Quartzlock

A8

5x10-14
Offset

GPS Time & Frequency Standards

carrier phase tracking microwave GPS receivers

A8-M

FEATURES

- RF Outputs:1, 5, 10MHz Sine & Squarewave
- Offset to 5x10^{-14}/week
- Timing: 1pps
- RF Options: 13MHz, 10.24MHz, E1, T1, TTL
- Phase Noise: -160dBc/Hz
- Display: Time, date, position, Δf, Δt, Sat data
- Time Accuracy: to 4ns
- 24V battery back up glitchless switch built in

APPLICATIONS

- Telecom network synchronisation
- Cellular phone base stations
- Satellite navigation
- Time Transfer
- Network Time

BENEFITS

- Highest performance
- Space saving (A8-B)
- Indoor or outdoor antenna
- Environmentaly tolerant
- Ideal for mobile applications

A8-B

A8-R

INTRODUCTION

GPS is a satellite navigation system conceived, designed and operated by the US DoD. Originally intended to be used for precise positioning through the determination of pseudoranges from the satellites (of which there are ~28 in low earth orbit) to the (normally ground based) receiver. The key idea is that by measuring the time of flight of a radio signal from 4 or more satellites to the receiver, the position of the receiver may be accurately determined. In addition the time offset of the receiver (from composite clock GPS time) may be calculated from information within the orbit data (modulated onto carrier). By taking the time differential of these two quantities, the velocity of the receiver and the frequency offset of the receiver may be ascertained.

SATELLITE SIGNALS

The satellites transmit two L-Band (390-1600 MHz) carrier signals, L1 and L2. The carrier frequencies of L1 and L2 are 1575.42 and 1227.6 MHz respectively. Each carrier is turn modulated (phase shifted by a wave of lower freq. to convey signal) with one or more binary codes. L1 is modulated with first the C/A (Coarse/Acquisition) code, which is the basis of the standard positioning service (civilian GPS provision). This is a pseudo-random (i.e. random like but actually not) but regularly repeating noise-like code. It has a chipping rate (rate at which binary digits are produced) of 1.023 MHz. The code modulation effectively spreads the spectrum of the carrier signal (i.e. over a far a wider frequency band than is actually required by the quantity of information sent). This gives it high resistance to interference and non- authorised jamming. The code length is limited to 1023 bits, giving a refresh rate (or duration of the code) of 1ms. The C/A code has a fast acquisition time and is easy for users to lock onto. Each of the ~26 active satellites modulates their L1 carrier with a satellite characteristic C/A code, enabling easy satellite identification through C/A code demodulation. L1 is also modulated with a 50Hz navigation message, which provides GPS satellite orbits, clock corrections etc. The Precise (P) code modulates both the L1 and L2 carriers, and has a far longer (7-day) duration than the C/A code. It has a chipping rate of 10.23 MHz. C/A code was designed partly to help users acquire the P-code. Through a method called antispoofing (AS) the P-code is encrypted to form the user-restricted P(Y) code, available only to US military authorised users, through the use of decryption keys. The normal civilian users can all but forget about the P-code due to its encryption.

CARRIER PHASE

The C/A code correlation length of 1us limits dramatically the resolution of the C/A measurement. The substantially higher frequency of the L1 carrier (as compared to the C/A code), and the resulting shorter cycle of 635 ps, will reduce its sensitivity to jamming and also improve the resolution 10000 fold over C/A code measurement. A 1-% noise induced change in the carrier and code signal amplitude results in a phase shift of 10ns and 1ps in the code and carrier respectively. The advantage of carrier phase tracking is that frequency measurements are achievable with almost no receiver noise contribution. This enables relative frequency determination with uncertainties of a few parts in 10^{-11} within fractions of a second. The short dwell times (on each satellite signal) enable a single time multiplexing channel (tracking of multiple satellite signals by using a rapid sequencing process) instead of the costly multichannel method, with better results.

QUARTZLOCK GPS

Unlike most low cost GPS receivers the Quartzlock model A8 series Frequency Standard Receivers are able to perform extremely high resolution carrier phase measurements for each satellite being tracked. This yields a frequency resolution which is better than “code-only” detection by a factor of 10, 000.

