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

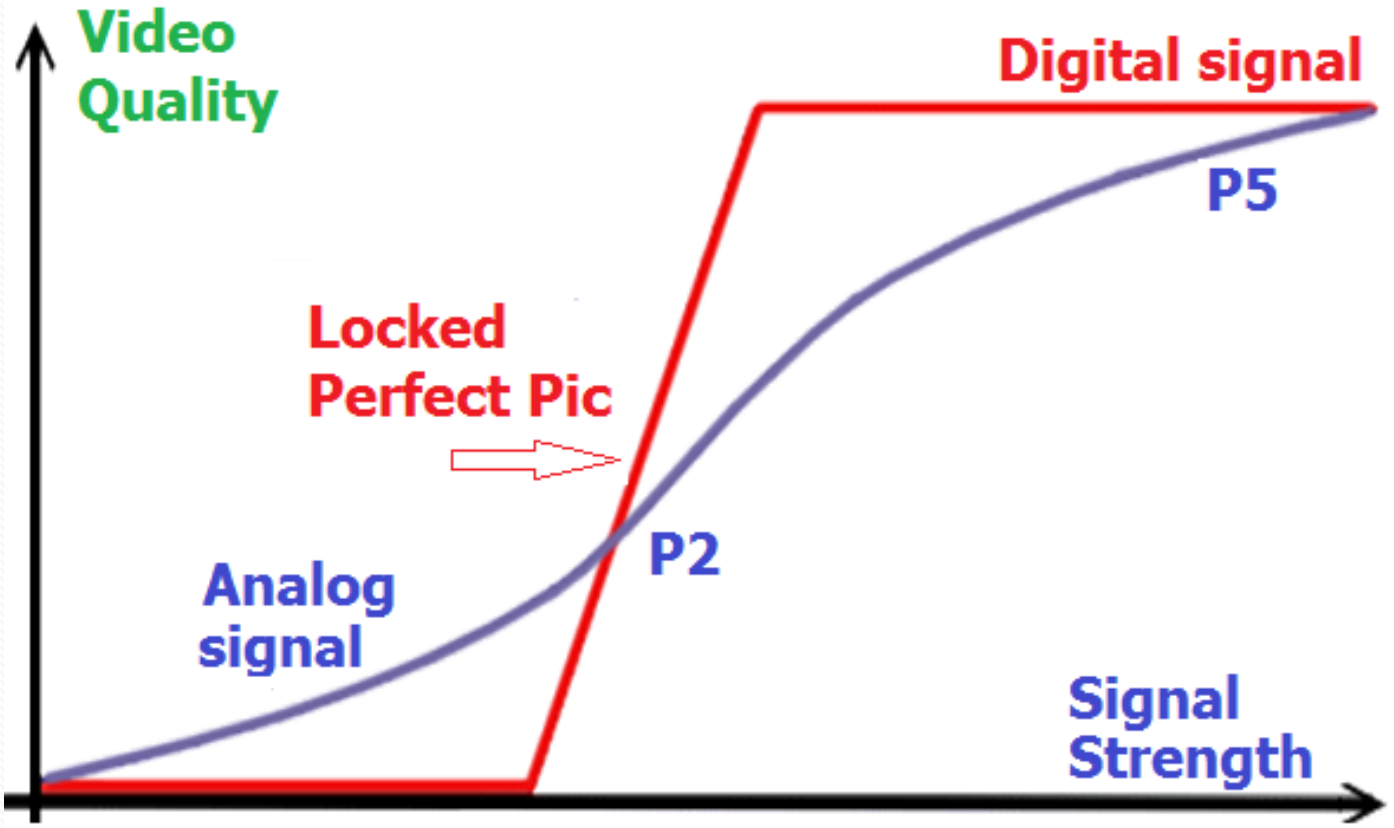
What is DVB and Why use it?

- **D**igital **V**ideo **B**roadcasting – **T**errestrial 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…

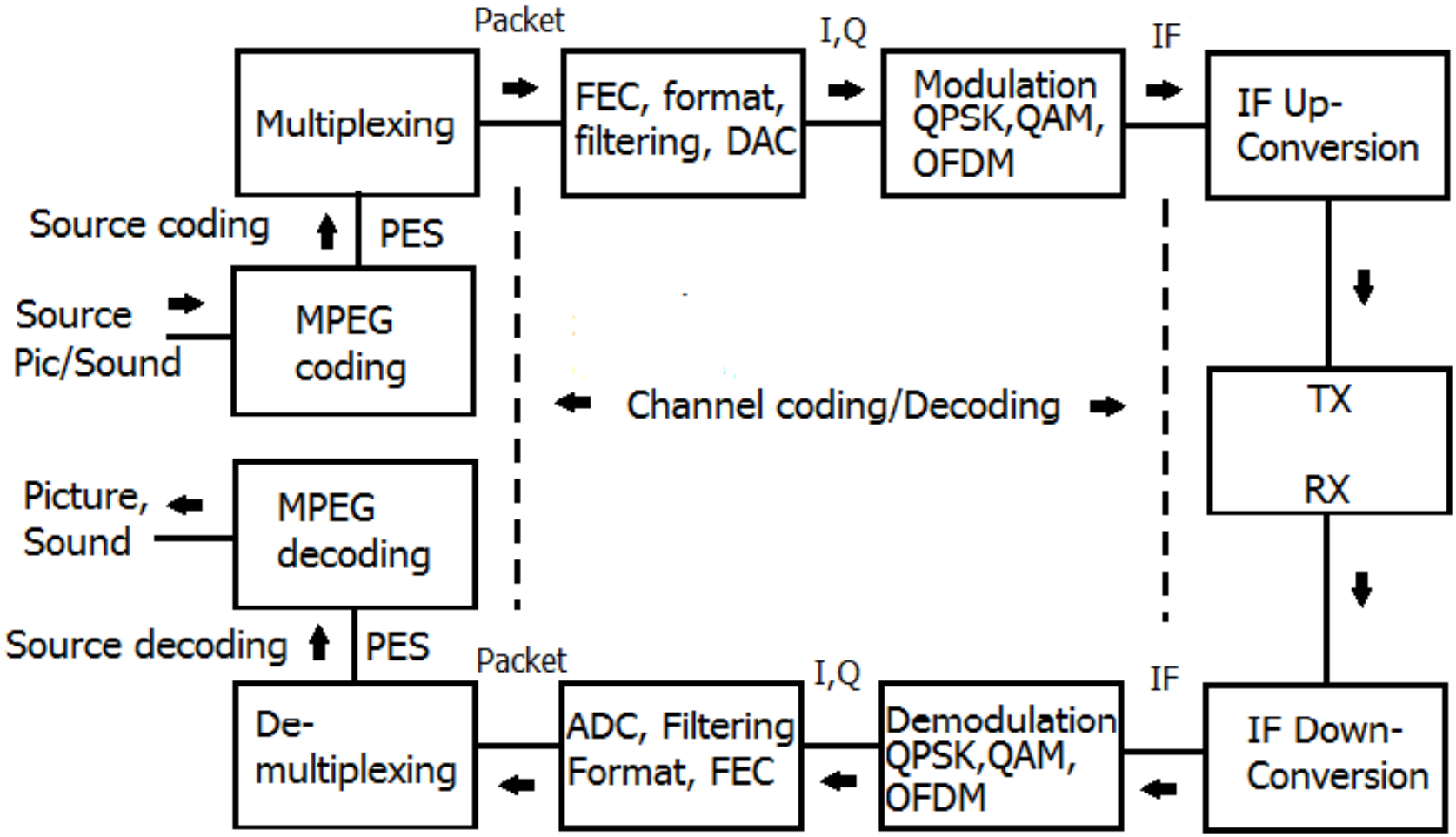


Some DVB history…

- 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
- **M**otion **P**icture **E**xpert **G**roup 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

