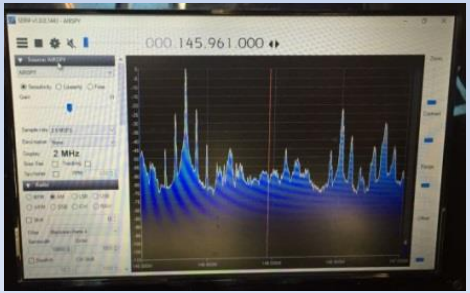
DATV receive systems



Noel G8GTZ

The approach

- ATV is unique as we build our own rx systems
  - No black boxes here!!
- But we use pre-built components
- So system design is important
- We do have the tools to get it right
- This is a practical guide
  - Just a little theory and maybe not a purist approach
  - But it does work for me ☺
  - Does not cover satellite LNB for QO100 as they just work!

Topics

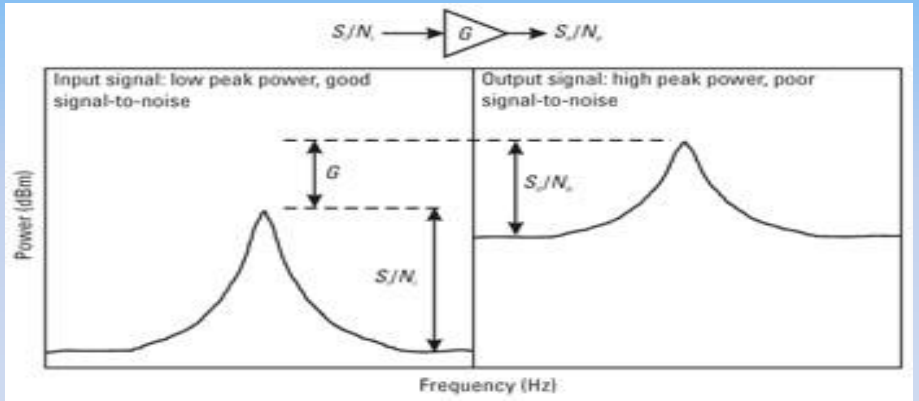
- 3 important parameters
  - Noise figure
  - Gain and dynamic range
  - Filtering
- DATV rx system design
- Practical designs
- Tx Rx sequencer
- Masthead pre-amp boxes
- Microwave transverters

Rxr Noise figure

- All electrical circuits make their own noise
  - EG Audio amplifier hiss
  - More dominant above 1 GHz
- This internal noise stops us hearing weak signals
- Good system design keeps the effect of noise to a minimum
- Measured in dB as difference between input noise ratio and output noise ratio

Noise figure

- The signal power is higher at the amplifier's output than that of the signal before entering the amplifier.
- However, because the amplifier adds noise, the noise floor at the output is raised significantly.
- Thus, the signal-to-noise ratio at the output is less than that of the input.



https://www.globalspec.com/reference/63780/203279/4-2-noise-figure

Receive system NF

- The first stage in any system is crucial and sets the system noise figure
- You can never recover from a poor noise figure
- ANY loss in front of the first stage will affect your ability to receive weak signals
  - Co-ax
  - Connectors
  - Relays
  - Filters**
  - Water in the co-ax!
- So always try to get your pre-amp at masthead on the higher bands

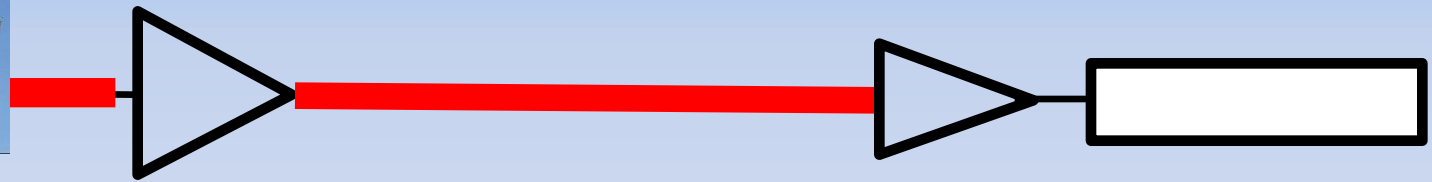
What is a good NF?

