

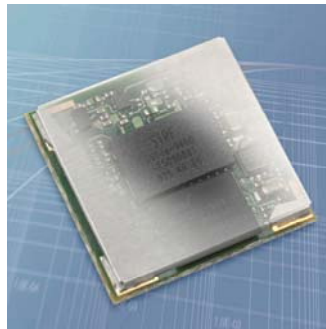


GPS Receivers A2100-A

**A Description of Vincotech's
GPS Receiver Module A2100-A**

User's Manual

**Version 0.3
Hardware Revision 50**



PRELIMINARY

Revision History

Rev.	Date	Description
0.1	08-24-09	Copied from A1084 V1.1
0.2	01-25-10	RoHS, pin-out, clean-up, ...
0.3	01-29-10	nWAKEUP correction, new pictures, ON_OFF correction, BOOTSEL correction
	mm-dd-yy	

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1 Introduction

The A2100-A is Vincotech's first implementation of CSR's SiRFstarIV chip on a GPS module. It is a highly integrated GPS receiver that can be used as an SMT component. A very easy implementation (power, serial, and antenna) allows receiving position, velocity and time information.

1.1 Feature Overview

The A2100-A is based on the well-established A1084-B outline and offers new, outstanding features.

- Fast, responsive location experience
 - High-sensitive navigation engine with tracking sensitivity down to -163dBm
 - 48 track verification channels
 - SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Breakthrough micro power technology
 - Requires only 50 – 500 μ 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 / 32mA (typ.) @ 1 fix per second
- UART interface at 3.3V CMOS level
- Prepared for SPI Slave support at 3.3V CMOS
- Direct passive antenna support
- Switched antenna voltage for active antenna support
- Small form factor of 15.24 mm x 15.24 mm (0.6" x 0.6")
- Supported temperature range: -40°C to +85°C
- Single-sided SMT component, for reflow soldering
- Tape & reel packaging

The A2100-A receiver module is available as off-the-shelf components, 100% tested and shipped in standard tape-and-reel package.

1.3 RoHS and Lead-Free Information

Vincotech'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).

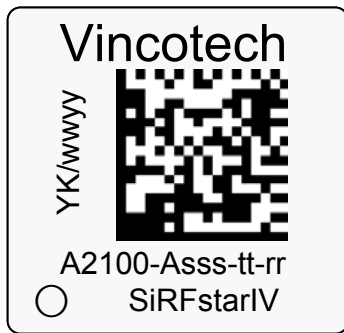


All Vincotech GPS receiver modules, smart GPS antenna modules and telematics units are RoHS compliant.



1.4 Label

The A2100-A labels hold the following information:



General description

Hardware

rr: hardware revision

Software

sss: software version

tt: software release

Location and date code

YK: Bicske / Hungary

ww: production week

yy: production year



Example

: Green, if OK

Figure 1: A2100-A label

The label is placed on the shield of the module.

1.5 Characteristics

The modules are characterized by the following parameters.

1.5.1 GPS Characteristics

Channels		48, parallel tracking
Correlators		~ 400,000
Frequency		L1 (= 1,575 MHz)
Tracking Sensitivity ⁽¹⁾		-163 dBm
Horizontal Position Accuracy	Stand alone	< 2.5 m CEP (SA off)
Time To First Fix – TTFF (theoretical minimum values; values in real world may differ)	Obscuration recovery ⁽²⁾	0.1 s
	Hot start ⁽³⁾	< 1 s
	Warm ⁽⁴⁾	< 32 s
	Cold ⁽⁵⁾	< 35 s

Table 1: A2100-A GPS characteristics

- (1) Typical with good antenna – see also paragraph “3.2 Antennas”
- (2) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the μ s level).
- (3) The receiver has estimates of time/date/position and valid almanac and ephemeris data.
- (4) The receiver has estimates of time/date/position and recent almanac.
- (5) The receiver has no estimate of time/date/position, and no recent almanac.

Note: Performance (sensitivity and TTFF) might slightly decrease below -30°C .

1.5.2 Mechanical Characteristics

A2100-A Mechanical dimensions	Length	15.24 mm, 0.6”
	Width	15.24 mm, 0.6”
	Height	2.4 mm, 0.095”
A2100-A Weight		1.2 g, 0.042 oz

Table 2: A2100-A dimensions and weight

1.6 Handling Precautions

The GPS receiver module A2100-A is sensitive to electrostatic discharge (ESD). Please handle with appropriate care.

2 Ordering Information

2.1 GPS Receivers A2100-A

The order number is built as follows:

- **V23993A2100A-xxx**

V23993 stands for Vincotech's wireless and communication products, A2100A for the A2100-A module. The "xxx" refers to the current firmware version on the module. If no firmware version is referenced in an order, the latest version will be provided.

2.2 Packing of the A2100-A

The A2100-A GPS modules come in a tape and reel package suitable for pick and place machines.