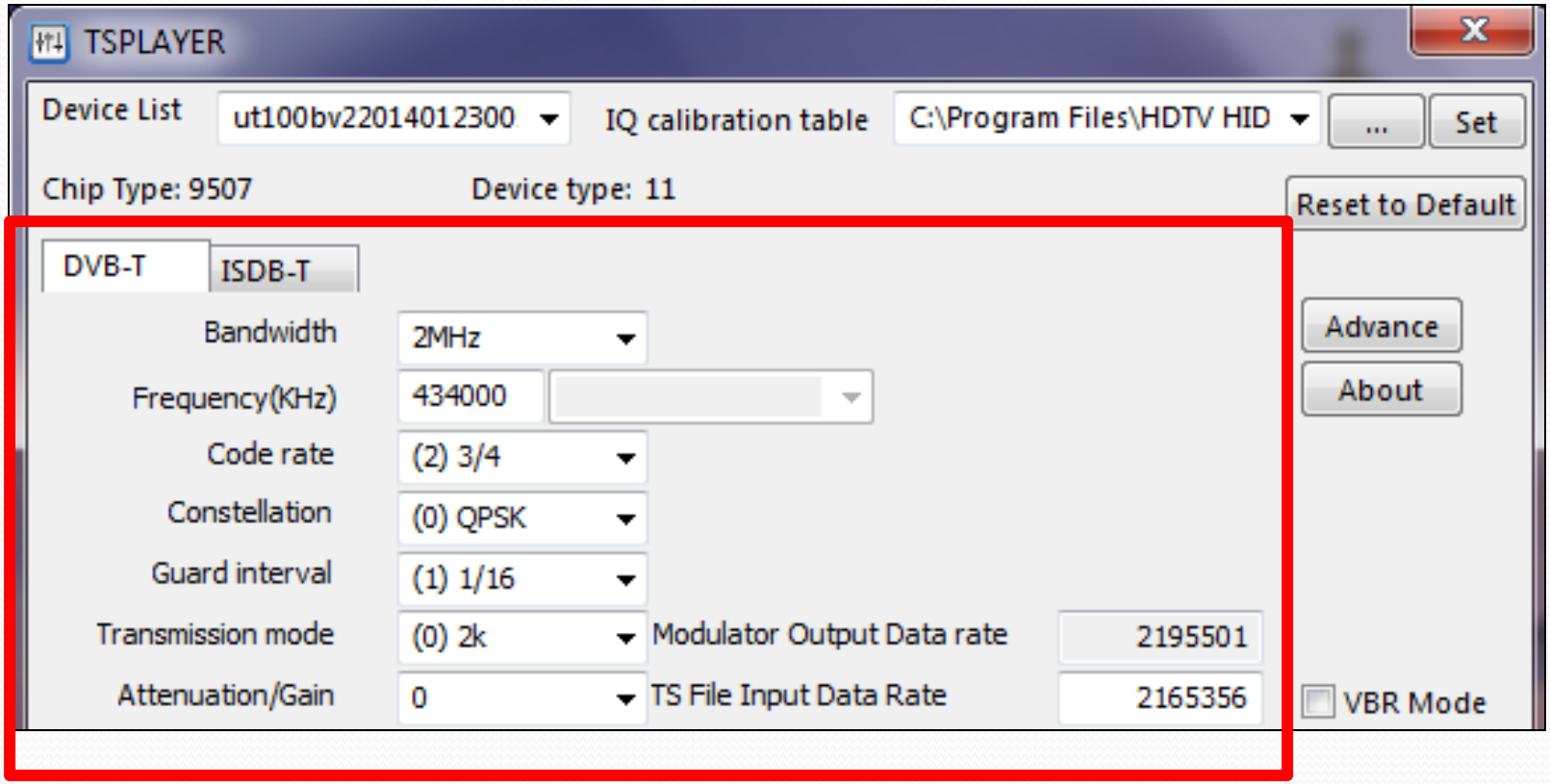
Now, let's take a look at how a DVB picture is sent and received

DVB Transmit and Receive chain…

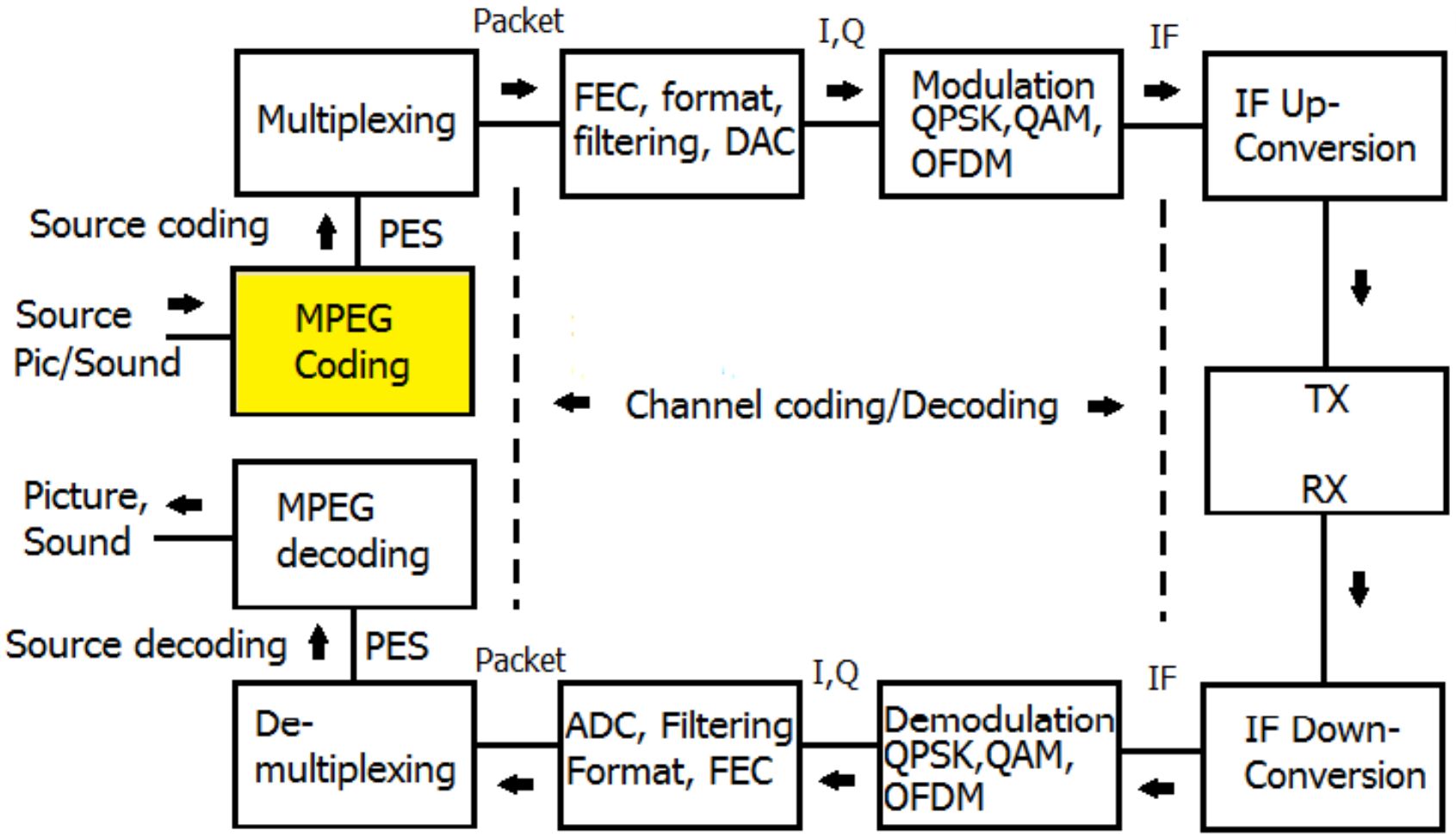


Some software Data Parameters to take note as we look at DVB-T

Configuration for Modulator Output Data Rate



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)

