

High Definition Amateur Digital Television

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AMATEUR TELEVISION

The FCC allows wide-bandwidth, fast-scan, TV on the 70cm (420-450MHz) band and all higher, microwave bands. Most TV operations are on the 70cm band. On 70cm, we use bandwidths of 6 MHz. Our standard channels are CATV's 57 (420-426), 58 (426-432), 59 (432-438) & 60 (438-444).

The ARRL band plan calls for
Ch 60 = Repeater Input, Ch 57 = Repeater Output
& Ch 58 = Simplex. Use of channels 59 & 61
discouraged

TV Timeline

- **1925** – QST reports on TV experiments using mechanical scanning
- **1926** – John Blair in Scotland, demos 1st working TV using mechanical scanning
- **1927** – Philo Farnsworth, 1st patent for all electronic scanned TV system
- **1929** – 1st TV broadcast, London
- **1939** – NBS 1st live TV broadcast, NYC
- **1940** – 1st ham TV 2 way QSO, W2USA & W2DKJ in New York City, 56 & 112MHz

TV Timeline contd.

- **1941** - FCC issues NTSC standard, VUSB
- **1941-45** WWII, TV development suspended
- **1946-50** Major deployment of broadcast TV stations in all major metro areas
- **1948** – San Francisco bay area hams are transmitting NTSC TV on 70cm band
- **1950** – Ed Tilton, QST June issue reports on major ham TV activity in USA, UK, and Holland
- **1953** – Color added to TV, compatible with B&W
- **1957** – Cop McDonald, VY2CM, develops slow-scan TV for use on HF

TV Timeline contd. - HDTV

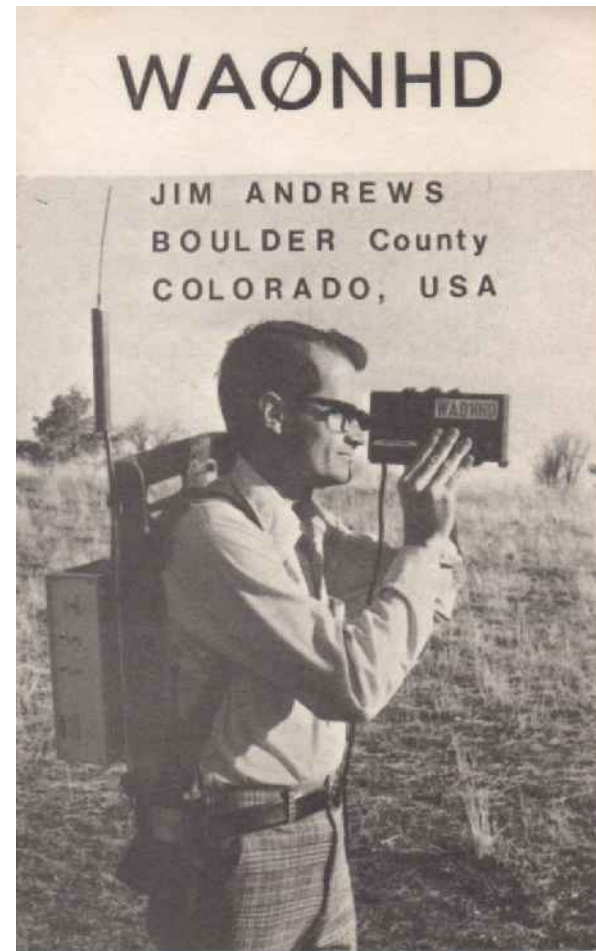
- **1968** – Japan starts HDTV development
- **1986** – USA & Europe turn down Japan's proposal for their analog HDTV system
- **1987** FCC creates ATSC to develop DTV
- **1991** DVB development starts in Europe
- **1991-92** FCC holds field trials for competing digital and analog HDTV systems
- **1993** MPEG-2 video encoding standard adopted
- **1993** Europe selects DVB as their DTV system

TV Timeline contd. - HDTV

- **1996** FCC selects ATSC's 8-VSB system for broadcast DTV in USA with 10 year transition period from analog to digital
- **1999** Sinclair Broadcasting challenges selection of 8-VSB over DVB-T. Field tests show superiority of DVB-T for indoor reception with simple antennas. FCC turns down petition.
- **2009** USA switches completely from analog TV to DTV (8-VSB)

Boulder Colorado ATV Timeline

- **1975** – availability of low cost, B&W TV cameras starts ATV activity. Jim, WA0NHD (now KH6HTV) plus several other hams
- **1978** – 70cm TV Repeater operational on Lee Hill
- **1981** – TV Repeater off the air due to RFI from new 10kW, FM broadcast station on same site. Local ATV activity dies for next decade.



