






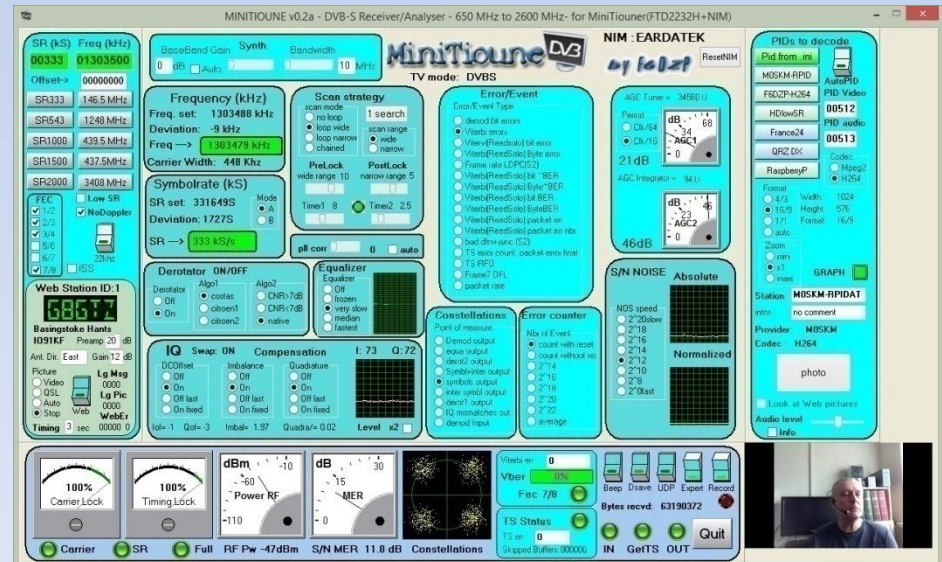
■ Advances in Amateur Television

Noel Matthews - G8GTZ











Topics

-  UK ATV overview
-  RB-TV & 146 MHz update
-  10GHz and other bands
-  What next...
-  ATV is looking up







UK ATV overview

-  **71 & 146 MHz**
 - The new ATV bands!
-  **70cms**
 - Digital only on 437MHz
-  **23cms**
 - Analogue and digital
 - Activity on repeaters and simplex
-  **13cms**
 - Still room after PSSR!
 - Repeaters and simplex

-  **3.4 GHz**
 - Digital only
 - Excellent results
-  **5.6 GHz**
 - Repeater inputs
-  **10 GHz**
 - Repeaters and simplex
 - DATV
-  **24 GHz**
 - MODTS and G1LPS







New ATV band at 146 MHz



-  From October 2014 UK amateurs had access to 146 – 147 MHz
 - Also access to 1 MHz at 70 MHz
-  However, Ofcom have said new technologies only
 - Not more of the same FM etc...
 - 25 watts erp maximum
-  RSGB has allocated middle 500 KHz for digital modes including reduced bandwidth DATV
-  Not enough space for “normal” DATV so we needed something new = RB-TV

146 MHz		
RSGB Band Plan (effective from 31st October 2014)		
<small>Access to this band requires an appropriate NoV, which is available to Full Licensees only Please note that the current NoV will expire on 31st Oct-2015 For further information see the 146-147 MHz FAQ or contact vhf.manager@rsgb.org.uk</small>		
146-147MHz (2m extension)	Necessary Bandwidth	UK Usage
146.000-146.900	500kHz	Wideband Digital Modes (High speed data, DATV etc) 146.500 MHz Centre frequency for wideband modes (Note 1)
146.900-147.000	120kHz	Narrowband Digital Modes including Digital Voice 146.9000 146.9125 146.9250 146.9375 146.9500 146.9625 146.9750 146.9875
<small>Note-1: Users of wideband modes must ensure their spectral emissions are contained within the band limits</small>		
<small>LICENCE NOTES: Full Licensees only, with NoV, 25W erp max - not available in the Isle of Man or Channel Isles</small>		
<small>Note that additional restrictions on geographic location, antenna height and upper frequency limit are specified by the NoV terms</small>		
<small>It should be emphasised that this band is UK-specific and is available on a non-interference basis to existing services Upper Band limit 147.000 MHz (or 146.93750 where applicable) are absolute limits and not centre frequencies The absolute band frequency limit in or within 40km of Scotland is 146.93750 MHz - see NoV schedule</small>		

What is Reduced Bandwidth (RB-TV)?

-  RB-TV is “normal” fast scan DATV below 1 Msymbol / sec
 - Bandwidth = <1 MHz wide
-  UK standard is 333kSym/s 7/8 FEC
 - = ~450Khz bandwidth (450 Kbit/s video)
-  Based on DVB-S standard BUT...
 - Needs MPEG-4 encoding for transmit
 - “Normal” satellite rx won’t work below 1 Ms
-  So we needed to do something different!

RB-TV(and DATV) Tx choices

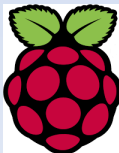
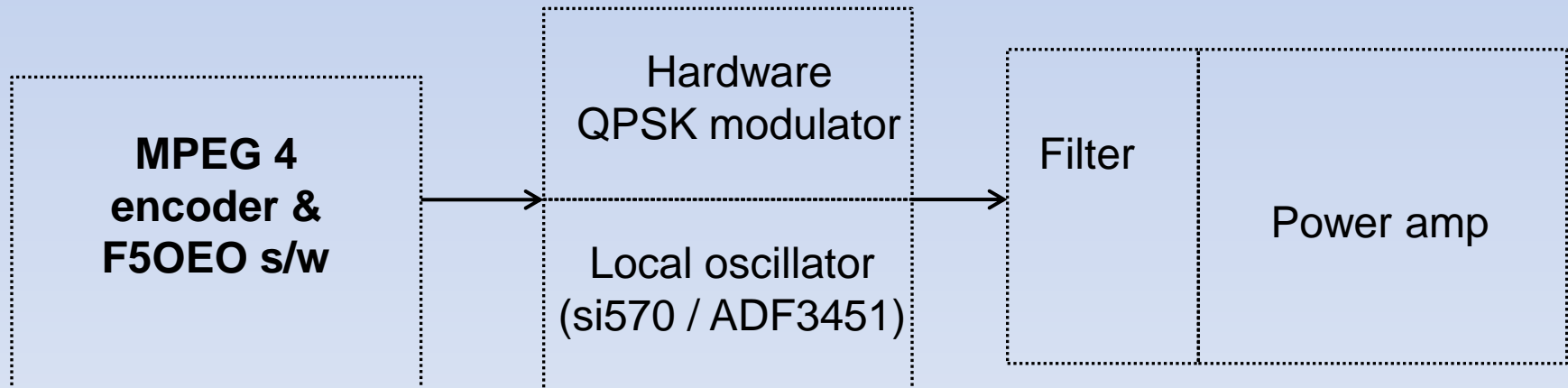
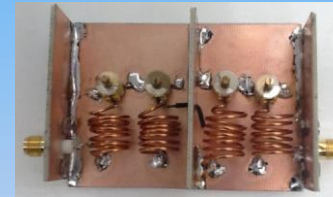
-  Raspberry Pi has native MPEG4 encoder and camera
 - Several solutions based around F50EO s/w
-  DATVexpress – flexible FPGA hardware based solution
 - 65 – 2500 MHz
 - 100 Ks – 45 Msymbols
 - Windows and Linux








