



# 2010 ARRL TAPR Digital Comm Conference

## 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



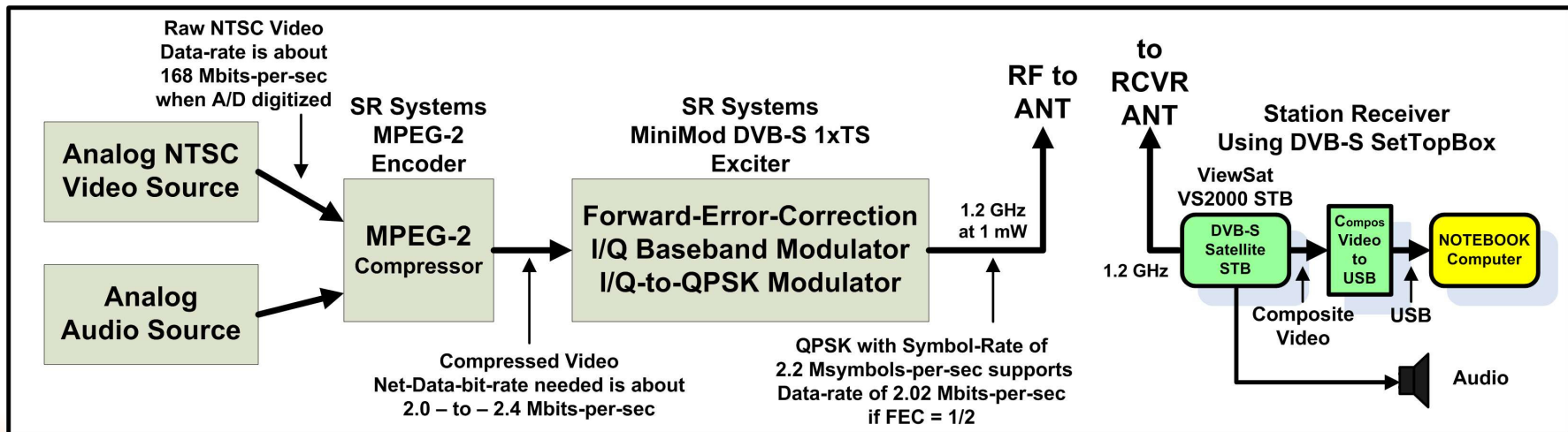
## Why Go Digital ATV?

