Quartzlock A7-A & A7-M

Frequency, Phase & Phase Noise Measurement System

Hydrogen Maser compatible performance to compare, calibrate & characterise
H-Masers, Caesium, Rubidium, Quartz Oscillators & Passive Components

Precision Difference Measurement

- Very high resolution
- Very low noise
- Ultra fast measurement time
- A7-A (Analogue) simple to use E-13 resolution
- A7-M (Metrology) best available E-16 resolution
- Selectable filters, resolutions & tau's
- 24V battery back up glitchless switch built in

Applications

- Stability analysis
- Phase noise analysis
- Atomic Frequency Standard Calibration
- Temperature & Phase testing

Benefits

- Unskilled Operation
- World Leading & Futureproof
- Versitility of application: laboratory to producton line
- Precision Product Characterisation

Detailed Specification

INPUTS	
a) Reference	5 or 10MHz sine wave +/- 50 x 10^{-6}
b) Measurement	5 or 10MHz sine wave +/- 50 x 10^{-6}
c) Input levels:	+0dBm to +13dBm into 50Ohm
d) Max Freq difference (Filter off):	Low resolution +/- 10 x 10^{-6} High resolution +/- 100 x 10^{-6}
OUTPUTS	
a) Counter A channel	100kHz square wave CMOS/TTL (frequency mode) 10us pulse CMOS/TTL (phase difference mode)
b) Counter B channel	10us pulse CMOS/TTL (phase difference mode)
c) Counter external reference	10MHz CMOS/TTL
FILTER	Selectable bandwidth IF filter reduces measurement noise
Nominal 3dB Bandwidths	200Hz, 60Hz, 10Hz
FRACTIONAL FREQUENCY MULTIPLICATION	
Selectable	High resolution 10^5 Low resolution 10^3
MEASUREMENT RESOLUTION	
a)	Using external frequency/ time interval counter with 1ns or better time interval resolution
Frequency difference mode	High resolution 1 x 10^{-13}/gate time Low resolution 1 x 10^{-12}/gate time Gate times 1ms to 3200s
Phase difference mode	(High resolution: filter off)
RMS resolution (single measurement)	50fs (Measured as the standard deviation of 1000 phase difference measurements/ 1s)
Short-term stability (Allan variance)	<5x10^{-11} 1ms <1x10^{-14} 10s <5x10^{-12} 10ms <2x10^{-15} 100s <5x10^{-13} 100ms <5x10^{-16} 1000s <5x10^{-14} 1s <1x10^{-16} 10000s
Sampling interval:	1ms to 1000s in decade steps
Drift:	<1ps per hour typical at constant ambient temperature <5ps per day typical at constant ambient temperature
Drift with temperature:	<2ps per °C
b)	Using internal moving coil meter
Frequency difference mode	Full scale ranges +/- 1x10^{-7} to +/- 1x10^{-12} in decade steps Time constant 20ms to 10s linked to range Displayed noise <2x10^{-13} peak Zero drift <2x10^{-13}/ hour
Phase difference mode	Full scale ranges +/- 10us to +/- 100ps in decade steps Displayed noise TBD Zero drift TBD
MECHANICAL	2U full rack unit
POWER SUPPLY	120/ 240V AC line 50W max24V DC battery back up with auto switching. Current consumption 1A max (+ 2A for op17, 1A for op1)
OPTIONS (A7-A)(A7-M = A7-A + Options)	Option 33 Add GT200 PC Counter card with driver software Option 17 Add Rubidium frequency standard Option 1 Add built in 4 channel distribution amplifier (rear panel connectors) Option 2 Add Stable 32 frequency and phase analysis software
Options (A7-A & A7-M)	Option 37 Add input splitter (enables noise floor measurements)

Option 33 requires user supplied PC (486 or higher) with ISA slot and DOS O/S. Windows 3.1/ 95/ 98 may be used if run under DOS mode. See separate data sheets for options 17, 1 and 2.

Introduction

The A7-A frequency/ phase difference comparator is a new Quartzlock product for measuring a wide range of frequency standards, isolation amplifiers, frequency multipliers and dividers and passive devices such as cables. The instrument includes a moving coil meter for rapid, unambiguous display of fractional frequency difference or relative phase difference between two sources. Outputs are also provided for an external counter to provide higher resolution analysis of the time domain stability of a source or amplifier. The instrument combines the production orientated capability of rapidly adjusting a source to within a certain tolerance using the panel meter, along with the metrology capability of a full time domain analysis of a source or passive component using data acquisition from the frequency counter.

Quartzlock can supply a PC card based counter that can accumulate 1000 readings per second (option 33). The data file can then be analysed using the industry standard software package Stable 32 (option 2). Stable 32 can plot all the variants of time domain statistics, and can convert to the frequency domain to provide close in phase noise analysis. The rapid data acquisition rate of 1000 readings per second enables phase noise to be calculated to a Fourier Frequency of 500Hz from the carrier. Close in phase noise analysis may be made to within 1mHz of the carrier by extending the length of the data acquisition to several thousand seconds. The very low drift of the A7-A makes such measurements valid. Stable 32 can also extract frequency offset and drift information.

