

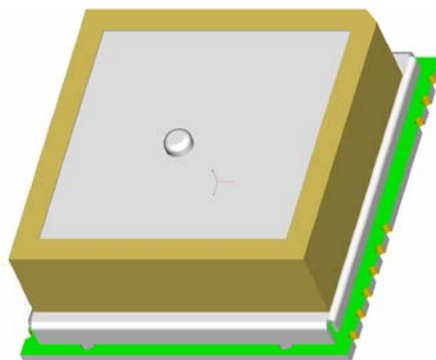


# GPS Receiver A2235-H

A Description of Maestro's  
GPS Antenna Receiver Module A2235-H

## User's Manual

Version 0.1



## Revision History

Rev.	Date	Description
0.1	08-15-12	First release
	mm-dd-yy	

	Name	Date	Signature
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## 1 Introduction

A2235-H is an antenna module with SiRF Star IV ROM based chip and an on-board patch antenna (15mm x 15mm x 4mm). It is cost down version of A2035-H with reduced size and stacked up antenna architecture. In order to have easier migration for existing customers, we decided to keep same pin assignment as that of A2035-H. Since there is RF feed point underneath the module, special PCB design is required on user's application and therefore it can't be stated as pin-to-pin compatible with A2035-H. The module is capable of receiving signals from up to 48 GPS satellites and transferring them into position and timing information that can be read over a serial port.

The A2235-H is a module designed for a 3.3V environment.

### 1.1 Feature Overview

The A2235-H is a new module with the following outstanding features.

- Fast, responsive location experience
  - High-sensitive navigation engine with tracking down to -163dBm
  - 48 track verification channels
  - SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Breakthrough micro power technology
  - Requires only 50 – 500 $\mu$ A to maintain hot start capability
- Active jammer remover
  - Removes in-band jammers up to 80dB/Hz
  - Tracks up to eight CW (continuous wave) jammers

## 1.2 Characteristics Overview

The module's most important characteristics are:

- Operable at 3.3V / 31mA (typ.) @ 1fix per second
- UART interface at CMOS level
- Small form factor of 17.78 x 16.51 mm<sup>2</sup> (0.7" x 0.65")
- Supported temperature range: -40°C to +85°C
- Single-sided SMT component, for reflow soldering
- RoHS compliant, lead-free
- Tape & reel packaging
- On-module patch antenna

The antenna receiver module is available as an off-the-shelf component, 100% tested and shipped in tape-and-reel packaging.

## 1.3 RoHS and Lead-Free Information

Maestro's products marked with the lead-free symbol either on the module or the packaging comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).



All Maestro GPS receiver modules, GPS antenna receiver module and telematics units are RoHS compliant.

### 1.4 Label

The A2235-H label (size: 12.0x 4.0 mm<sup>2</sup>) contains the following information:



Figure 1: A2235-H label

The label is placed on the side of the GPS antenna. The data matrix code holds the product type, part number, software release, hardware release, factory code, year & week of assembly and a 6-digit serial number. Due to limited space on module label, only product type, year & week of assembly and 6-digit serial number will be printed on it.

Representing	Factory location	Product Number	Part Number	Software Release	Hardware Release	Assembly Year/Week	Serial Number
Number of digits (16)	XX 2	XXXXXXXX 6	XXXX 4	XX 2	XX 2	XXXX 4	XXXXXX 6
Example	GS	A2235H	9322	01	01	1211	000005
Meaning	GSL	Given	Given	Given	Given	Year=12 Week=11	Increment from 000001 up to 999999

Example of MID#: GSA2235H932201011211000005



## 1.5 Characteristics

The module is characterized by the following parameters.

### 1.5.1 GPS Characteristics

Channels		48, parallel tracking
Correlators		~400,000
Frequency		L1 (= 1,575 MHz)
Tracking Sensitivity On-module antenna		-163 dBm
Horizontal Position Accuracy	Stand alone	< 2.5 m CEP (SA off)
Time To First Fix – TFFF (theoretical minimum values; values in real world may differ)	Obscuration recovery <sup>(1)</sup>	0.1 s
	Hot start <sup>(2)</sup>	< 1 s
	Warm <sup>(3)</sup>	< 35 s
	Cold <sup>(4)</sup>	< 38 s

Table 1: A2235-H GPS characteristics

- (1) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the  $\mu$ s level).
- (2) The receiver has estimates of time/date/position and valid almanac and ephemeris data.
- (3) The receiver has estimates of time/date/position and recent almanac.
- (4) The receiver has no estimate of time/date/position, and no recent almanac.

Note: Performance (sensitivity and TFFF) might slightly decrease below  $-30^{\circ}\text{C}$ .

### 1.5.2 Mechanical Characteristics

A2235-H Mechanical dimensions	Length	17.78 $\pm$ 0.20 mm, 0.7 $\pm$ 0.008"
	Width	16.51 $\pm$ 0.20 mm, 0.65 $\pm$ 0.008"
	Height	7.11 mm, 0.28"(Max)
A2235-H Weight		4.0 g, 0.14 oz

Table 2: A2235-H dimensions and weight

## 1.6 Handling Precautions

The GPS receiver module A2235-H is sensitive to electrostatic discharge (ESD). Please handle with appropriate care.

## 2 Ordering Information

### 2.1 GPS Receiver A20235-H

The order number is built as follows:

- **A2235-Hxxxx**

A2235-H is the model name. The “xxxx” refers to the current part number on the module.

