A 10 MHz Reference Oscillator

I was looking for a stable accurate 10 MHz reference source to check some of the frequency counters I have here. None of the counters I have are equipped with good reference oscillators and can result in frequency display inaccuracies. Most inexpensive frequency counters are like this. They may be able to count to very high frequencies but the internal reference source is typically not all that good. The count accuracy appears worse as the frequency goes up. If a counter has an accuracy of +/- 5 PPM and you are measuring audio frequencies this spec won't matter much but at 500 MHz it likely will.

A Hewlett Packard crystal controlled reference oscillator became available at a very reasonable price. They are sometimes available on E-Bay. It came out of an HP 8660C signal generator and has very good specs. It uses a temperature controlled proportional oven to keep the crystal at a constant temperature. I suspect similar reference oscillators may have been used in other HP equipment as well.

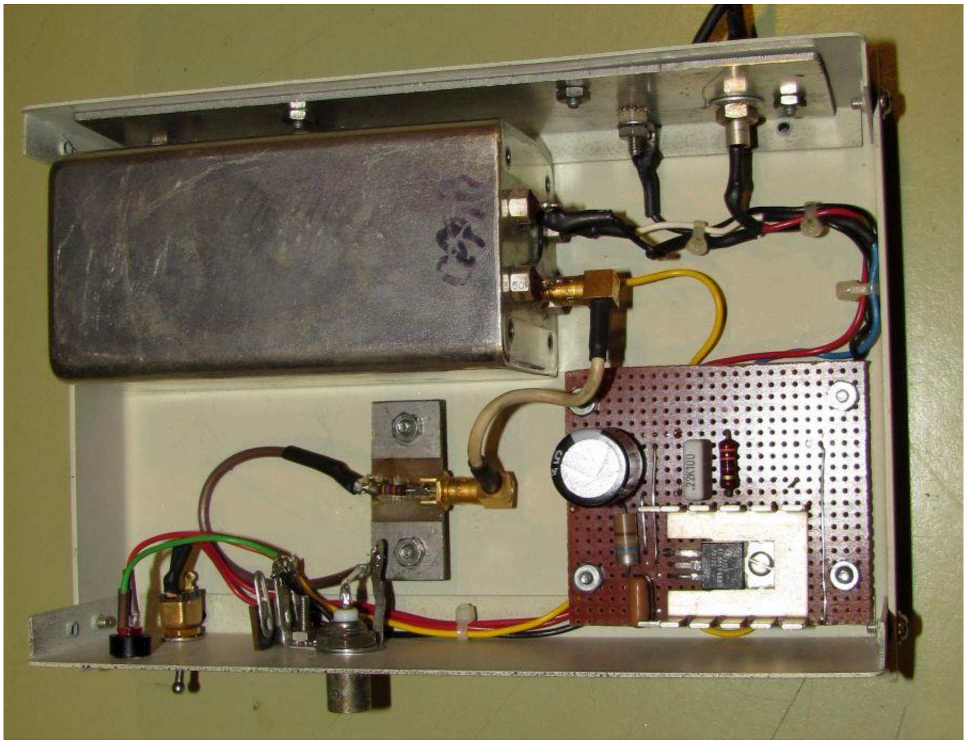
It did not come with a power supply or a suitable enclosure. It requires two voltages, 30 Volts for the oven and 15 Volts for the oscillator. After thinking about different power supply options I had, I ended up using a 25 VDC 2 Ampere wall wart that I think was used as a battery charger for a cordless drill. It is used to power both the oven and the oscillator. I used an old RS232 A/B switch enclosure that turned out to be a good size for this project. I also took advantage of the existing holes on the front.

On a piece of perf board I installed a 7812 regulator with a small heat sink and required support components. I also installed a 1000 µF capacitor on the perf board where the power came in from the wall wart via an OFF/ON switch. This brought the voltage up to about 30 Volts as measured on a DMM. I assume there is no filter capacitor in the wall wart. This unregulated voltage drives the oven and the regulator. Instead of supplying 15 Volts for the oscillator I supplied it with regulated 12 Volts from the 7812 regulator.

I have no schematic for the oscillator/oven. A schematic for the rest of the HP 8660C is available on the Internet. It looked like the oscillator/oven was designed to feed about 150 Ω load. I planned to use it to drive high impedance loads. For a precaution I added a 470 Ω resistor before the output connector just in case the output got shorted.

Calibration of the oscillator is tricky as I only have 10 MHz WWV as a source. The problem is QSB (fading) with WWV. The idea is to combine both the oscillator frequency and WWV through a coupler so the oscillator could be adjusted to be either in or out of phase with WWV. When they are in phase the signals add (higher S meter reading) and subtract when they are out of phase. QSB from WWV is an issue and you want the signal to be as stable as possible strength wise. Below is the calibration set-up. I use an old Drake receiver for WWV as I like the analogue S meter. I use the HP 400EL meter shown below because it has an AC output on the back and I can adjust the level to the coupler from the oscillator using the attenuator switch on the front of the 400EL. I also use a 50 Ω step attenuator (not shown) between the antenna and the coupler. You want to get both the WWV signal and the oscillator at about the same level going into the receiver. The strongest signal and least QSB from WWV for this location and time of year seems to be a few hours before sunset.

So far the stability of the oscillator seems pretty good. I calibrated it after a 2 day warm up and again about 10 days later. From what I can tell it moved a little but not very much, only a fraction of a Hertz at 10 MHz. I plan on doing long term stability tests on the oscillator.



December 5, 2016

UPDATE December 18, 2016

The frequency accuracy was checked against WWV almost daily for about 3 weeks after the last calibration. It was impossible to notice any frequency difference between 10 MHz WWV and the reference oscillator. The oscillator was then turned off for a day and then turned back on. After a 6 hour warm up the frequency was checked again. It looked like it would go in and out of phase with WWV once every 6 or 7 seconds. The oscillator was left on and checked the next day and the day after. The oscillator appeared to stabilize by going in and out of phase every 6 or 7 seconds.

Home Page www.ve6kq.com