Getting Started in Terrestrial Digital Amateur Television

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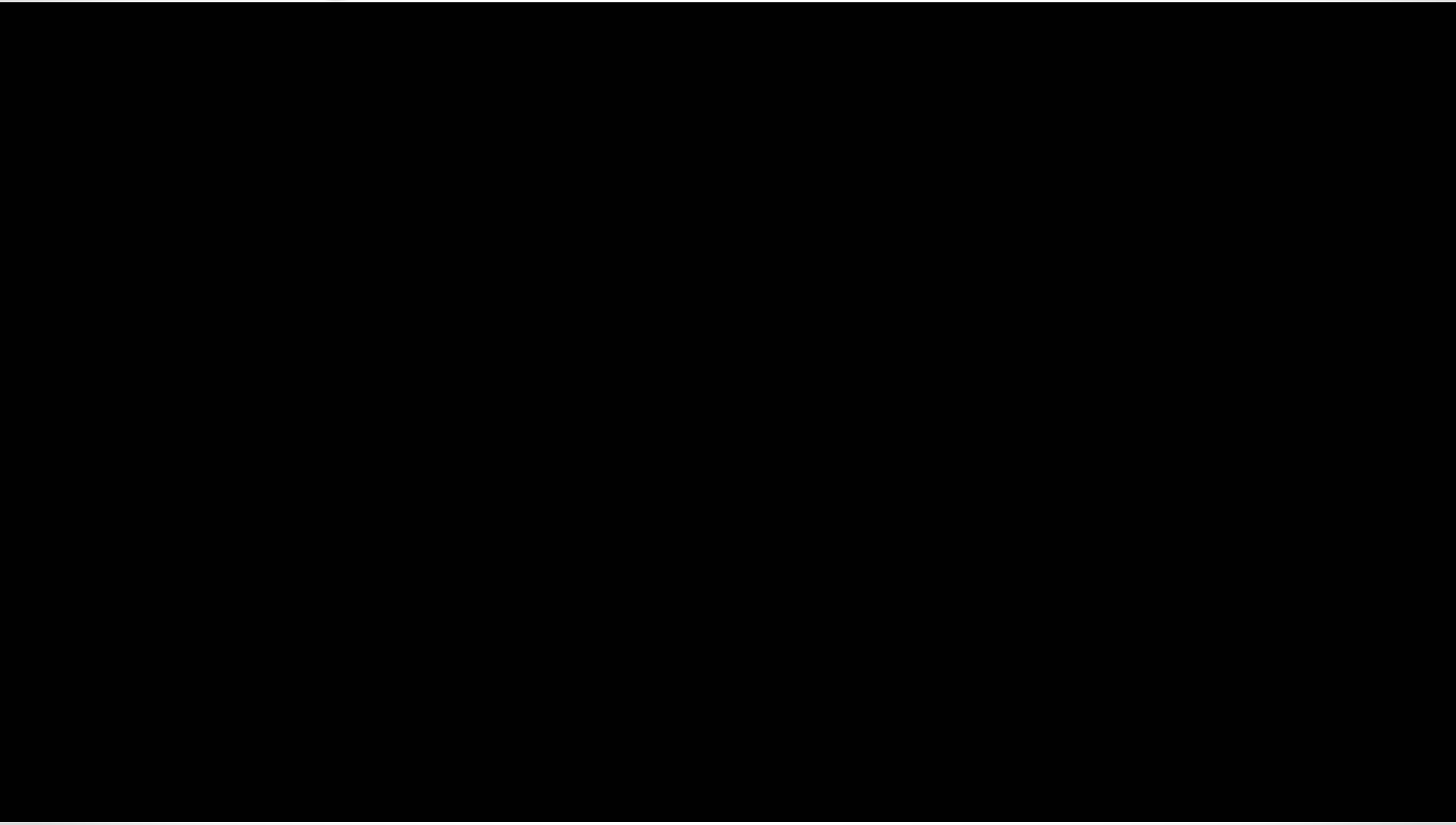
mel@melwhitten.com

Digital TV for Amateur Radio!



Topics...

- Our Amateur TV Bands
- DVB-T standard for digital video and audio
- HiDes manufacturer of DVB-T equipment
- Configuring and building your Digital ATV station
- Adding more capability to your ATV station
- Digital ATV Repeater Design
- On line resources

Amateur Television

- FCC rules allow wide bandwidth, analog and digital TV on 70cm (420-450MHz) and all higher into the microwave bands in most areas within the US.
- On 70cm 2 to 6 MHz BW channels are used. Second popular band is 23cm (1.2GHz). Higher microwave frequencies are in use especially for links.


DVB T
TERRESTRIAL

What is DVB-T?

- **D**igital **V**ideo **B**roadcasting – **T**errestrial is a European developed TV system introduced in the UK (1998)
- Follows an open standard published as EN 300-744, "Framing structure, channel coding and modulation for digital terrestrial television."
- Uses modern compression techniques (MPEG-2/h.264) and efficient modulation schemes to deliver SD and HD video in a streaming format on multiple carriers
- Flexible transmission modes can provide strong Forward Error Correction to cope with noise, multi-path and Doppler effects
- Receiver's "agility" can adapt to the transmitter's signaling requiring no human intervention.

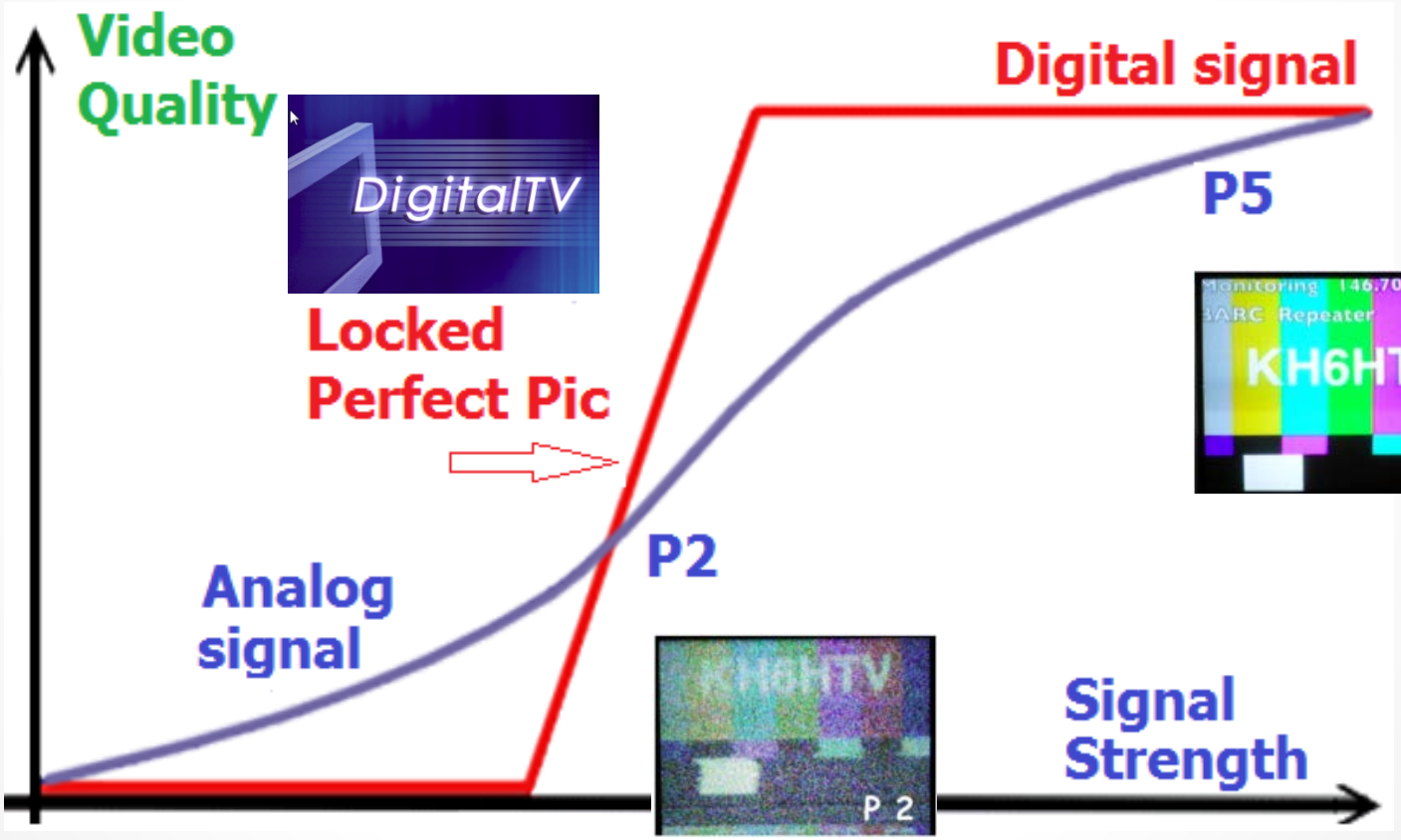
DVB-T vs ATSC

Why use DVB-T and not our US ATSC Standard?

