Central Goldfields Amateur Radio Club - VK3JA

AO40 The Easy Way by VK3CJS

Like me, you may have despaired of receiving AO40 on 2.4 ghz. I love to homebrew, but draw the line at messing with precision printed circuit boards and tiny surface mount components. If this description fits you then NIL DESPERANDUM ! Grab a big magnifying glass, hitch up your trousers and read on.....

To the left is a Conifer terrestrial downcoverter which will cover the AO40 2401 mhz downlink band. This one came in new condition with it's open wire dish from the Eaglehawk (Bendigo) rubbish tip "shop".

The Conifer converts 2401.0 mhz pretty near exactly down to 450.0 mhz, but how to receive SSB on that frequency? Here's how to do it on the cheap.....

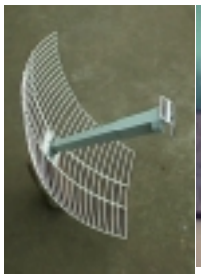
Most scanners will cover 450 mhz. As far as I know most scanners use a first IF of 21.4 mhz, so we can use a scanner as an intermediate converter to bring our 450 mhz signals down to the 15 metre band. The scanner first IF can be tapped with a small (20pf) capacitor and a bit of coax to bring it out to your HF receiver. Handheld scanners are fine too, providing they have coax antenna sockets.

You can verify if your scanner has a first IF of 21.4 mhz by looking inside for the IF filter. It looks like an ordinary crystal but has 3 legs and will be marked 21. The tapping point should be BEFORE the crystal filter so there will be sufficient bandspread for the HF receiver tuning. Look for the IF transformer that feeds the crystal filter and try tapping around there. In my case there was an unused low impedance link on the first IF transformer.... how's that for good luck!

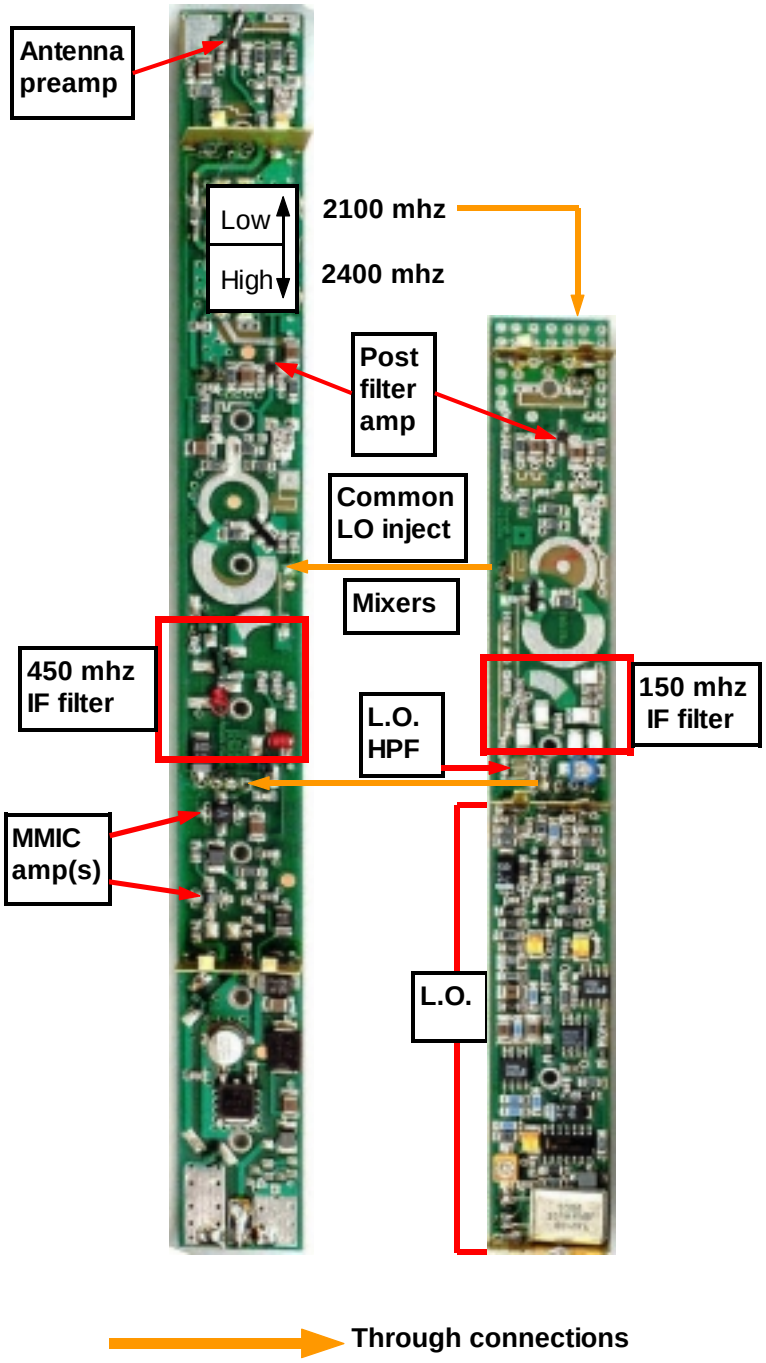
I also disabled the second local oscillator in my scanner by cutting the PC track to one leg of the 20.945 xtal. No point in having unnecessary birdies. Keep it simple!

