



2017 JPL DATV Presentation Pasadena, CA

Current Advances in Digital-ATV

by

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Digital-ATV



The Presentation Authors....



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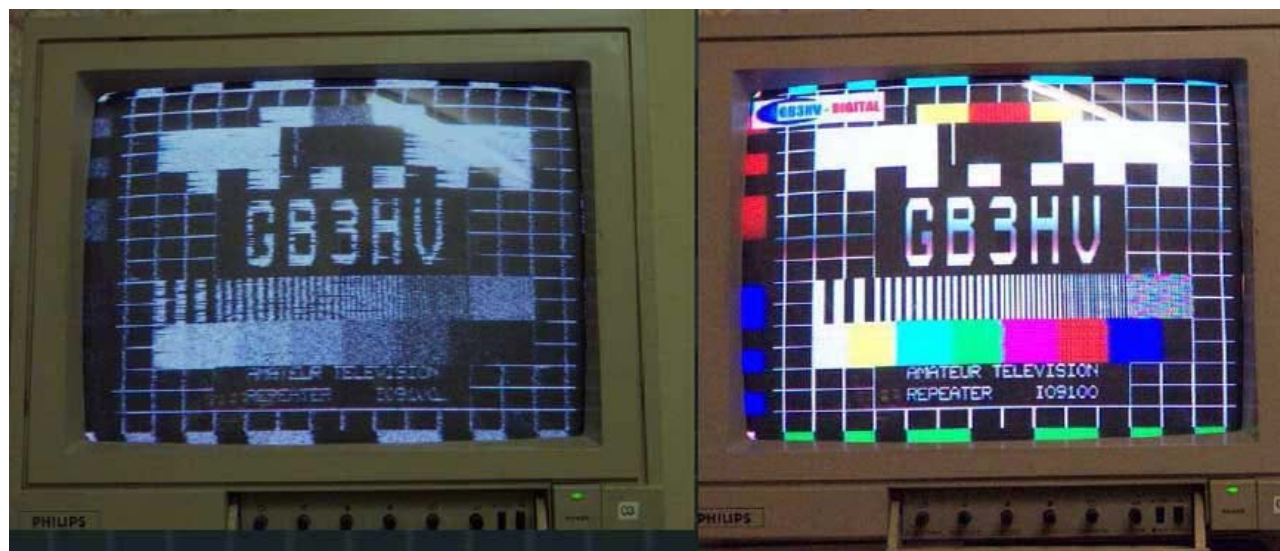


Robbie KB6CJZ



Digital-ATV

Digital-ATV technology allows Video Quality to exceed analog-ATV



Comparison of analog video and an DATV video using the same antennas with weak sigs

(courtesy of G8GTZ & GB3HV)



