

MAGNAVOX MX 4400 GPS POSITIONING AND NAVIGATION SYSTEM

GPS Accuracy
for a broad range
of applications.





Presenting GPS
in a compact,
flexible, and
rugged package.

Magnavox meets your needs with the GPS navigator that's designed for maximum use with today's interim GPS constellation — and even greater utility when the GPS satellite system is fully deployed.

The versatile and affordable MX 4400 is a rugged, portable, two-channel C/A code receiver designed for a broad spectrum of scientific, military and commercial applications at sea, on land, and in the air. Applications include marine survey and navigation, drill rig positioning, land navigation and positioning, search and rescue, GPS test and evaluation, and many more.

The MX 4400 has a wide range of features and capabilities, yet is exceptionally easy to use. A sealed, waterproof enclosure assures dependable operation, even in harsh environments. The compact receiver weighs under 16 pounds and draws a modest 20 watts of power.

EMPHASIS ON ACCURACY AND RESPONSIVENESS

Because of its state-of-the-art design, the MX 4400 provides a level of accuracy that surpasses many costly, multi-channel receivers.

The system has demonstrated navigation accuracy of better than 15 meters RMS and static accuracy of 7-10 meters RMS.† Position and velocity are updated every 1.2 seconds.

Advanced navigation software incorporated in the MX 4400 includes an eight-state Kalman filter that continuously weighs and evaluates satellite data and compensates for the effects of antenna motion. As a result, you can navigate a smooth line and have confi-



dence in accurate point positioning. Accuracy and responsiveness are further enhanced by a simple "tuning" of the Kalman filter when the MX 4400 is being initialized. Simply specify the type of application and anticipated level of dynamics (e.g., "land — low dynamics") to activate this desirable feature.

BUILT-IN ASSURANCES OF PRECISION

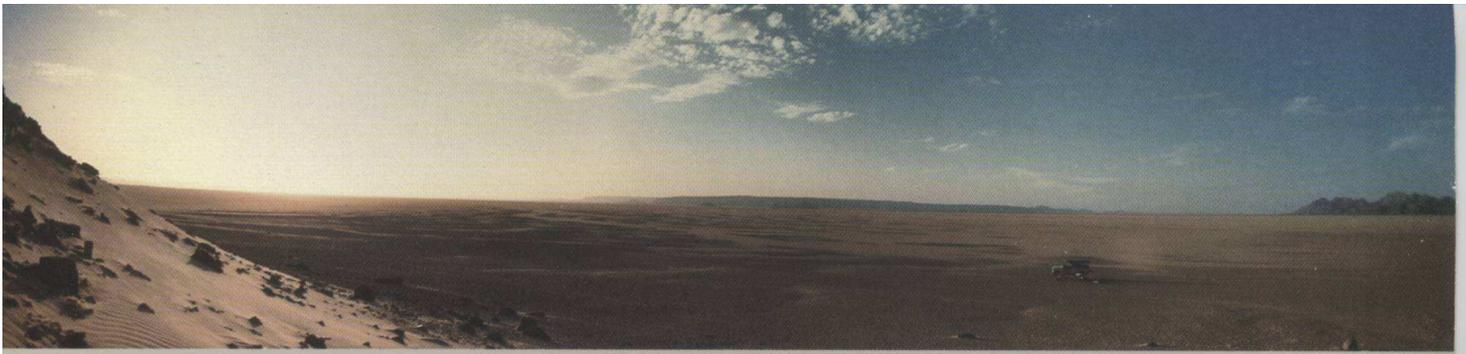
The system automatically reviews all available satellites, evaluating their geometry to select the best set for navigation. This evaluation is continuous, with ephemeris updates every hour for each visible satellite. This means the constellation being tracked can be adjusted without delay and assures use of the best available satellites for the best possible accuracy at all times.

Marine navigation also benefits from a built-in geoidal height map which references altitude to mean sea level. This provides for more accurate calculation of antenna height and, in the Altitude Hold Mode, more precise updates of latitude and longitude.

MAXIMIZING USE OF GPS

The two-channel MX 4400 receiver provides continuous navigation when sufficient GPS satellite coverage is available. One channel sequences through the best set of up to four visible satellites, forwarding satellite data to the Kalman filter for processing. The second channel constantly evaluates the satellite set, updating almanac (approximate orbital information) every four hours and ephemeris (precise orbital information) every hour, for each visible satellite.

