G8

Interface Summary

- G8 OEM Board
- Compatible GPS Antenna
- G8 Interface Protocol

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1. Functional Description

The G8 OEM board is a low-cost, high-performance GPS sensor for reliable position, speed, and time reporting in difficult environments such as vehicle navigation, fleet management, and personal asset management. Designed for system integration, G8 offers autonomous or DGPS positioning, low power, small size, and the standard NMEA protocol. It utilizes 5 VDC power and supports two TTL serial communication ports that are accessible through the I/O connector. The G8 is sold and supported through the Ashtech OEM Precision Product Business Unit of Magellan Corporation, with corporate offices in Santa Clara, California, USA.

2. Technical Specifications

Table 1.1 lists key technical specifications.

Table 1.1. Technical Specifications

Item	Specification
General	8-channel continuous tracking OEM GPS receiver board
GPS parameters	L1 frequency, C/A code (SPS)
Update rate	1 Hz
Communication interface	NMEA 0183 V2.1 using standard Ashtech command set
RTCM V2.1 message types	Differential remote message types 1, 3, 6, 9, 16
Serial ports	One TTL full duplex for primary I/O One TTL half duplex for RTCM
Baud rate	Software selectable 300 bps to 19200 bps. Maximum recommended character rate is 400 characters per second.
Size	Versions 1 and 2: 1.58 x 2.41 x 0.52 in (40 x 61 x 13 mm) Version 3: 1.54 x 2.36 x 0.41 inches (39 x 60 x 10 mm)
Weight	Versions 1 and 2: 1.6 oz (45.4gr) Version 3: 0.7 oz (19.8gr)
I/O interface	TTL
Input voltage/power	5 VDC ± 0.25 VDC <700 mW (typical)
Backup power	2.7 to 3.5 VDC (12 µA) 3.6 to 5.25 VDC (10 µA)
Receiver noise figure	<7 dB typical without antenna

3. Performance Specifications

Table 1.2 summarizes key performance specifications.

Table 1.2. Performance Specifications

Item	Specification
Real-time position accuracy	Horizontal CEP 2.0 m with DGPS correction Horizontal 95% 5.0 m with DGPS correction
Typical acquisition time	<10 sec hot start <40 sec warm start <120 sec cold start
Typical reacquisition time	<1 sec from total satellite blockage
Update rate	User-selectable from 1 second to 99 seconds in 1-second increments synchronized with GPS.
1 PPS output	G8 calculates time and outputs a 1 PPS pulse when it has a position and is tracking one (in most cases) or more satellites. 1 PPS pulse output is synchronized to GPS time ± 1 µsec.
Geoid model	Supported internally
Magnetic variation model	Supported internally

4. Hardware Description

The G8 is available in three versions:
Version 1 - Board enclosed in mechanical shield case with I/O connector suitable for cable interfaces
Version 2 - Board enclosed in mechanical shield case with I/O connector suitable for stackable interfaces
Version 3 - Board without the mechanical shield case with I/O connector suitable for stackable interfaces

Version 1 is shown in Figure 1.1. It features a mechanical shield case and I/O connector suitable for cable interfaces. The mechanical shield case provides protection while handling, a significant degree of ESD protection, and a small degree of EMI protection. In this configuration, the most common mounting method utilizes the three mounting holes on the bottom of the mechanical shield case, as shown in Figure 1.2. Key dimensions are summarized in Table 1.3.

Figure 1.1: G8 Version 1, OEM Board with Mechanical Shield Case and Cable Ready I/O Connector