Digital-ATV



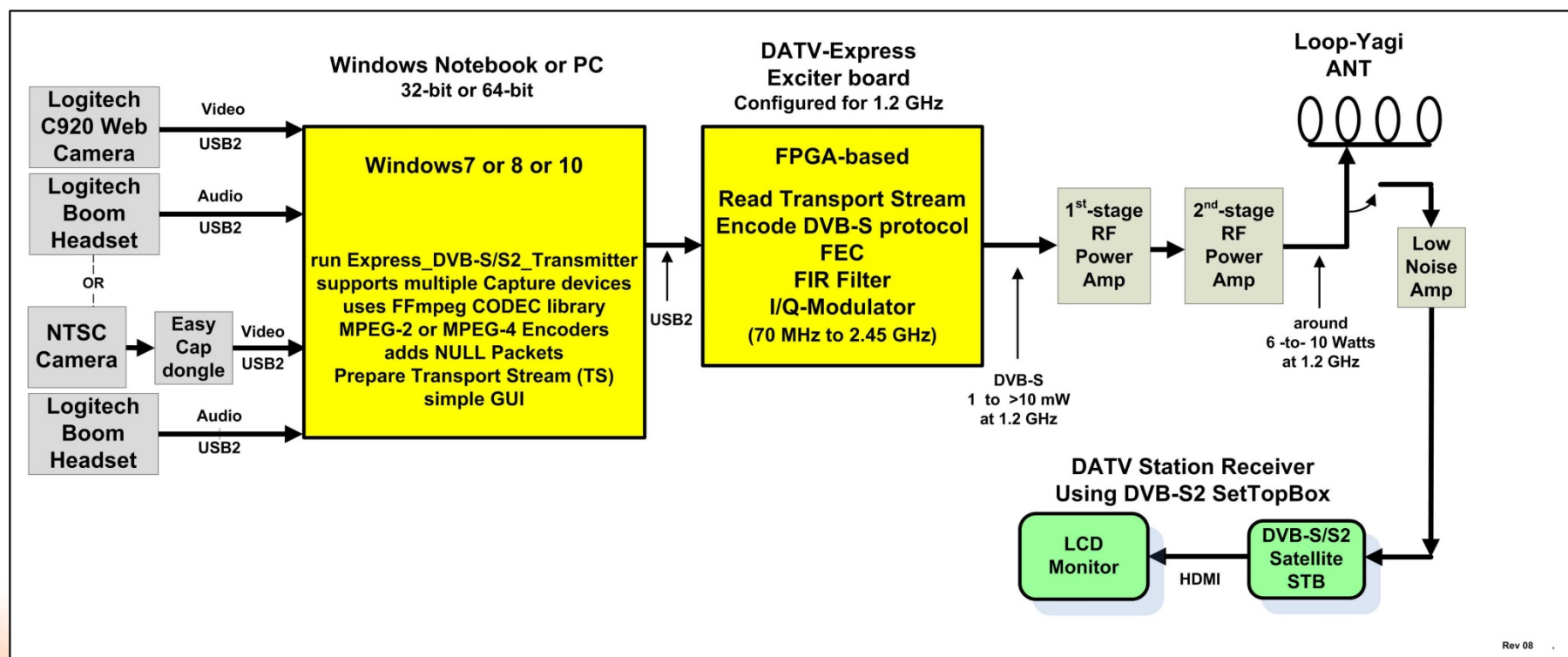
Status of Digital-ATV Today

- DATV Video Quality can exceed analog ATV
- Few hams transmit DATV in USA today
- European DATV is very active and growing
- Australia/New Zealand have lots of DATV activity
- In 2017, there are finally 16 DATV-repeaters in USA
- Digital-ATV transmitters had been expensive
- US \$900-and-up for MPEG/DVB-S Encoder/Transmitters
- DATV Transmitter was cost barrier for most in USA



Digital-ATV

Block Diagram of DATV Station



Typical System Block Diagram for DVB-S DATV Station





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Different Protocols used for DATV

- DVB-S (satellite based)
- DVB-S2 (satellite for HDTV)
- DVB-T (terrestrial reception)
- ATSC (commercial terrestrial reception in US)
- ITU-T J.83B (US/Canada cable television)





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DVB-S Protocol used for DATV

- DVB-S is used for commercial satellite downlinks
- DVB-S was designed for commercial SD-DTV
- Protocol allows only QPSK Digital modulation
- Protocol typically calls for MPEG-2 encoding
- RF bandwidth is variable = $1.33 \times \text{Symbol-Rate}$
- Hams have hacked RF bandwidth down to 0.5 MHz
- very widely used by hams





Digital-ATV

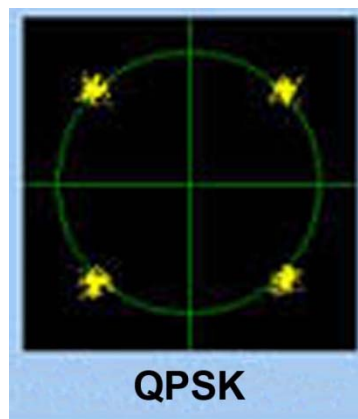
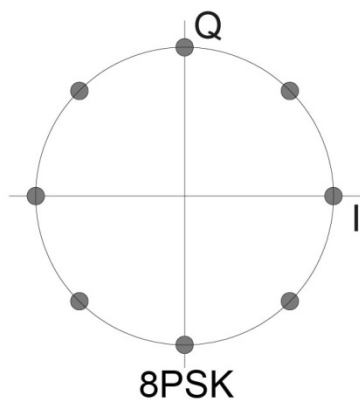
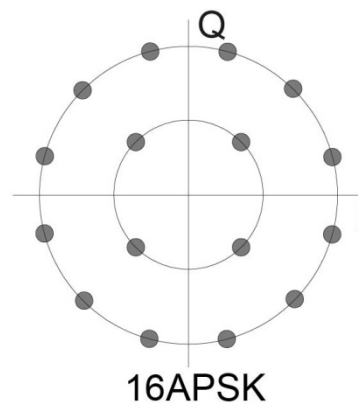
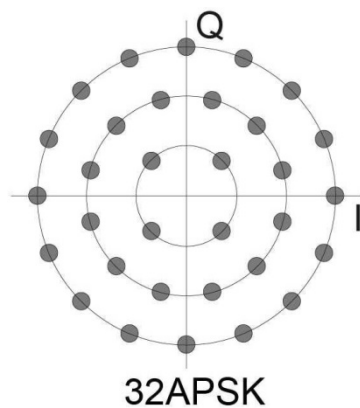
DVB-S2 Protocol used for DATV

