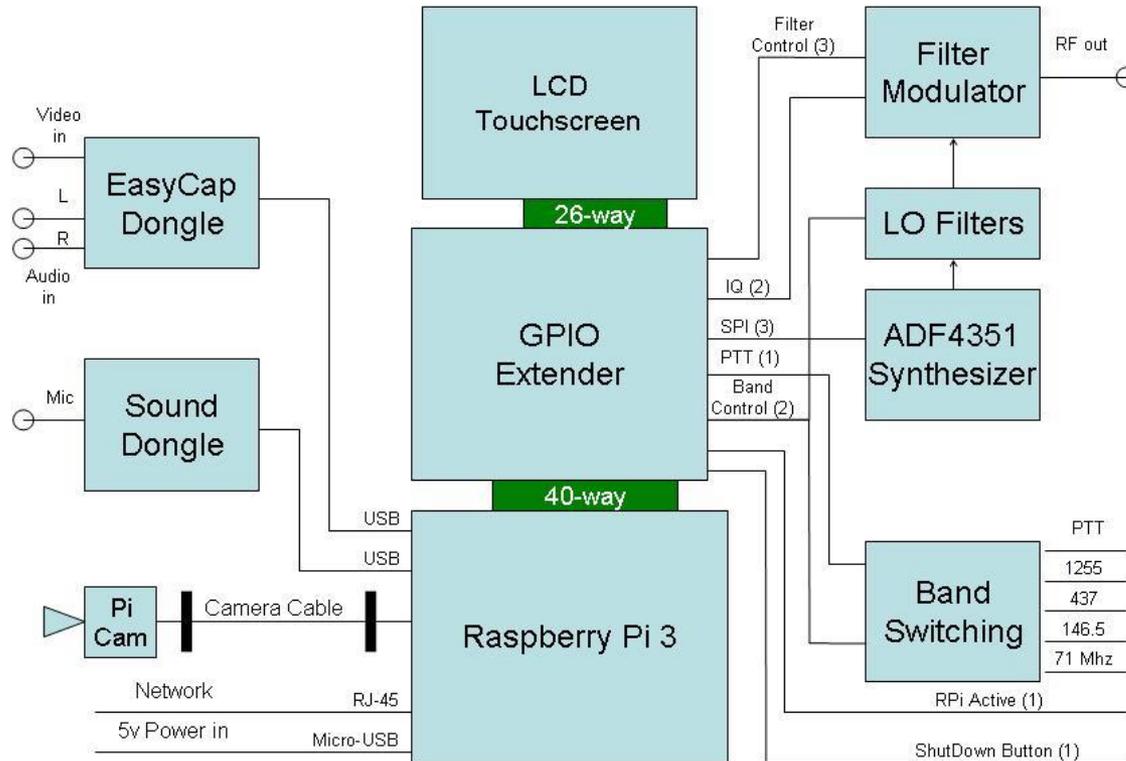
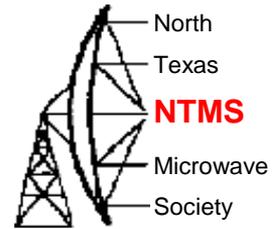
Transmitting not so Easy!

Some Commercial products existed but were considered too expensive for the masses and/or no longer in Production