-  Potential future solutions based around Lime SDR...

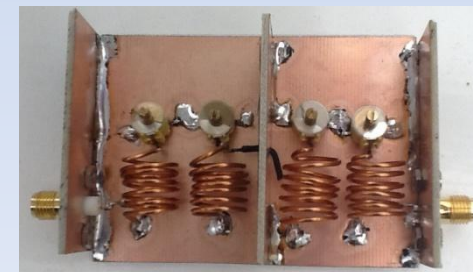
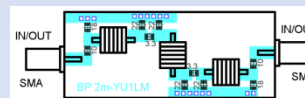


Rpi based RB-TV Tx








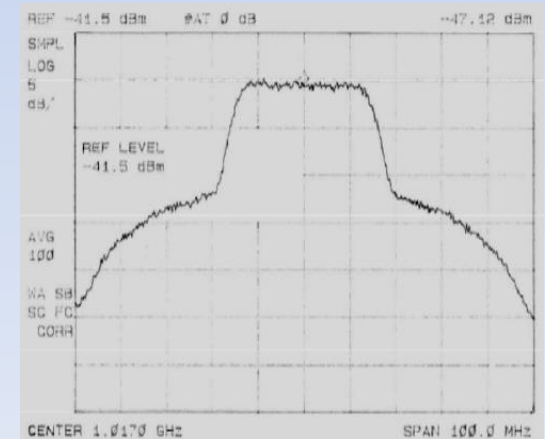
Filters

-  The big issue!
-  RB-TV on 146 MHz demands tight filtering on tx and rx!!
-  Minimise spectral re-growth
-  Satellite tuners are wideband
 - Need bandpass and notch filters on rx
 - There's lot of loud signals on 2 mts!
-  People are realising how important they are!
 - Blowing the dust off the text books!



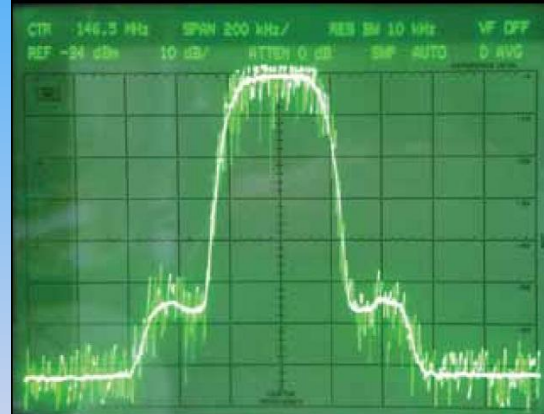
DATV Power amplifiers

-  Spectral re-growth is a major issue when operating ANY digital modes
-  Minimal spectral re-growth is very hard to achieve
 - Professional satellite uplinks = -30 dB!!
 - 146MHz target is -60 dB!
-  Requires very linear PAs
-  Average home constructor has to “back off” the PA
 - Typically 6 – 10 dB
-  Pre-correction would help



PAs for digital modes

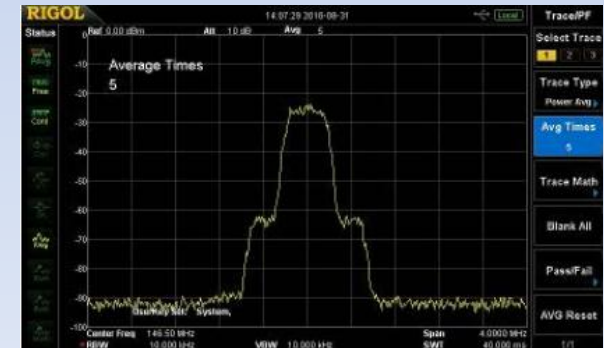
- RD70 rated at 70watts
 - 5 watts with -55dB IMD3



- RA60H1317M
 - 5 amps @ 12v = 7 watts out!



- Need good heat sinks and fans!
 - And BIG batteries when out /p!

