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Testing a DATV Station using DVB-S

by

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Testing a DVB-S DATV Station

So What Started our DATV Project?

Over several years both of us have been involved in interesting conversations like:

“...we hams should change analog ATV over to Digital-ATV (aka DATV) to keep up with technology...”
Testing a DVB-S DATV Station

Why Go Digital ATV?

• Picture quality can be nearly perfect much of time
• Digital allows error correction from noise, multipath
• Digital techniques allow advanced modulation
  – compression
  – less bandwidth
• Digital TV components for hams will become more common
• Analog TV components for hams will start to disappear
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

Block Diagram Showing DATV Exciter being Tested
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

MPEG2 and DVB-S 1.2 GHz Exciter from SR-Systems on the Test “Breadboard”
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

DVB MiniMod Firmware V54.34 LOWDVBT
(c) 2009 maintech GmbH

Modulation Settings
1) TX Enable (ON AIR)
2) Output Frequency (1290000 kHz)
3) Spectrum (normal)
4) Carrier Only (no)
5) Output Gain (12)
6) Symbolrate (2500 ksym/s)
7) Coderate (FEC) (3/4)
0) exit menu

Typical HyperTerminal Menu Display of the DVB-S Exciter Settings
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

Determining How to Tune SetTopBox

Local Oscillator = 10,600 MHz

STB Search Freq = XMIT Freq + 10,600 MHz
STB Search Freq = 1290 MHz + 10,600 MHz
STB Search Freq = 11890 MHz
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Testing the DATV Exciter boards

STB Configuration Menu for Editing Received Frequencies and other Settings
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Testing the DATV Exciter boards

First DATV Test Pictures (of Ken W6HHC) are Displayed on Dell Notebook Computer
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

Robbie-KB6CJZ Inspects RF Bandwidth with an HP Spectrum Analyzer
Testing a DVB-S DATV Station

Testing the DATV Exciter boards

Predicting QPSK RF Bandwidth

\[
\text{RF Bandwidth}_{(\text{allocation})} = 1.33 \times \text{Symbol-Rate} \\
\text{RF Bandwidth}_{(\text{allocation})} = 1.33 \times 2.5 \text{ MSymbols/sec} \\
\text{RF Bandwidth}_{(\text{allocation})} = 3.33 \text{ MHz signal}
\]
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Testing the DATV Exciter boards

Close-up of the 1.290 GHz Signal RF Bandwidth on the HP Spectrum Analyzer Display
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

Block Diagram Showing the Full DATV Station being Bench Tested
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

Breadboard of MPEG-2 Board and MiniMod Exciter Board and the Kuhne 1st-Stage 1W PA (on right side)
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

HP Model 8559A Spectrum Analyzer looks at Kuhne first-stage PA output
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

Construction of Down East Model 2330PA 30W Power Amplifier
## Testing a DVB-S DATV Station

### Bench Testing the DATV Power Amplifiers

<table>
<thead>
<tr>
<th>MiniMod-S exciter power setting</th>
<th>Measured MiniMod Output mW</th>
<th>Measured Kuhne 1st-amp Output mW</th>
<th>Measured Down East 2nd-amp Output W</th>
<th>&quot;shoulder&quot; below main carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0661 mw</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>0.158 mw</td>
<td>N/A</td>
<td>5.75 W</td>
<td>35 dB</td>
</tr>
<tr>
<td>7</td>
<td>1.32 mw</td>
<td>N/A</td>
<td>10.7 W</td>
<td>31 dB</td>
</tr>
<tr>
<td>8</td>
<td><strong>1.74 mw</strong> <strong>115 mW</strong></td>
<td><strong>12.9 W</strong></td>
<td>28 dB</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2.24 mw</td>
<td>N/A</td>
<td>15.1 W</td>
<td>27 dB</td>
</tr>
</tbody>
</table>

(Note: the readings below are with 5 dB attenuator between the first-PA and the second-PA)

Power Measurements taken during the DVB-S Station Testing
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

De-rating RF Power Amplifiers for QPSK

- QPSK has high ratio of peak-power to average-pwr
- Overdriven RF PA will begin to compress the peaks and eventually “flat top” the peaks of power
- Roberto (DGØVE) recommends “in the DVB-S mode only about 20% to 25% of maximal output power (P-1dB) can be used [without distortion]”
  - P(FM) = 40W
  - P-1dB = 30W
  - 25% of P-1dB = 7.5W maximum DVB-S power out
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

HP Spectrum Analyzer looks at Down East output signal (shoulders about 28 dB down)
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

Choices of Video Resolution

-- D1 Resolution --
D1 is the normal resolution that is used on a normal Standard-Definition Digital television (DVD quality).
D1 = 720 x 576 Pixel for PAL
D1 = 720 x 480 Pixel for NTSC

-- HD1 Resolution --
The HD1 resolution does NOT mean “High Definition”. It turns out that HD1 really means “Half of D1”.
HD1 = 352 x 576 pixels for PAL
HD1 = 352 x 480 pixels for NTSC
Volker-DJ1CU states that in his opinion HD1 resolution is perfectly acceptable for DATV.

