Vincotech

GPS Receiver A1080

**A Description of Vincotech's
GPS Receiver Module A1080-A/-B**

User's Manual

**Version 4.2
Hardware Revision 04**

Revision History

Rev.	Date	Description
1.0	10-18-06	Initial Draft.
1.1	12-04-06	First released revision
1.2	12-08-06	Application note: Antenna current limiter
1.4	03-13-07	Some minor changes and updates
2.0	03-23-07	New design, adjustments
2.1	06-01-07	Correction solder pads size
2.2	07-03-07	Minor updates serial port configuration
2.3	06-07-07	Application note: reset pin
3.0	07-23-07	Hardware revision 2; PTF function implemented
3.1	10-08-07	Minor style corrections; review; combination of –A and –B versions
3.2	03-05-08	Format corrections
4.0	08-04-08	HW rev. 03 introduced; new layout; moved to Vincotech
4.1	11-14-08	HW version 02 & 03 deleted, HW version 04 added, DC Electrical Characteristics added, Hybernate Mode added, link to 1PPS application note and 1PPS timing accuracy remarks added, contact details (email addresses) corrected, storage temperature corrected, minor changes
4.2	07-07-09	Additional note on Tracking Sensitivity regarding antenna; added hint about Ephemeris Push in FW 3.5.0; corrected reflow soldering profile
	mm-dd-yy	

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Table of Contents

1 Introduction

Vincotech's GPS modules A1080-A and -B are highly integrated GPS receiver modules that can be used as SMT components. They are capable of receiving signals from up to 20 GPS satellites and transferring them into position and timing information that can be read over a serial port. This new generation of GPS modules combines small size and high-end GPS functionality at low power consumption:

- Operable at 3.3V / 23mA (typ.) @ 1fix per second
- Small form factor of 19 x 16.2 mm (0.75" x 0.64")
- On board antenna supply voltage feed
- Single-sided SMD component, for reflow soldering
- Tape & reel packaging

The difference between the "A" and the "B" version is the supported temperature range. While the "A" can be operated from -30°C to +85°C, the "B" version extends this range down to -40°C.

The A1080-A and -B GPS receivers are available as off-the-shelf components, 100% tested and shipped in standard tape-and-reel package.

1.1 Label

The A1080-A labels holds the following information:

```
 A-rr          Hardware
               rr: Hardware Ausgabe / Hardware Release

sss-tt         Software
               tt:  Software Release
               sss: Software Version

YK/wwyy        Datecode and Location
               BZ: Munich / YK: Bicske
               ww: Woche / week
               yy: Jahr / Year
```
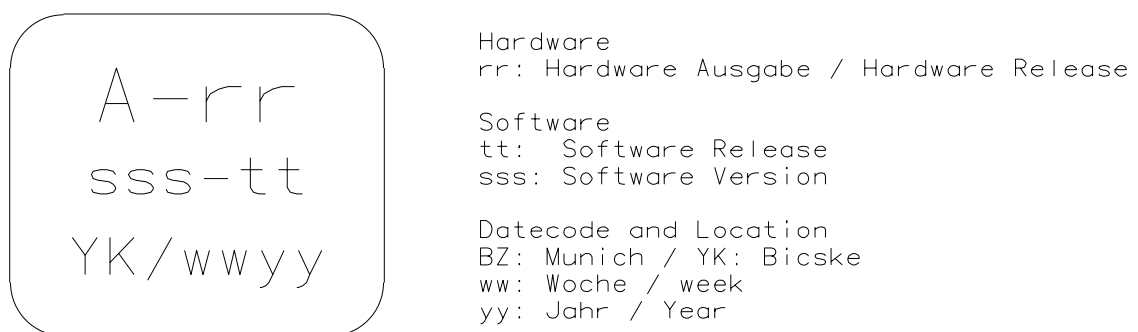
Figure 1: A1080-A label

The A1080-B's label shows a "B" instead of the "A".

1.2 Characteristics

The modules are characterized by the following parameters.

1.2.1 GPS Characteristics

Channels		20, parallel tracking
Correlators		200,000 plus
Frequency		L1 (= 1575 MHz)
Tracking Sensitivity [1]		-159 dBm
Position Accuracy	Stand alone	< 10 m CEP (SA off)
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: A1080 GPS characteristics

(1) Typical with external active antenna – see also paragraph "3.2 Antenna"
(2) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the µs 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.