- That depends!
  - Leave aside EME where every .1dB counts!
- Above 1Ghz aim for a 1dB system NF on the bench
- Below 1 GHz general noise becomes the major factor
  - Ground noise & Electrical noise
  - Aim for 1.5dB system NF on the bench
  - Filter before the pre-amp!!
- Measuring NF is difficult / expensive
  - May change with the Portsdown project!
- So use known components
  - and measure filter / relay / co-ax loss

Poor Receive system

Good Receive system

Loss Pre-amp **LOSS** Amp Receiver

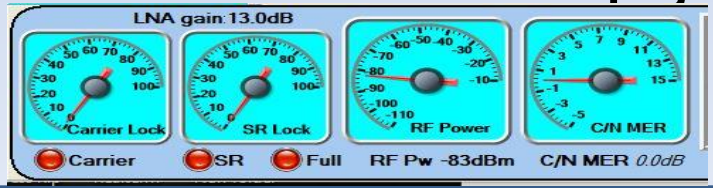


Rx system Gain

- Gain is needed to overcome other losses after the pre-amp
  - Filters
  - Co-ax
- But too much gain can be a problem
  - Dynamic range limitations
  - Not so much in DATV systems
- Need careful system design to avoid overload
- See GM3SEK paper on the DG8 pre-amp
  - http://www.ifwtech.co.uk/g3sek/vhfdx/dg8-preamp-v7.pdf

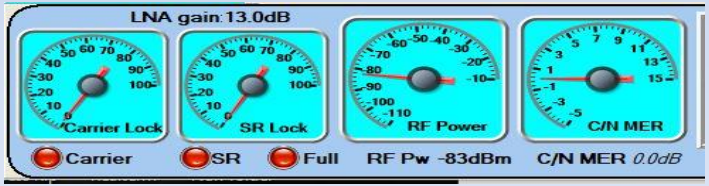
So how much gain?

- Well that depends!
- Narrow band transceivers don't need much
  - Beware of over loading when building a dual purpose system
- Knucker needs a little more
  - Terrestrial tuners are designed to be plugged in to an antenna
- But Minitiouner hardware needs a lot!
  - Satellite tuners are designed to work behind LNB with ~55db gain
  - There is no amplifier on the MiniTiouner PCB
- Portsdown and Minitiouner s/w can help you



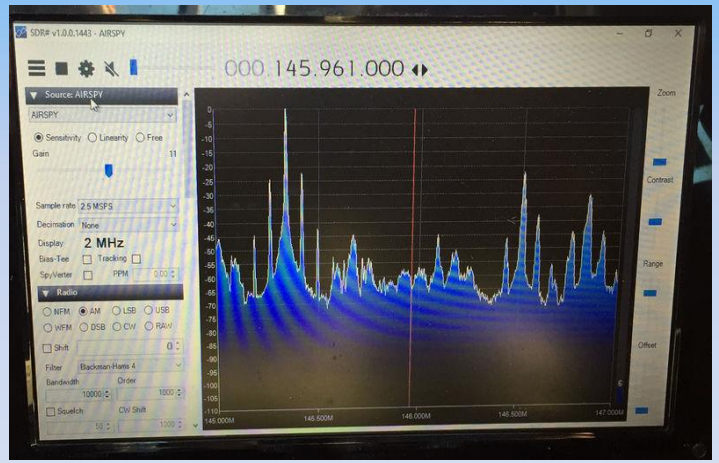
Serit 4473 gain

- At low input levels (below -70 dBm) the 4473 runs at maximum gain
  - Unable to use the full range of the analogue to digital converter. This leads to lower MER or failure to decode.
- Between -70 dBm and -27 dBm provides the optimum decoding performance.
- So we need lots of gain in front of a MiniTiouner
- See wiki page for detailed explanation
  - https://wiki.batc.org.uk/MiniTiouner_Power_Level_Indication