Boulder, CO ATV Timeline contd.

- **1990** – Boulder Sheriff requests BCARES to add ATV to it's services. ATV activity restarted with ARES emphasis
- **1991** – TV Repeater operational again. This time from Chautauqua Park, coverage of eastern ½ of county. Plus a portable TV repeater.
- **1991-present** ATV is the most requested service from BCARES. Used for forest fires, floods, riots, public protests, major athletic events, etc.
- **1995** – BCARES starts security TV coverage of all CU home football games for CU-PD.
- **1997** – BCARES starts providing TV coverage of Boulder Sheriff SWAT operations
- **2011** – High-Definition Digital TV experiments start

TV Acronyms

- **ATV** – Amateur Television
- **DTV** – Digital Television
- **NTSC** – National Television Subcommittee, the original Analog TV system with 525 (480i) lines, standard definition, VUSB
- **VUSB** – Vestigial Upper Side Band – analog TV modulation method, a form of AM with carrier, full upper side-band and small portion of lower side-band
- **ATSC** – Advanced Television Subcommittee – developed current USA broadcast DTV

TV Acronyms contd.

- **8-VSB** - Eight Vestigial Side Bands, *USA std. for broadcast DTV*
- **DVB-C** - Digital Video Broadcast – for Cable, uses QAM
- **DVB-S** – Digital Video Broadcast – for Satellite, uses BPSK, QPSK, 8PSK or 16-QAM
- **DVB-T** – Digital Video Broadcast – Terrestrial, uses QPSK, 16-QAM or 64-QAM *European std. for broadcast TV*

TV Acronyms contd.

- **BPSK** – Binary Phase Shift Keying 0 & 180 degrees
- **QPSK** – Quadrature Phase Shift Keying 0, 90, 180, 270 degrees
- **QAM** - Quadrature Amplitude Modulation, combination of both QPSK & discrete digital level amplitude modulation. 2^n states, such as 16, 64, 256, etc.
- **COFDM** – Coded Orthogonal Frequency Division Multiplexing

Amateur DTV Timeline

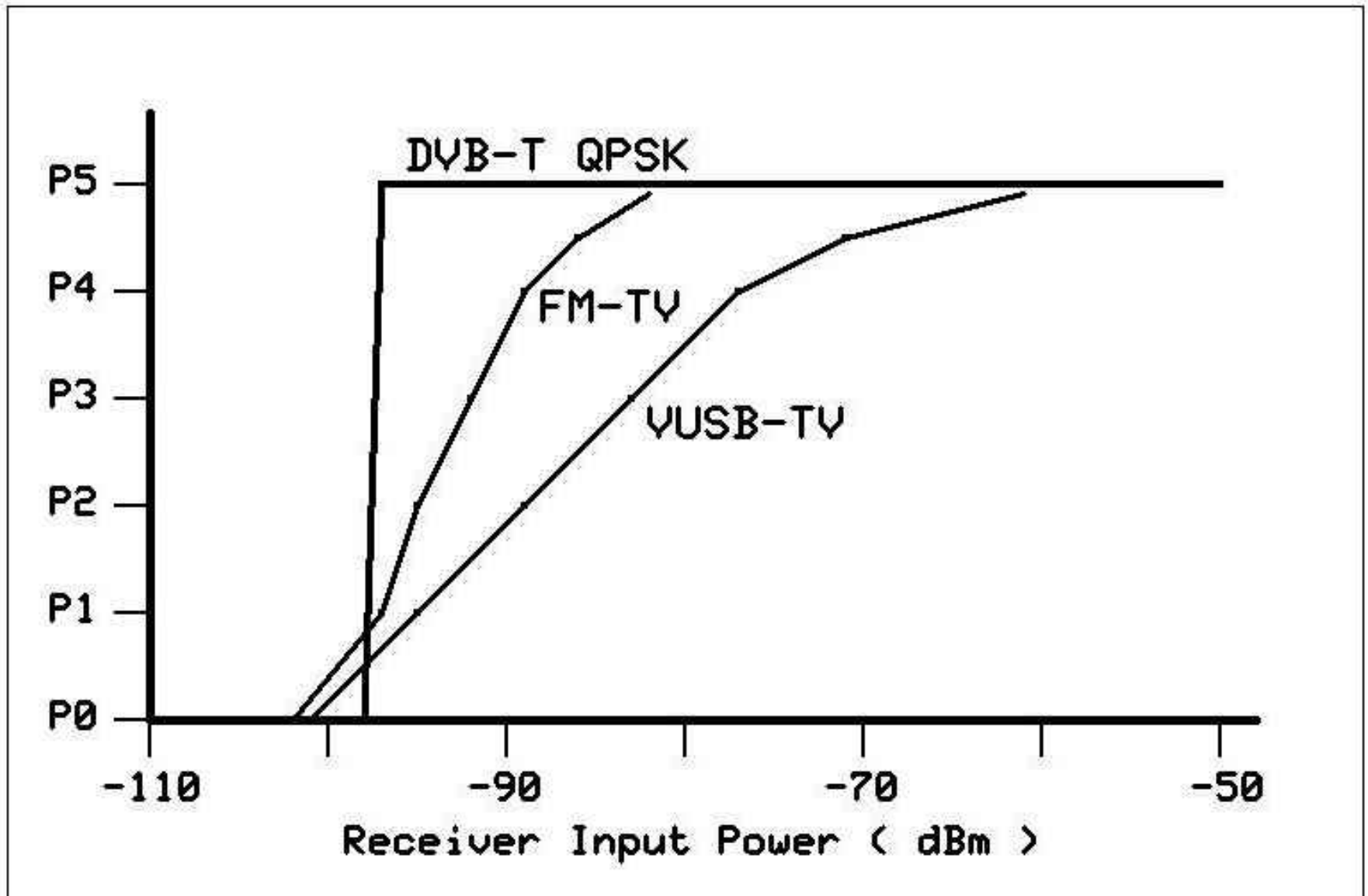
- **Early 2000s** - Earliest work was in Germany, France & UK, using DVB-S, standard definition only. USA TV hams slow to get on DTV bandwagon.
- **2011** – Drake introduces, low-cost (\$1.2K), CATV, QAM modulator. Experiments show it works over the air, but only when little or no multi-path present.
- **2014** – Hi-Des in Taiwan introduces, low-cost, DVB-T modulator and receivers. Field trials show DVB-T to be far superior than analog TV or CATV-QAM
- **Fall 2014** – 77 mile DVB-T DX record, Cheyenne, WY to Boulder, CO, 10 watts + conventional yaggi antennas. KH6HTV to N0YE