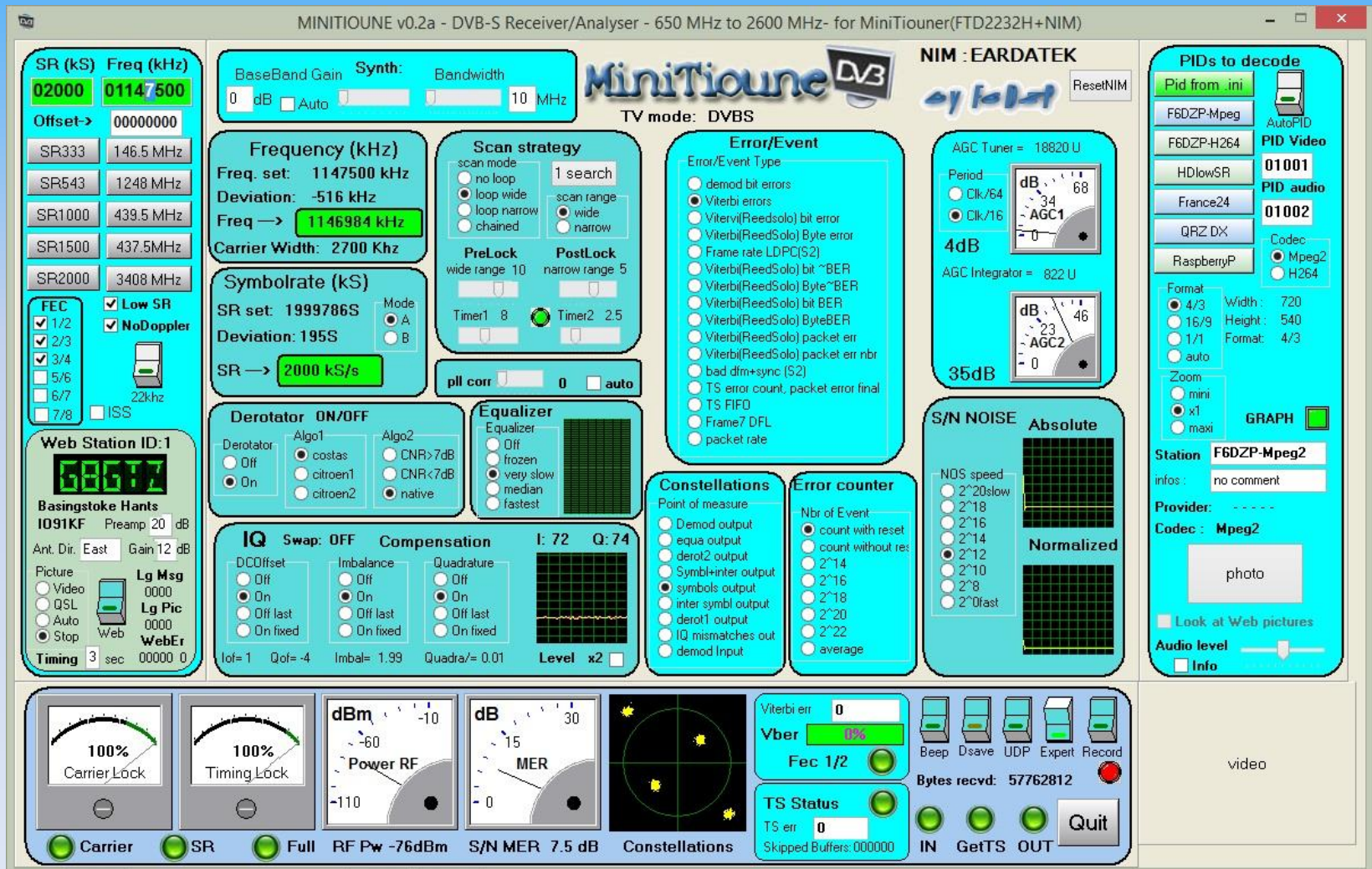


RB-TV receive

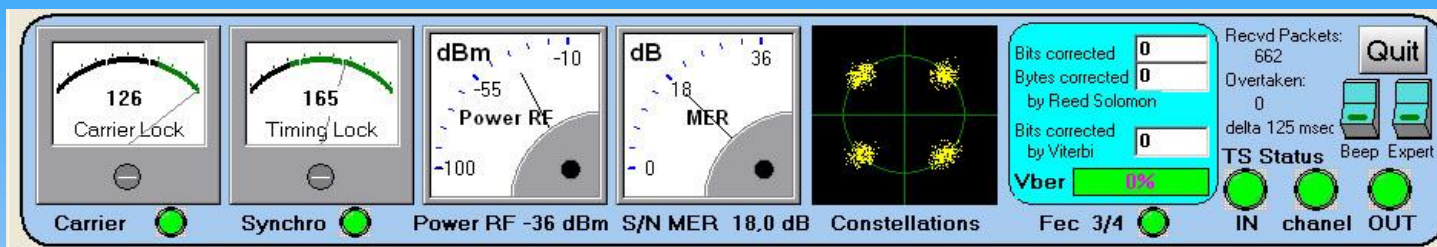
- ➊ Consumer STBs do not go below 1 Msymbol 😞
- ➋ Only solution was to design one!
- ➌ USB tuner hardware
 - Stocked in BATC shop
- ➍ F6DZP developed Tutious s/w
 - Optimised DATV receive solution
 - .125 to 45 Msymbols (not just RB-TV)
 - And a really valuable diagnostic tool
- ➎ Taught us to forget the S meter!
 - It's the MER that counts



I&Q inbalance

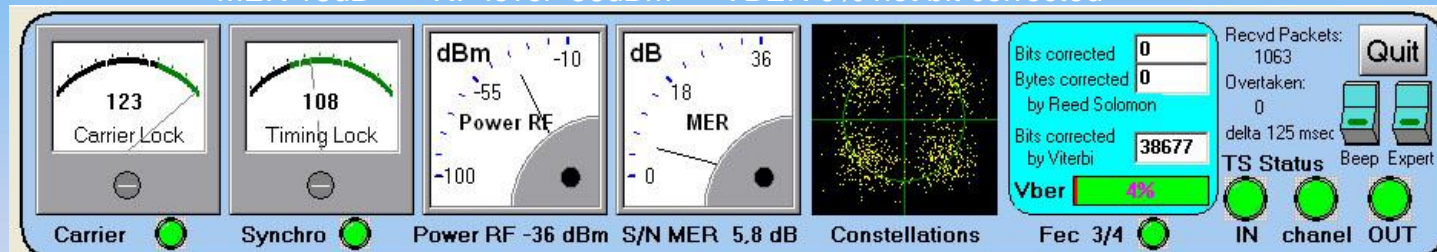


Forget the S meter!



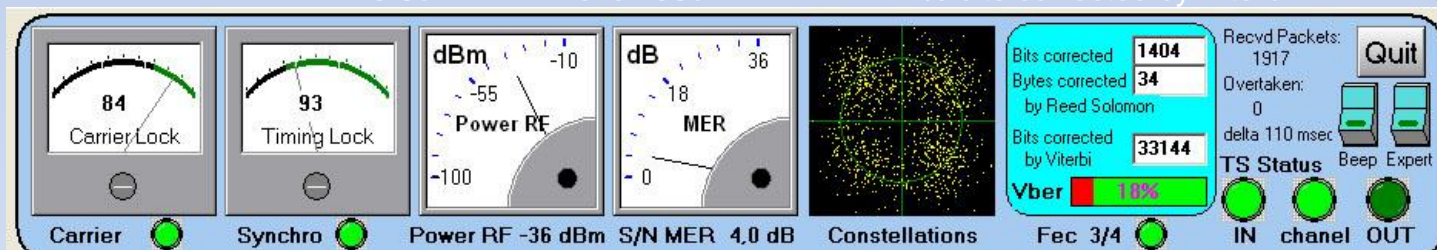
MER 18dB -----RF level -36dBm ----VBER 0% not bit corrected