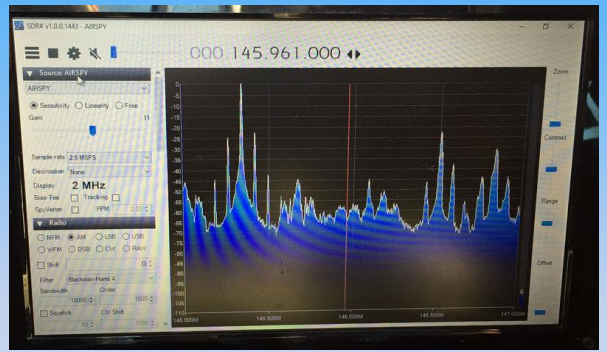


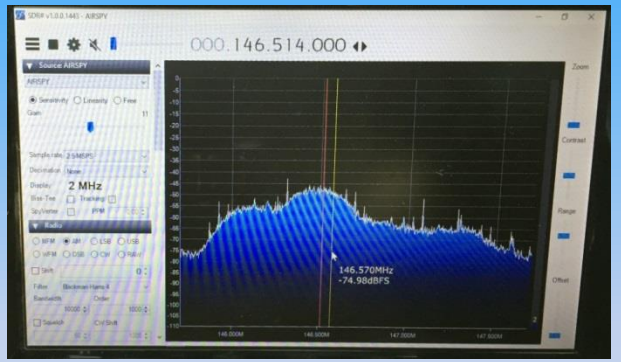
Rx Filtering

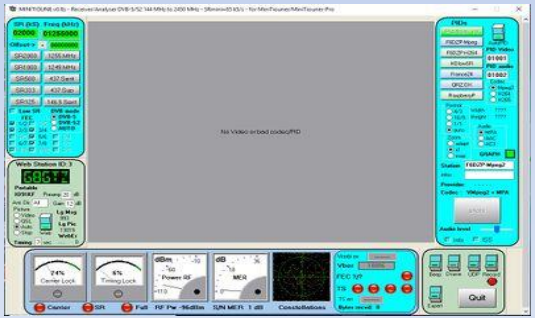
- A system may work on the bench but not on the air ☹
  - We are not alone! There are many “interference” sources
- Broadcast / Cell sites
  - Adjacent and near channels
  - Harmonics and multiples
  - Overload from Freeview * 2 on 23cms
  - Always use a filter on 70cms!
- Digital is the worst
  - Just white noise….
- Bandpass filter will remove most crud on rx
  - Prevent pre-amp overload
  - Maybe a notch to remove specific problems
- Sacrifice system NF for better filtering
  - See the GM3SEK 144MHz DG8 pre-amp design



Rx Filter = more DX!!







GW8VPG/P received (or not!) on the Isle of Wight
146.5MHz @ 185kms (record for 146MHz at the time)

DATV rx system design

- Masthead low noise pre-amps on all bands above 1GHz
- Good co-ax with pre-amps in shack below 1GHz
- Band pass filtering on all bands
- Optional band switching
- Additional gain to overcome switch and filter losses
- Signal splitter to feed Minitiouner and Knucker NIMs plus band viewer / SDR
- Aim for correct gain level in MiniTiouner and put attenuators in Knucker and SDR feed
- Transmit / Receive sequencing to protect pre-amp

DATV rx system design





Below 1GHz

Above 1 GHz

Microwaves

Filter + gain

Filter + gain

Filter + gain

Filter + gain

Gain

8 way switch or relay

Splitter

10 dB

Knucker

MiniTiouner

Band Viewer

ATV rxr!