1.2.2 Mechanical Characteristics

A1080 Mechanical dimensions	Length	19mm, 0.75"
	Width	16.2mm, 0.64"
	Height	2.4mm, 0.095"
A1080 Weight		1.2g, 0.042oz

Table 2: A1080 dimensions and weight

1.3 Handling Precautions

The GPS receiver modules A1080-A/-B are sensitive to electrostatic discharge (ESD). Please handle with appropriate care.
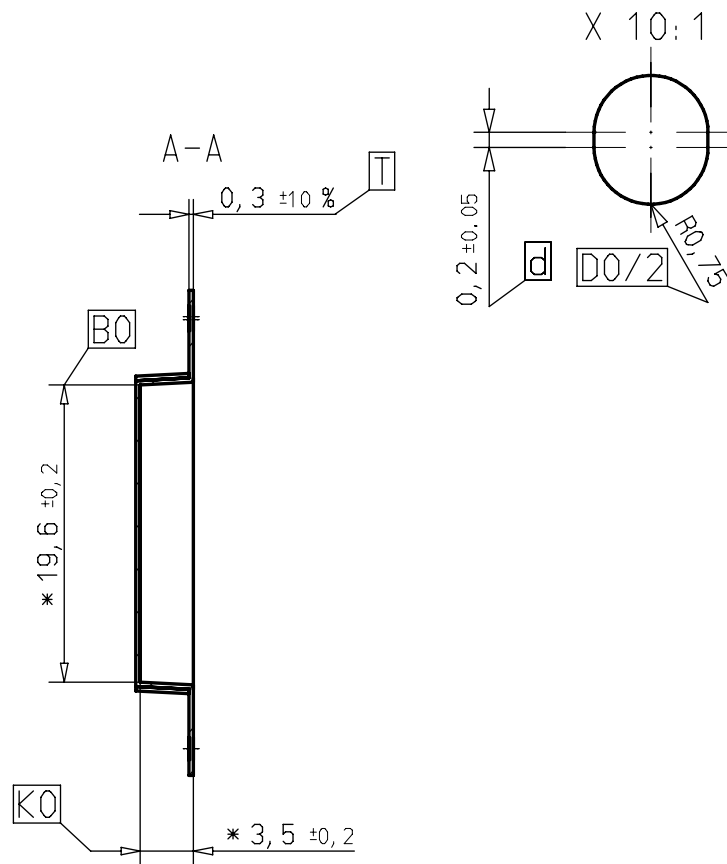
2 Ordering Information

2.1 GPS Receivers A1080

The order number is built as follows:

- **V23993A1080A-xxx**
- **V23993A1080B-xxx**

V23993 stands for Vincotech's wireless and communication products, A1080A for the A1080-A module, A1080B for the A1080-B module. The "xxx" reflects the current firmware version. If no firmware version is noted in an order, the latest version will be provided.

2.2 Packing of the A1080

The A1080-A/-B GPS modules come in a tape and reel package suitable for pick and place machines.

Figure 2: A1080 tape specifications (1)

Figure 3: A1080 tape specifications (2)

2.3 Additional Equipment

V23993EVA1080A	Evaluation Kit (including one module V23993A1080A)

Table 3: Additional equipment

A detailed description of the additional kit can be found in the according manuals.

Note: There is no specific evaluation kit for the A1080-B, as evaluation kits are designed for demonstration purposes and testing. The GPS parameters for both modules are identical.

3 Quick Start

In order to allow an easy and quick start with the modules A1080-A/-B, this chapter provides a short overview on the most important steps to receive NMEA messages with position information on a serial port.

