Digital Video Broadcasting-T for Ham Radio

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Summary of topics...

- What is DVB and Why use it?
- DVB Transmit/Receive signal chain
- Building your DVB-T ATV station
- Software
- Resources
- Demo
What is DVB and Why use it?

- Digital Video Broadcasting – Terrestrial is a European developed TV system introduced in the UK in 1998
- Uses modern compression techniques and efficient modulation schemes to deliver SD and HD video

...and “Why would hams want to use it?”
- More robust in weak signal conditions
- Requires less power and spectrum efficient
- No analog-like “ghosting” - always good picture
- Readily available low cost hardware
DVB-T signal advantage...
Some DVB history...

- Before the 90s, it was not technically or economically possible to digitize TV - bit rates too high to transmit!
- Japan, Europe and finally U.S. threw a lot of money into developing digital TV/HDTV in the 80s/90s
- **Motion Picture Expert Group** compression standards were developed for moving pictures (MPEG 1, later 2)
- Europe’s ELG defined and standardized DVB in 1993
- By the late 90s, 3 DVB variants S/M/T were available
- Later MPEG4/H.264/AVC was developed for HDTV
Now, let’s take a look at how a DVB picture is sent and received
Some software Data Parameters to take note as we look at DVB-T
## Configuration for Modulator Output Data Rate

![TSPLAYER Configuration Interface]

### DVB-T
- **Bandwidth**: 2MHz
- **Frequency (KHz)**: 434000
- **Code rate**: (2) 3/4
- **Constellation**: (0) QPSK
- **Guard interval**: (1) 1/16
- **Transmission mode**: (0) 2k
  - **Modulator Output Data Rate**: 2195501
- **Attenuation/Gain**: 0
  - **TS File Input Data Rate**: 2165356

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DCC Austin
Transmit Chain > MPEG
Digital Format ITU BT.601/709

- 1987 ITU Standard defines digitization parameters for encoding NTSC/PAL/SECAM 525/625 TV line rates into a digital format for interoperability worldwide
- Set the standard for luminance and chrominance sampling frequencies of 13.5 and 6.75 MHz for a 270 Mbit/s uncompressed rate

NTSC – National Television Std Committee (60 Hz)
PAL – Phase Alternating Line (50 Hz)
SECAM – Sequential Color And Memory (French)
MPEG – making DTV possible

- Data compression reduces spectrum BW by about 6 times just for SD... HD by another 5-6 times
- MPEG’s “Prediction with movement compensation”
  - Compares differences between the prior and subsequent pictures using a movement estimator
- Compresses data for audio, video and private data into Elementary Streams (ES)
- ES are packetized into Program Elem Streams (PES)
Transmit Chain > MUX
Source multiplexing... MPEG

- The PESs are packetized with the payload and *multiplexed* into a Transport Stream (TS) for the TX.
- The TS packet length is short (188bytes) for robustness and efficient FEC applications.
Transmit Chain > FEC
Channel coding... FEC

- Reed-Solomon and Forney convolutional interleaving corrects burst and other data errors
- FEC is applied at a **Code Rate** of 1/2, 2/3, 3/4, 5/6, 7/8
  - 1/2 = 1 real bit & 1 FEC bit = 100%
  - 7/8 = 7 real bits & 1 FEC bit = ~9%
- FEC must be balanced between the payload data rate needed, signal robustness requirement *and* available BW
- A DAC converts data to In-phase (I) and Quadrature (Q) signals mixed to produce final output for the modulator
Transmit Chain > Modulation
COFDM Modulation
(Coded Orthogonal Frequency Division Multiplexing)

- Many discrete carriers spread over a 2 to 8 MHz BW
- 3 modulation schemes QPSK - 16QAM - 64QAM
- QPSK lowest BER BPS to 64QAM highest BER BPS
  - tradeoff between bit rate and robustness
- 2 Carrier Mode options (2k/1705 and 8k/6817 carriers)
  - 2k= more tolerant to Doppler effects (mobile)
  - 8k= more robustness in multipath fading
- Guard Interval reduces ISI and is adjustable by 1/4,
  1/8, 1/16 or 1/32 of the original symbol block length
Transmit Chain > IF to TX

Diagram showing the process from the source coding and MPEG coding to the TX and RX, including multiplexing, FEC, format, filtering, DAC, modulation QPSK, QAM, OFDM, and channel coding/decoding.
I.F. conversion to TX...

- IF Transport Stream is up converted to the transmit frequency
- TS feeds the TX where it is amplified and sent out to the antenna
Receive Chain...

(reverse complementary steps of TX)
Getting on the air with DVB-T

It’s easy with today’s technology

Let’s see how we can do it!
Basic DVB-T Digital ATV Station

- **Camera** with *built-in* DVB-T Modulator/Transmitter
- **Amplifier** Class A
- **Receiver** with HDMI output connected to your TV
- **Yagi** for 70cm ATV frequency in your area
HiDes DVB-T
HV-110 Receiver

HiDes DC101/2 CAM/TX
HiDes HV-100 receiver...

- Decodes SD thru HD 1080p / MPEG 1 - 4
- HDMI and Composite Video output
- Includes Ham narrow BW modes 1, 2, 3 and 4 MHz
- OSD with Remote
- 170 to 950Mhz in 1 KHz steps
- Sensitivity* dependent upon Modulation/BW
  - QPSK – 102dBm @ 2 Mhz BW on 70cm
  - 64QAM -82dBm @ 6 MHz BW on 70cm
- Runs on 5v @ 325Ma

*from KH6HTV lab
HiDes DC-101 HD Camera...