By performing carrier smoothed high resolution code evaluation the model A8 is able to make range (or time) measurements of far superior precision to non-carrier, code only detection receivers. This enables the model A8 to detect almost instantaneously any local oscillator frequency excursions and makes fast corrections such that, even with a low cost crystal, the short term stability is well controlled. The model A8 is therefore unique in its price range and yields performance equal to that of less affordable multi-channel receivers.

All satellites in view are tracked and fast time frequency averaging is performed which minimises errors due to any single satellite. All satellites URAs (User Range Accuracies) are taken into account in the course of the averaging process. Further, significant errors can be eleiminated from the averaging process by the use of special plausibility checks and the ability of the receiver to assume that it is stationary with respect to the earth having fixed its position to an accuracy of better than ±2m (which it may do automatically given sufficient time, ie: <24hours). Software clock techniques are used to minimise the effects of constellation changes.

Quartzlock GPS Frequency Standards A8

STANDARD SPECIFICATIONS

MODEL	A8-B	A8-R	A8-M
Output Sine (+13dBm/50 Ω) Square (+5V) Timing	 1,5,10MHz 1,5,10MHz 1pps (UTC)	 1, 5, 10MHz 1, 5, 10MHz 1pps (UTC)	 1, 5, 10MHz 1, 5, 10MHz 1pps (UTC)
Frequency Stability (AVAR) 1s 10s 100s 1000s 1day 1 week	 2x10^{-11} 2x10^{-11} 3x10^{-12} 2x10^{-12} 8x10^{-12} 8x10^{-13}	 2x10^{-11} 2x10^{-11} 3x10^{-12} 2x10^{-12} 8x10^{-12} 8x10^{-13}	 1x10^{-11} 2x10^{-12} 4x10^{-13} 2x10^{-13} 3.5x10^{-13} 5x10^{-14}
Frequency Accuracy (5 days)	5x10^{-14}	5x10^{-14}	5x10^{-14}
Phase Noise dBc/Hz @ 10kHz	-155 dBc/Hz	-155 dBc/Hz	-145 dBc/Hz
Harmonics (Typical)	<-60dB	<-60dB	<-60dB
Spurious (Typical)	<-70dB	<-70dB	<-70dB
Time Accuracy (2 Sigma)	<50ns	<50ns	<4ns
Frequency Holdover (Unlocked)	5x10^{-10}/Day	5x10^{-10}/Day	3x10^{-12}/Day
Temperature Range °C Operating Storage	 -10 to +55 -40 to +85	 -10 to +55 -40 to +85	 -10 to +55 -40 to +85
Standard Equipment	Antenna Downconvertor 25M Cable 24V PSU	Antenna Downconvertor 25M Cable Power Cable	Antenna Downconvertor 25M Cable Power Cable
Options	13MHz 10.24MHz XO BBU 50m Cable 100m Cable	E1, T1 13MHz TTL 10.24MHz XO BBU LPRO 50mCable 100m Cable	+ 4 Outputs E1, T1 13MHz TTL 10.24MHz A, B, C, D Rb HSRO BBU 50m Cable 100m Cable