### 2.2 Packing

The A2235-H GPS modules come in a tape and reel package suitable for pick and place machines.

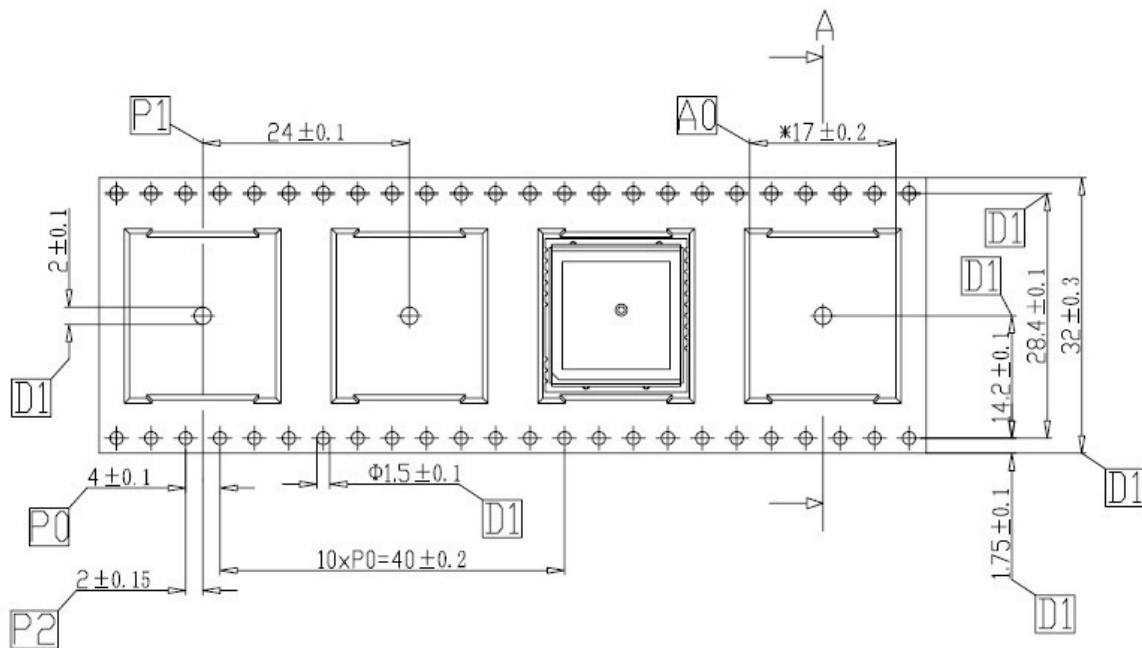


Figure 2: A2235-H tape specifications (1)

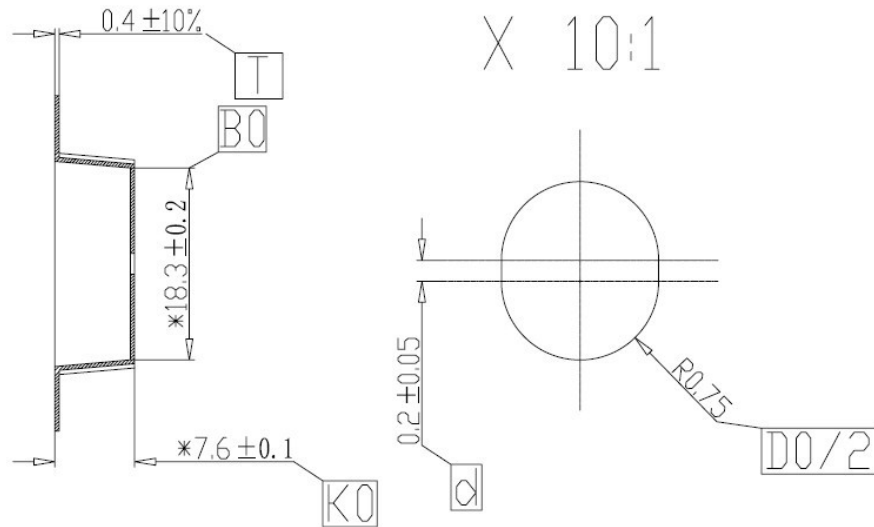


Figure 3: A2235-H tape specifications (2)

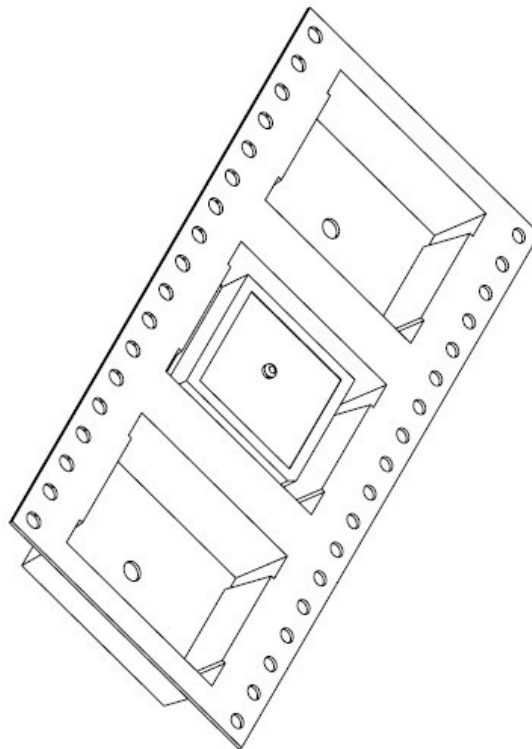


Figure 4: A2235-H tape specifications (3)

One complete reel holds 500 (TBC) A2235-H modules.