†Refer to specifications



The MX 4400 navigates
at sea, on land or in
the air with a minimum
number of satellites.

The second channel also makes initial range measurements to newly visible satellites. Because the first channel continues to receive satellite data, there is no interruption in navigation, even when changing the set of satellites being tracked.

With as few as two usable satellites, the MX 4400 can navigate at sea, on land, or in the air. In its four satellite navigation mode, the MX 4400 updates position in three dimensions.

When equipped with an optional internal Barometric Altimeter, the system navigates continuously in three dimensions with only three satellites, once the altimeter has been calibrated during a period of four satellite coverage.

If altitude is known and constant, the system's Altitude Hold Mode is used to navigate with three satellites, without the use of the altimeter.

MX 4400 receivers equipped with the Barometric Altimeter and interfaced



to an Atomic Frequency Standard can navigate with two satellites, once the time and altitude inputs have been calibrated during a period of four satellite coverage. (An optional Atomic Frequency Standard interface board is required.) An Atomic Frequency Standard can be used for two satellite navigation in the Altitude Hold Mode without the Barometric Altimeter, when altitude is known and constant (such as in marine applications).

The ability to navigate with only two available satellites is an important Magnavox feature that can double the useful GPS coverage periods in many locations.

As another assurance of maximum

Twelve function keys enable the operator to quickly choose the type of data to be displayed.



system utility, the optional MX 44G Speed and Heading Interface Board permits the MX 4400 to dead-reckon during GPS coverage gaps. This interface board accepts inputs from most standard gyrocompasses and speed logs.

POWERFUL FEATURES THAT ARE EASY TO USE

A straightforward keypad assures ready access to every feature — from marking a position to waypoint navigation. Twelve function keys enable the operator to quickly access the type of data to be displayed, while the four keys below the display call up the specific information desired.

Summary of MX 4400 functions and displays

POS Shows present position in geographic coordinates and, optionally, in UTM. Also displays altitude computed by GPS and manually entered altitude above mean sea level.

PLAN Used for planning operations requiring GPS satellite coverage. Shows rise and set times of 2-, 3-, or 4-satellite constellations for any specified location and date, present or future.

MARK Marks present position to simplify return to the same point. Receiver can display marked position, as well as time marked, plus range and bearing to return to the marked position.

NAV Displays course (COG) and speed (SOG) over the ground. Also accommodates manual input and display of speed and heading, or automatic display of speed and heading from sensors. Set and drift and present position are also displayed.

WPT Lets the operator set and review the location of up to 30 waypoints. The "auto" waypoint function automatically enters present position as a waypoint.

SATS Displays the PRN number of the satellite being tracked, as well as the azimuth angle, elevation angle and signal-to-noise ratio for each satellite. HDOP and VDOP, indicators of the quality of satellite geometry, and satellite health status are also available for display.

KYBD Lets the operator select desired level of keyboard and display illumination, and can lock the keyboard. Also used to define the desired data input and output parameters for the two data ports.

INIT The initialization function is used to enter, review or change information for setting up MX 4400 operation. System prompts help the operator enter data.

DEST Displays range and bearing to the intended waypoint (Rhumb Line or Great Circle). Also shows heading to steer to arrive at a specified waypoint. Steering display shows the along-track distance traveled and cross-track error. ETA at the specified waypoint is also displayed.

TIME Time is shown as Universal Time Coordinated (UTC) or local time; time offset between the two is easily entered. This key also selects either UTC or local time as the time mode for other MX 4400 displays.

ALRM Lets the operator set alarms for events related to GPS satellite coverage and waypoint navigation.

STAT Displays time of day, number of satellites being tracked and the status of each of the two receiver channels. Also displays codes for any activated alarms.



Options provide added versatility to tailor the MX 4400 to your application.

For example, the operator presses "POS" to display position. Now, a menu presents a selection of information.

Pressing the left arrow key displays latitude and longitude. Pressing the next arrow key displays altitude computed by GPS on the top line and height of the antenna above sea level as input by the operator on the lower line. The third arrow key displays position in UTM coordinates in receivers equipped with this optional feature.