DVB-T DX Record

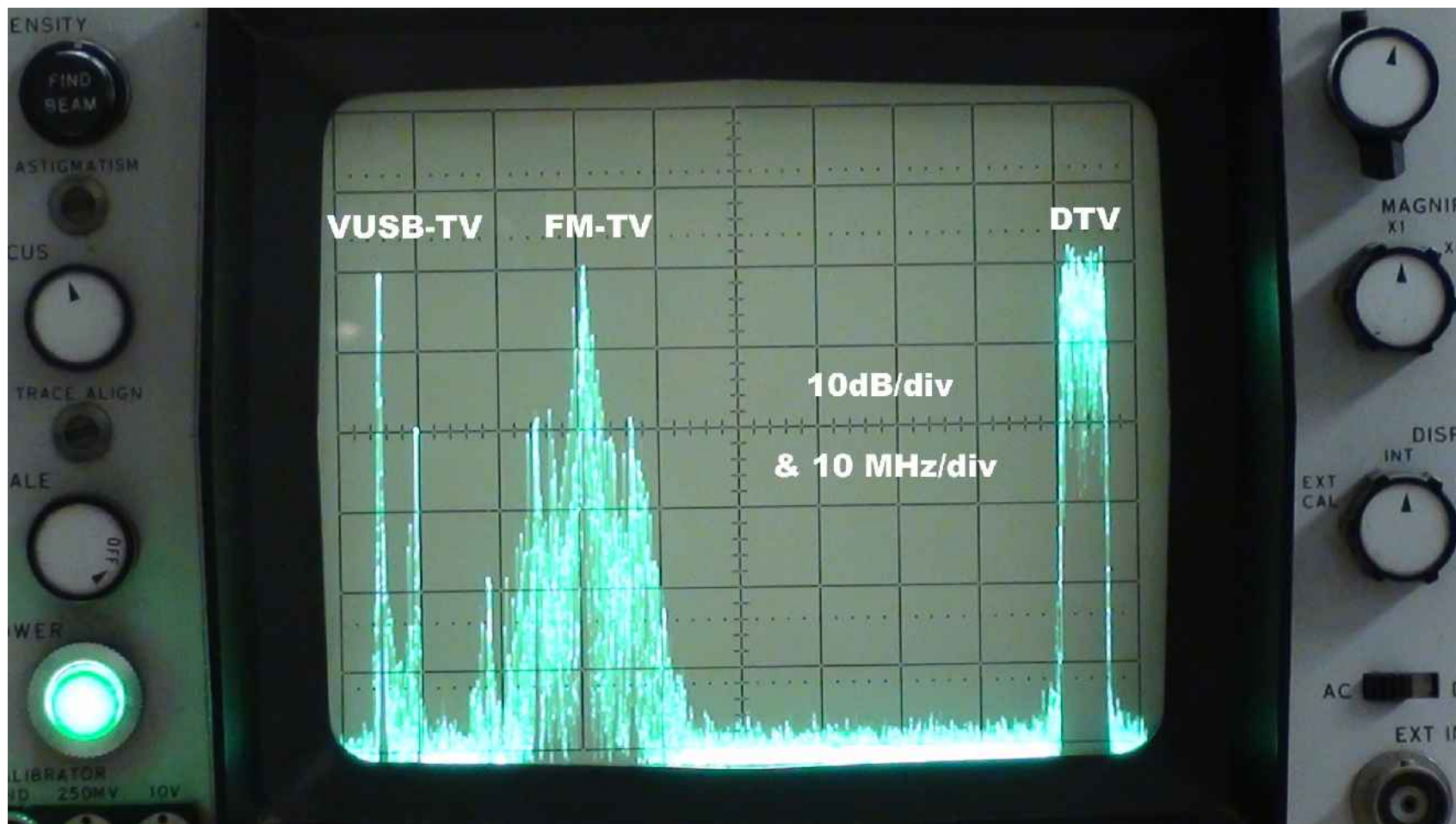
Cheyenne to Boulder, 77 miles



DTV vs Analog TV