There are 2 kinds of packaging for shipment (TBC):

A: One box holds 1 reel

Reel diameter: 38 cm

Outer Box dimensions: 38.8 (W) x 38.8 (L) x 5.7 (H) cm

Gross weight: 5.06 Kg

Net weight: 4.13 Kg

B: One box holds 2 reels

Reel diameter: 38 cm

Outer box dimensions: 38 (W) x 38 (L) x 12.3 (H) cm

Gross weight: 10.03 Kg

Net weight: 8.26 Kg

## 2.3 Additional Equipment

EVA2235-H	Evaluation Kit (including one module A2235-H)
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Table 3: Additional equipment

A detailed description of the EVA2235-H Evaluation Kit can be found in the appropriate manual.

### 3 Quick Start

In order to allow an easy and quick start with the A2235-H module, this chapter provides a short overview on the important steps to be taken to receive NMEA messages with position information on a serial port (UART).

**NOTE 1:** The A2235-H needs an external pull-up resistor to be configured for UART operation. Please consider the pull-up resistor in your design or pull the GPIO up right after reset by other means.

**NOTE 2:** The ON\_OFF input of the A2235-H needs to be connected to a push-pull output of a microprocessor. For a wake-up, including the initial one after power on, a LOW-HIGH transmission is mandatory.

**NOTE 3:** It is recommended to connect the nRST pin of the A2235-H to an open collector / open drain output of a microprocessor!

#### 3.1 Minimum Configuration

The following picture shows the minimum configuration for NMEA or binary outputs received and commands sent via an RS232 interface based on the GPS module A2235-H.

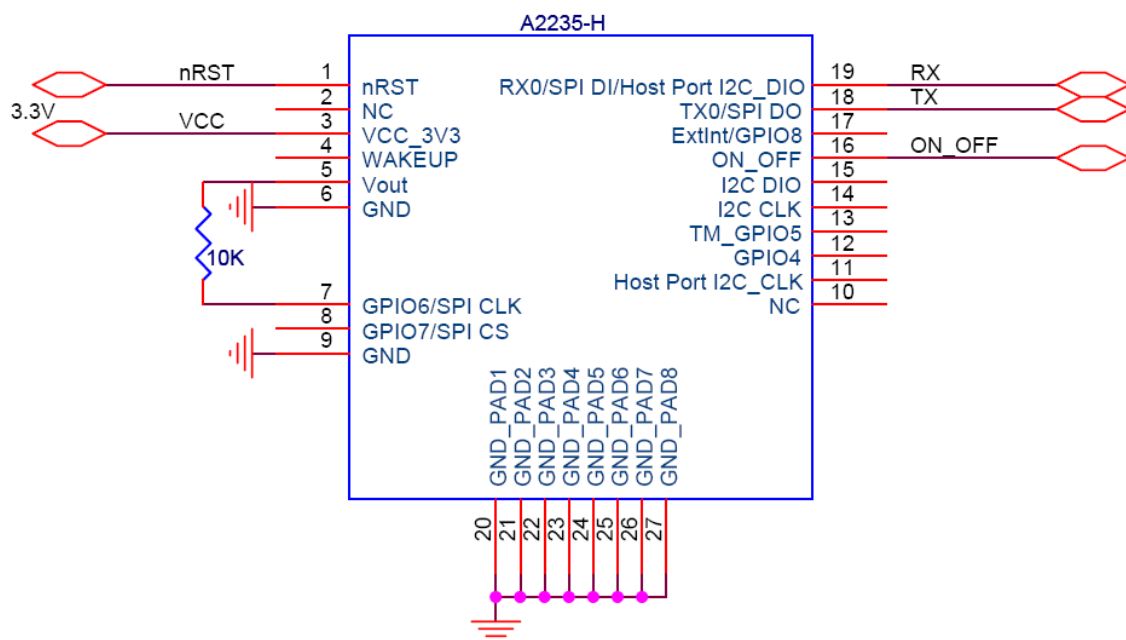


Figure 5: Minimum configuration A2235-H

**NOTE:** It is recommended to supply Vcc continuously! Use SiRFaware™ or other low power modes to reduce power consumption of the module while no position information is required.

For completeness the following picture shows the use of an RS232 level shifter.

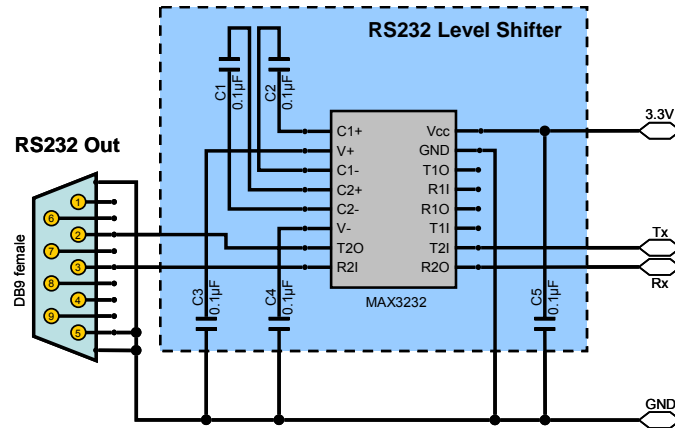


Figure 6: RS232 level shifter for minimum configurations

Remarks:

- Place C1 to C5 (here: 0.1µF) close to MAX3232. For capacity values see datasheet of actual component used.
- Use 3.3V level shifter (MAX3232 or equivalent).