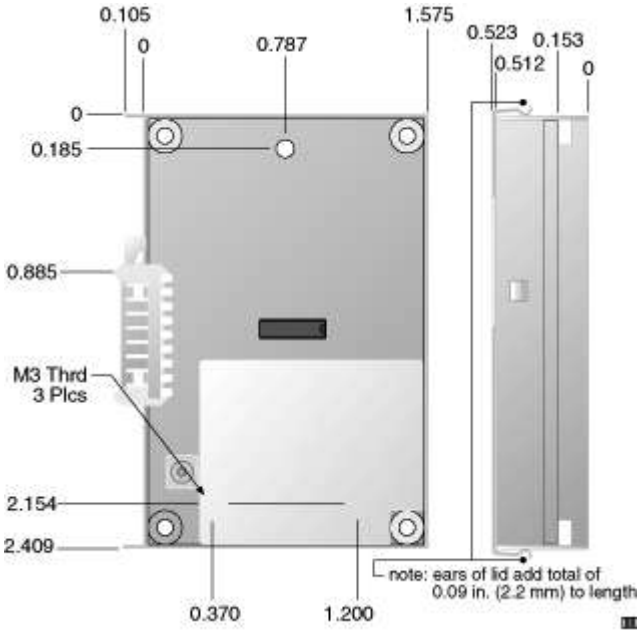

Figure 1.2: G8 Version 1, Shield Case Dimensional Drawing Top View (transparent cover) and Side View

Version 2 is shown in Figure 1.3. It features a mechanical shield case and I/O connector suitable for stackable interfaces common to mounting configurations that mount the G8 directly onto a motherboard with other electronics. The mechanical shield case provides protection while handling, a significant degree of ESD protection, and a small degree of EMI protection. There is a slot in the bottom of the shield case for a mating I/O connector. In this configuration the most common mounting method utilizes the three mounting holes on the bottom of the mechanical shield case, as shown in Figure 1.4. Key dimensions are summarized in Table 1.3.

Figure 1.3: G8 Version 2, OEM Board with Mechanical Shield Case and Stackable I/O Connector

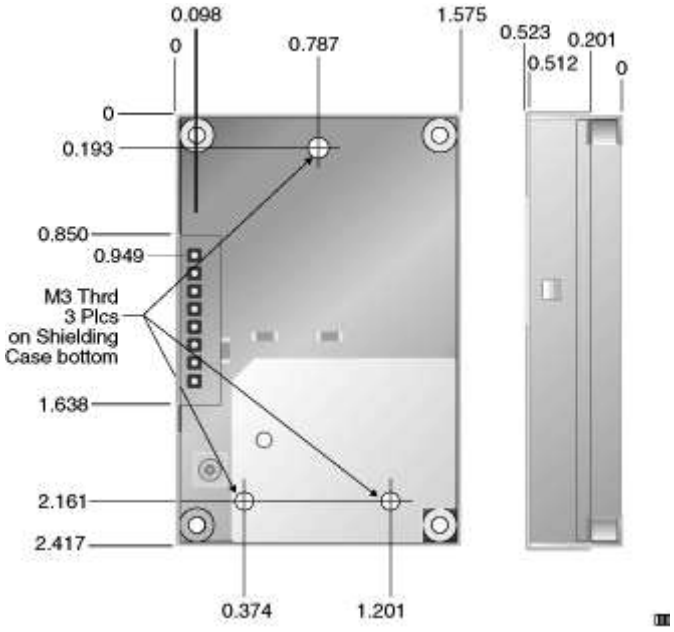

Figure 1.4: G8 Version 2, Shield Case Dimensional Drawing
Top View (transparent cover) and Side View

G8 Version 3 is shown in figure 1.5. This version is intended for the user that desires to minimize the overall amount of space required for the GPS board due to an especially "tight fit" system implementation. The G8 is designed to meet specification with or without its mechanical shield case, so this version requires no special accommodation. Version 3 features a stackable I/O connector suitable for mounting the G8 on stand-offs using the mounting hole in each corner of the board. The height of the mating I/O connector can be chosen to be compatible with the height of the stand-offs. As a special feature, the I/O connector can be accessed from either the top or bottom of the board. The applicable mounting dimensions of the G8 board are shown in Figure 1.6.

Please note that in all three versions of the G8 board, an RF shield case is soldered to the board, but it is visible only in the Version 3 configuration. For reliable operation, the RF shield case must always remain soldered on the board.

