



2013 ARRL/TAPR DCC

DATV-Express – a Testing Report

by

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The Presentation Authors....



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Status of Digital-ATV Today

- Video Quality of DATV far exceeds analog-ATV
- Very few hams transmitting DATV in USA today
- European DATV is very active and growing
- Australia/New Zealand has more DATV activity than USA
- Digital-ATV transmitters are currently expensive
- US\$1,000 (and more) for MPEG/DVB-S Encoder/XMTR
- Cost of DATV Transmitter is barrier to more ham use

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Goals of the DATV-Express Project

- Significantly reduce the price of Digital-ATV transmitters
- Plug-and-Play H/W board to minimize home construction
- Provide an open platform for future DATV development
- Help educate the community about new technologies
- Get more DATV stations on-air
- Encourage a wider audience to get ham licensed
- Byproduct will be a Software Defined Transmitter from 144 –to-2400 MHz ham bands with a B/W of up to 8 MHz.

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The DATVexpress Team

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

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Overview of DATVexpress System

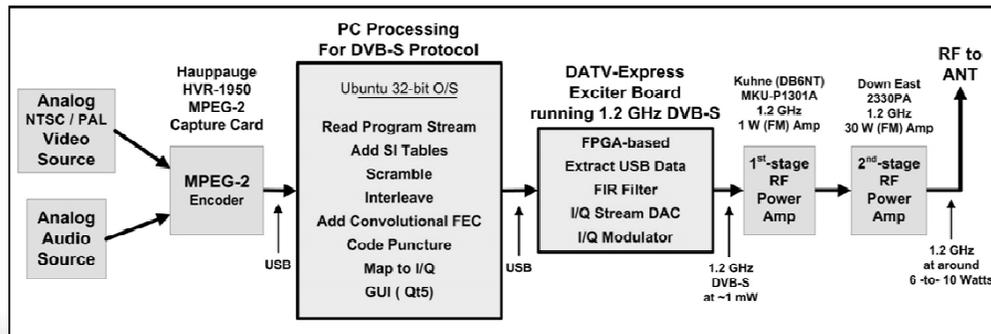
- USB Video Capture card for MPEG-2 encoding
- PC (Linux) performs DVB-S protocol processing and outputs I/Q stream
- Simple Hardware board exciter preps I/Q stream & does IQ modulation at 144-2400 MHz
- Just add RF Power Amps and Antenna

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Overview of DATV-Express System – cont'd



System Block Diagram for DATV-Express DVB-S DATV Transmitter Tested

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Overview of Hardware Board

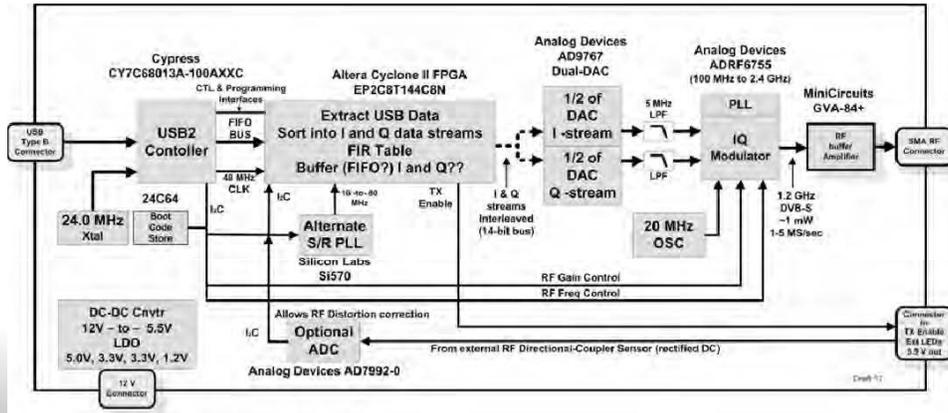
- Single custom designed board preps I/Q stream and provides IQ modulation at 1.3 GHz in our tests
- Interfaces to PC processing by USB2
- Contains PLL for the 70-to-2450 MHz freq control
- Controls Symbol-Rate
- Provides small buffer-RF amplifier to 1 to 15 mW
- DC-DC power supplies allows single 12V input
- SMA connection to RF Power Amp stages and antenna