3.1 Minimum Configuration

The following picture shows a recommended minimum configuration for NMEA output and commands sent and received via an RS232 interface based on the GPS module A1080-A (identical for A1080-B).
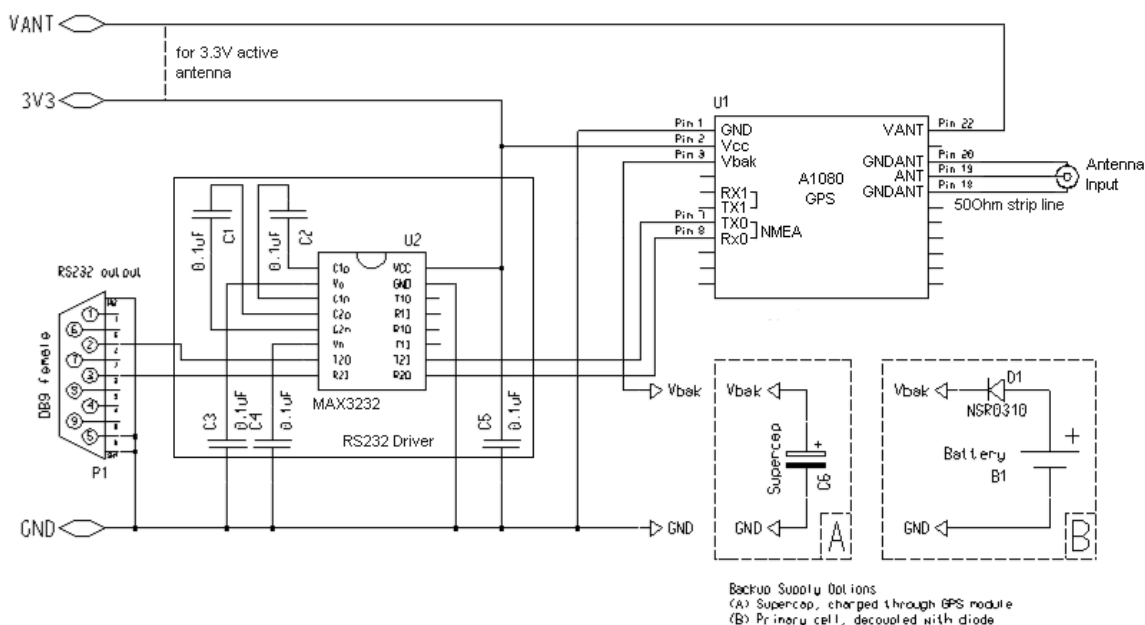

Figure 4: Recommended minimum configuration A1080

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).
- Use separate ground plane for antenna ground.
- Antenna input impedance is 50Ohm. Match as close as possible.
- Maximum allowed antenna current is 50mA. Consider a current limiter. (see chapter: 10.2.2 Antenna Sensor with Current Limiter)
- A battery back-up circuit for the RTC (Real Time Clock) should be considered (see chapter: 10.6 Battery Back-up)

NOTE: Please make sure the A1080-A/-B is mounted either electrically shielded or at least protected from direct airflow. This avoids degradation of GPS performance generated by temperature fluctuations. (see GPS AppNote RF-shield A1080)

3.2 Antenna

It is recommended to use an active GPS antenna with supply voltage of 3 to 5VDC and a current draw of 50mA maximum. The quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system. An active antenna should have a gain ≥ 20dB and a noise figure ≤ 1.5dB, which applies to more than 95% of the active antennas available in the market.

3.3 Serial Port Settings

The default configuration within the standard 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 support the RTC with a back-up power supply when no system power is available (see chapter: 10.6 Battery Back-up).

Furthermore, starting with FW revision 3.5.0 "Ephemeris Push" is supported. Please see according application note!