- DVB-S2 used for commercial satellite downlinks
- DVB-S2 was designed for commercial HD-DTV
- Protocol allows following digital modulations:
 - QPSK (2-bits/symbol)
 - 8PSK (3-bits/symbol)
 - 16APSK (4-bits/symbol)
 - 32APSK (5-bits/symbol)
- Protocol typically calls for MPEG-4 encoding
- RF bandwidth is variable = $1.2 \times \text{Symbol-Rate}$
- There are licensing issues for ham radio usage



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DVB-S2 Protocol – modulation technologies





Digital-ATV

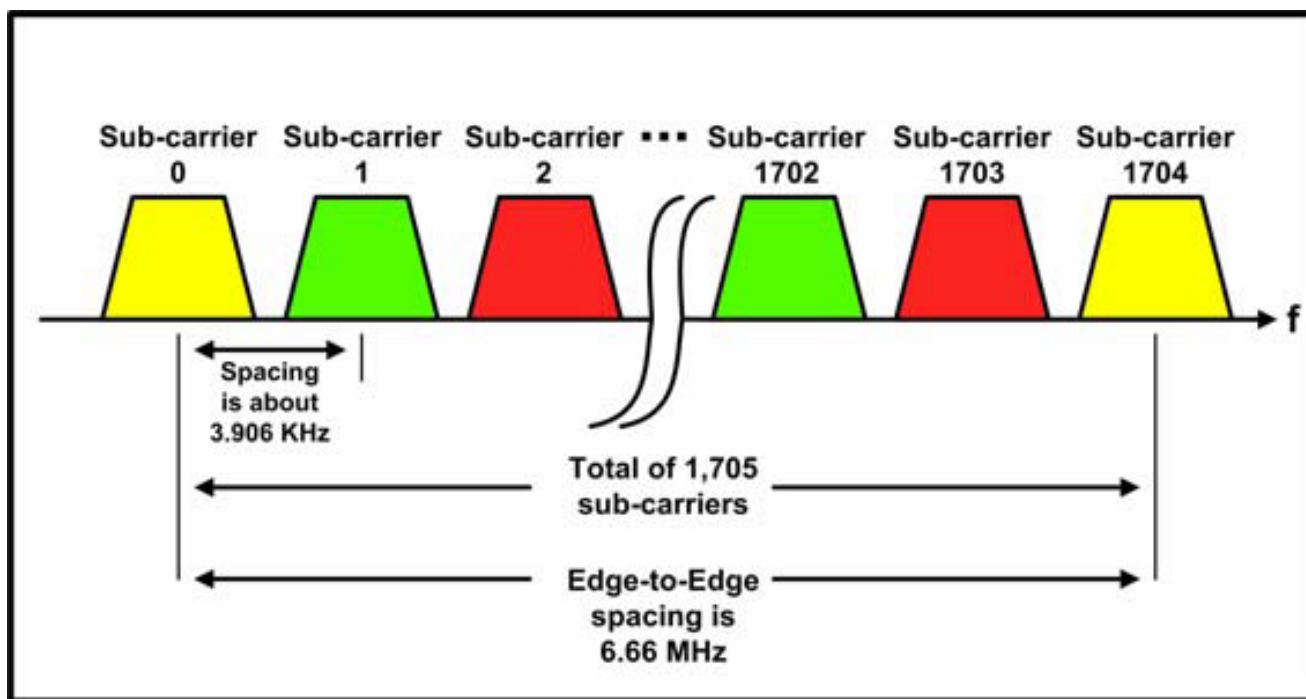
DVB-T Protocol used for DATV

- DVB-T was designed for commercial SD-DTV
- COFDM protocol allows these digital modulations:
 - QPSK (2-bits/symbol)
 - QAM-16 (4-bits/symbol)
 - QAM-64 (6-bits/symbol)
- RF bandwidth can be 1, 2, 3, 4, 6, 7, or 8 MHz
- increasing usage by hams (repeater downlink)
- Used by Amateur Television Network in LA mountains



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DVB-T Protocol used for DATV



COFDM technology allows 1705 sub-carriers (or more)





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ATSC Protocol used for DATV

- ATSC is used for US commercial TV reception
- ATSC was designed for commercial HD-DTV
- Protocol allows only one digital modulation:
 - 8-VSB (3-bits/symbol)
- Protocol typically calls for MPEG-2 video encoding and Dolby (AC3) sound encoding
- RF bandwidth fixed at 8 MHz
- Dolby licensing issues for ham radio usage
- no current active ham experiments