BATC came up with their own design ("Portsdown") based on a Raspberry Pi 3

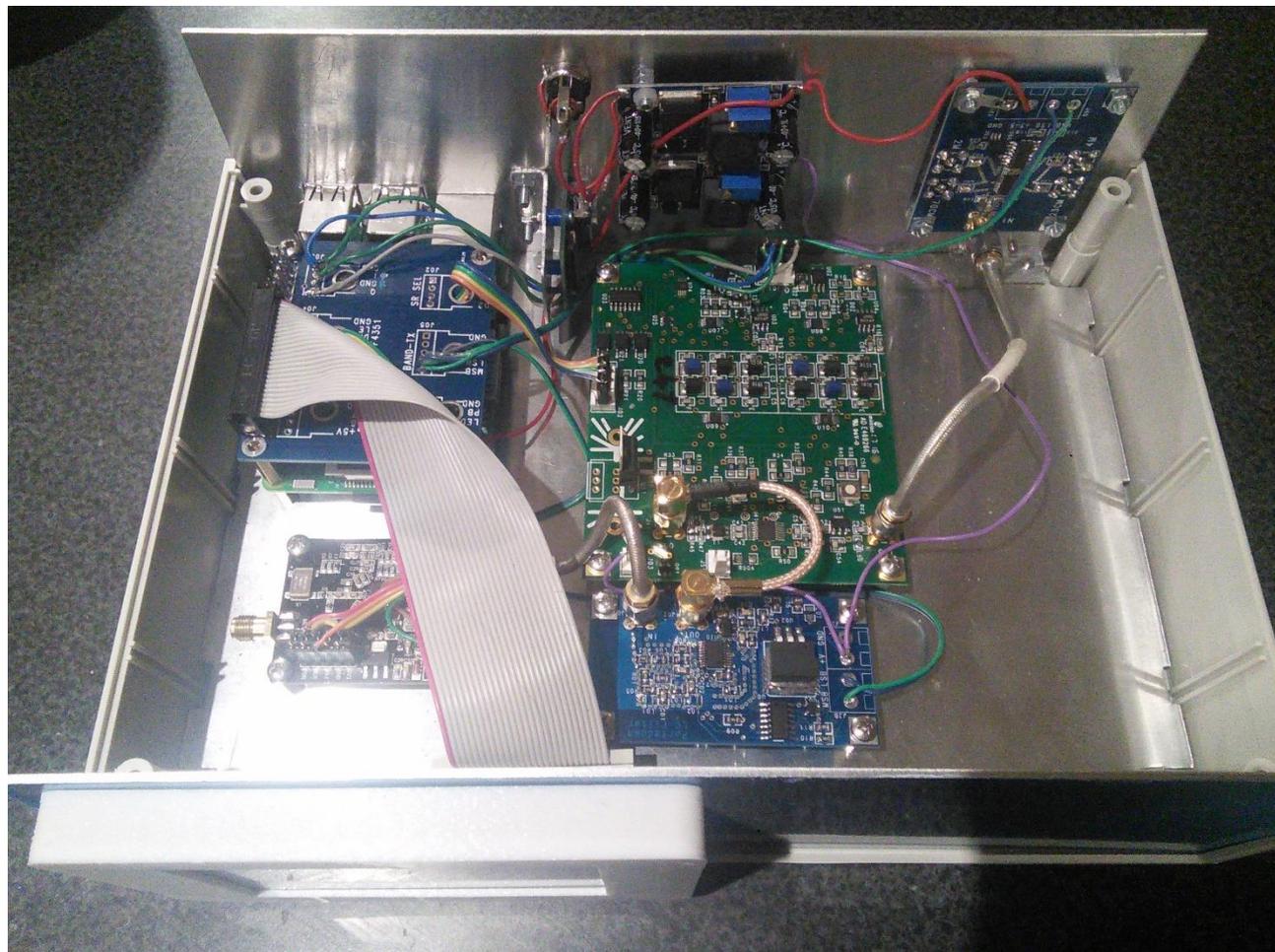
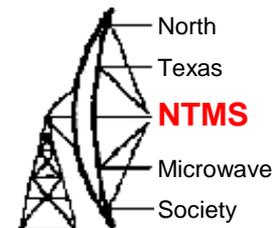
Software by G8GKQ