Figure 1.5: G8 Version 3, OEM Board with Stackable I/O Connector

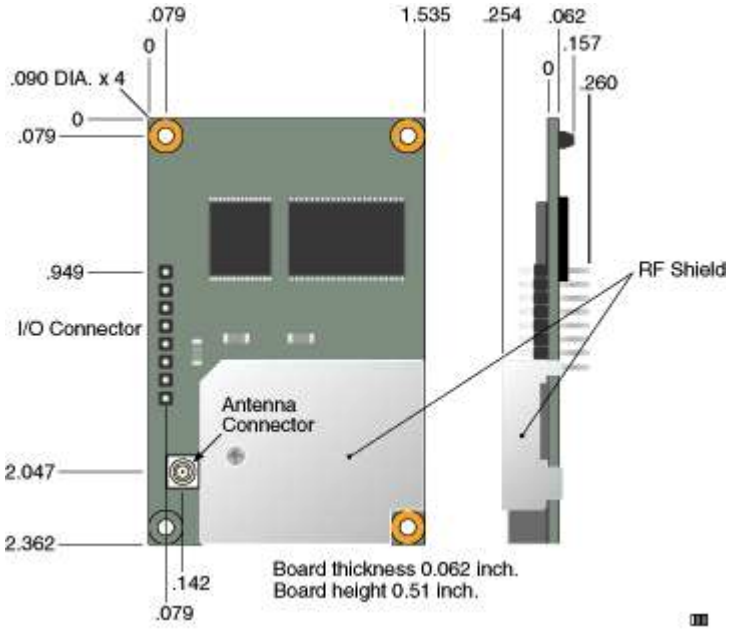

Figure 1.6: G8 Version 3, OEM Board Dimensional Drawing
Top View and Side View

Table 1.3: Dimensions and Weight

Characteristic	Versions 1 and 2		Version 3	
	Inches	Millimeters	Inches	Millimeters
Length	2.410	61.2	2.362	60
Width (*)	1.575	40	1.535	39
Thickness	0.523	13.3	0.41	10.4
Weight	1.6 oz	45.4 gr	0.7 oz	19.8 gr
Mounting hole diameter	refer to figure 1.2	n/a	refer to figure 1.3	n/a
Mounting hole location	refer to figure 1.2	n/a	refer to figure 1.3	n/a

(*) Note: The I/O connector on the Version 1 board extends approximately .15 inches (3.8mm) beyond the width dimension shown

5. Power/Input/Output Connections

Table 1.4 lists the power/input/output connections for the 8-pin I/O connector.

Table 1.4. Power/Input/Output Connections

Pin	Signal Designation	Function
1	VCC	Primary board power connection
2	V_ANT	Antenna power connection
3	V_BACK	Battery backup power connection
4	GND	Ground
5	RTCM	Receive data, port B (receive data at G8 from external device)
6	RXD	Receive data, port A (receive data at G8 from external device)
7	TXD	Transmit data, port A (transmit data from G8 to external device)
8	1 PPS	1 PPS output

6. Power Requirements

The G8 board requires the following operating power (typical):

Main power: 5 VDC ± 0.25 VDC, maximum ripple 50 mV P-P
Nominal current: <140 mA @ 5 VDC
Nominal power: <700 mW @ 5 VDC
Backup power: 12 µA at 2.7 to 3.5 VDC; 10 µA at 3.6 to 5.25 VDC
Sleep mode power: <450 mW
Antenna power (V_ANT): up to 25 VDC, 300 mA max (This is for an active antenna. Power must be applied to a different pin than the one used to supply the main power to the G8)

7. Environmental Specifications

The G8 board operates within the environmental limitations listed in Table 1.5.

Table 1.5. Environmental Limitations

Condition	Specification
Operating temperature	-30°C to +80°C
Standby temperature	-30°C to +80°C
Storage temperature	-40°C to +85°C
Humidity	95% RH non-condensing
Vibration	1.7 g^2/Hz 20 Hz -6 dB/octave 20 to 500 Hz 0.003g^2/Hz 500 to 2000 Hz
Speed limitations	1000 knots (514 m/sec)*
Altitude limitations	60,000 feet (18,288 m)*
* The G8 produces no valid position information when this specification is exceeded.	

