

# Active & Passive Hydrogen Masers + GPS-BVA

PRECISE TIME & FREQUENCY STANDARDS

 The most stable Frequency Standards available	
 Rubidium Atomic Standard Hydrogen Masers	<b>Quartzlock</b> Hydrogen Masers Gothic, Plymouth Road, Totnes, Devon TQ9 5LH England Tel: +44 (0)1803 862062 Fax: +44 (0)1803 867962
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## TIME & FREQUENCY STANDARDS

### 'A' Spec

### 'B' Spec

### 'GPS-BVA' (A8-MX)

<b>Frequency Outputs</b> 50 Ohms, 1±0.2 Vrms sine	(2) 5MHz (2) 1Hz, (1 pps), >2.5V peak Pulse Width: 10 to 20ms Rise Time: ≤30ns Jitter: ≤100ps		10MHz, 100MHz 2048kHz 2.5V 75 Ohms In addition to standard outputs	1MHz sine & sq 10MHz sine & sq + options In addition to standard outputs
<b>Clock Synchronisation</b>	Auto to within 200ns of ref. pulse. Amplitude: 2.5 to 5V			5...20ns with adj to ±500ms in 1ns steps
<b>Stability, 5MHz Outputs</b>	<b>Average Time (s)</b>			
<b>Allan Variance, <math>\sigma_y(2, \tau)</math></b>	1 10 100 1000 1hour 1 day	≤1.5E-12 ≤5E-13 ≤1.5E-13 ≤5E-14 ≤2E-14 ≤1E-14	2E-12 6E-13 2E-13 6E-14 2E-14	8E-14 8E-14 2E-13 5E-13 5E-14
(Although this is a rugged instrument which operates within +5 to 40°C ambient, the quoted specifications apply while the instrument is confined to a ±1°C ambient temperature change)				
<b>Temp/Freq Coefficient</b>		≤2E-14/°C	5E-15	ask QL
<b>Drift</b>		≤1E-15/Day	6E-14/Mo	nil
<b>Accuracy</b>		≤1.5E-12 over 5 years	1E-12	5E-14
<b>Frequency Trim Range</b>		At least 1E-10	1E-10	±500ms
<b>Setting Resolution</b>		1E-14 Steps	1E-14	1ns
<b>Retrace</b>		≤3E-14 after 24 hrs op	1E-13	5E-14
<b>Phase Noise 5MHz</b>	<b>Offset from Carrier (Hz)</b>	<b>Phase Noise (dBc)</b>		
	1 10 100 1000 10000	-100 -120 -140 -150 -150	-95 -125 -135 -150	-110 -140 -145 -155 -160...-170
<b>Spurs</b>	Harmonics: Non-Harmonics: ≤-100 dBc	≤-30 dBc		-40 dBc -100 dBc
<b>Power Input - ac</b>	220 VAC, ±10%, 100, 120 V±10%, 240 V+5-10%; 45-65 Hz			
<b>Power Input - dc</b>	As an alternative to ac the unit can be powered by an external 22-30 Vdc supply.			
<b>Auto Battery Backup</b>	In case of ac failure the instrument switches to the dc input line.			
<b>Power Consumption</b>		ac <140 VA, dc <90 W	ac 80W	ac 20W
<b>Warm-up Time</b>		≤10 hrs lock. (typ 6 hrs)	8 hours	8 hours, to full spec.
<b>Operating Temperature</b>		+5 to +35°C	+5 to +40°C	0 to +50°C
<b>Storage Temperature</b>		-50°C to +50°C	0 to +50°C	-20 to +50°C
<b>Magnetic Sensitivity</b>		≤2.5E-14/ Gauss	2E-14	ask QL
<b>Pressure</b>	630 to 795 mm Hg (84 TO 106 kPA)			
<b>Humidity</b>		Up to 80% at 25°C	80% 35°C	80% 35°C
<b>Size</b>		11"H x 19"W x 22"D (280 x 480 x 560mm)		2U rack (88 x 480mm)
<b>Weight</b>		120 lbs (55 kg)		12kg
<b>Warranty</b>		1 year. (2...5 year options)		2 years + options
<b>Service Life</b>		15 years		20 years