- Lower modulator/transmitter costs
- Adjustable/Adaptive Transmission parameters
- Excellent multi-path and mobile performance
- Variety of readily available TX/RX equipment
- Linux and Win Software Development Kit (SDK)
- Application Program Interface (API) available

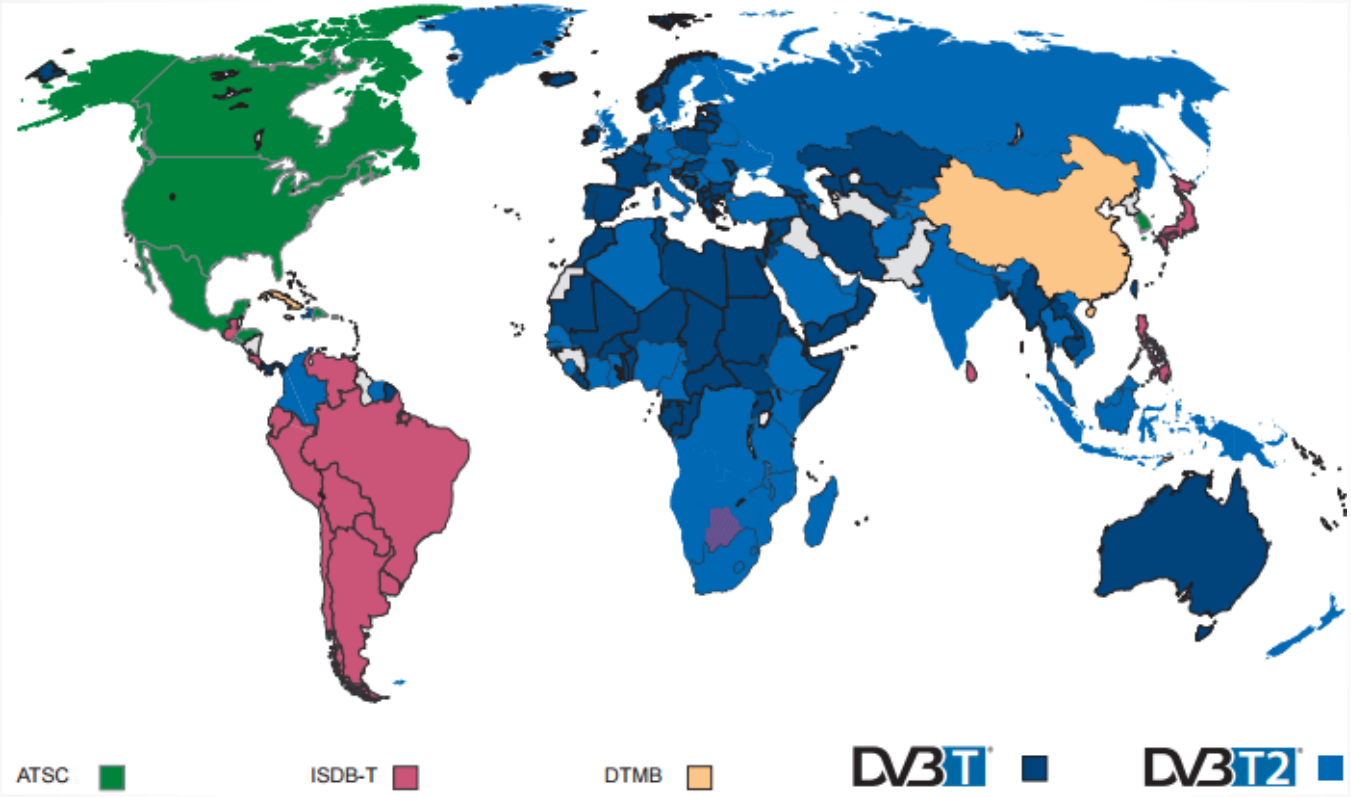
Analog ATV vs Digital ATV Signals

Digital Signal's "Brick wall/Cliff effect"



Analog remains visible with a snowy picture – good for DXing

DVB-T world wide



ATSC Advanced Television Systems Committee
ISDB-T Integrated Services Digital Broadcasting
DTMB Digital Terrestrial Multimedia Broadcast

DVB has over a billion users worldwide

Some DVB history…

- Before the 90s, it was not technically or economically possible to digitize TV
- Japan, Europe and finally U.S. threw a lot of money into developing digital TV/HDTV in the 80s/90s
- **M**otion **P**icture **E**xpert **G**roup compression standards were developed for moving pictures (MPEG 1, later 2, 4)
- Europe defined and standardized DVB in 1993
- By the late 90s, 3 DVB variants S/M/T were available
- Later MPEG4/h.264/AVC compression was developed

Satellite TV uses DVB-S/S2

MPEG – making DTV possible

Compression of Video and Audio Signals

- Built upon a number of *profiles* and *levels* (res/bit rates)
- 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
  - MPEG-2 for SD and MPEG-4 (h.264) for HD
  - Advanced Audio Compression (AAC) used for sound

COFDM (multiple carriers)

(Coded Orthogonal Frequency Division Multiplexing)

- *Many* discrete carriers spread over 2 to 8 MHz BW
- 3 modulation schemes QPSK - 16QAM - 64QAM
  -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*
  Counters echoes and reflections *(avoiding ISI)*
  Allows RX to ID the start of a symbol *(correlation)*
  Impacts on number of carriers and useful bit rate

Channel coding… FEC

(Forward Error Correction)

- *Reed-Solomon's* block level code (RS204,188) adds 16 bytes for correction of up to 8 errors for total packet length of 204
- *Forney convolutional interleaving* corrects burst and other data errors allowing R-S to be more effective over multiple packets
- FEC is applied at a *Code Rate* of 1/2, 2/3, 3/4, 5/6, 7/8

  1/2 = 1 real bit and 1 FEC bit = 100%

  7/8 = 7 real bits and1 FEC bit = ~9%

  (defined as the *"Puncture Rate" of the encoder)*
- FEC must be balanced between the payload data rate needed, signal robustness requirement *and* available BW

Modulation: QPSK and QAM

- Max Video Encoding data rates for various modulations with 6MHz BW: QPSK = 7.3Mbps, 16-QAM = 14.6Mbps and 64-QAM = 21.9Mbps

- Higher bit rates needed to follow really fast action, such as sports, thus prefer QAM (~7Mbps 1920 x1080p full motion video)

- For most normal video scenes, perfectly acceptable, hi-def 1080p images are possible with QPSK *(~3.5 Mbps "shack" video)*

Source: KH6HTV

MPEG Transport Stream (TS)

- Compressed video and audio data signals found in MPEG are called Elementary Streams or ES
- These streams are then packetized and multiplexed together into a Transport Stream or TS
- Forward Error Correction (FEC) is then applied to the TS data to achieve a very low Bit Error Rate (BER) at the receiver
- This data stream is now ready for modulating the multi-carrier OFDM signal sent to the receiver

So What Bit Rate should I use?

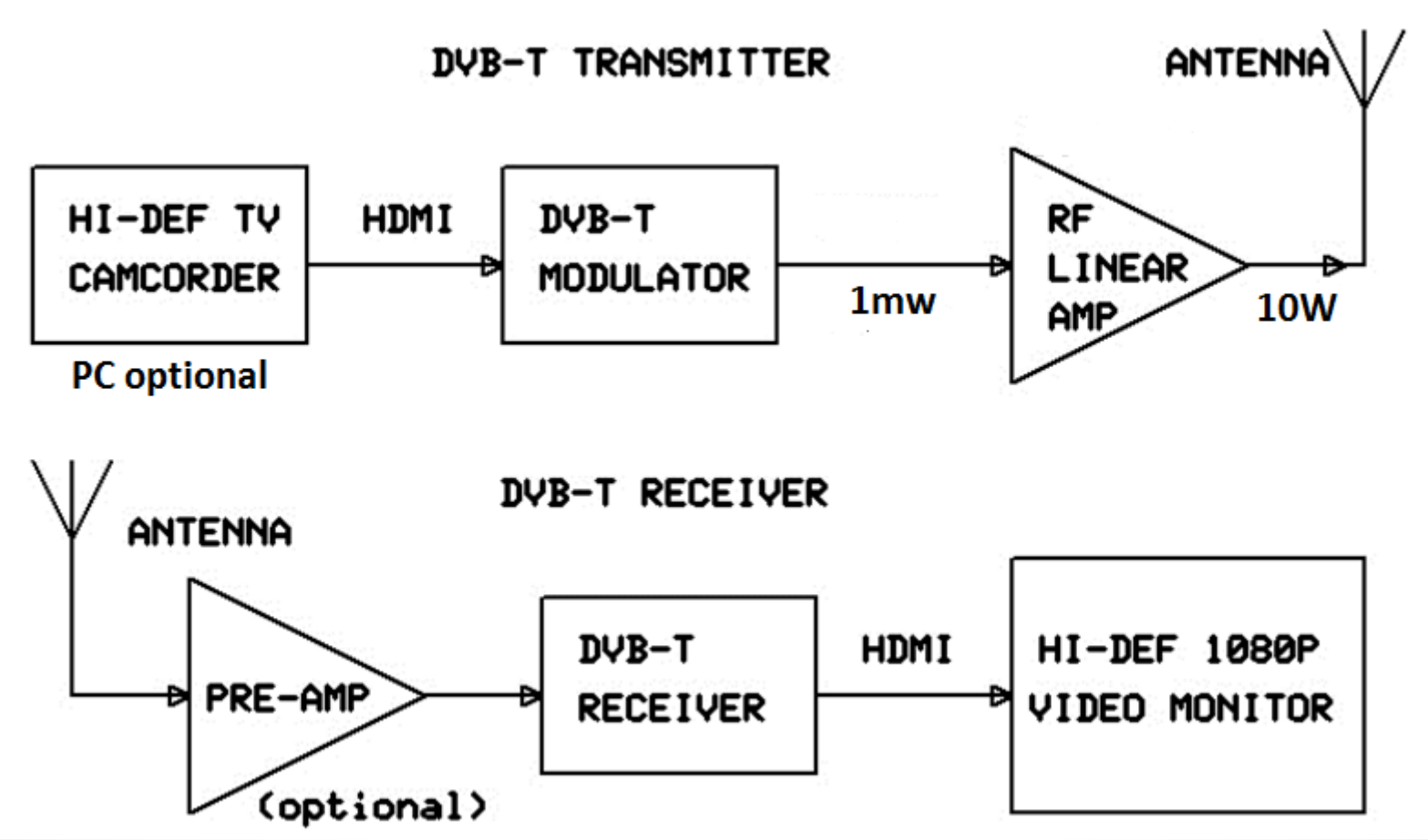
- For 1080p videos, use a range between 3.5 to 6.0 MB/s
- When using the standard 30fps rate, try the lower end of the range between 3.5 and 5.0 MB/s
- If the higher 60fps frame rate is needed, use 4.5 to 6.0 MB/s

DVB-T Receiver Sensitivity

- QPSK = -95 dBm @ 6MHz@1080p
- 16-QAM = -90 dBm @ 6MHz@1080p
- 64-QAM = -82 dBm @ 6MHz@1080p
- Adding a low noise pre-amp buys another 3dB+ in sensitivity

Source:
KH6HTV

Typical Amateur DVB-T Station



from KH6HTV.com

What do I need to get started?

