

G4HUP Panoramic Adaptor Tap (PAT) – Version 2

Abstract:

This circuit is designed to provide a convenient method of tapping off the Intermediate Frequency of an amateur receiver or transceiver, so that it can be displayed panoramically via an SDR, such as the Funcube Dongle or similar product.

The unit is intended as an entry level SMD construction project, with a relatively low parts count. Once completed, it can be installed in the target rig, with the output brought out via a suitable connector, or a cable pigtail, through the rear panel. The PCB is small enough to fit inside a modern all-band portable rig, such as the FT817, and can conveniently be 'lost' inside base-station rigs.

Both high 1st IF's around 70MHz and lower 1st IF's in the region of 10MHz can be accommodated by the board, with a change of LPF on the output. It is preferable that the input to the PAT is tapped off the input to the 1st IF filter, to give the maximum displayed bandwidth on the SDR.

Power for the PAT is taken from inside the existing rig, preferably from a switched Rx supply. The circuit draws approximately 11mA from the host rig.

Objective:

This circuit was created as a simple interface to allow a signal to be tapped off from the receive path of a rig and brought out to an external SDR, so that panoramic display can be seen in addition to the audio of the directly tuned signal. Research showed a number of techniques for extracting a signal from the radio, varying from the very basic approach of connecting the SDR input to the IF filter via a low value capacitor, to several more complex designs using MMIC's or transistors. The design presented here is a development of some of those approaches, but also has some novel features.

Circuit Description:

The buffer has two active stages - a JFET source follower to present a high impedance to the IF filter, and therefore minimise any loading on the main signal path of the radio. This is followed by a BJT as an emitter follower to provide impedance transformation for a following filter stage. There are two passive stages following this - a 50R low pass filter to limit the passage of signals above the IF, and a resistive attenuator to allow the overall gain of the board to be matched to the input requirements of the SDR.

Fig 2 shows the circuit schematic, with component values for 7 - 13v operation of the circuit. Since the 1st IF filter of many rigs is bidirectional, and used on both Tx and Rx, it is recommended that the PAT voltage supply, Vcc, is taken from a switched supply which is 'on' during Rx. This avoids any strong TX path signals being presented to the SDR during TX periods. Typically in base station rigs, the +RxB is around 8 to 10V.

The filter shown at the output of the amplifier is a broad low pass filter to give some bound to the overall pass band of the PAT. It is not intended as a band limiting filter to restrict the IF range passed to the SDR. It is recommended that an outboard tuned filter is provided - the onboard filter may be omitted in this case. Similarly, there is the capability to place an output attenuator on the PAT PCB, although in most cases it will not be needed - the value of the attenuator may vary depending on the SDR to be used. It is preferable that this attenuator, too, is provided off board, since it avoids opening up the rig if the SDR is changed

Circuit Implementation:

The layout is designed for SMD construction, but has been laid out with a moderately large spacing between components, making it suitable as an entry level SMD project. The final size of the PCB has been dictated by the need for it to fit in an FT817. The layout is shown in Fig 1, and Fig 3 shows a photograph of a completed PCB. All resistors and capacitors are 0805 size - this is good compromise between miniaturisation and hand construction. The active devices are SOT23 devices (MMBJF310 and BFS17), and the inductors in the filter are 1008 or 1206 sizes, which make for slightly easier handling. The use of a commercially produced PCB ensures that there is minimal opportunity for getting solder in the wrong places!

