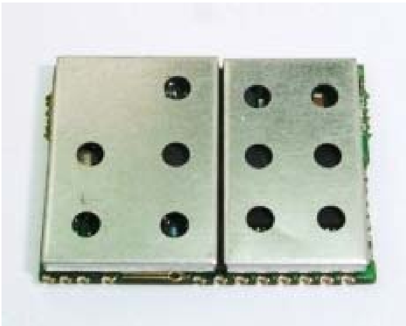
ANTARIS™4 SuperSense™

GPS Module



User's Manual Ver 1.03

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Item	Date	New Release Information	In Charge
1	2006/06/06	Reassign PIN7 from VCC1.8 to GPSmode3, pre-design for Supersense.	Godspeed
2	2006/08/07	Update Schematics, GPIO, BaudRate and Backup info	Harry

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1. Introduction

1.1. Overview

The ATMEL ANTARIS™4 supersense GPS solution emerged from the successful co-operation of Atmel Germany GmbH and ublox AG, Thalwil/Switzerland. In this co-operation, Atmel contributed the RF IC Design know-how, Digital IC Design know-how and Chip Production know-how. ublox contributed its GPS System and software know-how. Due to this constellation, the customer benefits from the combined design-in support strength of both companies. Modulestek GPS module **MG-A01S** is a high sensitivity ultra low power consumption cost efficient, compact size; plug & play GPS module board designed for a broad spectrum of OEM system applications. This product is based on the ANTARIS™4 supersense technology and it will track up to 16 satellites at a time while providing fast time-to-first-fix. Its far reaching capability meets the sensitivity & accuracy requirements of car navigation as well as other location-based applications, such as AVL system. Handheld navigator, PDAs, Wrist Watches, Personal Locators, Toll collection, Fleet Management, pocket PC, or any battery operated navigation system.

The **MG-A01S** design utilizes the latest surface mount technology and high level circuit integration to achieve superior performance while minimizing dimension and power consumption. This hardware capability combined with software intelligence makes the board easy to be integrated and used in all kinds of navigation applications or products. The module communicates with application system via TTL level with NMEA0183 protocol.

1.2. Main Feature

- Built-in high performance ATMEL chipset. 16 channels “All-in-View” tracking.
- Average Cold Start in 34 seconds.
- -158 dBm weak signal sensitivity with SuperSense™
- Ultra Low power consumption.(60mW at 1 Hz output rate, tracking 4 SVs)
- ROM Firmware (no external memory needed)
- USB Slave V1.1 (V2.0 compatible)
- Support of SBAS satellites for navigation
- Compact Size: 24.0x18.0x2.0mm, Easy integration into hand-held device.
- ARM7TDMI inside
- Full DGPS / WAAS / EGNOS support
- FixNow™ Mode advanced power-saving function.

2. Technical Specifications

2.1. Electrical Characteristics

2.1.1 General

Frequency	L1, 1575.42 MHz
C/A code	1.023 MHz chip rate
Channels	16

2.1.2 Sensitivity

Standard

Cold starts:	**-142 dBm**
Tracking:	**-158 dBm**

2.1.3 Accuracy

Position	2.5 meters CEP
	2.0 m CEP DGPS / WAAS / EGNOS
Time	50ns RMS

2.1.4 Datum

Default	WGS-84
Other	Support different datum by request

2.1.5 Acquisition Rate (Open sky, stationary requirements)

Hot start	<3.5 sec, average
Warm start	33 sec, average
Cold start	34 sec, average

2.1.6 Dynamic Conditions

Altitude	10,000 meters max
Horizontal Velocity	300 kilometers/hour max
Vertical Velocity	36 kilometers/hour max
Acceleration	2g, max
Jerk	**4 meters/second^3, max**

2.1.7 Power

Main power input	3.3 ±5% VDC input.
Supply Current	**MG-A01S** **<100mW(at full acquisition)**

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2.1.8 Serial Port

Electrical interface	one full duplex serial communication, TTL interface
Protocol message	NMEA-0183.
Default NMEA	GGA, GSA, GSV, RMC and VTC. 9600 baud rate,