- ***HiDes, Inc*** DVB-T Receiver and Transmitter
- Linear Amplifier (class A), DC power supply
- 70cm antenna (normally a yagi is needed)
- Video camera (720p to1080p resolution)
- Windows PC/laptop (with HDMI/USB)
- Find the "ATV Talk-back" FM frequency in your area

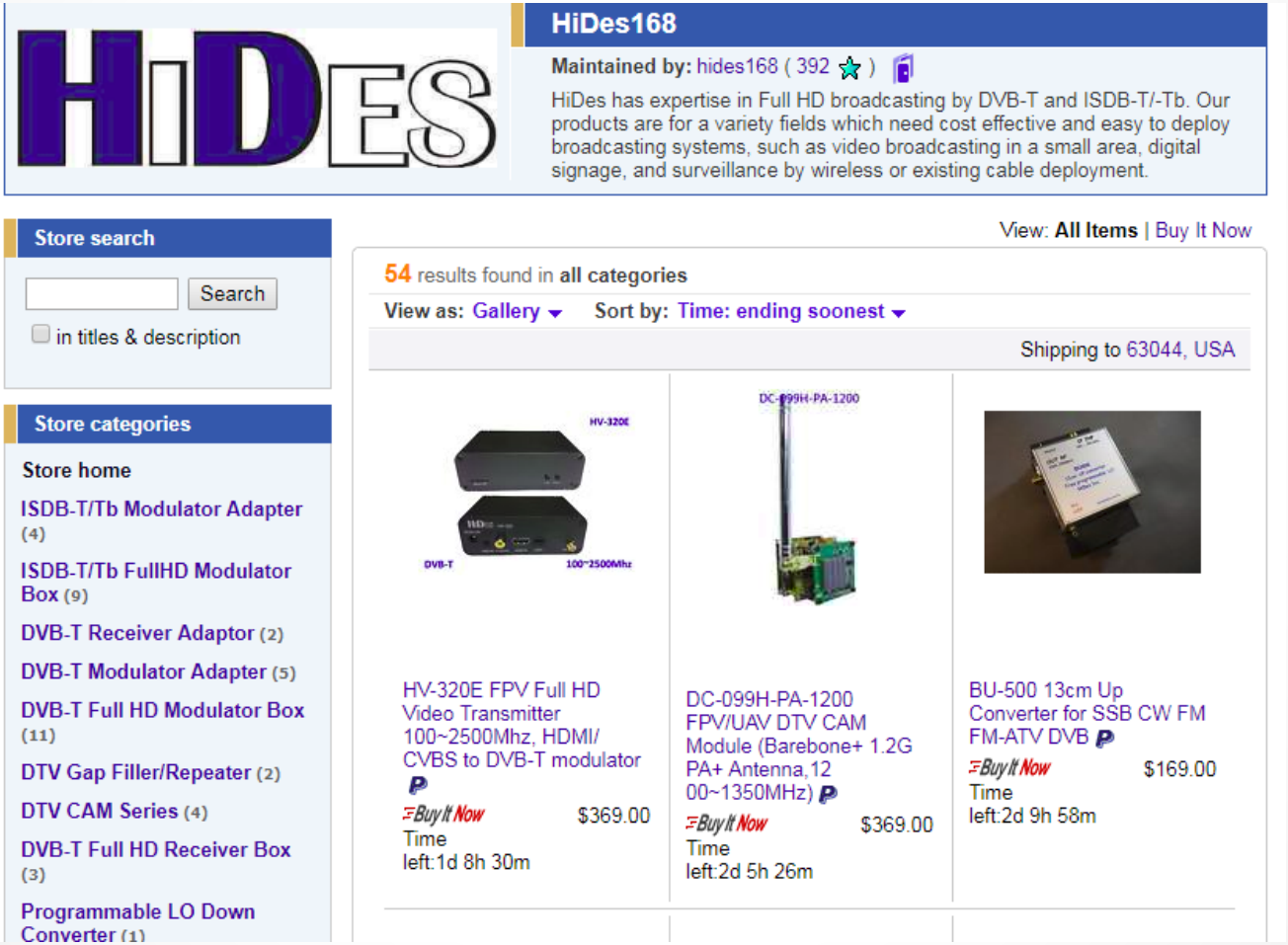
Who is HiDes, Inc ?

HiDES

New Taipei City
info@hides.com.tw
+866-2-29172417

- Taiwan manufacturer of digital video equipment for broadcasting, surveillance, signage and HAM RADIO!
- Over 50 digital video broadcasting products
- English docs and English speaking technical support staff
- Responsive to hams requests for additions and changes

Where do I find HiDes gear?



DVB-T Receiver and Transmitter

HiDes

HV-110 Receiver

($119)

OSD Remote

Web

ebay

HV-310 Transmitter

($279)

4″W x 1.25″H x 3″D

HV-110 Rx and HV-310 Tx Features

- Standard and High Definition video using MPEG/h.264
- 1/2/2.5/3/4/5/6/7/8 MHz Spectrum Bandwidth
- COFDM w/QPSK, QAM16 and QAM64 modulation
- 170 to1350 MHz on TX, to 950 MHz RX in1KHz steps
- TX power up to 3mW with programmable gain attenuator
- HDMI video in/out with MPEG stereo audio
- Analog to Digital Converter for analog/NTSC cams/monitors
- Video recorder with micro SD memory card up 32Mb
- 12vdc Bias-T for pre-amp at antenna
- 12vdc operation and SMA RF connectors

HiDes RX and TX for 23cm

HV-120A Receiver

($259)

DVB-T 100~950MHz, 1.212~1.308Ghz

HV-320E Transmitter

($399)

DVB-T/ ISDB-T/ ISDB-Tb 100~2500Mhz

Additional Features Provided in the HV 120/320

- Direct conversion TX 100 to 2500 MHz in1KHz steps
- RX Frequency 100 to 950 MHz – 1.212 to 1.308GHz
- TX power up to 1w with optional internal amp
- Channel/Freq changes with front panel PB switches
- Supports data mux/demux in transport stream
- Control interface for external host (PC) available

English Documentation

HiDES Easy HD Expressway!

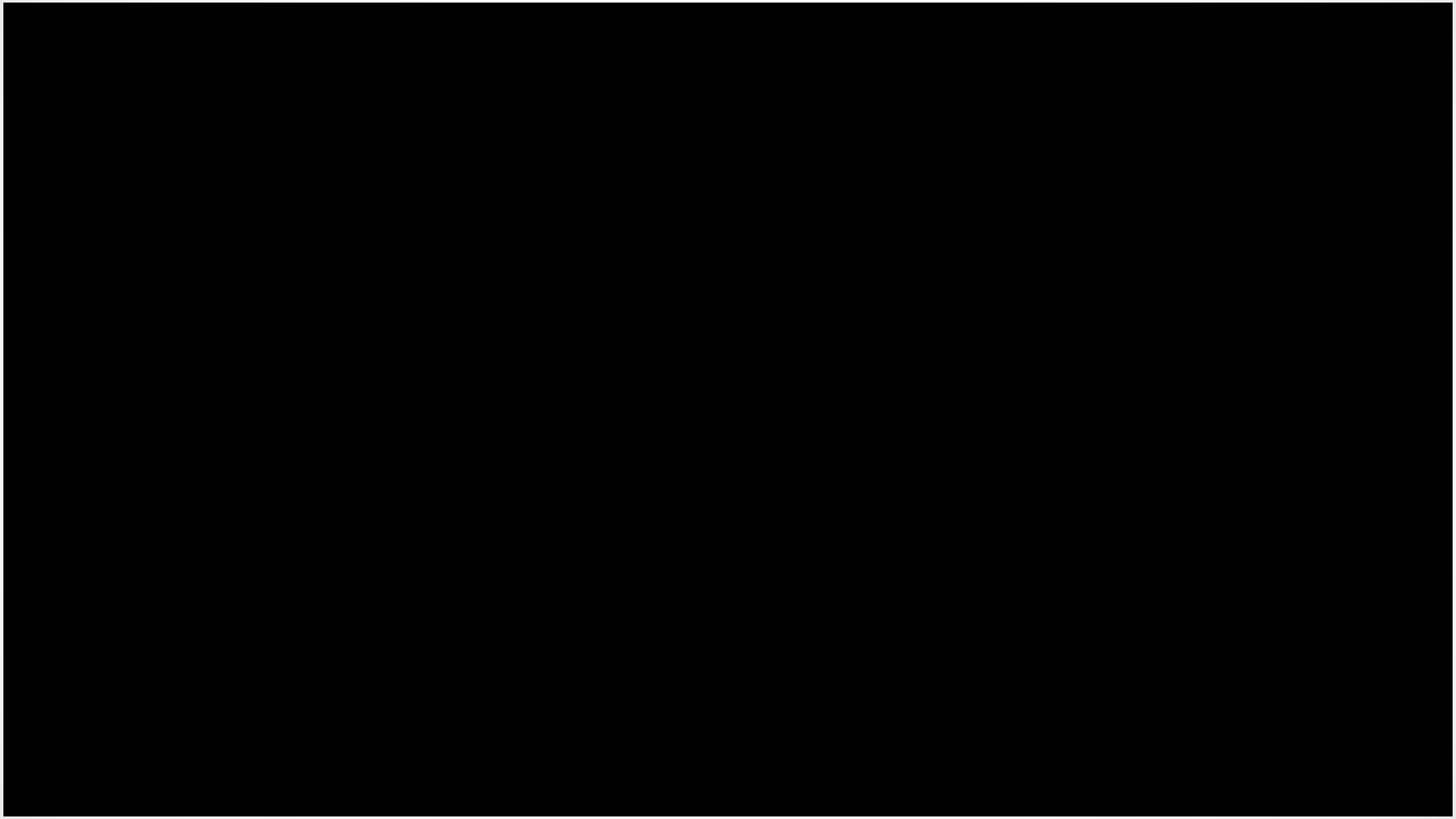
HV-110 DVB-T HAM TV Receiver Box
Quick Installation Guide

