

Quartzlock

A7 A & MX

E-16 Resolution

# Frequency, Phase & Phase Noise Measurement System

A7-A replaces: *Adret 4110*, *Tracor 527E*, *R&S XSRM-Z3*, *HP K34-59991* (but with higher spec)  
A7-A becomes A7-MX with internal time interval counter option & software (option A7-X)



## NEW 2006

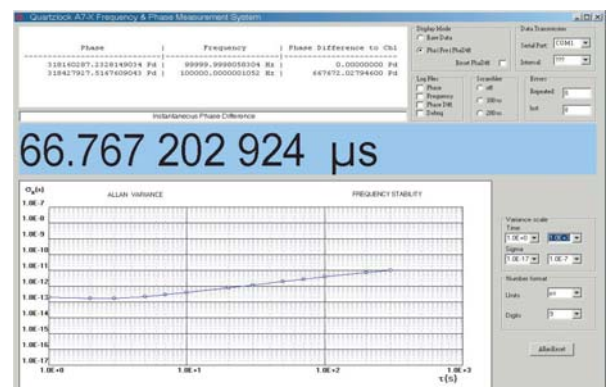
- Internal time interval counter card
- AVAR software included Stable32 supplied
- RS232 connect to any PC
- 32000 data points
- Data stored in A7-MX
- Crash proof with 24Vdc Battery Back Up
- On screen plot visual immediately
- Large digital display of  $\Delta\phi$  or  $\Delta f$

## FEATURES

- Very high resolution: 50fs single shot
- Very low noise:  $\sigma$  1s  $< 5 \times 10^{-14}$
- Ultra fast measurement time
- Sample rate: 1000 readings/second
- A7-A (Analogue): simple to use E-13 resolution
- A7-M (Metrology): best available E-16 resolution
- Selectable filters, resolutions & tau's
- Phase/ frequency on analogue meter

## APPLICATIONS

- Stability analysis
- Phase noise analysis
- Atomic frequency standard calibration
- Active & passive components
- ADEV, Modified ADEV, TVAR, MTIE etc
- Temperature & Phase testing



## BENEFITS

- Unskilled operation
- World leading performance
- Versatility of application
- Precision product characterisation
- "National Measurement" level with H-Maser

**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  $1 \times 10^{-12}$ .

The comparator will operate at either 5MHz or 10MHz with automatic switching. The inputs are 50Ω 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  $\pm 50$  in  $10^6$ . The maximum frequency difference should be less than  $\pm 10$  in  $10^6$  in low resolution mode and less than  $\pm 100$  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 internal counter is configured as a frequency counter. Meter full scale ranges are selectable from the front

panel in the range  $\pm 10^{-7}$  to  $\pm 10^{-12}$ . The internal counter is configured as a frequency counter with appropriate gate times selected. The frequency measured is actually the sum of the multiplied frequency difference at the inputs of the A7-A plus 100kHz. 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  $\pm 10\mu\text{s}$  to  $\pm 100\text{ps}$ . 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  $\pm 100\text{ps}$ .

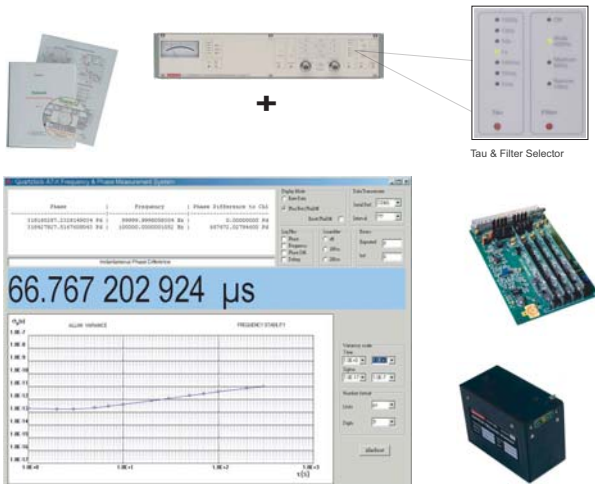
In phase mode the internal counter is configured as a time interval meter and measures the time difference between pulses on it's A channel and B channel. The pulse rate is set from the front panel of the A7-A. The time difference between the pulses is the multiplied time difference between the inputs 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 with A7-MX is an internal time interval counter 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. An external counter with sufficient resolution and sample rate may be used.

A sophisticated software package to provide instantaneous graphical representation plus Stable 32, is supplied for analysis of data (A7-MX). It supports every possible type of time domain stability analysis, as well as conversion to the frequency domain for close in phase noise analysis.