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RF Exciters for ham DATV

- SR-Systems – MiniMod exciter + MPEG-2 encoder
 - DVB-S , DVB-T – about \$875 as received in USA
 - DVB-S2 and ATSC – costs additional...also H.264 encoder was \$900 additional
- DATV-Express – exciter board + PC
 - DVB-S – \$300 + shipping
 - DVB-S2 - \$300 + shipping
 - DVB-T – (experimental 2 MHz bandwidth) \$300 + shipping
- Portsdown Project – exciter board + RPi-3
 - DVB-S – modulator blank PCB & blank filter PCB US\$21 + parts + soldering + ship
 - DVB-S – can use DATV-Express as modulator board \$300 + shipping





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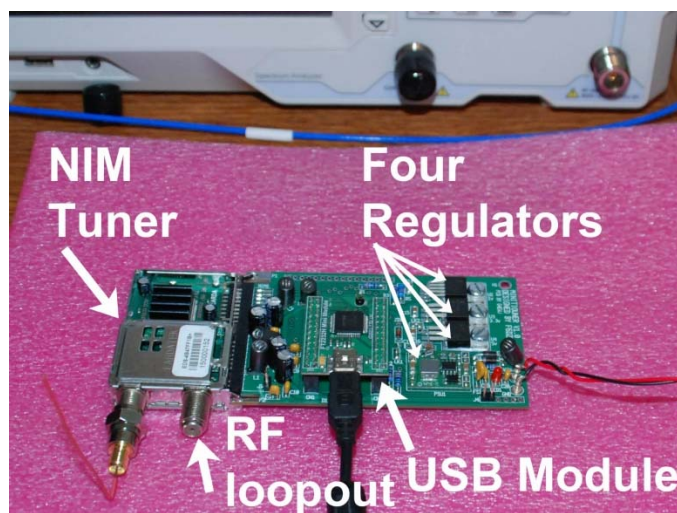
RF Exciters for ham DATV – cont'd

- HiDes – exciter with MPEG-2 encoder + PC
 - DVB-T – model UT100B Tx/Rx about \$250 + shipping on e-bay
 - DVB-T – model HV200E standalone (with MPEG-2 and H.264) \$658 on e-bay
- BATC – DTX1 exciter with MPEG-2 encoder
 - DVB-S – “standalone” model DTX1 about US\$590 + shipping(?) on BATC shop



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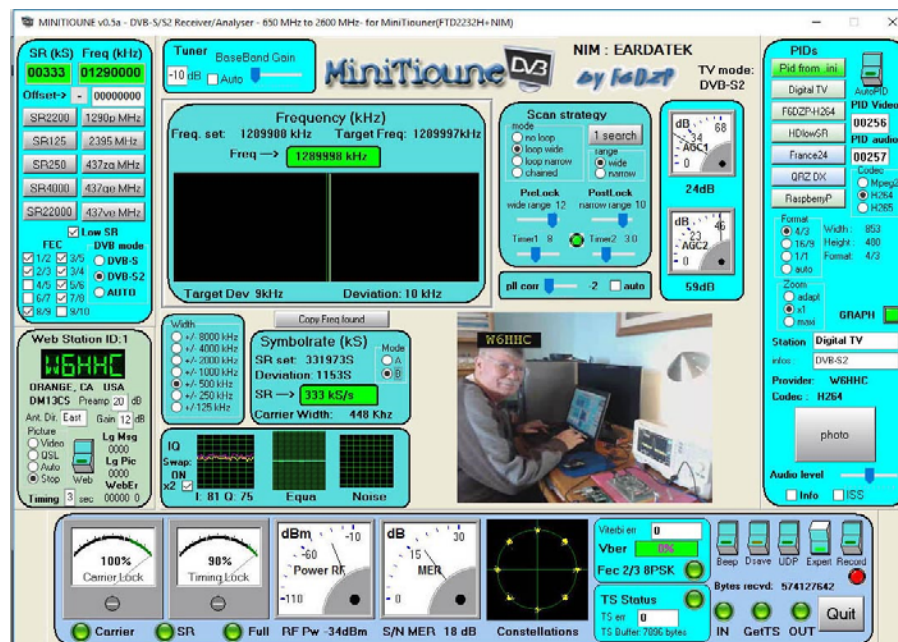
DATV Receivers – Ham-designed DVB-S/DVB-S2 Receiver and DATV Analyzer



- **MiniTiouner Low Symbol Rate** designed by Jean Pierre Courjaud F6DZP
- **Allows Reduced-Bandwidth DATV (RB-DATV)** for small BW & more signal robustness with reasonable reduction in Frame-Rate
- **S/N (C/N) improves 3 dB** every time receiver RF bandwidth is cut in half

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DATV Receivers – Ham-designed DVB-S/DVB-S2 Receiver and DATV Analyzer



MiniTouner can not only full-screen-display the received DATV video, but is a powerful analyzer of DVB-S and DVB-S2 signals in the “Expert Mode”.