-- SIF Resolution --
SIF stands for "Standard Input Format". It is related closely to CIF ("Common Interchange Format")
SIF = 352 x 288 pixels for PAL
SIF = 352 x 240 pixels for NTSC
CIF = 352 x 288 pixels for PAL and for NTSC
Testing a DVB-S DATV Station

Bench Testing the DATV Power Amplifiers

Net Data Bit Rate required for Video Resolutions

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Video NDBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>~2.0 Mbps</td>
</tr>
<tr>
<td>HD1</td>
<td>~1.1 Mbps</td>
</tr>
<tr>
<td>SIF</td>
<td>~0.5 Mbps</td>
</tr>
</tbody>
</table>
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Bench Testing the DATV Power Amplifiers

Digital-ATV “Latency”

Typical XMT-to-RCV delay is ~ 1 second

1. MPEG-2 Encoder
2. SetTopBox Receiver (the Decoder)
3. USB2 Video-Capture Board
4. Graphics Processing in Notebook Display
# Testing a DVB-S DATV Station

## Bench Testing the DATV Power Amplifiers

### Measured DATV Latency Delays

<table>
<thead>
<tr>
<th>Test</th>
<th>Analog TV</th>
<th>WinXP Pro</th>
<th>Win7 Pro</th>
<th>USB2 Video Capture board</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 sec</td>
<td></td>
<td></td>
<td>(none used)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.2 sec</td>
<td>1.2 sec</td>
<td>Startech.com USB2</td>
<td>StarTech GrabBee lite display SW</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.47 sec</td>
<td></td>
<td>Hauppauge WinTV-HVR-1950</td>
<td>WinTV Ver 6 display software</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2.8 sec</td>
<td></td>
<td>Hauppauge WinTV-HVR-1950</td>
<td>WinTV Ver 7 display software</td>
</tr>
</tbody>
</table>
Testing a DVB-S DATV Station

Field Testing the DATV Station

Some Background

• Authors are both members of COAR RACES

• COAR RACES frustrated with quality of field analog-ATV

• 440 MHz analog-ATV quality degraded by multi-path and obstacles (elevated freeways, buildings, trees)

• Analog-ATV quality only P1 or P2 from many locations

• Speculated that perhaps DATV might provide solution
Testing a DVB-S DATV Station

Field Testing the DATV Station

Block Diagram of DVB-S Transmitter and Receiver for DATV Field Tests
Testing a DVB-S DATV Station

Field Testing the DATV Station

1.2 GHz Loop-Yagi receiving antenna on roof of Orange PD
Testing a DVB-S DATV Station

Field Testing the DATV Station

• 24-element 1.2 GHz Loop-Yagi three stories high on OPD roof
• 1.2 GHz Low-Noise Amplifier (LNA) on roof near antenna
• 250+ feet of coax down to EOC Radio Room
• EOC Radio Room contains DATV STB and TV monitors
• DATV then distributed to large LCD displays in EOC room

• DATV Freq = 1.292 GHz
• DATV S/R = 2.2 Msymbols/sec
• DATV FEC = 1/2
• DATV NDBR = 2.03 Mbits/sec (payload for video + audio)
• RF BW allocated = 3.0 MHz
Testing a DVB-S DATV Station

Field Testing the DATV Station

Field set-up of 1.2 GHz Transmitting Loop-Yagi Antenna
Testing a DVB-S DATV Station

Field Testing the DATV Power Amplifiers

First Field Test – El Modena High School

First received DATV Video at the Orange PD – perfect P5
Testing a DVB-S DATV Station

Field Testing the DATV Power Amplifiers

First Field Test – El Modena High School

Robbie KB6CJZ receives DATV Video inside EOC Radio Room
Testing a DVB-S DATV Station

Field Testing the DATV Power Amplifiers

Second/Third Field Test – AMTRAK Train Station & RACES Drill

Close-up of a large-screen display in the EOC Room shows clarity of received DATV – perfect P5
Testing a DVB-S DATV Station

Conclusion and Plans

• Learned a lot about different aspects of DATV during testing
  – Video Resolution choices
  – DATV “Latency” details
  – RF Amplifier de-rating concepts

• COAR RACES very pleased with DATV video quality
• In both field locations where analog-ATV was poor – we got P5
• Digital-ATV really does work better than analog-ATV!
• DVB-S protocol/modulation is robust!
• More field testing to look at some pixilation from fast bus
• DATV project has been a great adventure...
  – From a study
  – To planning a station
  – To testing a station
Planning a DVB-S DATV Station

Useful Links:

- ARRL-TAPR DCC 2009 paper on “Planning a DATV Station on DVB-S”
  www.TAPR.org/pub_dcc28.html
- TAPR PSR Quarterly Journal Issue 111 on DVB-S Modulation Overview
  www.TAPR.org/psr.html
- Amateur Television of Central Ohio
  www.ATCO.TV
- British ATV Club - Digital Forum
  www.BATC.org.UK/forum/
- Orange County ARC complete series of newsletter DATV articles
  www.W6ZE.org/DATV/
- Charles Brain-G4GUO blog on Software-Defined-Radio project for DATV
  www.G4GUO.blogspot.com/
- Rob Swinbank-MØDTS details of “Poor Man's Digital ATV Transmitter – LIVE update”
  www.M0DTS.co.uk/datv.htm
- Volker Broszeit DJ1CU article for “The DVB-S 70 cm Sender” (in German)
  www.DATV.de/Projekte/projekte.html
- AGAF D-ATV components (Boards)
  www.datv-agaf.de and www.AGAF.de
- Down East Microwave microwave amplifiers, low noise amplifiers (LNA)
  www.DownEastMicrowave.com/
- Kuhne Electronics (DB6NT) RF Amplifiers
  www.Kuhne-Electronic.de
- SR-Systems D-ATV components (Boards)
  www.SR-systems.de