TechTalk #83

DATV Testing Report - Part 3 (Bench Testing)

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In TechTalk77, we provided a testing report (Part 1) of the Digital-ATV exciter and the SetTopBox (STB) DVB-S receiver for the first time. A lot of information has been learned about DATV since our first testing report. Now, a first-stage (driver) power amp and a second-stage 30W power amplifier have been added. This report will cover bench testing the new power amplifiers and discuss information on receiving signals with different video resolutions.

First-Stage Power Amp

If you look at the block diagram in **Fig 1**, you will see that the first-stage 1.2 GHz PA chosen was the Kuhne model MKU-P1301A unit. We knew we wanted to use the Down East unit for stage-two...and we knew that Down East specified that their PA needed no more than about 25 mW to drive to full linear output levels. But, the SR-Sys MiniMod-S exciter output was only around 1 mW. So the 1 W Kuhne MKU-P1301A PA turned out to be a good choice. A little expensive, this 1W PA costs more than the Down East 30W unit, but it is a well-engineered PA for our purposes.

Fig 2 shows a photo of the exciter connected to the first-stage Power Amp on our "bread board" set-up. Notice that the Kuhne 1 W PA (on the far-right) is mounted on a thick aluminum plate that serves as a heat-spreader (aka "heatsink"). The Kuhne PA contains two internal voltage regulators to provide correct voltage to the power amp circuitry from the big 12V external power supply. These internal regulators draw a standby power of about 6 W.

When tested with an HP Model 432A microwave power meter, the Kuhne delivered plenty of power for our needs. **Table 1** shows that we could get "measured average power" of over 300 mW output when driven hard by the exciter.

Figure 1 – Block Diagram Showing DATV Station being Tested

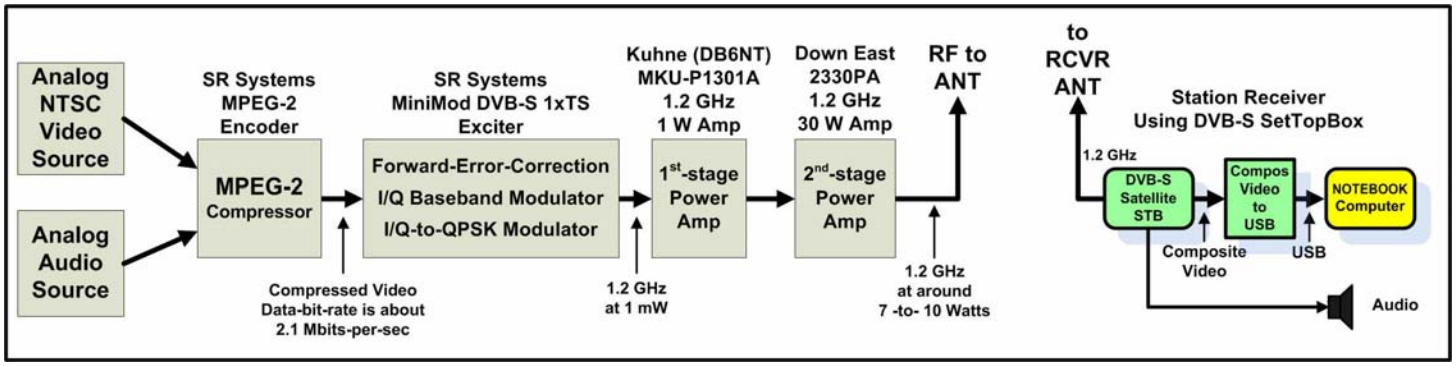

Figure 2 – Breadboard of MPEG-2 Board and MiniMod Exciter Board and Kuhne 1st-Stage PA

