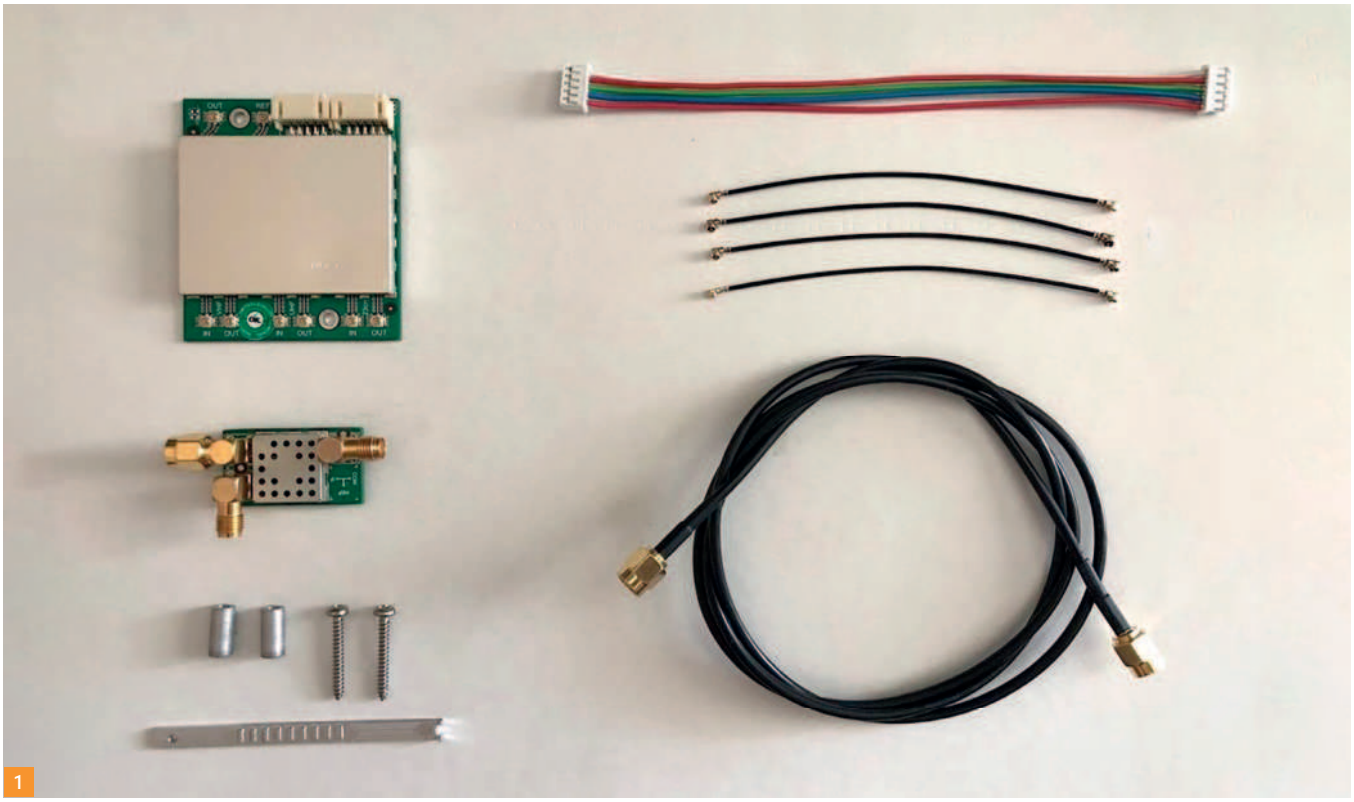

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RadioAnalog PTRX-9700

Sam Jewell G4DDK takes a look at an add-on board to allow a second receiver to be added to the IC-9700.

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When I reviewed the then-new IC-9700, back in the July 2019 issue of *Practical Wireless*, it was not clear how popular the new VHF/UHF transceiver would be. At close to £1800 it would have to offer a lot of value to prospective buyers. Subsequently sales seem to be doing well, judging from the number of people I have worked who use one.

Without doubt the IC-9700 has some shortcomings in terms of RF performance and 'missing' facilities. This article describes one of the accessories I have used to enhance my own IC-9700.

PTRX-9700

A second receiver, on the same band, with a frequency spectrum display, is now considered by many to be an indispensable operating aid. Although the IC-9700 does have two receivers the second receiver cannot operate on the same band as the main receiver and this limits its ability to monitor, for example, the beacon sub-band while operating in the 'DX' allocation on the same band. Opening up the display width (dispersion) of the spectrum display usually results in poor resolution of weak signals when using the IC-9700's built in display. Adding the waterfall display can improve matters, but again, resolution is lost at wide display widths. The IC-9700 does not provide for connecting a larger, external display, as you can with the IC-7610, TS-890 and some other transceivers.