TIME & FREQUENCY STANDARDS		'A' Spec	'B' Spec	'C' Spec	
<b>Frequency Outputs</b> 50 Ohms, 1±0.2 Vrms sine	(2) 5MHz (2) 100MHz (2) 1Hz, (1 pps) >2.5V pk Pulse Width: 10 to 20ms Rise Time: ≤30ns Jitter: ≤100ps	10MHz & 1.4GHz In addition to standard outputs			
<b>Clock Synchronisation</b>	Auto to 50ns of ref. pulse Amplitude: 2.5 to 5V Width: 1 - 100ms Rise Time: ≤20ns Input Z: 50 Ohms				
<b>Stability <math>\sigma_y(2,T)</math></b>	<b>Average Time (s)</b>				
<b>5MHz &amp; 100MHz Allan Variance</b>	10 ms 100ms 1 10 100 1000 10000/1hr 1 day	≤2.3E-13 ≤2.8E-14 ≤6E-15 ≤3E-15 ≤2E-15 ≤2E-15	≤3E-13 ≤5E-14 ≤1E-14 ≤5E-15 ≤3E-15 ≤5E-15	≤4E-11 ≤6E-12 ≤1E-12 ≤2E-13 ≤3E-14 ≤9E-15 ≤7E-15 ≤7E-15	
(Although this is a rugged instrument which operates within +5 to 35°C ambient, the quoted specifications apply while the instrument is confined to a ±1°C ambient temperature change)					
<b>Aging</b>			≤5E-16/day at delivery ≤3E-16/day after 1 year op		
<b>Accuracy</b>			5E-13 over 5 years	±3E-13	
<b>Frequency Trim Range</b>		1E-6	At least 1E-10	1E-10	
<b>Setting Resolution</b>		1E-15	1E-14 Steps	≤7E-14	
<b>Retrace</b>			≤3E-14 after 24 hrs of op		
<b>SSB Phase Noise (dBc/Hz)</b>	<b>Hz from carrier</b>		<b>5MHz</b>	<b>100MHz</b>	<b>5MHz</b> <b>10MHz</b>
	1	-110	-110	-95	≤-105 ≤-100
	10	-140	-130	-105	≤-135 ≤-130
	100	-145	-140	-115	≤-145 ≤-135
	1000	-155	-150	-125	≤-150 ≤-140
	10000	-160....-170	-150	-125	≤-150 ≤-145
<b>Frequency Measurement Error (RMS) of Comparator</b>	1 sec 10sec 100sec 1hr or more	5E-14 1E-14 2E-15 1E-16	1E-13 1.5E-14 3E-15 5E-16		
<b>Power Input - AC</b>	115/220 Vac, ±10%, 45 to 430Hz <150 VA power consumption				
<b>Power Input - DC automatic battery back-up</b>	These masers may be powered by an external 22-30 Vdc supply. <100 watts powerconsumption. In case of ac failure the instrument automatically switches to the dc supply.				
<b>Warm Time</b>			240 hours to meet spec		
<b>Operating Temperature</b>		+5 to +35°C	+5 to +35°C		
<b>Temperature Coefficient /°C</b>		5...20E-15	5E-16/°C	≤1E-14	
<b>Storage Temperature</b>			-50°C to +50°C		
<b>Magnetic Sensitivity</b>		2E-14/Gauss	≤1E-14/Gauss		
<b>Pressure</b>			630 to 795 mm Hg		
<b>Humidity</b>			Up to 80% at 25°C		
<b>Size</b>		23.5"H x 23.5"W x 55"D 600 x 600 x 1400mm	27"H x 19"W x 22"D 680 x 480 x 560mm		
<b>Weight</b>			210lbs (90kg)		
<b>Warranty</b>	1 year (2....5 year options)				
<b>Service Life</b>	15 years				