The A7-A comparator has state of the art noise floor and drift characteristics. Its technique of frequency multiplication followed by down conversion provides lower noise floors than the simpler dual mix downconvert system. The very low drift is achieved by providing identical multiplier/ mixing chains for the reference and measurement channels. When the multiplied signals are finally mixed together (subtracted), any drift in the multiplier chains is cancelled.

The automatic battery backup provision fitted as standard enables very long measurement runs to be undertaken without concerns over line power failures. An external 24V car battery will power the instrument for at least 24 hours.

A rubidium frequency standard may be fitted (option 17) along with a 4-output distribution amplifier with very low phase noise (option 1).

Detailed Technical Description

Measurements are made in the time domain and consist of time difference measurements between a reference source and a measurement source. Measurements may be made on passive devices such as amplifiers by splitting a source output and comparing the time delay through the device under test with the direct path. In this way the time or phase stability of the amplifier may be measured. Unlike a general purpose time interval meter, the inputs must be substantially sine wave and at either 5MHz or 10MHz. The resolution is much better than even the fastest counters, being around 50fs for a single measurement.

The A7-A is a completely new design using phase locked multipliers as opposed to the harmonic multipliers used in Quartzlock's other phase/frequency comparator, the A7. Several new features have been added. The frequency input range is much wider, enabling measurements on VCXOs and OCXOs. Two resolutions are provided, with multiplication factors of 10^3 and 10^5. This optimises measurement on very stable sources such as rubidium and caesium oscillators and hydrogen masers, as well as lower stability sources. Phase and frequency mode are as the A7, although the sampling rate in phase mode is now selectable from the front panel to be from 1ms to 1000s. A variable bandwidth IF filter has been added. This essentially sets the measuring bandwidth and allows sources with considerable phase noise to be filtered. This has particular advantages in frequency mode where the apparent jitter of a real time frequency readout can be reduced. A Rubidium frequency standard can be adjusted using 100ms gates to an accuracy of 1×10^{-12}.

The comparator will operate at either 5MHz or 10MHz with automatic switching. The inputs are 50Ohm impedance, and a level of between 0dBm and +13dBm is required at both inputs. The absolute accuracy of both reference and measurement inputs should be less than
+/-50 in 10^6. The maximum frequency difference should be less than +/-10 in 10^6 in low resolution mode and less than +/-100 in 10^9 in high resolution mode. The inputs are provided with level indicators.

The comparator has two modes of operation, frequency measurement mode and phase difference mode. In frequency mode the moving coil meter indicates fractional frequency difference and the external counter is configured as a frequency counter. Meter full scale ranges are selectable from the front panel in the range $+/-10^{-7}$ to $+/-10^{-12}$. The external counter is configured as a frequency counter with gate times selected on the counter as usual for a frequency measurement. The frequency measured is actually the sum of the multiplied frequency difference at the inputs of the A7-A plus 100kHz. It is therefore desirable that the external counter has a maths facility to remove the offset and allow for the multiplication. The RMS resolution is typically better than 5 parts in 10^{14} for a 1 second gate.

In phase mode, the meter is configured to read phase difference between the reference and the measurement inputs. The full scale range is selectable between +/-10us to +/- 100ps. An extended range phase detector is used so phase roll over will be between +10 and 0 on the meter if the frequency is increasing, and between -10 and 0 on the meter if the frequency is decreasing. The meter shows relative phase difference between the reference and measurement inputs. Because of the multiplication process in the comparator, the absolute phase difference is not available. A phase reset key is provided that zeros the indicated phase to within +/- 100ps.

In phase mode the external counter is configured as a time interval meter and measures the time difference between pulses on it's A channel and B channel. The pulse rate is set from the front panel of the A7-A. The time difference between the pulses is the multiplied time difference between the inputs to the A7-A. Thus if the counter has 1ns time interval resolution, the effective resolution (multiplication factor 10^5) at the input of the A7-A is 10fs. In practice this resolution is not achievable due to instrument noise. Single shot time resolution has been measured at 50fs.

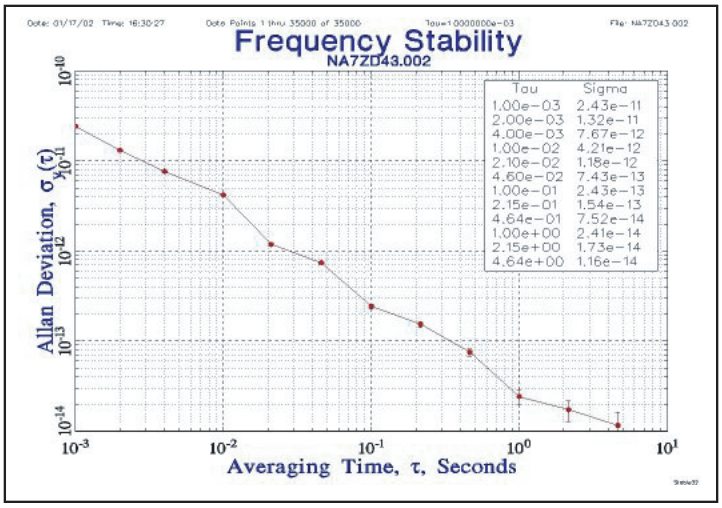
The counter supplied as Option 33 is a GT200 card that comes with its own virtual front panel software. Measurements may be stored on hard disk for later analysis. The counter is capable of storing ASCII formatted readings in computer memory at at least 1000 readings per second.