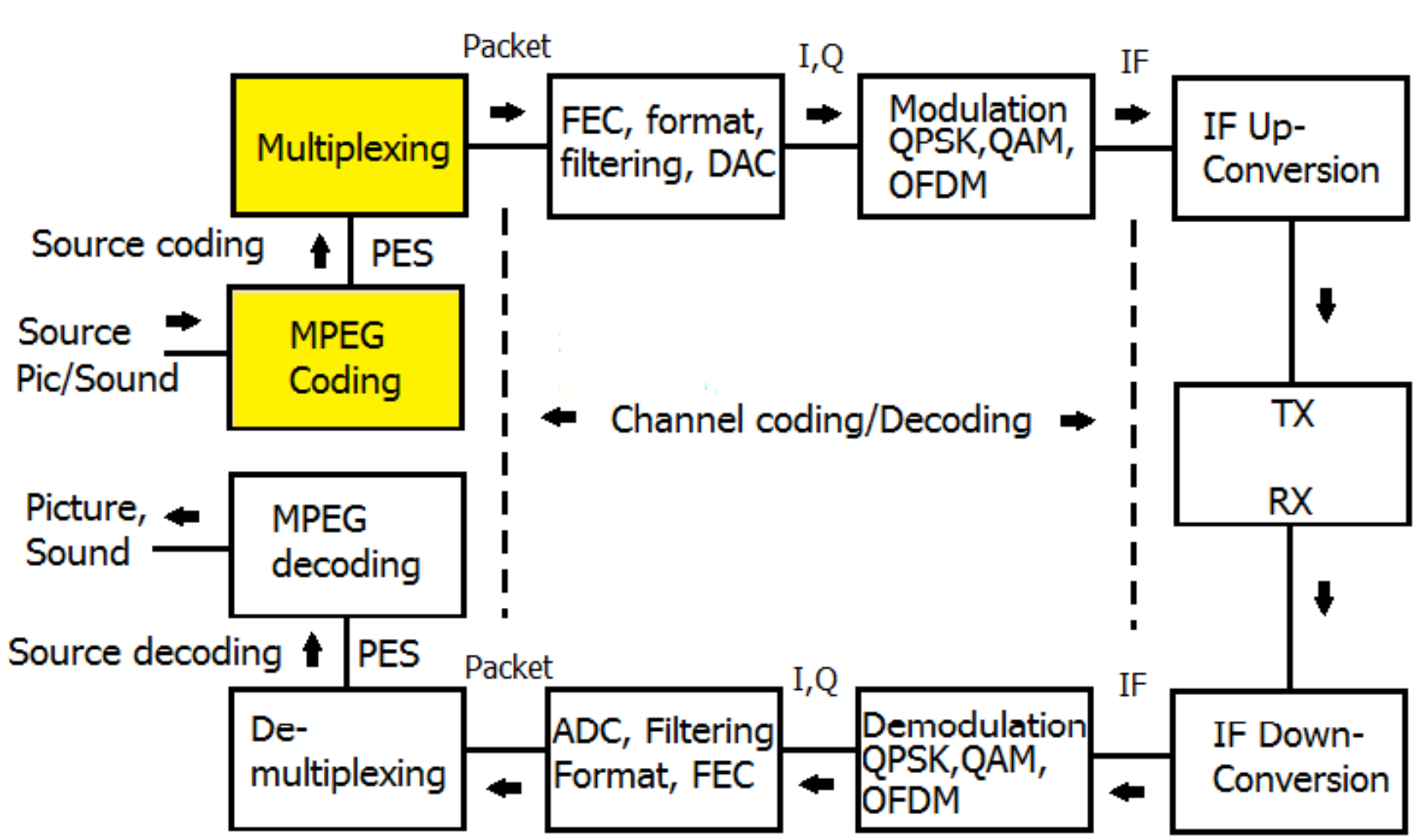
PAL – Phase Alternating Line (50 Hz)

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 **P**rogram **E**lem **S**treams (**PES**)

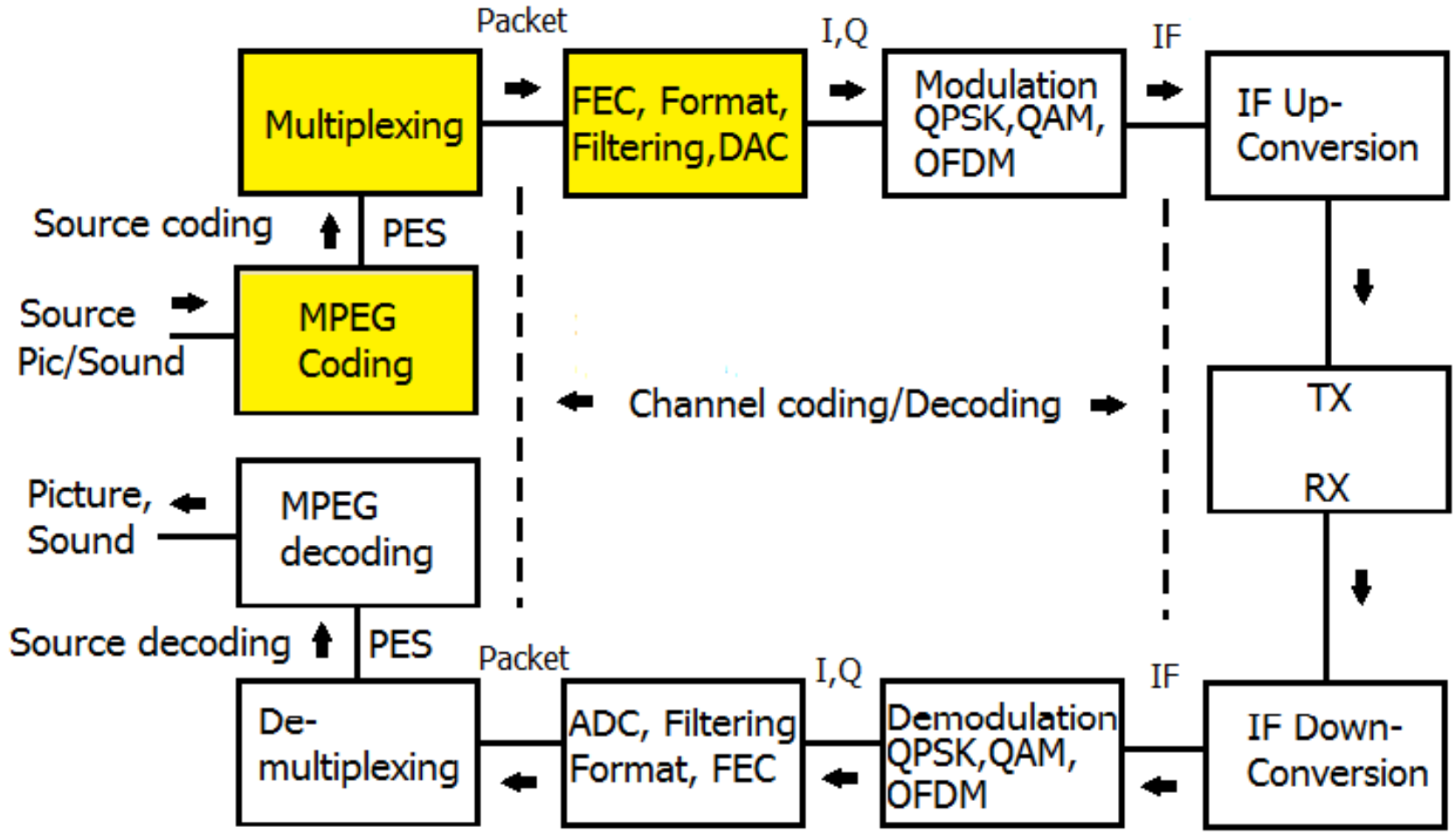
Transmit Chain > MUX



Source multiplexing… MPEG

- The **PES**s are packetized with the payload and *multiplexed* into a **T**ransport **S**tream (**TS**) for the TX
- The **TS** packet length is short (188bytes) for robustness and efficient FEC applications

