# Getting Ready for Phase 4 – Part 2
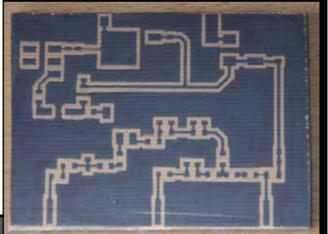
## A UHF–VHF Receive Converter for use with a satellite LNB

*In Oscar News 211 we looked at how a modern commercial Satellite TV LNB can be used to receive signals from the 250kHz narrow band transponder on Es'hailSat-2 (1). An LNB converts the X-band signal from 10.489 GHz, down to an intermediate UHF frequency of 739 MHz. This can be received directly using a FUNcube dongle with a PC, laptop or tablet running suitable SDR software.*

While the PLL technology used in the current generation of LNBs produces low phase noise, it was demonstrated that the frequency drift with temperature change, could be improved by replacing the 27MHz reference crystal with a temperature compensated crystal oscillator (TCXO).

Personally, I'm really looking forward to seeing the transponder passband on a big screen and being able to click on new stations appearing as they start to call CQ. – So much easier than sweeping a VFO from one end to the other trying to find a weak DX station.

There will however also be occasions when using a computer is impractical. – Bright sunlight, poor audio from speakers or simply having too much equipment to make portable operation simple and easy. Under these conditions using a LNB with a conventional radio has several advantages including being able to use a transceiver for generating the uplink on S-band.

Presented in fig.1 is the circuit of a UHF to VHF converter for use with P4A. It includes a bias tee to feed DC power to the LNB, and a mixer that converts the 739MHz signal from the LNB down to the 2m band.
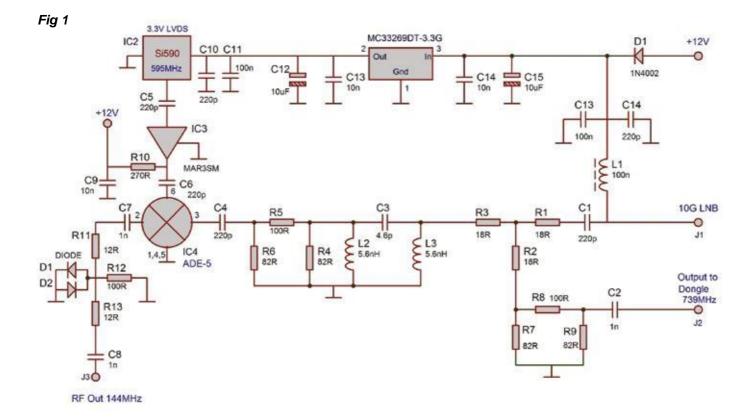
# Circuit description.

A supply of 12 – 13.8V is applied to the DC input, where a series diode D1 protects from reverse polarity. The supply passes through inductor L1 to connector J1 where it travels along the coax to power the LNB. The RF output at 739MHz from the LNB passes along the same coax in the opposite direction arriving at connector J1. L1 acts as an RF choke and the signal is AC coupled through C1 to 50 ohm power divider, R1 R2 and R3. The power divider attenuates each output by 6dB. The output at the lower end of R2 is applied to resistive attenuator R7 R8 and R9. This adds another 12dB of attenuation to the signal which is AC coupled to J2. Although 18dB of loss seems a lot, a typical LNB will have 30 – 50dB of conversion gain and so some attenuation is needed. The UHF output from J2 can be used to drive a FUNcube dongle or other software defined radio in combination with a PC, laptop or tablet. The other output from the power divider appears at the left hand end of R3. It passes through high pass filter L2 C3 and L3. These components have a cut-off frequency of 700MHz and provide about 14dB of attenuation at the image frequency of 450MHz.
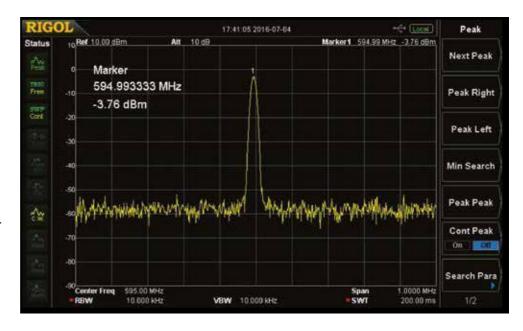
While 14dB is not much, the LNB has its own internal filtering which also reduces the signals below 750 MHz. In combination there is enough image rejection to prevent noise degrading the wanted signal at 2m.

The HPF is followed by another 50 ohm attenuator. This reduces the level of the signal so that it does not overload the mixer or the 2m receiver, it also provides a nice match into the RF port of the ADE-5 which is a Mini-Circuits double balanced diode ring mixer.

The local oscillator, IC2, is a custom made part (2) available from Digikey and deserves an explanation as it is the modern alternative to the crystal and multiplier chain. The Silicon Labs Si590 is a 6 pin 7 x 5mm module which has an internal oscillator in the 4GHz range. It also contains DSP electronics to divide the signal down to 595.000MHz. AMSAT-UK is using the CMOS and LVPECL versions in the ESEO satellite payload, so this family of devices has seen a lot of use and testing over the past 2 years.

**Fig 1**

As part of the programming service, Digikey take a blank generic Si590 which has the required frequency and thermal specification, in this case 20ppm frequency and 7ppm thermal stability. Then they program the part to your specification. This defines the output stage to either LVPECL or LVDS logic, both of which have differential outputs. You also need to define the frequency, the supply voltage from 3.3, 2.5 or 1.8V and if you want the output enable pin active high or low. In a test of thermal stability I cooled the device from 30 degrees to -10 degrees. The part was seen to be 6.7kHz low at 30 degrees and on cooling by 40 degrees moved to 1kHz above the specified frequency.

My original intention was to use the differential outputs from a Si590 with a mixer that had an isolated winding for the local oscillator. Unfortunately the Tech-Support team at Minicircuits Europe didn't spot the local oscillator input of the ADE-5 isn't isolated but has one end earthed along with other internal connections. After making them aware of the error they stopped responding to e-mail.
I suppose the rule is; if you don't have a really large order, don't expect much tech-support. – a bit disappointing really.

Anyway, this Si590 requires 3.3V at 80mA from regulator IC1. Only one of the 2 differential outputs is used, generating -3dBm into a single ended 50 ohm load. The signal is amplified by IC3, a MAR3SM which has 10dB gain.
The +7dBm output is AC coupled to the local oscillator input of the mixer. The 144 MHz output is taken from the IF port and passed to connector J3 via a small attenuator which assists in matching the IF port. Finally an optional pair of PIN diodes limit the amplitude of the output

preventing damage to the external receiver. They also offer some token protection from accidental transmissions into the mixer but will not protect from outputs greater than a few Watts.

When in orbit the narrowband transponder on Es'hailSat-2 will be converted down to 144.550 to 144.800 MHz. A homemade PCB was produced and is 57 x 40mm. J1 to J3 are PCB edge mounted SMA sockets. These are also used to secure the board into an 80 x 55 x 25mm Hammond 1550P diecast enclosure.

## References.

1   Getting ready for Phase 4. - D Bowman
    G0MRF Oscar News 211 p.16
2   Si590BD595M000DG
    http://www.digikey.co.uk/product-detail/
    en/silicon-labs/590BD-DDG/590BD-DDG-
    ND/3878878