MEETING YOUR SPECIAL NEEDS

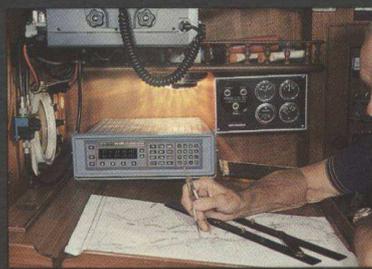
Harsh Environments—The MX 4400's sealed, waterproof enclosure assures dependable operation in virtually any mission environment—from pouring rain to driving snow.

Marking Present Location—You can mark your current position and later display range and bearing to return to this location. Here's a valuable feature for search and rescue operations, salvage work, man-overboard situations, and many other applications.

Planning for GPS Coverage—The system can display satellite coverage for 2, 3, and 4-satellite constellations for any date or location. This is a major aid in mission planning, particularly with the current interim GPS constellation.

Steering Display for Precise Navigation—The MX 4400 shows cross-track error and the direction to steer to correct your course, assuring that you hold a precise line.

Flexible Data Handling—The MX 4400 has two RS-422 I/O ports. Port A provides access to both raw and processed data. Port B provides data outputs in National Marine Electronics



Association NMEA-0183 format for ease of interface to plotters, autopilots and other devices. Baud rates, word lengths and parity are selectable.

Options for Added Versatility—To tailor the MX 4400 to your specific application, you can specify...

- Atomic Frequency Standard Interface to allow for operation in "Clock Hold Mode" with a rubidium or cesium standard.
- Choice of Antenna:
 - Mast mountable marine antenna/preamp
 - Low-profile antenna and preamp—ideal for vehicle or aircraft installations
 - Tripod mountable antenna/preamp for land applications
- Internal Barometric Altimeter extends useful GPS satellite coverage period for land or air applications up to an altitude of 10,000 feet.
- AC to DC converter, with internal battery back-up, permits operation from 110 VAC or 220 VAC power.
- RS-422 to RS-232C Adapter facilitates interface to devices requiring an RS-232C input.
- Rack-Mount Kit allows for installation in a standard 19-inch rack.
- Manpack Configuration—The MX 4400 is available as a receiver/display assembly, low-profile antenna, preamplifier and eight-hour battery—all installed in a backpack assembly weighing approximately 30 pounds. Position can be displayed on latitude/longitude, UTM or MGRS (Military Grid Reference System) coordinates. The system provides fast, accurate position updates for a wide range of field applications.

MX 4400 GPS SPECIFICATIONS*

ACCURACY (demonstrated)

Navigation:	Better than 15 meters RMS (3 dimensions)† Better than 12 meters RMS (2 dimensions)†
Static:	Better than 10 meters RMS (3 dimensions)† Better than 8 meters RMS (2 dimensions).†
Velocity:	0.1 knots (0.05 meters/sec.)†

OPERATIONAL

Time-to-First-Fix:	5 minutes maximum (warm oscillator with almanac stored in memory)
Maximum Dynamics:	Velocity: 300 meters/sec. (671 miles/hr. or 591 knots) Acceleration: 6 meters/sec ²
Position Update Rate:	Every 1.2 seconds (nominal)
RECEIVER	
Type:	2-channel, L ₁ , C/A code
Sensitivity:	-143 dBm Costas acquisition threshold
ANTENNA	
Type:	L ₁ circularly polarized
Marine Antenna:	-4 dBic minimum gain for elevation angles greater than 20 degrees below the horizon
Low Profile Antenna:	-2 dBic minimum gain for elevation angles above 0° Peak gain 5 dBic. 0 dBic minimum gain above 15° elevation angle.
Tripod Mountable Antenna:	-2 dBic minimum gain for elevation angles above 0° Peak gain 3 dBic. 0 dBic minimum gain above 15° elevation angle.
Cable Options:	30 or 60 meters RG214/u non-armored 30 or 60 meters RG215/u armored 8 or 30 meters RG223/u lightweight, non-armored
Power:	+10 to +30 VDC unregulated, 25 watts maximum, 20 watts nominal