2.2. Environmental Characteristics

Operating temperature range	-40 deg. C to +80 deg. C
Storage temperature **range**	**-55 deg. C to +100 deg .C**

2.3. Physical Characteristics

Dimension: **MG-A01S** 24.0x18.0x2.0(mm)

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3. Mechanical Dimensions

3.1. MG-A01S

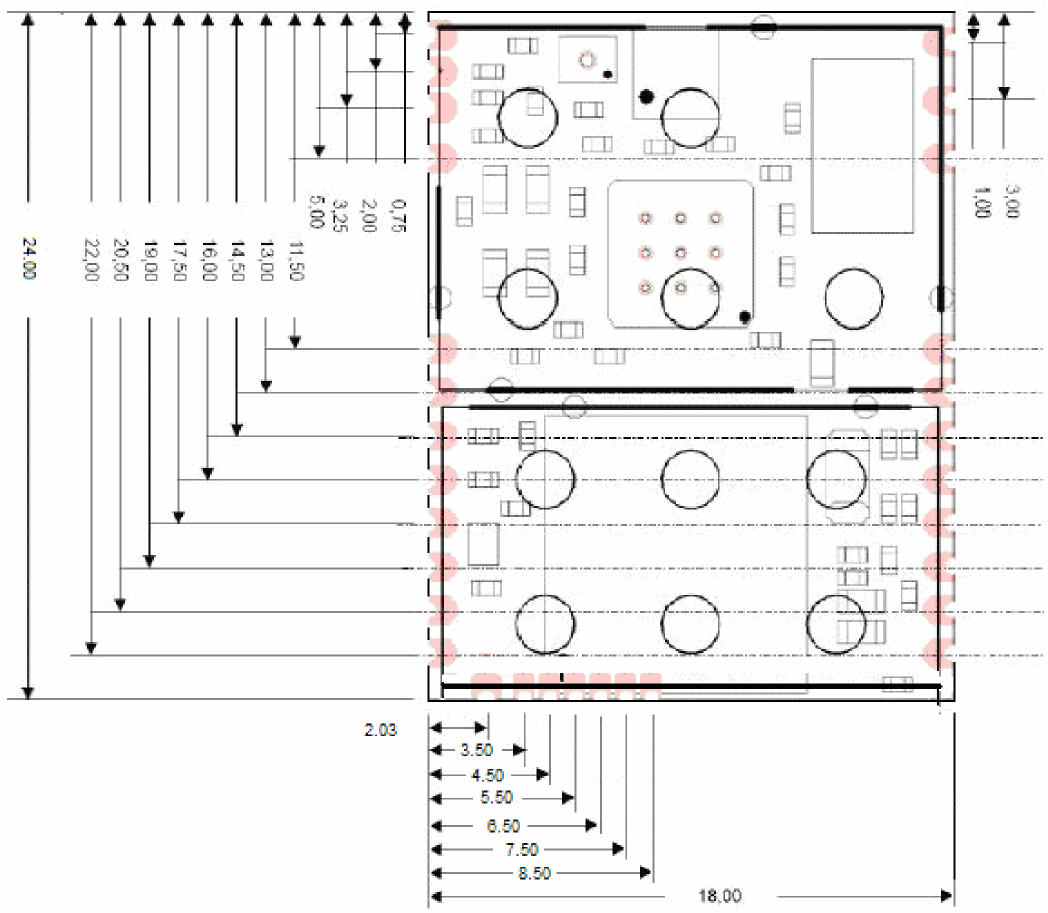

Figure 1: Board dimensions (in mm)

