

By Jan Skirrow

Using the HP Z3801A as a Lab Frequency Standard

The Hewlett Packard Z-3801A, shown below, is a GPS-based frequency standard that tracks Global Positioning System satellites to obtain precise timing information. These data are used to stabilize an internal ovenized precision crystal oscillator. Should the GPS signal be lost, the Z3801A switches to holdover mode that allows it to maintain synchronization for up to 24 hours,



with loss of accuracy. Accuracy is roughly equivalent to rubidium lamp-based systems.

The Z3801A was built as an OEM module for use in cellular telephone systems. The modules have appeared on the surplus market recently in substantial numbers at modest prices, and can be easily adapted to meet amateur radio or small laboratory needs.

In my case I wanted to have an accurate frequency standard that could be used to provide a reference frequency to a variety of frequency counters, signal generators, and radios operating at HF and microwave frequencies.

There is little in this article that is original. But having dragged together various bits of information, I thought it might be useful to have it and my conclusions all in one place. The most generally useful information I found was on Bill Jones, K8CU's great webpage (see the **Sources** section at the end of this article).

Basic Adaptation

The Z3801A was made with two different power supply voltage options, 24VDC and 48VDC. As supplied, my Z3801A was configured for the higher voltage, which seems to be the case for most of the units on the market. The module also has provision for computer monitoring and control using an RS-422 serial control port.

Power Supply

The power supply issue is most easily solved using a simple unregulated power supply using a transformer, diode bridge and electrolytic filter capacitor. Another popular solution is to use a commercial switching supply.

The manufacturers specifications state that the supply should provide between 37VDC and 60VDC at about 25 watts. However, the specs require at least 46VDC for the GPS receiver to start reliably. According to information on the internet, some Z3801As are sensitive to supply voltage and perform more reliably if the input voltage is around 54VDC. Also, some users have found problems with using current limited power supplies due to the current requirements associated with the switching oven circuits.

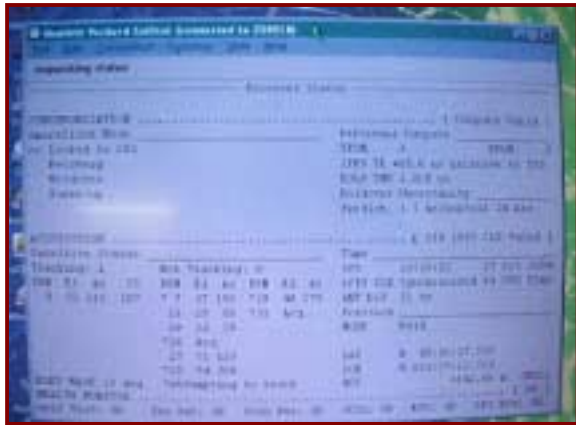
Users should pay very careful attention to the polarity of the supply voltage. The low voltage version of the Z3801A is intended to work in applications using a nominal 24VDC, negative ground system. The higher voltage version is designed to work with telephone equipment using a nominal 48VDC supply, positive ground. The Z3801A itself uses a three pin connector with both plus and minus power

connections floating, plus a separate grounding stud for proper system grounding.

I decided to use a commercial switching power supply that provided adequate voltage adjustability should my Z3801A require it. I chose a Jameco unit #201953CA. This power supply is rated at nominal 48VDC, 1.35A. The voltage is adjustable plus or minus 10%. As it turned out, my GPS receiver - which runs continuously - is fine with 48VDC.

The Serial Port

I wanted to be able to monitor the Z3801A's operation. The GPS receiver has front panel tell-tales that indicate power and lock or holdover mode. There are also other LEDs that under software control. However, the timing, position, tracking and other information is only available through the serial port. My Z3801A came with PC software that provides access to some of this data, and provides for user control of the GPS receiver's functions. The picture below shows the main data screen. A graphic clock output is also selectable. A web search will identify a variety of such software.



The Z3801A uses an RS-422 serial port whereas most home computers use an RS-232 serial port. This problem can be solved either by modifying the Z3801A, or by building (or buying) an adapter.

There is information on the web providing detailed instructions on modifying the Z3801A to an RS-232 port. The unit was designed to provide either, and all that is required to switch is to change some internal jumpers. However, this change requires some tricky

disassembly! That, combined with a strong bias on my part to leave equipment unmodified, suggested the adapter approach.

My adapter was constructed from a design provided by Bill Jones, K8CU. The circuit can be found on his website. Other approaches are possible. The one I chose uses a MAX232 chip to provide translation of the RS232 signal levels to RS422, and a



75179BN chip to provide the RS422 to RS232 level changes. The unit was built inside an old RS232 Null Modem adapter that had the right DB25 connectors. I had several of these in my junk box, and similar devices are common in computer and electronic junk stores. The adapter is shown above. It

could also be built into the DB25 connector on your serial cable if you have one with a big enough shell.

My adapter requires 5VDC, and can be powered from the Z3801A using one of the unused pins on the GPS receiver's serial port connector. This pin is then connected to the Z3801A's 5VDC supply through a 10 ohm protective resistor.

However, I decided to avoid any mods to the Z3801A, and had 5VDC available on the distribution module outlined in the next section. Of course, it would be possible to power the adapter from the 48VDC supply using a suitable regulator. However, in my setup the Z3801A is fairly remote from the distribution module, so I preferred to power the adapter and the distribution module separately from the receiver.