### **3.2 Antenna**

The A2235-H connected to a ceramic passive GPS patch antenna.

### **3.3 Serial Port Settings**

The default configuration within the custom-specific GPS firmware is:

- Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control

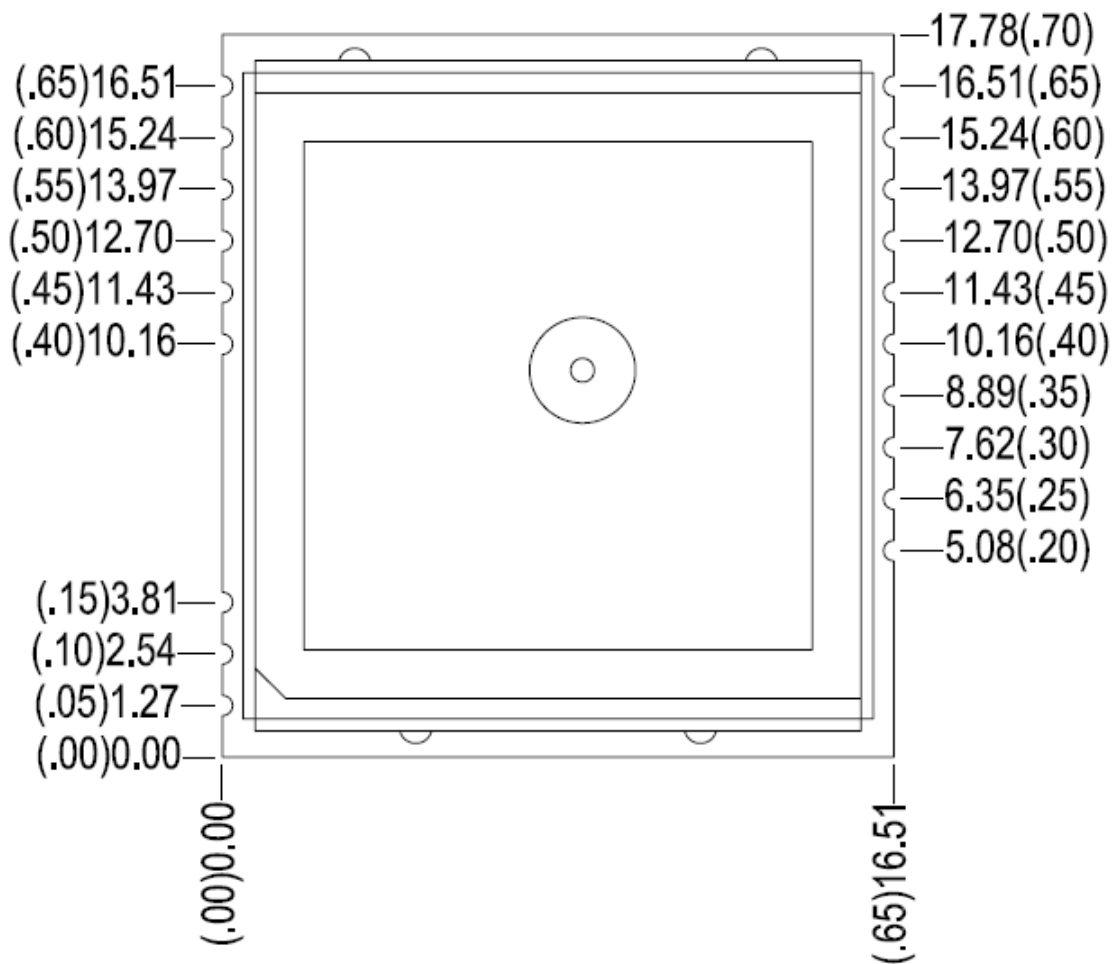
### **3.4 Improved TTFF**

In order to improve the TTFF (Time To First Fix), it is recommended to keep Vcc supplied at all times. This will allow taking advantage of sophisticated low power mode features of the SiRFstarIV ROM chip set.



## 4 Mechanical Outline

### 4.1 Details Component Side A2235-H



All dimensions in [mm] / [(inches)]