Comparison of Analog & Digital TV Spectrums



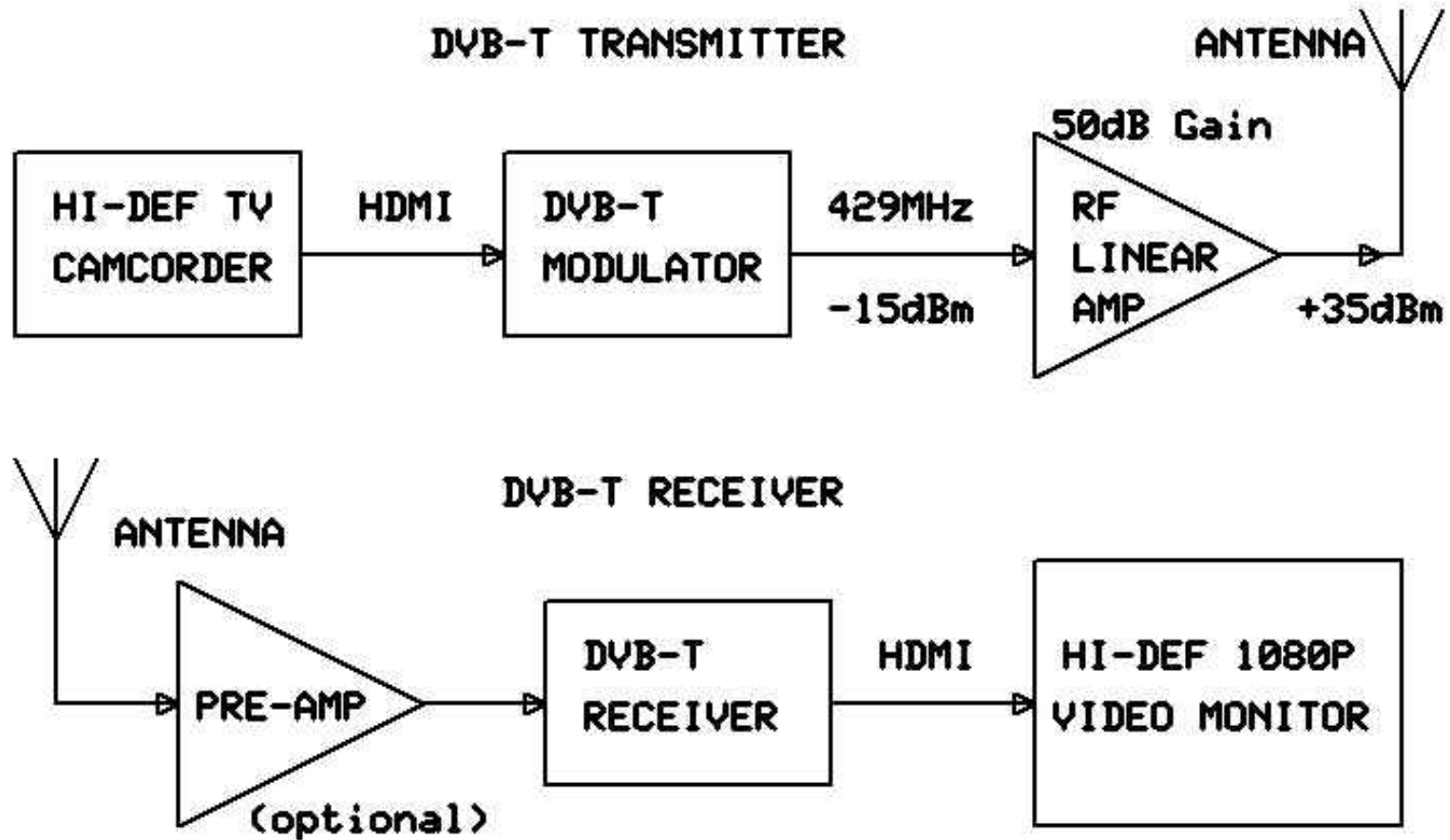
Why Not Use 8-VSB ?