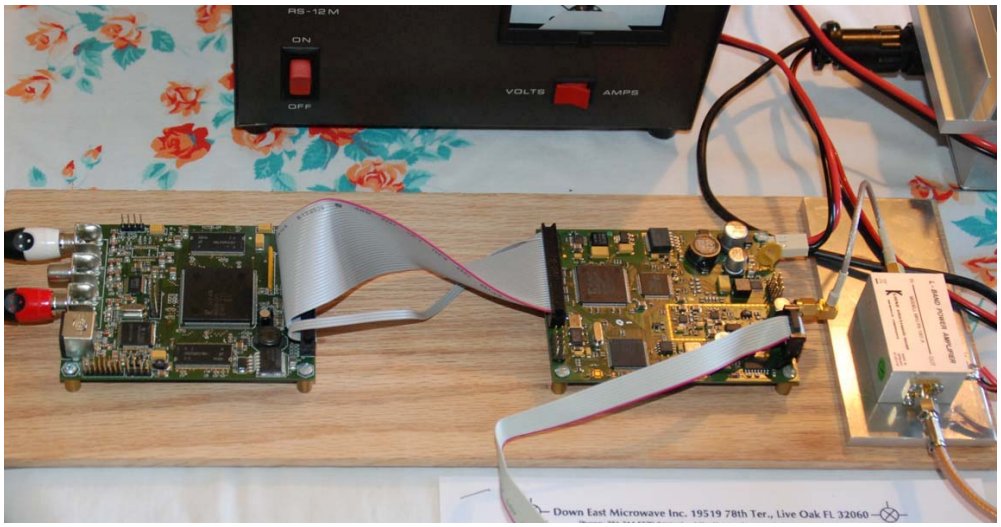

Table 1 – Power Measurements taken during the DVB-S Station Testing

MiniMod-S exciter menu power setting	Measured MiniMod Output mW	Measured Kuhne 1st-amp Output mW	Measured Down East 2nd-amp Output dBm	Measured Down East 2nd-amp Output W	"shoulder" below main carrier
1	0.0661 mw	N/A	N/A	N/A	N/A
2	0.158 mw	N/A	37.6 dBm	5.75 W	35 dB
3	0.302 mw	N/A	39.7 dBm	9.33 W	32 dB
4	0.490 mw	N/A	41.8 dBm	15.1 W	29 dB
(Note: the readings below are with 5 dB attenuator between the first-PA and the second-PA					
5	0.724 mw	N/A	38.0 dBm	6.31 W	34 dB
6	1.00 mw	N/A	39.3 dBm	8.51 W	32 dB
7	1.32 mw	N/A	40.3 dBm	10.7 W	31 dB
8	**1.74 mw**	**115 mW**	**41.1 dBm**	**12.9 W**	**28 dB**
9	2.24 mw	N/A	41.8 dBm	15.1 W	27 dB
10	2.63 mw	158 mW	42.3 dBm	17.0 W	25 dB

Fig 3 shows that the output signal of the Kuhne Power Amp was very clean (without spectral regrowth "shoulders") even when being driven to the maximum by the exciter RF output settings.

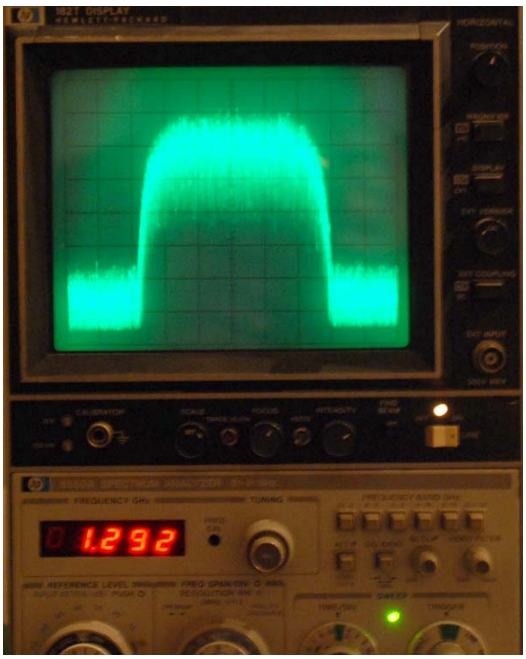

Figure 3 – HP Model 8559A Spectrum Analyzer looks at Kuhne first-stage PA output

Second-Stage Power Amp

The block diagram in **Fig 1** shows that the final-stage 1.2 GHz PA is a model 2330PA 30W unit from Down East Microwave (in Florida USA). **Fig 4** shows the

Some Discussion on Hand-soldering SMT Amplifier Kits

A funny thing happened while trying to select the first-stage PA for the W6HHC DATV station. The first choice was not the Kuhne. Our first-choice was a very low-cost kit for a 1 Watt 1.2 GHz model using an ATF50189 PHEMT from MiniKits in Australia. The kit was only about US$50, but offered a big challenge...it was a Surface Mount Technology (SMT) kit.