- Outputs SD/HD video + Mic audio
- RF Output 0 dBm w/ 1 dB step attenuator
- Lens 2.0mm / 66 deg field view
- Compression H.264 1280x720 30 FPS
- 50-950 and 1200-1300 MHz in 1 KHz steps
- 2-8 MHz BW
- Parameters configured using presets or SD card
OE7DBH Class A Amplifiers for HiDes

>50dB gain

>30dB gain
The RA60H4047M1 is a 60-watt RF MOSFET Amplifier Module for 12.5-volt mobile radios that operate in the 400- to 470-MHz range.

The battery can be connected directly to the drain of the enhancement-mode MOSFET transistors. Without the gate voltage ($V_{GG}=0V$), only a small leakage current flows into the drain and the nominal output signal ($P_{out}=60W$) attenuates up to 60 dB. The output power and the drain current increase as the gate voltage increases. The output power and the drain current increase substantially with the gate voltage around 0V (minimum).

The nominal output power becomes available at the state that $V_{GG}$ is 4V (typical) and 5V (maximum).

At $V_{GG}=5V$, the typical gate currents are 5mA. This module is designed for non-linear FM modulation, but may also be used for linear modulation by setting the drain quiescent current with the gate voltage and controlling the output power with the input power.

**FEATURES**

- Enhancement-Mode MOSFET Transistors
  ($I_{OD}=0 \quad V_{DD}=12.5V, V_{GG}=0V$)
- $P_{out}=60W, \eta_{1}>40\% \quad V_{DD}=12.5V, V_{GG}=5V, P_{in}=50mW$
- Broadband Frequency Range: 400-470MHz
Linear ATV Amp from KH6HTV
DVB-T
Digital ATV

HD TV
16x9
720-1080

HDMI

HV-110 Receiver

RF Amp

Antenna Switch

DC-101/2
SD/HD Cam

Yagi

1mW

4-10w

RX

TX
Adding station capability...
DVB-T Dongle and PC applications

- **Dongle** for TX/RX from Hi-Des
- **Amplifier** Class A
- **Yagi** for 70cm
- **Camera** USB 1080p
- **PC Win7/8**
HiDes UT-100B

- PC USB based Modulator (TX)/Demodulator (RX)
- *Full hardware implementation* and Full Duplex capable
- Ham Version Signal BW 2-4 MHz RX and 1-8 MHz TX
- 50-950 MHz RX, 50-950/1200-1350 MHz TX 1KHz Steps
- Supports 1080p Full HD H.264 and MPEG 2/4
Free Software...

- **BDA Viewer Plus**: Receive/Record/View
- **TS Player**: TX Transport Stream/TS Files Player
- **Media2TS**: File converter for MPEG2/H.264 TS

**Others**...

- **PC2TV**: TX/RX/Record TS files and desktop
- **Digital TV**: Receive/Record/View
API available for Windows and Linux

Windows/Linux SDK Programmer’s Guides

ITE’s IT9507 HDtv TX and IT9130 Receiver
Digital ATV at KØPFX

HV-110 Receiver
UT-100B TX/RX
DC-101 HD Camera
10W Amplifier
Watt meter
Sequencer
20A DC supply
Homebrew ADVB-T 10w
Inside view  ADVB-10w
DVB-T 10w Configuration

Notes:
1- CA#9 is 9pin SubD M-F assembly
2- Pin Nbrs refer to Sequencer’s 9pin male SubD I/O connector  
   3- For HV-110 RX option, see sheet 2
DVB-T 10w 2nd Receiver opt

Notes:
1. RX HV110/Fans switch positions:
   UP = Fans On
   Center = Fans Off
   Down: Fans On & Relay #4 On switching antenna from UT-100B (RX) to HV-110 RX
2. DC-DC Converter is optional when 12v coil relays are not available. Converter output is adjustable from 1.25v to 28v @ 1A.
3. RX opt moves CA #2 from REL #1 NC to REL #4 NC contact.
DVB-T OFDM Signal at 1Mw
DVB-T OFDM Signal at 10w
DVB-T “DX” HD Television...
Where to find Digital ATV DVB-T gear...

HiDes Technologies Web Site:

HiDes Technologies eBay Store:
http://stores.ebay.com/HiDes168?_rdc=1

OE7DBH Class A Amps:
http://dl1mfk.de/Sonstiges/Darko/

USB Camera Logitech:
http://www.logitech.com/product/hd-pro-webcam-c920

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Can I really do this?? Yes!
Operating and Technical info...

- digitalATV Yahoo Group [www.groups.yahoo.com](http://www.groups.yahoo.com)
- ATV Television Quarterly [http://ATVQuarterly.com](http://ATVQuarterly.com)
- British Amateur Television Club [www.batc.org.uk](http://www.batc.org.uk)
- Digital Amateur TV Primer [www.g7lt.com/datv.html](http://www.g7lt.com/datv.html)
- Jim Andrews DATV “App notes” [www.kh6htv.com](http://www.kh6htv.com)
- *Digital Television* Herve Benoit, 3rd Edition (Amazon)
“When the enabling technology is in place, the next thing is going to happen.”

Vic Poor, W5SMM (SK)

“Talk about it as if everybody is doing it and eventually they will be.”

Wayne Green, W2NSD/1 (SK)
...and next,
Thanks!

Questions?