

## TechTalk #75

### Planning a Digital-ATV Station

by Ken W6HHC  
&  
Robbie KB6CJZ

In the May 2009 newsletter, TechTalk presented an introduction to D-ATV called: “**ATV – the Digital Fork in the Road**”. This month, TechTalk will cover planning to create our own D-ATV station. But to a certain extent (especially in the US), Digital-ATV seems like a maze. There are plenty of decisions that need to be made to plan for a D-ATV station:

- Some decisions could be very expensive
- Some decisions may lead to an obsolete design
- Some decisions could have major technical issues

I am pleased to be joined by fellow OCARC club member Robbie-KB6CJZ for the creation of this month's TechTalk article. Robbie is the club guru on analog ATV and commercial satellite receivers and ham microwave communications in general.

#### What Band Should I plan for D-ATV?

Robbie explained that the view of ham radio bands for ATV and D-ATV in Southern California looks like this:

- **440 MHz** – very crowded - looks like a difficult band for D-ATV, but RF amps are cheaper
- **920 MHz** – presents a tight fit for D-ATV, plus lots of noise from “part 15” devices.
- **1,200 MHz** – more room for simplex D-ATV, probably no room for a D-ATV repeater-pair. RF amplifiers get more expensive.
- **2,400 MHz** – RF amplifiers get even more expensive. But, probably has room for a D-ATV repeater.

The decision we made is to plan for ham home/portable transmitters on the 1.2 GHz band as a good compromise. Later if we can put up a D-ATV repeater...the repeater will output on 2.4 GHz.

#### ATSC or DVB-S Modulation Scheme??

TechTalk #74 explained that Europe/Asia/Pacific was using the DVB-S commercial standard for D-ATV, using QPSK modulation for video and MPEG-2 for audio. But, in the US (and Canada), the terrestrial commercial HDTV standard is called ATSC and uses a modulation scheme called 8-level-VSB for video and AC3 (Dolby) for audio. Because of band-plan limitations in US, we have selected 1.2 GHz band for doing the planning for D-ATV. What D-ATV modulation standard should we choose for our station?

#### Possible DVB-S and ATSC Transmitters

##### - First let's look at DVB-S

So far, we have seen that while there are several ham designs in Europe for DVB-S D-ATV boards, especially AGAF and SR-Systems, both in Germany...the lion's share of units appear to be made by Stefan-DG8FAC of SR-Systems (see the link/URL at the end). The block diagram in **Fig 1** uses a SR-Systems MiniMod-DVB-S board and a MPEG-2 board as the heart of a D-ATV transmitter.

The MiniMod board will produce about 1 mWatt RF output. I will need a small RF amplifier to get that power up to about 25 mWatts to drive the 10 Watt RF. All Digital RF modulations require very linear Class A power amplifiers. We plan to run a 30W 1.2 GHz linear amp at about 10 watts or so. Note that the SR-Systems datasheets caution that the RF output of the MiniMod board is UNFILTERED. Stefan-DG8FAC of SR-Sys explained this note means that we need to

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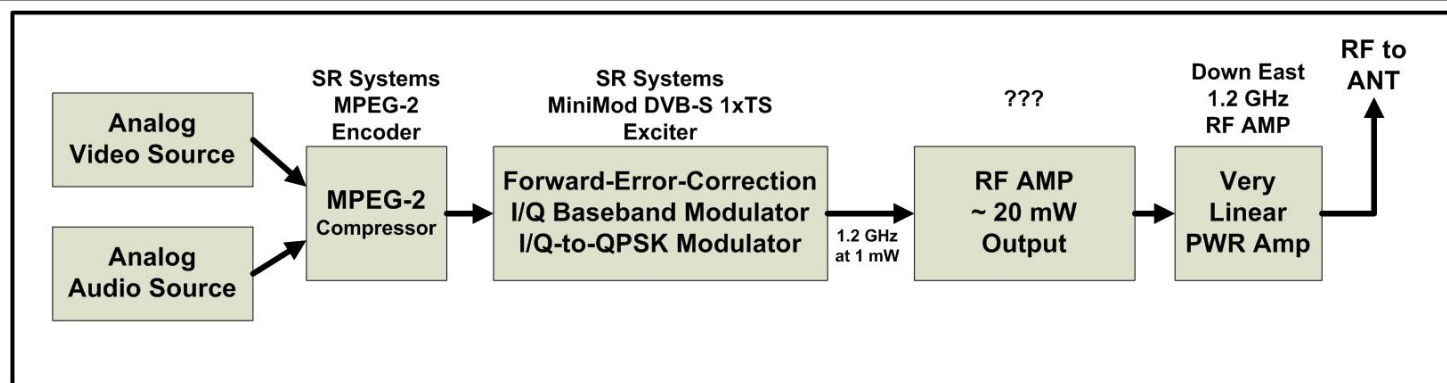