8. Radio Frequency Interference

The G8 OEM board uses eight dedicated separate and parallel channels for Coarse/Acquisition (C/A) code-phase (a.k.a. pseudo-range) on the L1 (1575.42 MHz) band. The G8 receives satellite signals via an L-band antenna with integral low-noise amplifier (an active antenna must be supplied separately).

Some radio transmitters, cellular phones, or other mobile communications equipment can interfere with the operation of GPS receivers. The Ashtech Precision Products Business Unit recommends you verify that nearby hand-held or mobile communications devices do not interfere with GPS receivers before setting up your project.

The G8 is equipped with an RF shield over the RF section of the receiver. This protects the sensitive components in this area of the board, and also eliminates emissions from this section. The RF shield is soldered to the board and must remain in place at all times. The mechanical shield case does provide a small degree of additional RF isolation. It is recommended that the mechanical shield case be used, but the G8 operates reliably without the mechanical shield case.

9. I/O Connector

The I/O connector on the G8 Version 1 board is a Molex 53254-0810, a small 8-pin connector. It's mating connector is 51065-0800 (terminal crimp housing) and 50212-8100 (crimp terminal). Eight crimp terminals for each terminal crimp housing are needed. The I/O connector for the G8 Version 2 and 3 boards is a SAMTEC MTMM-108-06-G-S-245. A common mating connector is SAMTEC SMM-108-01-S-S, though an equivalent may be used. It is important to choose a mating connector height suitable to your mounting scheme (how far you choose to mount the G8 board from the board to which it connects). SAMTEC and other connector manufacturers have many options to choose from.

10. Antenna Connector

The RF connector on G8 is a Hirose S.FL2-R-SMT. This is a small, upward facing, coaxial connector. It's mating connector is a S.FL2-LP-0.7DW (right angle plug). This connector also requires a center pin insert, P/N S.FL2-LP female terminal. This connector is one of the lowest cost reliable connectors available. The Ashtech Precision Products Unit has several sources for this connector and interface cables featuring this connector. This information is provided in the G8 Accessories Guide.

11. Antenna

For optimum performance, G8 requires a reliable, low-power antenna with a built-in low-noise amplifier (LNA). Many antenna manufacturers provide low-cost antennas optimized for a mobile environment, with many choices of design, filtering options, LNA gain level, packaging, connector style, cable length, and mounting options. Given the wide variety of choices in the marketplace, we recommend that you obtain your antenna directly from the manufacturer. Table 1.6 lists the required antenna electrical performance specifications. Contact your local G8 distributor or the Ashtech Precision Products Business Unit for a list of recommended antenna sources (antenna sources are also provided in the G8 Accessories Guide).

Table 1.6. Antenna Specifications

Parameter	Specification
Center frequency	1575.42 MHz
Output impedance	50 ohms
Polarization:	RHCP
Gain	Recommended 0 dBic at zenith, minimum -5 dBic at 5° elevation above horizon
LNA gain	26 dB ± 2.5 dB. Excess gain at board input must exceed 10 dB (LNA gain - cable loss >10 dB)
Filter	30 dB attenuation 100 MHz above or below center frequency
Noise figure	< 2.5 dB
Power input	Antenna is powered via V_ANT at pin 2. User supplies power for antenna. Voltage input should be limited to 25 VDC or less.
FCC	Per user specification.

The G8 contains an antenna supply circuit that utilizes a 20-ohm series resistor and L/C filter to isolate the DC power from the GPS RF energy. This circuit supplies power to the antenna via the center pin of the RF connector, using the 20-ohm resistor to protect the DC output from short circuits.

The 20-ohm resistor can dissipate up to 1.5 W. The maximum V_ANT voltage which can be safely short-circuit protected is 5.5 volts. The maximum current allowance through the V_ANT pin is 300 mA. There is no impedance requirement at pin 2 (V_ANT). Pin 2 is usually driven by a low-impedance power supply. RF decoupling is done on the G8 board.