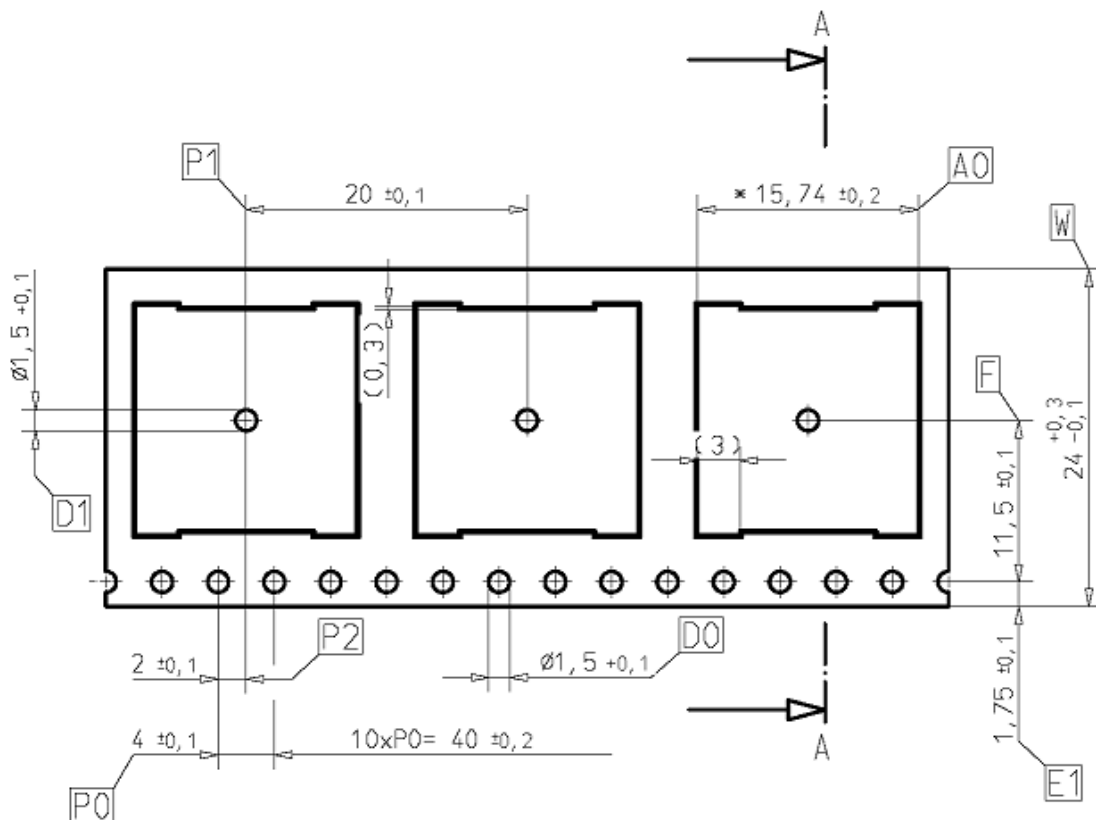


Figure 2: A2100-A tape specifications (1)

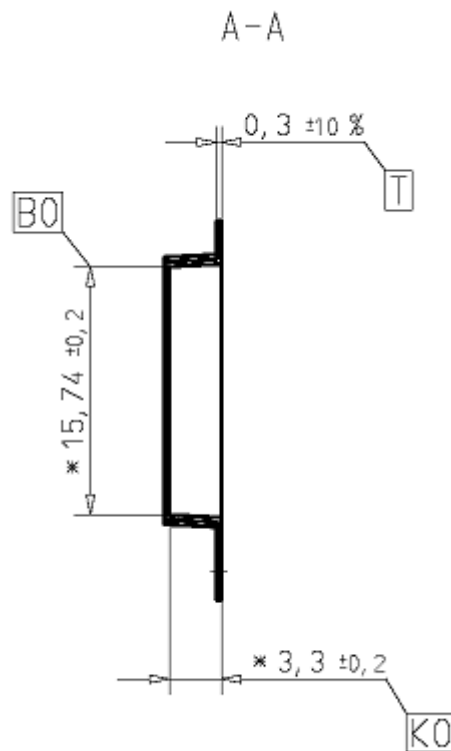


Figure 3: A2100-A tape specifications (2)

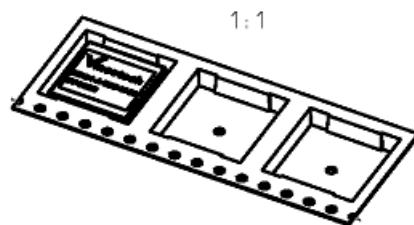


Figure 4: A2100-A tape specifications (3)

One complete reel holds 900 A2100-A modules.
 One box holds three reels, so a total of 2.700 A2100-A modules.

2.3 Additional Equipment

V23993EVA2100A	Evaluation Kit (including one module V23993A2100A)
----------------	--

Table 3: Additional equipment

A detailed description of the EVA2100-A Evaluation Kit can be found in the appropriate manual.

3 Quick Start

In order to allow an easy and quick start with the A2100-A 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 A2100-A needs an external pull-up resistor to be configured for UART operation. Although first firmware releases will work with the UART interface by default future releases will not. 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 A2100-A 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.

3.1 Minimum Configuration

The following picture shows the minimum configuration for NMEA output and commands sent and received via an RS232 interface based on the GPS module A2100-A using a passive antenna.