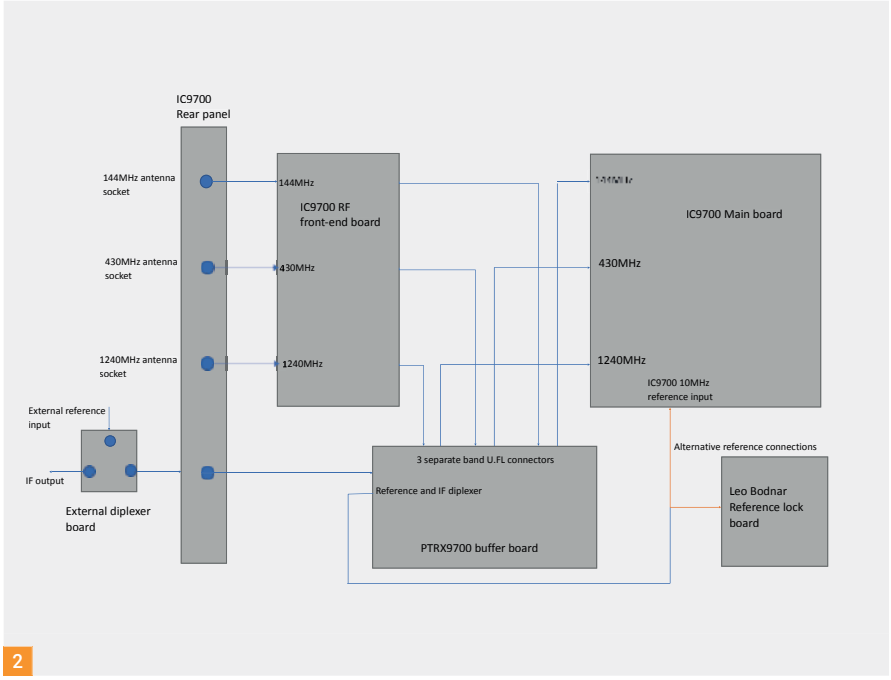
A second receiver also allows the operator to listen for a wanted station while in QSO with another station, without continually switching between VFO A and B.

A second receiver can often be added to a single receiver rig by using what is known as a PAT board (Panoramic Adapter Tap), together with an external SDR receiver or spare transceiver. PAT boards were made popular by G4HUP from his G4HUPRF company, and now available from SDR Kits. A PAT board taps into the transceiver's IF at some convenient point in the receiver circuit and allows the connection of an external second receiver, such as the SDRPlay RSP or Airspy SDR. This can then function as a second receiver with the added benefit of a larger spectrum display.

Some transceivers, such as the Elecraft K3 already incorporate a suitable IF output, which allows an external SDR or another transceiver/receiver to be used without having to access the inside of the radio. The problem with providing an IF tap on the IC-9700 is that it is an SDR and therefore does not have an IF to tap into. This is not strictly accurate as the IC-9700 1296MHz receiver and transmitter part does have an IF at 311 to 371MHz, ahead of its SDR stages. This is not, though, the case with 144 and 430MHz.

RadioAnalog (manufacturer of the PTRX-9700) have got around the problem of a lack of IF output by using a high frequency, high impedance, 'probe' or buffer board, which taps the three IC-9700 internal receiver RF front ends with minimal effect on normal IC-9700

Fig. 1: The PTRX9700 kit on arrival.
Fig. 2: The various interconnections required.
Fig. 3: The new boards installed in the author's IC-9700.



receive operation. In the case of the 1240 to 1300MHz (23cm band) the probe is connected after the internal down-conversion from 1240 to 1300MHz to the 311 to 371MHz IF. Otherwise, it is the same as the 430MHz (70cm band) band tap. The tap is, of course, across the entire bandwidth of the individual bands and is not actually an IF tap (except for the 1240MHz band).

It should be noted that the IC-9700 front-end stages are necessarily bandpass limited to eliminate aliasing (see my July 2019 review). What this means is that although you may be connecting a wideband SDR receiver after the in-built front-end stages, the frequency range that can be displayed is still limited to a little more than the range of the three individual IC-9700 bands. In practice the filters do not cut off too sharply and the available frequency display range exceeds that of the radio by a few extra MHz either side of the three amateur bands. **Table 1** shows the 3dB bandwidth for each of the three bands, as measured from IC-9700 RF input socket to PTRX IF output socket (after the diplexer – more on this later). Since the frequency response within each of the bands is not completely flat, a best estimate of the 3dB bandwidth has been shown in the table.