4 Mechanical Outline

4.1 Details Component Side A1080
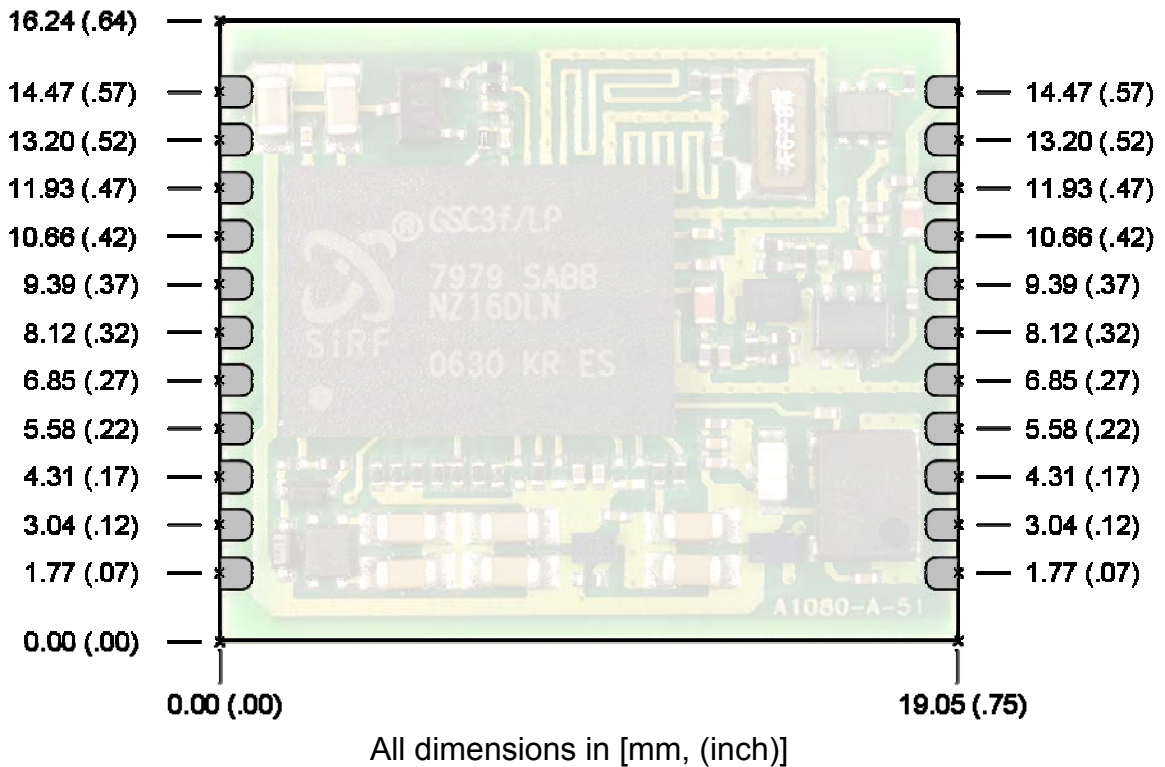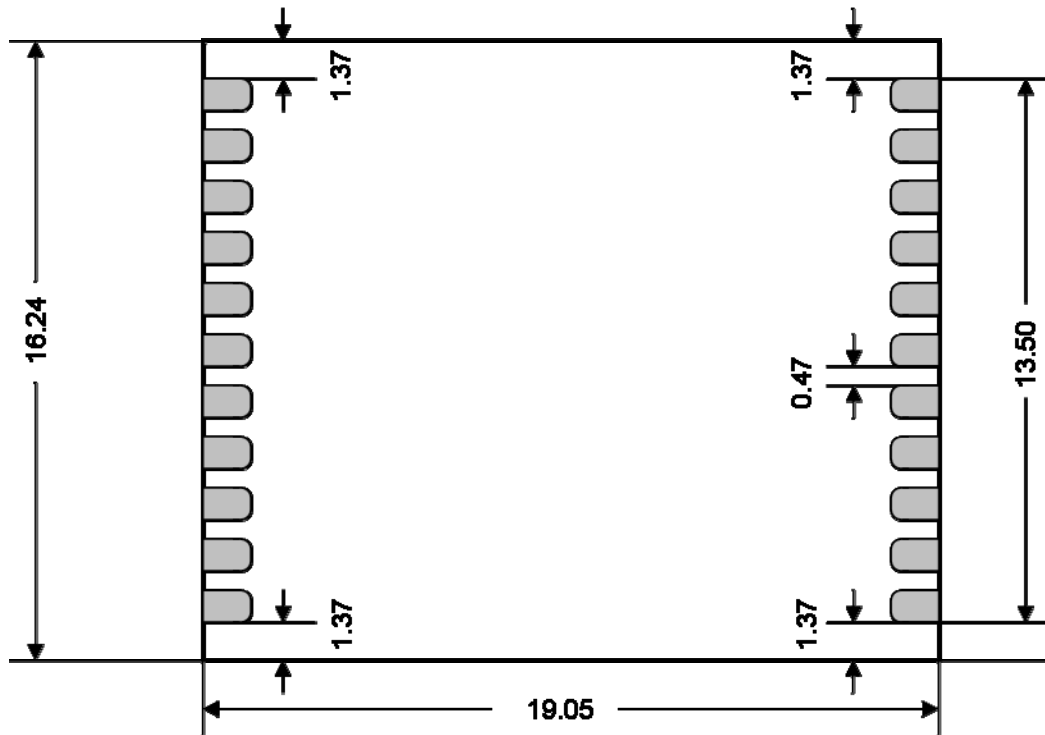

All dimensions in [mm, (inch)]

Figure 5: Mechanical outline component side A1080

4.2 Details Solder Side A1080

Solder pad size: 1.0 x 0.8
All dimensions in [mm].

