

# MKARS

Milton Keynes Amateur Radio Society

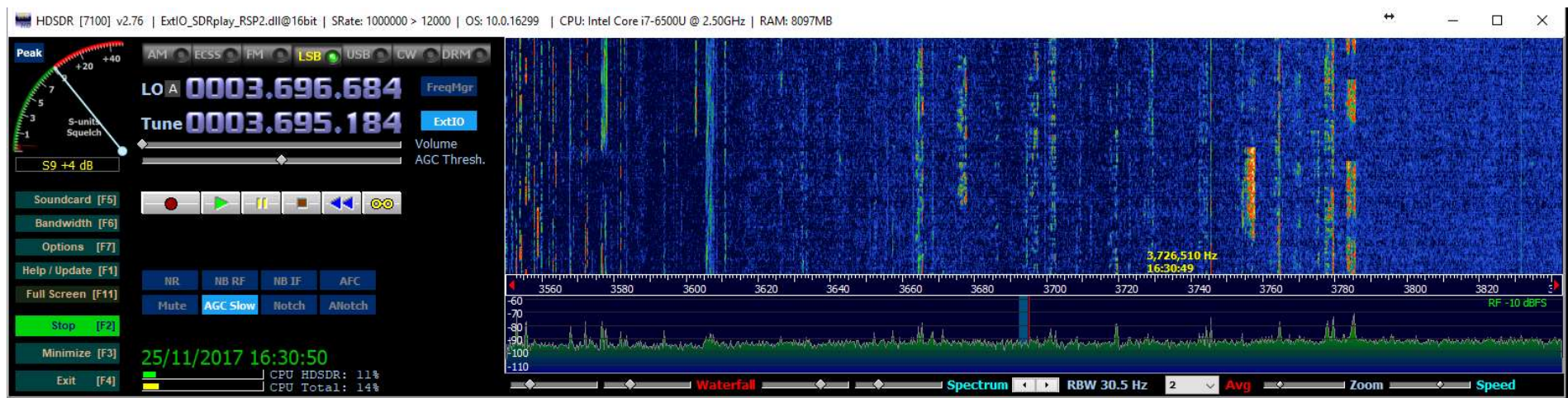
Adding a Panoramic Display to your Radio

By

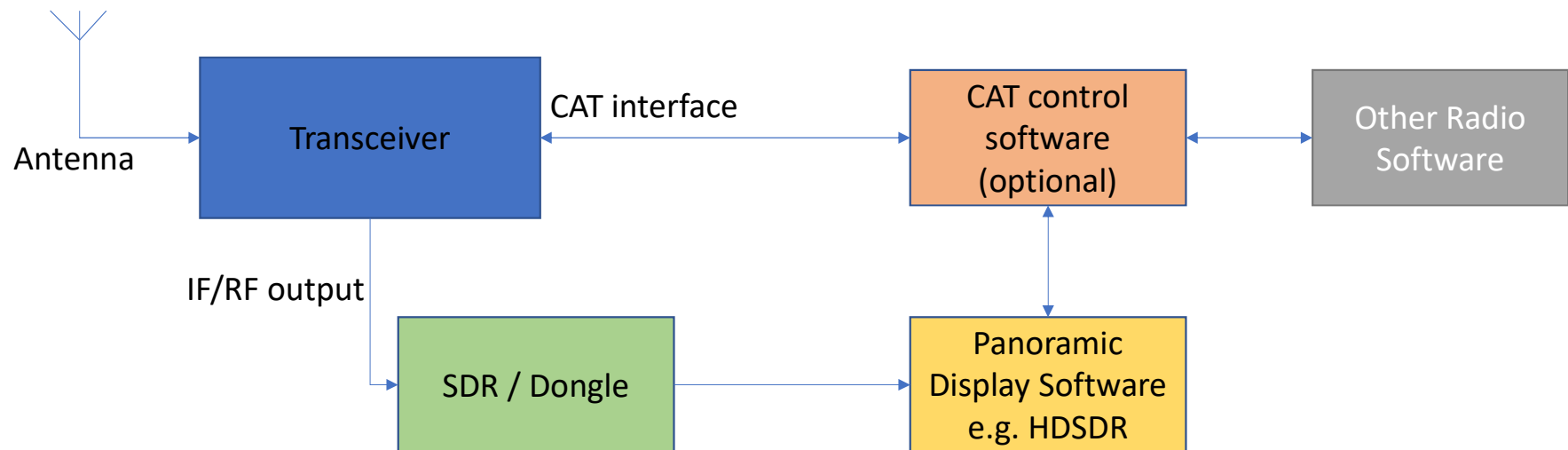
Tim Cowell – G6GEI

# WHAT IS A PANORAMIC DISPLAY ?

- Visual Display of the RF Spectrum
- Real Time trace with scrolling history
- Shows activity and noise levels on a broad RF Spectrum



# The principle



- IF/RF output from Transceiver processed by SDR
- Spectrum displayed on software
- Operating frequency read from Radio using CAT
- Radio tuned to new selected frequencies using CAT
- Use of CAT software (OmniRig) allows other apps to share CAT interface (logging etc.)

# WHY USE ONE?

- Finding signals in a quiet conditions
- Finding gaps in a busy band
- Spotting very short transmissions
- Quick tuning – point and click/touch to tune to signal
  - Scroll mouse wheel to fine tune
- Signal hunting with Rotator
  - Can view entire band as rotator is turned
  - Great for contesting when it's quiet
- Share one antenna with your Transceiver and SDR