Original Portsdown 2018

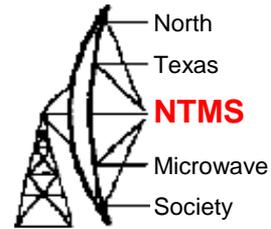


The Portsdown ATV Transmitter

Original Portsdown 2018

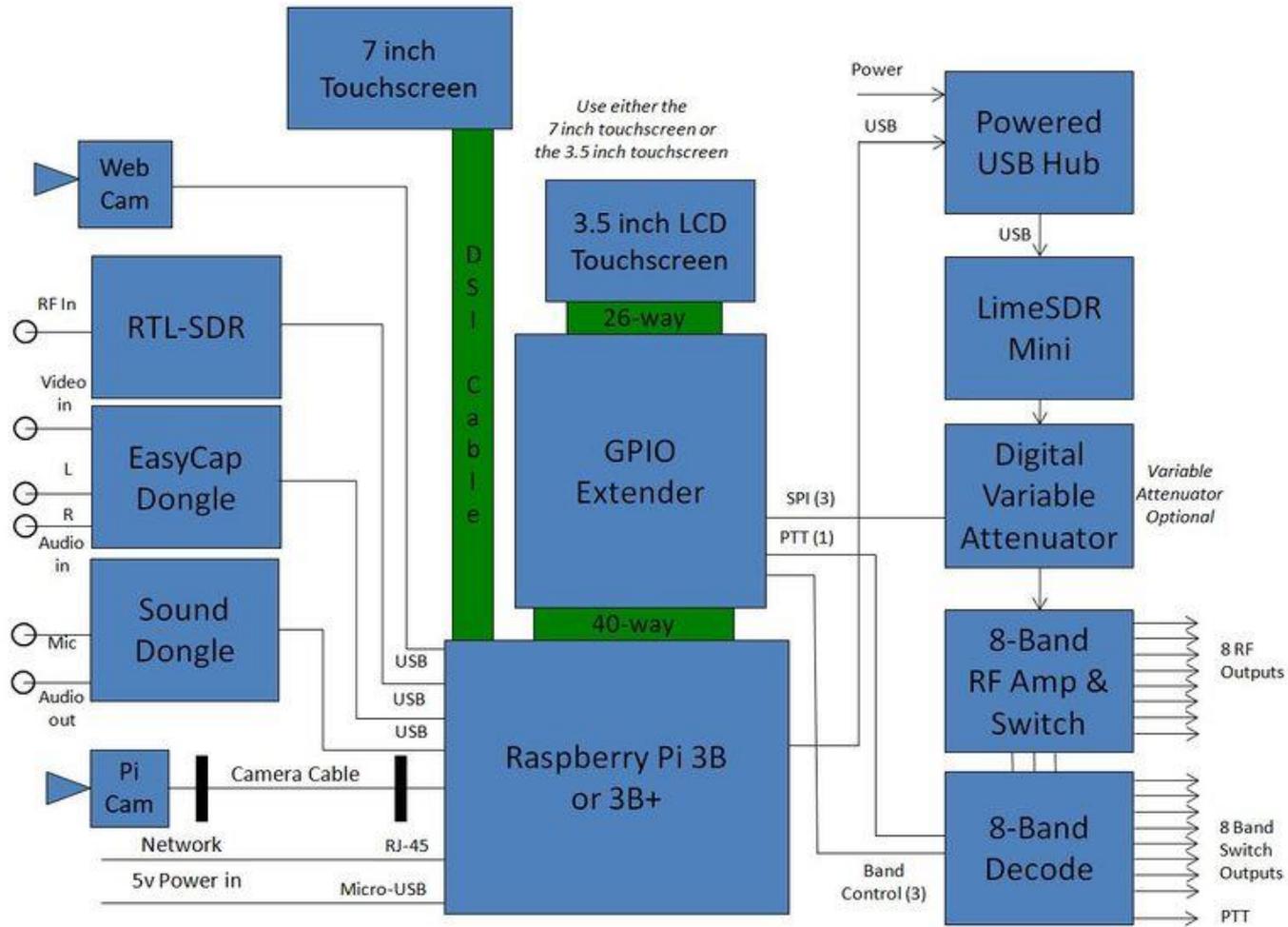
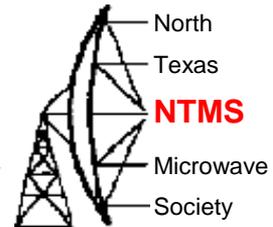


Portsdown Next Generation

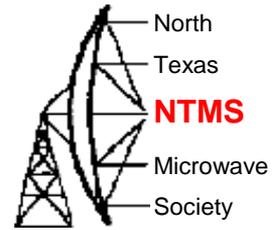


Critical Part of design was the Frequency modulator.
Built and aligned board was made available from BATC
Parts sold to 350+ builders including USA+
Design needed updating especially as insufficient
demand for another batch of 100FM boards
It was decided that next generation would be SDR based
LimeSDR was chosen as software design was easier as
better supported