- \$\$\$ - Big Bucks necessary to buy modulators. Tightly controlled patents.
- From FCC 1999 report "...the COFDM (DVB-T) system has better performance in dynamic and high level static multi-path situations, and offers advantages in mobile reception."
- No modulators available in small units for 12Vdc, portable service

DVB-T

- Broadcast standard for terrestrial DTV broadcasting for Europe and most of the rest of the world. Only USA, Canada, Mexico & S. Korea use 8-VSB
- Uses COFDM with 2K or 8K close spaced sub-carriers with packetized, digital data
- Uses QPSK, 16-QAM or 64-QAM
- Includes dynamic channel characterization and correction and forward error correction (FEC)
- Highly tolerant of extreme multi-path
- Works in mobile situations with doppler shift

Amateur DVB-T System



70cm, 3 Watt, DVB-T Transmitter



Hi-Des model HV-100EH DVB-T Modulator



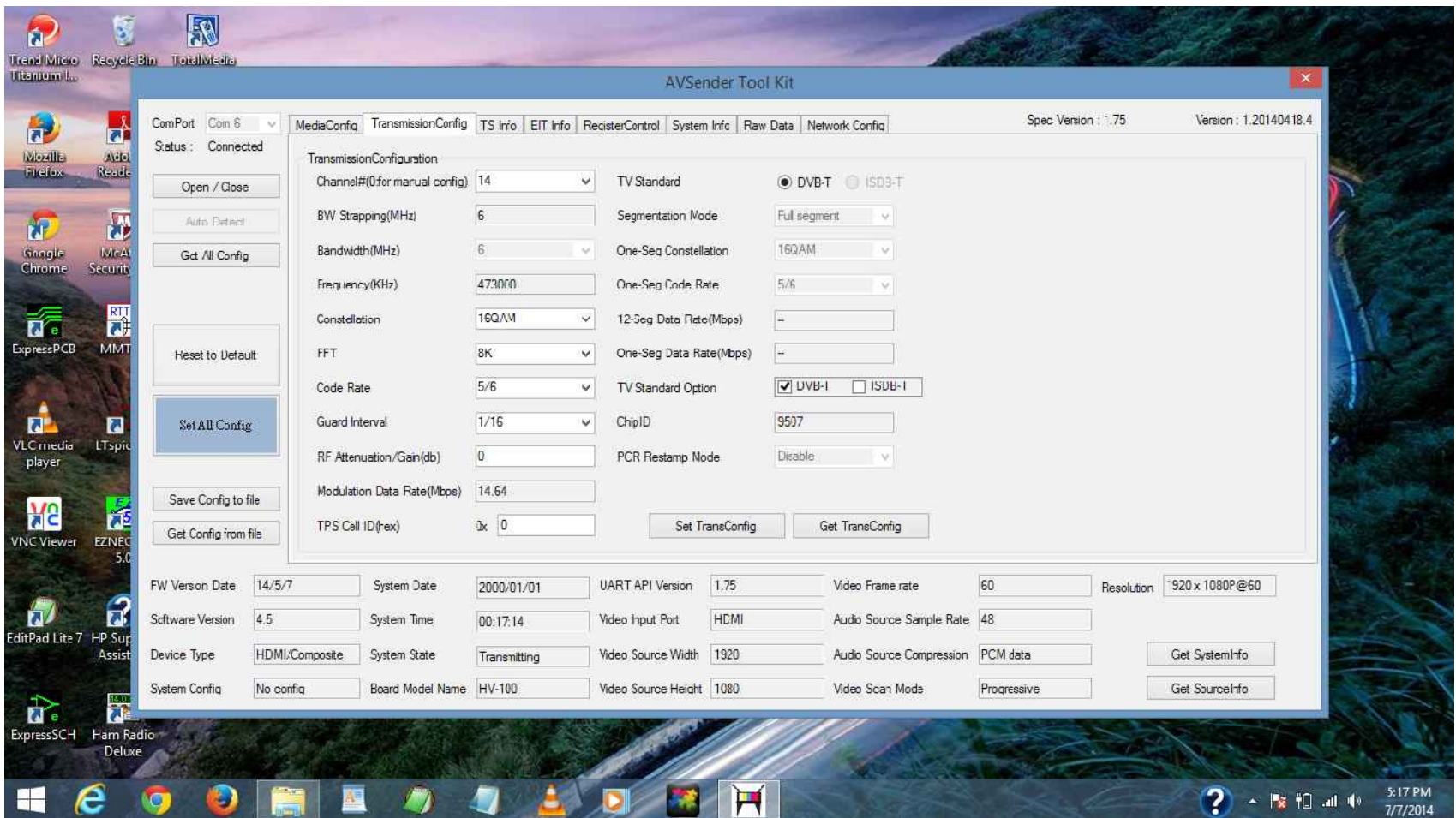
- Extremely simple to operate – only control is channel selector. Up to 100 channels.
- Frequency Synthesized – 50 to 950MHz plus 1200 to 1350MHz, 1kHz resolution, covers amateur 70cm, 33cm & 23cm bands
- Adjustable Bandwidth – 2 to 8 MHz, 1MHz steps