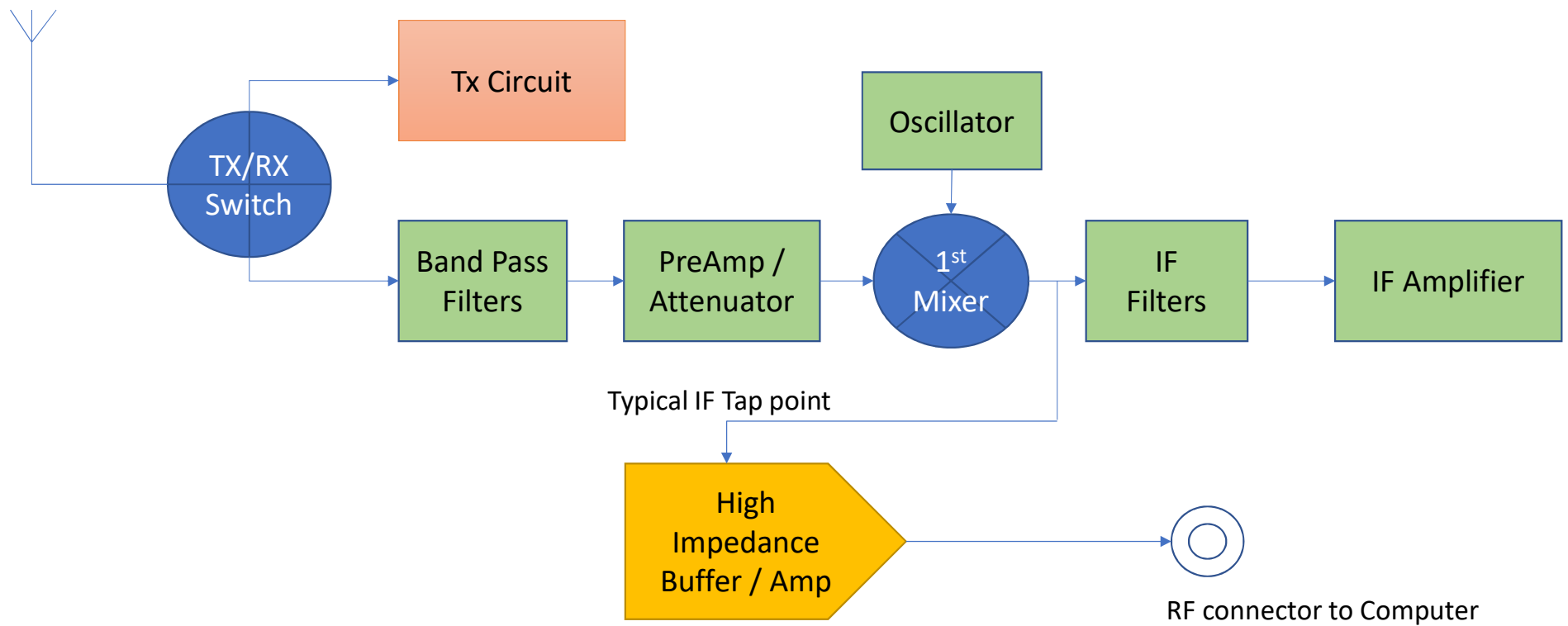
# WHAT DO I NEED?

- SDR Receiver / dongle
  - Capable of Rx at Radio IF or the band(s) to be operated
  - Needs to be a good SDR ( RSP1/RSP2 or AirSpy )
- Computer with Software
  - This example is PC with HDSDR
- CAT interface to Radio
  - To read/control the frequency (and optionally mode)
- High impedance buffer / Tap interface
  - G4HUP SDR-Kits or KD2C (Dave Calo)
- SMA pigtail lead, wire, Magnifying glass, Fine tipped soldering iron, steady hand
- Schematic / Circuit Diagram for Radio (Google)

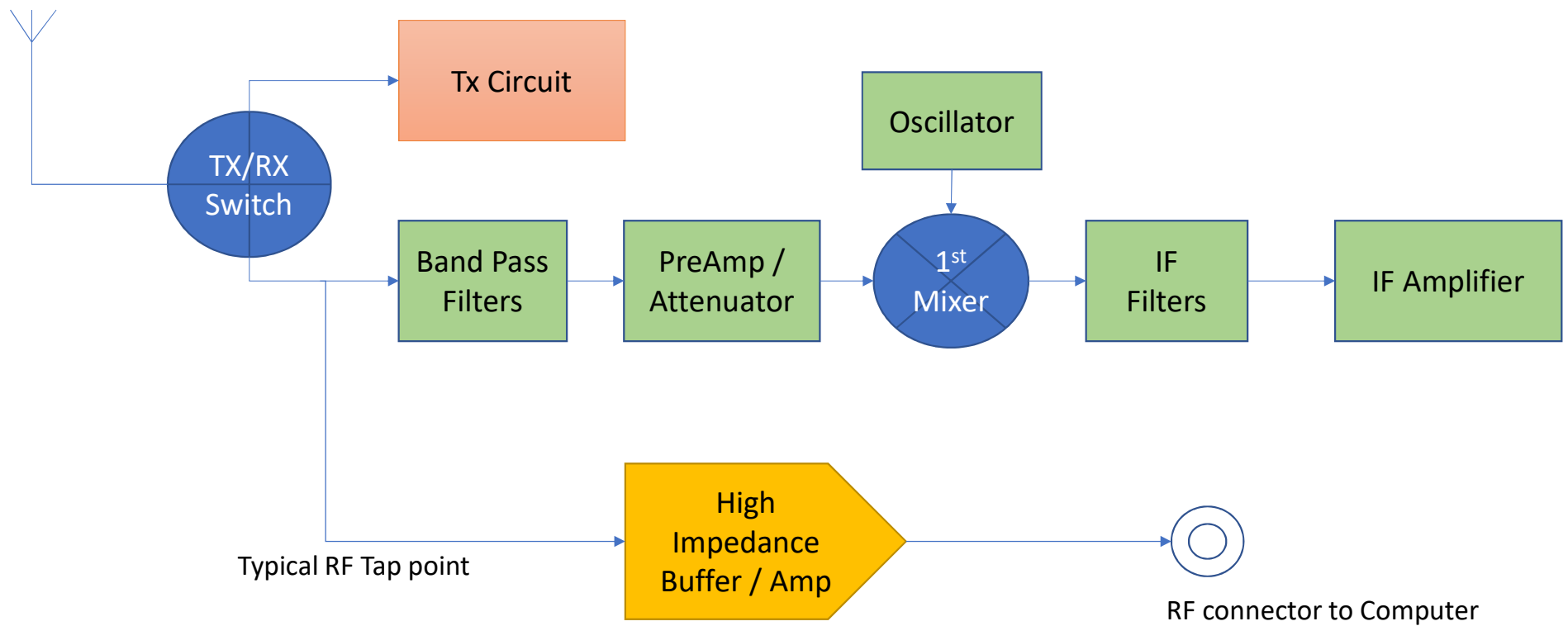
# TYPES OF TAP

- IF TAP
  - Take TAP from after 1<sup>st</sup> IF Mixer
  - Output is fixed frequency (1<sup>st</sup> IF)
  - SDR must tune to 1<sup>st</sup> IF
  - Utilises front end of Radio (filters etc.)– usually better than the SDR
  - Limited bandwidth around tuned frequency (in theory)
- RF TAP
  - Take TAP from before 1<sup>st</sup> IF Mixer
  - Output is whatever comes in via the antenna
  - Excludes TX signal (protects SDR)
  - Suitable for Direct Conversion transceivers (e.g. IC-7300) with no IF
  - Tap before or after Band-pass filters/ pre-amp etc.