Portsdown 2019

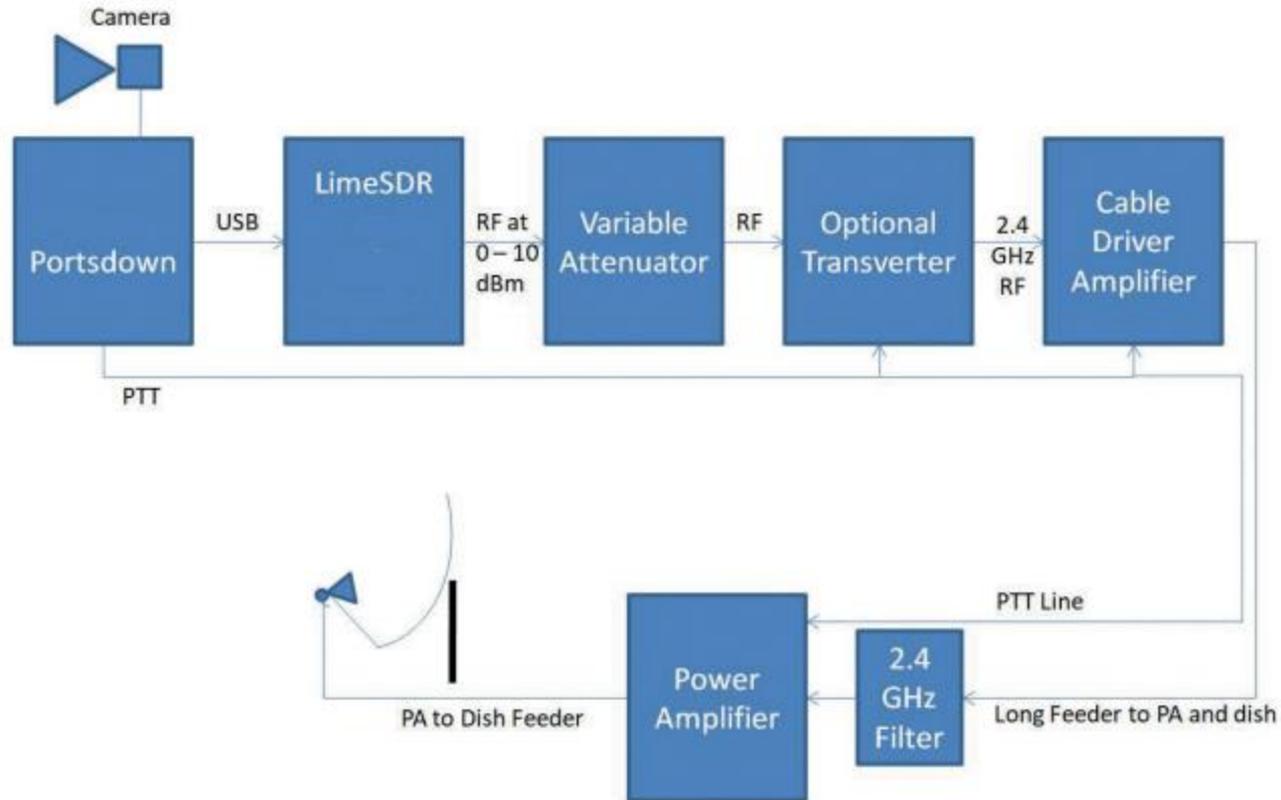


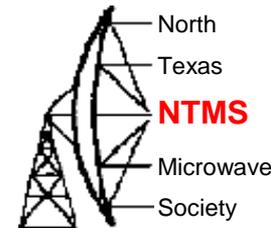
The Portsdown 2019 ATV Transmitter



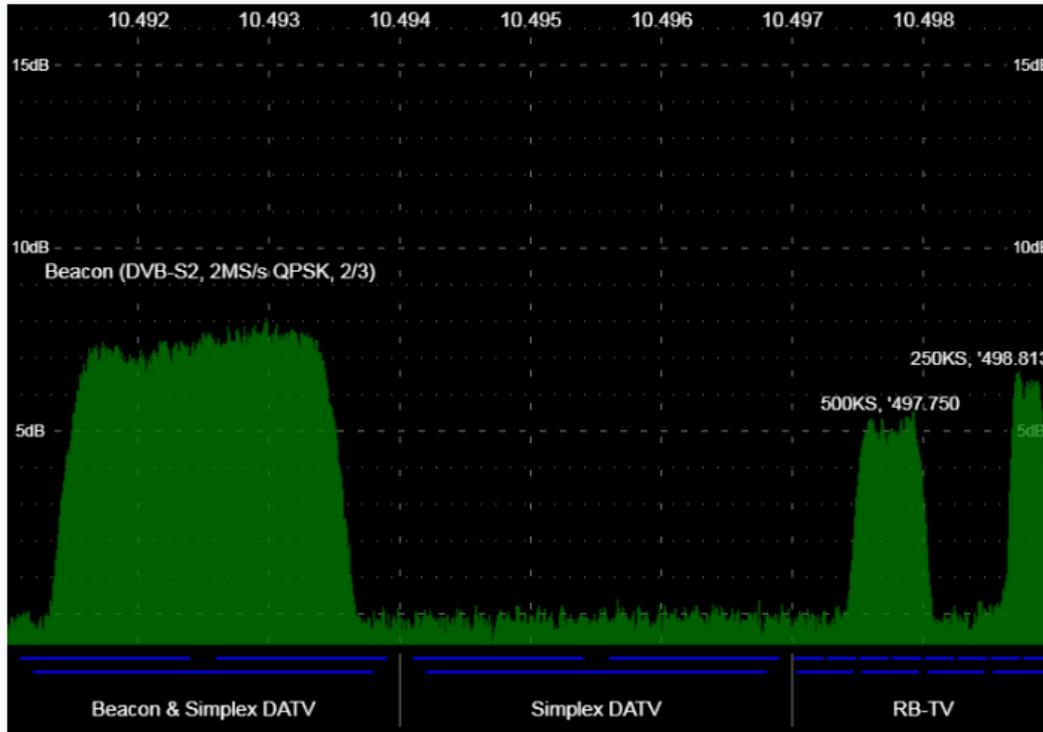
Es'HailSat-2 DATV

DATV Uplink Transmitter





BATC Wideband Spectrum viewer



Wideband viewers: 77

[DATV Bandplan](#)

[Open fullscreen](#)