Hi-Des DVB-T Modulator



- -3dBm RF output, with programmable attenuator to -20dB, 1dB steps
- HDMI (up to 1080p) & Composite (480i) video & audio inputs
- USB & Ethernet
- +12Vdc @ 700mA cost = \$570

Program with external PC computer via USB



Recommended Modulator Parameters

** = compromised conditions*

*** = extremely poor multi-path conditions*

- Frequency = as desired, 423000kHz for ch 57
- Bandwidth = 6 MHz
- Modulation = QPSK
- Sub-Carriers = 8K
- Code Rate (i.e. FEC) = 5/6 (2/3 *, 1/2 **)
- Guard Interval (i.e. sync) = 1/16 (1/32 *, 1/32 **)
- RF Attenuation = as needed for particular linear amplifier
- Video Resolution = 1080P (720P **)
- Video Encoding = H.264
- Max Video Bit Rate = 6.0Mbps-CBR (5.4Mbps *, 4.2Mbps **)
- Audio Encoding = MPEG2
- Audio Encoding Bit Rate = 96kbps
- Service Name = your call sign, example KH6HTV, Note this satisfies FCC requirement for IDing

RF Linear Power Amplifier

- 70 cm (420-450MHz)
- 50 dB Gain
- 3 Watts avg (DTV)
- 10 Watts pep (VUSB)
- 20 Watts sat (FM)
- Adjustable power -5 dB & -10 dB (3W, 1W, 300mW)
- 12Vdc @ 3A, 1.1A & 600mA
- KH6HTV Video model 70-7B, \$315



Hi-Des model HV-110 DVB-T Receiver



HV-110 Specs

- Frequency Synthesized – 170 to 950 MHz, 1kHz resolution, covers 70cm & 33cm bands
- Bandwidth – 2 to 8 MHz, 1 MHz steps
- HDMI(up to 1080p) & Composite (480i) video outputs
- Program & control via IR remote control
- +5Vdc @ 315mA Cost = \$170

Cheap ! \$10 DVB-T Receiver



- USB TV Tuner Dongle
- Available everywhere on internet
- Uses RTL2832 software defined radio receiver IC
- Use free shareware VLC program