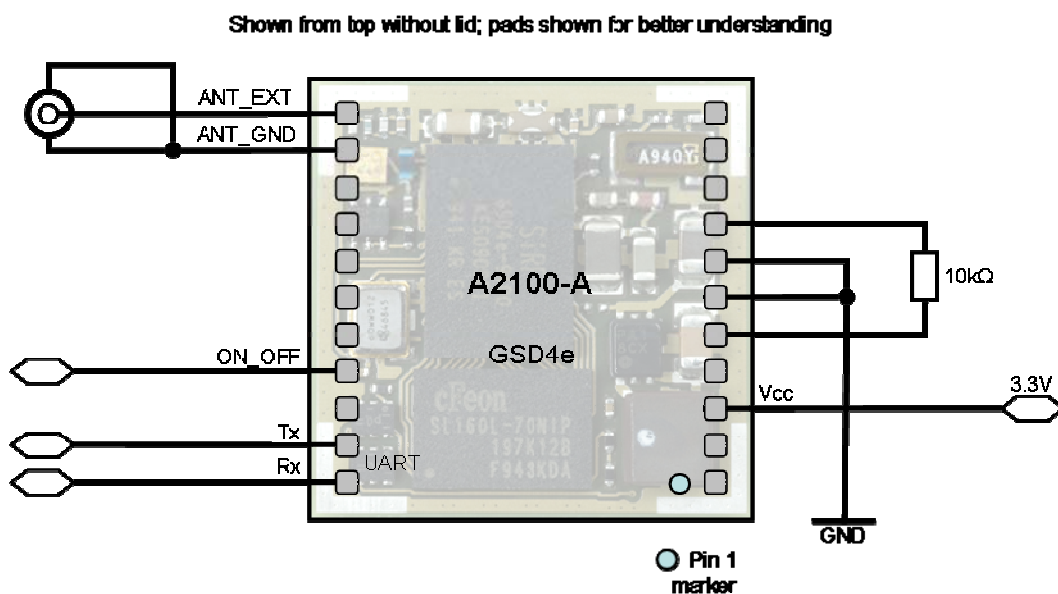


Figure 5: Minimum configuration A2100-A

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.

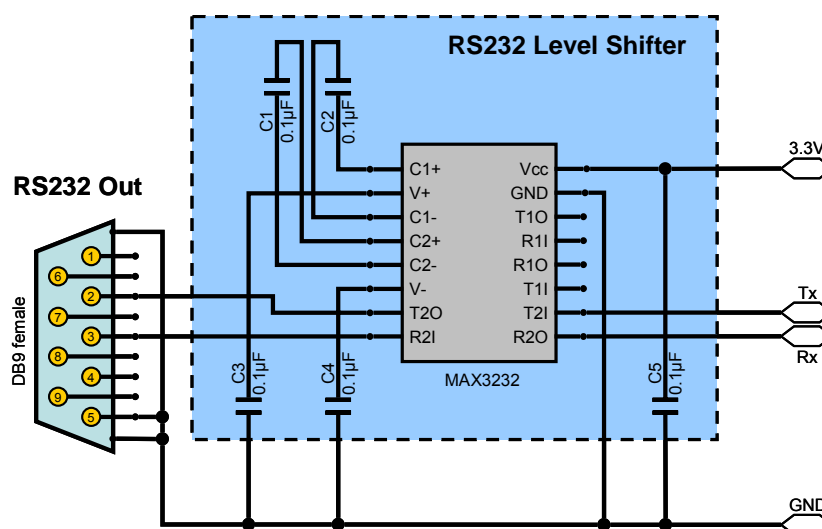


Figure 6: RS232 level shifter

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).
- External antenna input impedance is 50 Ω. Match as close as possible.

3.2 Antennas

Generally, the quality of the GPS antenna chosen (passive or active) is of paramount importance for the overall sensitivity of the GPS system. Losses through a bad antenna, long cables or tracks or a bad antenna position can't be compensated afterwards!

3.2.1 Passive Antennas

The A2100-A supports passive antennas via an integrated LNA directly.

3.2.2 Active Antennas

The A2100-A also supports active antennas directly, i.e. by offering an antenna voltage feed pin (VANT – pin 15). If this connection is used, it is recommended to use an active antenna with a supply voltage of 3 to 5 VDC and a current draw of 50 mA maximum. The antenna should have a gain ≥ 20 dB but the total gain (antenna gain minus cable loss at the antenna input of the module should not exceed tbd. dB) + cable loss and a noise figure ≤ 1.5 dB.

3.3 Serial Port Settings

The default configuration within the standard GPS firmware is (UART configuration):

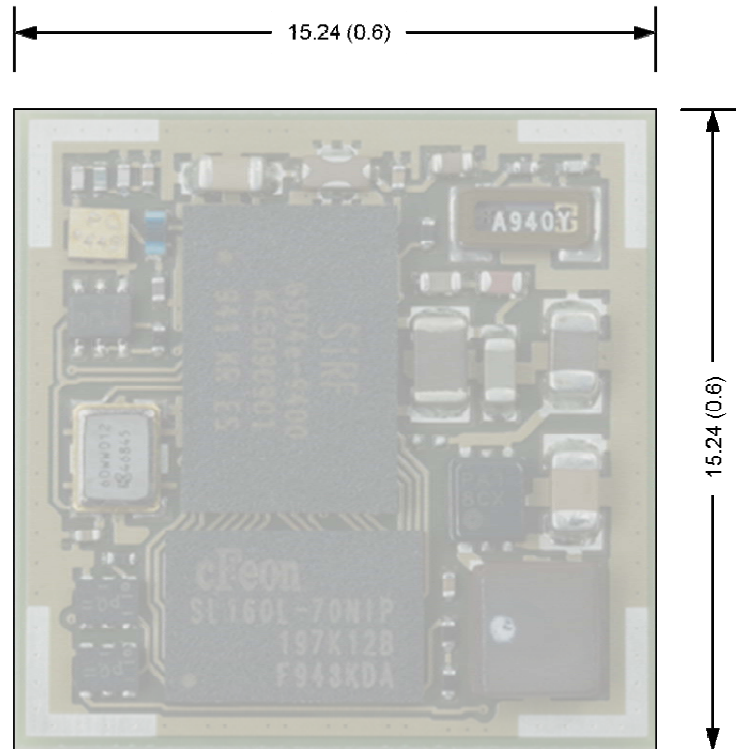
- Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control

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 chip set. More details can be found in chapter “Application Notes”.