- 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

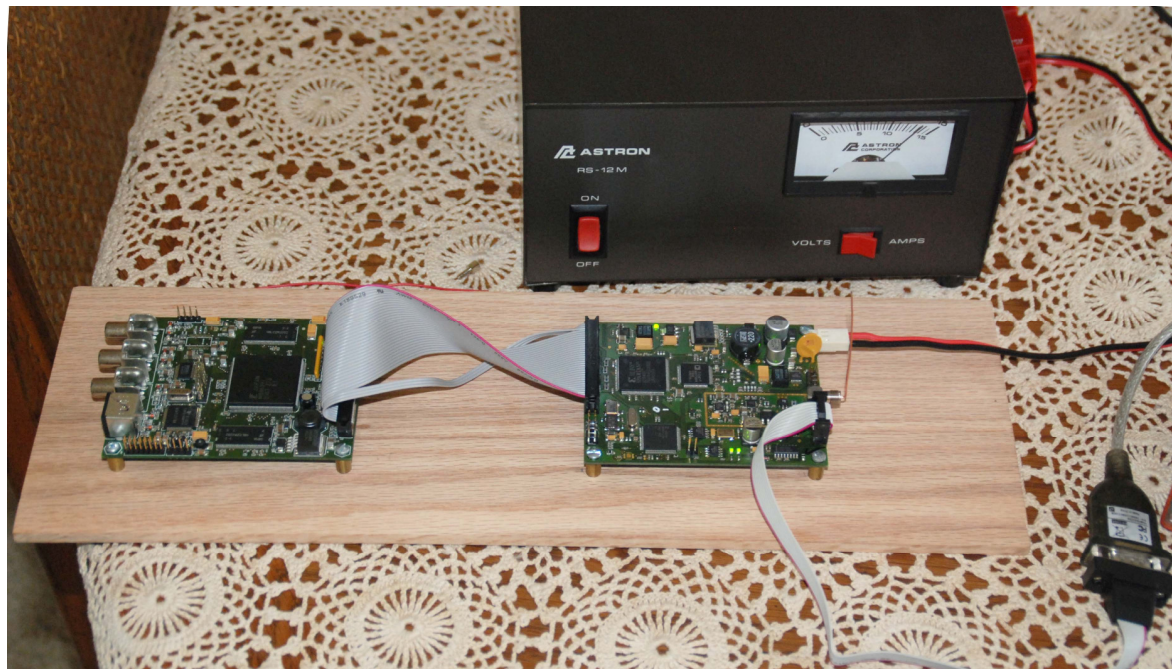


Block Diagram Showing DATV Exciter being Tested

# 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**

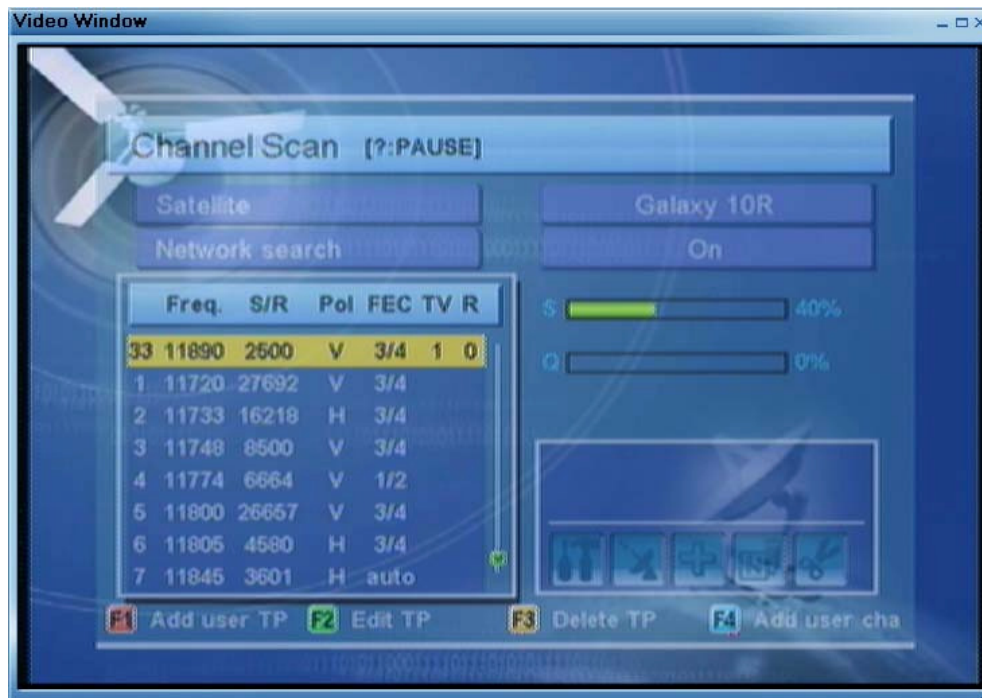
**STB Search Freq = 1290 MHz + 10,600 MHz**