## Typical Superhet (with IF) schematic

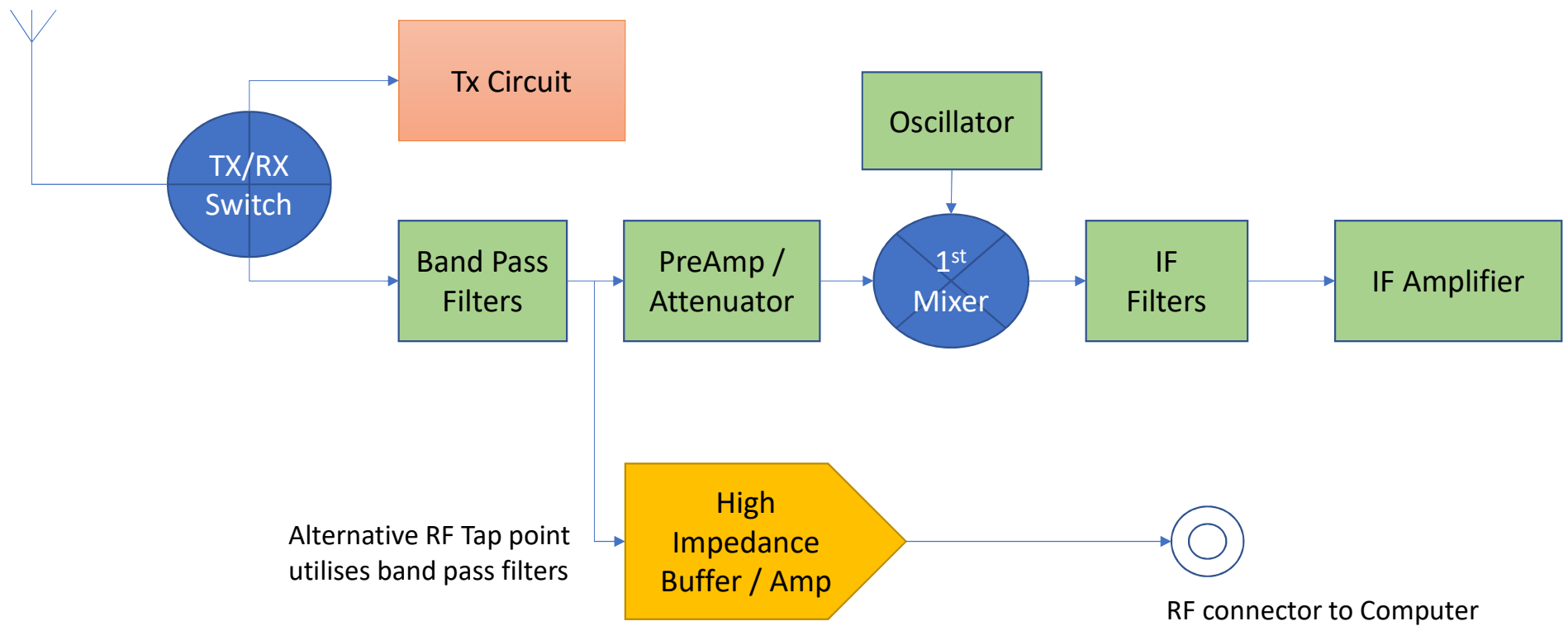


## Typical Superhet (with IF) schematic

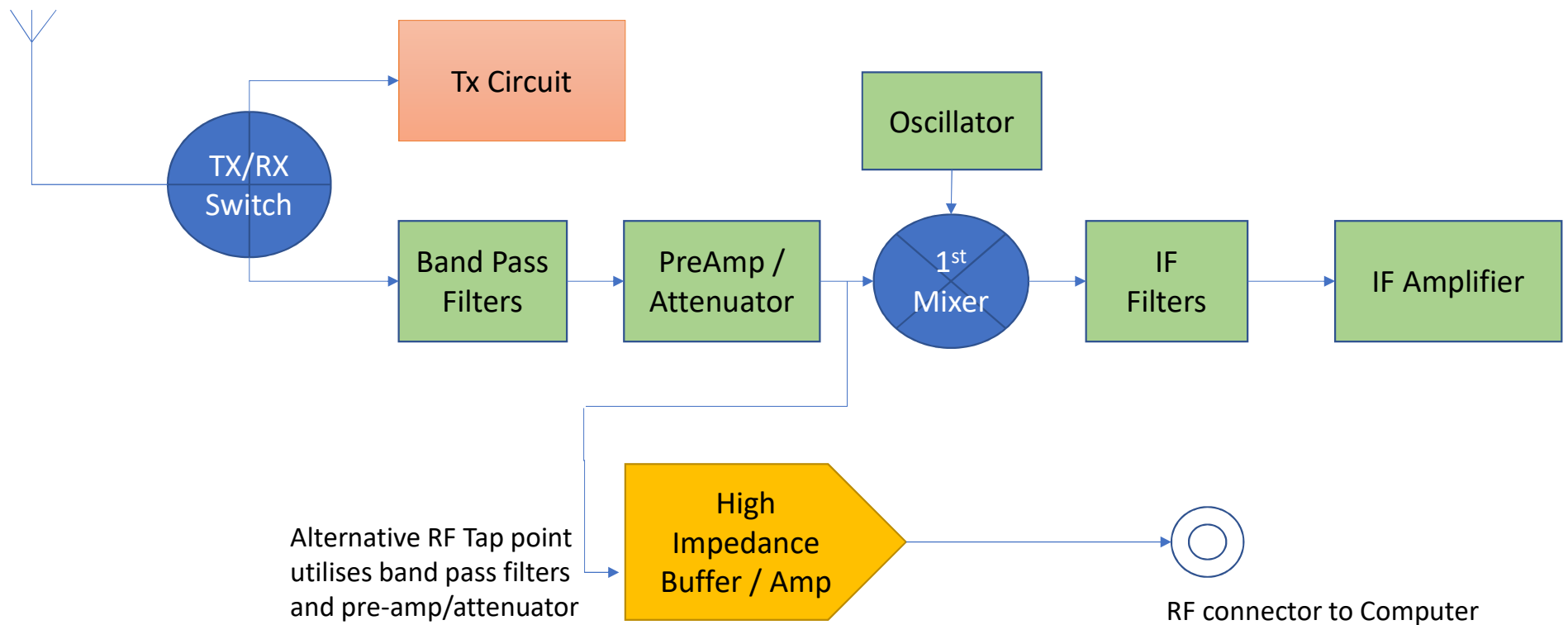




## Typical Superhet (with IF) schematic

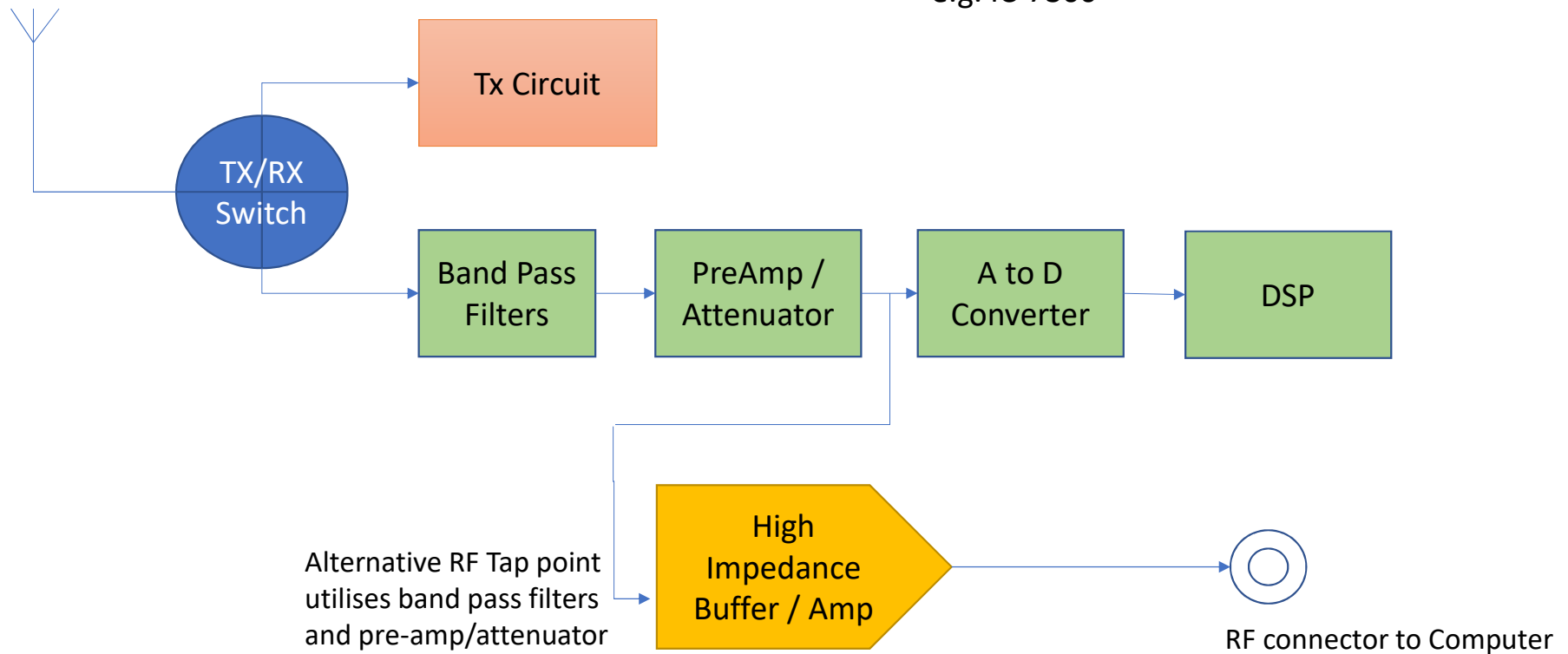


## Typical Superhet (with IF) schematic



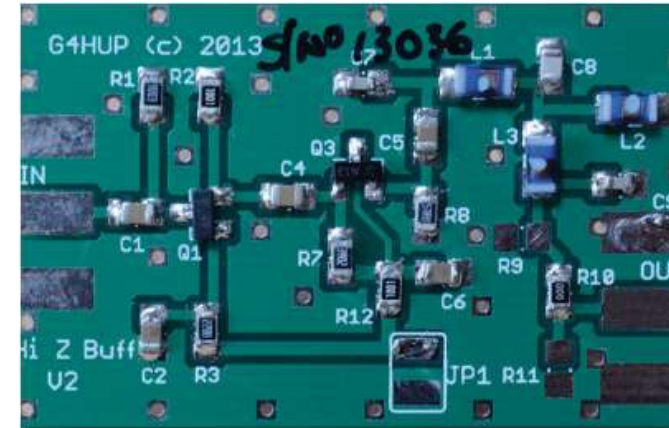
# Typical Direct Conversion (SDR) schematic

e.g. IC-7300



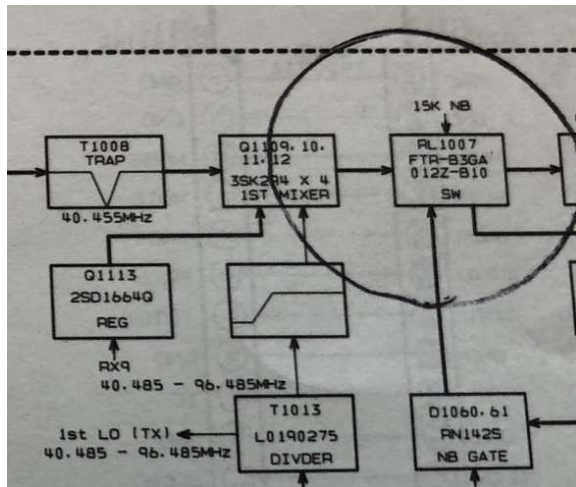
# High Impedance Buffer

- Prevents loading Rx circuitry of Radio
    - No effect on receive sensitivity
  - Prevents noise back from SDR dongle
    - Some SDRs output high levels of noise on their input
  - Protects radio from external damage
  - Presents 50 ohm output suitable for SDR input
  - Low pass filter on output – removes unwanted 1<sup>st</sup> mixer signals
- 
- Thanks to Dave Powis G4HUP (silent key) for his original work and article in RadCom Nov 14. URL at end of this presentation.



# Determine where you're going to TAP

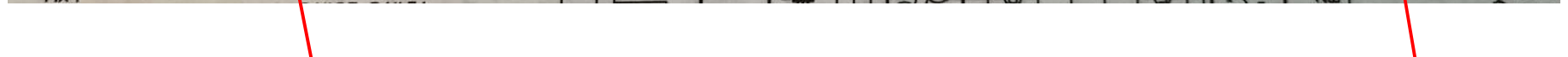
- Look online for someone who's done it.
- G4HUP website or KD2C has good examples. (see last slide)
- Failing that – get schematic & circuit diagram.
- FT-DX1200 (example)



Locate 1<sup>st</sup> Mixer on schematic.