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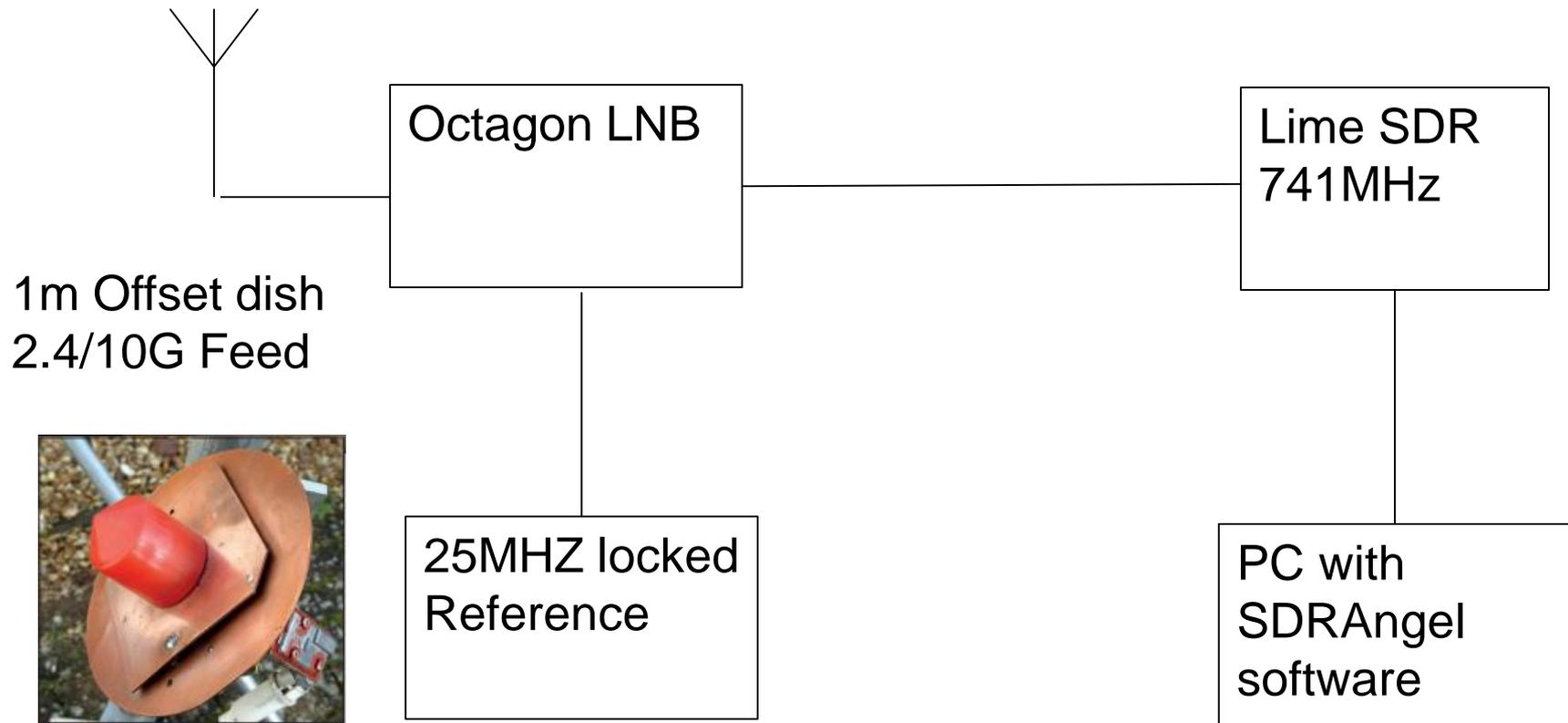
22:44 f5oee_evariste Waht is your GOP size ?
22:45 f5oee_evariste Seems very short..12 frame or something
22:45 PE2JKO_Joop 100
22:46 f5oee_evariste Strange, not sure about 100...seems very short (inpecting timing)
22:46 G7JTT-John Big delay
22:46 G7JTT-John Yes have sound
22:52 f5oee_evariste As I understand, RTMP is the "over the edge" technic ...
22:54 f5oee_evariste You are now workaround my lime encoder bugs ..specially buffering... You are great !
22:57 f5oee_evariste Joop do you use FPGA mode (lot of latency now) ?
22:58 f5oee_evariste OK, you have to do the clown now JOHN to see...
23:00 PE2JKO_Joop no FPGA mode, due to the fact that I also use the same for SSB
23:00 G7JTT-John I will try your software tomorrow Evariste and see how that works as well
23:00 PE2JKO_Joop I use Gnuradio + GR-CSSB which can't work with FPGA mode
23:01 f5oee_evariste OK Joop, we need to implement a pass-through mode with the firmware to avoid that
  
```

- DD4YR Robert
- HB9RYZ Wolfgang
- Jonny_MI0MT
- f5oee_evariste
- f5nvp rené
- DL2VT Dieter
- G4VTQ Darren
- OE8JPO_Phil
- SV8RV
- terror1st
- G17UGV-John
- DD0KP Heiner
- G0MJW Mike
- SV8RV
- PE2JKO_Joop
- EA6WQ-Tom
- SV8RV
- G0MJW Mike
- G7JTT-John

Type '/nick your_name' and press enter to register.

<https://eshail.batc.org.uk/wb/>

TV Downlink Receiver