**STB Search Freq = 11890 MHz**

# Testing a DVB-S DATV Station



## Testing the DATV Exciter boards



**STB Configuration Menu for Editing Received  
Frequencies and other Settings**



# Testing a DVB-S DATV Station



## 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

**RF Bandwidth<sub>(allocation)</sub> = 1.33 x Symbol-Rate**

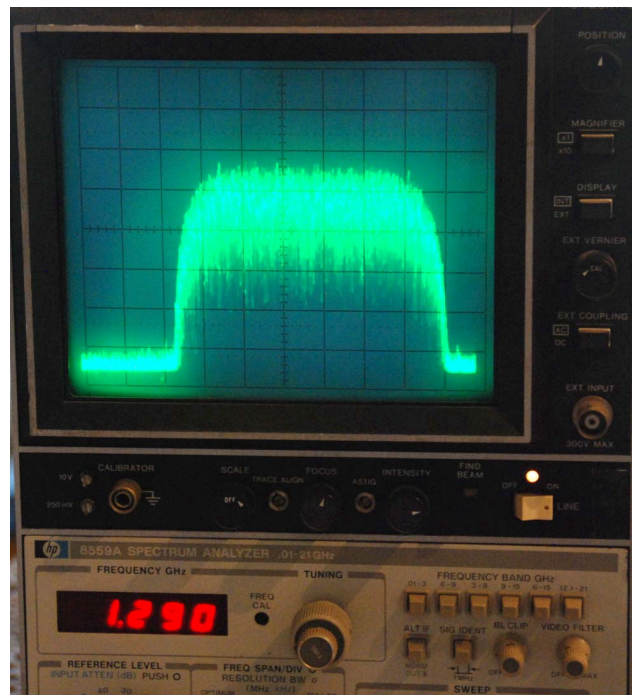
**RF Bandwidth<sub>(allocation)</sub> = 1.33 x 2.5 MSymbols/sec**