→TS OK



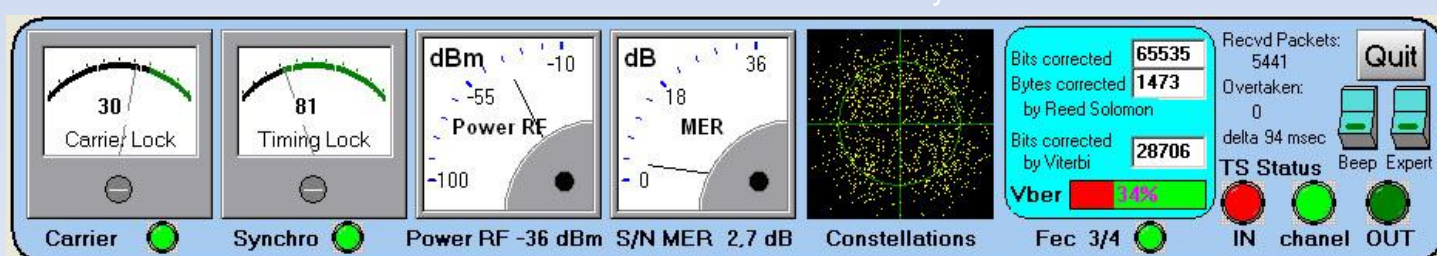
MER 5.8dB -----RF level -36dBm ----VBER 4% bits corrected by Viterbi

→TS OK



MER 4dB -----RF level -36dBm ----VBER 18% bits corrected by Viterbi and Reed Solomon

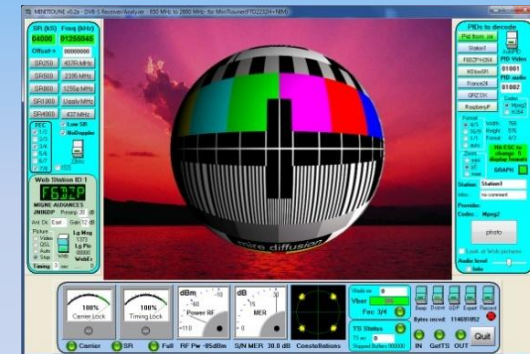
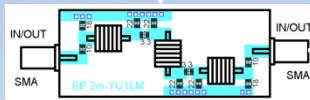
→TS OK



MER 2.7dB -----RF level -36dBm ----34% bits corrected by Viterbi and Reed Solomon

→TS NOT OK

RB-TV Rx system



**Pre-amp
And
Filter**

**L band up
converter**

**USB
Tuner**

PC

RB-TV “on air” - 146 MHz

- 📻 25 watts erp on 146 MHz is tough!
 - 25watts erp in 500 KHz bandwidth vs 1 Kwatt erp in 2.5 KHz for SSB = 40 dB difference!
 - Yes we are sticking to it!
 - But at least we can use existing aerials / pre-amps
- 📻 Portable operation is needed to work DX
 - 146 MHz is inter “G” only
- 📻 First ATV QSO on 146 MHz
 - 30/12/14 G4CPE & GOWFT
- 📻 Current record = 183 Kms
 - Brown Clee to Bell Hill



GOMJW - 130 Kms

SR (kS) Freq (kHz)
00333 01303500
Offset - 00000000
SR333 146.5 MHz
SR125 1248 MHz
SR1000 439.5 MHz
SR1500 437 MHz
SR2000 3408 MHz
FEC 1/2 22kHz
2/3 OFF
3/4 ON
5/6 TS_OK
6/7
7/8 ISS

Tuner BaseBand Gain 0 dB Auto
MiniTione DV3 NIM : SHARP/Samsung by F6DZP TV mode: DVBS

Frequency (kHz)
Freq. set: 1303500 kHz Target Freq: 1303521 kHz
Freq → 1303521 kHz
Target Dev 21kHz Deviation: 21 kHz

Scan strategy
scan mode
no loop
loop wide
loop narrow
chained
1 search
scan range
wide
narrow
PreLock wide range 10
PostLock narrow range 3
Timer1 6 Timer2 2.5
pll corr 0 auto

Web Station ID: 1
GGGTZ
Hannington IO91GI Preamp 20 dB
Ant. Dir: East Gain 12 dB
Picture Video QSL Auto Stop
Lg Msg Lg Pic 00000 WebEr
Timing 3 sec 10060 1

Symbolrate (kS) Mode A B
SR set: 330390S
Deviation: 3442S
SR → 334 kS/s
Carrier Width: 446 KHz

IQ Swap: ON x2
I: 72 Q: 73 Equa Noise

dBm -110
Power RF
dB 15
MER
Constellations

Viterbi err 2373
Vber 18%
Fec 7/8
TS Status
TS err 49
TS Buffer: 13160 bytes

Carrier **SR** **Full** **RF Pw** -54dBm **S/N MER** 4.5 dB **Bytes recvd:** 51

PIDs to decode
Pid from .ini
Station1
F6DZP-H264
HDlowSR
France24
QRZ DX
RaspberryP
AutoPID
PID Video 00256
PID audio 04095
Codec
Mpeg2
H264
Format 4/3 Width: 720
16/9 Height: 576
1/1 Format: 4/3
auto
Zoom
adapt
x1
maxi
GRAPH

Station Station1
infos: no comment
Provider:
Codec: H264
photo

Radio Link
Edit View Swap
Azimuth=136.84° Elev. angle=-0.652° Obstruction at 75.15km Worst Fresnel=1.1F1 Distance=130.27km
Free Space=118.0 dB Obstruction=38.6 dB ITM Urban=0.0 dB Forest=0.0 dB Statistics=1.3 dB
PathLoss=155.2dB E field=11.2dBμV/m Rx level=100.3dBm Rx level=2.17μV Rx Relative=-0.3dB

Transmitter
Brown Clee
Role
Tx system name 146 MHz
Tx power 5W 36.99 dBm
Line loss 1 dB
Antenna gain 10 dBi 7.8 dBd
Radiated power EIRP=39.72 W ERP=24.22 W
Antenna height (m) 7.5
Net 146 TV

Receiver
GOMJW
Role
Rx system name 146 MHz
Required E Field 11.5 dBμV/m
Antenna gain 10 dBi 7.8 dBd
Line loss 1 dB
Rx sensitivity 2.2387μV -100 dBm
Antenna height (m) 5
Frequency (MHz) Minimum 144 Maximum 148