Transmit Chain > FEC



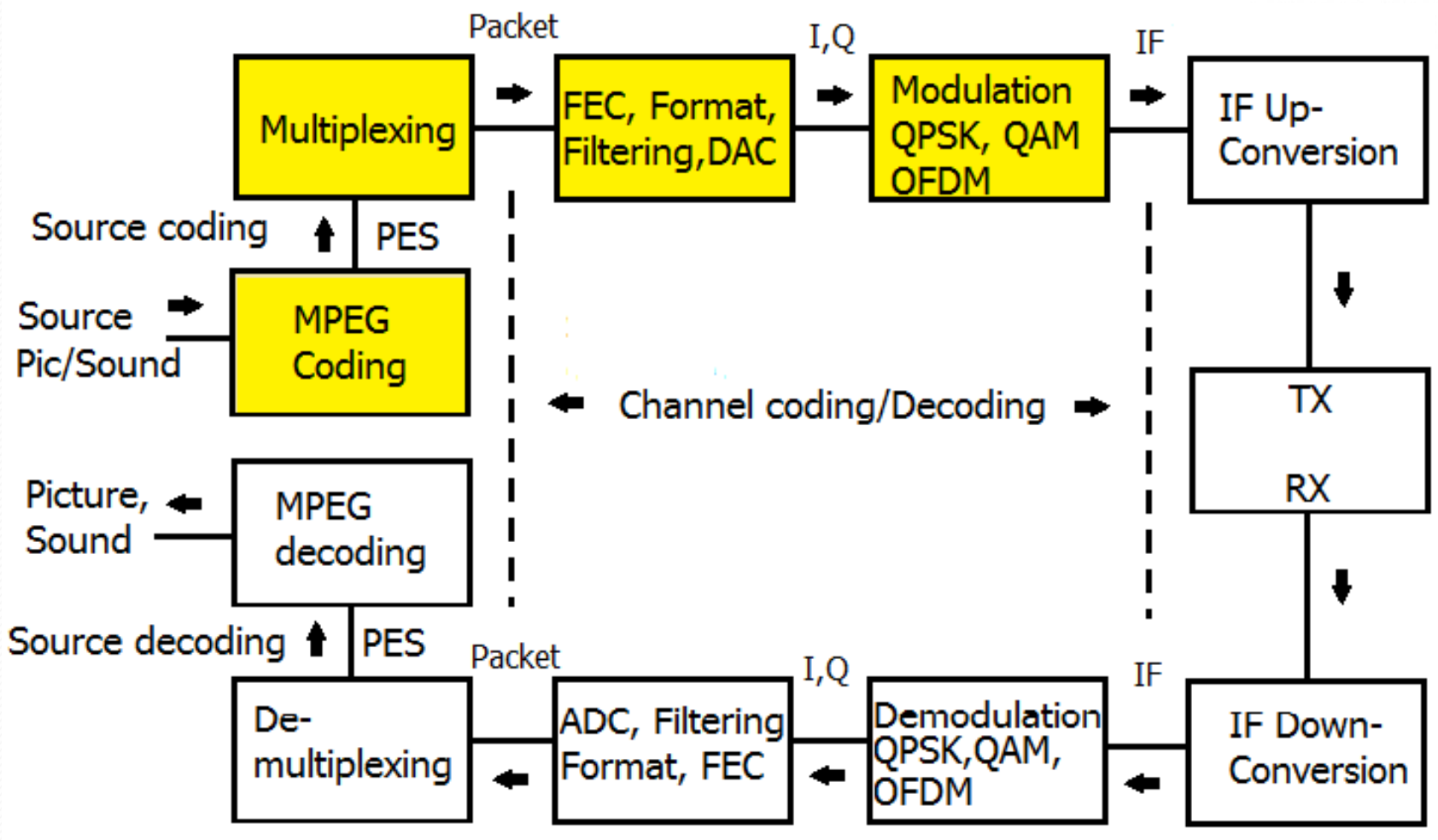
Channel coding… FEC

- 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

(**C**oded **O**rthogonal **F**requency **D**ivision **M**ultiplexing)

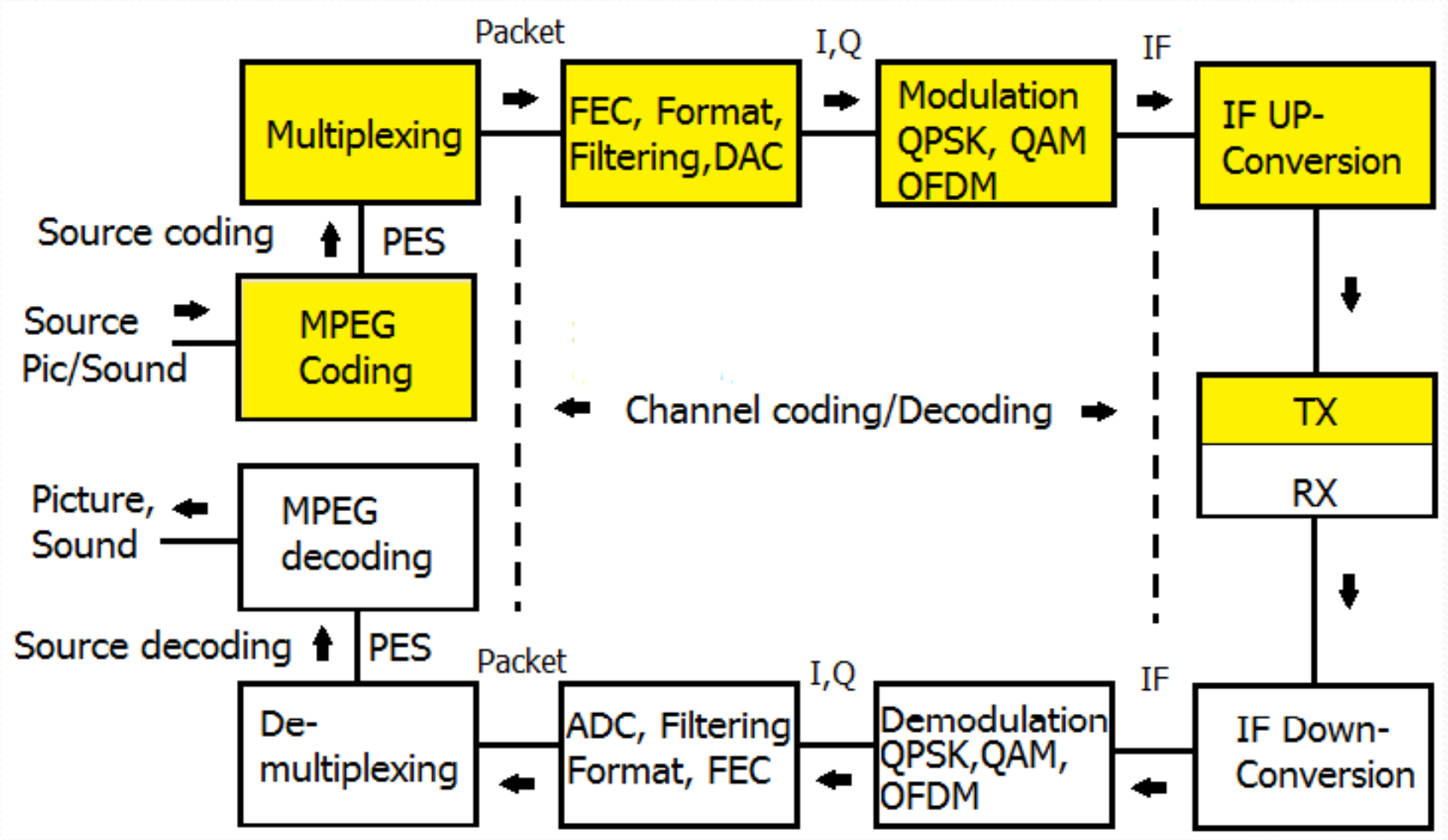
- *Many* discrete carriers spread over a **2** to 8 MHz BW
- 3 modulation schemes **QPSK** - 16QAM - 64QAM
- QPSK lowest BER BPS to 64QAM highest BER BPS

  -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

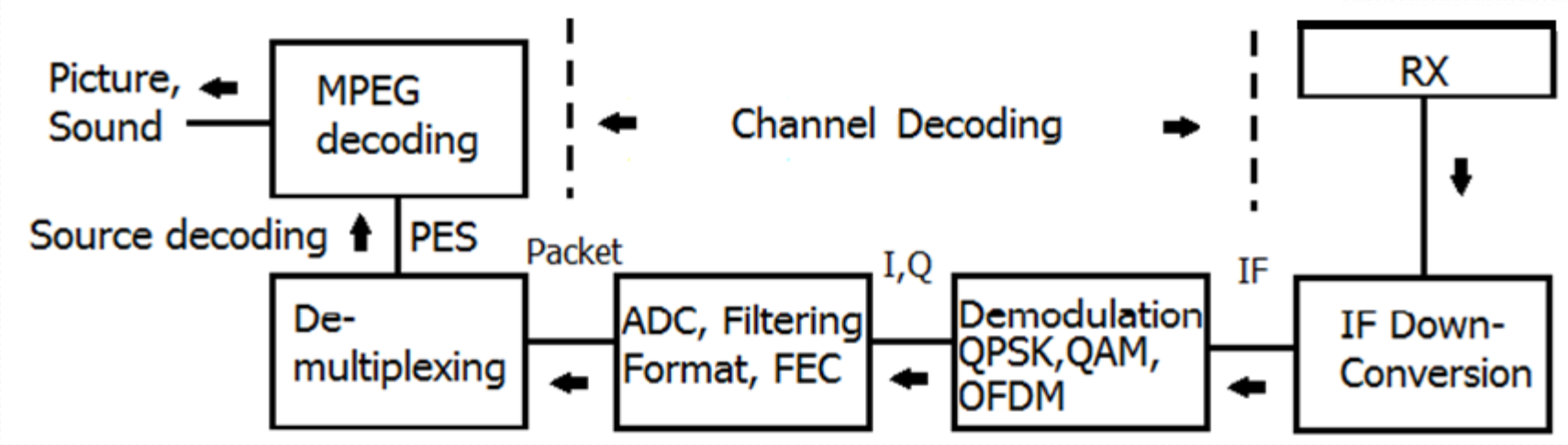
Transmit Chain > IF to TX



I.F. conversion to TX…

- IF **T**ransport **S**tream 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