Calculating how much uplink power is needed

BATC

How much power?

| Dish Diameter | Power Required for 250Ks |
|---------------|--------------------------|
| 2.4m | 7.5W |
| 2.0m | 11W |
| 1.8m | 13W |
| 1.5m | 19W |
| 1.2m | 30W |
| 1m | 43W |
| 90cm | 53W |
| 80cm | 67W |
| 60cm | 120W |

Power required to achieve same MER as the beacon at a receiving station – eg 8dB MER on 1.2mt dish

| SR | Factor |
|---------|--------|
| 66 KS | 0.26 |
| 125 KS | 0.5 |
| 250 KS | 1.0 |
| 333 KS | 1.33 |
| 500 KS | 2.0 |
| 1000 KS | 4.0 |
| 1500 KS | 6.0 |

125Ks = 15 watts with 1.2mt dish for 8db MER

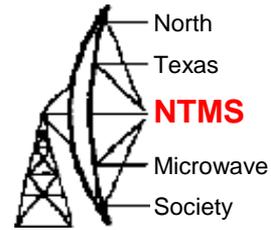
| Relative Power | Received MER |
|----------------|--------------|
| 100% | 8 dB |
| 80% | 7 dB |
| 63% | 6 dB |
| 50% | 5 dB |
| 40% | 4 dB |
| 31% | 3 dB |
| 25% | 2 dB |
| 20% | 1 dB |
| 16% | 0 dB |
| 13% | -1 dB |
| 10% | -2 dB |

7.5 watts, 1.2mt dish = 125Ks at 5dB MER

DATV Microwaves

Simple as can use Portsdown to drive
Microwave Narrowband Transverter

24GHz DATV

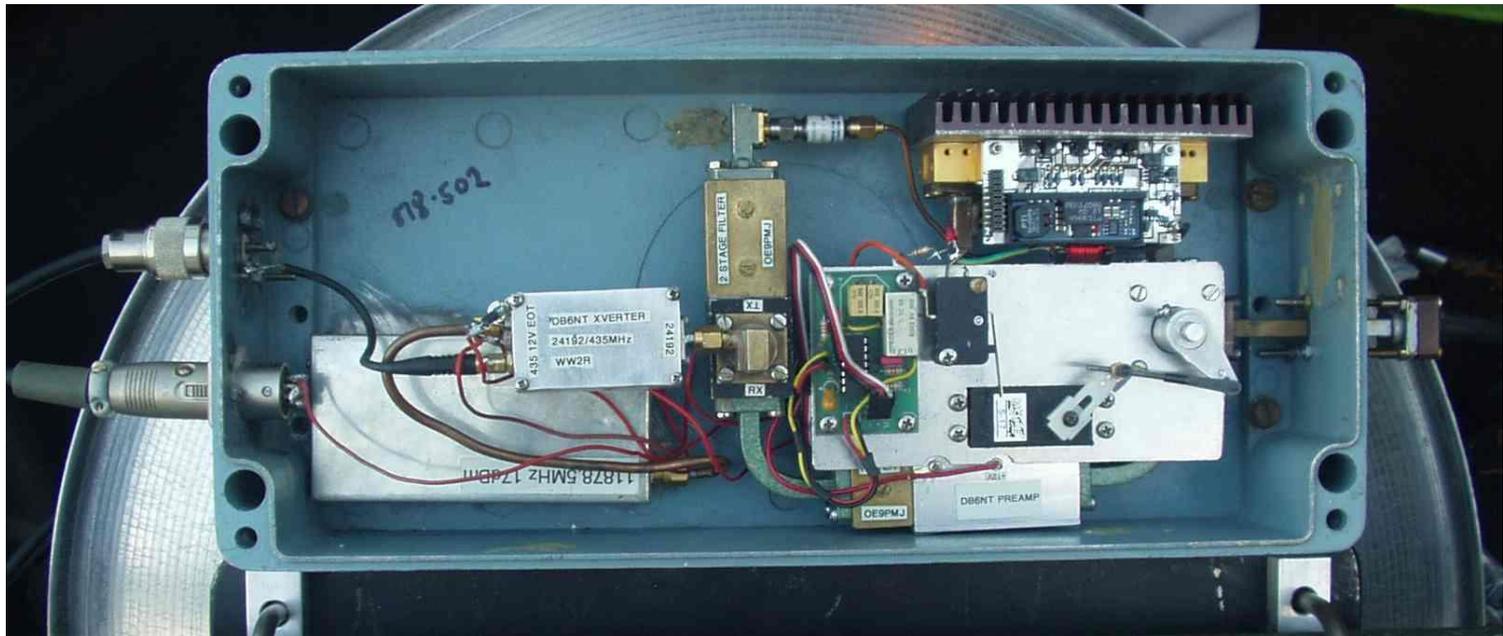


World record was 122km in Japan
First UK attempt was Brown Clee (IO82QL) to
Winter Hill (IO83SO) 126.6km



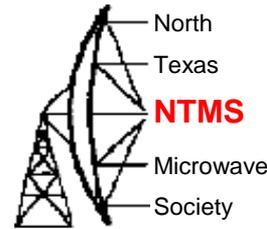
G4FRE/P
IO82QL

My 24GHz DATV Transverter



0.5W DATV 1.8dB noise figure

24GHz DATV 126.6km



MiniTione V2
NIM : Serit FTS-4334L

Symbolrate (kS)
SR set: 999991S
Deviation: 66S
SR → 1000 kS/s

Frequency (kHz)