Receiver configured with a handheld Remote On Screen Displays (OSD)

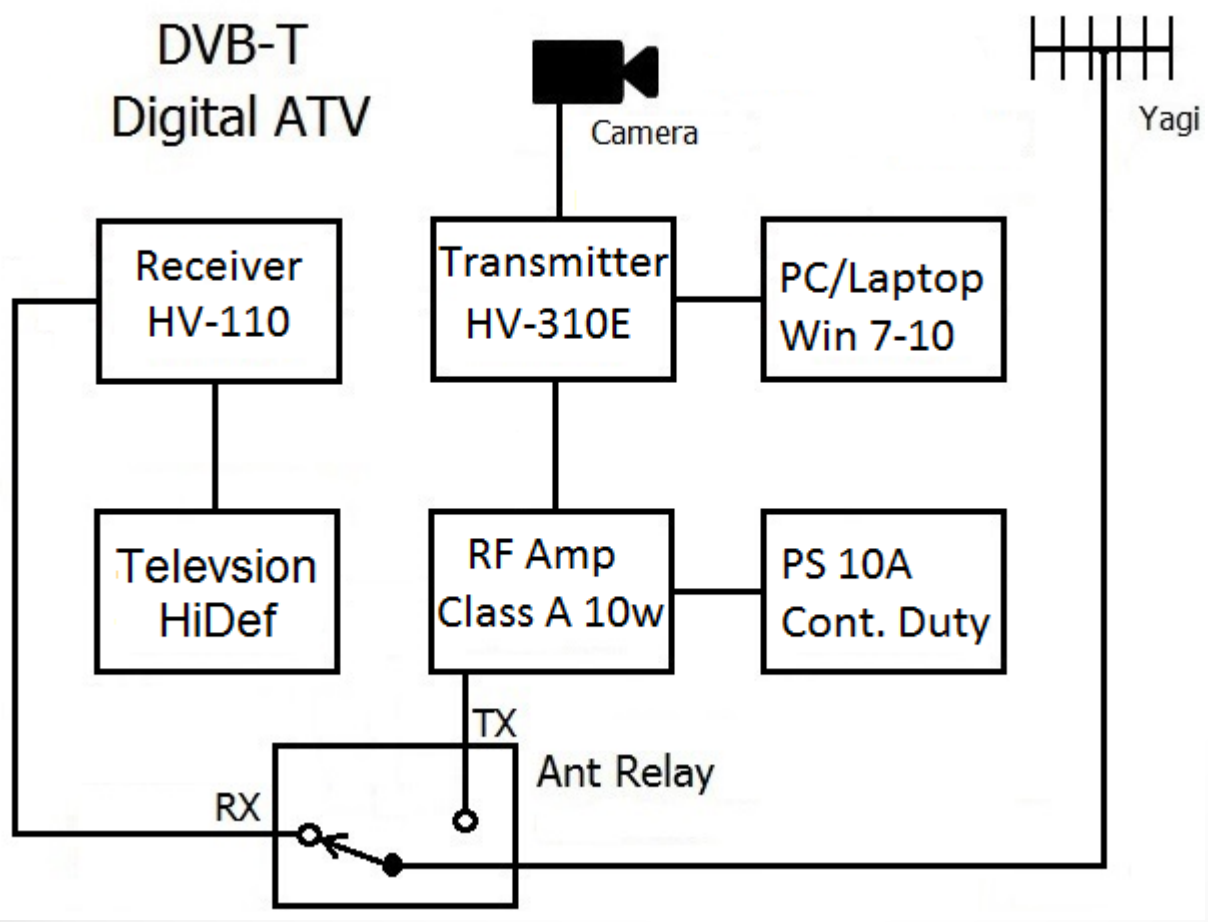
SNR, Signal, ID, Freq/BW

"the 4 corners signal report"

ATV QSO in progress…



ATV Station Configuration



HiDES Easy HD Expressway!

HV-310 DVB-T FPV TV Transmitter Box Quick Installation Guide

Tx Configuration Software

DVB T TERRESTRIAL

ComPort (COM9) Pi
Status : Connected

Open / Close
Auto Detect
Get All Config
Reboot
Reset to Default
Set All Config
Save Config to file
Get Config from file

MediaConfig | TransmissionConfig | TS Info | EIT Info | RegisterControl | System Info | Raw Data | Network Config | SerialPortConfig | Web Authorization | Encrypt | About

TransmissionConfiguration

Channel#(0:for manual config)	0	TV Standard	DVB-T / ISDB-T
Channel Table	User defined	Segmentation Mode	Full segment
Bandwidth(MHz)	4	One-Seg Constellation	QPSK
Frequency(KHz)	440000	One-Seg Code Rate	1/2
Constellation	QPSK	12-Seg Data Rate(Mbps)	--
FFT	2K	One-Seg Data Rate(Mbps)	--
Code Rate	5/6	TV Standard Option	DVB-T, ISDB-T
Guard Interval	1/16	ChipID	9517
RF Attenuation/Gain(db)	-1	PCR Restamp Mode	Disable
Modulation Data Rate(Mbps)	4.88		
TPS Cell ID(hex)	0x 0		

Set TransConfig | Get TransConfig

Edit User Channel Table

Get

DVBT Table

Ch #	Freq	BW
00	440000	4
01	426000	4
02	434000	4
03	439000	4
04	441000	4
05	177500	7
06	184500	7
07	191500	7
08	198500	7
09	205500	7
10	212500	7

Get from file | Save to file

SystemInfo | Source Info

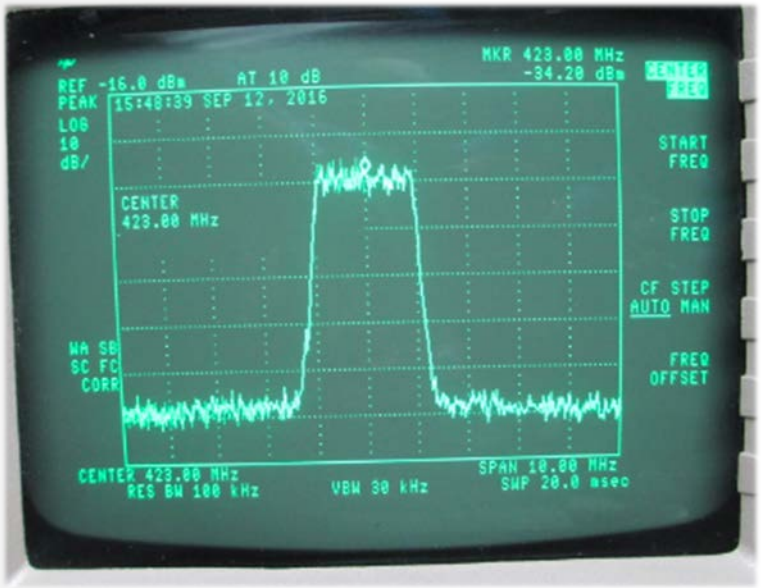
FW Version Date	0/0/0	System Config	No config	System State	No video Input	TimeZone	Dateline (UTC-12:00)
Software Version	55.14	System Date	0000/00/00	Board Model Name	IT9919	Daylight Saving	Disable
Device Type	HDMI/Composite	System Time	00:00:00	UART API Version	1.75	NTP Update Counter	0

NTP Client
NTP Server

Get SystemInfo

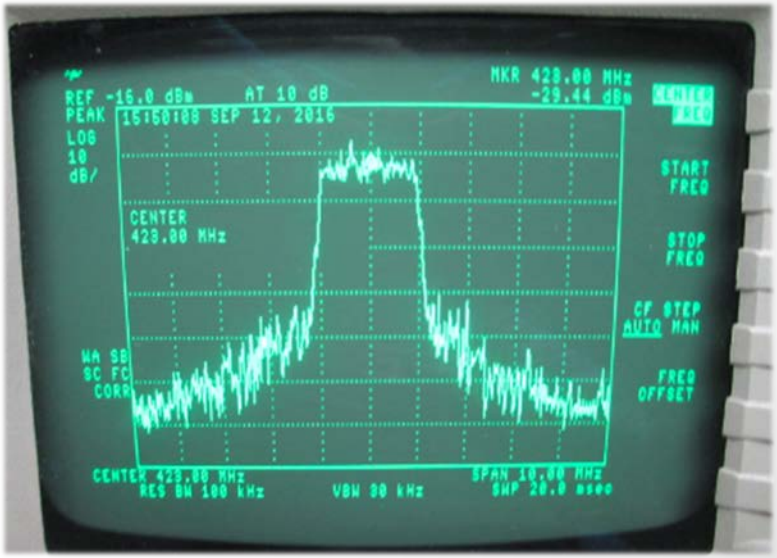
"AVSender" via PC USB port to Tx

DVB-T's OFDM Multi-Carrier Signal with FEC



Good TX Signal
Class A amplifier

Spectral spreading usually caused by amplifier driven into compression causing data errors