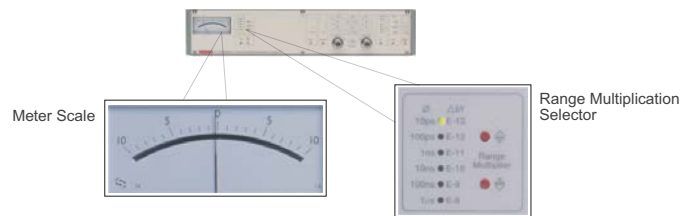
**A7-MX**

A7-MX supplied with internal TIC providing RS232 for connection to a PC, Options: - Stable32 Frequency Analysis Software, High Performance Rubidium Module and 4 Channel RF Distribution Card.



**A7-A**

The A7-A may be upgraded to A7-MX performance at a later date.



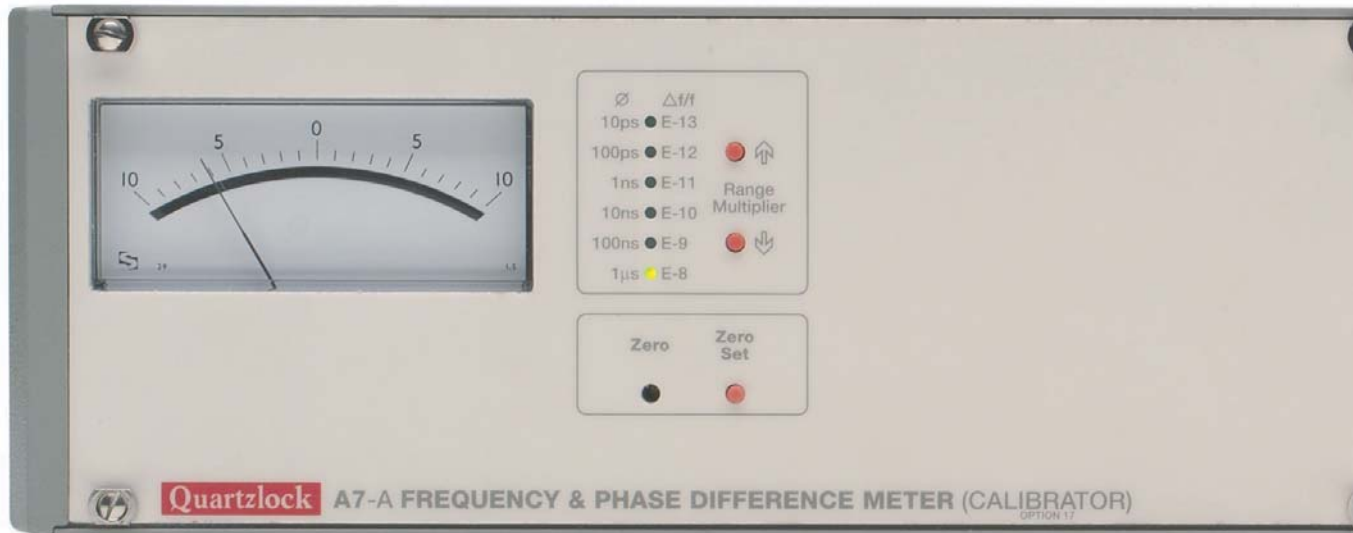
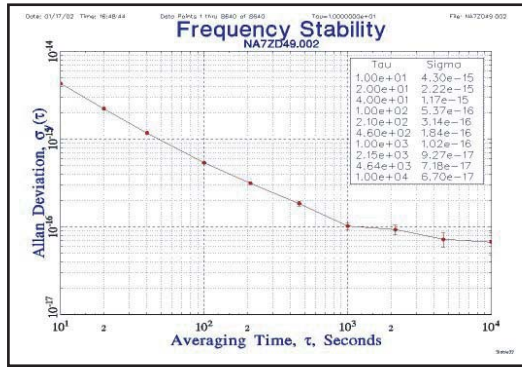
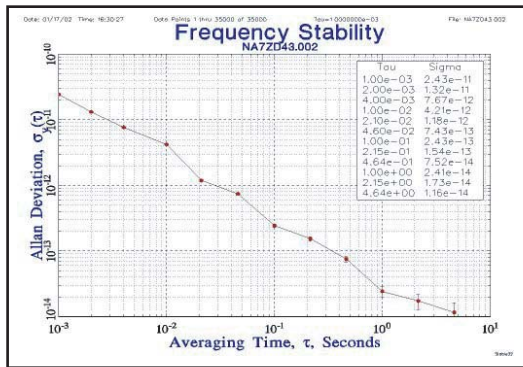
**Quartzlock (UK) Ltd**  
 Gothic, Plymouth Road,  
 Totnes, Devon TQ9 5LH,  
 England  
 Tel: +44 (0) 1803 862 062  
 Fax: +44 (0) 1803 867 962