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DATV Receivers - Low Symbol Rates were a blocker

DVB-S (QPSK) with H.264					
S/R	H.264 Video	Audio	Resolution	Frames per Sec	FEC
250 KS/sec	300 Kbps	32 Kbps (MPEG1)	352x288 (SD)	18 or 20 fps	7/8
125 KS/sec	110 Kbps	32 Kbps (MPEG1)	320x240 (SD)	12 or 15 fps	7/8
400 KS/sec	360 Kbps	192 Kbps (AC3)	1920x1080 (HD)	??	7/8

- MiniTiouner Low Symbol Rate testing by Jean Pierre Courjaud F6DZP
- Commercial Receivers could not receive SR less than about 1500 KS/sec
- S/N (C/N) improves 3 dB every time receiver RF bandwidth is cut in half





Digital-ATV

Goals of the DATV-Express Project

- Significantly reduce price of Digital-ATV transmitters
- Provide Plug-and-Play hardware board to minimize home construction.
- Provide open platform for future DATV development
- Help educate community about new technologies
- Get more DATV stations on-air
- Encourage wider audience to get ham licensed
- Byproduct can be Software Defined Transmitter from 70 – 2450 MHz ham bands with a B/W of up to 10 MHz



Digital-ATV



The DATV-Express Project Team

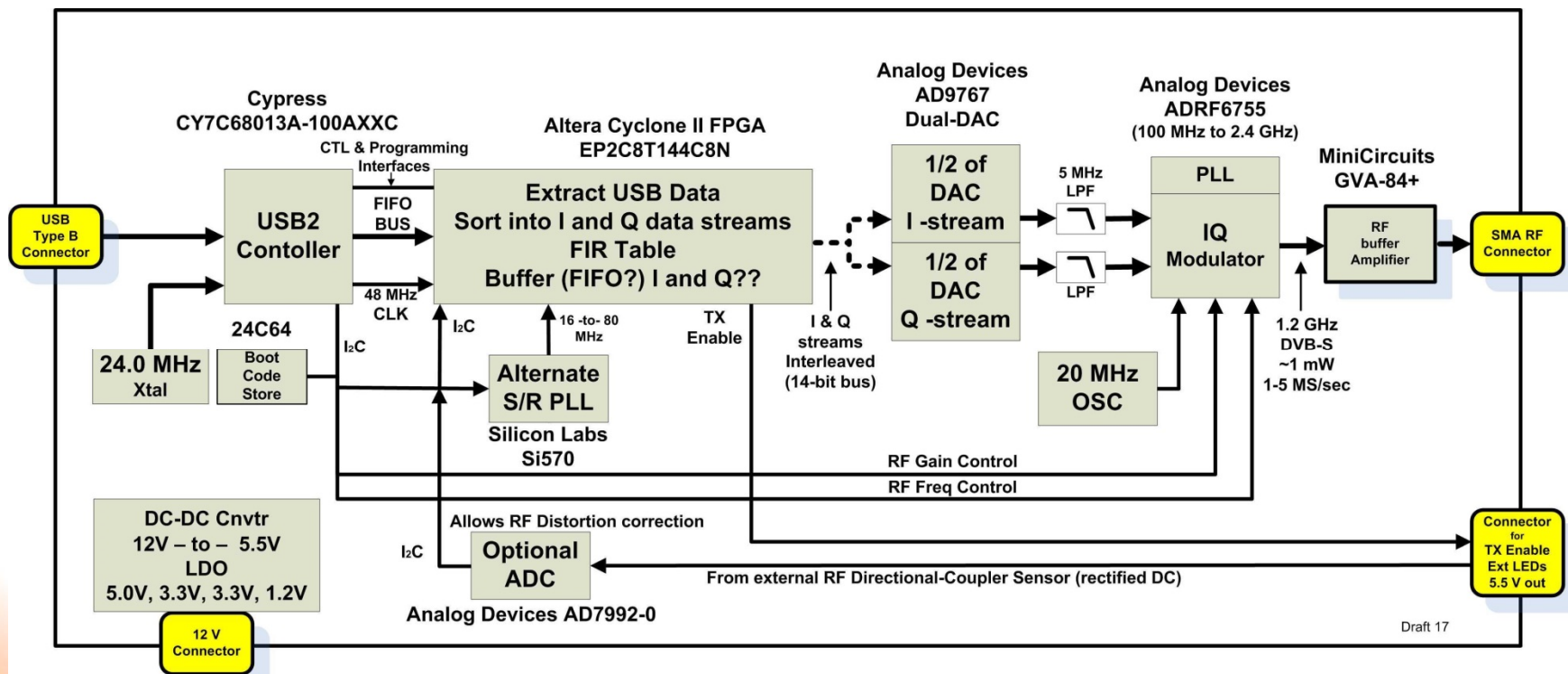
- Charles Brain - G4GUO Ferring, England
- Ken Konechy - W6HHC Orange, CA, USA
- Art Towslee - WA8RMC Columbus, OH, USA
- Tom Gould - WB6P Portland, OR, USA