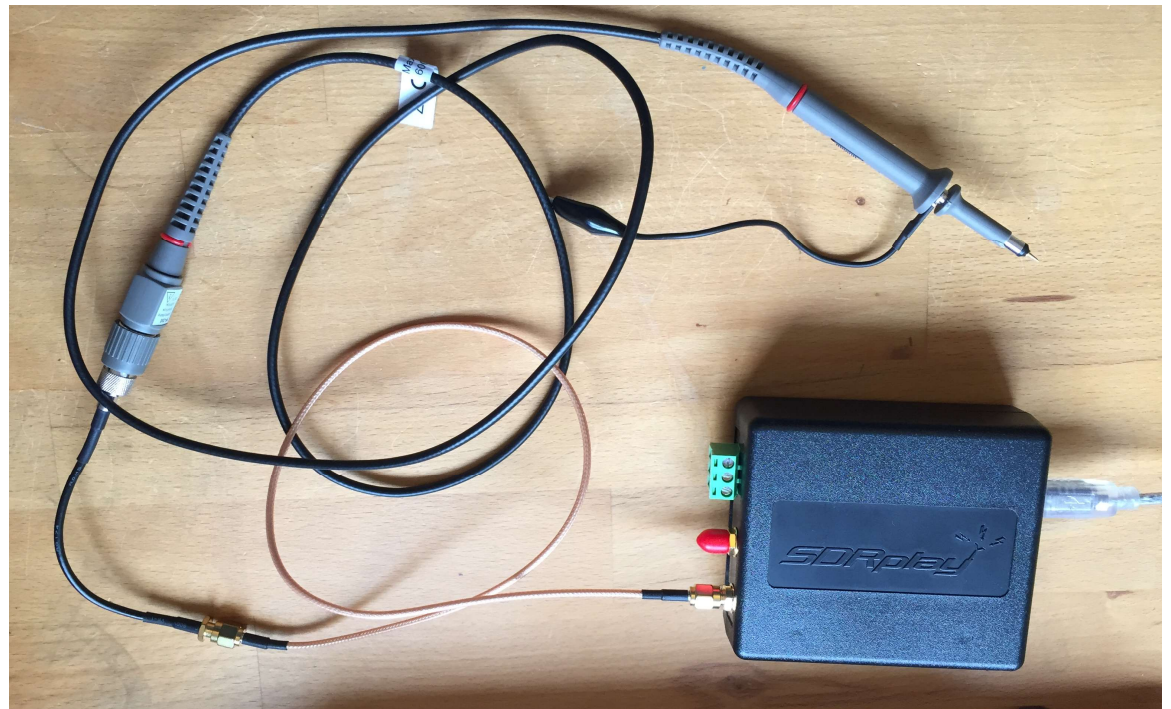
Note key components that can be found on diagram and pcb, e.g. Relays/Coils

This example RL1007 will be easily found being a Relay.



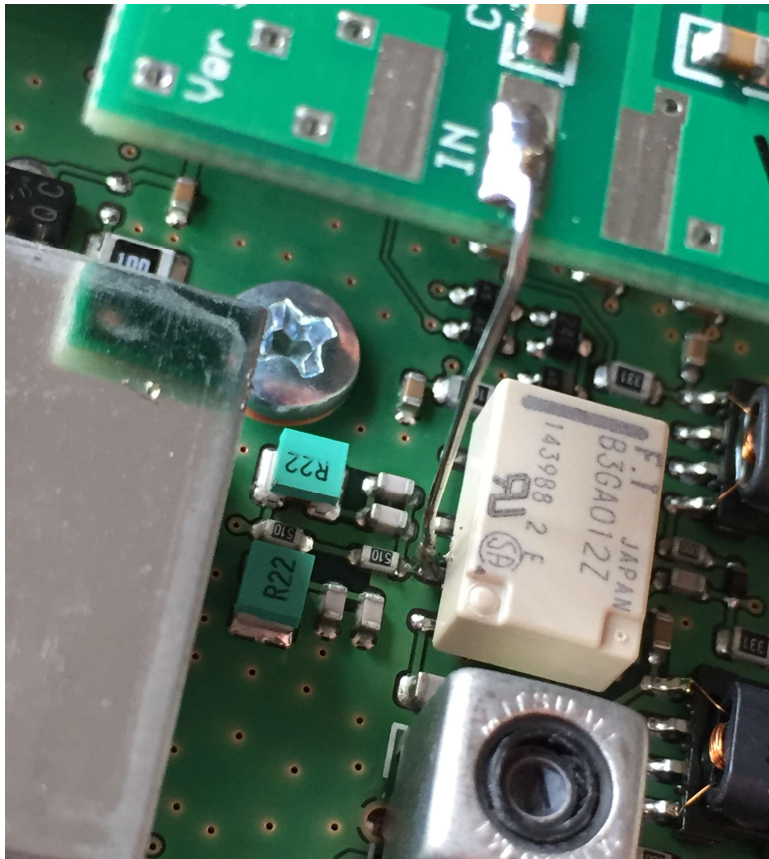
# Test before you commit

- An oscilloscope probe connected to your SDR is a good way to test that your TAP point is going to work.
- The probe is high impedance.
- You can tune your SDR to the IF frequency and should see a waterfall!





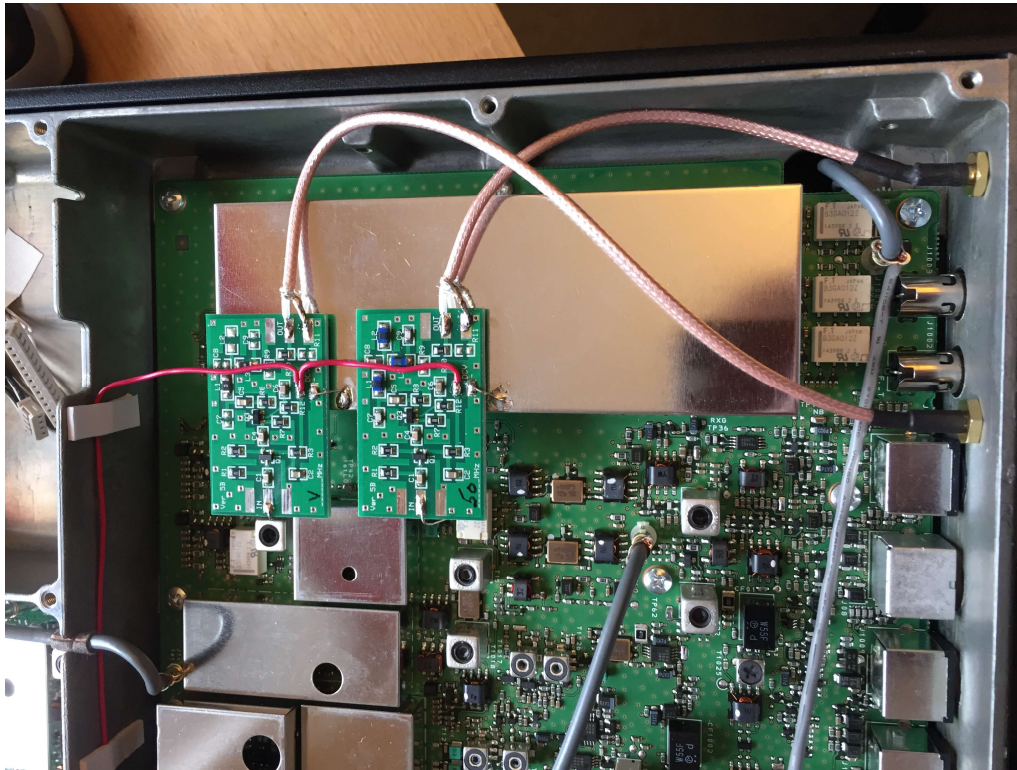
## FT-DX1200 IF TAP point



- Pin 3 of relay 1007.
- This looks small and fiddly but is pretty good compared to some.
- I find wearing 2 or 3 reading glasses and a head torch is essential to see clearly.