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Overview of Hardware Board – cont'd



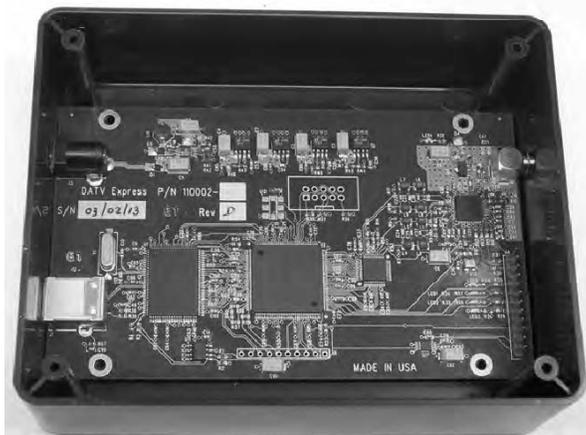
Block Diagram for DATV-Express Hardware Board

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Overview of Hardware Board – cont'd



DATV-Express Hardware Board (Prototype #3)

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DATV-Express System Specs

- DVB-S protocol was tested
- All IQ modulations (QPSK modulation was tested)
- Frequency Range:
 - 70–2500 MHz (allowed by ADRF6755 chip)
- Symbol-Rate:
 - Adjustable: 1 MSymb/sec -to- 5 MSymb/sec
- Forward Error Correction is selectable
- RF output ~ 20 mW buffered (SMA connector)
- USB Video Capture card allows for NTSC or PAL
- Initially designed for one video stream
- Operating system – first release as Ubuntu-32/64

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1st DVB-S Transmission on First prototype

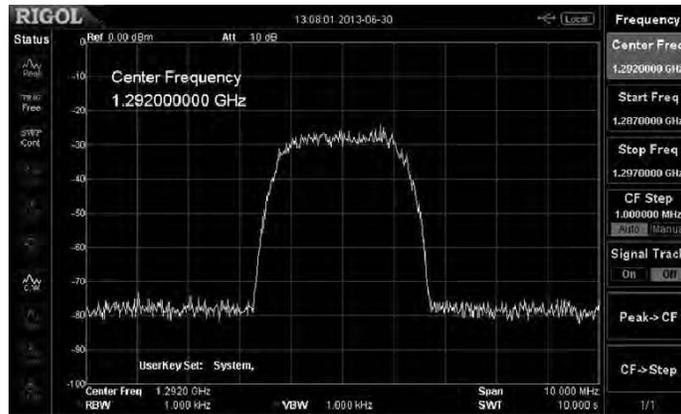


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Clean DVB-S 1.2 GHz spectrum



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

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QPSK Constellation noise improvements with second-etch Layout



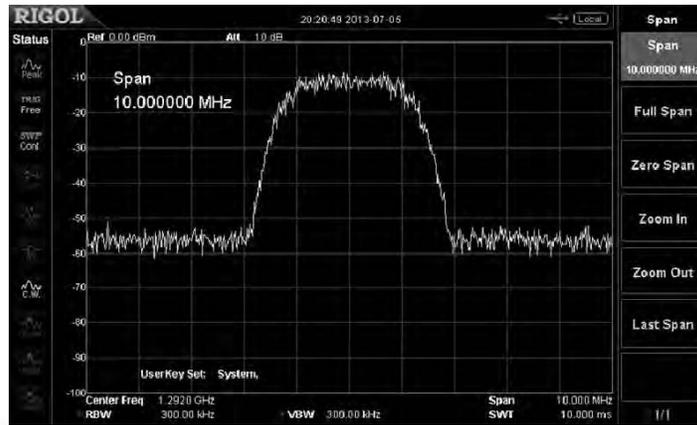
Second-etch (left) is clean – Original etch (right) had noisy RF section

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DVB-S clean with 1st stage RF amp