The Distribution Problem

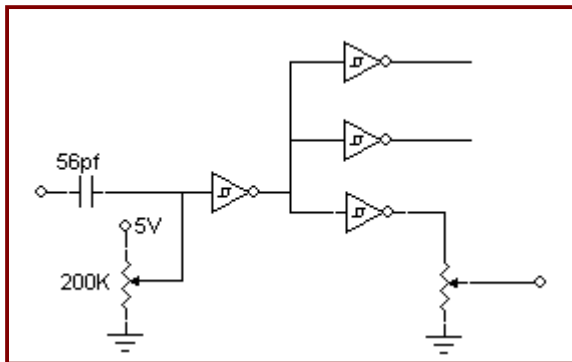
The equipment I wanted to use with the Z3801A usually has provision for an external

10MHz reference signal. A couple of older units require 5MHz. All of these required signal levels more or less like the standard output of the Z3801A.

A search of the web provided a variety of approaches to a distribution system. The simplest used a passive signal splitter of the sort used to distribute TV signals to multiple receivers. I decided this wasn't practical given the number of units I wanted to drive simultaneously. A better solution where high fan-out was needed typically used a high frequency amplifier chip with high output drive capability, such as the MAX477. There is an excellent design on the Bill Jones, K8CU, website. These 50 ohm modules can be daisy-chained to provide any number of separate outputs.

However, a colleague, Greg Bailey - K6QPV, suggested a much simpler approach using a 74HC14 Schmitt trigger. By cascading the appropriate number of chips, a large fanout was easily achieved.

The schematic is shown below. Component values aren't critical. The trimmer on the first Schmitt trigger is adjusted to provide about 2.5VDC on the trigger input. This makes the

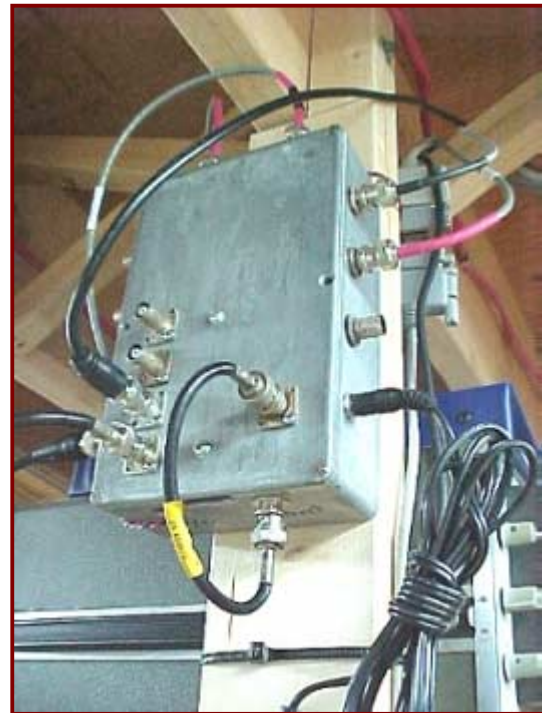


Schmitt trigger change state at the optimal point, and should give the most symmetrical output waveform. Each of the other triggers has a trimmer on the output to allow adjusting the signal level as needed. In practice I'm not sure these are needed, as the various pieces of equipment seem satisfied with the direct output. If they are omitted though, unused outputs should be terminated with, say, a 1K resistor. Some of interconnecting cables I use are 20 feet long, and even though the waveshape at the far end is hardly a pretty sight, it works

fine. Subject to the fanout limits of the chip's technology, additional outputs can be constructed as needed.

The circuit was constructed, dead bug style, on a piece of copper clad board. To reduce ringing and maintain a reasonable output waveform it is important to shield input and output cables, and generally to keep all leads as short as possible. Also, bypass the chip power connection right at the chip.

For the 5MHz requirement, I used a 74HC74 dual flip flop as a simple divider. The input



10MHz signal drove both flip flops with the output of each providing a separate 5MHz signal. As I only needed two outputs at this frequency, a single chip was adequate. I built a second unit, however, to provide for future needs.

The distribution box is shown in the picture above. The connectors around the sides are 10MHz outputs, and those on the top are 5MHz. I have used one of the 10MHz outputs to drive the 5MHz divider. No good reason - it just worked out that way!

The distribution box circuits and the RS232-RS422 adapter are powered by a 5V wall wart connected through the power connector on the lower right hand side of the module.

Future Possibilities

I would also like to use the Z3801A to drive some R-1051 military radios I have in the lab. These radios have a high precision, ovenized internal oscillator that was intended to run 7/24/365. However, I'm not keen to have these ageing radios on continuously, even in the Standby mode that keeps the oscillator hot. The problem is that the oscillators have a substantial warmup drift from cold, requiring half an hour or more to reach more or less the cor-

rect frequency. The crystals are getting on, and some have a habit of starting in the wrong oscillation mode, rendering the radio unusable until they warm up adequately and flip into the correct mode.

The R-1051s provide for an external 5MHz reference. However, they need a reasonably clean sine wave, and my distribution system provides, at best, a less than clean square wave. So I will need a further adapter to provide the sine wave.

Sources

Jameco Electronics: <http://www.jameco.com>

K8CU Z3801A Site: http://www.realhamradio.com/GPS_Frequency_Standard.htm