Figure 6: Mechanical outline solder side A1080

5 Pin-out Information

5.1 Layout A1080 (HW revision 04)

Figure 7: Pin-out information A1080

5.2 Description A1080 Signals (HW revision 04)

Pin	Symbol	Function	Description
1	GND	Power Supply	Ground (power supply)
2	Vcc	Power Supply	3.0 – 3.6 VDC (power supply)
3	Vbak	Power Supply	Back-up pin of module for "super cap" or battery (see below)
4	1PPS	Output	1PPS (pulse per second) output
5	RX1	Input	Serial input 1 – unused in current firmware (leave open)
6	TX1	Output	Serial output 1 – unused in current firmware (leave open)
7	TX0	Output	Serial output 0, NMEA out
8	RX0	Input	Serial input 0, NMEA in
9	nRST	Input	Reset input
10	ON_OFF	Input	-ON_OFF, used in PTF mode to request a fix by toggling from LOW to HIGH -ON_OFF, used to switch to hibernate mode and back -leave open if not used
11	BOOTSEL	Input	Special boot mode – leave open for normal operation
12	RFPWUP	Output	Status of analog section (Low = OFF, High = ON)
13	nWAKEUP	Output	Status of digital section (Low = ON, High = OFF) Open Drain with internal pull-up (100k), can not source current!
14	Res.		Reserved – leave open
15	Res.		Reserved – leave open
16	Res.		Reserved – leave open
17	GPIO 0	Output	Internal antenna switch status (Low = OFF, High = ON)
18	GNDANT	Antenna Input	Antenna Ground, do not connect to GROUND, connect to antenna shield (see below)
19	ANT	Antenna Input	Antenna signal / Z=50 Ohm
20	GNDANT	Antenna Input	Antenna Ground, see above
21	Res.		Reserved – leave open
22	VANT	Power supply	Power supply antenna – provide according voltage

Table 4: Pin description A1080

Note: Pins marked in yellow are new compared to HW revision 01 to support Push-To-Fix and ON_OFF functionality. These pins have been described as „Reserved – leave open" in earlier manual versions. If this was obeyed, the new assignments will have no impact on the module's functionality.

5.3 General Comments

The following comments should be considered for a design with and use of the module:

- 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 pins (pin 18, pin 20) close to the antenna input for RF ground.

6 Electrical Characteristics

6.1 Operating Conditions

Pin	Description	Min	Typical	Max
3	V_{bak}	1.8V		3.6V
	Standby Current [4]		20µA	
2	V_{cc}	3.0V	3.3V	3.6V
	Peak Acquisition Current [1]		32mA	
HW rev	Average Acquisition Current [2]		28mA	
04	Tracking Current [3]		23mA	

Table 5: A1080 electrical characteristics

Note: Conditions marked in yellow are for new HW revision 04.

(1) Peak acquisition current is characterized by millisecond bursts above average acquisition current
(2) Average acquisition 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
Vcc	power supply	-0.3	+3.6	V
Vin	voltage to any 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
Vant	antenna supply voltage	0	5.5	V
Iant	antenna supply current	0	50	mA

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
1PPS, TX1, TX0,RFPWUP, nWAKEUP, GPIO 0	Voh	2.6	Vcc	V
	Vol		0.2	V
RX1, 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	2.3	Vcc	V

Table 7: DC Electrical Characteristic

7 Mounting

This chapter covers the mounting of the A1080-A/-B.

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.
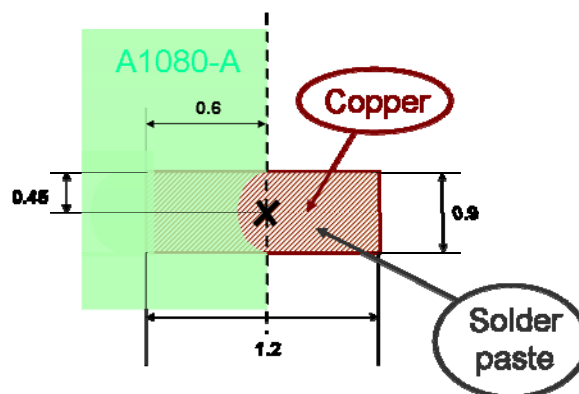
Figure 8: Soldering footprint proposal A1080

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 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 A1080

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 Antenna

8.1 Connection of RF Signal

The ANT pin is used to connect the receiver with the GPS antenna. The design of the antenna connection has to be done strictly according to RF design rules. A 50Ω 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 (GNDANT) should be routed to the ground plane of the PCB (the ground plane is on a lower PCB layer) by via as demonstrated in the drawing.
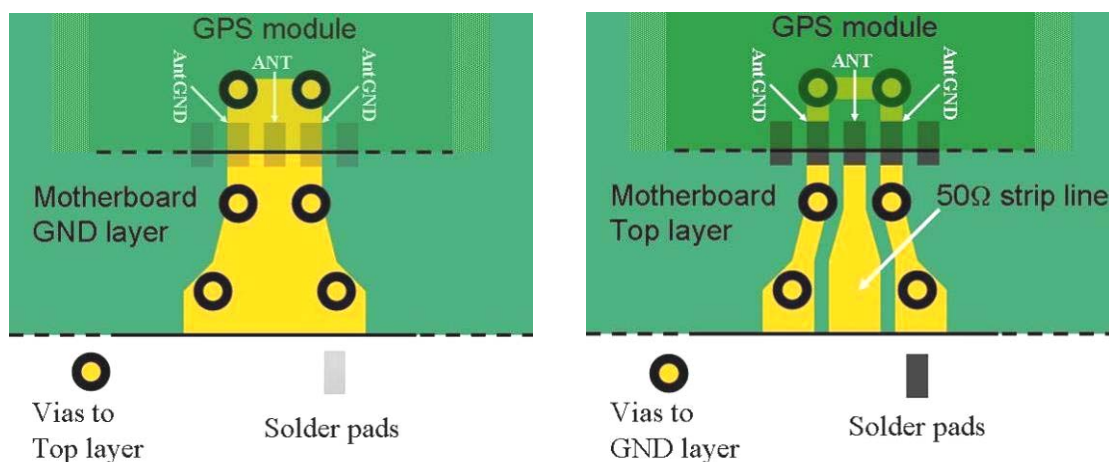
Figure 9: Antenna connector strip line A1080