Now, Ken W6HHC has built more than his fair share of building the famous Heathkit ham gear. Including the really terrific SB-301/SB-401 SSB station. But, Ken was no match for hand-soldering SMT components.

The first trick learned for easy hand-soldering was to buy a tube of solder-paste (used by automated SMT soldering). This works very well. It is very easy to control the amount of solder. Normal solder-wire tended to melt too much solder on the board for Ken. Solder-paste also nicely keeps the part in position on the board while you get ready to use solder-iron.

The big SMT problem was losing parts while trying to get them onto the PCB. These SMT parts are small.

1) Tweezers could shoot an SMT part half-way across the lab. Sometimes Ken searched the lab floor on "all fours" for a half-hour without success.
2) Pressing an SMT part into the finger-tip and lifting it into position seemed to work better. But, parts still "disappeared" before they reached the magnifying glass view of the PCB.
3) Dipping a toothpick in solder rosin worked even better for picking up and placing SMT components.

Finally, purchasing an assembled-and-tested 1 Watt amplifier from Kuhne Electronics was the very best solution.

rugged well-cooled construction of the Down East Power Amp. **Fig 5** shows the HP Model 432A Power Meter (a bolometer type) that was used for power measurements. Note the stack of precision attenuators at the top of **Fig 5** that are used to drop the power down close to 0 dBm for meter readings.

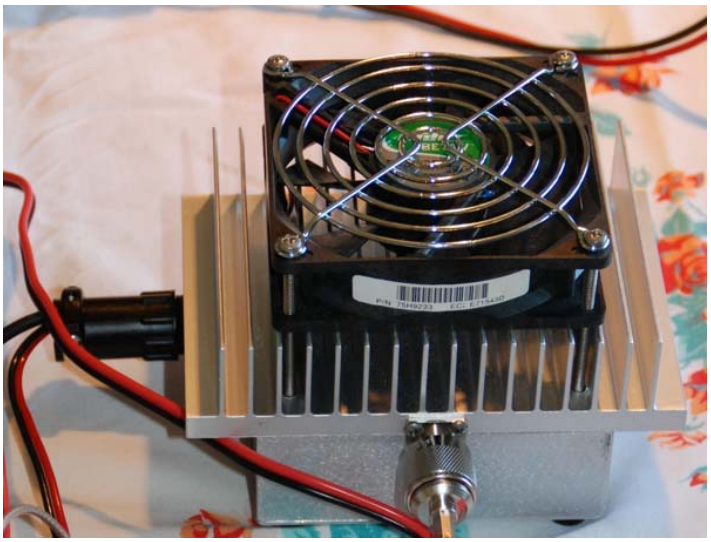

Figure 4 – Construction of Down East Model 2330PA Power Amplifier

Figure 5 – HP Model 432A Power Meter
Note attenuator-stack at the top of the photo

Fig 6 shows the quality of the Down East PA output signal at about 13 W. The spectral regrowth shoulders are down about 28 dB from the main carrier signals. Power measurements are shown in **Table 1**.

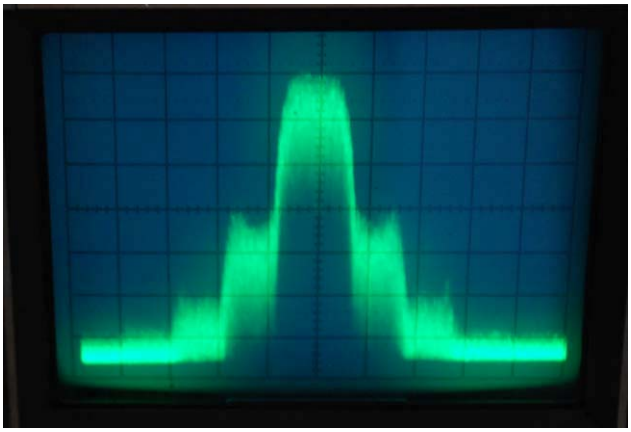

Figure 6 – HP Spectrum Analyzer looks at Down East output signal (shoulder about 28 dB down)