G8VPG – 168 Kms

MiniMOON V04C - DVB-S Receiver/Analyser - 950 MHz to 2000 MHz - 101 MiniMOON (1.022321) (nm)

IR (kS) Freq (kHz)
0333 01303500

tset-> 00000000

SR333 146.5 MHz
SR125 1248 MHz
SR1000 439.5 MHz
SR1500 437 MHz
SR2000 3408 MHz

FEC
1/2 22kHz
2/3 0 DFF
3/4 0 ON
5/6 0 TS_OK
6/7 0
7/8 0 ISS

Web Station ID:1
G8G1Z

lannington
J91GI Preamp: 20 dB
Dir: East Gain: 12 dB
Lg Msg 0000
Lg Pic 0000
Web 0000
WebEr 000000 0

G8VPG/P

IO80WX
Win Green, Shaftesbury

Carrier 100% SR 100% Full RF Pw -39 dBm S/N MER 29.0 dB Constellations

Viterbi 0
Vber 0%
Fec 7/8

TS Status
TS err 0
TS Buffer: 13160 bytes

Beep Dsave UDP Expert Rec

Bytes recvd: 3347978

IN GetTS OUT

PIDs to decode

Pid from ini

Station1
F6DZP-H264
HDlowSR
France24
QRZ DX
RaspberryP

Format
4/3
16/9
1/1
auto

Width
Height
Format

Zoom
adapt
x1
maxi

Hit ES
chang
display i
GRAP

Station Station1

infos no comment

Provider:
Codec: H264

photo

Audio level

Info

Radio Link

Edit View Swap

Azimuth=168.71° Elev. angle=0.677° Obstruction at 92.78km Worst Fresnel=0.8F1 Distance=169.36km
Free Space=120.3 dB Obstruction=25.5 dB Mix Urban=0.0 dB Forest=0.0 dB Statistics=-1.6 dB
PathLoss=144.1 dB E field=22.3 dBµV/m Rx level=89.2 dBm Rx level=7.80µV

Transmitter

Role Brown Clee
Tx system name 146 MHz
Tx power 5 W 36.99 dBm
Line loss 1 dB
Antenna gain 10 dBi 7.8 dBd
Radiated power EIRP=39.72 W ERP=24.22 W
Antenna height (m) 7.5

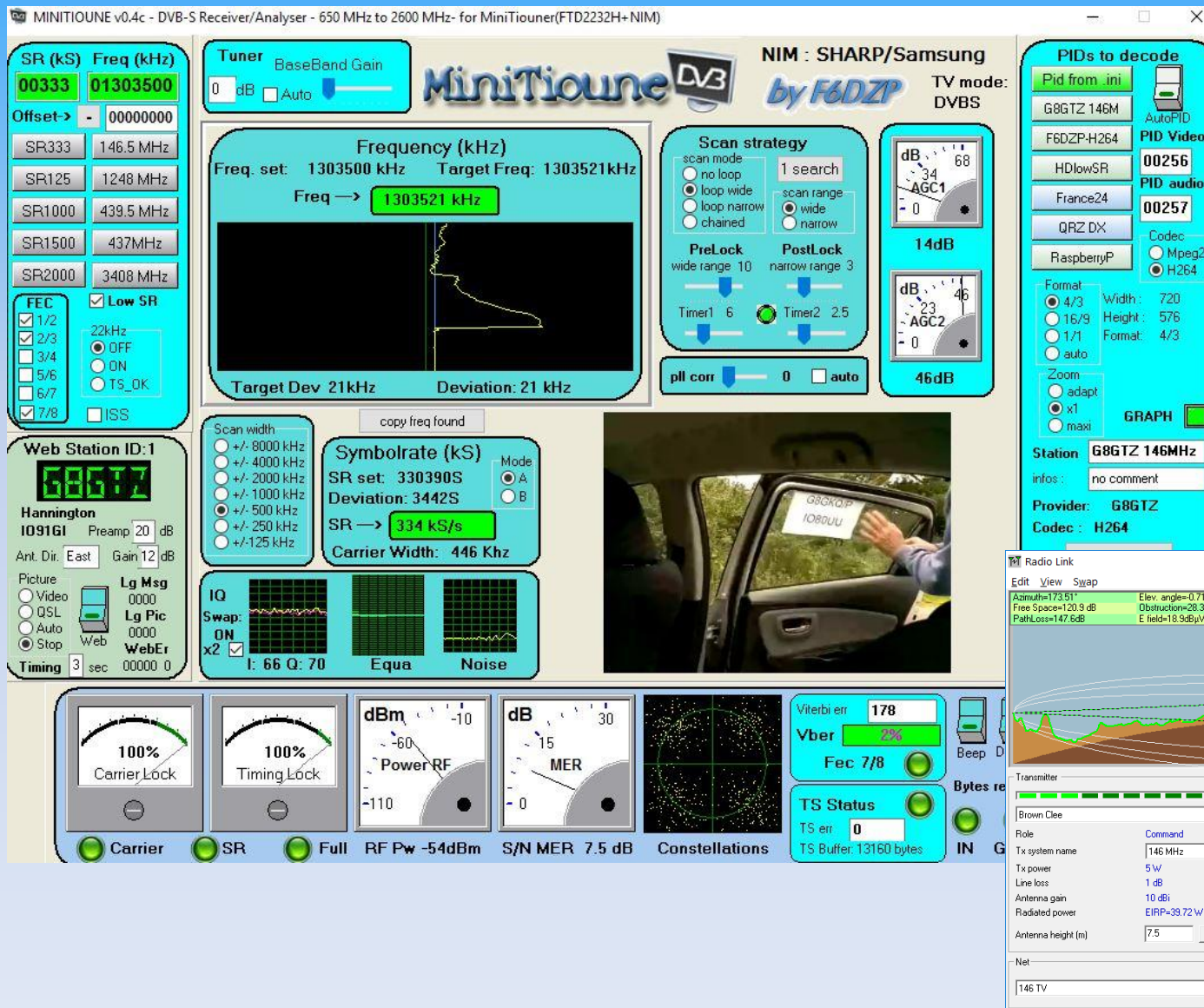
Receiver

Role Test 2
Rx system name 146 MHz
Required E Field 11.5 dBµV/m
Antenna gain 10 dBi 7.8 dBd
Line loss 1 dB
Rx sensitivity 2.2387µV -100 dBm
Antenna height (m) 5

