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DATV-Express - a Testing Report

by

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DATV-Express

The Presentation Authors....

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DATV-Express

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

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.
DATV-Express

The DATVexpress Team

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• Charles Brain - G4GUO Ferring, England
• Ken Konechy - W6HHC Orange, CA, USA
• Tom Gould - WB6P Portland, OR, USA

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
Overview of DATV-Express System - cont’d

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

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 MSymbol/sec -to- 5 MSymbol/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

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
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.

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.”
**DATV-Express**

**Bench Test RF Measurements for DVB-S**

<table>
<thead>
<tr>
<th>DATV-Express exciter Menu Power-level setting</th>
<th>Kuhne first-amp spectrum level</th>
<th>Spectrum Analyzer RBW setting</th>
<th>&quot;distortion shoulder&quot; below main carrier</th>
<th>Down East 2nd-amp spectrum level</th>
<th>Spectrum Analyzer RBW setting</th>
<th>&quot;distortion shoulder&quot; below main carrier</th>
<th>Down East Power Measurement (HP 435A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>-12 dBm</td>
<td>300 kHz</td>
<td>NONE</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>Output dBm</td>
</tr>
<tr>
<td>30</td>
<td>-3 dBm</td>
<td>300 kHz</td>
<td>NONE</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>Output dBm</td>
</tr>
<tr>
<td>40</td>
<td>+8 dBm</td>
<td>300 kHz</td>
<td>NONE</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>Output dBm</td>
</tr>
<tr>
<td>44</td>
<td>+15 dBm</td>
<td>300 kHz</td>
<td>-34 dB</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>Output dBm</td>
</tr>
</tbody>
</table>

The above spectrum analyzer readings account for 20 dB of external attenuation.

| 20   | N/A | +22 dBm | 300 kHz | NONE | N/A | Output dBm | Output W |
| 25   | N/A | +20 dBm | 300 kHz | -55 dB | N/A | Output dBm | Output W |
| 30   | N/A | +21 dBm | 300 kHz | -22 dB | 38.3 dBm | 4.3 W | Output dBm | Output W |
| 33   | N/A | +32 dBm | 300 kHz | -30 dB | 38.8 dBm | 7.6 W | Output dBm | Output W |
| 35   | N/A | +38 dBm | 300 kHz | -28 dB | 49.3 dBm | 10.7 W | Output dBm | Output W |

The above spectrum readings account for 10 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.
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.

Useful Links:

- Amateur Television of Central Ohio
  [www.ATCO.TV](http://www.ATCO.TV)
- British ATV Club - Digital Forum
- OCARC library of newsletter DATV articles
- TAPR Digital Communications Conference proceedings (free downloads)
  [www.TAPR.org/pub_dcc.html](http://www.TAPR.org/pub_dcc.html)
- Yahoo Group for Digital ATV
  [http://groups.yahoo.com/group/DigitalATV/](http://groups.yahoo.com/group/DigitalATV/)
- Charles-G4GUO blog on DATV-Express project development
  [www.g4guo.blogspot.com/](http://www.g4guo.blogspot.com/)
- DigiLite Project for DATV (derivative of the “Poor Man's DATV”)
- SR-Systems D-ATV components(Boards)
  [www.SR-systems.de](http://www.SR-systems.de) and [www.D-ATV.org](http://www.D-ATV.org)
- CQ-DATV online (free bi-monthly) e-magazine (ePub format)
  [www.CQ-DATV.mobi](http://www.CQ-DATV.mobi)