

MHM 2010™

Active Hydrogen Maser



Key Features and Benefits

- Patented magnetic quadrupole for superior atomic beam focusing
- Very low hydrogen usage for extended maintenance-free operation
- Demonstrated lifetime of greater than 20 years
- Unique, stand-alone, cavity auto tuning feature for exceptional long-term standalone stability
- Proprietary Teflon coating technique, eliminating any re-coating requirement and extending maintenance free life
- CE compliant
- A low phase noise option for superior short-term stability in an active hydrogen maser
- Seven year standard warranty

Applications

- Scientific frequency reference source
- National time keeping service
- Radio astronomy: VLBI, VLBA
- Deep space tracking and navigation
- GNSS/GPS satellite monitoring

The Symmetricom® MHM 2010™ is the world's most widely installed active hydrogen maser for applications that require extreme frequency stability, low phase noise and long service life. It is the only commercially available active hydrogen maser with stand-alone cavity switching auto tuning manufactured in the USA. This technique enables the MHM 2010 to deliver long-term stability normally only attributed to the most stable of cesium atomic standards.

Hydrogen masers operate on the principal that when hydrogen atoms are provided the proper environment, they emit radiation of a precise frequency (1420 MHz) and spectral line width (21 cm). Phase locking this extremely small power, high purity signal to a very high performance quartz oscillator, provides the user with incredible long-term stability, as well as excellent phase noise.

Active masers are typically 4 times more stable than passive hydrogen masers and 100 times more stable than high performance cesium. Active maser advantages in metrology include superior noise (eliminating the necessity for reference clock noise corrections) and 10,000 times shorter interval to reach a specified frequency stability compared to high performance cesium.

Each MHM 2010 is manufactured to exacting quality standards and carefully checked at each stage to insure a top quality product. Once built, the units are subjected to extensive performance testing, verifying all aspects of operation. All maser product design, manufacturing and testing are conducted at a Symmetricom facility dedicated to these operations.

Auto-Tuning

The MHM 2010 incorporates an automatic frequency control system to maintain the cavity at a constant frequency relative to the hydrogen emission line. This technique enables the MHM 2010 to deliver long-term stability normally only attributed to the most stable of cesium atomic standards.

Environmental Sensitivity

The MHM 2010 is designed to for low sensitivity to temperature, magnetic field and power supply changes.

Outputs

The MHM 2010 provides multiple 5, 10, 100MHz outputs and 1PPS. Multiple configurations can be ordered to optimize for varied applications.

Low Phase Noise Output Option

The MHM 2010 can be factory configured with low phase noise outputs that enable higher resolution measurements in VLBI applications and provide improved reference signals for master timing systems. Users looking for extreme long-term stability no longer must trade off short-term stability.

MHM 2010

Low lifetime cost of ownership, maintenance free operation

Lifetime cost of ownership for active masers is a critical consideration. The MHM 2010 is designed for long life and low maintenance. The hydrogen supply is adequate for over 20 years of operation. An efficient hydrogen state selector minimizes the load on ion pumps (< 0.01 mole per year), and the pumps themselves are designed for greater than 20 year life at nominal hydrogen flux. The Teflon bulb coating virtually eliminates any recoating requirement and has a demonstrated life of over 20 years. Should it be required, the MHM 2010 is designed for on-site module replacement.

MHM 2010 Back Panel Configuration

* Battery pack not included



Specifications

STABILITY

Allan deviation (measured in 0.5Hz bandwidth):

	Standard	Low Phase Noise Option
1s	1.5E-13	8.0E-14
10s	2.0E-14	1.5E-14
100s	5.0E-15	4.0E-15
1,000s	2.0E-15	2.0E-15
10,000s	1.5E-15	1.5E-15

Floor* <1.0E-15 Typical <1.0E-15 Typical

Long term: <2.0E-16 per day* <2.0E-16 per day*

Auto tuning: no external reference required

* Typically achieved after extended period of unperturbed, continuous operation. Temperature variation: $\pm 0.25^{\circ}\text{C}$.

Relative humidity: $\pm 10\%$

ENVIRONMENTAL

- Temperature sensitivity: <1.0E-14/ $^{\circ}\text{C}$
- Magnetic sensitivity: <3.0E-14/Gauss
- Power source sensitivity: <1.0E-14

CONTROL

- Synthesized frequency resolution: 7.0E-17
- Frequency control range: 7.0E-10

Note: The synthesizer maintains continuous phase throughout frequency change.