DATV-Express



DATV-Express board internal block diagram



Block Diagram for DATV-Express Hardware Board



DATV-Express



DATV-Express hardware board





DATV-Express

DATV-Express System Specs

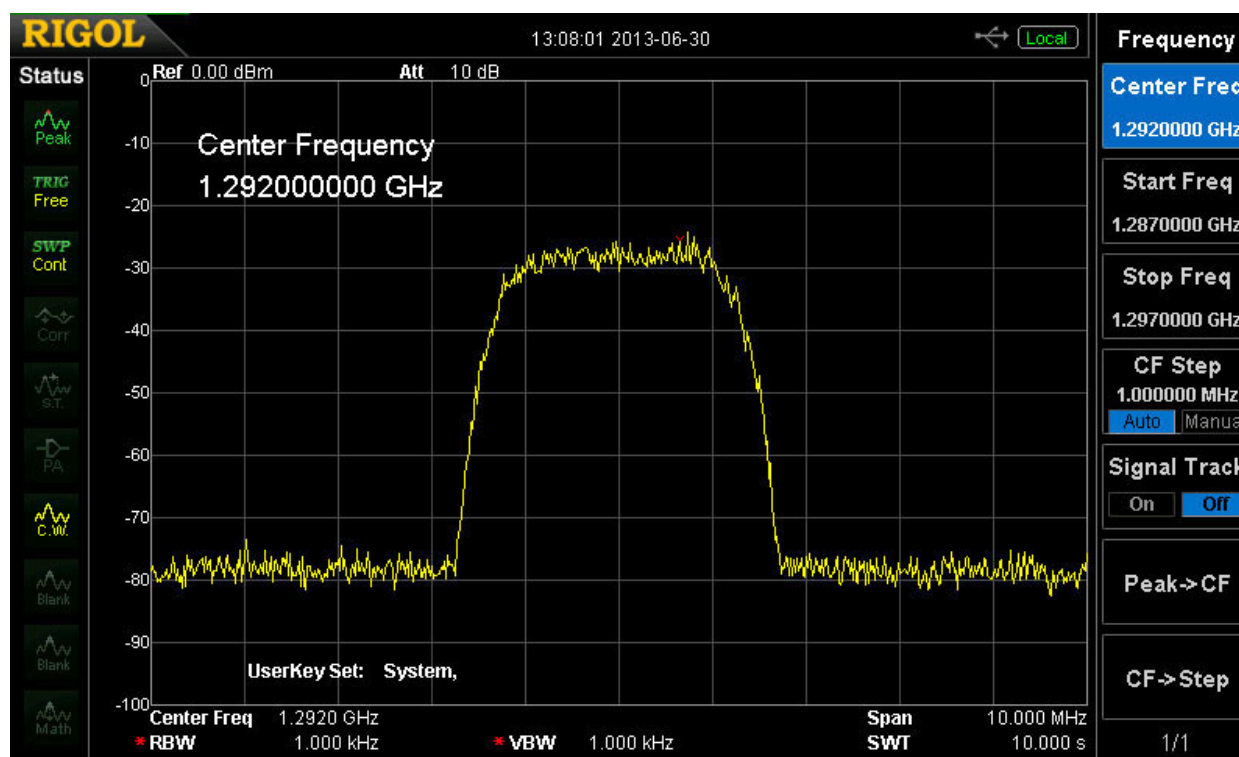
- DVB-S protocol is tested and released
- All IQ modulations fully tested
- Frequency Range:
 - 70–2450 MHz (Modulator chip specification)
- Symbol-Rate:
 - Adjustable: 125 Ksymb/sec to 5 MSymb/second
- Forward Error Correction is selectable
- RF output ~ 1-20 mW buffered (SMA connector)
- USB Webcam or Video Capture card for NTSC/PAL
- PC Operating System – first Ubuntu-32/64-bit
 - Then was quadcore-ARM w/ Libuntu,
 - Then was Windows10 -32/64-bit