ENVIRONMENTAL

Operating Temperature:	Receiver: -20° to +50° C Marine Antenna: -40° to +70° C Low-Profile Antenna Element: -50° to +80° C Tripod Mount Antenna: -40° to +70° C
Relative Humidity:	100%

DIMENSIONS

Receiver/Display Assembly:	35.4 cm W x 32.5 cm D x 10.5 cm H (13.93 x 12.79 x 4.13 in.) Weight: 7.2 kg (16 lbs.)
Marine Antenna/Preamp Assembly:	Height: 33.0 cm (13.1 in.) including mounting bracket Diameter: 20.6 cm (8.1 in.) maximum Weight: 4.5 kg (10 lbs.)
Low Profile Antenna Assembly Antenna Element:	Height: 6.35 mm (.25 in.) Diameter: 8.89 cm (3.50 in.) Weight: 142 g (5 oz)
Preamp/Downconverter	Height: 4.14 cm (1.63 in.) Width: 20.32 cm (8 in.) Depth: 20.32 cm (8 in.) Weight: 1.65 kg (3.63 lbs.)
Land Antenna/Preamp Assembly:	Height: 18 cm (7 in.) Diameter: 21 cm (8.3 in.) Weight: 1.5 kg (3.3 lbs.)

DATA PORTS

Number and Type:	Two RS-422 I/O ports
Port A:	Outputs: Selectable groups of processed and unprocessed GPS data. Update rate is 1.2 seconds (nominal). Programmable data rates ranging from 50 bps to 19,200 bps. Word lengths and parity selectable. Input: Reserved for future use.
Port B:	Outputs: NMEA-0183 format. Update rate selectable from once per second. Programmable data rates from 50 bps to 19,200 bps. Word lengths and parity selectable. Inputs: Reserved for future use.

ATOMIC FREQUENCY STANDARD INTERFACE (option)

5 MHz reference signal input required.
Input voltage: -10dBm (sine wave) to TTL frequency standard drift rate should not exceed 4 parts in 10^{11} per month from a rubidium or cesium frequency standard.

INTERNAL BAROMETRIC ALTIMETER (option)

Altitude Range: -100 ft. to 10,000 ft.

MX 44G SPEED AND HEADING INTERFACE BOARD (option)

Speed Inputs

Contact Closure:
Minimum Open Time 0.5 milliseconds
Minimum Closure Time 0.5 milliseconds
Maximum Repetition Rate 1000 closures per second

Input Voltage:
Open Contacts 2.5 to 15.0 VDC
Closed Contacts -15 to 0.8 VDC

Fore/Aft Sign:
On Level 2.5 to 15.0 VDC
Off Level -15 to 0.8 VDC

Heading Inputs

Heading Sensor Accepts the output from most commercially available gyro compasses, either with a stepper or synchro output.

Synchro:

Impedance 25 k Ω Stator (S1, S2, S3) and Reference (R1, R2)
Voltage 12 to 200 VAC = 20% Stator and 24 to 220 VAC = 20% Reference
Frequency 50 to 400 Hz = 10%
Repeater Output 1 revolution of repeater may represent from 1 $^{\circ}$ to 10.0 $^{\circ}$ of ship's heading

Stepper:

Impedance 25 k Ω
Current Required 14 to 50 mA
Voltage DC with maximum 10% ripple or full-wave rectified AC 50 to 400 Hz. Step amplitudes from 25 volts to 100 volts are acceptable.

Gray Code Stepping: Resolution is 6 steps per 360 $^{\circ}$ of synchro rotation. ($\frac{1}{6}$ $^{\circ}$ resolution is provided if 360 $^{\circ}$ synchro rotation equals 1 $^{\circ}$ heading change)

*Magnavox reserves the right to make changes to its products and specifications without notice.

MX 4400 static and dynamic test results are included in "GPS Static and Dynamic Testing - Techniques and Results" by Dennis G. Jones and Kenneth W. Rhoades, copies of which are available from Magnavox.

†GPS satellites currently in operation are experimental in nature and the accuracy obtained is dependent upon the level of system maintenance provided by the U.S. Government, as well as satellite geometry, the number of satellites in operation, ionospheric conditions, and other factors. The U.S. Government's stated policy is that GPS accuracy will be degraded to 50 meters RMS when Block II GPS satellites become operational.

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