Figure 7: Mechanical outline component side A2235-H



## 5 Pin-out Information

### 5.1 Layout A2235-H

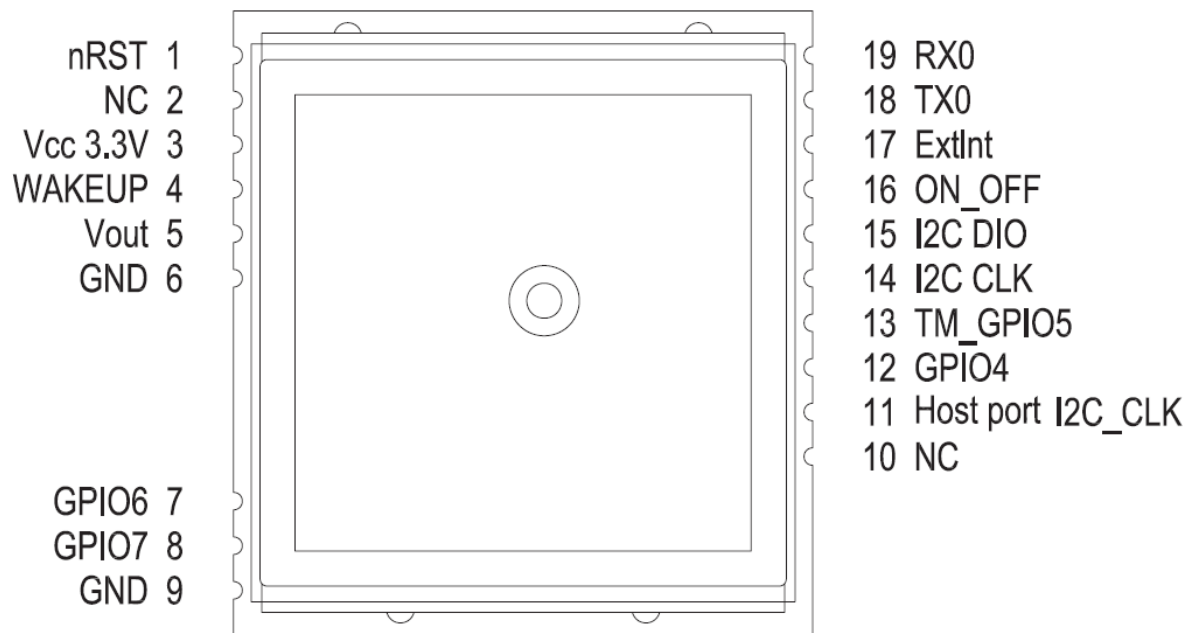


Figure 9: Pin-out information (top view) A2235-H

## 5.2 Description A2235-H Signals

Pin	Symbol	Function	Description
1	nRST	Input	Reset input, active low
2	GPIO3	None	Leave open
3	VCC3V3	Power Supply	3.0 – 3.6 V DC
4	WAKEUP	Output	Status of digital section
5	Vout	Voltage Output	Permanent 1.8V voltage output for up to 20mA current max.
6	GND	Power Supply	Ground (power supply)
7	GPIO6 CTS (SPI CLK)	Input	Configuration pin for communication mode. 10K to 1.8V for UART mode; leave open for SPI & host port I2C modes. SPI clock pin when module works in SPI mode
8	GPIO7 RTS (SPI CS)	Input	Configuration pin for communication mode. 10K to GND for host port I2C mode; leave open for SPI & UART modes. SPI chip select pin when module works in SPI mode
9	GND	Power Supply	Ground (power supply)
10	GPIO2	None	Leave open
11	Host Port I2C_CLK	Input	Host port I2C clock pin when module works in host port I2C mode
12	GPIO4	Input	External interrupt input pin – reserved for future use, leave open
13	TM_GPIO5	Output	Time Mark – 1PPS signal
14	I2C CLK	Input	I2C clock input for MEMS interface
15	I2C DIO	Input / Output	I2C I/O for MEMS interface
16	ON_OFF	Input	Connect to push-pull output is mandatory. - Set to LOW by default - Toggle to HIGH and back to LOW > for first start-up after power on > to request a fix in SiRFaware™ or PTF mode > to go into or wake up out of hibernate mode
17	ExtInt (GPIO8)	Input	Interrupt input for MEMS interface (If ExtInt is not going to be used, it is recommended that this pin be tied directly to ground. Otherwise, a 100K pull-down resistor to ground should be connected to the ExtInt pin.)
18	TX0 / (SPI DO)	Output	Serial output 0.NMEA out if configured for UART; SPI data out pin when module works in SPI mode.
19	RX0 / (SPI DI) / (Host Port I2C_DIO)	Input	Serial input 0.NMEA in if configured for UART; SPI data in pin when module works in SPI mode; Host port I2C data I/O pin when module works in hist port I2C mode.

Table 4: Pin description A2235-H

## 6 Electrical Characteristics

### 6.1 Operating Conditions

Pin	Description	Min	Typical	Max
3	Vcc	3.0V	3.3V	3.6V
	Full power mode (Searching) Peak Current (1)		69mA	
	Full power mode (Searching) Average Current (2)		56mA	
	Full power mode (Tracking) Average Current (3)		31mA	
	TricklePower™ Mode		14mA	
	Push-to-Fix Mode		46.4uA	
	Micro Power Mode (SiRFaware™)		45uA	
	Hibernate Status		27uA	

Table 5: A2235-H electrical characteristics

- (1) Peak searching current is characterized by millisecond bursts above average searching current
- (2) Average searching current is typically only the first two seconds of TTFF
- (3) Tracking current typically includes tracking and the post searching portion of TTFF

### 6.2 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
Vcc	Power supply	-0.3	+4.6	V
Vin	Voltage to I/O pin	-0.3	+3.6	V
Iov	Input current on any pin	-10	10	mA
Itdv	Absolute sum of all input currents during overload condition		200	mA
Tst	Storage temperature	-40	85	°C

Table 6: Absolute maximum ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### 6.3 DC Electrical Characteristics

Symbol	Parameter	Min	Max	Unit
TX0, WAKEUP	Voh @ 4mA	2.6	Vcc	V
	Vol @ 4mA		0.45	V
RX0	Vih	2.0	Vcc	V
	Vil		0.8	V
nRST	For safe reset		0.2	V
ON_OFF	Vih	1.35	Vcc	V
	Vil	-0.3	0.45	V

Table 7: DC electrical characteristics

## 7 Mounting

This chapter describes the suggested mounting process for the A2235-H GPS receiver modules. In a RoHS compliant product with a RoHS compliant process it is recommended to use chemical tin as the counter-part to the module's pins. This will guarantee highest resistance against shocks.