For the nominal case of V_ANT = 5 VDC, a 4.5 VDC (approximate) signal will appear on the center pin of the G8 RF connector. You need to account for the voltage drop across the 20-ohm current-limiting resistor in your choice of antenna and power allocation for your application. A diagram of the antenna supply circuit is shown in Figure 1.5.

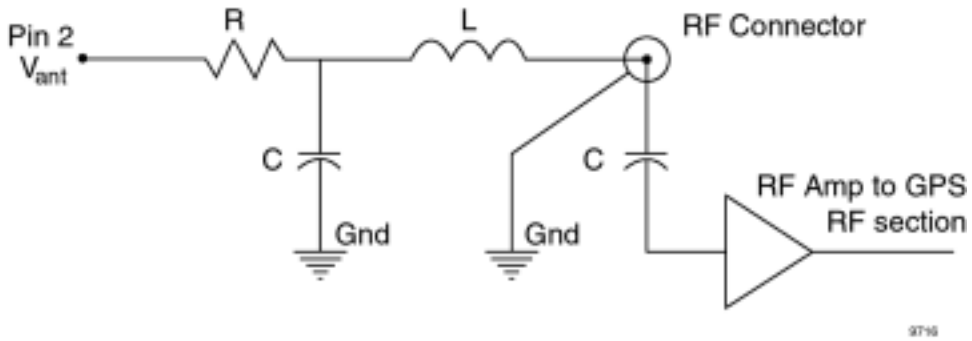

Figure 1.5: G8 Antenna Supply Circuit

12. Interface Protocol

All Ashtech GPS receivers use a combination of standard NMEA commands and proprietary NMEA-like commands ("$PASH" commands). The G8 returns responses in standard NMEA format or NMEA-like format, depending upon the command given the receiver. The standard NMEA responses are $GPALM, $GPGGA, $GPGLL, $GPGSA, $GPGSV, $GPRMC, $GPVTG, and $GPZDA. NMEA Specification NMEA0183 V2.1 provides details for these commands.

13. $PASH Set, Query, and Response Commands

Set and Query serial port commands set receiver parameters and request data and receiver status information. All commands sent by the user to the receiver are either Set commands or Query commands. Set commands generally change receiver parameters and initiate periodic data response. Query commands generally request receiver status information provided in a single response. Response commands describe the format of data returned from the receiver. All Set commands begin with the string $PASHS and all Query commands begin with the $PASHQ string. Commands are commonly sent to the receiver through serial port A. Table 1.7 summarizes the set/query commands and response messages.

Table 1.7: Summary of Set/Query Commands and Responses

Set Command	Query Command	Response	Description
$PASHS,ALM		$PASHR,ACK/NAK	Upload almanac data
$PASHS,ALT		$PASHR,ACK/NAK	Set ellipsoidal height of antenna
$PASHS,DTM		$PASHR,ACK/NAK	Select datum to use
$PASHS,FIX		$PASHR,ACK/NAK	Set altitude position fix mode
$PASHS,HDP		$PASHR,ACK/NAK	Set HDOP mask for position computation
$PASHS,INI		$PASHR,NAK	Reset receiver
$PASHS,KFP,DYN	$PASHQ,KFP,DYN	$PASHR,KFP,DYN	Set filter dynamics
$PASHS,LTZ		$PASHR,ACK/NAK	Set local time line
	$PASHQ,PAR	$PASHR,PAR	Receiver parameters query
$PASHS,PDP		$PASHR,ACK/NAK	Set PDOP mask
$PASHS,PEM		$PASHR,ACK/NAK	Set elevation mask angle
$PASHS,PMD		$PASHR,ACK/NAK	Set navigation position mode
$PASHS,POS		$PASHR,ACK/NAK	Upload initial position data
	$PASHQ,PRT	$PASHR,PRT	Serial port baud rate query/response
$PASHS,PWR		none	Directs receiver to go to sleep mode
	$PASHQ,RID	$PASHR,RID	Reports receiver ID, Mfg ID, FW version, date, options
$PASHS,RAW,ITA	$PASHQ,ITA	$PASHR,ITA	Set receiver to output compact inverse differential message
$PASHS,RST		$PASHR,ACK/NAK	Reset receiver
$PASHS,SAV		$PASHR,ACK/NAK	Save user parameters.
$PASHS,SPD		$PASHR,ACK/NAK	Set serial port speed
$PASHS,UID	$PASHQ,UID	$PASHR,UID	Set 4 character identification number
$PASHS,UDD	$PASHQ,UDD	$PASHR,UDD	Set/Query user-defined datum parameters
$PASHS,USE		$PASHR,ACK/NAK	Selects Satellites to track or not track
$PASHS,ZDA		$PASHR,ACK/NAK	Upload initial real-time clock value