# The finished article



Here are 2 boards mounted inside the FT-DX1200.

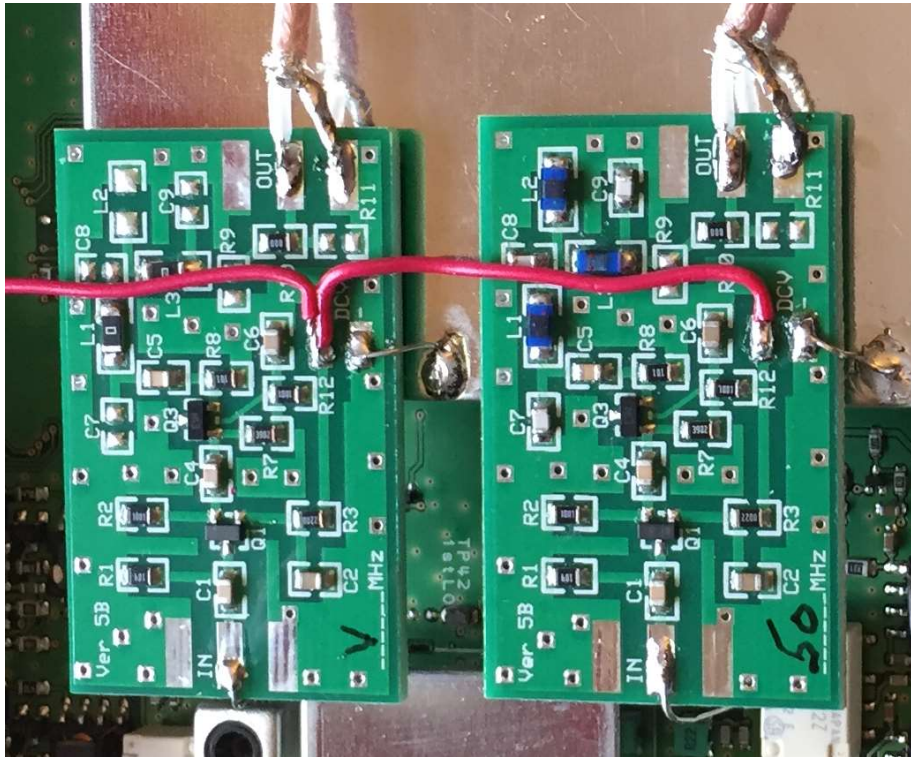
One IF tap and one RF tap.

Mount the boards as close to the tap point as possible.

Boards can be fixed using double-sided sticky 'mirror' pads or in this case I have soldered component leads to shielding can.

The red wire is +8v, preferably from a supply that is only live on Receive to reduce tx signal getting fed out.

Be careful drilling holes for the SMA connectors, you don't want swarf in the radio!



The SMA chassis sockets are easily purchased online (eBay etc.) for a few pounds complete with suitable coax already connected which you can cut to length. Look for SMA pigtails.

The board marked '50' is the IF tap, the 50 represents the 50 Mhz low pass filter ( the radio IF being 40.455 Mhz.

The board marked 'V' is the RF tap. It has no low pass filter fitted (note missing components L2 C9 etc.)

Some people prefer to use coax to the tap point. This will help prevent rf pickup on the input, but it may add capacitance (load) and hence interfere with the receiver circuitry.

If the distance is short I just run a short component lead, unshielded. It is also easier to solder.

If the distance is longer, I suggest using a low value capacitor (10pf) between the coax and the actual tap point and a length of coax to the board.

Cut and pre-solder the coax ends well away from the radio – fine strands can be hard to get out if they fall inside.

# Configure the Software (example HDSDR)

- The IF frequency needs to be set
  - 124.487 Mhz (shown) is the IF of my IC-7100
- Sync in both directions
  - Tuning the radio will tune the SDR
  - Tuning the SDR will tune the Radio

RF front-end frequency options

**SDR hardware coupling**

☐ SDR hardware connected to antenna (default)

☒ SDR on IF output, which is controlled by Omni-Rig2 ▾

Sync Mode

☒ Full sync in both directions

☐ Independent Tune in HDSDR

☐ Independent Tune, but sync on external change

☐ Full sync, except LO

IF-frequency:  [Hz] Global Offset:  [Hz]

Additional Offset per Mode in Hz

AM	FM	LSB	USB	CW_U	CW_L	DIG_U	DIG_L
0	0	0	0	0	0	0	0

☐ Mirror RF Spectrum in general

☐ Mirror RF Spectrum for Tune >=  kHz

☐ operate CW in lower sideband (LSB)

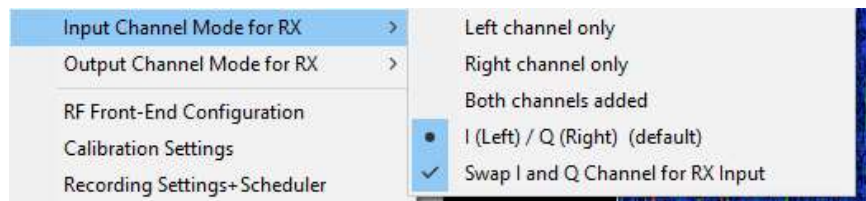
☐ Swap CW and CWR for Omni-Rig

☐ SDR hardware on Down/Up-Converter  
LO Frequency of Down/Up-Converter in Hz:

☐ SDR hardware in undersampling mode  
Samplerate of Analog-Digital Converter in Hz:

Apply

# Configure the Software (example HDSDR)

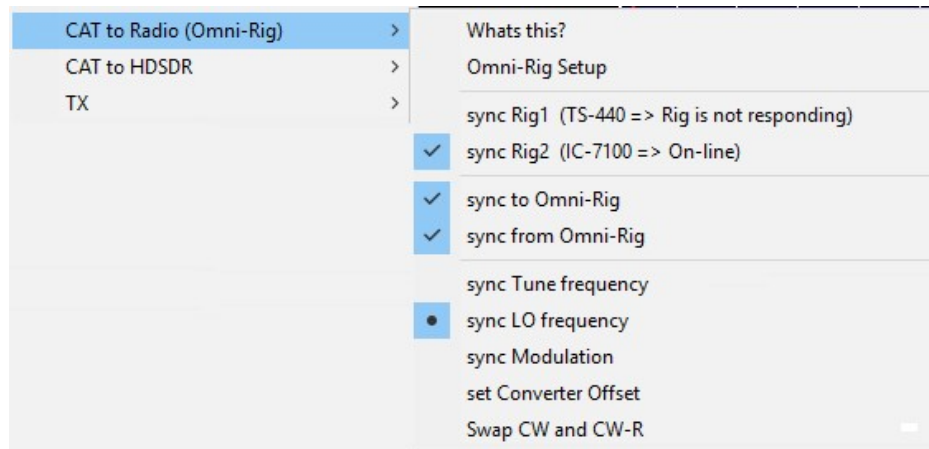


Depending on how the IF mixer is implemented the spectrum displayed on the panadapter can be inverted, i.e. a signal showing higher on the band is actually lower in frequency.