In order to gain the impedance of 50Ω, 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.
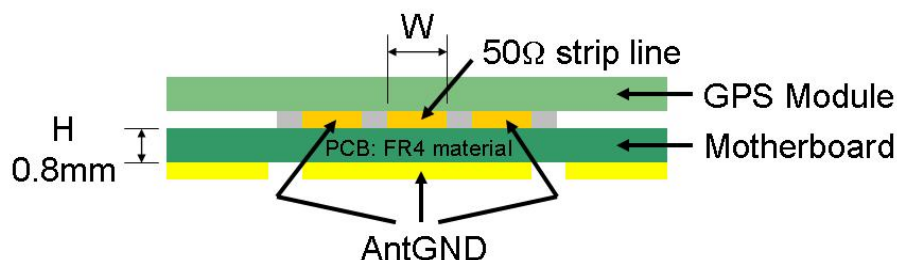
Figure 10: Strip line parameters A1080

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 x 0.8mm = 1.44mm.

8.2 Active Antenna

General GPS active antenna specification:

Limitations:

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

Recommendations:

- Gain ≥ 20dB (should not exceed 35dB)
- Noise figure ≤ 1.5dB

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 Vcc, Vcc 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	-30°C … +85°C (A1080-A)
Operating temperature	-40°C … +85°C (A1080-B)
Operating humidity	Max. 85% r. H., non-condensing, at 85°C
MSL JEDEC (Moisture Sensitivity Level)	3
Storage	-40°C … +85°C / 6 months in original package

Table 9: 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 –30°C … +85°C (A1080-A)
- Temperature Cycling –40°C … +85°C (A1080-B)
- Temperature Humidity Bias 70°C / 85% RH
- Low / High Temperature Operating –30°C / +85°C (A1080-A)
- Low / High Temperature Operating –40°C / +85°C (A1080-B)
- 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 Minimum Configuration

Please refer to chapter 3.1 Minimum Configuration for details. In addition, for optimized start-up behavior it is strongly recommended to add a battery back-up circuit (see chapter 3.4)!

10.2 Antenna Status Adaptation

This chapter shall give assistance in designing a circuit for detecting if an 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: Iant < 9mA
- Logic high when: 9mA > Iant < 16mA
- Logic low when: Iant > 16mA