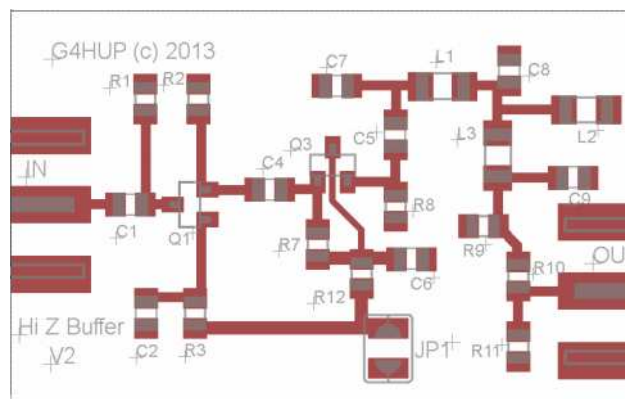


Fig 1 – PAT V2 parts overlay

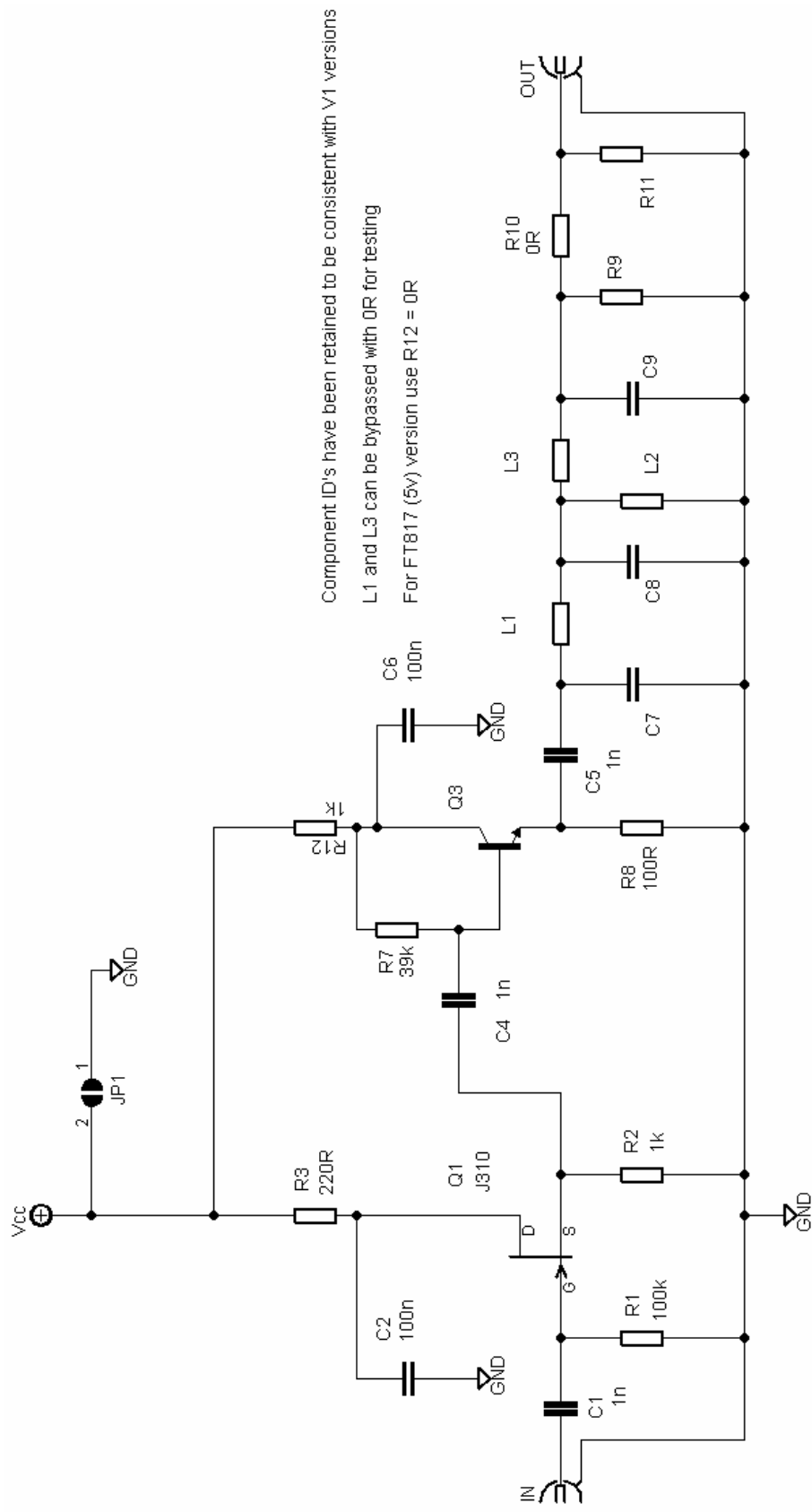


Fig 2 - PAT V2 Circuit

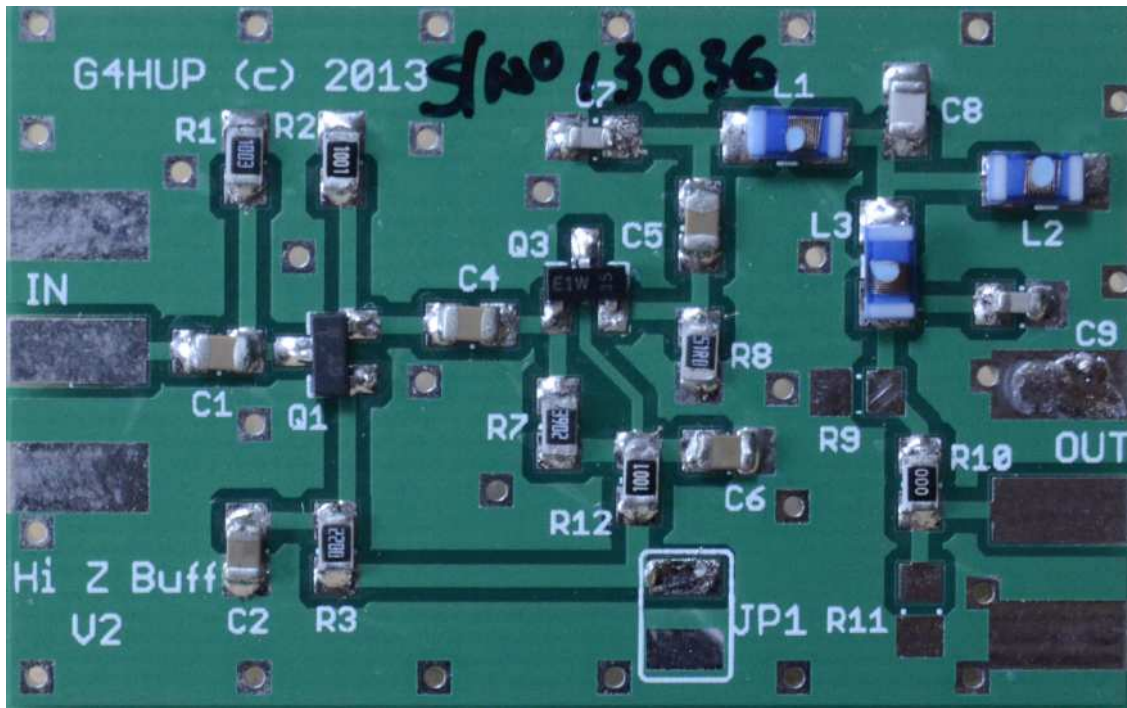


Fig 3 – View of assembled PAT V2

Circuit Construction:

Successful construction of SMD circuits requires the right tools:

- A small diameter solder - typically 0.3 to 0.5mm diameter, flux cored leaded solder. With larger diameters it is impossible to control the amount of solder deposited.
- A suitable temperature controlled iron with a tip of around 0.8mm.
- A good light source.
- A magnifier - I find headband magnifiers the most convenient
- A good pair of stainless steel tweezers - straight or curved, or clamping style is a personal preference.
- A vice or clamp to hold the PCB in place.
- A white working surface with a barrier round the edges - helps to prevent components that fly out of the tweezers going too far, and makes them easier to find when they do!

I find that the best method is to melt a small amount of solder onto one pad of the PCB, then hold the component in place with the tweezers and reflow the solder. Once the component is secure, the other pad can be soldered.