Fig 1 - Block Diagram of DVB-S Transmitter for D-ATV

suppress the second harmonic and the third-harmonic a little. Following the RF output of the MiniMod with two 1.2 GHz amps provides the required harmonic suppression. The DVB-S 1xTS D-ATV signal will be about 2 MHz wide. **Table 1** below looks at an estimate of costs for a DVB-S transmitting station.

#### - Next let's look at ATSC

While there are several ham designs in Europe for DVB-S D-ATV boards...there is only one ham design that we can find for an ATSC D-ATV transmitter. Again Stefan-DG8FAC of SR-Systems in Germany produces a board for the US 8VSB terrestrial video standard. Block diagram in **Fig 2** uses the SR-Systems MiniMod-ATSC board and MPEG-2 board as the heart of a D-ATV transmitter. There is one "quirk" with MiniMod-ATSC design. The US ATSC standard calls for transmitting audio in AC3 format (Dolby), but the Dolby licensing fees for AC3 are very expensive. SR-Systems elected to pair up the 8-VSB video with MPEG-2 audio to avoid the AC3 licensing fees. This 8-VSB/MPEG-2 combo works in many receivers in US as we will see later in this article, but is not compatible with the plentiful and really cheap ATSC Terrestrial SetTopBoxes.

The ATSC transmitter block diagram looks almost the same as the DVB-S. The MiniMod ATSC board will

also produce about 1 mWatt RF output. I will need a small RF amplifier to get that power up to about 25 mWatts to drive the final 10 Watt RF amplifier. All Digital RF modulations require very linear Class A power amplifiers. We plan to run a 30W 1.2 GHz amp at about 10 watts or so. Note again that the SR-Systems datasheets caution that the RF output of the MiniMod board is UNFILTERED. What this means is that we need to suppress the second harmonic and the third-harmonic a little. Following the MiniMod output with two 1.2 GHz amps provides the required harmonic suppression. The 8VSB signal will be about 5.5 MHz wide. **Table 2** (on next page) looks at an estimate of costs for an ATSC transmitting station.

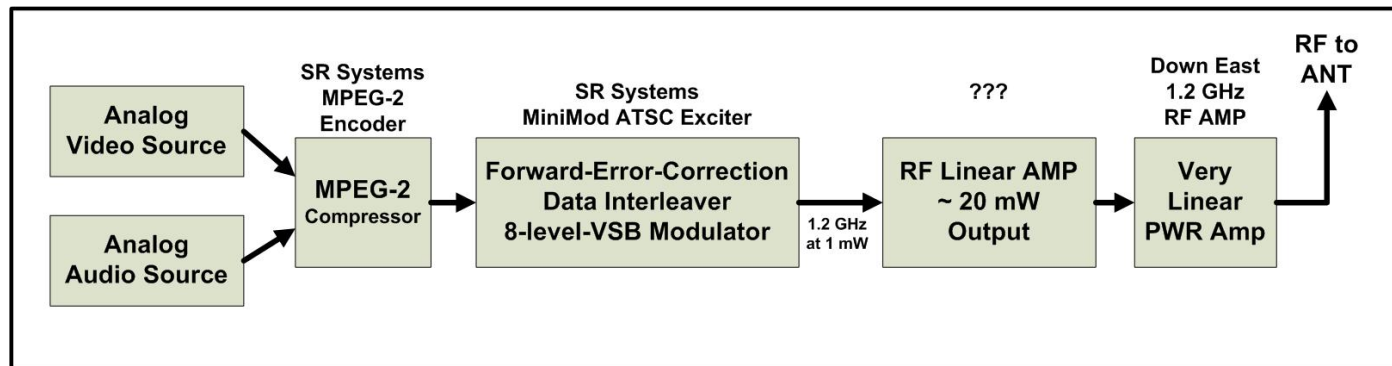
#### Possible D-ATV Receiving Station

Now we will look at possible choices for the D-ATV receiving station. The video can be displayed on an old analog TV, a new DTV/HDTV, or a computer or a notebook computer. In **Fig 3** on the next page, we show nine possible alternative configurations: four configurations are aimed at receiving ATSC ham signals and five configurations are aimed at receiving DVB-S ham signals.