>30dB gain

>50dB gain

MITSUBISHI ELECTRIC

DVB T TERRESTRIAL

< Silicon RF Power Modules >

RA60H4047M1

RoHS Compliance, 400-470MHz 60W 12.5V, 2 Stage Amp. For MOBILE RADIO

DESCRIPTION

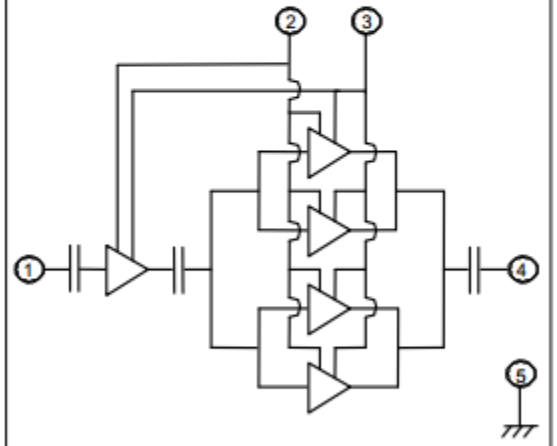
The RA60H4047M1 is a 60-watt RF MOSFET Amplifier Module for 12.5-volt mobile radios that operate in the 400- to 470-MHz range.

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_{DD}≅0 @ V_{DD}=12.5V, V_{GG}=0V)
- P_{out}>60W, η_T>40% @ V_{DD}=12.5V, V_{GG}=5V, P_{in}=50mW
- Broadband Frequency Range: 400-470MHz

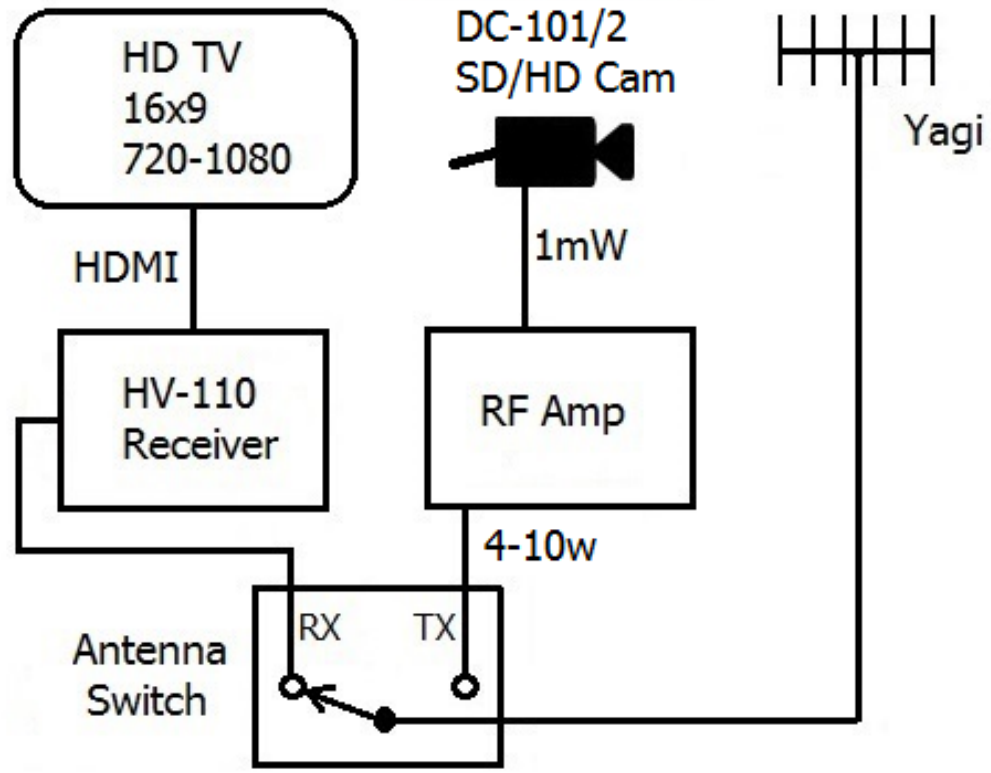
BLOCK DIAGRAM



1. RF Input (P_{in})
2. Gate Voltage (V_{GG}), Power Control
3. Drain Voltage (V_{DD}), Battery
4. RF Output (P_{out})
5. RF Ground (Case)

Linear ATV Amp from KH6HTV

DVB-T
Digital ATV

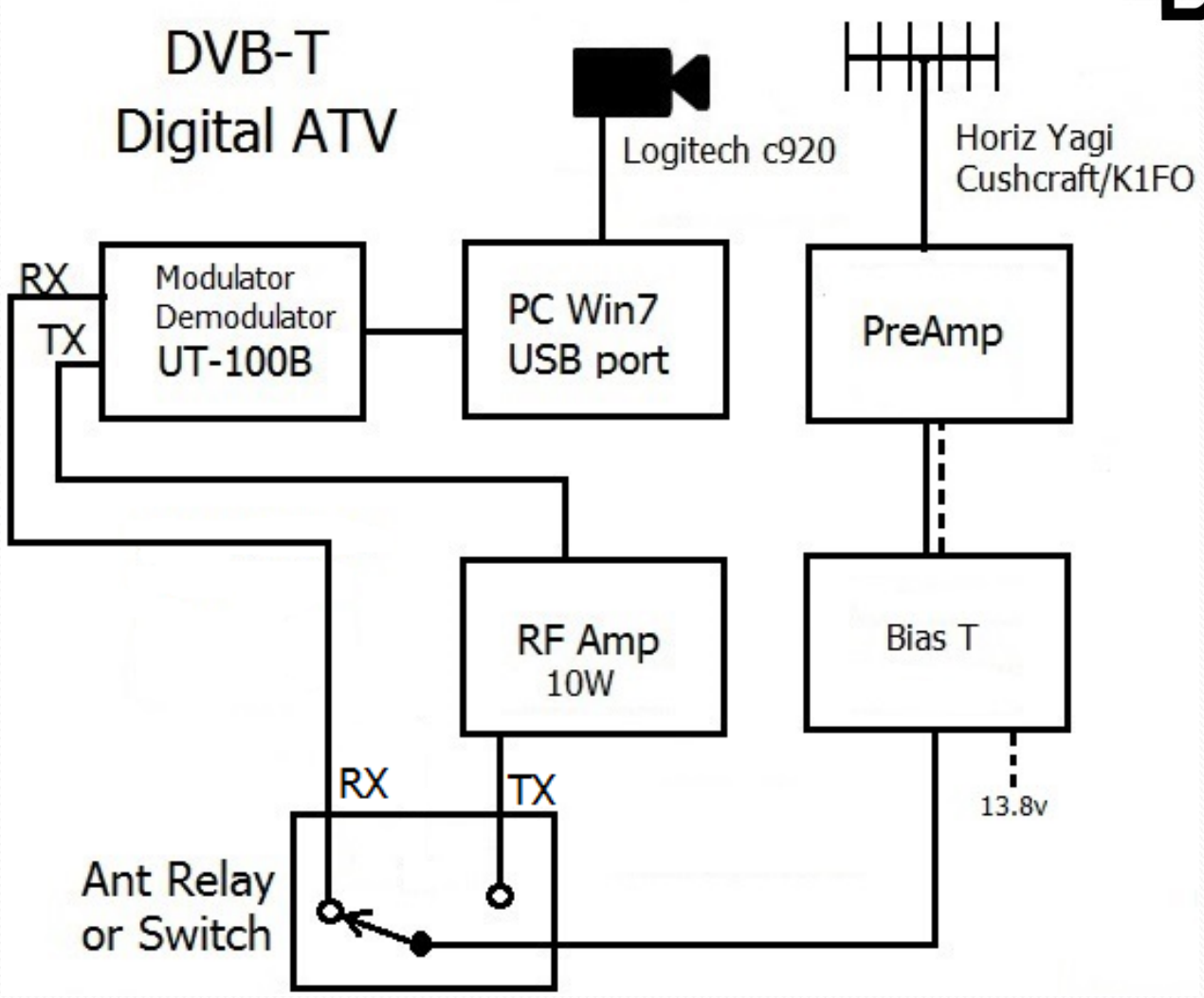


Adding station capability… DVB-T Dongle and PC applications

- **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


DVB-T
Digital ATV
Logitech c920
Horiz Yagi
Cushcraft/K1FO
RX
TX
Modulator
Demodulator
UT-100B
PC Win7
USB port
PreAmp
RF Amp
10W
Bias T
13.8v
RX
TX
Ant Relay
or Switch