Choices of Video Resolution

The User Documentation manual (English) that we had found on the SR-Systems web site for the Mini-Mod-S exciter did not go into depth concerning the configurations for video resolution that can be selected. The manual clearly shows that there are three choices for the transmitted DATV video:

- D1
- HD1
- SIF

But, what do these choices really mean? It took some Google searches to begin sorting out the puzzle and then finally found a very good article by DJ1CU (called “The DVB-S 70 cm sender” in German) is up on the www.DATV.de web site (under Projekte). Let’s look at each of these three resolutions.

-- D1 Resolution --

D1 is the normal resolution that is shown 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

DJ1CU states that in his opinion SIF is unacceptable for ordinary video transmission. Ken and Robbie used SIF for many tests. The main problem is observed while displaying full screen video. Since you only have one-fourth of the video pixels...the display graphics needs to generate three more "phantom" pixels for every "real" pixel. What we could see in a full-screen video were that some pixels in the background appeared to "flicker". The picture was clear...but the "phantom pixel flicker" was distracting.

Another impact of choosing the video resolution is that it determines the Net-Data-Bit-Rate (NDBR) coming out of the MPEG-2 encoder, and therefore affects the RF Bandwidth. A higher NDBR typically means a larger RF Bandwidth. DJ1CU reports:

Resolution	Video NDBR
D1	~2.0 Mbps
HD1	~1.1 Mbps
SIF	~0.5 Mbps

We are currently using the D1 video resolution for our DATV TechTalk83 testing.

Digital-ATV "Latency"

During our first table-top tests in TechTalk77, we described that we had seen a latency (delay) of about 1 sec and that the video motion really got "jerky" (lost frames) if we displayed at full-screen on the notebook display. We needed to dig onto what were the causes.

We have determined that there are at least four primary potential-sources of latency involved with digital transmission/reception:

- **MPEG-2 Encoder**
- **SetTopBox Receiver**
- **USB2 Video-Capture Board**
- **Graphics Processing in Notebook Display**

After the TechTalk77 tests, Ken W6HHC was concerned that he was display-processing-limited with his 6-year-old entry-level Dell notebook. There were also concerns that the low-end video-capture USB adapter could also be the source of delays. So, it seemed like a good time to buy a new Dell notebook computer (Precision model M4400) configured with a good graphics-processor for the notebook display.

At the same time, Ken had read a DATV article that introduced him to new Hauppauge WinTV-HVR-1950 USB-based ATSC/NTSC/video-capture adapter. It had an external AC power adapter, so it had plenty of power for fast-processing. A series of tests were conducted to measure the DVB-S real-time delays from camera-to-display. The latency results are shown in **Table 2** on next page. Let's look at each of these four areas of potential delays.

-- MPEG-2 Encoder delays --
There is a lot of processing that goes on during the MPEG-2 encoding (compressing data) processing. While discussing latency with Stefan-DG8FAC of SR-Systems, Stefan explained that typically 90% of the latency that I was seeing going to an analog TV (Test #1 in **Table 2**) was occurring in the MPEG-2 board. Stefan stated "....The delays have nothing to do with the DVB-S Modulator/exciter, the delay is only generated by the MPEG-2 Chip on the Encoder board and the MPEG-2 Decoder that is in your SetTopBox...." We will see later when we discuss the SetTopBox, the SR-System MPEG-2 encoder board is generating about 1 second delay. Stefan explained that there is a "LowDelay Solution" for the encoder, but this encoder is very expensive, about 2500 Euro.

-- SetTopBox Receiver delays --
Each frame of video requires 33 msec in NTSC. A quality STB will lag by about four frames (0.13 seconds) for the MPEG-2 decoding. A lot of inexpensive STBs have a delay of around 5-8 frames. The ViewSat VS2000 Xtreme STB is reported to be an excellent STB and we are inclined to believe it fits into the group of BOXes with a four frame delay. That means that the MPEG-2 Encoder board in Test #1 (see **Table 2**) has about a delay of ~1 second.