4 Mechanical Outline

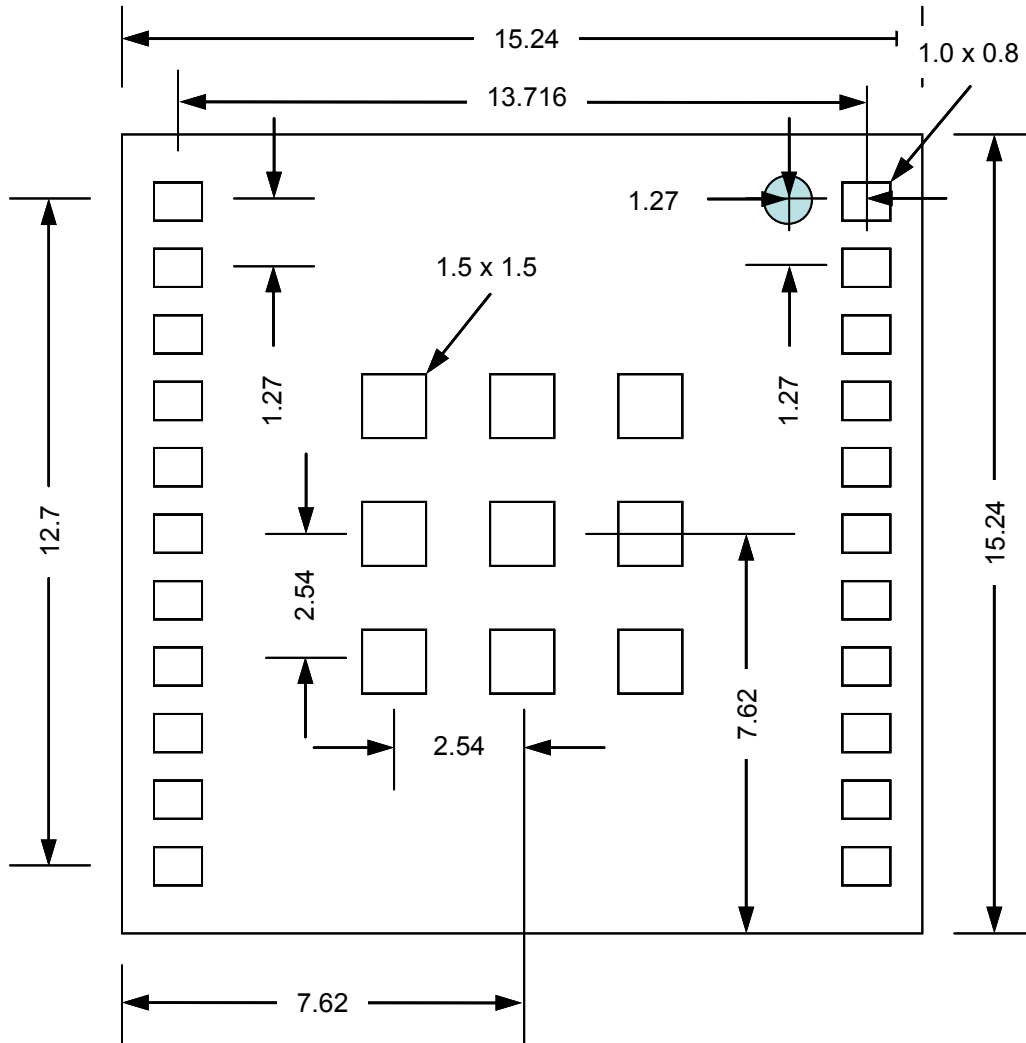
4.1 Details Component Side A2100-A



All dimensions in [mm, (inch)]

Figure 7: Mechanical outline component side A12100-A

4.2 Details Solder Side A2100-A



Solder pad size (outer pads): 1.0 x 0.8
 Solder pad size (inner pads): 1.5 x 1.5
 All dimensions in [mm]