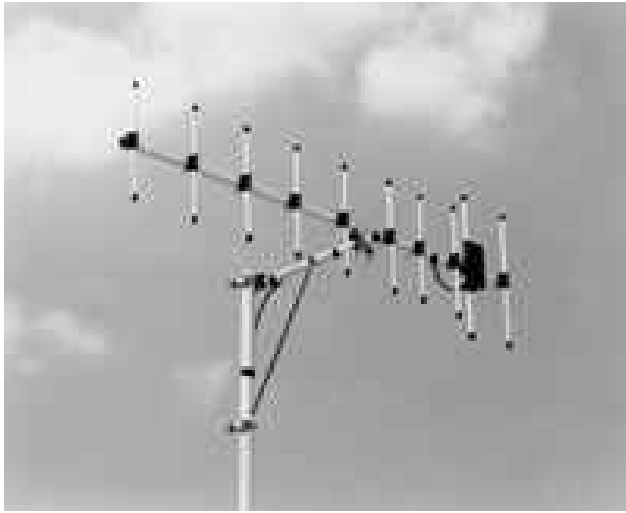
Hi-Des Receiver Sensitivity

- QPSK = -97 dBm
- 16-QAM = -92 dBm
- 64-QAM = -82 dBm
- Adding a low noise pre-amp buys another 3dB in sensitivity

QPSK vs QAM

- Max Video Encoding data rates for various modulations with 6MHz BW: QPSK = 7.3Mbps, 16-QAM = 14.6Mbps & 64-QAM = 21.9Mbps
- Higher bit rates needed to follow really fast action, such as sports, thus prefer QAM
- For typical ham TV, low power, marginal antenna situations, the 15dB QPSK margin often means the difference between no signal vs. a perfect signal.
- For most normal video scenes, perfectly acceptable, hi-def., 1080P images are possible with QPSK

TV Antennas must be Broad-Band !