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4. Board connections

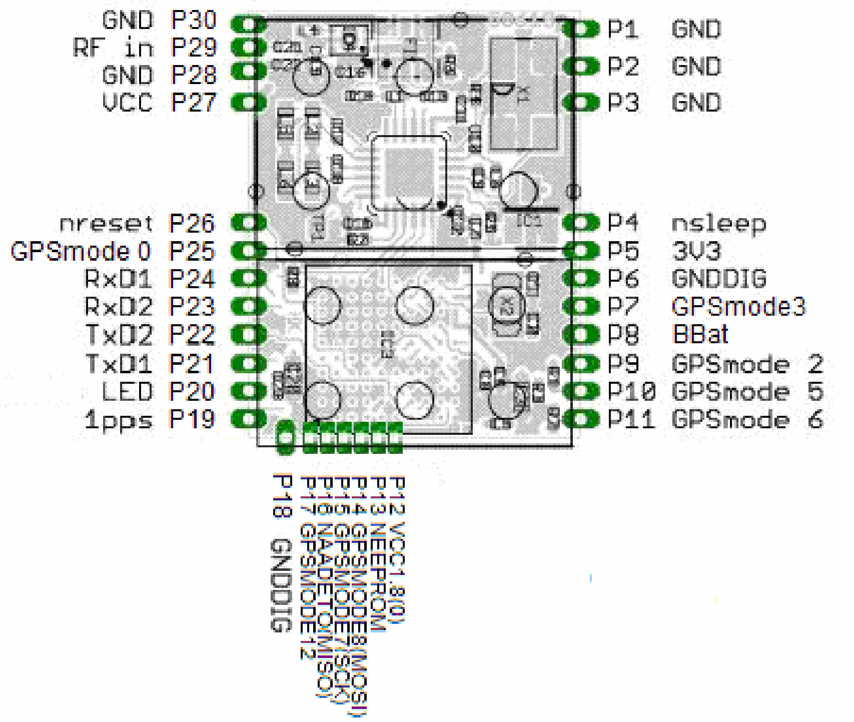

Figure 2: Board connections and placement diagram.

PIN	Voltage level/ active level	Description
P1	GND	Analog Ground
P2	GND	Analog Ground
P3	GND	Analog Ground
P4	nsleep[*1]	Shut down RF receiver(ATR0601). only for test purposes
P5	3V3	3.3V digital power supply
P6	GNDDIG	Digital Ground
P7	GPSmode3	GPS sensitivity settings; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P8	BBat	Backup battery supply(1.95~3.6V)
P9	GPSmode2	GPS sensitivity settings; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P10	GPSmode5	Serial I/O configuration; Internal pull-down resistor, can be left open if the GPSmode feature is not used or configured as output be user application.

P11	GPSmode6	Serial I/O configuration; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P12	VCC1.8	External Output Voltage(1.8V)
P13	NEEPROM	Internal pull-up resistor, leave open if no serial EEPROM is connected. Otherwise connect to GND.
P14	GPSmode8	General I/O Configuration; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P15	GPSmode7	USB Power Mode; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P16	NAADETO	Internal pull-down resistor, leave open if Antenna Supervision functionality is unused. Can be left open if configured as output by user application
P17	GPSmode12	Serial I/O configuration; Internal pull-up resistor, can be left open if the GPSmode feature is not used or configured as output be user application.
P18	GNDDIG	Digital Ground
P19	1PPS	Time puls signal
P20	LED	Output in default ROM firmware: leave open, only needs pull-up resistor to VDDIO or pull-down resistor to GND if used as GPIO input by user application and is not always driven from external sources.
P21	TxD1	Output in default ROM firmware: leave open if serial interface is not used.
P22	TxD2	Output in default ROM firmware: leave open if serial interface is not used.
P23	RxD2	Internal pull-up resistor, leave open if serial interface is not used.
P24	RxD1	Internal pull-up resistor, leave open if serial interface is not used.
P25	GPSmode0	Enable configuration with GPSmode pins; Internal pull-down resister, leave open, in order to disable the GPSmode pin configuration feature. Connect to VDDIO to enable the GPSmode pin configuration feature. Can be left open if configured as output by user application.
P26	nreset	Low level force reset

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P27	**VCC**	**Power supply for board(2.7V~3.3V)**
P28	**GND**	**Analog Ground**
P29	**RF in**	**RF in**
P30	**GND**	**Analog Ground**

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5. Applications

MG-A01S module board receiver is a high performance, ultra low power consumption, plug &play product. These applications are as follow.