### 7.1 Proposed Footprint for Soldering

The following proposal of a footprint for soldering is assuming a stencil thickness of 150µm. ✕ marks the center of the through holes.

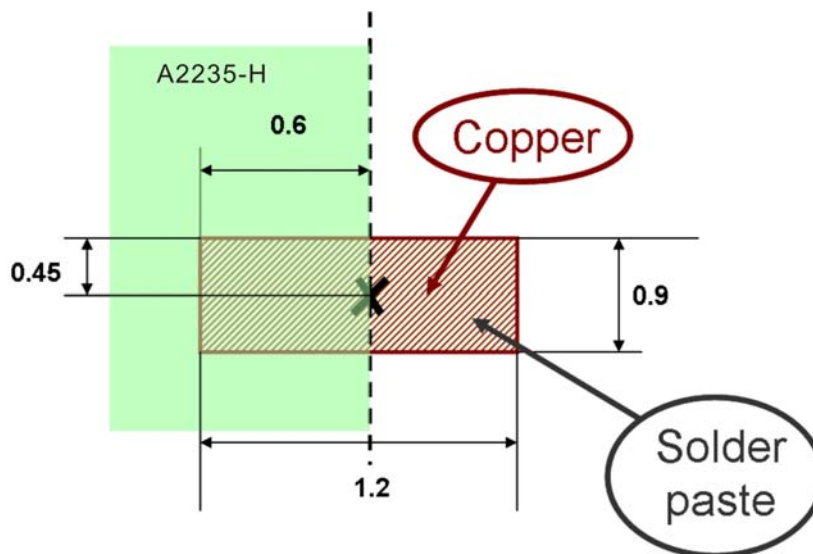


Figure 10: Proposal of Soldering footprint

Please note that copper and solder paste footprint are identical. The final footprint has to be evaluated and qualified by the manufacturer according to the specific processes.

### 7.2 PCB Design Guide

1. Drill a through hole with diameter greater than or equal to 3mm in the application PCB which underneath the RF feed-point to allivate the interference from RF signal to other part of circuitries. Besides, ground vias (says, 8) should be placed surrounding the through hole for further shielding purpose.

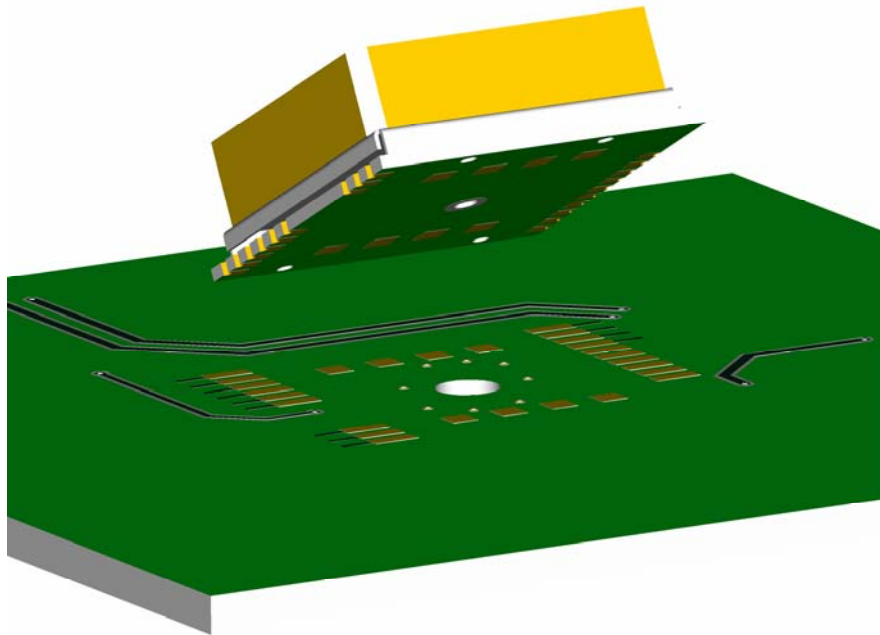


Figure 11: Proposal (1) of the PCB design

2. If proposal 1 is not allowed. Placd a round Copper keep out region (diameter  $\geq 3\text{mm}$ ) on the application PCB underneath the RF feed-point to allivate the interference from RF signal to other part of circuitries. Besides, ground vias (says, 8) should be placed surrounding the through hole for further shielding purpose.