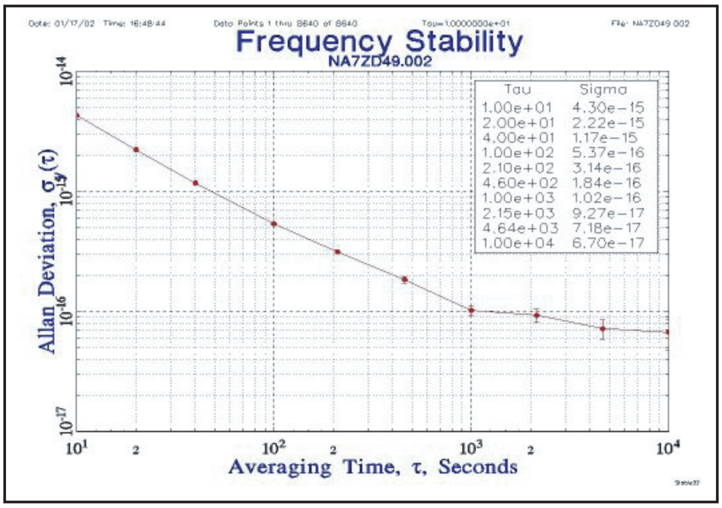
A sophisticated software package, Stable 32, is available for analysis of data (option 2). It supports every possible type of time domain stability analysis, as well as conversion to the frequency domain for close in phase noise analysis.

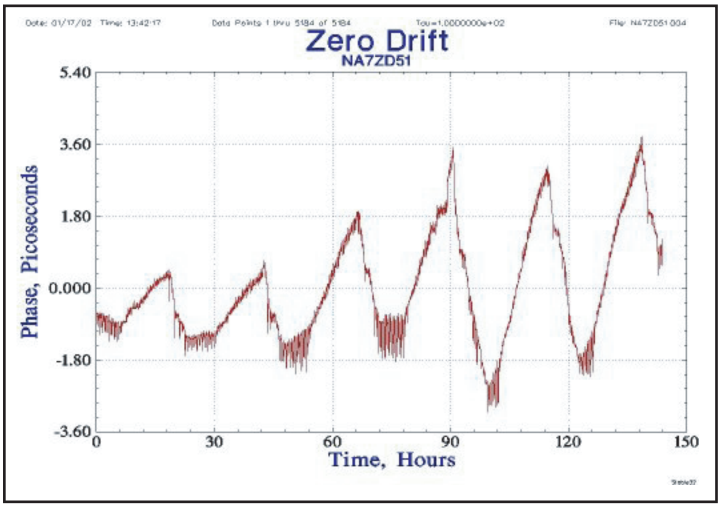
The A7-A is Futureproof!

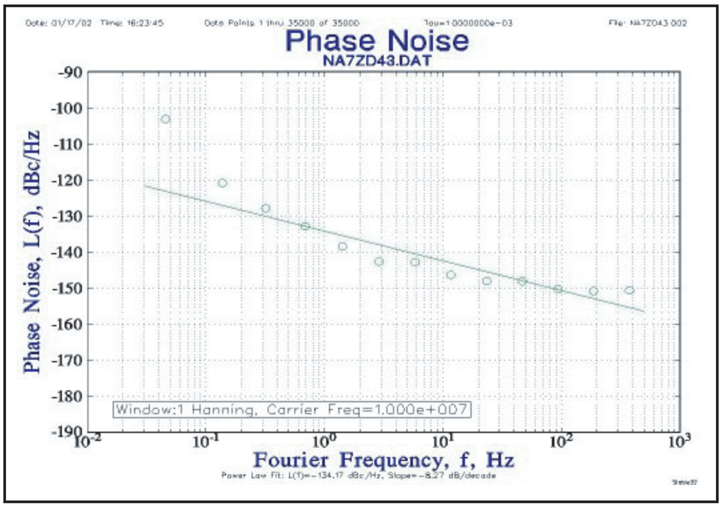
The A7-A may be upgraded to A7-M performance at a later date by adding A5-4 or A5-12 distribution amplifier, A10-M precision rubidium reference, GT 200 counter card, Stable32 analysis software and a Pentium PC.

Frequency Stability 10^{-3} to 10^{4} (tau), Zero Drift & Phase Noise









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