Orthogonal **F**requency **D**ivision **M**ultiplex

KH6HTV 70cm Class A 10w Amplifier

3 Pwr Ranges, Stand-by position,
PTT line ctrl, compatible w/HiDes.
High Quality in a small package

kh6htv.com $450

OE7DBH Class A Amplifiers for HiDes

~$147 kit

~$186

~$225 w/heatsink

Available from OE7DBH, Darko

OE7DBH Class A Amplifiers for HiDes

~$186

~$225

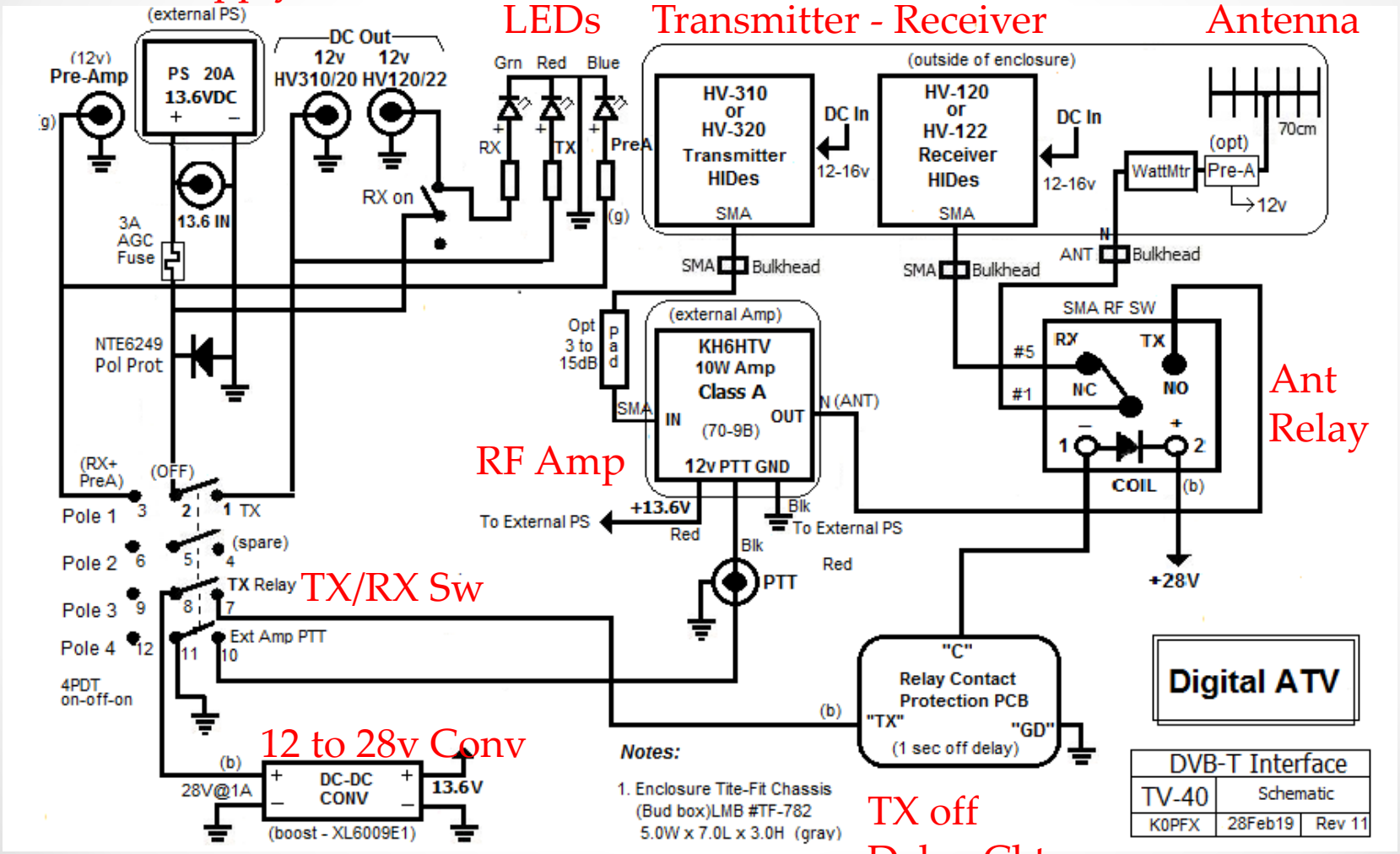
Available from OE7DBH, Darko

Simple Interface Controller for the HiDes Receiver and Transmitter

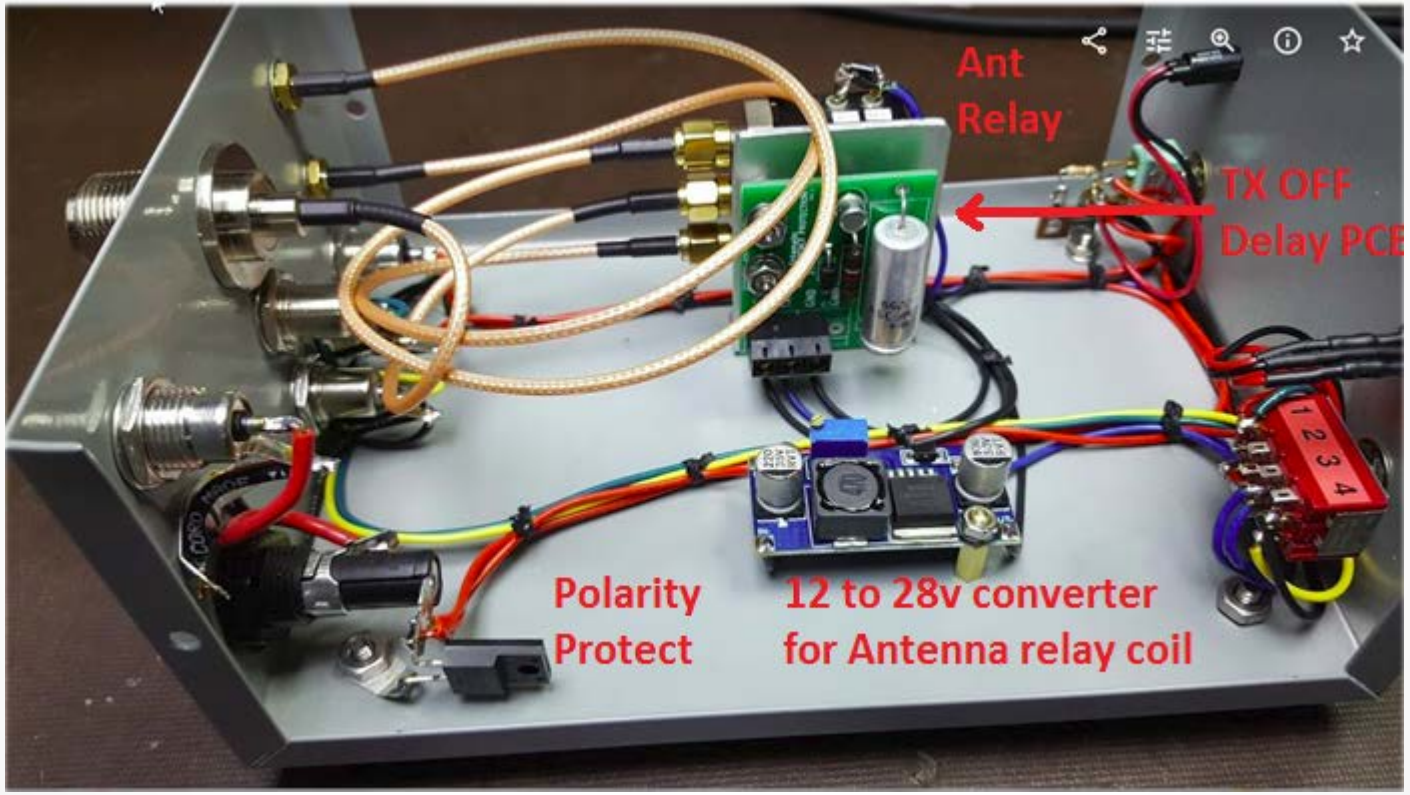
"Bud" box 3"x 5"

Rear Panel

Simple Interface Controller for HiDes



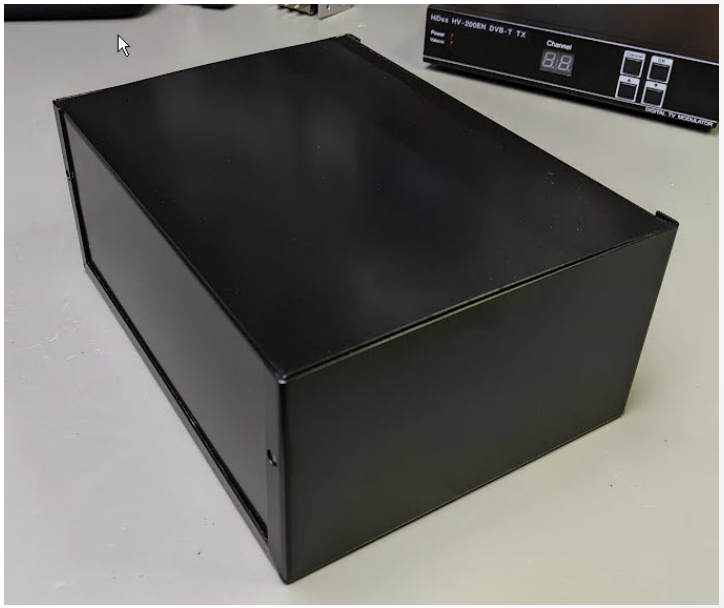
Controller Assembly



"TX OFF DELAY PCB" is a simple Sequencer to avoid "hot- switching" the ant relay contacts. PCBs/docs are available from K0PFX.