## TIME & FREQUENCY STANDARD

### APPLICATIONS

Astro Laser ranging • Geodesy • Space Navigation • Glacial Movement • **Defence** • **GPS Satellite monitoring** • Intelligence • **Navigation** • Gravity prospecting • Climatology • **Position fixing** • Support of radar imaging • Calibration • Determination of Earth rotation • National frequency standards • Geo-dynamics • Earthquake research • Heat transport • **Calibration of Cesium, Rubidium & Quartz** • Telecommunications • VBLI • **Fast missile tracking** • Astronomy • Baseline definition • Plate tectonics • **National timekeeping** • Secure telecommunications • Company Laboratory Standard

### TECHNOLOGY

The PHM principle of operation is based on a 5 MHz quartz crystal oscillator, frequency locked to the hyperfine transition of the hydrogen atom. The basic block diagram of a Passive Hydrogen Maser is shown in Figure 1.

The Passive Maser is specifically designed to provide an alternative technology to the high performance option cesium oscillators. As shown in Figure 2, the Maser's stability specification is factor of 10 better than the best commercial cesium. Unlike Cesium, the Passive Maser does not have an expensive wear out physics package. In light of the above, the Passive Maser may be the number one choice over high performance option cesium oscillators when better stability and competitive accuracy are needed at comparable price, while at the same time reducing the 10 year life cycle cost.

Applications include: laboratory standard; Stratum 1 primary reference clock; satellite ground station standard, especially valuable for testing GPS disciplined oscillators/syne systems in telephone networks; VLBI; time scales; and others.

### GENERAL INFORMATION

The Passive and Active Hydrogen Maser Frequency Standards, and associated instruments are available from Quartzlock. These units have been built in substantial quantities for the last 40 years. The instruments are produced and exported from Quartzlock. Additionally, by special request, the performance of the instruments can be independently certified by the NIST, USA. PTB Germany or NPL, UK.

Complete customer service and support is provided at the customer's installation site, or, when necessary, the equipment can be returned to Quartzlock, or your local Quartzlock agent.

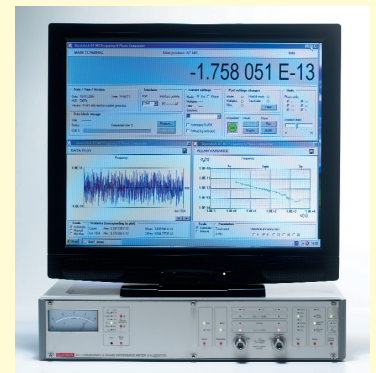
Both Passive and Active Masers have been in use at various institutes including: NIST, Boulder, Co; NRL, Washington, D.C; Smithsonian Astrophysical Observatory, Cambridge, MA; USNO, Washington, D.C; PTB, Braunschweig, Germany; DLR, Munich, Germany, Royal Belgian Observatory, Radio Observatory, Yebees, Spain & NPL's in Japan, S.Korea, UK, Brazil, China, USA, Canada, Sweden, Finland, France and elsewhere.

### Quartzlock H Maser compatible instruments



#### A8-MX

**GPS** disciplined BVA frequency & time standard, can provide GPS sync to 5ns and satellite/H Maser time transfer facility



#### A7-MX

Frequency/Phase Measurement system  
Resolution <1E16 Drift <1ps/h



#### A6

Frequency Converter Provides 1Hz & 1pps & 0.1, 1, 5 & 10 MHz sinewave & squarewave outputs



#### A5

Distribution amplifiers (4, 12, 24 or 32 outputs) Stability 1E-13/s. Phase noise -165dBc at 100Hz. Isolation 130dB@5MHz

#### A10-Y

Rb + Low noise SC OCXO. Very low noise clean-up loop technology. May be used to improve H Maser phase noise & AVAR.

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### ALLAN VARIANCE COMPARISON OF CESIUM, PASSIVE & ACTIVE MASERS