The clever bit of the RadioAnalog PTRX-9700 arrangement is that it taps the IC-9700 RF circuits such that the internal signal path is not disturbed. Doing this at 144MHz, 311MHz (1240MHz band IF) and 430MHz, without introducing additional loss into the tapped-off path, and without increasing the noise figure between the IC-9700 antenna sockets and the 'IF' output socket, is not easy, but RadioAnalog seem to have achieved it with the PTRX-9700. Making up for lost signal level with additional amplification is quite easy, retaining noise figure is not. If this is not done, then the external SDR receiver may not be as sensitive as the main path receiver.

Table 2 shows my measured insertion loss and noise figures from IC-9700 antenna sockets to diplexer IF output. The insertion loss is shown as higher than the RadioAnalog published figures because it necessarily includes the front-end stages of the IC-9700. The slightly higher noise figure and lower insertion gain at 145MHz, compared to the two other bands, had to be double checked and is confirmed.

A check of the IF output spectrum from the PTRX-9700 showed a completely spurious-free output over the frequency range from 10MHz to 500MHz.

What is Included?

The PTRX-9700 comes as a comprehensive kit of parts, with a pre-assembled radio buffer board, diplexer board (more on this a bit later) several miniature coaxial leads with Hirose U.FL series connectors, a U.FL 'tool' to ease attaching the connectors to the boards, an RG174 coaxial lead with SMA male connectors, a DC supply lead and some mounting screws and pillars, **Fig. 1**.

Fitting the PTRX-9700 is straightforward using the RadioAnalog web page instructions, requiring the removal of two grounding screws from the original main board and then carefully fitting the new buffer board with the two spacers and the two longer screws that are supplied. The more difficult part is removing the three miniature coaxial U.FL connectors from their original input sockets on the IC-9700 main board and fitting three of the new (supplied) leads. This is made easier by using the supplied tool but even then, requires a lot of care.

In effect the original three IC-9700 front-end signals are diverted from their input to the main board to now being routed via the new PTRX-9700 board and then to the main board. Martin Lynch and Sons, the official UK supplier of the RadioAnalog PTRX-9700, can do this for you. **Fig. 2** shows how the new buffer board and reference interconnects with the IC-9700 boards.

I have deliberately not yet mentioned the diplexer board that is supplied with the PTRX-9700. Unfortunately, there is no convenient place on the rear panel of the IC-9700 to mount a new and dedicated IF output socket. The RadioAnalog solution is to use the existing 10MHz reference input signal SMA connector for this purpose. However, this socket may still be required for use as the reference signal input. The dual use of the one connector is accomplished using diplexers.

Multiplexing two signals together, over a single RF path, requires two diplexers, one at either end of the path. The internal diplexer is contained on the buffer board. The second, external, diplexer is in the form of a small, screened board with three SMA connectors. This diplexer combines the 10MHz or 49.152MHz reference input with the new IF output.

Inside the IC-9700 another U.FL connectorised miniature coaxial lead is used to connect the reference signal from the PTRX-9700 buffer board to the IC-9700 main board. The existing back panel SMA is an SMA bulkhead cable end jack, the other end of which is terminated in a U.FL plug connector, and this is plugged into the remaining U.FL socket on the buffer board. This may all sound quite complicated but is quite straightforward if you follow the instructions on the RadioAnalog web page: www.radioanalog.com

As the new buffer board needs to be powered, this is done by using the new, supplied, power lead. This entails removing an existing multiway plug from its socket on the IC-9700 main board and moving it over onto the right connector on the buffer board. The new cable is now plugged into the second socket on the buffer and routed back to the original socket on the main IC-9700 board.