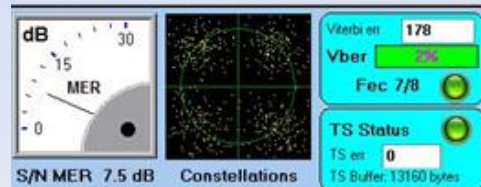
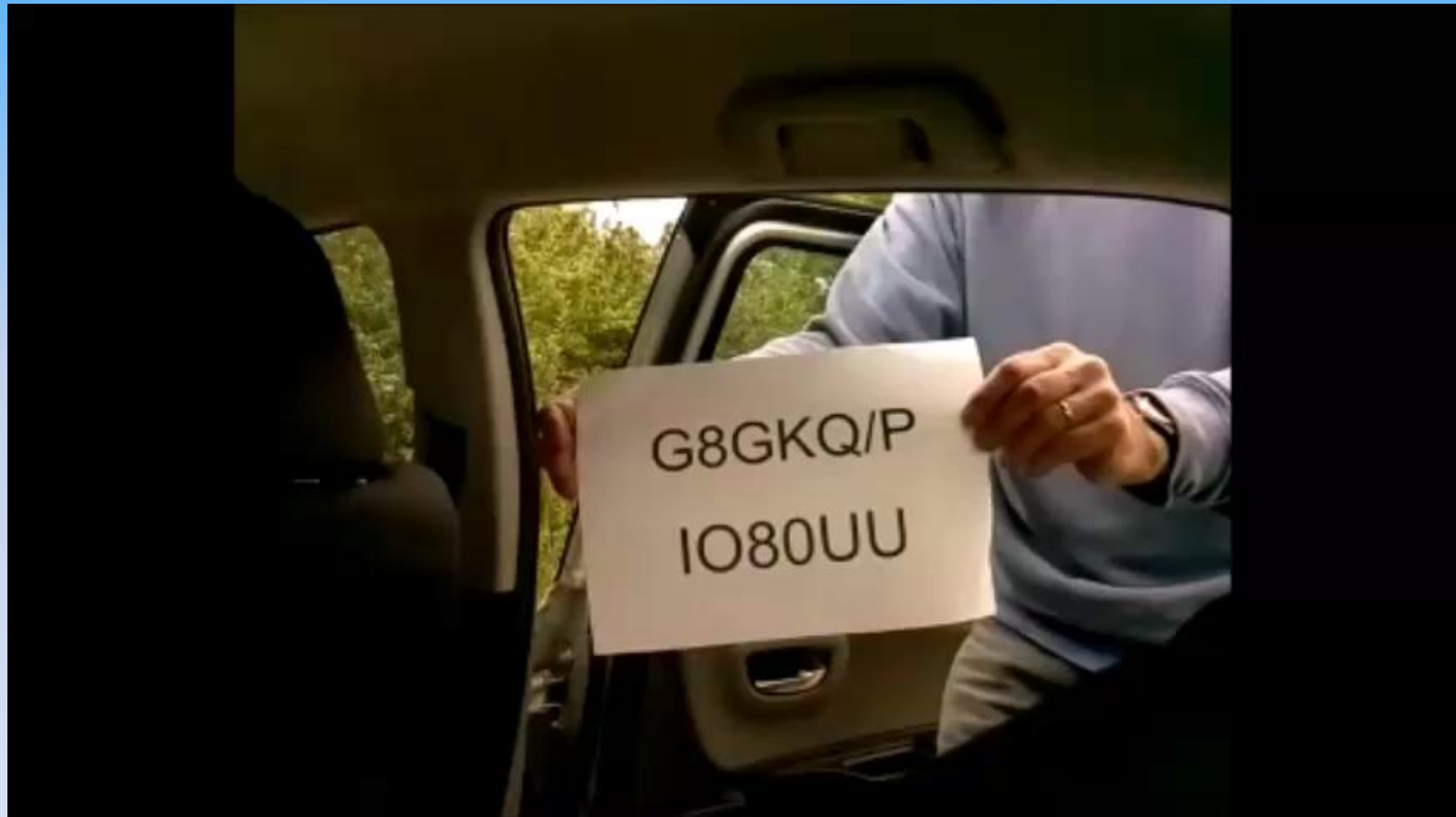
Net
146 TV

Frequency (MHz)
Minimum 144 Maximum 148

G8GKQ - 183 Kms



IO82QL – IO80UU = 183 Kms



RB-TV “on air” – the other bands

70cms is easier than 146 MHz

- No erp limit and more ant gain
- Much noisier environment
- Can fit between other users

F9ZG tests over 200+ Km with high success rate

- 125 Ks is significantly better than 250 Ks

10 GHz using NB transverters





- Use 437 MHz as the IF
- Current UK record = 93 Kms

Interest in 71 MHz is growing

- 4 stations applied for special permits







BATC activity days

-  Organised to encourage people to “get on the air”
-  Several stations go out /p
-  ATV and DATV activity on all bands
-  RB-TV activity on 146, 432 and 10 GHz