Freq asked: 24049000kHz
Freq → 24048998 kHz IF 145000kHz

Web Station ID: 1
Newcastle-Under-Lyme
IO83UB
Ant. Dir: East Gain 12 dB

Program: G4FRE/P
Info: DVB-S2
Provider: G4FRE/P
Codec: VH264 + AAC

Carrier Lock, SR Lock, RF Power, CIN MER, Constellations, LDPC, FEC 5/6 QPSK_L35, C/N MER 18.0dB, Bytes recvd: 1621 kb/s

<<<<G4FRE/P received at G4CBW/P

MiniTione V2 by F6DZP
NIM : Serit FTS-4334L

Symbolrate (kS)
SR set: 1000216S
Deviation: 63S
SR → 1000 kS/s

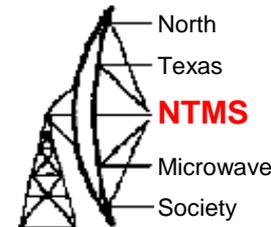
Frequency (kHz)
Freq asked: 24049000kHz
Freq → 24049007 kHz IF 433000kHz

Web Station ID:
BROWN CLEE IO82QL
Ant. Dir: East Gain 12 dB

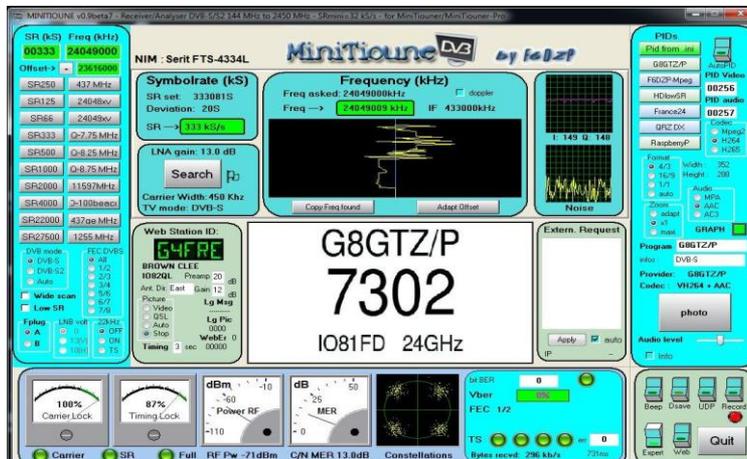
Program: Digital TV
Info: DVB-S2
Provider: G4CBW
Codec: VH264 + MPA

Carrier Lock, SR Lock, RF Power, CIN MER, Constellations, LDPC, FEC 2/3 QPSK_LP95, C/N MER 17.0dB, Bytes recvd: 1251 kb/s

G4CBW/P received >>>> at G4FRE/P

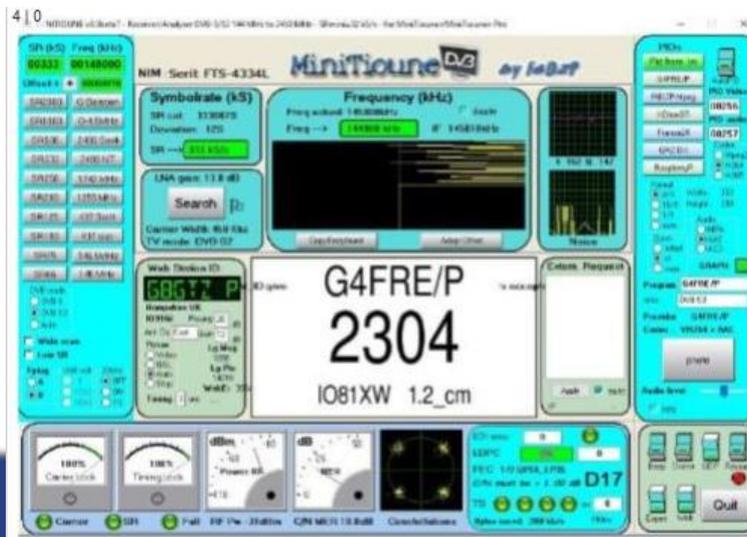


Three weeks later during IARU TV Contest



G4FRE/P
IO81XW

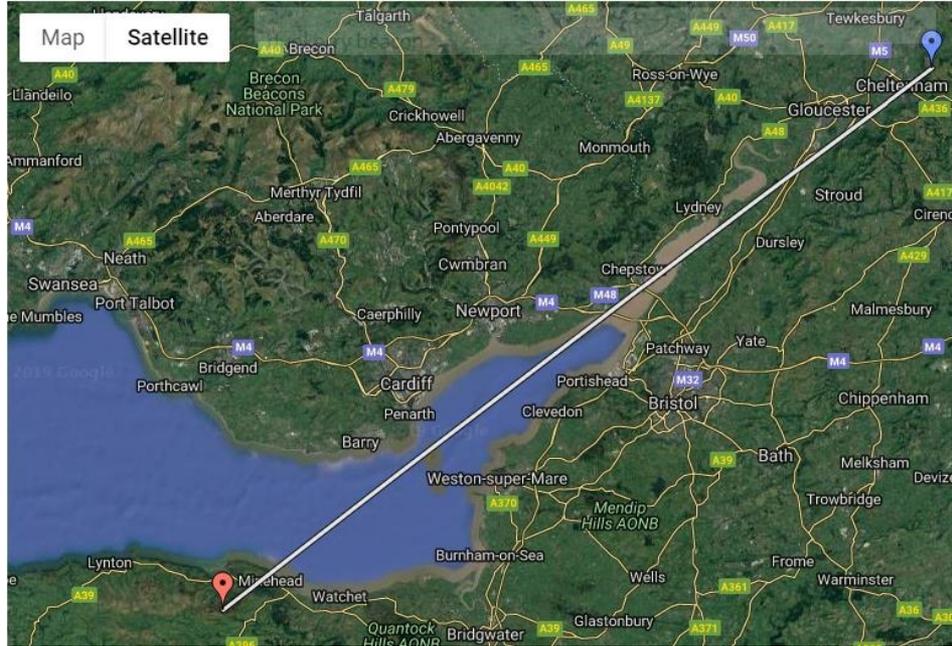
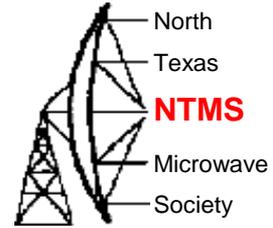
136km



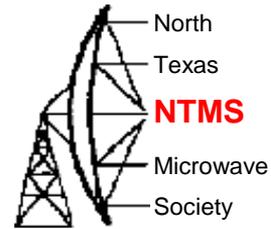
G8GTZ/P
IO81FD



Cleeve Common to Dunkery Path



Other Microwave Band DATV Records



10GHz

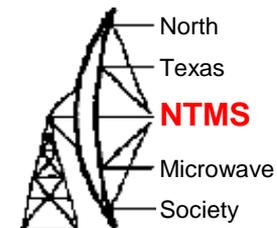
| | | | | | |
|---------|---------|--------|-------|--------|-------|
| 407 kms | M0DTS/P | IO94MJ | G4UVZ | IO80KX | 2Ms/s |
