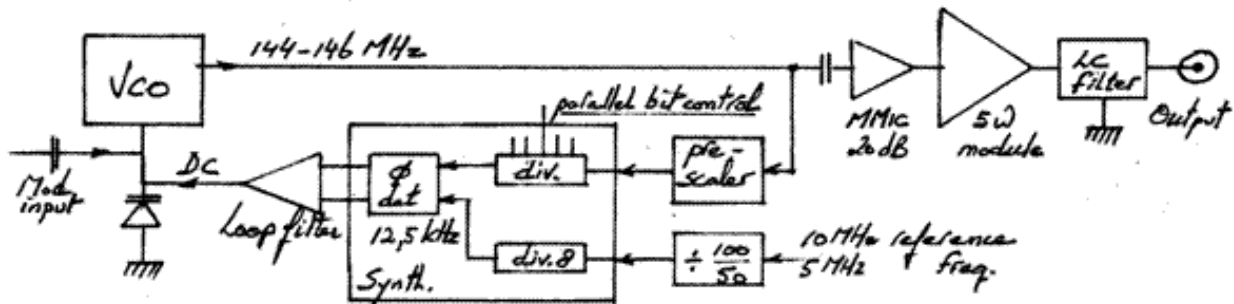


# An accurate on-air frequency standard

ZS6KR

Today it is possible to use the atomic standard accurate 1pps available from a GPS receiver to discipline oscillators as high as 10MHz and maintain extreme timing/frequency accuracy. Various manufacturers offer either kits or ready-made units that do the job and find applications such as replacing standard references in counters and other instruments in laboratories and calibration centres. Having obtained such a unit courtesy of Nico ZR6VT, the author wanted to apply it for the benefit of radio amateurs by applying it to create an accurate carrier frequency in the 2m band and continue the service of the late Hofie ZS6CC who also had a similar set-up for several years.

The design philosophy was to have no mixers like in ham radios, but to have a PLL controlled VCO running directly in the 2m band. A simplified diagram is shown below. The objective was also to cover the entire 2m band in 12,5kHz steps and output at least 5W.

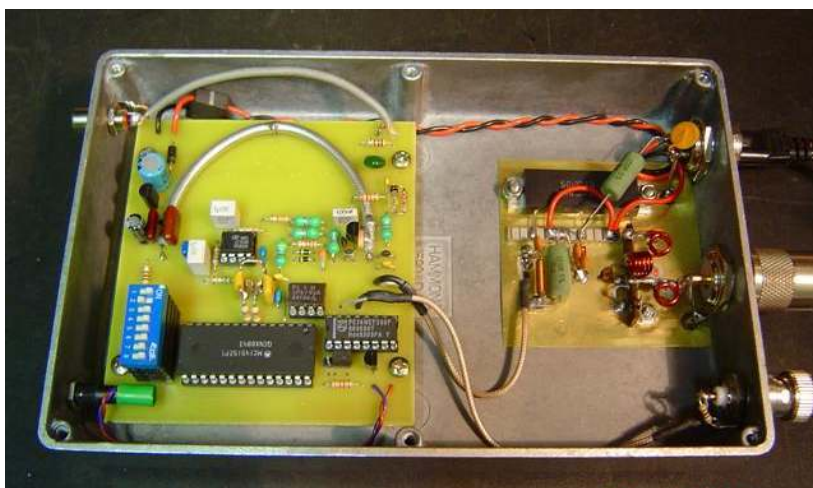


The VCO design was cribbed from a Plessey publication and uses a piece of UT-141 transmission line as an inductor. The transistor is the well-known J310 FET in common-gate configuration and the source the output. This then feeds a prescaler which in turn feeds a Motorola MC145152 synthesizer IC, (thanks Vince ZS6BTY) which offers parallel control of the internal dividers. These bits can be set with a DIP switch such that 2 bits control 500kHz segments upward from 144,000 MHz and the remaining 6 bits control 40x12,5kHz=500kHz in each. This means the internal phase detector runs on 12,5kHz from this divider and 12,5kHz from the reference. The latter comes from the GPS disciplined 10MHz (or 5MHz) source. The detector has an up and down output smoothed by an op-amp integrator which provides DC control of the VCO varicap.

This filter is a very important component in the loop and needs careful design taking into account VCO sensitivity, damping factor, capture time, lock-in range and suppression of 12,5kHz components whilst keeping enough modulation bandwidth available.

The signal amplification chain comprises an ERA-5 Mini-Circuits MMIC and an ICOM ICH-16 hand-held SC-1046 "Brick" capable of 7W output. Last but not least, a harmonic filter precedes the output socket. This was designed with "Elsie" software that came with my ARRL Handbook.

Herewith are pictures of my prototype/final version as very little tweaking was required. The VCO is on the top half of the PCB on the left with the transmission line bent into a semi-circle. DC is fed into the left end and the FET is at the right end. The lower 3 IC's and the DIP switch comprise the complete synthesizer. On the RHS is the amplifier chain and LC output circuit built on a piece of hobby-brass foil as ground plane.



### What can we do with it?

Well, if you ask me to switch it on, I guess it firstly favours anyone with a comms-analyzer or VFO receiver to calibrate it on-air for frequency accuracy. Secondly, counters can be checked at VHF frequency if brought near enough. If modulated with an accurate 1KHz derived from the same standard, you can create your own 10MHz standard in the shack with a simple PLL.

Further thoughts will be appreciated!