NB rxr

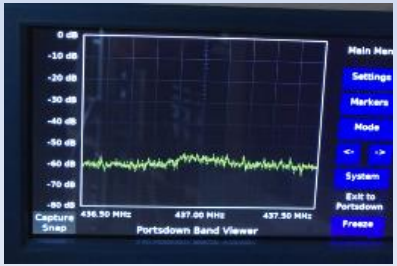
Practical thoughts

- Pre-amps
  - Commercial eg DB6NT and G4DDK
  - Use Ebay and Aliexpress with caution
  - Simple MMIC designs are good (G4DDK PCB)
    - PGA103, SPF 4531,

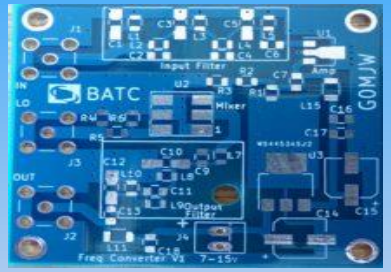
- Filtering
  - Surplus is fine
  - Chinese is fine
  - But ALWAYS check the loss and if possible the shape (use a mini VNA)
- Co-ax not too critical after your pre-amp
  - But always measure the loss

Practical thoughts

- Tx / Rx relays
  - Buy the best you can afford
  - Surplus is fine (often the only option)
  - Check the spec and measure the loss
- After the pre-amp you can use satellite co-ax!
- Band switching
  - Better than swapping plugs!
  - BATC / ebay 8 way switch (beware 13cms loss)
  - Multipole Relays
- Use satellite amps and splitters to feed multiple receivers
  - Include Lime Band viewer
  - Put an attenuator before the Knucker!!



Practical thoughts



- Up and down converters
  - Serit 4473 and 4762 frequency range is different
  - 4473 does not cover 29/50/70 MHz
    - Use an upconverter to L band (BATC design)
  - 4762 does not cover above 1 GHz
    - It does cover transverter IF frequencies so only missing 23cms
- Connectors
  - Do not use F types unless you have to!
  - BNC are fine, beware crimps
  - SMAs are great for microwave but tend to bind
  - N types are good when you need power handling
  - Beware shiny Chinese adaptors!
  - Don't even think about PL.....!

Masthead box design

- GOOD changeover relay
  - Normally on = Tx
- Power pre-amp and relay on receive
  - Use a sequencer
  - Power via co-ax saves a cable
- Leave a vent hole – in the bottom
  - Dangle a piece of string out of it!!
- Co-ax
  - “Great” co-ax between antenna and box
  - “Good” co-ax on transmit
  - “OK” co-ax on receive

Tx / Rx sequencer

- Without a sequencer there is a risk the tx will still be on when you power the PA
  - Result = smoke from pre-amp ☹

- Plenty of designs available – ask Google
  - Drive from Portsdown PTT output – before band steering

Microwave rxrs

- Most stations use transverters or LNBs for bands above 2.3GHz.
  - Takes care of LNA and band pass filtering
- Most transverters have an IF of 144 or 432 MHz
- Can be treated as just another input as far as rx system design
- Designed for use with NB transceivers so low on rxr gain
  - Needs additional gain but not bandpass filtering although it may help!
- Be careful if using satellite LNB for 10GHz
  - Very high noise level out
  - Switch DC off when not in use if using band switching

Conclusions

- Low noise amplifier – preferably at mast head
  - Cables have BIG losses!
- Enough gain to over come cable and filter losses
- Gain stages to maintain overall gain
- The first stage is the critical stage!
  - Low noise, medium gain and filtering
  - You can never win it back!

- Next steps:
- Read Ian GM3SEK paper and use his spreadsheet!
  - http://www.ifwtech.co.uk/g3sek/vhfdx/dg8-preamp-v7.pdf
  - GM3SEK noise figure realities https://www.youtube.com/watch?v=G8jECrsgsCY
- Measure all your co-ax
- Measure all your filters
- And then work the DX!