10.2.1 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 your realized version before using it. In any case, it is the responsibility of the designer to test and verify the implementation.
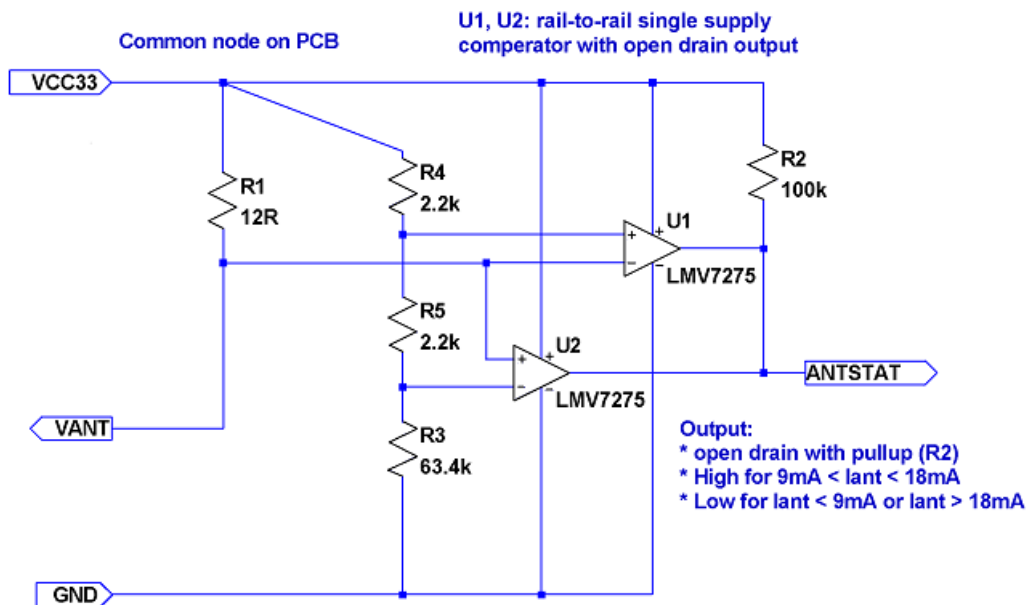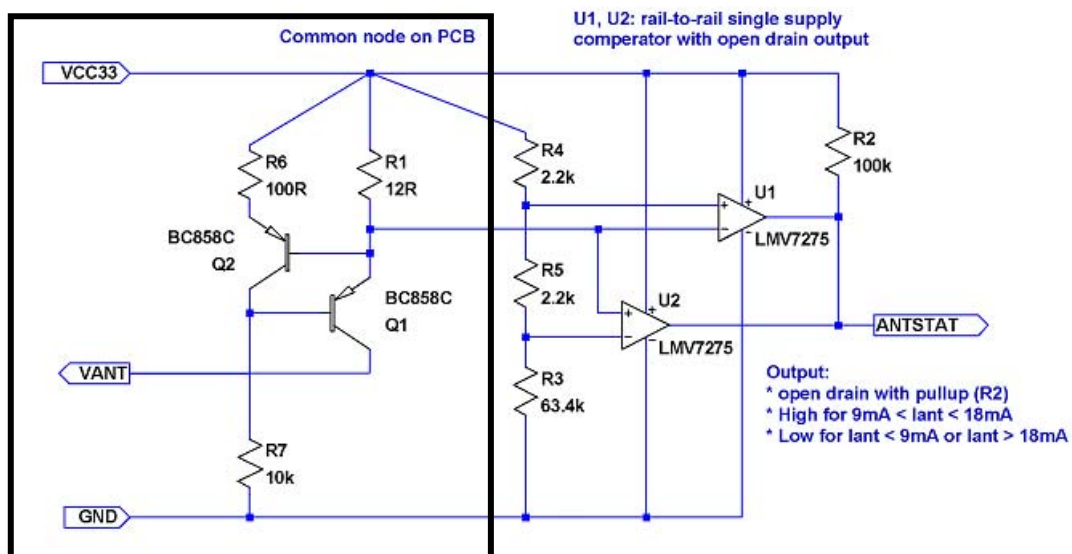
Figure 11: Application note: Antenna sensor adaptation

10.2.2 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 your realized version before use. In any case it is the responsibility of the designer to test and verify the implementation.

Figure 12: Application note: Antenna sensor adaptation with current limiter

10.3 VANT Pin (antenna voltage input pin)

The VANT pin is an input pin.

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

Note: Shortcut between ANT and GND may damage the A1080-A/-B GPS receiver module. This should be avoided by using an antenna current limiter.

The circuit (chapter 10.2.2 / Current Limiter) works for Vcc from 3V to 5V. The antenna current will be limited to 50mA 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.

10.4 1PPS 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 A1080 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 ≈ 33ns 1PPS deviation (typically)
100m position deviation ≈ 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.
The given values are based on a 10 satellite, static GPS simulator scenario.

10.5 Reset Signal

The nRST pin is an input pin.

The nRST pin can be used to generate a reset on the A1080-A/-B module. Resetting the module will result in a restart of the complete firmware. All information stored in SRAM will still be valid.

10.5.1 Internal reset circuit

The A1080 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.

10.5.2 External reset circuit

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

(1) Only use an open drain/collector device (e.g. a bipolar NPN transistor to ground, see Fig. 1) to pull the nRST pin low in order to issue a reset.
(2) A1080 Hardware version 04 will work without any problem in applications following the previous External Reset Circuit recommendations for Hardware Version 02 and 03.