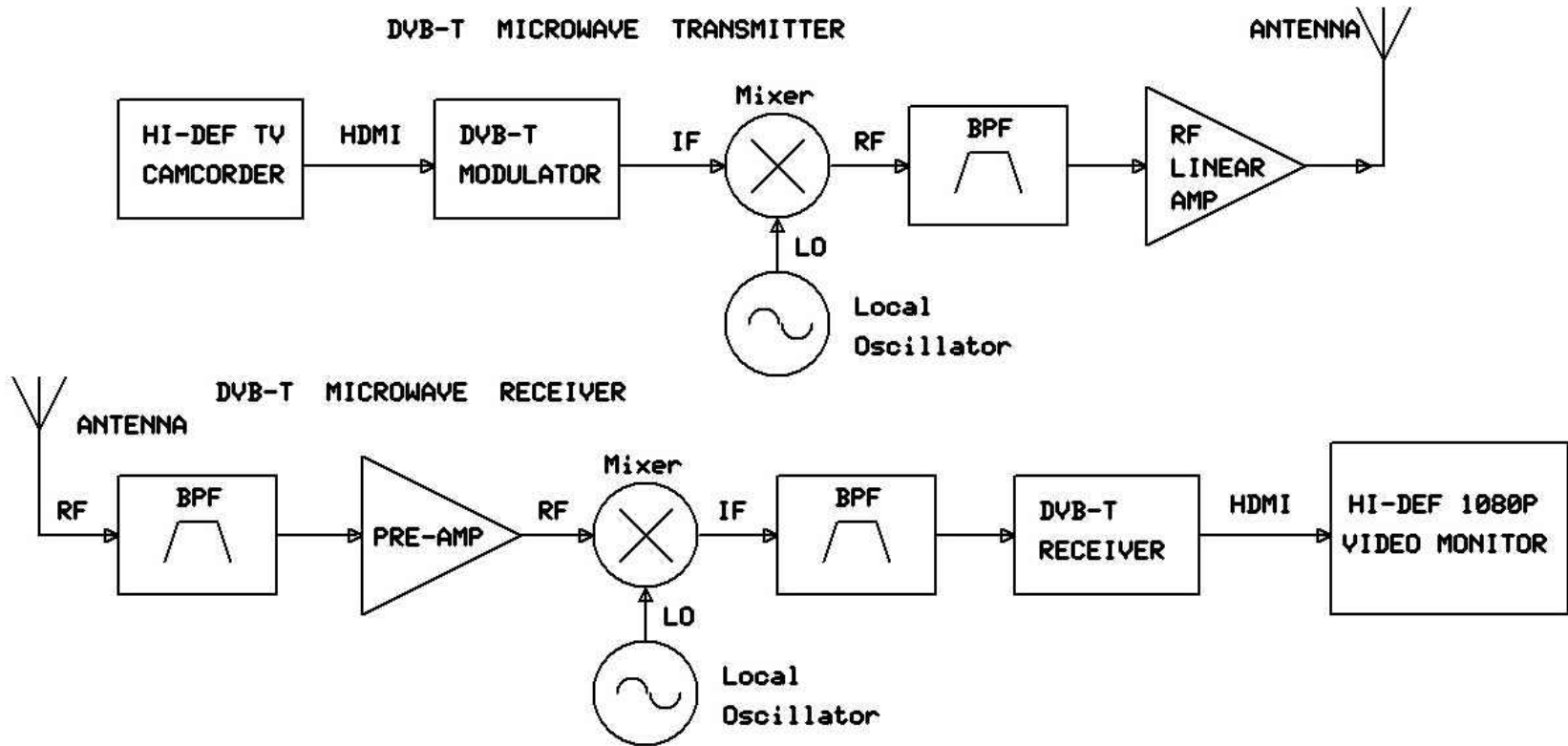


Boulder ARES has standardized on using Vertical Polarization for 70cm & 23cm TV – most suitable for back-pack portable & mobile ops



Higher Microwave Bands

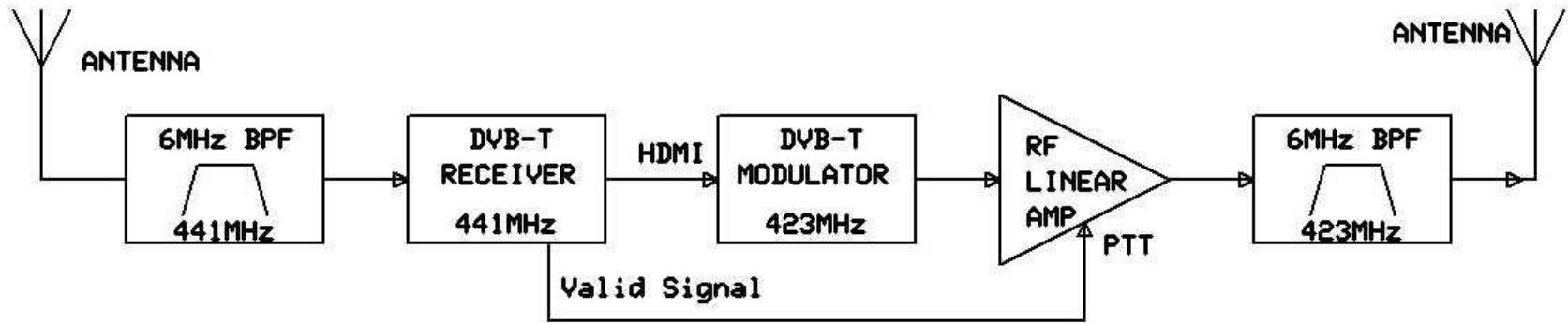
note: LO must have very low phase noise



Propagation Characteristics of various bands

- 70cm (430MHz) - best all around for usefulness, reasonable size antennas, lower path loss and good penetration. 30MHz supports up to five, 6MHz, hi-def channels or fifteen, 2MHz, std. def channels
- 33cm (900MHz) – 909MHz worked. Do have RFI issues due to proliferation of unlicensed part 15 devices
- 23cm (1250MHz) – 2ed choice, best used for point-to-point links. Main RFI issue is DIA radar at 1267MHz
- 13cm (2.4GHz) – marginal results at 2.395GHz - worthless due to Wi-Fi signals above 2.40GHz
- 5cm (5.8GHz) – successful results at 5.862GHz
- 3cm (10GHz) – unknown yet, will do future experiments. NOYE has a lot of SSB experience at 10G

DVB-T TV REPEATER



DVB-T, 70cm, 6W, Repeater built by Matt, K0DVB



6MHz BW, 70cm, Inter-Digital Band-Pass Filter



More Information

- KH6HTV VIDEO www.kh6htv.com over 20 ATV/DTV related application notes, plus RF linear amplifiers and other amateur TV products
- “DVB-T: A Solution for ARES Television Operations”, QST, June 2015, pp. 42-44, by KH6HTV
- Amateur Television Quarterly, national ATV magazine, www.atvquarterly.com

More Info contd.

- Hi-Des Technologies www.hides.com.tw
supplier of low cost, quality, DVB-T
modulators and receivers
- “Digital Video & Audio Broadcasting
Technology” by W. Fisher, Springer, ISBN
978-2-642-11611-7
- www.wa4dsy.net on-line design calculator
for inter-digital band-pass filters

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This Power-Point slide show is available in .pdf
format on the web at: www.kh6htv.com

A color calibration chart consisting of seven vertical bars of different colors: grey, yellow, cyan, green, magenta, red, and blue. Below these bars are several smaller colored squares and rectangles in blue, black, magenta, cyan, and grey. The text 'KH6HTV' is overlaid in the center in a bold, white, sans-serif font.

KH6HTV