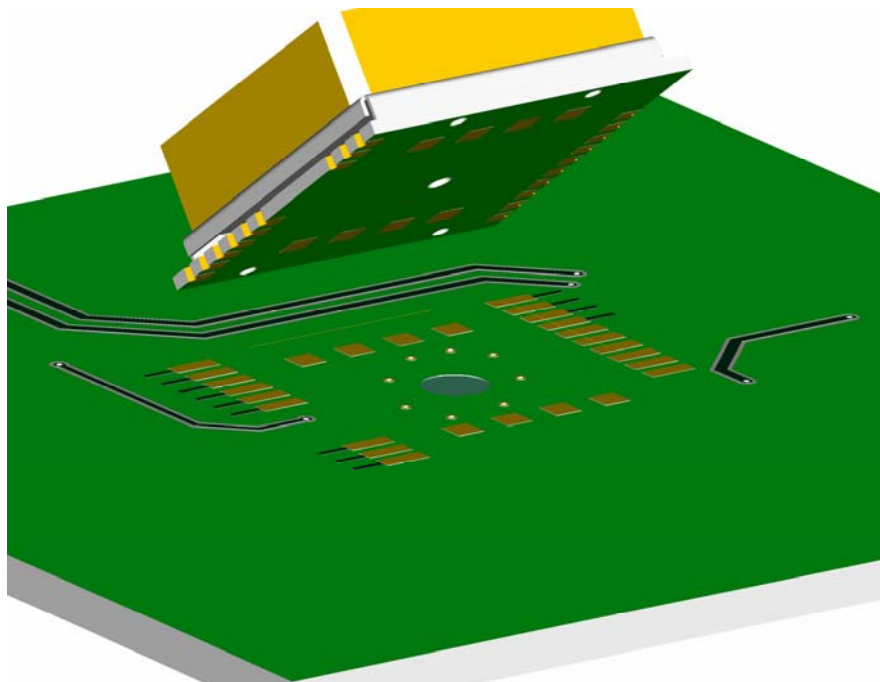


Figure 12: Proposal (2) of the PCB design



### 7.3 Recommended Profile for Reflow Soldering

Typical values for reflow soldering of the module in convection or IR/convection ovens are as follows (according to IPC/JEDEC J-STD-020D):

Parameter	Value
Peak temperature (RoHS compliant process)	245°C
Average ramp up rate to peak (217°C to Peak)	3°C / second max.
Preheat temperature	min=150°C; max=200°C
Ramp up time from min. to max. preheat temperature	60 ... 120 seconds
Temperature maintained above 217°C	60 ... 150 seconds
Time within 5°C of actual peak temperature	30 seconds
Ramp down rate	6°C / second max.
Time 25°C to peak temperature	8 minutes max.

Table 8: Reflow soldering profile A2235-H

As results of soldering may vary among different soldering systems and types of solder and depend on additional factors like density and types of components on board, the values above should be considered as a starting point for further optimization.

## 8 Quality and Reliability

### 8.1 Environmental Conditions

Operating temperature	-40°C ... +85°C
Operating humidity	Max. 85% r. H., non-condensing, at 85°C
MSL JEDEC (Moisture Sensitivity Level)	3
Storage	6 months in original package

Table 9: Environmental conditions

### 8.2 Product Qualification

Prior to product qualification the GPS receiver is preconditioned according to EIA/JEDEC standard JESD22-A113-B / Level 3.

Basic qualification tests:

- MSL Classification according to J-STD-020C (MSL3 @ 245°C)  
(Refer to report : SZRL2011110048)
- MSL Rework Compatibility according to J-STD-020C  
(Refer to report : SZRL2011110048)
- Temperature Cycling –40°C ... +85°C
- Temperature Humidity Bias 70°C / 85% RH
- Low / High Temperature Operating –40°C / +85°C
- High Temperature Operating Life +85°C
- Vibration Variable Frequency
- Mechanical Shock

Please contact Maestro for detailed information.

### 8.3 Production Test

Each module is electrically tested prior to packing and shipping to ensure state of the art GPS receiver performance and accuracy.

## 9 Applications and Hints

### 9.1 Initial Module Start

After initially applying power to the module, it is necessary to start the internal firmware by toggling the ON\_OFF pin. Toggling is done by pulling the signal to HIGH for about 200ms. This first toggling can be done after a LOW – HIGH transmission was detected at the WAKEUP pin or by simply waiting for 1s after power-up. In case of configuration for UART mode, messages should be transmitted afterwards. If no messages should appear, a new toggling should be applied.

### 9.2 Proper Shutdown and Power-On-Reset (POR)

The A2235-H modules require an orderly shutdown process to properly stop internal operation and complete any writes of critical data to BBRAM or EEPROM data area. Abrupt removal or drop of main power while the system is running has risks ranging from minor impact on TTFF to fatal, permanent corruption of EEPROM code area on the module (Please refer to “Power ONOFF Sequences and Power -On-Reset (POR) on A2100-AB Application Notes”).

A controlled and orderly shutdown while the A2235-H is running in full power mode can be initiated by

- A 200ms pulse on the ON\_OFF pin,
- According messages either in NMEA or OSP mode.

The shutdown is completed after maximum 1s. Therefore the module should be supplied with voltage for that time after the shutdown sequence was initiated.

### 9.3 SiRFaware™ Support

SiRFaware™ is a low-power operating mode that seeks to maintain low uncertainty in position, time, and frequency, and to maintain valid current Ephemeris using either data collected from satellites in view or Extended Ephemeris methods.

The SiRFaware™ mode is entered using the One Socket Protocol, an extension of the SiRF Binary Protocol. Please refer to the appropriate manual. In order to request a fix and to exit SiRFaware™ it is necessary to toggle the ON\_OFF pin. Toggling is done by pulling the signal to HIGH for about 200ms.