**RF Bandwidth<sub>(allocation)</sub> = 3.33 MHz signal**

# Testing a DVB-S DATV Station



## Testing the DATV Exciter boards

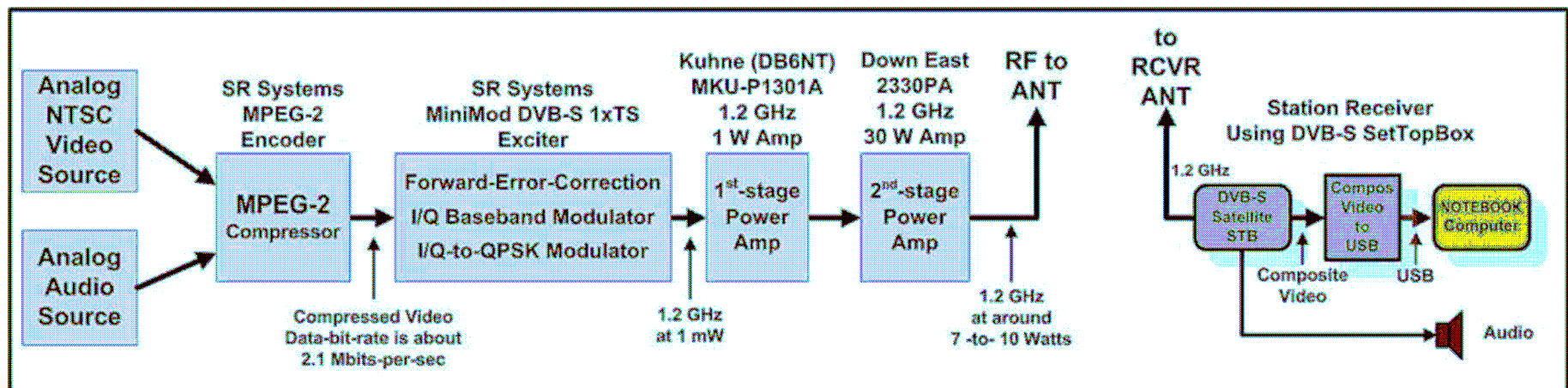


**Close-up of the 1.290 GHz Signal RF Bandwidth  
on the HP Spectrum Analyzer Display**

# Testing a DVB-S DATV Station



## Bench Testing the DATV Power Amplifiers

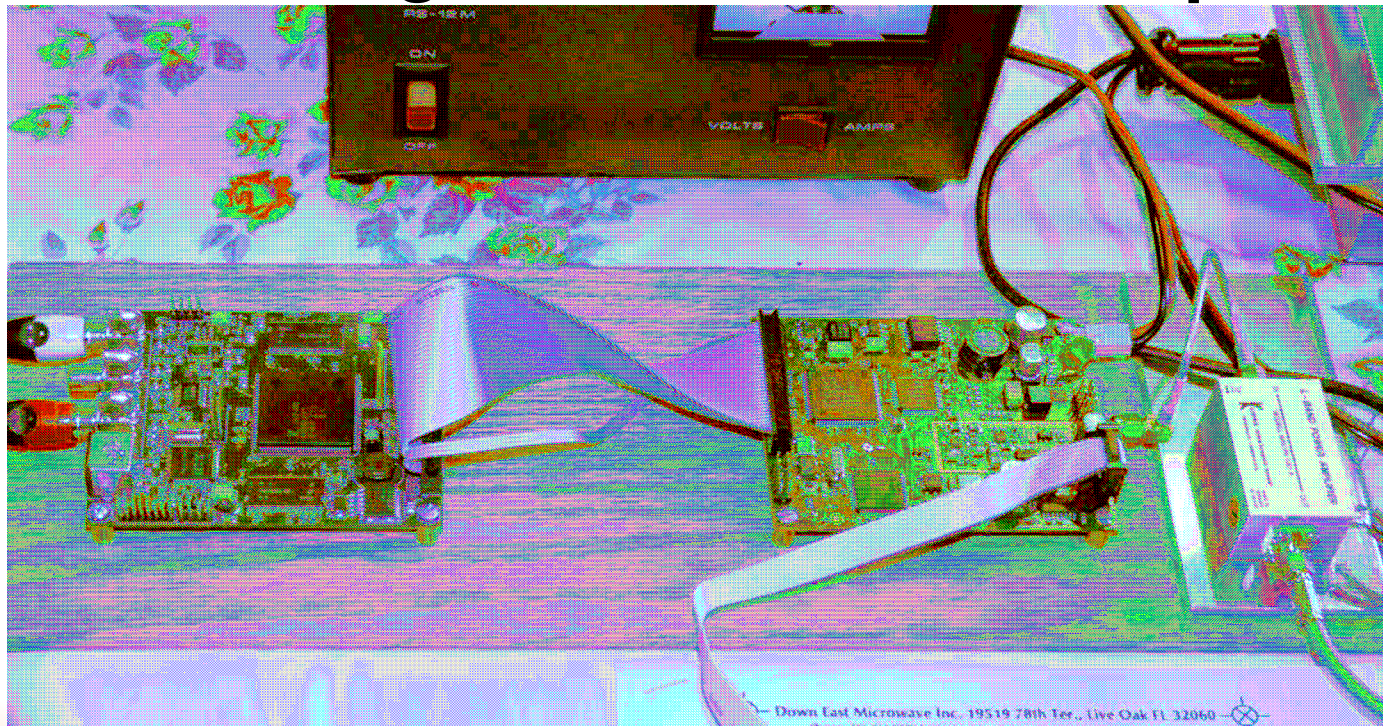


Block Diagram Showing the Full DATV Station being  
Bench Tested

# Testing a DVB-S DATV Station



## Bench Testing the DATV Power Amplifiers

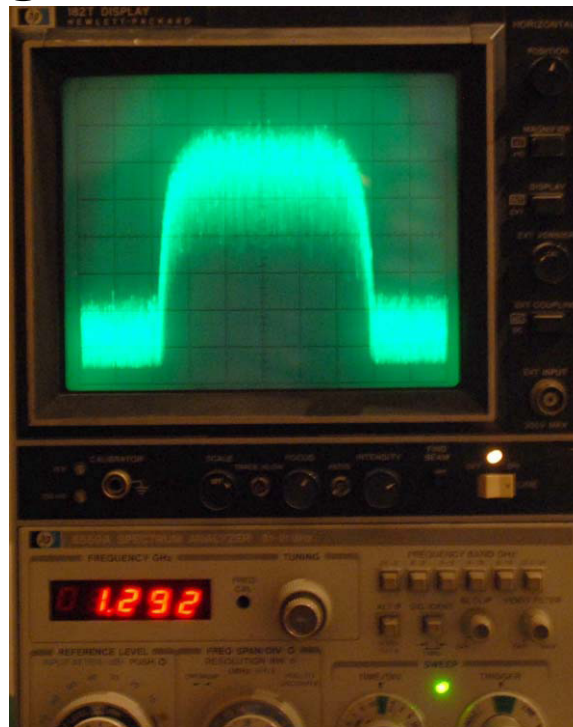


**Breadboard of MPEG-2 Board and MiniMod Exciter Board  
and the Kuhne 1st-Stage 1W PA (on right side)**

# Testing a DVB-S DATV Station



## Bench Testing the DATV Power Amplifiers

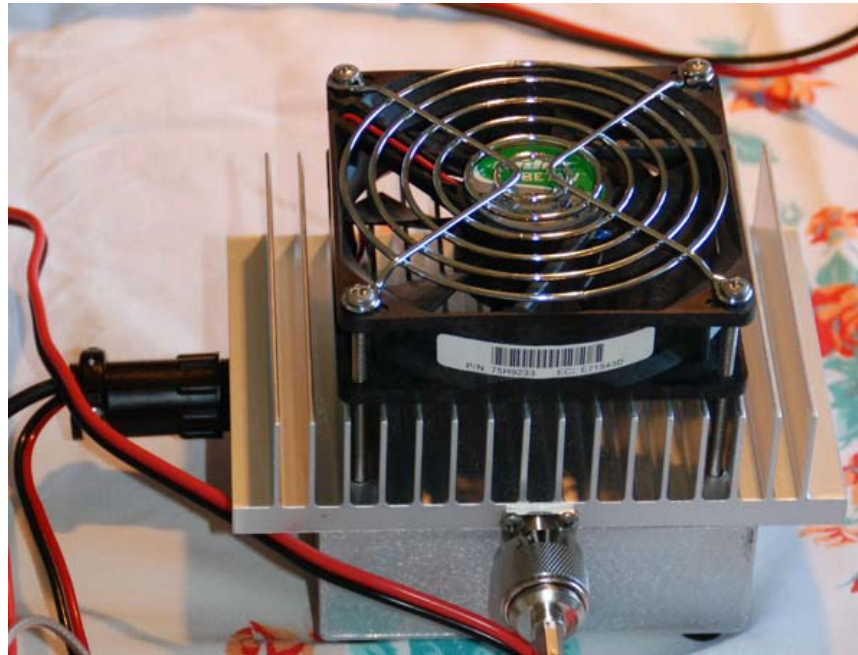


HP Model 8559A Spectrum Analyzer looks at  
Kuhne first-stage PA output

# 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

| MiniMod-S exciter power setting  | Measured MiniMod Output mW | Measured Kuhne 1st-amp Output mW | Measured Down East 2nd-amp Output W | "shoulder" below main carrier |
|--|----------------------------|----------------------------------|-------------------------------------|-------------------------------|
| 1  | 0.0661 mw                  | N/A                              | N/A                                 | N/A                           |
| 2  | 0.158 mw                   | N/A                              | 5.75 W                              | 35 dB                         |
| (Note: the readings below are with 5 dB attenuator between the first-PA and the second-PA) |                            |                                  |                                     |                               |
| 7  | 1.32 mw                    | N/A                              | 10.7 W                              | 31 dB                         |
| 8  | <b>1.74 mw</b>             | <b>115 mW</b>                    | <b>12.9 W</b>                       | <b>28 dB</b>                  |
| 9  | 2.24 mw                    | N/A                              | 15.1 W                              | 27 dB                         |