This is corrected by swapping the I and Q channel on the SDR input.

This will be very obvious if you try to tune to a nearby signal and find you are tuning the wrong way, or try rotating the tuning dial clockwise on the radio and all the signal traces shift to the right instead of the left on the waterfall.

# Configure the Software (example HDSDR)

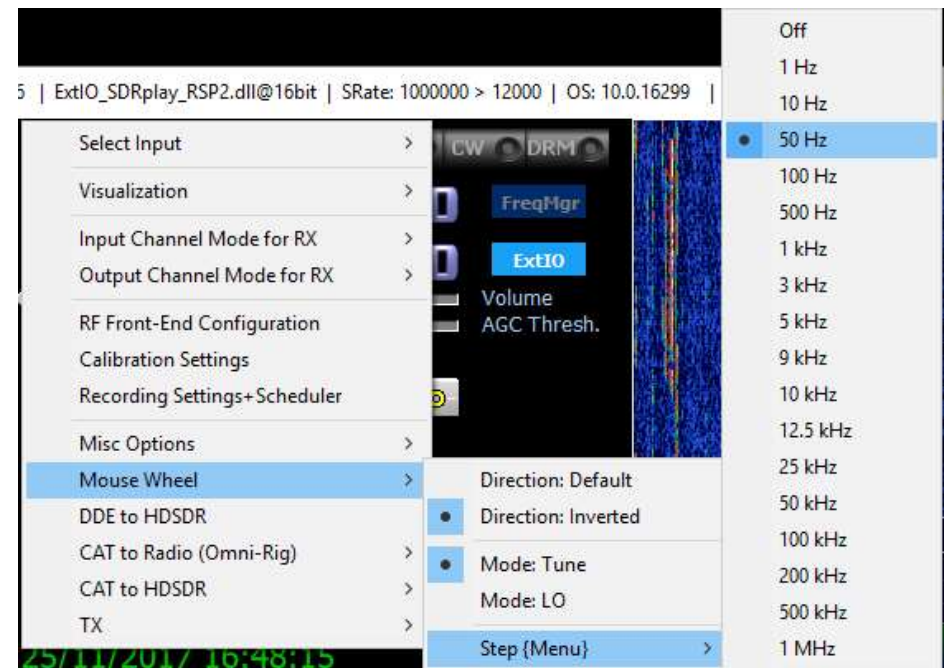


- Tell the SDR software what Radio you are connected to and what to synchronise.
- Here we are using OmniRig to control the IC-7100
- We are doing a 2 way sync
- We are only setting the frequency, not controlling modulation etc.

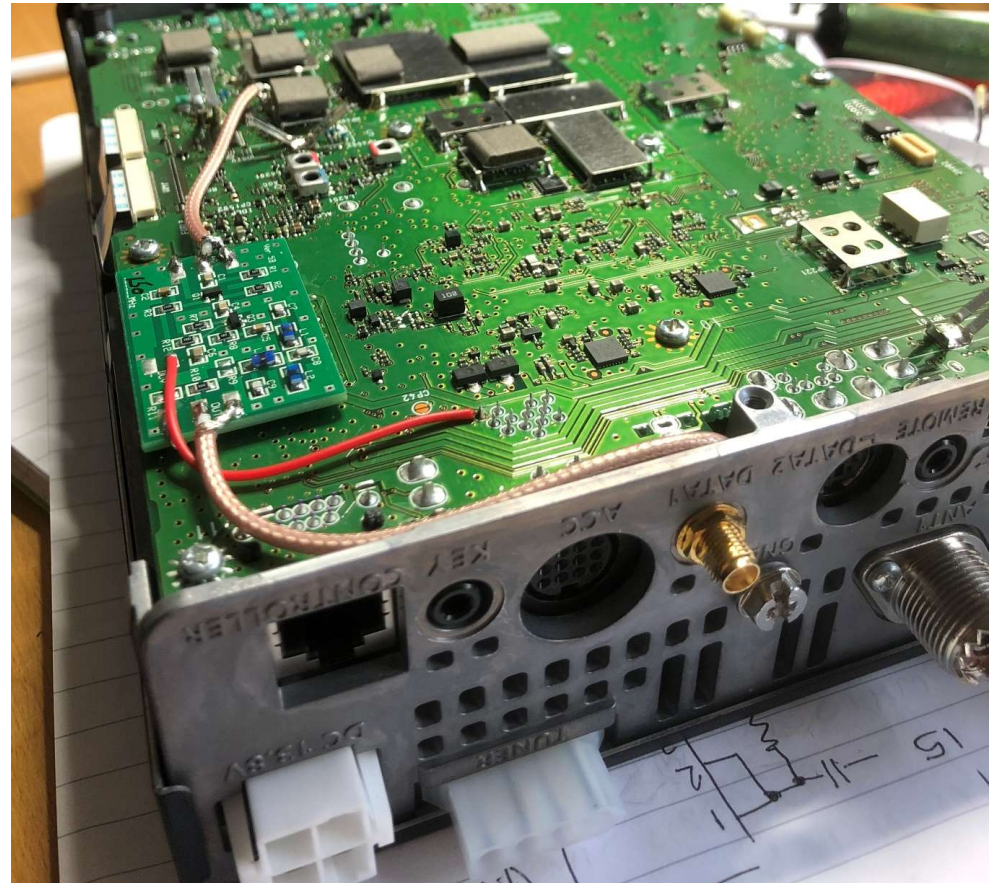
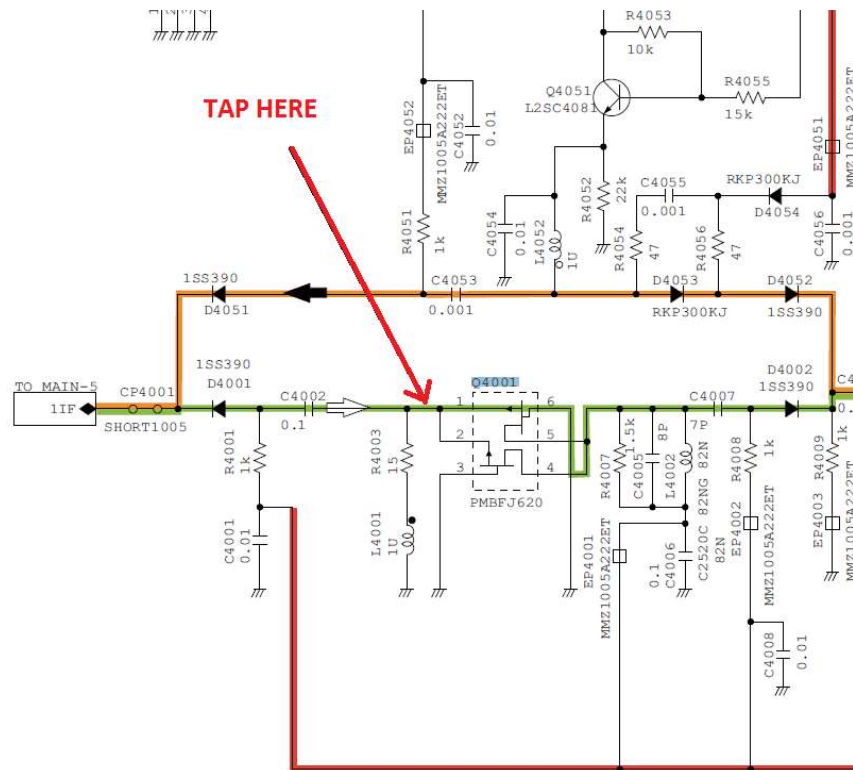