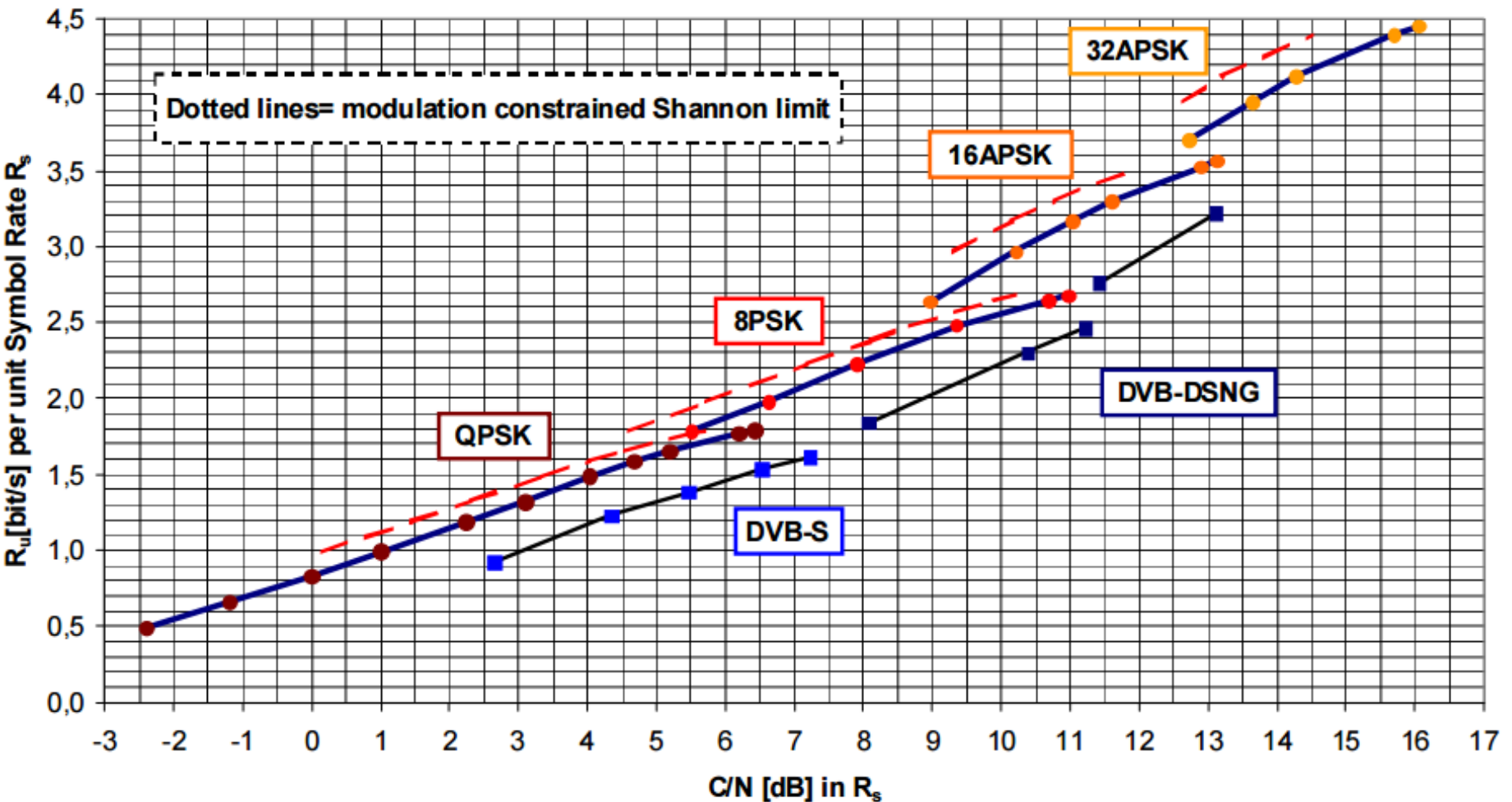


What next – DVB-S2






-  Published DVB standard and consumer equipment is available
 - Beta code for DATVexpress and Tutuione is available and has been used for early tests
-  Originally deployed on satellites as it is capable of carrying more bits/hz
 - HD in the same bandwidth as SD
-  But other modes operate closer to the Shannon Limit
 - 2 -3 dB gain over DVB-S
 - Significant when limited to 25 watts erp and 50+ dB spectral re-growth!
-  Will be the preferred modulation scheme on eshailsat 2

DVB-S2 vs DVB-S

Spectrum efficiency versus required C/N on AWGN channel



DVB-S2 results +/- 1 dB)

-  Test on 70cms over a 40Km path showed S2 will give some valuable gains
-  At 1/2 FEC 2 MS
 - DVB-S2 needs 3 dB less power than DVB-S
-  DVB-S2 2 MS:
 - going from 1/2 to 1/4 FEC needs 4 dB less power
-  DVB-S2 Pilot symbols made no difference at 2 MS
 - Intended to help rx over difficult paths but will it be fast enough for mobile use?
-  8PSK, 16APSK and 32APSK were also received



SR (kHz) Freq (kHz)
02000 01844550
Offset -> 00000000
SR2000 146.5 MHz
SR333 2395 MHz
SR125 1255 MHz
SR4000 437 MHz
SR27500 10373

☐ Low SR
☒ FEC 1/2 ☒ 3/5 ☒ DVB-S
☒ 2/3 ☒ 3/4 ☒ DVB-S2
☒ 4/5 ☒ 5/6 ☒ AUTO
☒ 6/7 ☒ 7/8
☒ 8/9 ☒ 9/10

Web Station ID:1
G6GKQ
Southampton
1090HV Preamp 20 dB
Ant. Dir. East Gain 12 dB
Picture: ☐ Video 0000 ☐ QSL 0000 ☐ Auto 0000 ☒ Stop
Lg Msg 0000 Lg Pic 0000 Web 0000 WebEx 0000
Timing 3 sec 00000 0

PIDs to decode
Pid from ini
Station1 AutoPID
256-H264 PID Video 00256
HDlowSR PID audio 04095
France24
DVB-S2_Tes Codec
RaspberryP ☐ Mpeg2 ☒ H264
Format: 4/3 Width: 720 16/9 Height: 540 1/1 Format: ?
Zoom: ☐ adapt ☒ x1 ☐ max
Ha ESC to change 5 display formats
GRAPH ☒
Station: Station1
info: no comment
Provider:
Codec: H264
photo
Audio level
☐ Info ☐ ISS

Carrier **SR** **Full** **RF Pw -61dBm** **S/N MER 23 dB** **Constellations**
Viterbi en 85610 Delin 100% FEC 7777
TS Status TS en 206 TS Buffer: 7896 bytes
Beep Deave UDP Expert Record
Bytes recvd: 13695864
Quit

DVB-S2 modes

SR (kHz) Freq (kHz)
02000 01844550
Offset -> 00000000
SR2000 146.5 MHz
SR333 2395 MHz
SR125 1255 MHz
SR4000 437 MHz
SR27500 10373

☐ Low SR
☒ FEC 1/2 ☒ 3/5 ☒ DVB-S
☒ 2/3 ☒ 3/4 ☒ DVB-S2
☒ 4/5 ☒ 5/6 ☒ AUTO
☒ 6/7 ☒ 7/8
☒ 8/9 ☒ 9/10

Web Station ID:1
G6GKQ
Southampton
1090HV Preamp 20 dB
Ant. Dir. East Gain 12 dB
Picture: ☐ Video 0000 ☐ QSL 0000 ☐ Auto 0000 ☒ Stop
Lg Msg 0000 Lg Pic 0000 Web 0000 WebEx 0000
Timing 3 sec 00000 0

PIDs to decode
Pid from ini
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Zoom: ☐ adapt ☒ x1 ☐ max
Ha ESC to change 5 display formats
GRAPH ☒
Station: Station1
info: no comment
Provider:
Codec: H264
photo
Audio level
☐ Info ☐ ISS

