Timing for Portable Digital Operation

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We describe a simple method of providing GPS locked time to better than 0.1 second accuracy based on using an inexpensive USB GPS receiver. A warning - some USB GPS receivers do not reliably produce UTC time and we recommend the Ublox r6010 or r7020 GPS receivers as packaged by Gmouse, which our testing has shown are reliable.

Issues for Portable Operation

When operating portable the internet is often not available and may not be reliable. Thus some independent and accurate source of time is required. In the past we have used a Garmin GPS 18 with a 1 pulse per second (1PPS) output which interfaces through a serial port with a program called NMEATime. This system works well with the XP operating system. Today's PC's rarely have a serial port and even when they do we have been unable to get this system to work on Windows 7 or 10. The solution is to use a new program called NMEATime2 and a USB GPS receiver as discussed later in this note.

What timing accuracy do we need?

The WSJT slow modes are offset towards the EME delay and have a much lower timing tolerance when used for terrestrial work:

- JT65 -3 to +5 seconds
- JT4f -1.4 to +6 seconds
- QRA -1 to +4 seconds

For example if using QRA for terrestrial an error 1 second can result in one way decoding. In the worst case an error of 0.5 seconds at both ends will cause one way decoding. When looking for a weak signal to rise out of the noise it is useful to have accurate timing as good syncs based on the correct DT and DF are a useful indication of the presence of a signal. When using averaging on JT4 the timing stability needs to be better than 0.2 seconds to be accepted by the averaging algorithm. Overall we consider one should aim for a timing accuracy of 0.1 seconds.

Testing for Time Errors

To test timing accuracy we send JT messages between two computers one of which has accurate time, such as can be provided by an XP computer with 1 PPS or from a known accurate internet source. We use the WSPR mode as it averages the DT over two minute periods to improve the accuracy. K1JT has added another decimal place to the ALL_WSPR file so it reads to 0.01 seconds. However, the DT resolution of WSJT-X is limited to 0.04 seconds.

A Solution for Windows 7 or 10 using a USB Port

The author of NMEATime has produced a new version NMEATime2 that is designed to work with cheap USB GPS receivers with a USB output. It can be downloaded at: http://www.visualgps.net/#nmeatime2-content

The program is available free for 30 days use and there-after requires a one-off registration fee of around US$ 20.

NMEATime2 works by detecting first letter of the NMEA sentence and uses a long time constant loop to remove jitter. It has a claimed accuracy of 5 ms after calibration .

The NMEATime2 web site lists a number of GPS receivers that are claimed to have been used successfully. We initially chose the BU-353-S4 - USGlobalsat from this list but found it does not reliably give accurate UTC time.

GPS and UTC time

GPS units work on GPS time which is currently 18 seconds out to UTC time. In our case we need accurate UTC time. This difference increases by 1 second roughly every 19 Months, but is corrected when necessary on 30 June or 31 December by international agreement. Cheap GPS receivers set the initial GPS to UTC time difference in what is called an almanac at the time of manufacture. For example the GlobalSat unit was initially two seconds out up to 31 December 2016 and then 3 seconds out. This error is normally corrected when the GPS unit downloads what is called an ephemeris which should arrive within 12 minutes of switch-on. Accordingly, we would expect that if we wait 12 minutes before operating the UTC time should be correct. However, extensive testing of the GlobalSat unit shows that it does not reliably make this correction and about 25% of the time it is switched on it can remain 3 seconds out.

Gmouse with Ublox r6010 or r7020 GPS

In discussions with the author of NMEATime2 he suggested we try the Ublox GPS receivers to overcome the timing reliability problem. Extensive testing has shown that the Ublox GPS receivers reliably determine UTC time given 12 minutes after switch-on to gain the ephemeris and the accuracy is within the limits of the WSPR resolution of 0.04 seconds with calibration.

Calibration

NMEATime2 has a calibration facility to allow for the time delay to the first NMEA letter. For calibration one needs an accurate time reference such an internet time server of known accuracy. We have found that the calibration correction is generally no more than 0.05 seconds and the accuracy is still within the 0.1 second goal even without calibration.

Drivers for Ublox

Drivers are included in Windows 10 but need to be downloaded from Ublox site for Windows 7 at the URL below:

https://www.u-blox.com/en/product-resources?f[0]=property_file_product_filter%3A2779

Conclusions

- Use NMEATime2 with a Gmouse unit with uBlox r6080 or r7020 and you should be within 0.1 seconds after 12 minutes, without calibration.
- Accuracy can be improved with calibration.
- This gives a simple and reliable system that works with and is powered by a USB port.