4m to 2m receive upconverter

Introduction

In recent times there has been an upsurge of interest in the 70MHz band, not least because it has been opened up to many more countries. Long a 'Cinderella' band available only in the UK and a couple of other places and, importantly, overlooked by most amateur radio transceivers, it is now becoming far more popular and even appearing on the spec sheet of some 'shack-in-a-box' transceivers.

But if you haven't got deep enough pockets to buy a new all-singing, all-dancing rig, what to do? I present one possibility, an inexpensive and easy to build upconverter that lets you receive the 70.0 to 70.5MHz range by tuning your existing 2m setup between 145.0 and 145.5MHz.

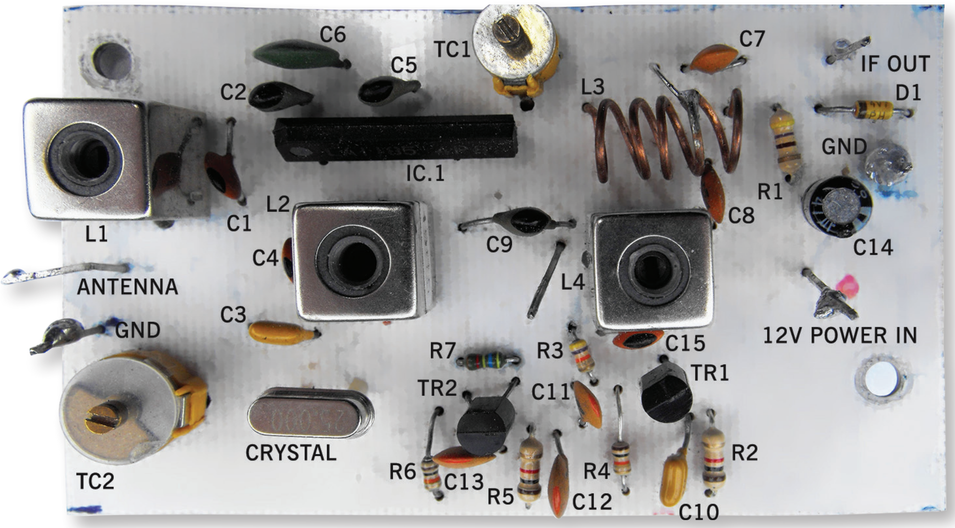

PHOTO 1: General view of the completed 70MHz to 145MHz upconverter, including component legend.

Circuit description

The heart of the device is an FM broadcast 'front end' IC. I used a Sanyo LA1185; the Toshiba TA7385 is a direct equivalent. A snoop on eBay in late June showed these devices were plentiful and about £1 or £2 each. It comes in a 9-pin in-line package (the chamfered end indicates pin 1, see **Figure 1**) and consists of an RF amplifier, double balanced mixer and local oscillator, which has a voltage regulator and buffer amplifier. For FM broadcast radios the local oscillator (LO) is usually a free-running LC type, used to tune the radio, but in this application I use a crystal oscillator.

The usual configuration for this IC is a downconverter from the FM broadcast band to a 10.7MHz IF, but as seen here it also works just as well as an upconverter, given suitable components. The data sheet doesn't specify a frequency range but hints that the IC is usable in the 76-108MHz Japanese FM broadcast band so it's not unreasonable to ask it to work on the slightly lower frequency 70MHz amateur band.

The circuit diagram of the converter is shown in **Figure 2**. RF from the antenna is coupled via L1, whose secondary resonates with C1 around 70MHz to provide selectivity. The tap on L1 feeds via C2 to the IC RF amplifier input, pin 1. The amplifier output is via pin 3 into the tank circuit L2-C4 and coupled to the mixer input, pin 4, via C5. Inside the chip the LO signal is buffered and fed to the double balanced mixer.

Moving to the right side of the circuit, TR2 and the 25MHz crystal form the local oscillator frequency source, which is tripled by TR2 and the tank circuit formed by L4 and C15. The secondary of L4 couples to pin 8 of IC1, used here as the local oscillator input.

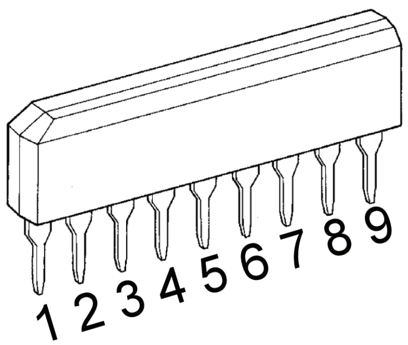

FIGURE 1: Pin identification, SIP package.