Carrier **SR** **Full** **RF Pw -61dBm** **S/N MER 23 dB** **Constellations**
Viterbi en 85610 Delin 100% FEC 7777
TS Status TS en 206 TS Buffer: 7896 bytes
Beep Deave UDP Expert Record
Bytes recvd: 13695864
Quit

SR (kHz) Freq (kHz)
02000 01844550
Offset -> 00000000
SR2000 146.5 MHz
SR333 2395 MHz
SR125 1255 MHz
SR4000 437 MHz
SR27500 10373


☐ Low SR
☒ FEC 1/2 ☒ 3/5 ☒ DVB-S
☒ 2/3 ☒ 3/4 ☒ DVB-S2
☒ 4/5 ☒ 5/6 ☒ AUTO
☒ 6/7 ☒ 7/8
☒ 8/9 ☒ 9/10

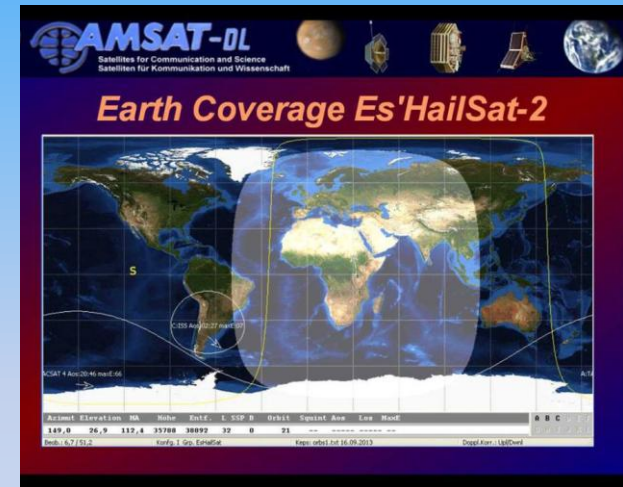
Web Station ID:1
G6GKQ
Southampton
1090HV Preamp 20 dB
Ant. Dir. East Gain 12 dB
Picture: ☐ Video 0000 ☐ QSL 0000 ☐ Auto 0000 ☒ Stop
Lg Msg 0000 Lg Pic 0000 Web 0000 WebEx 0000
Timing 3 sec 00000 0

PIDs to decode
Pid from ini
Station1 AutoPID
256-H264 PID Video 00256
HDlowSR PID audio 04095
France24
DVB-S2_Tes Codec
RaspberryP ☐ Mpeg2 ☒ H264
Format: 4/3 Width: 720 16/9 Height: 540 1/1 Format: ?
Zoom: ☐ adapt ☒ x1 ☐ max
Ha ESC to change 5 display formats
GRAPH ☒
Station: Station1
info: no comment
Provider:
Codec: H264
photo
Audio level
☐ Info ☐ ISS

Carrier **SR** **Full** **RF Pw -73dBm** **S/N MER 21 dB** **Constellations**
Viterbi en 0 Delin 100% FEC 7777
TS Status TS en 0 TS Buffer: 7896 bytes
Beep Deave UDP Expert Record
Bytes recvd: 16210317
Quit




ATV is looking up!

- 
- Es'Hail-2 will be the first amateur geo-stationary satellite
 - Es'Hail-2 wideband is an “ 8 MHz bent pipe” transponder
 - No spot beams – covers 1/3 of the earth!
 - Dedicated to DATV use 😊
 - DVB-S2 is preferred modulation
 - Occupied bandwidths could be 500 KHz – 8 MHz
 - Amateur service coordination is essential if we are to maximise the benefit
 - BATC is developing a web based monitoring solution
 - Es'Hail-2 is a fantastic opportunity for amateur TV experimentation
 - Stay tuned to hear more from G3ZVZ











ATV is looking up

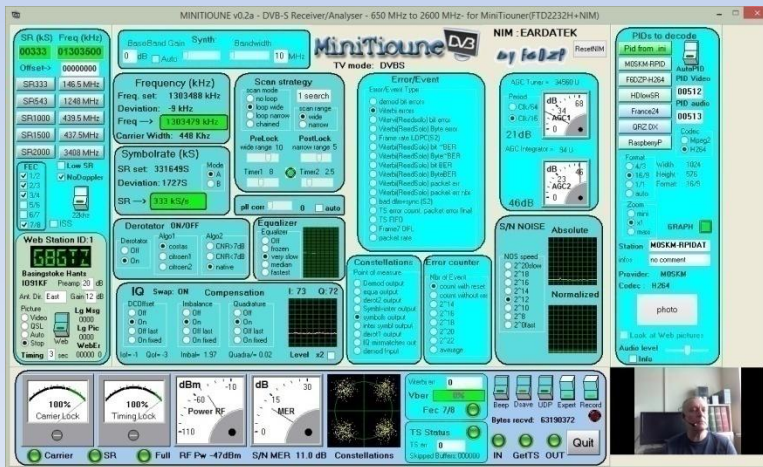
-  HamTV from the ISS
-  Should be easy but it's not!
 - Not DVB compliant
 - It moves at 17,500 mph
 - Unknown link budget on 2.3 GHz
 - And we tracked it from a mobile platform!
-  Learn more in stream 3 at 16:45 pm today



The new golden age for ATV!

-  ATV covers all skill levels from beginner to seasoned professional and all interests, propagation, antennas, RF design, studio, video editing, software development, SDR, DSP, FPGA, latest devices and techniques
-  Meshes well with emergent internet, video and radio technologies
 - Modern radio is predominantly software!
-  New skill sets are being developed – everything is “open source”
-  State of the art but not hindered by the type of constraints the professionals have.
-  And you get to see each other projects over the air or send back live video of testing
 - DVB-S2 tests transmitter RF level!
-  Do some real radio today – get involved in Amateur TV!

Thank you



BATC The British Amateur Television Club

CQ-TV

RB-TV Special - May 2015

New Band, New Mode, New Award...

Reduced Bandwidth TV is here!

RB-TV award for first QSO

Plus...

Reduced Bandwidth DATV (RB-TV) RB-TV Awards Programme

A Two way on 146.5MHz RB-DATV

DigitThin - A Narrowband QPSK Modulator for the Raspberry Pi

DigitThin Beta Testing

base of Licence:

operator's main station address:

■ Find out more...

www.batc.org.uk

https://wiki.batc.tv/BATC_Wiki

http://www.batc.tv/ch_live.php

[**www.rsgb.org**](http://www.rsgb.org)