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| Item | Description                          | Manufacturer        | Model              | Cost Est<br>Low end | Cost Est<br>High end |
|------|--------------------------------------|---------------------|--------------------|---------------------|----------------------|
| 1    | MPEG Encoder Board                   | SR-Systems          | MPEG Encoder       | \$290               | \$360                |
| 2    | 1.2 GHz FEC & IQ Modulator for DVB-S | SR-Systems          | DVB-S 1xTS MiniMOD | \$470               | \$540                |
| 3    | First RF amp                         | ??                  | (about 50 mW)      | \$25                | \$50                 |
| 4    | RF Power Amplifier 30W (very linear) | Down East Microwave | Part Number 2330PA | \$240               | \$240                |
|      | <b>TOTAL</b>                         |                     |                    | <b>\$1,025</b>      | <b>\$1,190</b>       |

**Table 1 – Cost Estimate of DVB-S Transmitter**

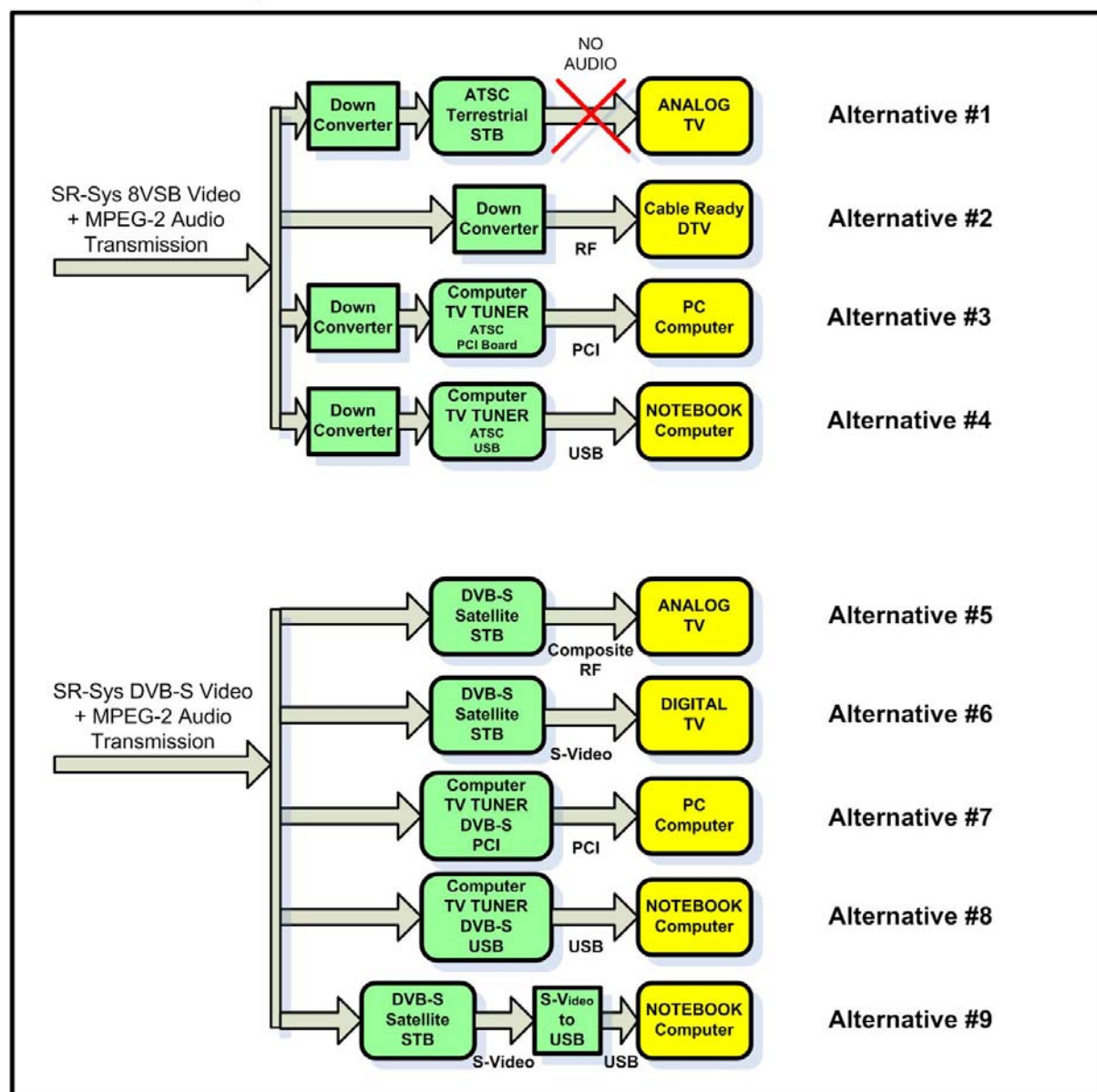


**Fig 2 - Block Diagram of ATSC Transmitter for D-ATV**

| Item | Description                          | Manufacturer        | Model              | Cost Est<br>Low end | Cost Est<br>High end |
|------|--------------------------------------|---------------------|--------------------|---------------------|----------------------|
| 1    | MPEG Encoder Board                   | SR-Systems          | MPEG Encoder       | \$290               | \$360                |
| 2    | 1.2 GHz FEC & IQ Modulator for ATSC  | SR-Systems          | ATSC Mini-MOD      | \$852               | \$925                |
| 3    | First RF amp                         | ??                  | (about 50 mW)      | \$25                | \$50                 |
| 4    | RF Power Amplifier 30W (very linear) | Down East Microwave | Part Number 2330PA | \$240               | \$240                |
|      | <b>TOTAL</b>                         |                     |                    | <b>\$1,407</b>      | <b>\$1,575</b>       |

Table 2 – Cost Estimate of ATSC Transmitter

Fig 3 - POSSIBLE D-ATV RECEIVER CHOICES



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Now we will walk through each of the receiving station alternatives that are shown in **Fig 3**...starting with receiving ATSC ham signals.