Complete ATV Station with Interface Controller for the RX, TX and Amp

Interface Controller with built-in Amplifier



"Bud" box
8 x 6 x 3.5"

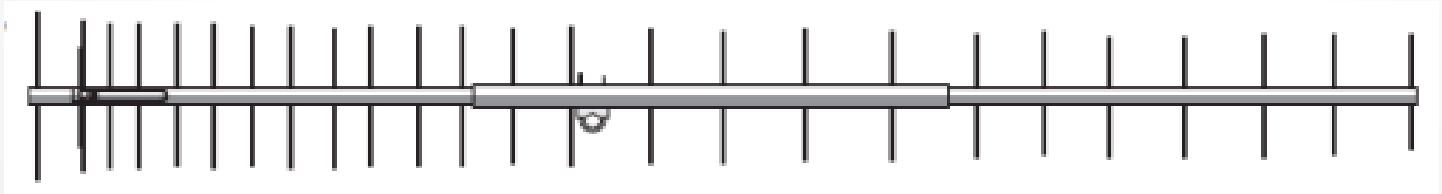
Homebrewing your ATV Interface e-Booklet

DVB T TERRESTRIAL

Optional Pre-amp and ATV Antenna

In RX line (3-5 dB)
No bypass relay – use with receiver in shack
kh6atv.com

With Bypass relay for use at antenna
vhfdesign.com



DSEFO432-25ATV

Directive Systems – K1FO design

Adding station capability

- HDMI multi-port switch
- Larger displays/TVs
- Pan-Tilt-Zoom PTZ camera
- “Gamer” video graphics card (*Nvidia*)
- Video capture card with HDMI input (*Elgato)*
- Video recording, streaming, transition, etc (*vMix)SW*
- Video editor/format converter (*Wondershare*)SW

Video Graphics and Capture

Nvidia Video Graphics

Blackmagic Design Intensity Pro Capture & Playback

$200

ebay

$50-100

Camera options

USB Logitech 920
Or use your Laptop's built-in Camera

Camcorder's HDMI

Smart Phone with USB to HDMI cable. Save video free in Google "Photos"

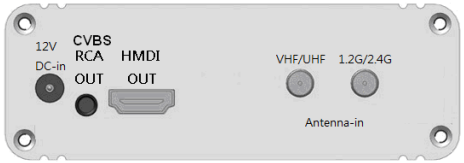
Transport Video Interface (HD TVI)

Coax to HDMI Converter

Rear View

HDMI Out

Transmitter



HV-310/20

Low cost HD-TVI Security Cameras

Front View

RG59

$39-79

Dripstone 2.1MP Sony IMX323

ebay

$50-80

Low cost Video/Audio Sources

HDMI Switch

DVR

ebay

ATV Research

Blackmagic Design

Broadcast Quality HDMI Switcher

$295

https://www.blackmagicdesign.com/

Alternative to Separate TX/RX

HiDES

UT-100A or B

$200-230

PC USB Dongle

- Modulator(TX) Demodulator(RX) USB2 PC port connection
- Full Duplex (monitor your own signal while transmitting)
- Receive 2 to 6 MHz Transmit 1 to 6 MHz
- 50-950 MHz RX, 50-950/1200-1350 MHz TX 1KHz Steps
- Up to 1080p HD H.264/MPEG-4 Advanced Video Coding
- Includes TX and RX software

RG316 Assemblies MCX, N, SMA

UT-100B Software Transport Stream Player

Sets Frequency, Bandwidth and Channel Coding parameters

TSPLAYER

Device List ut100bv22014011700 IQ calibration table C:\Program Files\HDTV HID ... Set

Chip Type: 9507 Device type: 11 Reset to Default

DVB-T ISDB-T

Bandwidth 4MHz Advance

Frequency(KHz) 423000 About

Code rate (0) 1/2

Constellation (1) 16QAM

Guard interval (1) 1/16

Transmission mode (0) 2k Modulator Output Data rate 5854671

Attenuation/Gain 2 TS File Input Data Rate 2476800 VBR Mode

Load Transmission Parameter from NIT

TS file: C:\Users\Mel Whitten\Desktop\Wildlife1.TS browse

0 00:00:36

Test mode (Sine Tone only)

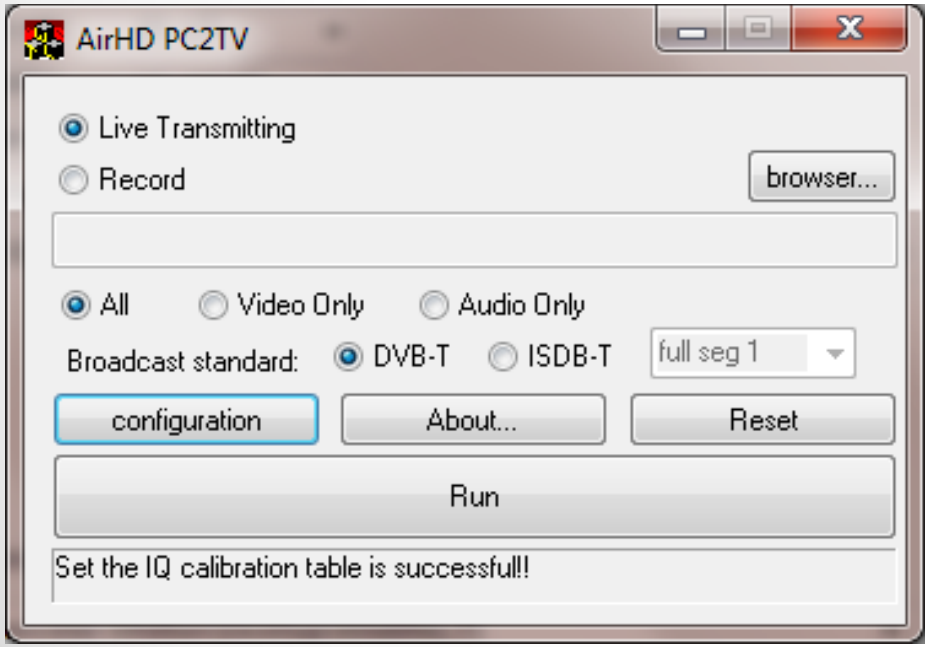
Test mode (null packet only) Output to file Stop Run