14. NMEA Responses (and corresponding Set/Query Commands)

All standard NMEA messages are a string of ASCII characters delimited by commas, in compliance with NMEA 0183 Standards Version 2.1. Most logical combinations of these messages can be output at the same time (G8 messages should be chosen so as not to overrun the maximum recommended I/O character rate of 400 characters per second). The output rate is determined by the $PASHS,NME,PER command or the specific $PASHS,NME command, and can be set to any value between 1 and 999 seconds. For each NMEA message type there is generally a set command, a query command, and a response message. The set command is used to continuously output the NMEA response message at the specified period. The query outputs a NMEA response message only once. Table 1.8 summarizes the NMEA data message commands and responses.

For G8 firmware version HD00 or later, the G8 automatically outputs the $GPGGA and $GPVTG messages at a rate of once per second on power up. These messages can be disabled, if desired, by the user.

Table 1.8: NMEA Data Message Commands & Responses

Set Command	Query Command	Response	Description
$PASHS,NME,ALL		$PASHR,ACK/NAK	Disable all NMEA messages
$PASHS,NME,ALM	$PASHQ,ALM	$GPALM	Enable/disable ALMANAC
$PASHS,NME,GGA	$PASHQ,GGA	$GPGGA	Enable/disable position response message
$PASHS,NME,GLL	$PASHQ,GLL	$GPGLL	Enable/disable latitude/longitude message
$PASHS,NME,GSA	$PASHQ,GSA	$GPGSA	Enable/disable satellites used message
$PASHS,NME,GSV	$PASHQ,GSV	$GPGSV	Enable/disable satellites in view
$PASHS,NME,MSG	$PASHQ,MSG	$GPMSG	Enable/disable base station message
$PASHS,NME,PER		$PASHR,ACK/NAK	Set send interval - all NMEA messages
$PASHS,NME,POS	$PASHQ,POS	$PASHR,POS	Receiver Position Message
$PASHS,NME,RMC	$PASHQ,RMC	$GPRMC	Recommended minimum specific GPS data response message
$PASHS,NME,SAT	$PASHQ,SAT	$PASHR,SAT	Enable/disable satellite status message
$PASHS,NME,VTG	$PASHQ,VTG	$GPVTG	Enable/disable velocity/course message
$PASHS,NME,ZDA	$PASHQ,ZDA	$GPZDA	Enable/disable time and date message

15. RTCM Set and Query Commands

The G8 is designed for outputting position, speed, and time information, either autonomously or differentially corrected using DGPS corrections in RTCM SC-104 Version 2.1 format. The RTCM commands allow you to control and monitor RTCM real-time differential operations. All RTCM commands except one are set commands. Through the set commands you can modify and enable a variety of differential parameters. There is only one query command: $PASHQ,RTC, used to monitor the parameters and status of RTCM differential operations. Table 1.9 summarizes the RTCM commands.

Table 1.9: RTCM Commands

Function	Command	Description
General parameters	$PASHS,RTC,OFF $PASHQ,RTC	Disables differential mode Requests differential mode parameters and status
Remote parameters	$PASHS,RTC,AUT $PASHS,RTC,MAX $PASHS,RTC,REM	Turns auto differential mode on or off Sets maximum age of RTCM differential corrections Sets receiver to operate as differential remote station