A8-B

Bench Mount GPS
1, 5, 10MHz Sinewave
1, 5, 10MHz Squarewave
1pps
OCXO

A8-R

1U 19" Rack Mount GPS
1, 5, 10MHz Sinewave
1, 5, 10MHz Squarewave
1pps
OCXO

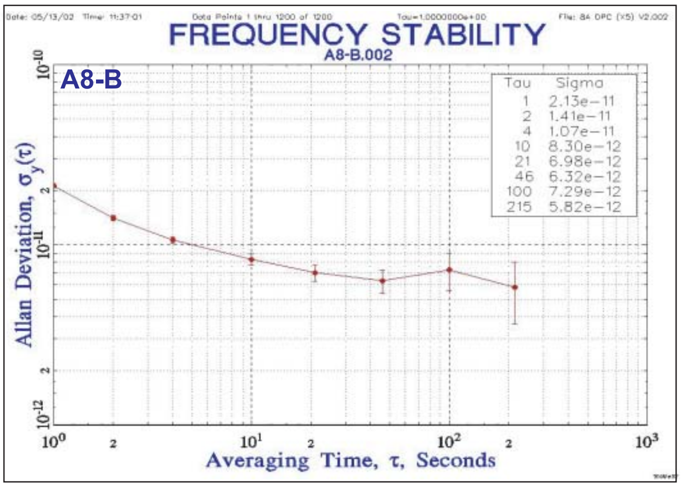
A8-M

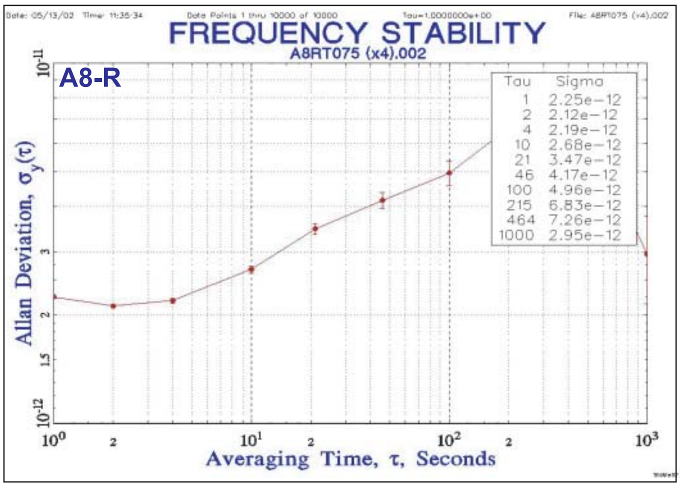
2U 19" Rack Mount GPS
1, 5, 10MHz Sinewave
1, 5, 10MHz Squarewave
1pps
HPRO 'D' Rb

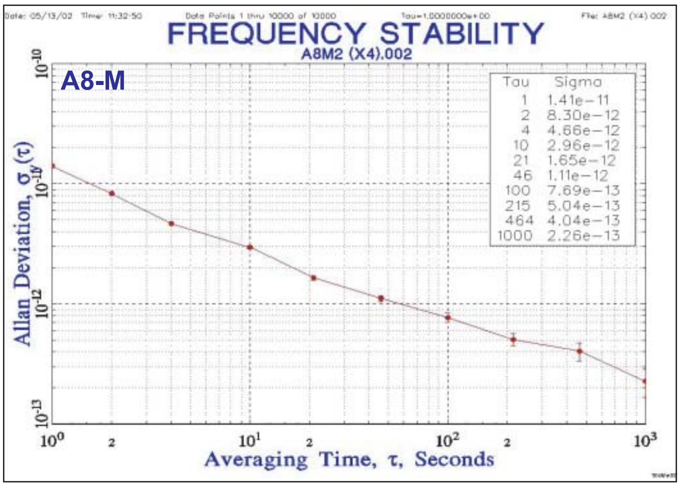
RUBIDIUM SPECIFICATIONS

Rubidium Spec	HPRO A	 B	 C	 D	HSRO	LPRO/ FRS
Drift 1 month 1 year	 1x10^{-11} 2x10^{-10}	 4x10^{-11} 5x10^{-10}	 1x10^{-10} 5x10^{-10}	 1x10^{-10} 5x10^{-10}	 2x10^{-11} 5x10^{-10}	 4x10^{-11} 5x10^{-10}
Frequency Stability 1s 10s 100s	 3x10^{-11} 1x10^{-11} 3x10^{-12}	 3x10^{-11} 1x10^{-10} 3x10^{-12}	 1x10^{-10} 3x10^{-11} 1x10^{-11}	 1x10^{-10} 3x10^{-11} 1x10^{-11}	 3x10^{-12} 1x10^{-12} 4x10^{-13}	 3x10^{-11} 1x10^{-11} 3x10^{-11}
Offset Over Temp Range	3x10^{-10}	3x10^{-10}	5x10^{-10}	5x10^{-10}	5x10^{-11}	3x10^{-10}
Operating Temerature °C	-10..+55	-10..+55	-10..+55	-10..+55	-10..+55	-10..+55
Phase Noise 10Hz 100Hz 1kHz 10kHz	 -100 -130 -140 -145	 -100 -130 -140 -145	 -100 -130 -140 -155	 -100 -130 -140 -145	 n/a -135 -145 -155	 -100 -130 -140 -145