**Alternative 1 – Using a Terrestrial ATSC STB**

The first approach for receiving ATSC is to use the cheap (\$50 new) ATSC terrestrial SetTopBoxes that have been made common by the US government preparations for eliminating commercial analog TV broadcasts. The MPEG-2 audio compression from the **Fig 2** transmitter appears to create a real problem for this approach. The STB is expecting the AC3 format (not MPEG-2) for audio. We have found no US hams who have succeeded in receiving the intended ATSC D-ATV transmission from SR-Systems MiniMod on these ATSC terrestrial SetTopBoxes.

**Alternative 2 – Using Cable-Ready DTV**

In the second approach, some models of “cable-ready” digital TVs can receive QAM (for cable) as well as ATSC (for terrestrial) and will correctly handle the MPEG-2 audio OK. Nick-N6QQQ in Santa Clara has reported he tested this approach with the MiniMod ATSC board and it does work well. This approach needs a front-end down-converter to take the received 1.2 GHz signal and bring it down to perhaps the 480-to-700 MHz range of US ATSC DTV tuners. Perhaps some cable-ready DTVs may not work?

**Alternative 3 – Using Computer PCI ATSC Tuner**

In the next approach, we use a PCI board designed to add an ATSC TV tuner to a PC. Nick-N6QQQ has reported MiniMod success with using computer peripheral tuners, simply because all they do is take the 8VSB and put out the MPEG-2 transport stream. The computer winds up doing the rest of the work by decoding the MPEG-2 video and the MPEG-2 audio. The Hauppauge WinTV-HVR-1600 PCI TV Tuner Card – 1101 covers analog (NTSC) and DTV (ATSC) for under \$100. Another interesting approach for a computer is the Silicon Dust HD HomeRun box that networks to the computer. Again, we need a down-converter to take the incoming 1.2 GHz signal and bring it down to the range of US ATSC DTV tuners.

**Alternative 4 – USB ATSC Tuner for Notebook**

In this approach, we use an ATSC tuner with a USB output that can deliver to a Notebook computer (no room for PCI card). The notebook will again accept the MPEG-2 transport stream output and provide for

the presenting the video and audio. The Hauppauge WinTV-HVR-950Q TV Tuner Stick can be purchased on the internet for around \$70 new. Again, we need a down-converter to take the incoming 1.2 GHz signal and bring it down to the range of US ATSC DTV tuners.