### 9.4 Push-to-Fix Mode

Push-to-Fix mode is designed for the application that requires infrequent position reporting. The receiver generally stays in a low-power mode, up to 2 hours, but wakes up periodically to refresh position, time, ephemeris data and RTC calibration.

The push-to-fix mode is initialized and entered using the SiRF Binary Protocol. Please refer to the appropriate manual, paying particular attention to the paragraph titled “Set TricklePower Parameters”. In order to request a fix outside the specified duty cycles, it is necessary to toggle the ON\_OFF pin. Toggling is done by pulling the signal to HIGH for about 200ms.

## 9.5 Hibernate Mode

In order to enter Hibernate Mode it is necessary to send a shutdown command or to toggle to ON\_OFF pin by pulling the signal to HIGH for about 200ms. Starting with firmware version 4.0.1 the according command is supported in NMEA and SiRF Binary mode. After a short delay the module will switch into hibernate mode. The RTC will keep on running and SRAM is backed with the typical current of 20  $\mu$ A drawn from Vcc. To wake the module up again, toggling the ON\_OFF pin is necessary (200ms pulse width).

## 9.6 Extended Ephemeris

The receiver is capable of supporting two versions of using Extended Ephemeris (EE) data. The first one is the version, where the EE data are calculated on a server, are transmitted to device incorporating the receiver, and are then loaded into the receiver. These data can be valid for up to seven days.

The second version is the internal extrapolation of available “natural” Ephemeris data. This is done automatically and no external support is required. The internally calculated EE data are valid for up to 3 days.

The receiver firmware will define which set of EE data to use or will neglect those in case “natural” data are available (need add an external EEPROM part). Both versions of EE data will help to further lower power consumption in SiRFaware™ mode.

## 9.7 TM\_GPIO5 pin (1 pulse per second pin)

The 1PPS pin is an output pin.

In addition to precise positioning, GPS also allows for accurate timing due to the synchronized atomic clocks in the GPS satellites. While the current date and time is transmitted in NMEA sentences (UTC), an exact and accurate timing signal is provided via the 1PPS pin of the A2035-H GPS receiver.

Under good signal conditions the 1PPS signal comes between 620ns and 710ns after the full GPS system second which is accurately (around 10ns) synchronized to UTC. Therefore the 1 second clock can be derived and maintained within around 90ns under good signal conditions.

Note:

The 1PPS clock accuracy directly depends on the position accuracy!

The GPS signals travel at the speed of light, therefore a position inaccuracy directly translates into 1PPS inaccuracies.

10m position deviation  $\approx$  33ns 1PPS deviation (typically)

100m position deviation  $\approx$  333ns 1PPS deviation (typically)

The NMEA messages containing absolute timing information (UTC time) are provided around 300ms after the 1PPS signal typically. This may change with the GPS receiver setup.

The 1PPS signal is provided on a “as is” basis with no accuracy specification. It’s NOT recommended to use 1PPS signal for accurate timing application.

The given values are based on a 10 satellite, static GPS simulator scenario.

## 10 Evaluation Kit EVA2235-H

For demonstration and easy evaluation of GPS performance Maestro offers an evaluation kit (including one GPS A2235-H module). It contains a USB interface with according drivers to connect easily to a PC. The USB interface is an extension of the serial port 0, therefore sending NMEA sentences and accepting commands. At the same time it provides power to the module. Accompanied by an antenna it offers a ready-to-go set.

For the development of new software and applications the Evaluation Kit also provides NMEA messages on CMOS level via a terminal plug.

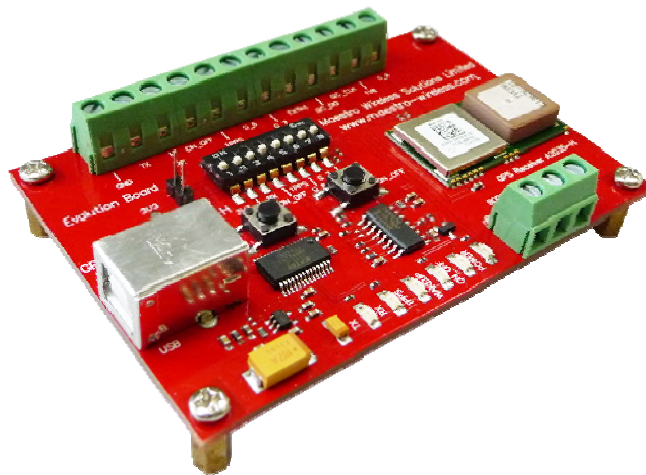


Figure 13: Evaluation kit EVA2235-H

For further information please contact Maestro.

## 11 Related Information

### 11.1 Contact

This manual was created with due diligence. We hope that it will be helpful to the user to get the most out of the GPS module.

Any inputs regarding possible errors or mistakable verbalizations, and comments or proposals for further improvements to this document, made to Maestro, HongKong, are highly appreciated.

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### 11.2 Related Documents

- GPS Evaluation Kit EVA2235-H (Maestro)
- Power ON/OFF Sequences and Power-On-Reset (POR) on A2100-AB (Maestro)
- SiRF\_OSP\_Reference\_Manual (SiRF)
- SiRF\_NMEA\_Reference\_Manual (SiRF)

### 11.3 Related Tools

- GPS Cockpit (Maestro)
- SiRFLive (SiRF)

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