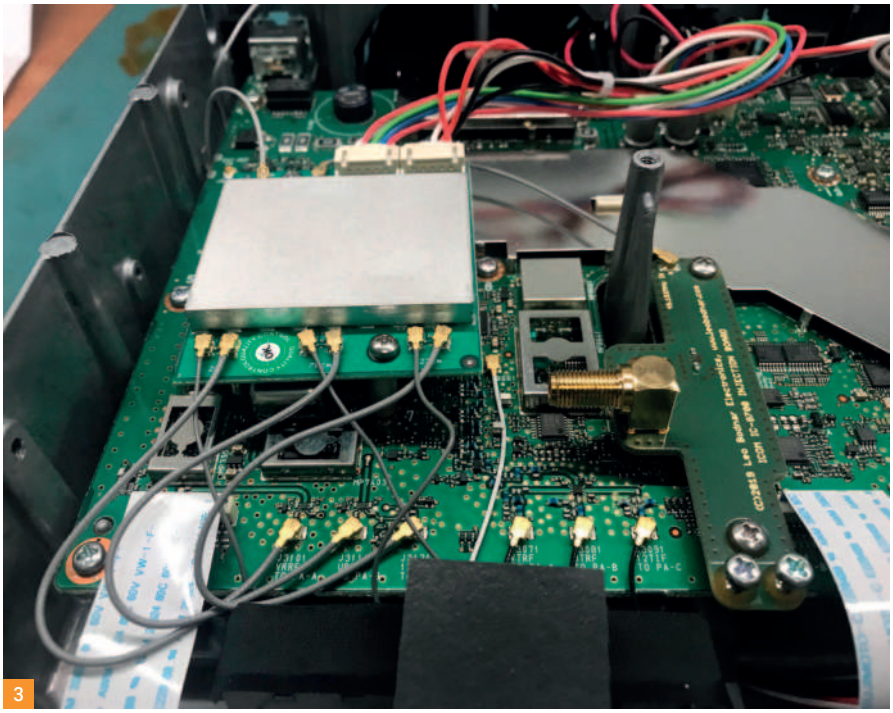
PTRX-9700 in Use

Before purchasing the PTRX-9700 I contacted RadioAnalog to enquire if the bandwidth of the diplexer was wide enough to pass the 49.152MHz reference signal that I use with my Leo Bodnar frequency locking board.

To digress from the review a little. The IC-9700 has an acknowledged frequency stability problem in the basic design. The PCB placement of the original IC-9700 reference 49.152MHz reference clock oscillator makes it susceptible to thermal changes when any of the three power amplifiers are in use. ICOM have released several firmware upgrades to minimise the problem. However, running digital modes such as FT8 or JT65 on 432MHz or 1296MHz, it still shows significant drift during each 'over', such that weak signals may not always decode. Several other parties have suggested solutions, but the one now most often used is the Leo Bodnar injection lock board. This, however, requires an external 49.152MHz reference signal instead of the original 10MHz. This alternative reference signal needs to pass through the diplexer. RadioAnalog assured me that the diplexer passband had been designed with this in mind. Indeed, my own measurements on the supplied diplexer showed it readily passed 49.152MHz with minimal loss. The photo, **Fig. 3**, shows both the PTRX-9700 and the Leo Bodnar ICOM IC-9700 Reference Injection Board installed in my IC-9700. With both boards installed I was keen to see how well the new PTRX-9700 performed and whether it had any negative effects on normal operation.

I use my RSP Pro 2 as a second receiver with the IC-9700 and PTRX-9700. My preferred software is SDR Console by **Simon Brown G4ELI**: www.sdr-radio.com

In operation the SDR must be set to cover all or part of the 144 or 432MHz bands, as required, and for the 23cm band the SDR is set to cover 367MHz to 368MHz, corresponding to 1296MHz to 1297MHz. Any part of the 1240



3

to 1300MHz band can, of course, be covered by setting the SDR to cover the corresponding IF of 311MHz to 371MHz. I found it possible to cover a bit beyond 1300MHz (the band extends to 1325MHz in the UK), although the RF filtering in the IC-9700 tightens quickly above 1320MHz, so sensitivity falls quite quickly with increasing frequency.

I prefer the display spectrum and waterfall display in SDR Console compared to that available using the Win4ICOM software. Resolution is better, together with the ability to measure noise levels with greater accuracy. This is important to me for sun and moon to cold sky measurements for moonbounce (EME).

Overall, the PTRX-9700 is a good solution to the problem of adding a second receiver to the IC-9700, with the bonus of being able to use a bigger spectrum display when using an external SDR. The 430MHz and 1240MHz band insertion gain and noise figure are adequate to ensure no penalty in sensitivity from the second receiver.

The slightly higher noise figure on the 144MHz band may result in slightly poorer sensitivity with the second receiver. If a good external preamplifier is in use, then the sensitivity should not be affected at all, since this will (should?) determine overall receiver sensitivity.

The RadioAnalog PTRX-9700 is available from Martin Lynch and Sons Ltd. at £279.95. I purchased mine in November 2021.

Frequency (MHz)	Insertion gain (dB)	Noise figure (dB)
145	12.3	7.7
435	23	4.2
1296	23.3	3.5

Table 1: Insertion gain and noise figure from IC-9700 antenna input to diplexer IF output with IC-9700 internal preamplifier on.

Band	From	To	3dB bandwidth
144MHz	140MHz	152MHz	12MHz
430MHz	427MHz	452MHz	25MHz
1240MHz	1237MHz	1322MHz	85MHz

Table 2: Approximate 3dB bandwidth available at the IF output, from antenna input, for each of the three bands. The frequency response is not completely flat across each band. There is some ripple and peaking apparent, especially in the 144MHz band.