- Car Navigation
- Wrist Watch
- Solar Operated Device
- Marine Navigation
- Fleet Management
- AVL and Location-Based Services
- Radar detector with GPS function
- Hand-Held Device for Personal Positioning and Navigation
- Ideal for PDA, Pocket PC and Other Computing Devices at GPS Application

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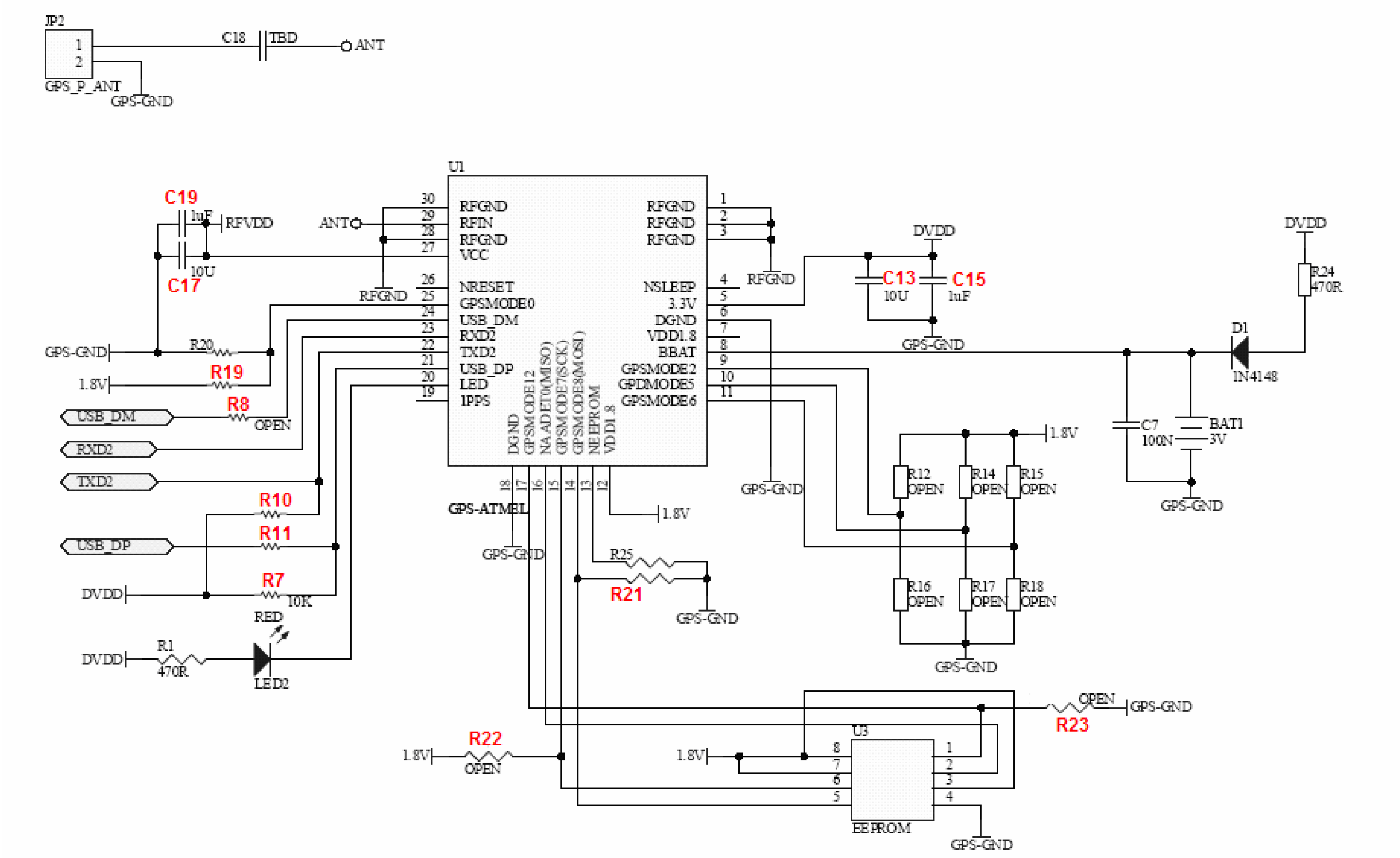
6. Schematics



For testing the MG-A01S module, please solder at least the component below.