The output of the mixer (input frequency ±LO) appears on pin 6. L3 and TC1 select the 145MHz component (the other component will be about 4.5MHz) and the output signal is tapped off and fed to the 2m radio via C7. I spent a lot of time obtaining and testing 25MHz and 75MHz crystal oscillator modules but none were sufficiently accurate or thermally stable.

The converter runs from the normal shack 12V nominal supply via reverse polarity protection diode D2. The LO and tripler run straight from this supply but IC1 requires a lower voltage, which is provided by R1 and 4.7V Zener D1. C3, C8 and C14 provide decoupling.

Construction notes

I built my prototype on a PCB of 85 x 50mm that I drafted by hand, seen above in **Photo 1**. **Figure 3** provides some guidance on the foil pattern I used but please note it is not reproduced here to scale. You can use any convenient VHF-grade construction technique including dead-bug. I do not recommend trying stripboard, but you may be lucky and get away with it.

I housed the completed unit in a diecast box with suitable sockets for input, output and power; the enclosure is not critical.

L1, L2 and L4 are Spectrum UH6 10mm canned coils, with 6p8 parallel capacitors to resonate around 70MHz. The G-QRP club has these on sale for members of that useful organisation, and of course they should also be available from Spectrum. The 2m IF output coil L3 is 5 turns of 1mm copper wire spaced over 14mm length, with a tap at 1.25 turns to feed the 145MHz IF output signal via C7.

Tr1 and 2 are general purpose RF transistors: I used BF495 simply because I had them to hand but BF241 or similar should work perfectly well. BFxxx RF types usually have their emitter on the middle pin, while BCxxx audio types usually have their base on this pin.

Alignment

Check to see that the 25MHz oscillator is running, using a general coverage receiver. Adjust TC2 to set the frequency exactly on 25MHz. This will ensure the upconverter

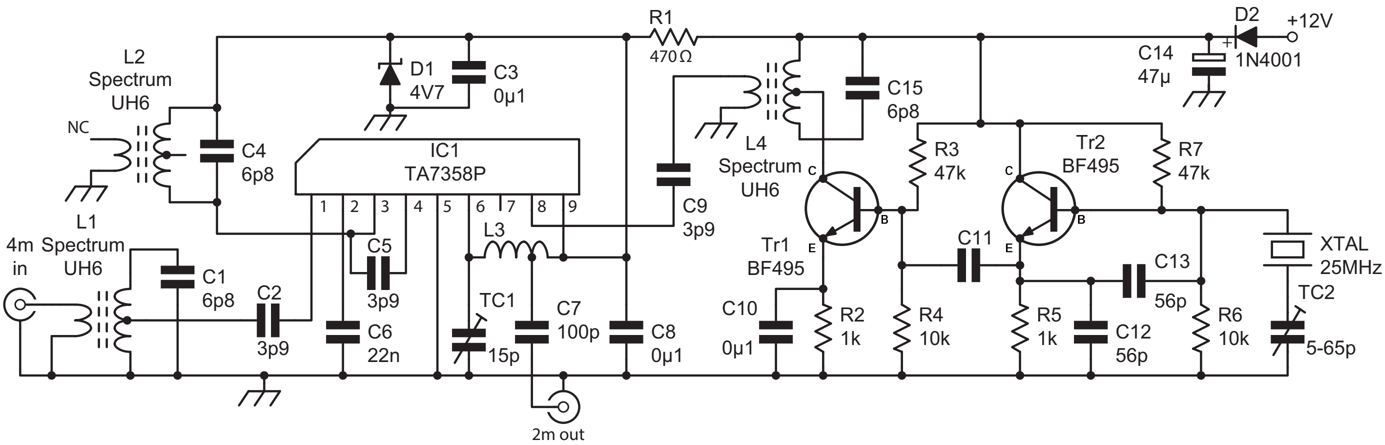

FIGURE 2: Circuit diagram of the upconverter. IC1 can be TA7385 or LA1185; Tr1 and Tr2 can be almost any small-signal NPN RF device.