DATV-Express

Clean DVB-S 1.2 GHz spectrum

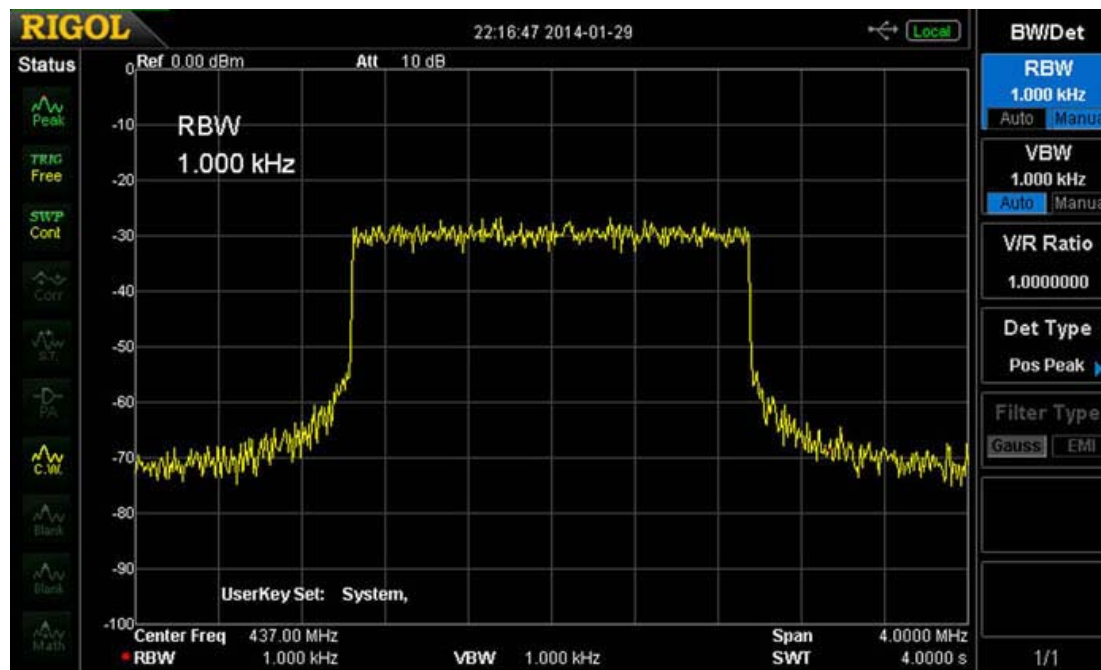


Barefoot board RF output – has 47 configurable levels of RF output



DATV-Express

DATV-Express capable of other DATV protocols used by hams



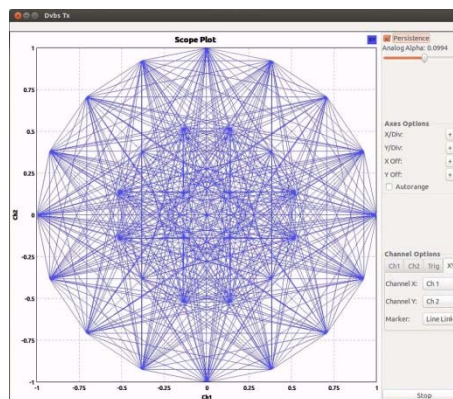
Testing DVB-T (2K mode) protocol at 2 MHz bandwidth on 437 MHz
(using 4096-point iFFT math - with NO alias spurs)



DATV-Express

GNU Radio with DATV-Express

- Alex OZ9AEC has developed gnuradio “sink” module for DATV-Express – (see Github URL at end)
- Ron W6RZ has adapted gnuradio to run DVB-S2 32APSK
- W6RZ uses DATV-Express DVB-S2 code and tested with BladeRF & Novra S300V DVB-S2 STB at up to 10 MSym/s.