Default IQ calibration table loaded

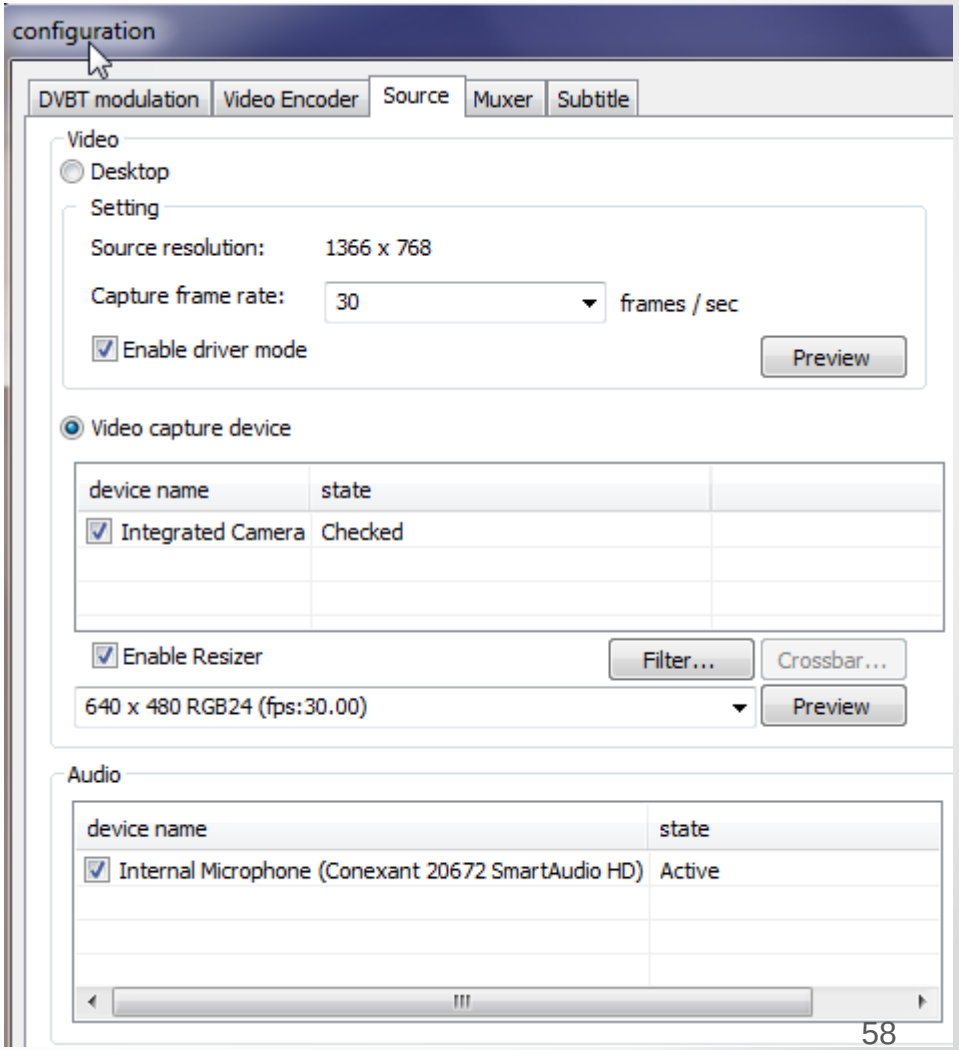
UT100B Transmit Software

DVB T TERRESTRIAL

Desktop or Camera
for video source



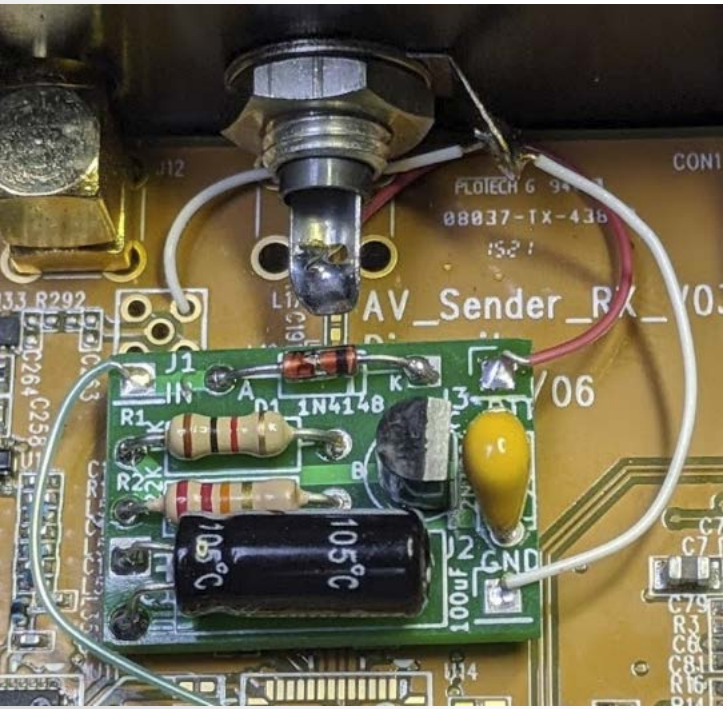
PC2TV software

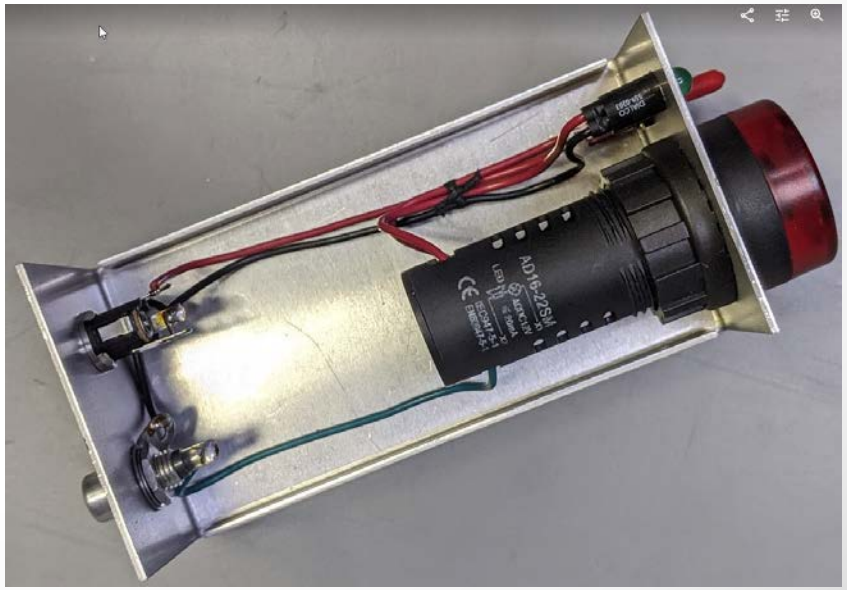


EMCOMM DATV Operation

KH6HTV in Colo.

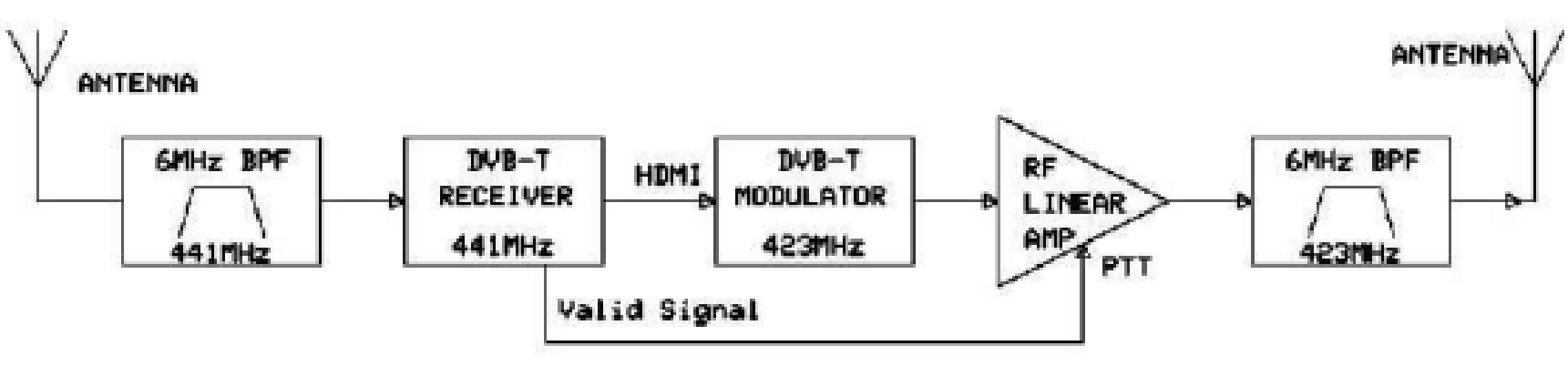
DATV Signal Alarm





What's next…?
-/-
Build a Repeater for ATV!