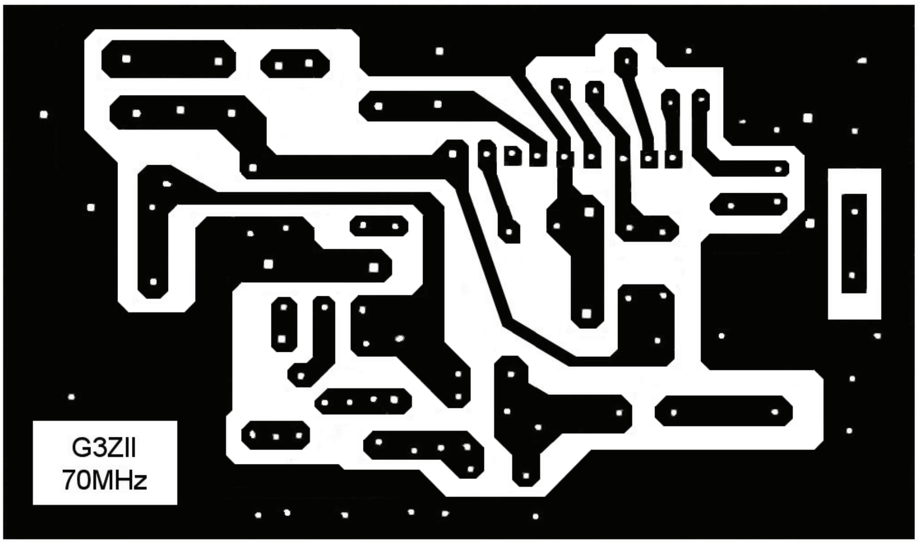

FIGURE 3: PCB foil pattern (not to scale; actual board is 85 x 50mm).

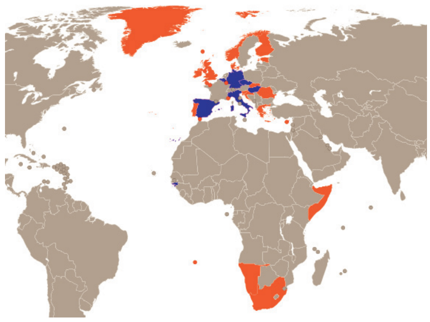

FIGURE 4: Countries with permanent 4m allocations (red) and experimental allocations (blue). Source: Wikipedia.

output accurately converts 70.0-70.5MHz to 145.0-145.5MHz. Due to the tripler, every 1kHz error on the 25MHz source translates to 3kHz error on the upconverted signal so it pays to get the frequency just right. The tripling of any error is one reason I spent so much time tryinbg different sources, as mentioned earlier.

In order that the tripler can work correctly, L4 needs to be peaked for the 75MHz third harmonic of the 25MHz drive. A diode probe and meter on pin 9 of IC1 will let you monitor the magnitude of the signal; adjust for maximum. A spectrum analyser, if available (or even a cheap SDR dongle) will let you check you are tuning up on the third harmonic and also provide a visual means to detect the point of 'maximum smoke'. Another alternative is to probe this point with a frequency meter to check you're getting 75MHz, which also provides a useful check that the crystal is oscillating spot on frequency. But I stress it doesn't matter if you don't have acess to such exotic test gear.

Connect a 2m receiver to the converter output and adjust TC1 for greatest noise from the speaker in AM, SSB or CW mode. Next, connect a suitable antenna to the converter input. You should hear a marked increase in noise when the antenna is attached. If you have a local beacon or other off-air signal (eg a low power 4m transmission from a local amateur) then you can adjust L1 and L2 for best reception. You can also re-peak TC1 for best signal quality. I happen to have a 11.710MHz crystal from an old Pye Westminster and the 6th harmonic from this, at 70.26MHz, provided a very useful mid-band weak signal source to tune up on.

Once the converter is set up for the first time, no further adjustments should be necessary during its operating life.

In use

You should be able to receive local 4m signals without difficulty, with DX coming in from time to time as conditions allow. I find that the converter gives about the same performance as my other 70MHz equipments that transvert down to 28MHz. When I plug a 50Ω dummy load into the aerial socket I get the expected slight increase in noise but this is completely masked by external noise when the antenna is connected. As elsewhere the 'air pollution' round here is getting worse and even affecting the VHF bands.

Conclusion

Perhaps this project may encourage more 4m activity. If enough interest is shown I may be able to make a packet of components available, including the IC and crystal, but exclusing the boxand PCB. Email me for info.

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