QO-100 Transceiver – Tjerk ZS1J

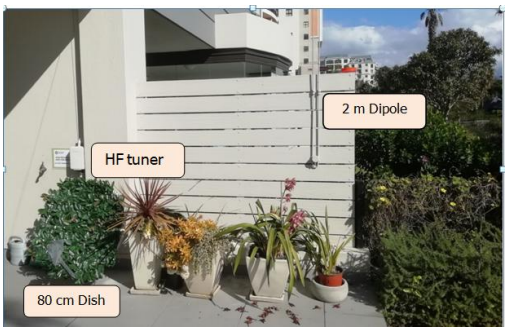
Introduction

I relocated to Cape Town two and a half years ago with little hope of installing anything else at the retirement resort than a long wire antenna and a 2 m folded dipole that would escape the scrutiny of the body corporate police.
Soon after my arrival I became the test pilot of the Cape Town Amateur Radio Centre's new MorningStar remote station and wrote the operating manual for use by the club members. Early this year MorningStar's sponsor Fred Ziss ZS1FZ added QO-100 capabilities to the station and I was once more tasked to unravel the intricacies and produce an operating guide.
Many club members have subscribed to use the station and one always has to bear in mind in that that there are others that would also like to use the station; thus unlike having your own equipment.
During that time Charlie DK3ZL arrived on the scene operating portable in South Africa (ZS95QO), Namibia and Botswana. Not only did I have contacts with Charlie on QO-100 but also chats on WhatsApp where he shared his knowledge, accompanied with photos, of the various components that made up his portable station. Charlie was the catalyst that spurned me to construct my own station and I started to research on the Internet the various components and ideas that I had gleaned from the seasoned satellite operators that I had met using MorningStar. No longer having the facilities that I had in Pretoria, I looked at ready- made modules.
I had ordered and paid for the components in March but only received them in late June due to the Lockdown.

Objective

To construct an all in one, small footprint and neat looking transceiver that could also be used as a portable station.
The various components used should have high stability and be so mounted to dissipate heat and thus minimize drift.

Dish



I seriously considered going with a small 30 cm camping dish as Wolfgang HB9RYZ had successfully proven. Pictures can be found at https://forum.amsat-dl.org/index.php?thread/2896-potable-qo-100-sat-kit-with-30cm-dish/
I finally decide to go with a full size 80 cm DSTV dish which I mounted at floor level on the terrace of my garden apartment. I had correctly reasoned that anything that does not heat up in a microwave would not affect the signal and covered the dish with artificial plastic hedge to make it less obvious.

LNB

The LNBs are commercial TV ones with a patch or helical antenna added to function as receive and transmit antennae. The POTY (Patch of the Year), that has a lower profile than a helix, was my choice.
The LNB not only requires a voltage supply for its electronics but also to select horizontal or vertical polarization and this is done with a Bias-T DC Injector that injects the voltage into the coax going to the LNB.

I purchased a dual port (H&V) LNB/POTY assembly, modified with a more precise 0.5ppm temperature stabilized XO to control drift, and a Bias-T from Joerg DJ4ZZ http://www.jdelektronik.de/dual-patch-antennen.html



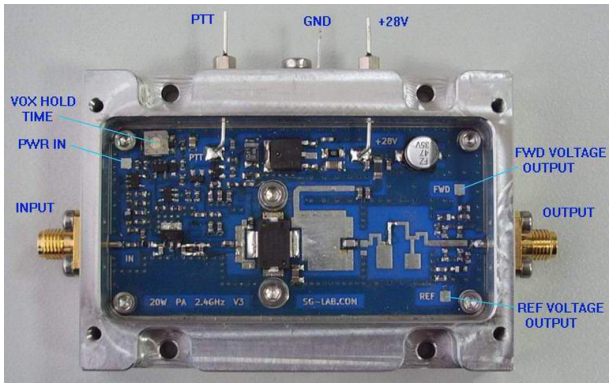
POTY


Dual port LNB with POTY

Bias-T to power the LNB

Transceiver
I was not prepared to invest in a multi-mode transceiver that might also require an up-converter to get to 2,3 GHz and thus opted for the less costly SDR. The Pluto SDR, multi -mode, covering a wide frequency range and the size of a deck of cards with a miniscule 10 mW output at 2,3 GHz, that would not be an obstacle as you will see later on, was the obvious choice.
The Pluto, as it comes out of the box with its original 100 ppm oscillator, is not ideal and has to be modified with a more stable one, such as an ASVTX-13-C-40.000-I05-T (40 MHz, 1.8v, 0.5ppm). You could do it yourself but it is rather difficult to de-solder the XO and solder in the new one, when they are tiny SMD devices. Joerg DJ4ZZ, supplies a modified Pluto with a 0,5 ppm oscillator.
The advantage of purchasing from one source to cut down on the courier cost became even better when Emil ZS6EGB (now ZS1XB) joined in and we became wholesale customers!