Figure 8: Mechanical outline solder side A2100-A

5 Pin-out Information

5.1 Layout A2100-A

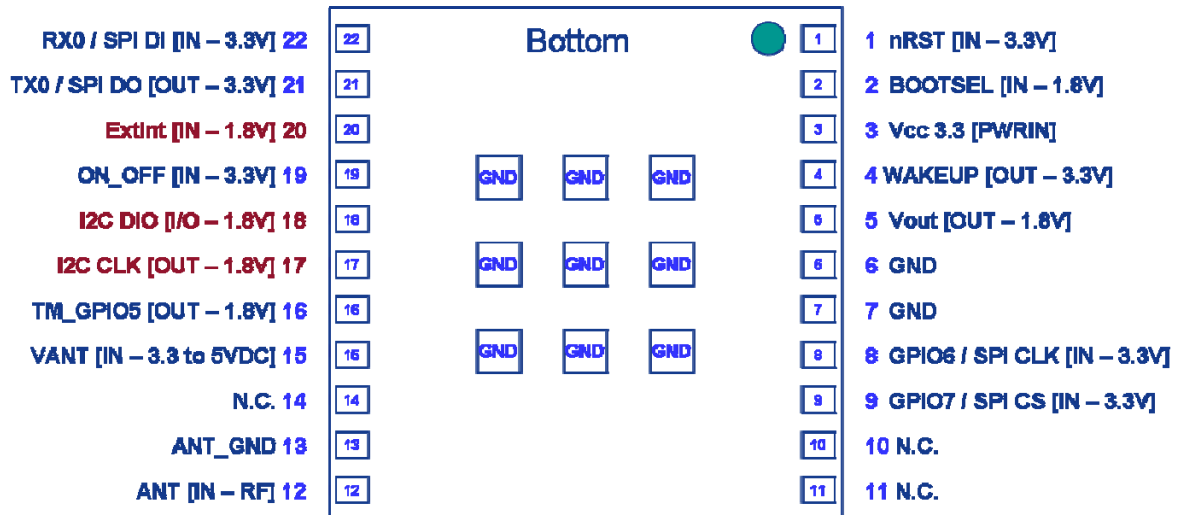



Figure 9: Pin-out information (bottom view) A2100-A

 “Pin 1” marker

5.2 Description A2100-A Signals

Pin	Symbol	Function	Description
1	nRST	Input	Reset input (open / HIGH – no reset, LOW - reset); see “10.6 Reset Signal”
2	BOOTSEL	Input	Special boot mode – leave open for normal operation; HIGH – boot loader active HIGH level: 1.8V
3	Vcc	Power Supply	3.0 – 3.6 VDC (power supply)
4	WAKEUP	Output	Status of digital section, Push-Pull output Low = OFF, KA (Keep Alive)-only, Hibernate, or Standby mode High = ON, operational mode Identical logic to RFPWUP of A1084 on same pin!
5	Vout	Voltage output	1.8V voltage output for up to 20mA current max.
6	GND	Power Supply	Ground (power supply)
7	GND	Power Supply	Ground (power supply)
8	GPIO6 SPI CLK	Input	Configuration pin to run in UART mode (10k pull-up to 1.8V, e.g. to Vout, pin 5) SPI clock pin when module works in SPI mode
9	GPIO7 SPI CS	Input	Unused configuration pin – reserved for future use, leave open SPI chip select pin when module works in SPI mode
10	N.C.	None	Leave open
11	N.C.	None	Leave open
12	ANT	Antenna Input	Antenna signal / Z=50 Ohm (antenna input) - see Note (1)
13	ANT_GND	RF GND	Antenna Ground
14	N.C.	None	Leave open
15	VANT	Antenna Supply Voltage	Power supply antenna – provide according voltage (up to 5.0 VDC)
16	TM_GPIO5	Output	Reserved - leave open
17	I2C CLK	Input	Prepared for I2C clock input for MEMS interface. Leave open.
18	I2C DIO	Input/Output	Prepared for I2C I/O for MEMS interface. Leave open.
19	ON_OFF	Input	Connect to push-pull output! This 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 PTF mode - to wake up out of hibernate mode
20	ExtInt	Input	Prepared for interrupt input for MEMS interface. Leave open.
21	TX0 SPI DO	Output	Serial output 0, NMEA out if configured for UART SPI data out pin when module works in SPI mode
22	RX0 SPI DI	Input	Serial input 0, NMEA in if configured for UART SPI data in pin when module works in SPI mode

Table 4: Pin description A2100-A

Note (1):

An active antenna connected to pin 12, ANT_INT must not exceed a gain of tbd. dB + antenna cable loss according to SIRF recommendation.

5.3 General Comments

The following comments should be considered for a design using the A2100-A in UART mode:

- Standard configuration of serial port (standard GPS software):
Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Antenna (antenna connected to antenna pin)
Use ground pin 13 close to the antenna input for RF ground

6 Electrical Characteristics

6.1 Operating Conditions

Pin	Description	Min	Typical	Max
3	V _{cc}	3.0V	3.3V	3.6V
	Peak Acquisition Current ⁽¹⁾		tbd.	
	Average Acquisition Current ⁽²⁾		tbd.	
	Tracking Current ⁽³⁾		tbd.	

Table 5: A2100-A electrical characteristics

- (1) Peak acquisition current is characterized by millisecond bursts above average acquisition current
- (2) Average current is typically only the first two seconds of TTFF
- (3) Tracking current typically includes tracking and the post acquisition portion of TTFF
- (4) During standby state: RTC block and core powered on and clock off.

6.2 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
V _{cc}	Power supply	-0.3	+3.6	V
V _{in}	Voltage to any pin	-0.3	+3.6	V
I _{ov}	Input current on any pin	-10	10	mA
I _{tdv}	Absolute sum of all input currents during overload condition		200	mA
T _{st}	Storage temperature	-40	85	°C
V _{ant}	Antenna supply voltage	0	5.5	V
I _{ant}	Antenna supply current	0	50	mA

Table 6: PRELIMINARY 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	2.6	Vcc	V
	Vol		0.2	V
RX0	Vih	2.0	Vcc	V
	Vil		0.8	V
nRST	for safe reset		0.2	V
ON_OFF	Vih	0.84	1.5	V
	Vil	-0.3	0.36	V
BOOTSEL	Vih	1.8	2.2	V

Table 7: PRELIMINARY DC electrical characteristic

7 Mounting

This chapter describes the suggested mounting process for the A2100-A 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

Following soldering footprint parameters are recommended:

- Copper and solder paste footprint are identical
- Pad-shape / -size, inner pads: 1.5 mm x 1.5 mm
- Pad-shape / -size, outer pads : 1.0 mm x 0.8 mm
- Stencil thickness of 120 – 150 μm

7.2 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 A2100-A

The solder pads hold solder of a thickness of about 150 μm for improved solder process results.

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 Use of GPS Antennas

8.1 Connecting a GPS antenna to the GPS receiver

The ANT pin is used to connect a GPS antenna to the receiver. The design of the antenna connection has to be done strictly according to RF design rules. A $50\ \Omega$ PCB strip line is required. The following drawings shall explain the guidelines. A major rule is to keep the strip line as short as possible. Additionally, antenna ground (ANT_GND) should be routed to the ground plane of the PCB (the ground plane is on a lower PCB layer) by vias as demonstrated in the drawing.