ITEM	Designator	Part Type	Footprint
1	C15, C19	1uF -20%~80%/Y5V/6.3V(105)	C0402
2	C13, C17	10uF/6.3V	TMC-P
3	R19,R21, R22, R23	1K±5%	R0402
4	R8, R11	0R±5%	R0402
5	R7, R10	10K±5%	R0402

	PIN 17	PIN 11	PIN 10	OUTPUT	Baud Rate
TTL NMEA Output	0	0	1	PIN 22/ 23	9600
USB NMEA Output	1	1	0	PIN 21/ 24	All speed
0 → Connect to VCC; 1 → Connect to GND					

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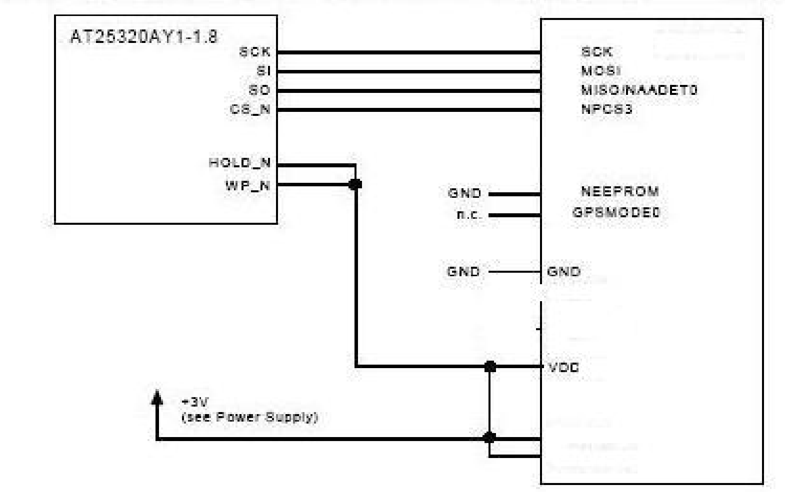
7. Connection with optional serial EEPROM

ATR0621/ATR0622 offer the possibility to connect an external serial EEPROM, as the internal ROM-firmware supports to store the configuration in serial EEPROM. The Pin P16/NEEPROM signals the firmware that a serial EEPROM is connected to the ATR0621/ATR0622. The 32-bit RISC processor of the ATR0621 accesses the external memory with SPI (Serial Peripheral Interface). A 32Kbit (4kByte) memory is needed and ATMEL recommends to use 1.8V serial EEPROM, e.g. the ATMEL AT25320AY1-1.8. Figure 29 shows an example of the serial EEPROM connection.

Using the command UBX-CFG-CFG command, the configuration is stored in whatever is connected to the base band (FLASH, serial EEPROM, or battery-backup RAM).



n.c.: not connected

Figure : Example of a serial EEPROM connection

Note

1: Using a serial EEPROM, the GPSMODE pin configuration feature can be disabled,because the configuration can be stored in the serial EEPROM (please do not disable the GPSMODE pins if you use the Active Antenna Supervisor functionality).

Note 2: VDDIO is the supply voltage for the pins: P23, P24, P25 and P29 plus the two USARTs. It can be chosen to be 1.8 V or 3.3 V. Please make sure to chose the EEPROM with the appropriate supply voltage range (1.8 – 5.5 V or 2.7 – 5.5 V).

Note 3: The serial EEPROM is not needed if (a) the user is satisfied with the standard settings of the receiver and what is configurable via GPSMODE pins or (b) the user can send the configurations after start-up from the host rocessor or (c) the user uses FLASH memory.

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8. Backup Battery

In StandBy mode, a RTC (real-time-clock) functionality is available that allows the software after the next start-up to make a hot-start, in case that the StandBy time was less than 4 hours (time for which the ephemeris is valid). For that, a part of the RAM is battery buffered and contains current PVT data, ephemeris and almanac.