Now you have a general coverage VHF/UHF SSB receiver to play with. Verify that all is well by dialling in to a beacon or some local activity with the scanner connected to an antenna while tuning around 21.4 with the HF receiver. IMPORTANT.... The scanner LO is ABOVE the desired frequency, so signals will be inverted. Set the HF rx to LSB to resolve USB (the convention on AO40). Also, to tune HIGHER in frequency using the HF receiver, you must tune DOWN from 21.4 .... Hmmmm.... confusing! You'll get used to it.

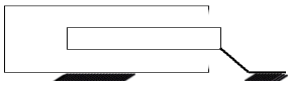
Here is my bare bones AO40 receiving setup. With the scanner readout set to 450.150 the Middle Beacon appears around 21.250 (centre of 15m band) depending on doppler shift, which can be around +/- 30 khz at 2.4 ghz. The dish is roughly pointed at the satellite.... don't worry, you'll hear it.



With a little care and patience it is possible to lift signals another 2 to 3 s-points out of the crud. First a little theorising about the design of the downconverter. The first clues come from the excellent web pages of Kerry, **VK1TKR**. Kerry shows the passband of the Conifer. With his information, I dismantled the beast and studied it under the big magnifier.
It seems to be two converters with a common preamp, L.O. and I.F. preamp. The range 2050 - 2100 mhz is converted to VHF 100 - 150 mhz while the range 2300 - 2400 is converted to UHF 350 - 450 mhz (approximately).



I destroyed the filters on this one, so I have tastefully edited them out. Each filter is a coaxial cavity made by copper plating the outside of a ceramic block. The block has a hole in which is inserted a separate centre conductor. There are 3 cavities in the LOW band and 4 in the HIGH.



A crude 2D drawing of a cavity resonator. If the whole cavity sub-assembly were to be removed, I suppose the cavities might be detached with a heat gun. By grinding them shorter the front end might be narrowbanded around 2.4 ghz.

Watch this space!

From the previous page, you can see that the lower frequency converter is redundant. Suspecting that it may be adding a little unnecessary noise, I severed the link between this converter and the IF preamp. Bingo! Just that little bit better. I cut through the circuit board track. You could just as easily crunch the last coupling cap which sits just to the rear of the mounting screw.

The UHF (IF) filter is made with normal air-wound coils. I spread the coils to bring the IF passband up in frequency and centre it more nearly on 450 mhz. Another s-point!

I adjusted the coils in the shack by rigging up a computer crystal module as a signal source.
Use a 66.667 mhz oscillator and a diode for a multiplier. The diode is the “antenna” too.

Just sit it in front of the Conifer..... the 360th harmonic comes through clear on 2400.0

Next a solid offset feed PAY TV dish was tried. Background noise was noticeably lower as predicted.

Using VK1TKR’s suggestions a helical feed was tried. A 5.25 turn helical was suggested as the best size for the job by G6LVB.

The circular reflector in the picture is a coffee tin lid. The centre stem is a riser tube from a sprinkler system. The standoffs are small cable ties with holes drilled at the correct radius for the coils to pass through.

There is noticeably less QSB when listening with the helical feed compared with the original dipole.

My next experiment will be to alter the local oscillator crystal to bring the IF out on 2 metres to suit my ICOM all mode rig.

The LO works by multiplying the fundamental crystal frequency X 256.

Hence in this case 256 X 7.621 = 1951 mhz.

So our frequency of 2401 - 1951 gives a first IF of 450 mhz.

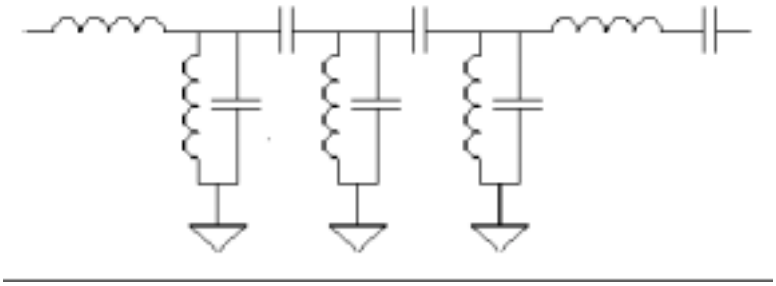
In order to convert to 145 mhz we would need a crystal frequency of 8.8125 mhz.

Providing the lower converter is disabled there should be no image problems. Likewise the IF filter coils can be easily rewound for 2 metres….

…..or the Lowband coils transferred from the Lowband converter board.

…..or the Highband signal diverted to the Lowband converter board.

Conifer IF filter



If you care to follow the circuit on the board, you will see that the coils are scattered all over the place. This is to reduce mutual coupling between them. On the lower frequency board the VHF coils are wound horizontally on surface mount formers. Any PCB pad with a hole in it simply connects through to the ground plane behind.

That's the extent of my thoughts and experiments so far. I may just enjoy listening to AO40 for a while. Please go on ahead…..

Here's a good place to start: http://patft.uspto.gov/netahtml/srchnum.htm
This is the Number server at the US Patent Office.

Patent numbers on the Conifer are: **5,202,699 5,300,941 5,394,115**

…….. and for Pacific Monolithics: **5,015,968 5,280,412 5,317,291**

Please post any discoveries and thoughts to our Club website: http://www.cgfar.com
…….. 73 de Chris VK3CJS ……