-- USB2 Video-Capture delays --
The low-cost StarTech.com USB2 video-capture adapter steals its power from the USB port on the computer. So, we knew that StarTech does not have a lot of power for fast processing, a potential concern. But, **Table 2** clearly shows a measureable delay of about only 0.1 second being introduced by the StarTech.com USB2 unit. On the other hand, the newer Hauppauge WinTV-HVR-1950, with its external power source, introduced a delay of 1.37 second using Ver 6 of WinTV display software. With the newer (Win7 certified) Ver 7 WinTV display software and device driver, an internal delay of 1.7 seconds was measured....for a total latency of 2.8 seconds.

Table 2 – Measured DATV Latency Delays

Test	STB w/ NTSC Analog TV	STB w/ Dell Inspiron 1150 Notebook Intel 2.4 GHz CPU WinXP Pro	STB w/ Dell Precision M4400 Notebook Intel 3.1 GHz Core2 Win7 Pro	USB2 Video Capture board	NOTE
1	1.1 sec			(none used)	
2		1.2 sec	1.2 sec	Startech.com USB2	StarTech GrabBee lite display SW
3			2.47 sec	Hauppauge WinTV-HVR-1950	WinTV Ver 6 display software
4			2.8 sec	Hauppauge WinTV-HVR-1950	WinTV Ver 7 display software

This Hauppauge HVR product was quite a disappointment for a DATV application, but OK for recording off-the-air TV broadcasts.

-- Display Graphics Processing delays --

The old entry-level Dell notebook had simple graphics processing....just a "vanilla" Intel 82852/82855 Graphics Controller. The new Dell M4400 notebook has a powerful NVIDIA Quadro FX 370M6 Graphics Controller. The video "jerking" I had described on the older Dell, when displaying quarter-size SIF resolution to full-display-size, completely disappeared on the new faster Dell with the NVIDIA graphics.

First Cross-Town Tests

Bench testing is important. But we get excited about seeing "proof of concept". So, we tried to send a 1.2 GHz test signal from Ken's home (using a 3-ft vertical) to the roof of the Orange PD where Robbie KB6CJZ set up a 24-element loop-Yagi. The FEC was set to 1/2 and the RF bandwidth was 3 MHz. The distance is about 3 miles at roof-top heights, with plenty of tree-lined streets and back-yard trees, and through one elevated-freeway. The DATV pictures were perfect!

Figure 7 – Robbie KB6CJZ set up a 24-ele Loop-Yagi on the OPD roof and received perfect DATV pictures

Fig 8 – First cross-town DATV Transmission received at Orange Police Department building (3 miles)

The use of a 24-ele Yagi at the OPD was probably not required. The signal was clear whenever the antenna was pointed within about 30 degrees of Ken's QTH.

More field testing is planned.

Interesting DATV Links

- AGAF D-ATV components (Boards) – see **www.datv-agaf.de** and **www.AGAF.de**
- SR-Systems D-ATV components (Boards) – see **www.SR-systems.de** and **www.D-ATV.org**
- Down East Microwave RF amplifiers – see **www.DownEastMicrowave.com**
- Kuhne Electronics (DB6NT) RF Amplifiers – see **www.Kuhne-Electronic.de**
- MiniKits (SMT kits for RF amplifiers) – see **www.MiniKits.com.au**
- British ATV Club - Digital Forum – see **www.BATC.org.UK/forum/**
- British ATV Club – select from about 25 streaming repeaters – see **www.BATC.TV/**
- German ATV portal for streaming repeaters and forum – see **www.D-ATV.net/**
- Orange County ARC newsletter entire series of DATV articles – see **www.W6ZE.org/DATV/**
- TAPR Digital Communications Conference free proceedings papers – see **www.TAPR.org/pub_dcc.html**
- Volker Broszeit DJ1CU article for "The DVB-S 70 cm Sender" – see **www.DATV.de/Projekte/projekte.html**
- Darren-G7LWT site for "DATV Primer" – see **www.G7LWT.com/datv.html**
- Nick Sayer N6QQQ site for his future DATV repeater – see **www.N6QQQ.org**
- Rob-MØDTS D-ATV site including details of F4DAY-design – see **www.M0DTS.co.uk/datv.htm**
- Ultimate Resource for Digital Amateur Television – see **www.D-ATV.com**