Free Software…

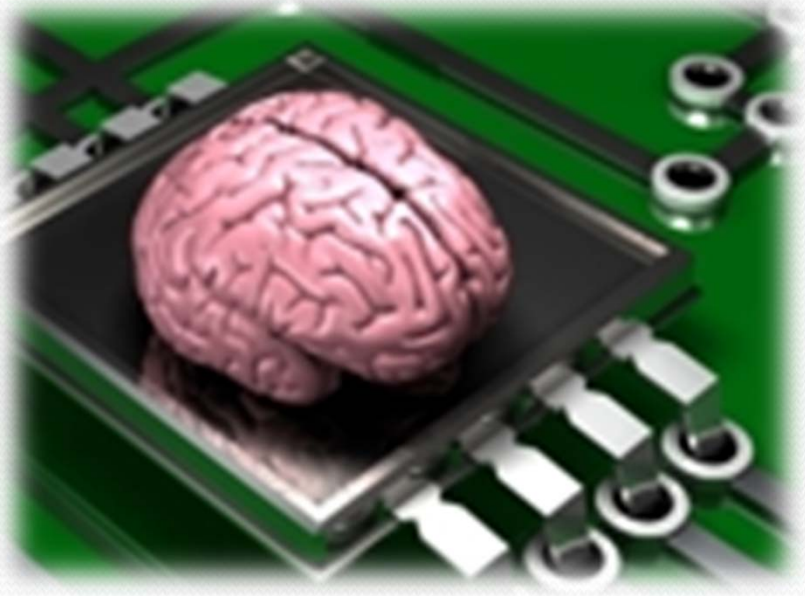
- **BDA Viewer Plus:** Receive/Record/View
- **TS Player:** TX Transport Stream/TS Files Player
- **Media2TS:** File converter for MPEG2/H.264 TS

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



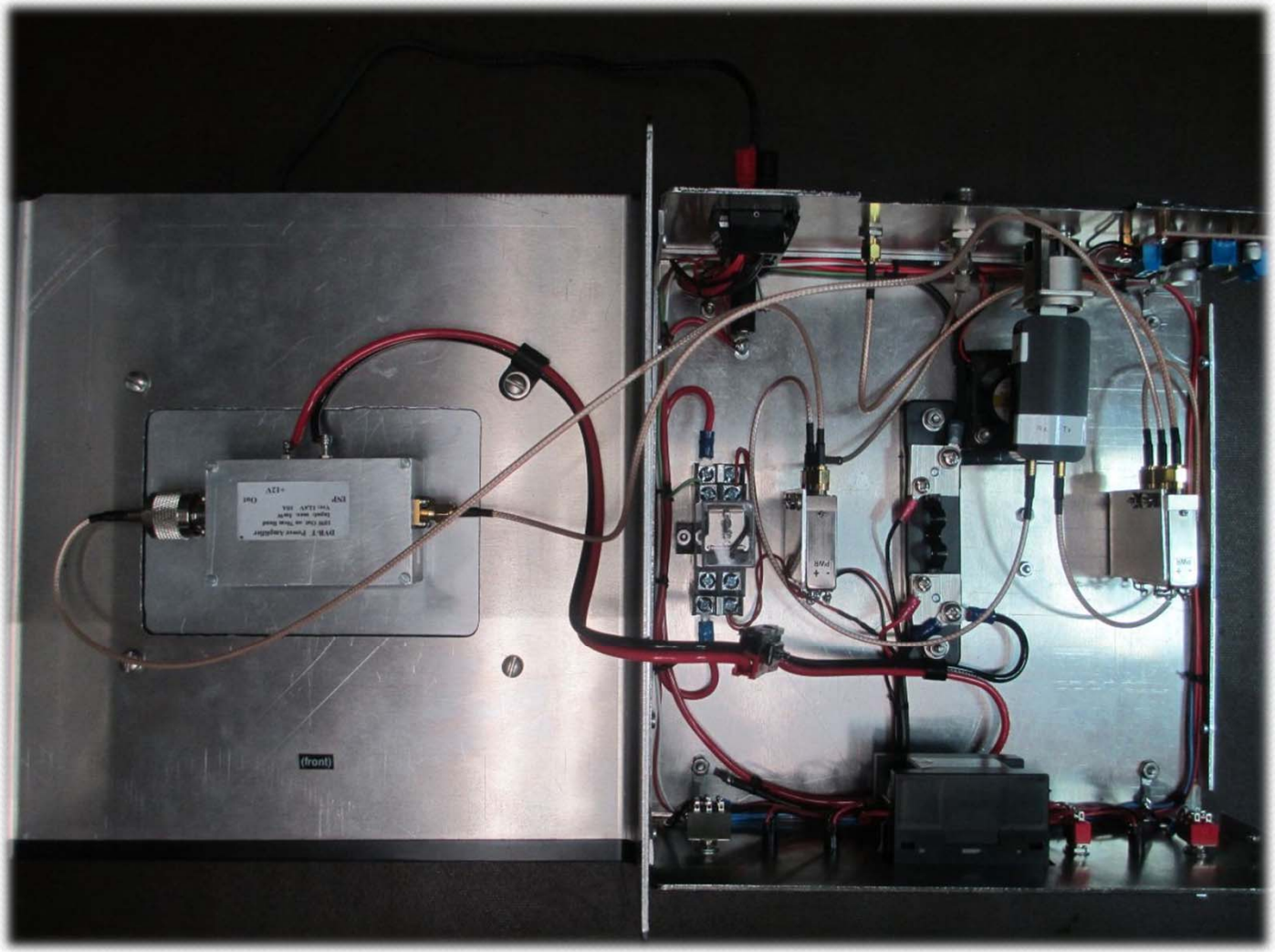
ITE's IT9507 HDtv TX and IT9130 Receiver

Digital ATV at KØPFX

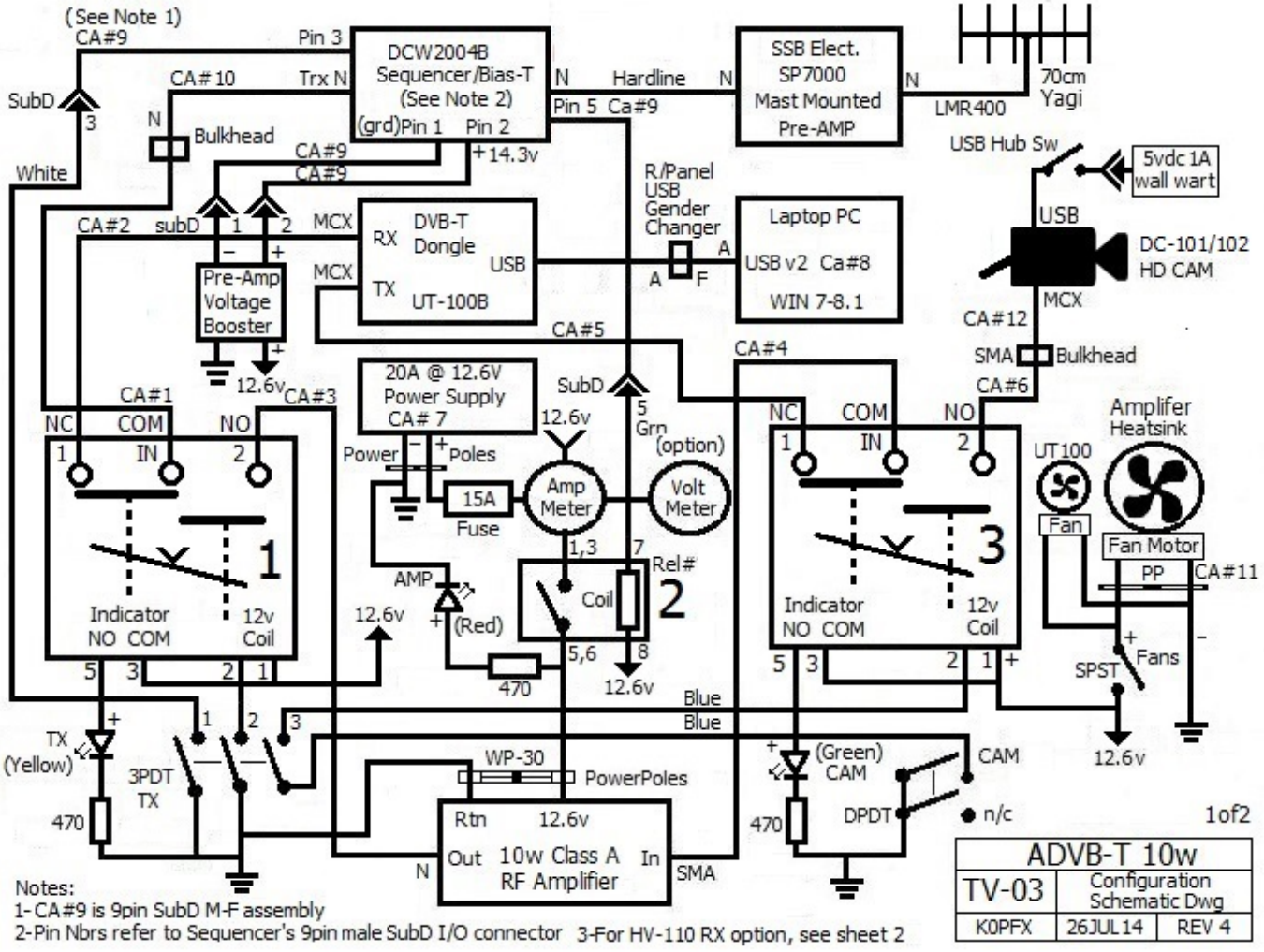
HV-110 Receiver
UT-100B TX/RX
DC-101 HD Camera
10W Amplifier
Watt meter
Sequencer
20A DC supply