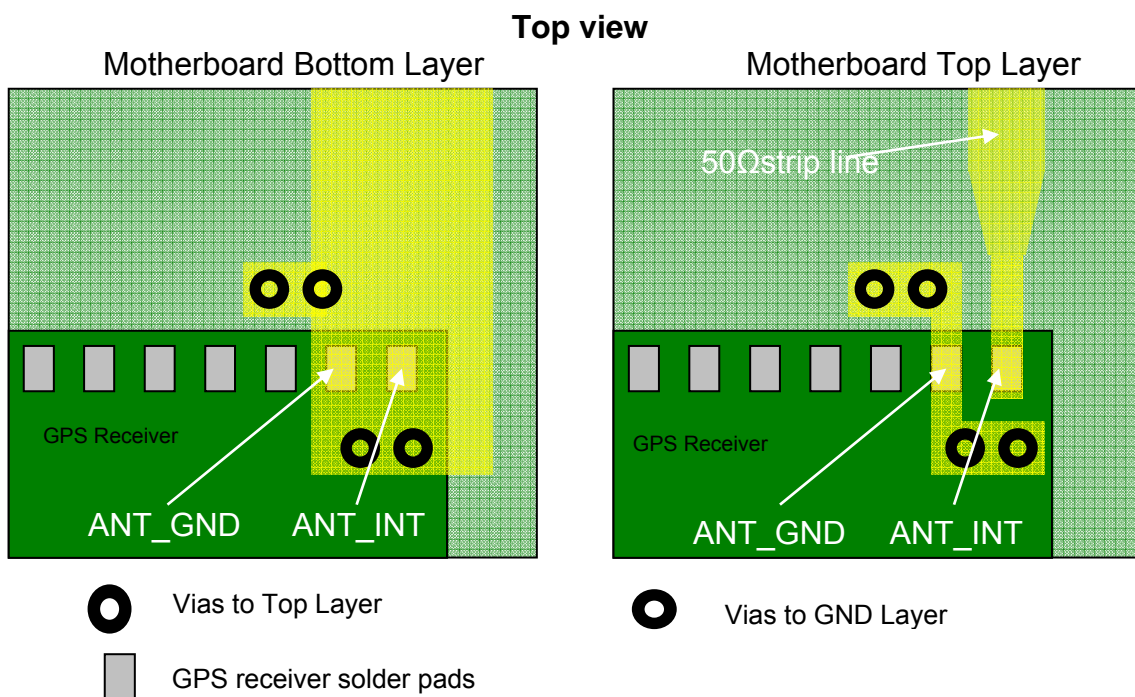


Figure 10: Antenna connector strip line A2100-A

In order to achieve the impedance of $50\ \Omega$, the width of the strip line needs to be calculated. It depends on the thickness or height of the PCB layer (both parameters are shown in following drawing). For the calculation, it is assumed that the PCB material is FR4.

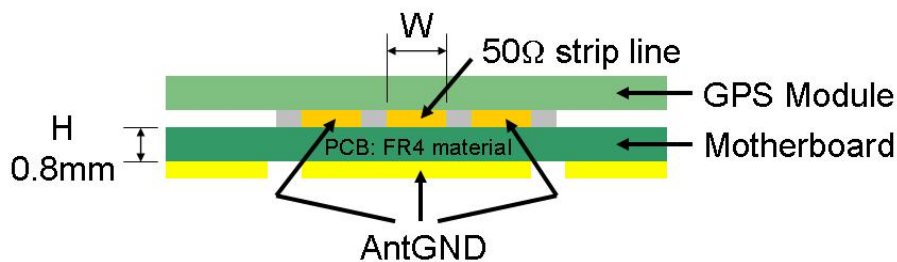


Figure 11: Strip line parameters A2100-A

In this case, the width should be about 1.8 times the height of the PCB:

$$W = 1.8 \times H$$

In the example, one would get a width of $W = 1.8 \times 0.8 \text{ mm} = 1.44 \text{ mm}$.

8.2 Antenna Connections

8.2.1 Passive Antennas

A passive antenna connected to ANT input (pin 12) should be placed as close as possible to the GPS receiver. The signal power lost by the antenna cable or lost by the strip line on the PCB can not be recovered by the LNA (Low Noise Amplifier) integrated in the GPS receiver.

A suitable Ground-Plane design should be considered depending on the antenna type connected to ANT input (pin 12).

8.2.2 Active Antennas

General GPS active antenna specification:

Limitations:

- Supply voltage (voltage fed into VANT pin) 5V (max.)
- Supply current 50mA (max.)

Recommendations:

- Gain $\geq 20\text{dB}$ (should not exceed tbd. dB + cable loss)
- Noise figure $\leq 1.5\text{dB}$

The recommendations apply to the majority of active antennas that can be found in the market. Anyhow, the quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system.

The system design needs to reflect the supply voltage of the antenna. If the supply voltage is equal to V_{cc} , V_{cc} can be connected to VANT. If the antenna requires a different supply voltage, the antenna bias can be provided through the VANT pin.

9 Quality and Reliability

9.1 Environmental Conditions

Operating temperature	-40 ... +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 6: Environmental conditions

9.2 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)
- MSL Rework Compatibility according to J-STD-020C
- 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 Vincotech for detailed information.

9.3 Production Test

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

10 Applications and Hints

10.1 SiRFaware™ Support

Detailed information will be provided.

10.2 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 pin ON_OFF. Toggling is done by pulling the signal to HIGH for about 100ms.

For more information see “AppNote Firmware GSC3” (which applies also to GSD4e).