Place the resistors first, according to the layout diagram. Follow with the capacitors, and finally the transistors to complete the PAT. At this stage, before building the LPF

it is worth testing the circuit. Use either 0R resistors or short wire links in place of L1, and L3. R10 is set as a 0R resistor.

Measurements and performance:

Table 1 DC measurements

Voltage version	10v		5v	
	Average	Range +/-	Average	Range +/-
Iq	10.00	0	6.00	0
Q1 gate	0	0	0	0
Q1 source	3.39	0.4	3.28	0.09
Q1 drain	9.20	0.11	4.26	0.03
Q3 base	1.26	0.05	1.23	0.05
Q3 emitter	0.47	0.03	0.43	0.03

Table 2 Dynamic Measurements – Gain by IF and Vcc

IF (MHz)	5v Vcc (FT817)	10v Vcc
12 (TS2k)	N/A	0.7dB
45 (FT840, 847)	N/A	1.1dB
70 (FT817, 857, 897, 1C706 etc)	1.3dB	1.5dB

Rig installation

No specific details are going to be given here due to the wide variety of rigs to which this adaptor can be fitted. However, the principle is the same for all rigs.

Identify the first IF filter, and ascertain the correct orientation of it - you need to pick up the input to the filter, since the output will already be reduced in spectral width. You also need to identify a switched RxB line, so that the PAT will be automatically muted on Tx.

Decide where you can mount the PAT PCB - there are no mounting holes provided on the PCB, but a small piece of double sided adhesive tape can be used to hold it in place inside the rig. Preferably, it should be located as close as you can get to the IF filter, so that the length of the high impedance wiring is limited.

The output signal from the PAT PCB can be taken by a short length of small diameter coax, eg RG174 polythene, or better still RG178A PTFE, out through the back panel of the rig. Often there are air ventilation holes which can be used, or it may be possible to mount a fixed socket, such as a BNC or SMA on the rear panel. Secure the cable so that any stress on it does not dislodge the PAT PCB from its mounting place.

Fig 4 shows a typical installation in a TS2000. The board conveniently fits at the side of the main PCB, close to a point where the IF is available from a PCB connector (close

by the marking VS-3). The output signal is lead out via an RCA (phono) socket which has been hi-jacked from its original use of separate HF Rx antenna input.



Fig 4 - PAT installed in TS2000

Suitable SDR's

This is a growing market, with new products appearing all the time. The prime factor in choice is the IF of your rig! Many rigs have a first IF at approx 70MHz, which limits the choice of SDR's unless an external converter is used, although there is a tendency to return to lower 1st IF's in the most recent rigs.

Popular SDR's which cover this range are the Funcube Dongle Pro plus and the many cheap RTL DVB Dongles. Be careful with these latter as they have rather restricted dynamic ranges, and can easily be pushed into compression. This may not be a major issue, since you are more likely to be using it for as panoramic adaptor than for recovering the received audio, but be aware that the distortion can cause 'extra signals' to appear in the display! Other products such as the Cross Country SDR 4+ also cover 70MHz.

The Flex radios and the HPSDR series (Mercury, Hermes, Anans') all cover up to approx 60MHz, while the more traditional HF SDRs such as the SDR-IQ and family cover up to 30MHz, so to use any of these, you would additionally need a simple 70 MHz down converter external to your radio for use at high IF's.

Any of these latter radios would be suitable, as would the Softrock type simple SDR's, for bringing out an IF in the 10MHz range. This is a common second IF in older rigs, and there has been a return to this range for the 1st IF in more modern rigs such as the TS990, Elecraft K3 etc because of the improved blocking performance that can be obtained. Where it is a second IF, there is the disadvantage of limited spectral width,

as the range has already been limited to approx 30kHz by the first IF filter. It is also worth noting that the Elecraft P3 could also be used directly in this frequency range to display the PAT output from the rig.