AVAILABLE OUTPUTS

Frequency	Amplitude
5 MHz	13dBm
10 MHz	13dBm
100 MHz	13dBm
• Load impedance:	50 Ω

TIMING OUTPUT

- Format: 1PPS (positive going pulse)
- Amplitude: >3 V into 50 Ω (TTL compatible)
- Pulswidth: 20 μs
- Rise time: <3 ns
- Jitter: <10 ps RMS

TIMING INPUT

- Auto-sync input: 1PPS
- Amplitude: >3 V into 50 Ω (TTL compatible)
- Pulswidth: $\geq 20 \mu\text{s}$
- Rise time: <5 ns
- Jitter: <1 ns RMS
- Synchronization input to output: <15 ns

PHASE NOISE $\mathcal{L}(f)$

Outputs	5 MHz	10 MHz	100 MHz
1 Hz	$\leq -116\text{dBc}$	$\leq -110\text{dBc}$	$\leq -90\text{dBc}$
10 Hz	$\leq -135\text{dBc}$	$\leq -129\text{dBc}$	$\leq -109\text{dBc}$
100 Hz	$\leq -148\text{dBc}$	$\leq -142\text{dBc}$	$\leq -122\text{dBc}$
1 kHz	$\leq -155\text{dBc}$	$\leq -149\text{dBc}$	$\leq -129\text{dBc}$
10 kHz	$\leq -155\text{dBc}$	$\leq -149\text{dBc}$	$\leq -129\text{dBc}$
100 kHz	$\leq -155\text{dBc}$	$\leq -149\text{dBc}$	$\leq -129\text{dBc}$

LOW PHASE NOISE OPTION

Outputs	5 MHz	10 MHz	100 MHz
1 Hz	$\leq -130\text{dBc}$	$\leq -124\text{dBc}$	$\leq -102\text{dBc}$
10 Hz	$\leq -150\text{dBc}$	$\leq -138\text{dBc}$	$\leq -117\text{dBc}$
100 Hz	$\leq -158\text{dBc}$	$\leq -146\text{dBc}$	$\leq -126\text{dBc}$
1 kHz	$\leq -160\text{dBc}$	$\leq -150\text{dBc}$	$\leq -133\text{dBc}$
10 kHz	$\leq -160\text{dBc}$	$\leq -153\text{dBc}$	$\leq -134\text{dBc}$
100 kHz	$\leq -160\text{dBc}$	$\leq -153\text{dBc}$	$\leq -134\text{dBc}$

POWER

- Operating voltage: 85 to 264 VAC
- Frequency range: 47 to 63 Hz
- Peak power: 150W
- Operating power: 75W
- External DC input: 22 to 28 VDC 3.1A (typical)
- Standby battery pack: 8 hours operation

PHYSICAL SPECIFICATIONS

- Height: 42.0" (106.68 cm)
- Width: 18.0" (45.72 cm)
- Depth: 30.0" (76.0 cm)
- Weight: 475 lbs. (without batteries*)

* Add 66 lbs. for batteries

ORDERING INFORMATION

(Number of ports in parentheses)	Part No.
• (3) 5 MHz, (1) 10 MHz, (1) 100 MHz	75001-101
• (3) 5 MHz, (1) 10 MHz, (2) 100 MHz	75001-102
• (3) 5 MHz, (1) 10 MHz, 1 PPS Sync. 1PPS output	75001-103
• (3) 10 MHz, 1 PPS Sync. (2) 1PPS output	75001-104
• (2) 5 MHz, (1) 100 MHz, 1 PPS Sync. 1PPS output	75001-105
• (2) 5 MHz, (2) 10 MHz, 1 PPS Sync. (2) 1PPS output	75001-106
• (2) 5 MHz, (2) 10 MHz, (1) 100MHz	75001-107
• (2) 5 MHz, (1) 10 MHz, (1) 100MHz, 1 PPS Sync, 1PPS output	75001-108
• (3) 5 MHz, (2) 10 MHz, (2) 100MHz	75001-109
• (3) 5 MHz, (3) 10 MHz	75001-110
• (4) 5 MHz, (2) 10 MHz	75001-111
• (3) 10 MHz, (2) 100MHz, 1 PPS Sync, (2) 1PPS output	75001-112
• (3) 5 MHz, (1) 10 MHz, (2) 100MHz, 1 PPS Sync. 1PPS output	75001-113
• (3) 5 MHz, (1) 10 MHz, (1) 100MHz, 1 PPS Sync, (2) 1PPS output	75001-114
• Low Phase Noise option	