**Alternative 5 – Using a Satellite DVB-S STB**

Our first approach to receiving DVB-S transmissions uses a DVB-S satellite box (commonly called Free-To-Air or FTA). A “composite RF” output from the STB can go straight into an old analog TV set. The frequency range of the DVB-S STB tuner range for satellites will include the 1.2 GHz ham band, so no down-converter is needed. The Viewsat VS2000 Xtreme is an example of a DVB-S FTA STB that can be purchased new for about \$100.

**Alternative 6 – Using DVB-S STB with DTV**

This approach is the same as #5 above, except it takes the S-Video output of the Free-to-Air DVB-S SetTopBox to provide the input to a HDV set.

**Alternative 7 – Computer PCI DVB-S Tuner**

In this approach, a PCI DVB-S tuner board is installed in the PC computer. The Hauppauge WinTV Nova-s PLUS DVB-S PCI Card costs less than \$100.

**Alternative 8 – USB DVB-S Tuner for Notebook**

This approach uses a DVB-S USB tuner box (for example: the SkyStar USB2 model costs about \$100) to output directly to the USB port on the notebook computer.

**Alternative 9 – Using DVB-S STB with Notebook**

This approach is very similar to #6 above except we add an S-Video to USB converter to take the STB output to the USB input on the notebook computer. A typical S-Video-to-USB converter is the Startech.com USB 2.0 and costs about \$50 through Radio Shack (in addition to the STB cost).

**Selecting Our D-ATV Station**

Robbie and I had both hoped for an ATSC approach for D-ATV because of the easy availability of low-cost terrestrial STBs in the US. But, neither of us wanted to deal on a trial-and-error basis to see if equipment we purchased for receivers would really work with the current “MPEG-2 audio quirk” of ATSC D-ATV transmissions. So our decision is to plan for a DVB-S D-ATV station here in Southern

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California. Also, by comparing the cost estimates in **Table 1** and **Table 2**, you can see we will save almost \$400 by choosing a DVB-S transmitting station instead of an ATSC station. As a note...if it was possible, both of us would have gladly paid an extra US\$50 or 50EUR for an AC3 Dolby license charge to avoid the “MPEG-2 audio quirk” situation that would allow us to go to the ATSC route with full compliance.

Now that we have chosen our D-ATV transmitting station, any of the D-ATV receiving station approaches ALTERNATIVE #5 through ALTERNATIVE #9 in **Fig 3** will work well. The costs of each of these five receiving approaches are reasonable. So the reader can choose the approach that appeals to him. I will choose ALTERNATIVE #8 because I want to use my notebook computer (instead of a TV set) for my home D-ATV station. Robbie-KB6CZJ prefers to go with ALTERNATIVE #5, because he prefers the wide-availability and feature-rich-capability of a DVB-S FTA SetTopBox.

There are still a few details to sort out for our station, but hopefully you can see that this top-down approach to planning a D-ATV station provides a “big picture” of alternatives...allows us to understand the trade-offs....and allows a direction to be chosen.

**More D-ATV Links**

- AGAF D-ATV components (Boards) – see [www.datv-agaf.de](http://www.datv-agaf.de) and [www.AGAF.de](http://www.AGAF.de)
- SR-Systems D-ATV components (Boards) – see [www.SR-systems.de](http://www.SR-systems.de)
- Typical Internet store for FTA DVB-S Receivers – see [www.GoSatellite.com](http://www.GoSatellite.com)
- British ATV Club - Digital Forum – see [www.BATC.org.UK/forum/](http://www.BATC.org.UK/forum/)
- Nick-N6QQQ blog on putting together an ATSC D-ATV station – see <http://nsayer.blogspot.com/search/label/ham>
- OCARC newsletter article “ATV – the Digital Fork in the Road” – see [www.W6ZE.org/TechTalk-74\\_D-ATV.pdf](http://www.W6ZE.org/TechTalk-74_D-ATV.pdf)
- Rob-MØDTS D-ATV site including details of F4DAY-design – see [www.M0DTS.co.uk/datv.htm](http://www.M0DTS.co.uk/datv.htm)
- Ultimate Resource for Digital Amateur Television – see [www.D-ATV.com](http://www.D-ATV.com)