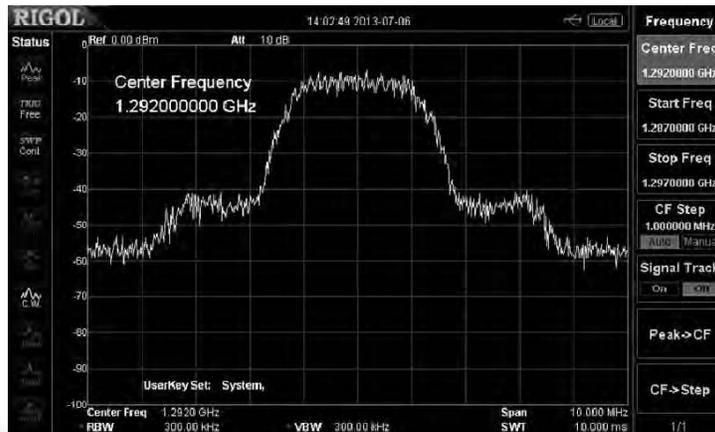
Test Using 1st-stage RF amp (Kuhne MKU-P1301A 1W FM) on 1.2 GHz

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DVB-S Acceptable with final RF amp



Test Using DownEast 30W (FM) on 1.2 GHz has shoulders at -30 dB

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DATV RF Amplifier Power De-rating

- One aspect of power amplifiers surprises newcomers to Digital-ATV
- DATV can NOT achieve the same average power out of an RF amplifier as FM modulation
- Most digital modulation technologies have a very high “peak-to-average ratio”
- To prevent DATV distortion, you need to reduce the drive so peaks do not go into compression or flat-topping.

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DATV RF Amplifier Power De-rating – cont’d

- **Web site from Alberto (DGØVE) explains (in German):**

“All [our FM] amplifiers can also be used for DVB-S and DVB-T with reduced power.

You will notice that in the DVB-S mode only about 20% to 25% of the maximal power (P-1dB) can be used.

Working in the DVB-T mode you will get only approximately 8% to 10% of the P-1dB power level.”

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Bench Test RF Measurements for DVB-S

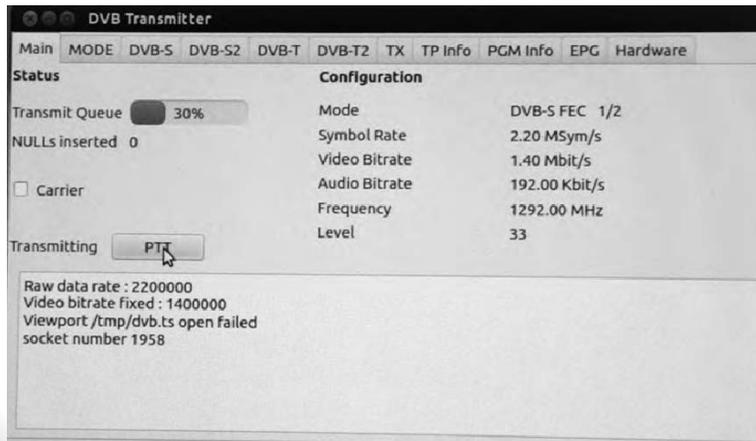
DATV-Express exciter Menu Power-level setting	Kuhne first-amp spectrum level	Spectrum Analyzer RBW setting	"distortion shoulder" below main carrier	Down East 2nd-amp spectrum level	Spectrum Analyzer RBW setting	"distortion shoulder" below main carrier	Down East Power Measurement (HP 432A)	
							Output dBm	Output W
20	- 12 dBm	300 KHz	NONE				N/A	
30	- 3 dBm	300 KHz	NONE				N/A	
40	+ 8 dBm	300 KHz	NONE				N/A	
46	+ 15 dBm	300 KHz	- 34 dB				N/A	
The above spectrum analyzer reading values account for 20 dB of external attenuation								
20	N/A			+ 22 dBm	300 KHz	NONE	N/A	
25	N/A			+ 28 dBm	300 KHz	- 35 dB	N/A	
30	N/A			+ 31 dBm	300 KHz	- 32 dB	36.3 dBm	4.3 W
33	N/A			+ 32 dBm	300 KHz	- 30 dB	38.8 dBm	7.6 W
35	N/A			+ 35 dBm	300 KHz	- 28 dB	40.3 dBm	10.7 W
The above spectrum readings account for 40 dB of external attenuation								