10.3 Hibernate Mode

In order to enter Hibernate Mode it is necessary to send a shutdown command. Firmware version 4.0.0 supports use of the command

```
$PSRF117,16*0B
```

in NMEA mode as described in the manual “GPS Firmware GSD4e 4.0.0”. In SiRF Binary mode the according command can be found in the “SiRF Binary Reference Manual” – Software Commanded Off – Message ID 205. 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 μ A drawn from Vcc. To wake the module up again, toggling the ON_OFF pin or resetting the module via nRST is necessary.

10.4 Antenna Status Adaptation

This chapter shall give assistance in designing a circuit for detecting if an active antenna is connected to the module. The information about the antenna status can be derived from the ANTSTAT signal generated by this circuit. The examples use values for components that roughly result in the following ANTSTAT output:

- Logic low when: $I_{ant} < 9\text{mA}$
- Logic high when: $9\text{mA} > I_{ant} < 16\text{mA}$
- Logic low when: $I_{ant} > 16\text{mA}$

10.4.1 Antenna Sensor

The following circuit is a proposal on how you can feed an antenna with 3.3V and provide an output for the ANTSTAT pin. The value of the components may need an adaptation in the final application. For example, the input current of the chosen comparator goes into that equation. The thresholds defined in this circuit are quite close to the ones described above. Their value is determined by resistors R4, R5, and R3.

We strongly recommend simulating and testing the GPS receiver integrated in your product design before implementing the finalized product in the appropriate market application.

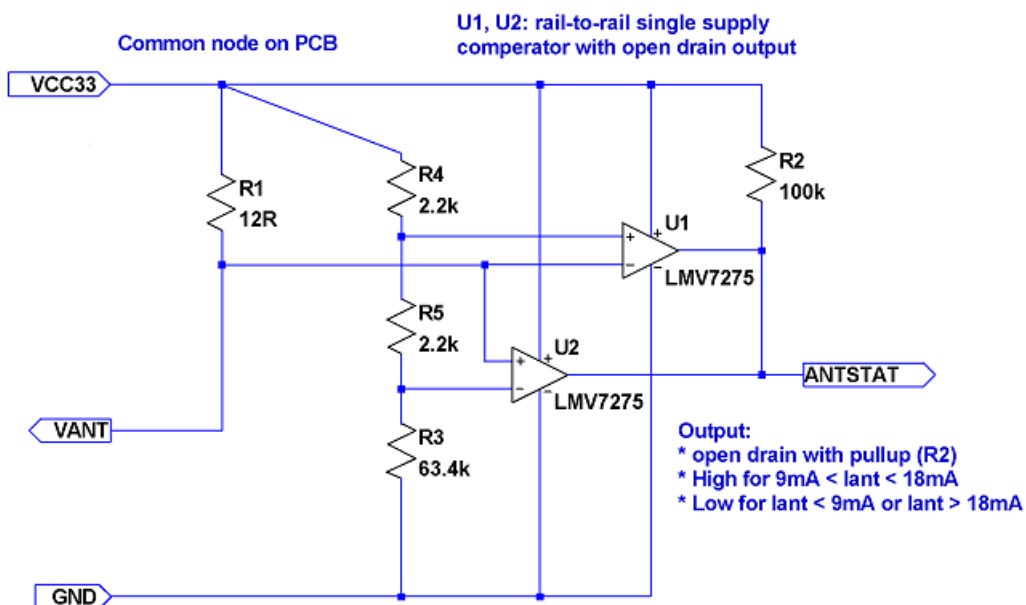


Figure 12: Application note: Antenna sensor adaptation

10.4.2 Antenna Sensor with Current Limiter

This proposal is similar to the first one, but includes a current limiter. Comments and notes as above apply.

We strongly recommend simulating and testing the GPS receiver integrated in your product design before implementing the finalized product in the appropriate market application. In any case it is the responsibility of the designer to test and verify the implementation.

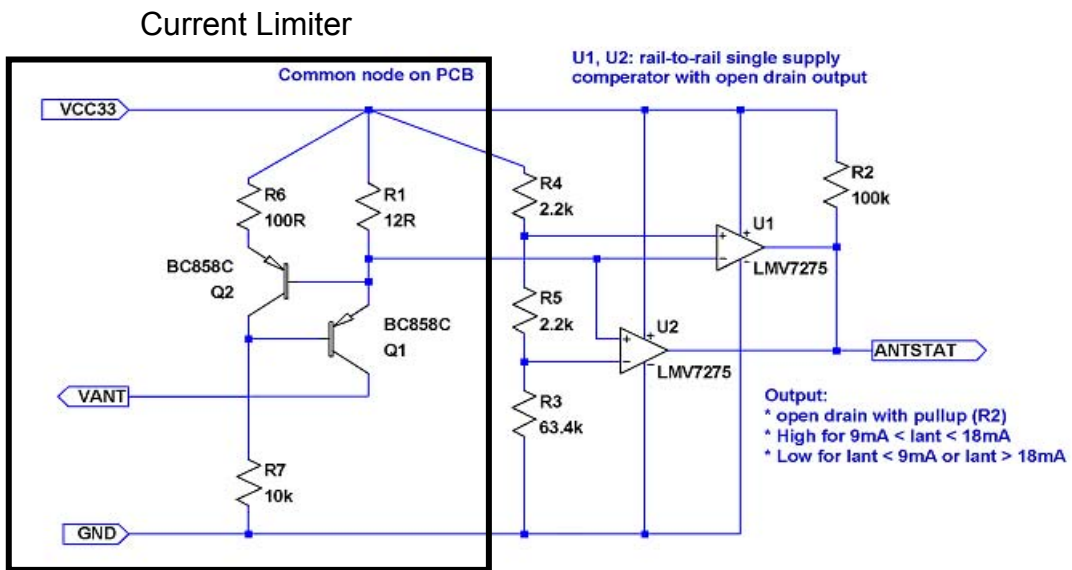


Figure 13: Application note: Antenna sensor adaptation with current limiter

10.5 VANT Pin

The VANT pin is an input pin.