# Configure the Software (example HDSDR)

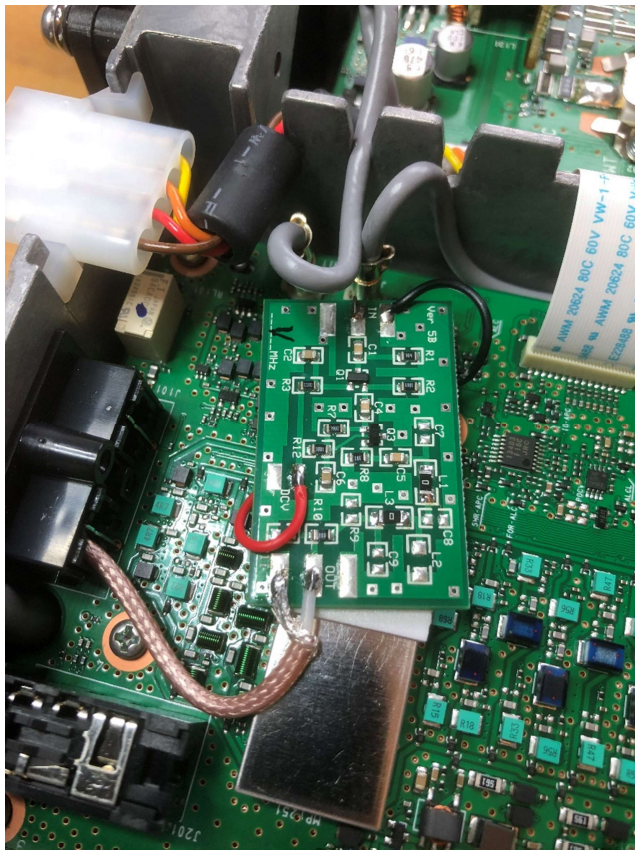
- Mouse wheel step size allows fine tuning.
- Typically you can instantly tune to a frequency by clicking/touching the waterfall, and then fine tune using the mouse scroll wheel.



# IF Tap on my IC-7100



# RF Tap on my IC-7300

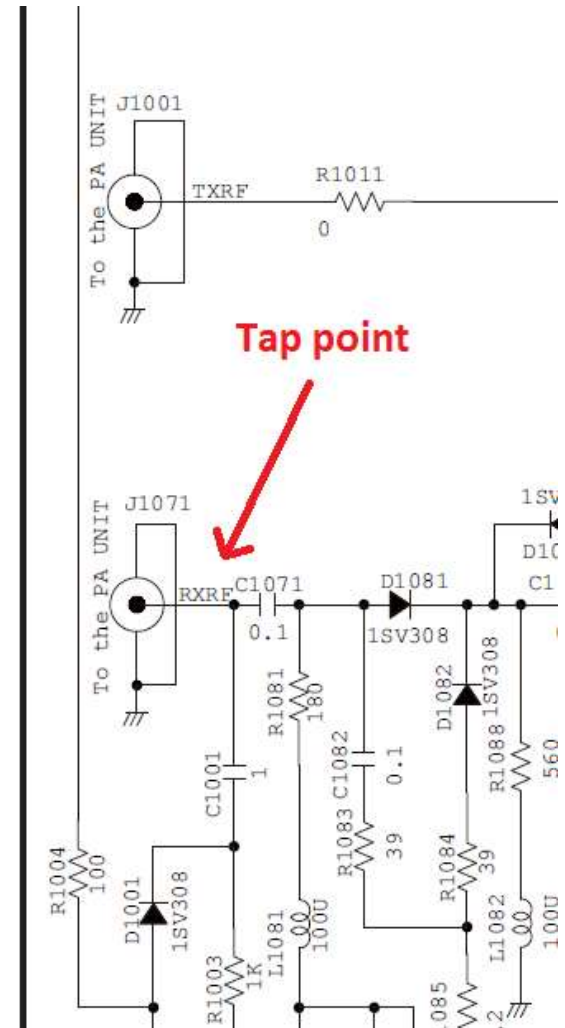


RX-RF interconnecting cable conveniently gives access.

Board mounted 'skew' to minimise distance for tap lead.

Coax fed out through centre of ALC connector, no hole drilling.

Uses same tap point as the Inrad Rx-7300 receive antenna mod.





## References:

- <http://huprf.com/huprf/pat-board> for installation guidance/notes
- [kd2c56@gmail.com](mailto:kd2c56@gmail.com) supplies PAT boards @ \$27 plus \$16 shipping
  - Up to 3 boards shipped per \$16 so worth collaborating with friends
- [https://www.sdr-kits.net/index.php?route=web/pages&page\\_id=64](https://www.sdr-kits.net/index.php?route=web/pages&page_id=64)
  - UK Supplier - £14.40 per board. £6.60 for kit with sma, cable etc.
  - Doesn't do ALL variants (LPF freqs on output)
- <http://huprf.com/huprf/wp-content/uploads/2016/03/PAT-Radcom-14.pdf> the original RadCom article by G4HUP in Nov 14.

# Disclaimer

- Fitting a PAT board is not for novices. If you are not confident do not attempt. It will invalidate any warranty you may have and could result in permanent damage to your radio.
- Fitting will likely require soldering to very small surface mount components which are easily damaged by heat and can come soldered from the PCB.
- Seek assistance or ask your local service agent/dealer if you are not comfortable with doing this. Experiment on some old surface mount boards first if in doubt.