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Simple DATV-Express User Interface



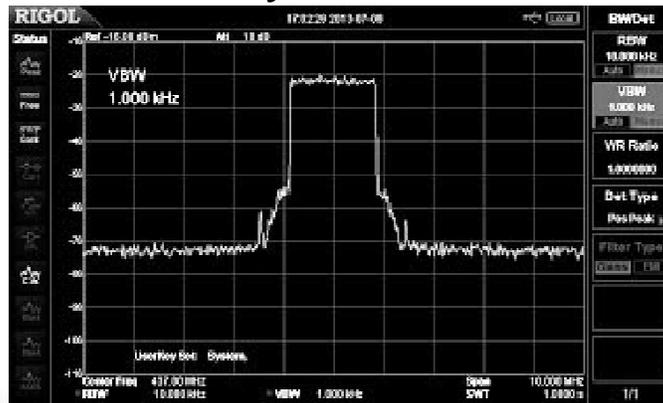
Software User Interface uses Qt5 (screen is configured for DVB-S Protocol)

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DATV-Express capable of other DATV protocols used by hams

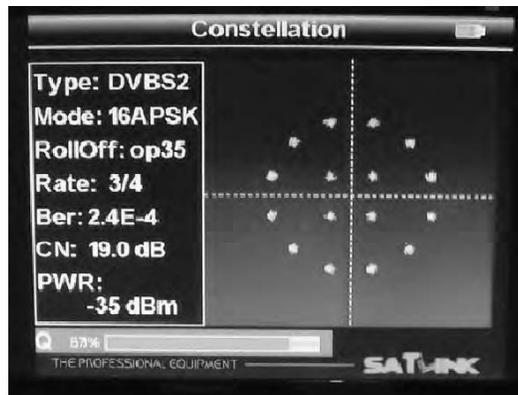


Test using prototype DVB-T protocol at 2 MHz bandwidth on 437 MHz

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DATV-Express capable of other DATV protocols used by hams – cont'd



Testing constellation for 16APSK digital modulation for DVB-S2 protocol

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Current Project Status

- Architecture – completed, stable
- Schematic Capture – completed in DXdesigner tool
- PCB Layout – second-pass completed in PADS tool
- Four prototype boards are assembled and still working
- Design check-out and software integration continues
- Initial DVB-S transmission tests completed
- Initial DVB-T protocol working
- Two switching-PS-freq spurs appear on RF (-60 dB)

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What about DVB-T, DVB-S2, 8VSB, ITU-T_J.83, etc?

- “Yes, they are possible....”
- “But, the team has only committed to DVB-S, probably DVB-T”
- We are being encouraged to plan for Raspberry Pi and looks feasible with more functions moved into FPGA.

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Conclusion and Plans

- Ubuntu 32/64 Code is essentially finished
- Finish tweaking FPGA code
- Looking for volunteers to help with software tasks
- Finish etch-clean-up “pre-production” layout (third layout)
- Source files will be freely available with no restrictions (Software, FPGA coding, Schematic, PADS-files, etc)
- DATV-Express team on target for ~ten pre-production DVB-S boards with Ubuntu for alpha testers...late October.

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Useful Links:

- Amateur Television of Central Ohio
www.ATCO.TV
- British ATV Club - Digital Forum
www.BATC.org.UK/forum/
- 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/>
- Charles-G4GUO blog on DATV-Express project development
www.g4guo.blogspot.com/
- DigiLite Project for DATV (derivative of the “Poor Man’s DATV”)
www.G8AJN.tv/dlindex.html
- SR-Systems D-ATV components(Boards)
www.SR-systems.de and www.D-ATV.org
- CQ-DATV online (free bi-monthly) e-magazine (ePub format)
www.CQ-DATV.mobi