Note: Never pull the nRST pin actively high in case Vcc is present.
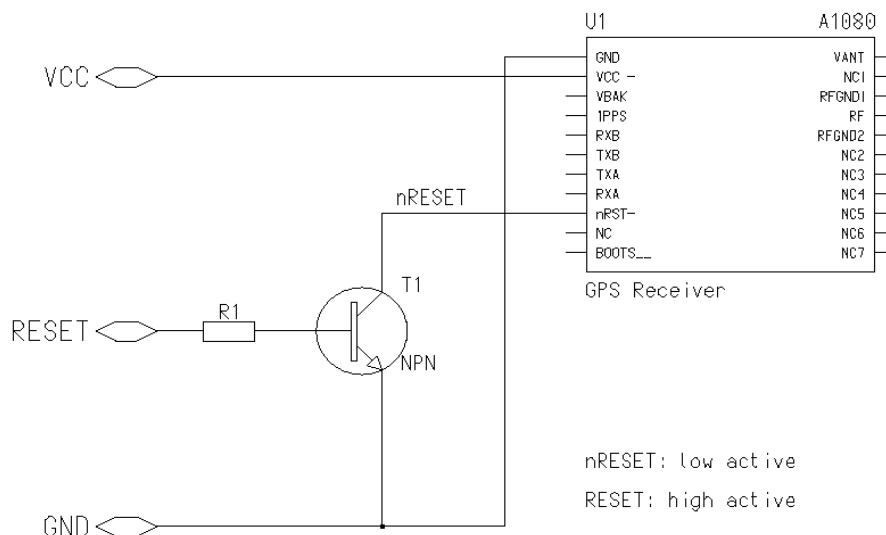

Figure 13: Application note: Recommended external reset circuit

10.6 Battery Back-up

This application note describes how to back-up the RTC and the SRAM of the GPS receiver module. The basic of the first examples is to provide a back-up by a separate battery or a "super cap".

While the "super cap" is charged thru the module during normal operation, the battery (primary cell) is decoupled thru a diode!
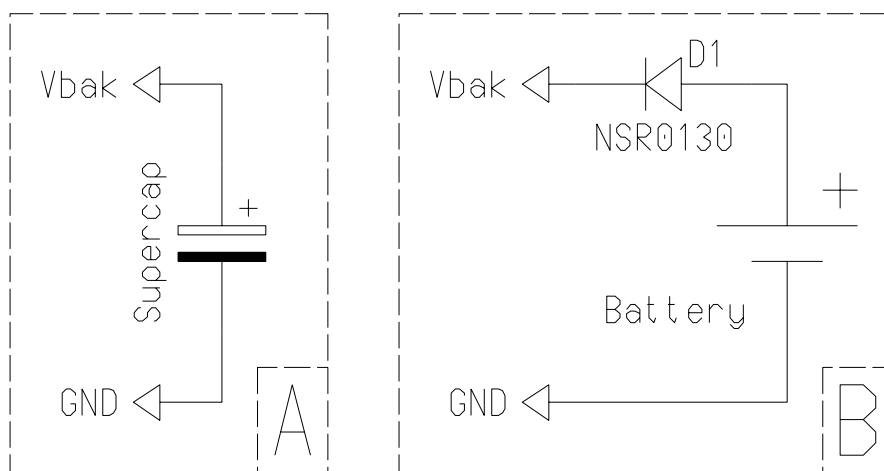
Backup Supply Options
(A) Supercap, charged through GPS module
(B) Primary cell, decoupled with diode

Figure 14: Application note: Module back-up

An alternative to this solution is to switch the supply voltage from the Vcc pin to the Vbak pin. Care needs to be taken that the there is no voltage outage during the switch-over phase!

The Vbak pin draws 20µA typically.

10.7 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 according manual, especially the paragraph "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.

(see also AppNote Firmware A1080)

10.8 Hibernate Mode

From Firmware version 3.2.5, firmware support for ON_OFF has been included, hence, a rising pulse on the ON_OFF pin will put the A1080 GPS receiver into hibernate state if it is on and wake up if it is in sleep state. During sleep state the receiver draws 20μA typically and maintains RTC and SRAM.

11 Evaluation Kit EVA1080-A

For demonstration and easy evaluation of GPS performance Vincotech offers an evaluation kit (including one GPS A1080-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 EVA1080-A

For further information please contact Vincotech.

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.

Anyway, inputs about errors or mistakable verbalizations and comments or proposals to Vincotech, Germany, for further improvements are highly appreciated.

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11.2 Related Documents

- GPS Receiver A1080 (Vincotech)
- GPS Evaluation Kit EVA1080 (Vincotech)
- GPS AppNote EDLC-Backup A1080 (Vincotech)
- GPS AppNote Backup A1080 (Vincotech)
- GPS AppNote GeoHelix Antenna A1080 (Vincotech)
- GPS AppNote Firmware A1080 (Vincotech)
- GPS AppNote nRST A1080 (Vincotech)
- GPS AppNote RF-shield A1080 (Vincotech)
- GPS AppNote 1PPS Pulse Width (Vincotech)
- GPS AppNote ResetControl A1080 (Vincotech)

12 List of Figures

13 List of Tables