Amplifier
With the Pluto only delivering 10 mW, a preamp would be required but SG Labs had just launched their 20 w output V3 2,3 GHz amplifier that has a built in preamp. The RF output level of the PLUTO is about -15 dBm at 2,4 GHz and the total small signal gain is 30 dB (x1000), 10 W output power is achieved with 10 mW drive, 30-40 mW - for full output power.



20W output power at 2,4 GHz
High speed RF VOX is always switched ON. Hold time can be tuned in range 0 - 3 sec by on-board trimmer.
Preamplifier included
30 dB (x1000) power gain
PTT if required is switched ON by connecting PTT pin to ground.
50 V max, 1.2 A max.

Enclosure and heatsink
I opted for a smart black Hammond 220x160x52 mm extruded aluminium enclosure and a 150x75x27 mm heatsink from RS Components.
Enclosure # 773-3022 https://docs.rs-online.com/a681/0900766b8131397b.pdf
Heat sink # 189-8454 https://docs.rs-online.com/6063/0900766b813eb961.pdf

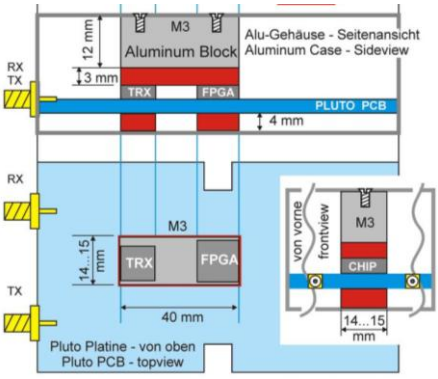
Power supplies

The supply in the shack is 13,8 V and as the amplifier requires 24 V, I installed a Mean Well 12 to 24 V converter.
They have two models available and I went for the smaller, but also more expensive, embedded one.
Mean Well RSD-60G-24 Vi 9-36 V, Vo 24 V @2,5 A and measuring 128x60x25 mm.

12 V to 5 V Communica DC/DC converter Buck 8-20 V to 5 V, 15 W

Assembly

The 24 V convertor was mounted against the enclosure and the amplifier against the heatsink both with Silicon paste. The heatsink/amplifier assembly was then "floated" 3 mm above an opening that I had made in the top rear of the enclosure to prevent the PA and its heatsink from heating up the transceiver. Holes drilled in the lower front of the enclosure duct the air through the transceiver out through the opening underneath the heat sink. The Bias-T was mounted against the rear with its F connector.



I mounted the bare-bones Pluto to the enclosure with M3 x10 mm stand offs. Between the Pluto and the enclosure is a 16x40x7,5 mm Al block, that was secured with two M3x10 mm screws, and a soft 2,5 mm thick heat pad from RS Components # 446-497 100x100x2,5 mm 3 W/m K to conduct the heat. (no temp change ... no drift!)

The Pluto heat sinking idea came from Sigi DJ9BFC who mounted his Pluto in a separate Al enclosure, thus I did not use the lower heat pad.

RF cabling

RS Components provided the crimp on N-type bulkhead connector and the RG-174 F-type crimp connector.
The RG-174 coax, SMA crimp on connectors and the N-type female to SMA female adapter came from RF Design.



RS Components 916-2772 RF Components 793-3588 RF Design 14-105B

The coax and the F connecters that came with the dish were used to connect the transceiver to the LNB.
A 5,5 m LMR-400 cable, terminated with a male and a female N connector was joined with the N-type female to SMA female adapter to the coax cable that came with the Pluto in turn connected to the POTY.

Software
SDR Console by Simon G4 ELI was the obvious choice as it supports the Pluto.
SDRConsole home page https://www.sdr-radio.com/console