

GPS Disciplined Frequency and Time Standard

A Unique Carrier Phase Tracking Microwave GPS Receiver

Quartzlock Ltd (Totnes, Devon, UK) has made a breakthrough in the design of GPS single channel receivers, achieving a performance that, until now, was the preserve of costly multi-channel receivers. The Quartzlock model 8 series Frequency Standard Receivers are microwave, satellite controlled frequency sources. They use emissions of the Navstar GPS satellites to control the frequency of a crystal oscillator (model 8) , a low cost SC cut OCXO (model 8A), a lower drift/higher stability SC cut OCXO (model 8A+) or a Rubidium Atomic Standard(8A-Rb).

The Quartzlock model 8 series are unique within their price range because they perform extremely high-resolution carrier phase measurements for each satellite being tracked. The 8A can operate with 1 satellite only. This enables the extraction of stable and accurate frequency information from the complex signal format. This leads to a frequency resolution, which is better than the C/A code tracking- used in all normal equipment- by a factor of 10,000.

The resolution of the 8A+ is so high that the frequency of the local oscillator can be measured to 1×10^{-11} in less than 1s. This allows ultra precise tracking of the reference. A typical output stability in 10s measurement time is 1×10^{-12} .

By performing carrier smoothed high-resolution evaluation, the model 8 series are able to make either range or time measurements far exceeding that possible with code-only detection receivers. The model 8 series are able to detect almost instantaneously any local oscillator frequency excursions and make gentle corrections. The short-term stability is therefore well controlled even in the simple model 8 XO version.

To minimise errors due to any single satellite, all satellites in view are tracked and a fast time and frequency averaging is performed. During this software weighted averaging process all satellite URAs (User Range Accuracy's) are taken into account.

The model 8 series can work if need be without entered position only. If given sufficient time (typically less than 16 hours) the receiver automatically fixes its position to a repeatability of within 2m. The receiver assumes stationary status with respect to the earth and this, together with the use of special plausibility checks, enables significant errors to be eliminated from the averaging process.

The use of a double conversion down-converter close to the antenna reduces signal frequency without losing any phase coherence by using a precise reference frequency derived from the receiver. This enables longer cable runs and less timing uncertainty than would be possible with a simple antenna pre-amplifier.

Standard square wave outputs of 10,5,1,0.1 MHz are provided, with the option of user defined frequency outputs if required. Times output of 1 PPS is standard with the option of an RS232 time tag option.

Software clock techniques are used to minimise the effects of constellation changes. The use of autonomous GPS techniques helps to achieve highly stable time information of a greater precision than for code-only receivers. In doing this the averaging process reduces the, at present, deleterious effects of SA (selective availability).

One of the main advantages the model 8 series possesses over most navigation engine based receivers, is that its design is dedicated to time and frequency applications. The use of entirely standard low-cost non-application specific component parts makes maintenance and lifelong support of the model 8 is easier and certain.

Due to the world class accuracy of the Quartzlock model 8, there exist many applications: The calibration of counters, timers, radio test equipment and all quartz based instrumentation within standards laboratories, time transfer, OEM, the referencing of radio transmitter frequency including quasi-sync systems, the synchronisation of telecom systems including Stratum I and II GSM, PCN base station commissioning and reference unit, a time scale correction to the UTC, Digital Audio Broadcasting (DAB) and Digital TV.

An independent NPL laboratory report of the 8A and 8A-Rb confirmed Quartzlock's position as the best in the world (out of 15 tested). The Quartzlock models recorded the best short-term accuracy and stability and the best long-term stability. Tests at the worlds best timing centres in Russia (IEM Kvarz) and Germany (PTB) gave identical long-term performance of 5×10^{-14} over 5 and 33 days. The performance was better than that of Caesium whilst costing less than a replacement Physics package for Cs. Such performance is likely to find wide-ranging application in a world increasingly dependent on the use of GPS for it's smooth running.