DATV-Express



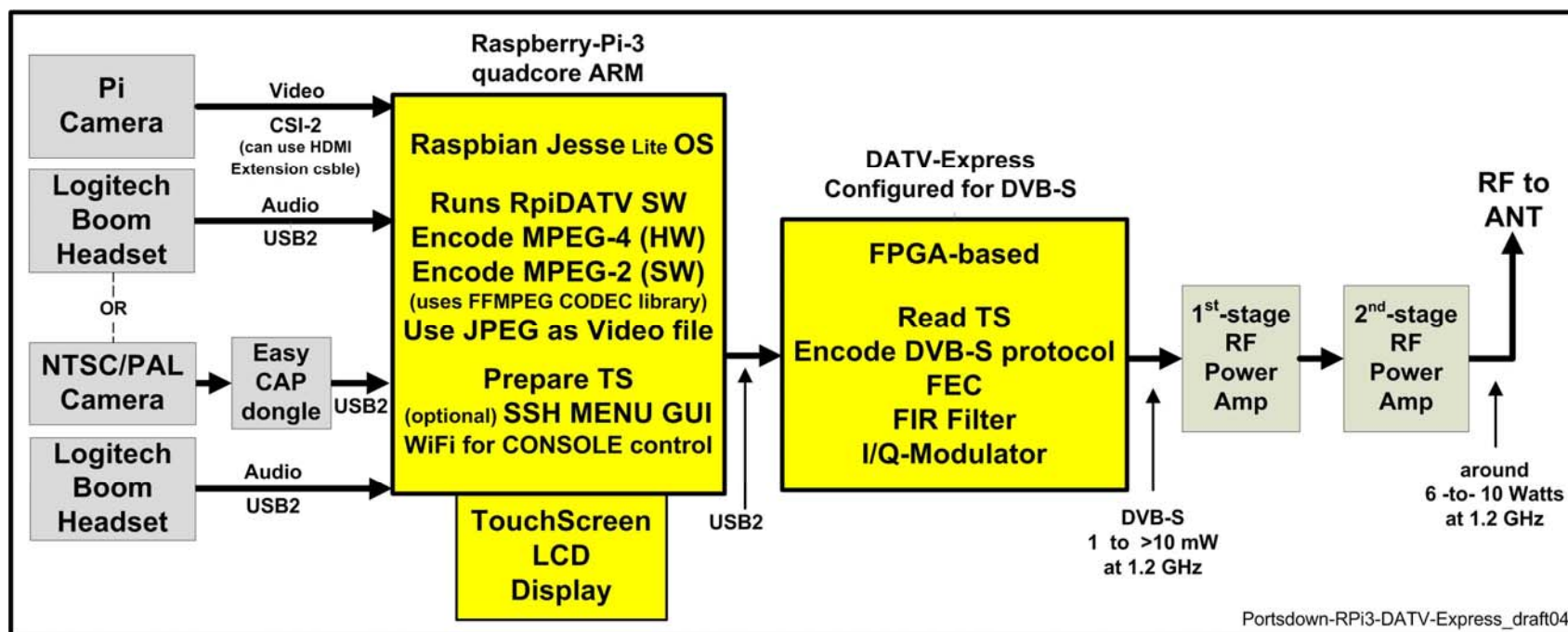
Raspberry PI

- Raspberry PI 3 has quad-core-ARM at 700 MHz
- Raspberry PI 3 typically uses Raspbian Jesse Lite OS
- Originally designed for education market
- Raspberry-Pi-3 is used by Portsdown Project in Europe
- Portsdown Project can use either Portsdown modulator brd or the DATV-Express board as modulator



DATV-Express

Raspberry PI – DVB-S Portsdown Project



Portsdown Project using RPi-3 / RpiDATV SW / DATV-Express modulator



DATV-Express

Raspberry PI – DVB-S Portsdown Project



Portsdown Project using RPi-3 / RpiDATV SW / DATV-Express modulator



DATV-Express



Conclusion and Plans

- DATV-Express Ubuntu 32/64-bit Code for PC is finished
- DATV-Express Windows10 Code for PC is finished
- Always looking for volunteers to help with software
- Focus now is now porting to LimeSDR hardware board
(bigger FPGA & hardware for both Transmitting and Receiving)
- Source files are available
(Software, FPGA coding, gerbers, etc.)
- Beginnings of source code repository at
https://github.com/G4GUO/datvexpress_gui.git



Digital-ATV



- British ATV Club - Digital Forum
www.BATC.org.UK/forum/
- CQ-DATV online (free monthly) e-magazine (ePub and PDF format)
www.CQ-DATV.mobi
- OCARC library of newsletter DATV articles
www.W6ZE.org/DATV/
- TAPR Digital Communications Conference proceedings (free downloads)
www.TAPR.org/pub_dcc.html
- Yahoo Group for Digital ATV
<http://groups.yahoo.com/group/DigitalATV/>
- DATV-Express project website
www.DATV-Express.com
- HiDes (Taiwan) DVB-T D-ATV (Boards – and standalone)
www.HiDes.com.tw/product_cg74469_eng.html
- Portsdown Project for DATV (RPI3-based BATC project for DVB-S)
<http://batc.org.uk/forum/viewforum.php?f=103>
- SR-Systems (Germany) D-ATV components(Boards)
www.SR-systems.de and www.D-ATV.org