The supply voltage for an active GPS antenna on the ANT input has to be fed into the Vant pin. The easiest way to do that is to connect Vcc to VANT. The maximum current is 50 mA.

Note: Shortcut between ANT and GND may damage the A2100-A GPS receiver module. This should be avoided by using an antenna current limiter.

The circuit (chapter “10.4.2 Antenna Sensor with Current Limiter”) works for Vcc from 3V to 5V. The antenna current will be limited to 50 mA approximately.

If other transistors are used, other resistor values may be necessary as well. We strongly recommend simulating and testing your realized version before using it.

10.6 Reset Signal

The nRST pin is an input pin.

The nRST pin can be used to generate a reset on the A2100-A module. Resetting the module will result in a restart of the complete firmware. All information stored in SRAM will still be valid.

10.6.1 Internal Reset Circuit

The A2100-A is already equipped with a voltage monitoring device that generates a proper power-on reset at the appropriate threshold and delay. Additionally it takes care about the brown-out protection. Usually there is no need to deal with the reset input externally, thus the general advice is to leave this pin open.

10.6.2 External Reset Circuit

Under verification!

If – for some reasons – an external reset input is really desired, the following instructions are recommended:

Only use an open drain/collector device (e.g. a bipolar NPN transistor to ground, see below) to pull the nRST pin low in order to issue a reset.

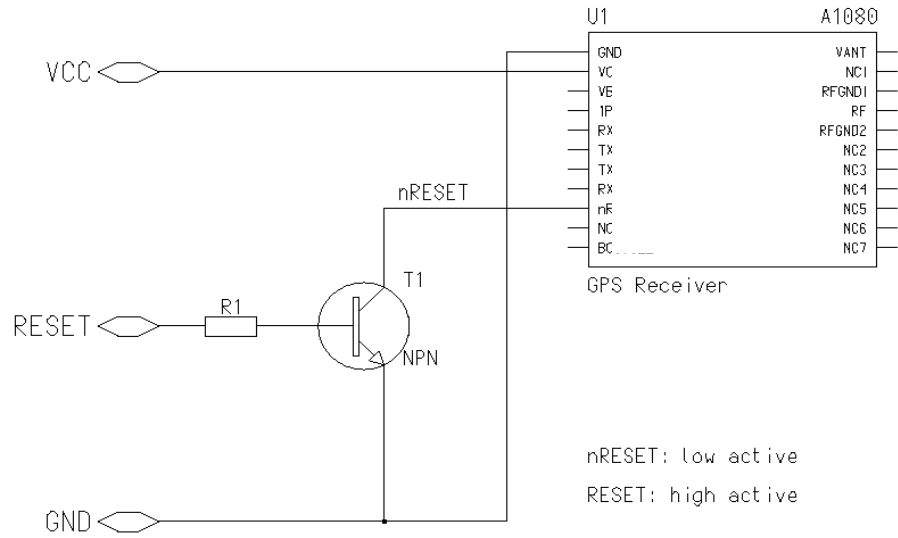


Figure 14: Application note: Recommended external reset circuit

11 Evaluation Kit EVA2100-A

For demonstration and easy evaluation of GPS performance Vincotech offers an evaluation kit (including one GPS A2100-A 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.

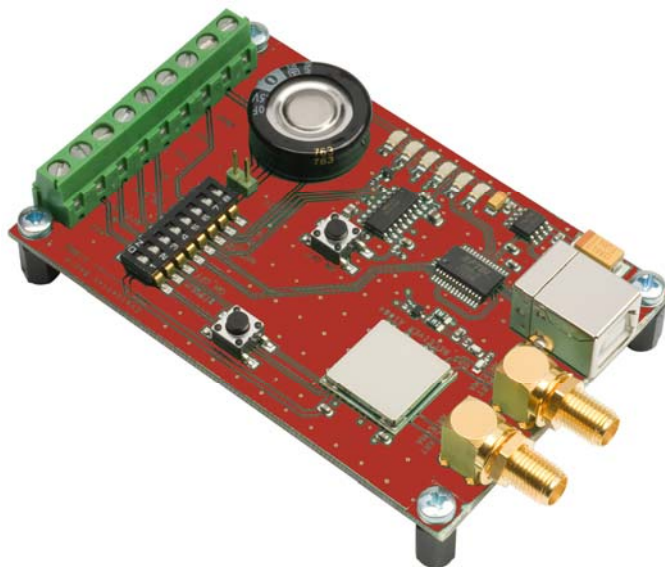


Figure 15: Evaluation kit EVA1084-A (similar)

For further information please contact Vincotech.

12 Related Information

12.1 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.

Inputs regarding errors or mistaken verbalizations and comments or proposals to Vincotech, Germany, for further improvements are highly appreciated.

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12.2 Related Documents

- GPS Firmware GSDe (Vincotech)
- GPS Evaluation Kit EVA2100-A (Vincotech)
- SiRF_Binary_Reference_Manual (SiRF)
- SiRF_NMEA_Reference_Manual (SiRF)

12.3 Related Tools

- GPS Cockpit (Vincotech)
- SiRFLive (SiRF)
- SiRFFlash (SiRF)

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