Power Measurements taken during the DVB-S Station Testing

# Testing a DVB-S DATV Station



## Bench Testing the DATV Power Amplifiers

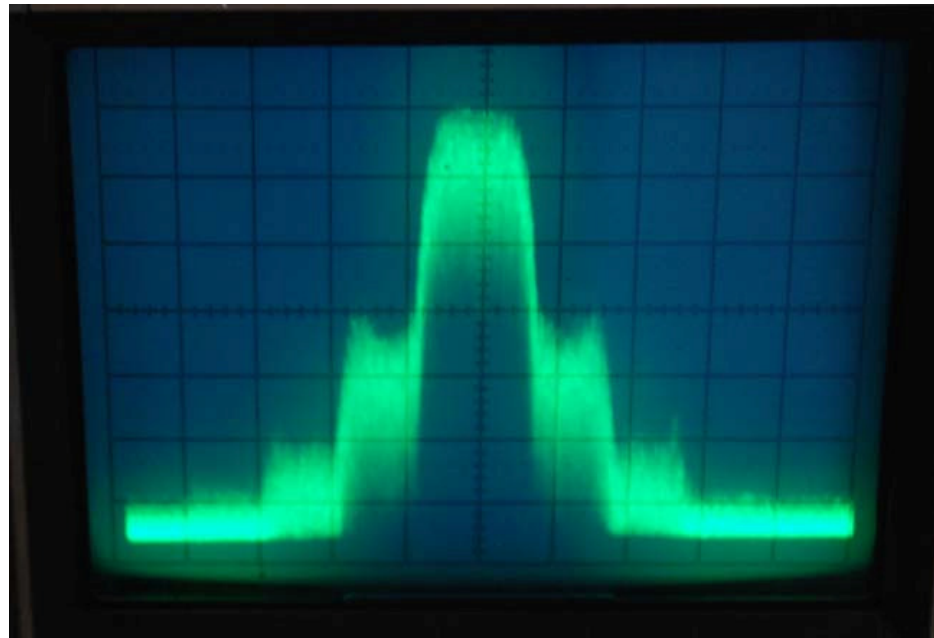
### De-rating RF Power Amplifiers for QPSK

- 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]”
- $P(\text{FM}) = 40\text{W}$
- $P-1\text{dB} = 30\text{W}$
- $25\% \text{ of } P-1\text{dB} = 7.5\text{W}$  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

| <b>Resolution</b> | <b>Video NDBR</b> |
|-------------------|-------------------|
| <b>D1</b>         | <b>~2.0 Mbps</b>  |
| <b>HD1</b>        | <b>~1.1 Mbps</b>  |
| <b>SIF</b>        | <b>~0.5 Mbps</b>  |

# Testing a DVB-S DATV Station



**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

|      |                   | STB w/<br>Dell Inspiron<br>1150 Notebook<br>Intel 2.4 GHz CPU<br>WinXP Pro | STB w/<br>Dell Precision<br>M4400 Notebook<br>Intel 3.1 GHz Core2<br>Win7 Pro |                          |                                  |
|------|-------------------|--|---|--------------------------|----------------------------------|
| Test | Analog TV<br>NTSC |  |   | 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     |