Homebrew *ADVB-T 10w*

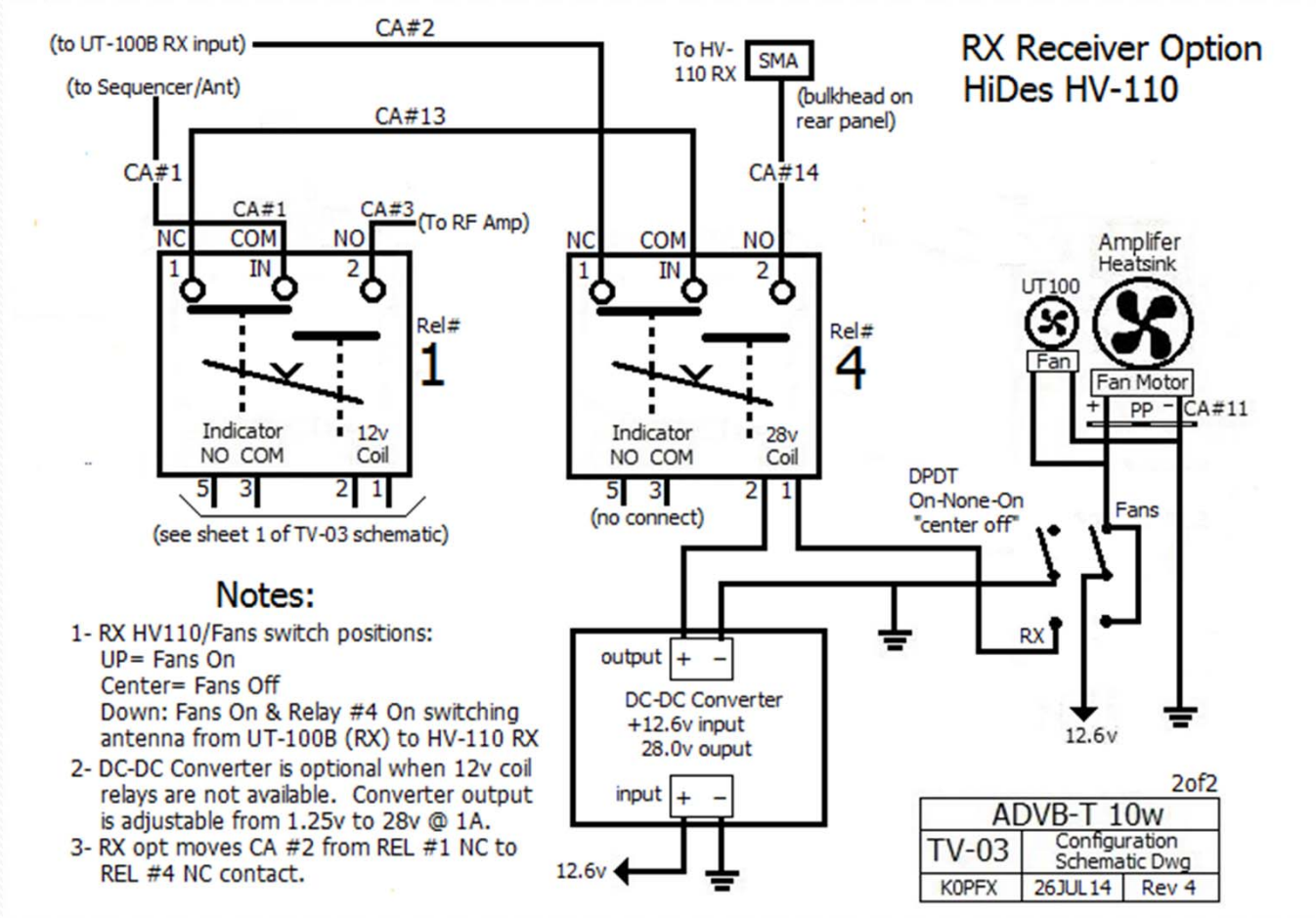
Inside view *ADVB-10w*



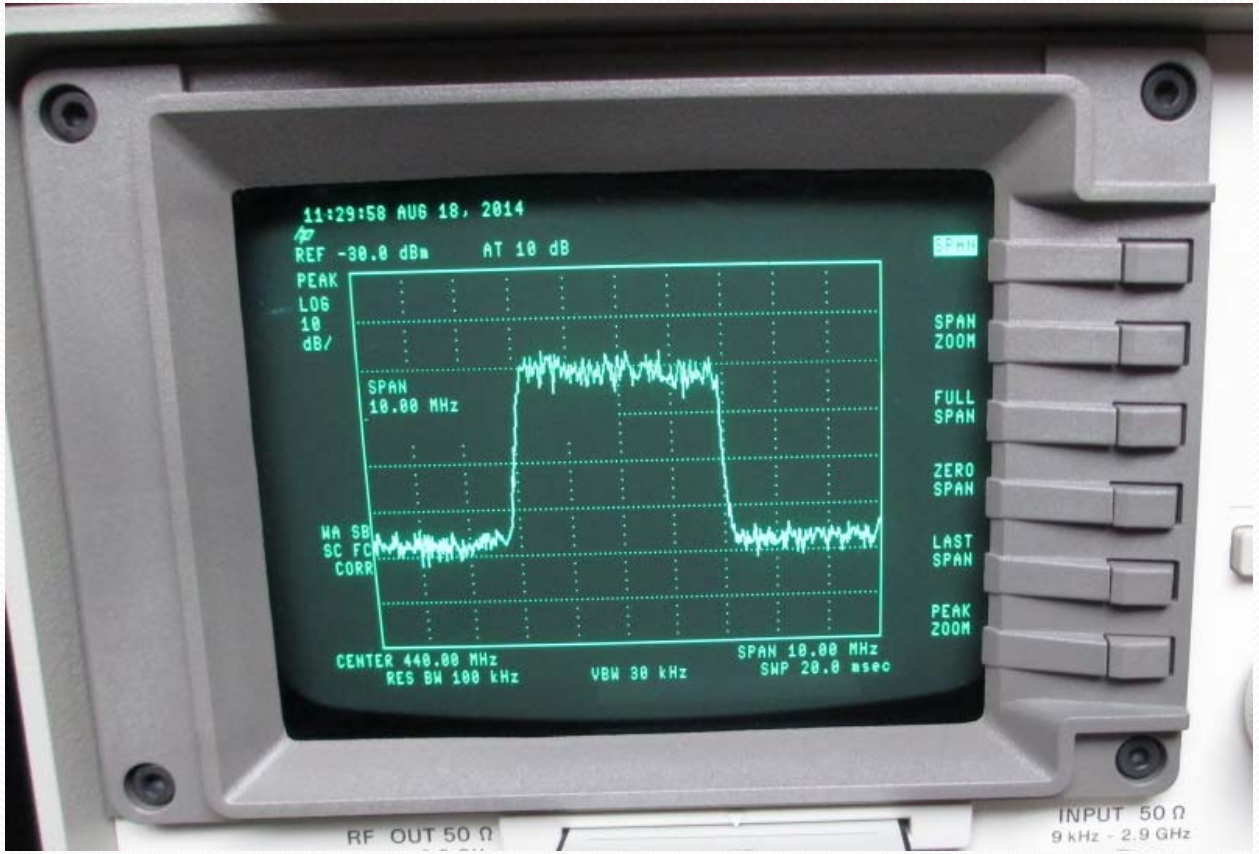
DVB-T 10w Configuration



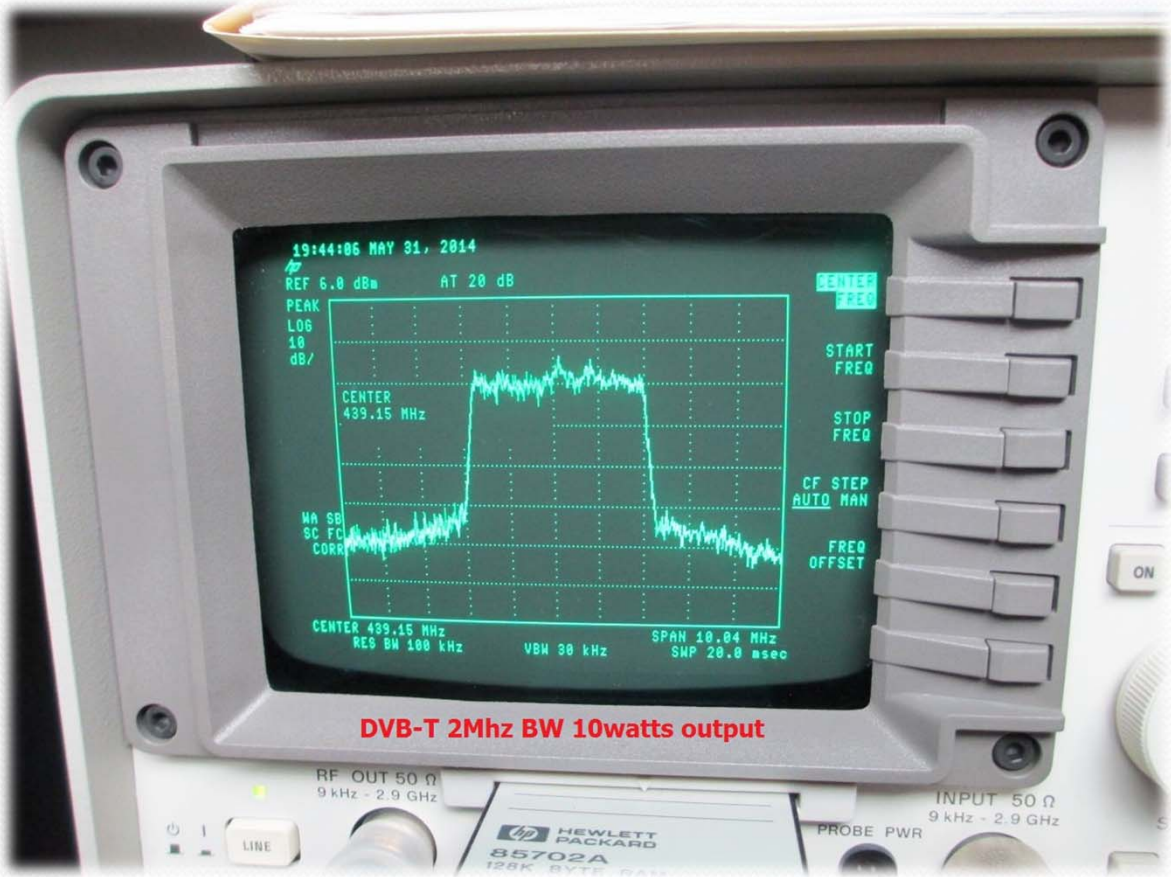
DVB-T 10w 2nd Receiver opt



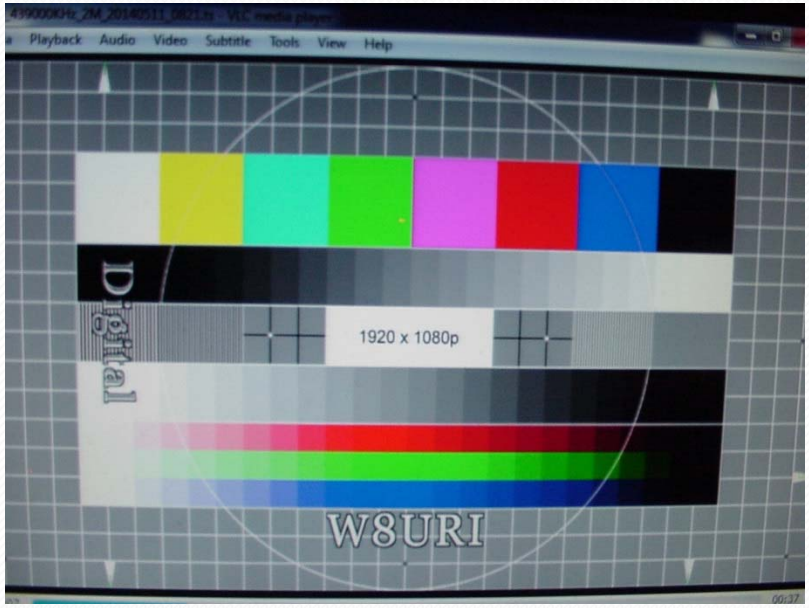
DVB-T OFDM Signal at 1Mw

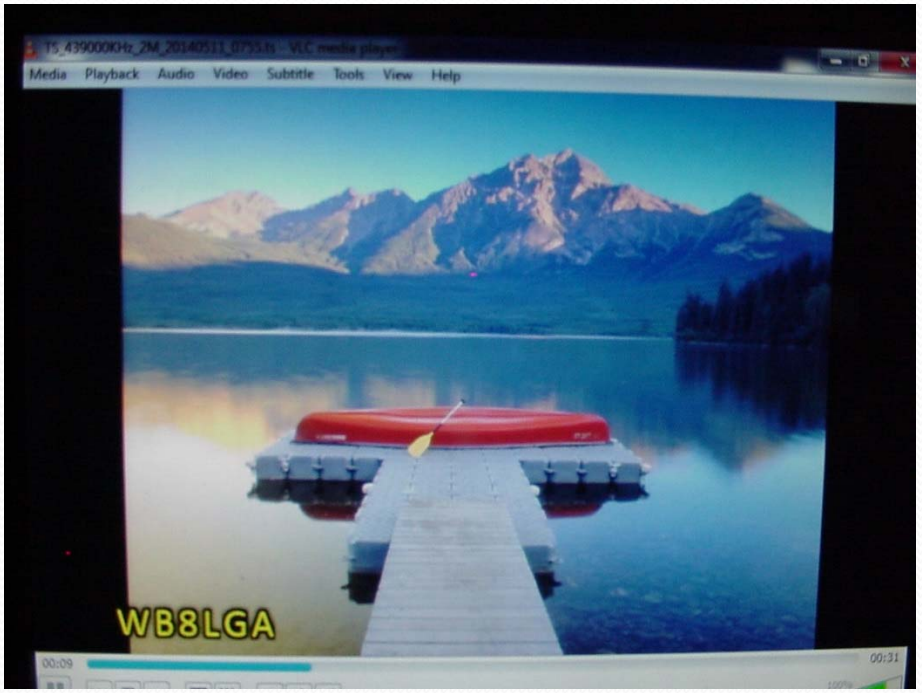


DVB-T OFDM Signal at 10w



DVB-T “DX” HD Television…





Where to find Digital ATV DVB-T gear…

HiDes Technologies Web Site:

http://www.hides.com.tw/index_eng.html

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

Can I really do this?? Yes!

Operating and Technical info…

- digitalATV Yahoo Group www.groups.yahoo.com
- ATV Television Quarterly http://ATVQuarterly.com
- British Amateur Television Club www.batc.org.uk
- OE7 Amateur Radio Forum www.oe7.at/index.php
- Digital Amateur TV Primer www.g7lt.com/datv.html
- CQ-DATV ePub www.cq-datv.mobi/ebooks.php
- Jim Andrews DATV "App notes" 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?