**Quartzlock (USA)**  
 P.O. Box 6094,  
 Astoria, NY 11106  
 USA  
 Sales  
 Tel: 718 614 8672  
 jrm1950@yahoo.com  
 Technical Service  
 Tel: 719 228 0540  
 Fax: 719 228 9009

Web: [www.quartzlock.com](http://www.quartzlock.com)  
 e-mail: [quartzlock@quartzlock.com](mailto:quartzlock@quartzlock.com)

**STANDARD SPECIFICATIONS & A7-M TEST RESULTS**

<p><b>INPUTS</b>                  a) Reference                  b) Measurement                  c) Input levels:                  d) Max Freq difference (Filter off):</p>	<p>5 or 10MHz sine wave +/- 50 x 10<sup>-6</sup>                  5 or 10MHz sine wave +/- 50 x 10<sup>-6</sup>                  +0dBm to +13dBm into 50 Ω                  Low resolution +/- 10 x 10<sup>-6</sup>                  High resolution +/- 100 x 10<sup>-9</sup></p>
<p><b>OUTPUTS</b>                  a) Counter A channel                   b) Counter B channel                  c) Counter external reference</p>	<p>100kHz square wave CMOS/TTL (frequency mode)                  10us pulse CMOS/TTL (phase difference mode)                  10us pulse CMOS/TTL (phase difference mode)                  10MHz CMOS/TTL</p>
<p><b>FILTER</b>                  Nominal 3dB Bandwidths</p>	<p>Selectable bandwidth IF filter reduces measurement noise                  200Hz, 60Hz, 10Hz</p>
<p><b>FRACTIONAL FREQ. MULTIPLICATION</b>                  Selectable</p>	<p>High resolution 10<sup>5</sup>                  Low resolution 10<sup>3</sup></p>
<p><b>MEASUREMENT RESOLUTION</b>                   a)                   Frequency difference mode                   Phase difference mode</p>	<p>Using external frequency/ time interval counter with 1ns or better time interval resolution                   High resolution 1 x 10<sup>-13</sup>/gate time                  Low resolution 1 x 10<sup>-12</sup>/gate time                  Gate times 1ms to 3200s                   (High resolution: filter off)</p>
<p><b>RMS resolution (single measurement)</b></p>	<p>50fs (Measured as the standard deviation of 1000 phase difference measurements/ 1s)</p>



## STANDARD SPECIFICATIONS & A7-M TEST RESULTS

<b>Short-term stability (Allan variance)</b>	<5x10 <sup>-11</sup> 1ms <5x10 <sup>-12</sup> 10ms <5x10 <sup>-13</sup> 100ms <5x10 <sup>-14</sup> 1s	<1x10 <sup>-14</sup> 10s <2x10 <sup>-15</sup> 100s <5x10 <sup>-16</sup> 1000s <1x10 <sup>-16</sup> 10000s
<b>Sampling interval</b>	1ms to 1000s in decade steps	
<b>Drift</b>	<1ps per hour typical at constant ambient temperature <5ps per day typical at constant ambient temperature	
<b>Drift with temperature</b>	<2ps per °C	
<b>b)</b>	Using internal moving coil meter	
<b>Frequency difference mode</b>	Full scale ranges Time constant Displayed noise Zero drift	+/- 1x10 <sup>-7</sup> to +/- 1x10 <sup>-12</sup> in decade steps 20ms to 10s linked to range <2x10 <sup>-13</sup> peak <2x10 <sup>-13</sup> / hour
<b>Phase difference mode</b>	Full scale ranges Displayed noise Zero drift	+/- 10us to +/- 100ps in decade steps TBD TBD
<b>MECHANICAL</b>	2U full rack unit	
<b>POWER SUPPLY</b>	120/ 240V AC line 50W max24V DC battery back up with auto switching Current consumption 1A max (+ 2A for op17, 1A for op1)	
<b>STANDARD EQUIPMENT (A7-MX) (Installed &amp; tested)</b>	Internal Time Interval Card	
<b>Options (A7-A &amp; A7-MX)</b>	Add input splitter (enables noise floor measurements) Rubidium frequency standard Built in 4 channel distribution amplifier (rear panel connectors) Stable 32 frequency and phase analysis software	