# Testing a DVB-S DATV Station



## Field Testing the DATV Station

### Some Background

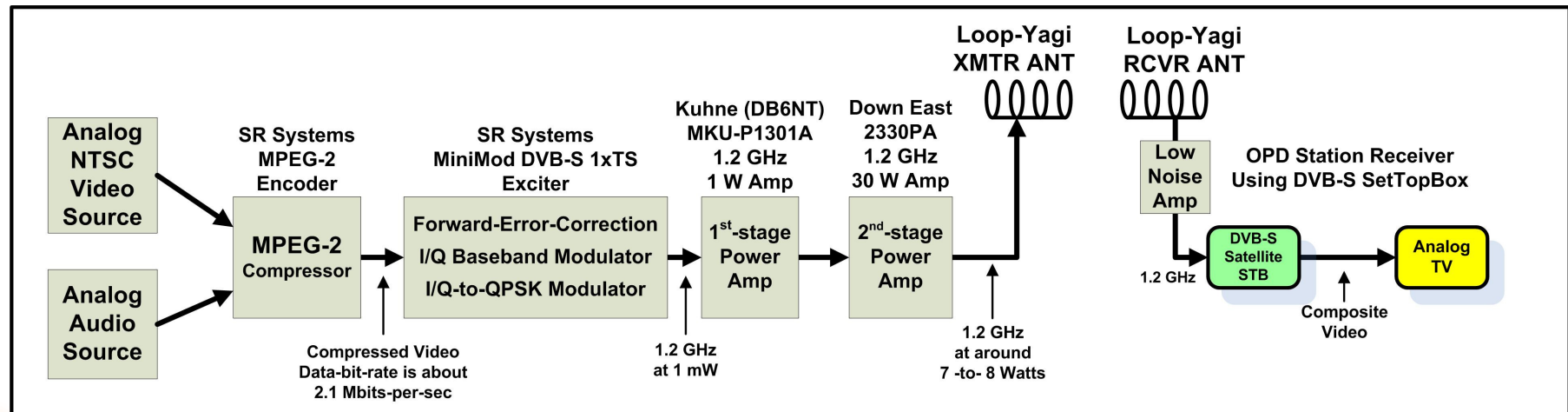
- Authors are both members of COAR RACES
- COAR RACES frustrated with quality of field analog-ATV
- 440 MHz analog-ATV quality degraded by multi-path and obstacles (elevated freeways, buildings, trees)
- Analog-ATV quality only P1 or P2 from many locations
- Speculated that perhaps DATV might provide 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**

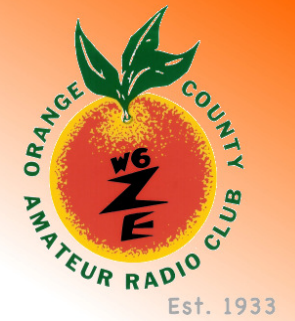
# Testing a DVB-S DATV Station



## 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<sub>allocated</sub> = 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](http://www.TAPR.org/pub_dcc28.html)
- TAPR PSR Quarterly Journal Issue 111 on DVB-S Modulation Overview  
[www.TAPR.org/psr.html](http://www.TAPR.org/psr.html)
- Amateur Television of Central Ohio  
[www.ATCO.TV](http://www.ATCO.TV)
- British ATV Club - Digital Forum  
[www.BATC.org.UK/forum/](http://www.BATC.org.UK/forum/)
- Orange County ARC complete series of newsletter DATV articles  
[www.W6ZE.org/DATV/](http://www.W6ZE.org/DATV/)
- Charles Brain-G4GUO blog on Software-Defined-Radio project for DATV  
[www.G4GUO.blogspot.com/](http://www.G4GUO.blogspot.com/)
- Rob Swinbank-MØDTS details of “Poor Man's Digital ATV Transmitter – LIVE update”  
[www.M0DTS.co.uk/datv.htm](http://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](http://www.DATV.de/Projekte/projekte.html)
- AGAF D-ATV components (Boards)  
[www.datv-agaf.de](http://www.datv-agaf.de) and [www.AGAF.de](http://www.AGAF.de)
- Down East Microwave microwave amplifiers, low noise amplifiers (LNA)  
[www.DownEastMicrowave.com/](http://www.DownEastMicrowave.com/)
- Kuhne Electronics (DB6NT) RF Amplifiers  
[www.Kuhne-Electronic.de](http://www.Kuhne-Electronic.de)
- SR-Systems D-ATV components (Boards)  
[www.SR-systems.de](http://www.SR-systems.de)