|---------|---------|--------|-------|--------|-------|

47GHz

| | | | | | |
|---------|-------|--------|---------|--------|--------|
| 34.9 km | G4FRE | IO82UC | G0FRE/P | IO92BA | 1 Ms/s |
|---------|-------|--------|---------|--------|--------|

76GHz

| | | | | | |
|----------|---------|--------|---------|--------|---------|
| 35.6 kms | G8GTZ/P | IO91GI | G4LDR/P | IO91JB | 333Ks/s |
|----------|---------|--------|---------|--------|---------|



What about lower Bands?

71MHz

UK full amateurs can get NOV on 70.5-71MHz for “experimental modes”

Using Portsdown + G4DDK Nacton 437/71MHz XV

| | | | | | |
|---------|---------|--------|---------|--------|-------|
| 160 Kms | G8GTZ/P | IO80WX | G4FRE/P | IO82QJ | 125Ks |
|---------|---------|--------|---------|--------|-------|

144MHz

UK full amateurs can get NOV on 145-146MHz for “experimental modes”

| | | | | | |
|---------|---------|--------|-------|--------|-------|
| 407 kms | M0DTS/P | IO94MJ | G4UVZ | IO80KX | 333Ks |
|---------|---------|--------|-------|--------|-------|

Note narrower bandwidths

140km also worked on 51MHz!

References

<https://batc.org.uk/>

<https://www.crowdsupply.com/lime-micro/limesdr>

<https://www.crowdsupply.com/lime-micro/limesdr-mini>

<https://wiki.analog.com/university/tools/pluto>

<https://github.com/f4exb/sdrangel>

<https://www.sdr-radio.com/Software/>

<https://eshail.batc.org.uk/nb/>

<https://eshail.batc.org.uk/wb/>