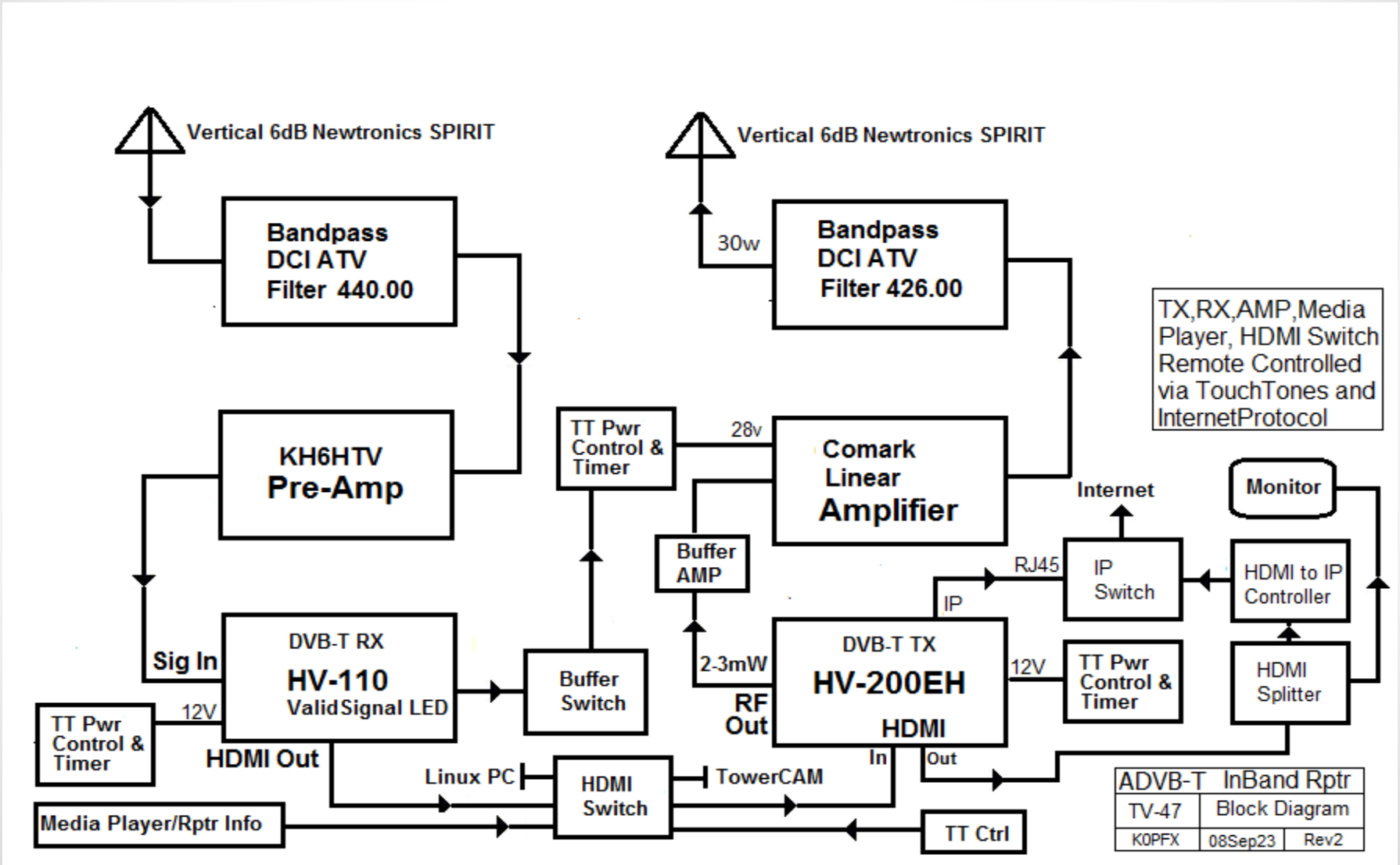
Repeater Design



~40 ATV repeaters in US
and ~20 are digital

Source:
KH6HTV

Digital ATV In-Band 70cm Repeater



70cm In-Band DATV Repeater

⇦ Bird Watt Meter

⇦ 70cm Amplifier

⇦ HV110, DTMF Split, HV200

⇦ 70cm Driver Amp

⇦ HDMI>IP, HDMI Sw

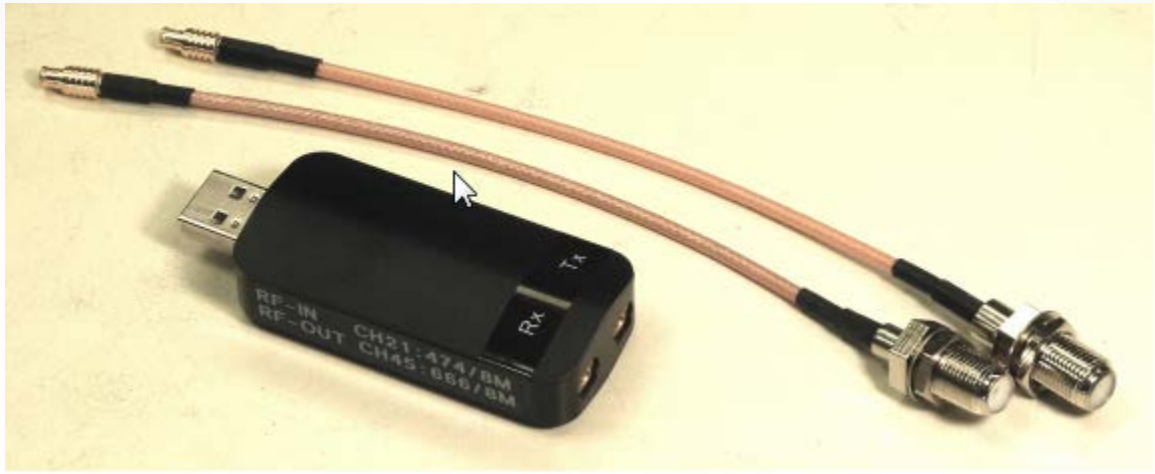
⇦ Media Player

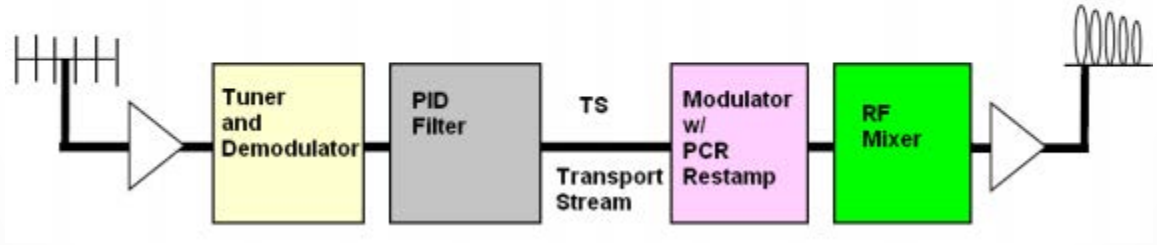
⇦ Rptr Controller

⇦ 2M FM Talk-Back

Dongle Repeater/BR-101EH

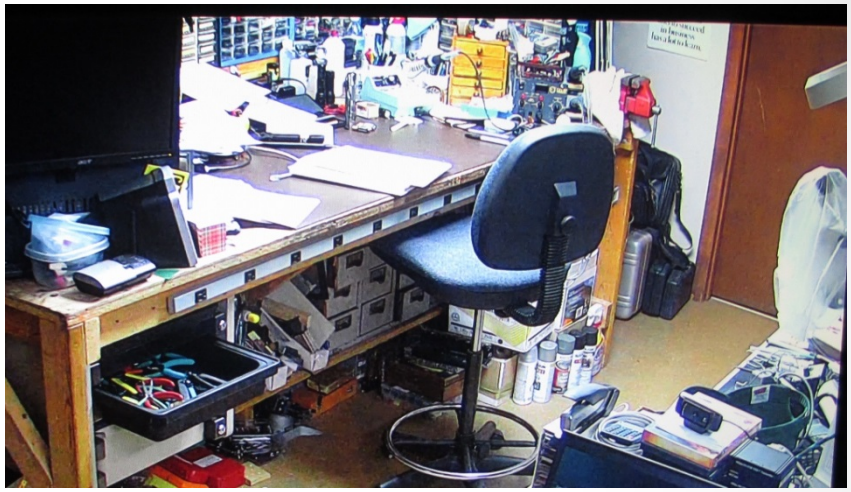
Cross-Band
70cm > 23cm
with 2 ants
or
In-Band
with
1 ant and
Band Pass
Filters
$239





Description: AN-54 at www.kh6htv.com

“DATV...Always a good picture”



On the web...

Jim Andrews Amplifiers and Application Notes
http://kh6htv.com

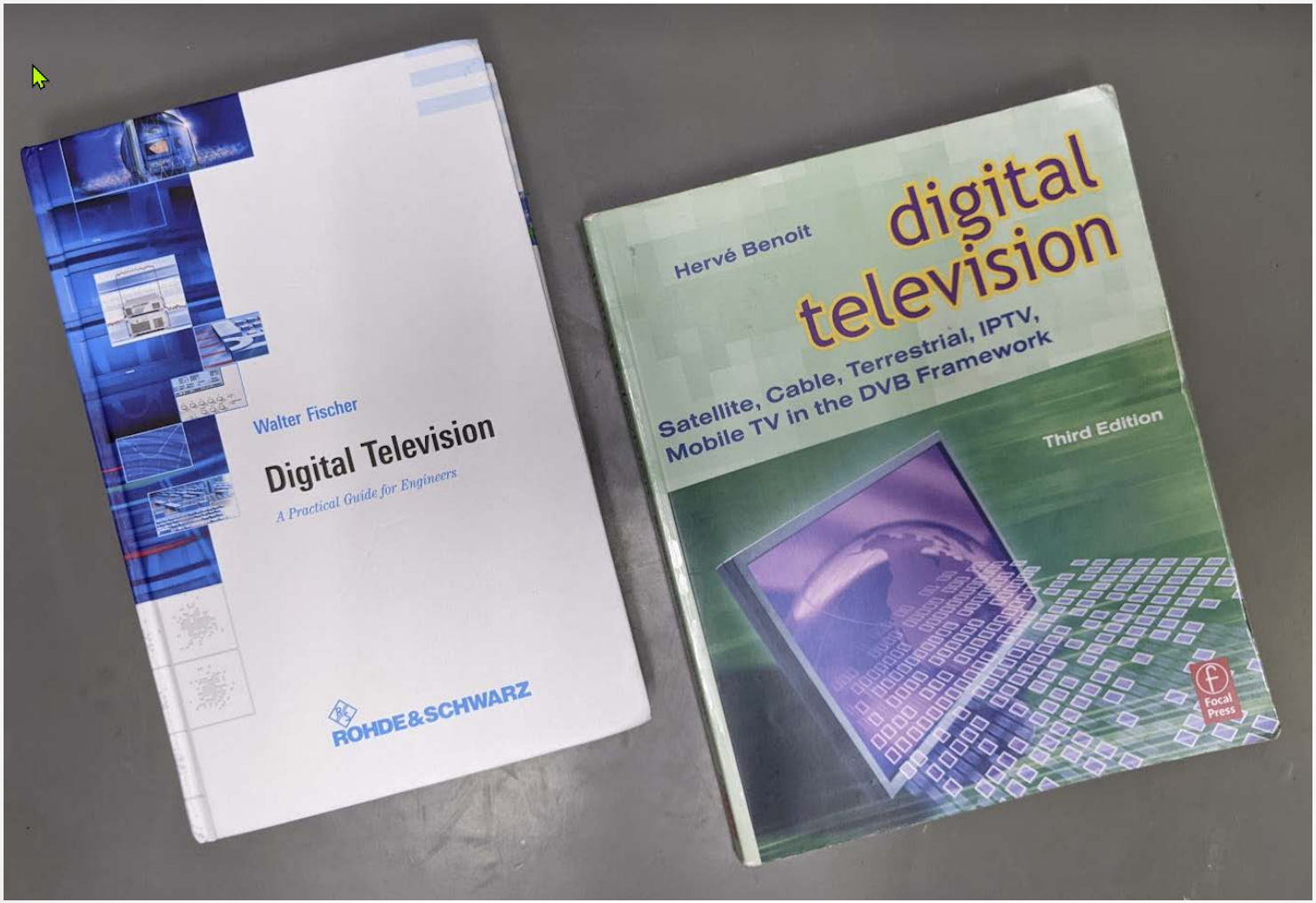
HiDes, Inc. Web Site:
www.hides.com.tw/index_eng.html

Amateur Television Network (ATN)
https://www.youtube.com/amateurtelevisionnetwork
https://www.atn-tv.com/

Mount Diablo W6CX Amateur Radio Club
https://www.mdarc.org/repeater-systems/atv

Operating and Tech Info...

- digitalATV Group digitalATV@groups.io
- DMR Brandmeister ATV TalkGroup #9410
- British Amateur Television Club www.batc.org.uk
- VHF Design 70cm Preamp https://vhfdesign.com/
- OE7DBH RF Amp http://dl1mfk.de/Sonstiges/Darko/
- Q5 Signal RF Amps/LNAs http://www.q5signal.com/
- *digital television* by Mark Massel
- *Digital Television* by Herve Benoit, 3rd Edition


Walter Fischer
Digital Television
A Practical Guide for Engineers
ROHDE&SCHWARZ
Hervé Benoit
digital television
Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework
Third Edition
Focal Press

Take-aways…

- *DVB-T is streaming MPEG with channel coding (FEC) defined in a broadcast standard used world wide*
- *DVB-T should be considered first where point-to-point or Repeater L-O-S access is not possible.*
- *Look for DVB-T HIDes TX/RX on eBay*
- *For a video source, start with your Zoom camera and PC or laptop.*
- *ATV is easy… HiDes makes it a plug-n-play mode!*

QUESTIONS?

Presentation will be available at:

www.slatsatn.net/news

SLATS
St. Louis Amateur Television Society

THANKS!