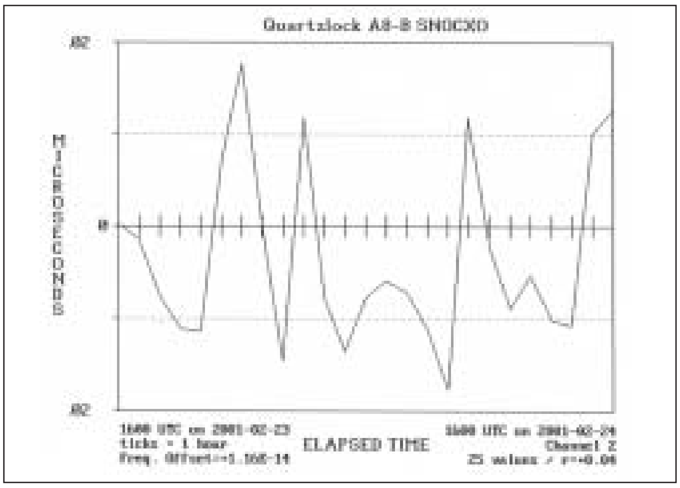
TEST RESULTS WITH A7-M

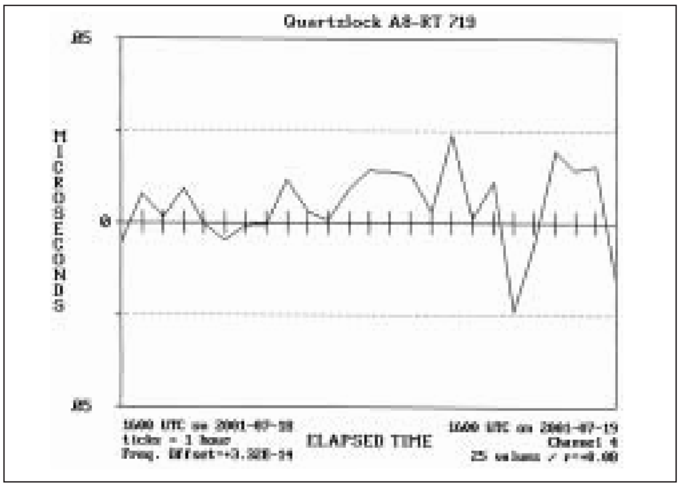


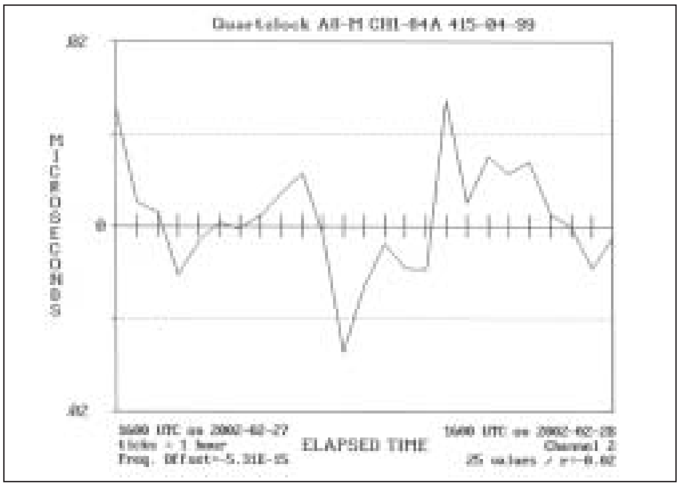




TEST RESULTS WITH NIST FMAS







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ISO 9001

NIST

NPL

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World Wide Representatives