After 4 hours of StandBy, the ephemeris needs to be re-loaded from the GPS satellites at startup, but there is still a benefit in TTFF compared to a cold start, as the Almanac is available in the Backup-RAM.

For the BackUp functionality a separate pin is available (BBAT, pin J7 of ATR0621) where a backup medium with a voltage of 1.95 - 3.6V can be connected. An internal switch in the base band changes the supply voltage from 3V3 (pin 16) to BBAT automatically, as soon as 3V3 has reached a certain level. Typical currents from the BBAT pin in StandBy mode are around 5uA.

If the RTC and the hot start are not required (system always performs a cold-start), no BackUp battery and no 32.768 kHz XTAL are necessary.

For the BackUp medium we propose to use

• either a rechargeable battery of MS Lithium type with 1-5mAh (e.g. MS621 from Seiko Instruments Inc. or ML621 from Panasonic)

• or a gold cap (super capacitor) with 3.3 ... 5.5V range (not 2.5V range), for example DSK-3R3H224 (3.3V / 0.22 F)

The advantage of the super capacitor compared to the MS Lithium cell is the unlimited number of charging and discharging cycles plus a faster charging time. The disadvantage is their lower energy capacity. Example:

1. Assuming a fully charged 1.2 mAh battery and a typical backup current of 5 uA (see ATR0621 data sheet), the RTC will run for 1.2 mAh / 5 uA = 240 hours

2. Assume a super capacitor with 0.22 F (3.3V type) is charged to 3.2 V. The ATR0621 can discharge the super capacitor down to at least 1.8 V, before the RTC stops. This results in a RTC time in BackUp mode of 17.6 hours (assuming 5 uA of BackUp current)

Please contact your battery supplier for the right charging circuit. We have found out, that the circuit shown in Figure below using a series resistor for current compliance and a low-cost, lowdrop Schottky diode to prevent discharging when the 3V supply is disconnected or shorted to

GND. The value of the series resistor is a compromise between the maximum allowed charging current and the charging time. Examples for Schottky diodes are

1. ASD751V from Full Power Semiconductor

2. MA2S728 from Panasonic (difficult to source in low volume)

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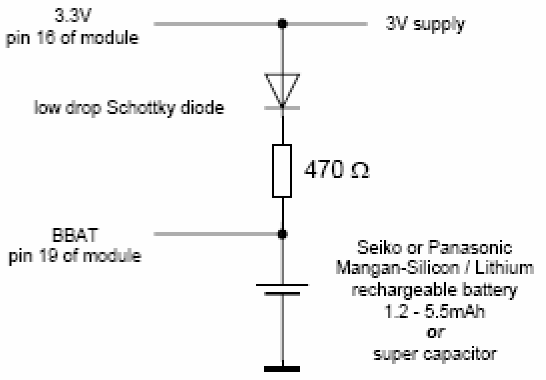


Figure : Example for low-cost charging circuit

Note:

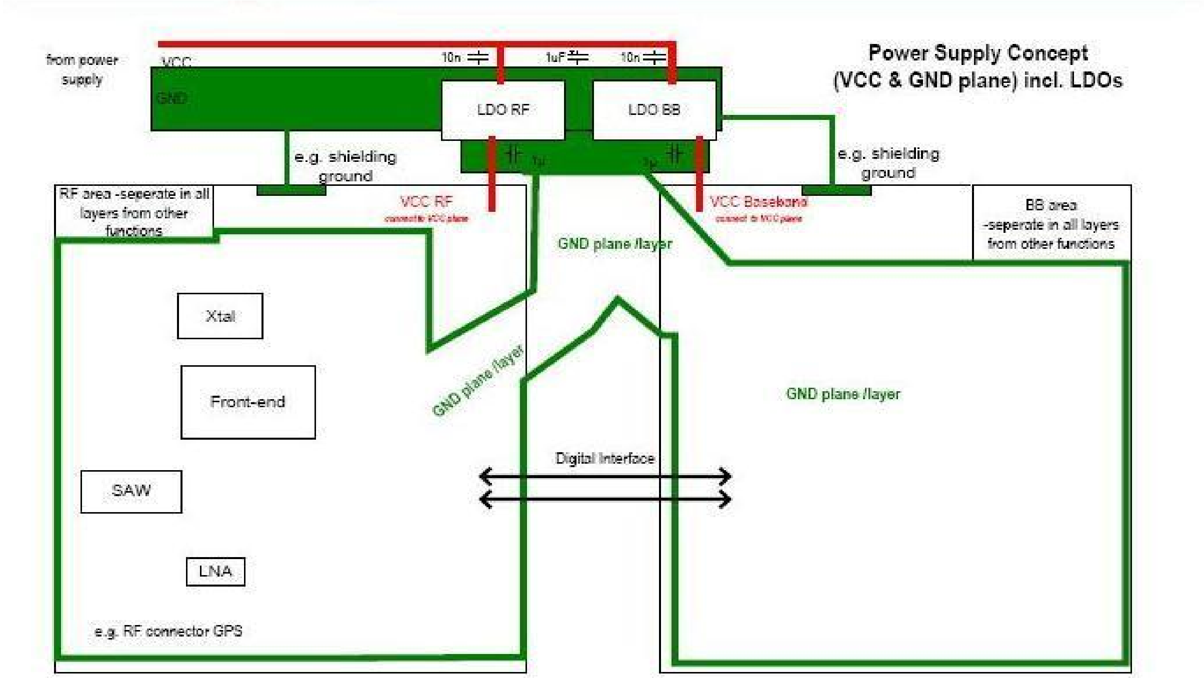
1. The full capacity of the battery is only reached if it is charged to the maximum voltage for a sufficiently long time (see data sheet of your battery).
2. If you use a super capacitor, please contact your manufacturer about the maximum charging current and adjust the series resistance accordingly
3. Both MS Lithium battery and super capacitor usually do not perform over the full range of –40°C to +85°C (as required for many automotive applications).
4. The Seiko MS621 is discontinued, please use MS621F instead. Please contact Seiko Instruments Inc. (SII) for details
5. To our knowledge, MS Lithium batteries cannot be reflow soldered using a lead-free process. If a lead-free process is required, they need to be soldered manually. Please check details with the supplier of your battery.

9. Power Supply Recommendations on the mother board

The example module has been designed for the usage of two separate power supplies: *RFVCC* (RF, 2.7 – 3.3V) and *DVDD* (base band, 2.3 – 3.3V with internal 1.8 V LDO). Therefore the design is flexible and the requirements of the motherboard can be met. Note, that GPS sensitivity is strongly correlated with the power supply structure of the motherboard. We recommend to use two separate LDOs for the two supply voltages. In case of a 5V main power supply, the usage of an additional DC-DC converter is recommended to improve the efficiency.

Figure below shows a recommendation how to place & route the LDOs. The LDOs (TK63130HC from Toko *or* S1167B30 from Seiko Instruments Inc.) have been chosen with respect to a high ripple rejection and low output noise voltage. The TK63130HC (S1167B30) is located on the motherboard and provides a dropout voltage of 80mV@100mA (150mV@100mA). The input and output requires a blocking cap with 1µF for stable operation.

The LDO-GND of both LDOs is led commonly to the module interface. This is necessary, since VDIG (digital interface supply voltage) is derived from the digital part (DVDD), but also supplies the RF part. The connection from the RFVCC pins of ATR06xx to the LDOs should be kept as short as possible.



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10. GPIO Setting

Setting GPSMODE0 to GPSMODE12

The start-up configuration of a ROM-based system without external non-volatile memory is defined by the status of the GPSMODE pins after system reset. Alternatively, the system can be configured through message commands passed through the serial interface after start-up. . This configuration of the ATR0622 can be stored in an external non-volatile memory like EEPROM. *Default* designates settings used by ROM firmware if GPSMODE configuration is disabled (GPSMODE0 = 0).

Table 3-3. GPSMODE Functions

Pin	Function
GPSMODE0 (P1)	Enable configuration with GPSMODE pins
GPSMODE1 (P9)	This pin (EXTINT0) is used for *FixNow* functionality and not used for GPSMODE configuration.
GPSMODE2 (P12)	GPS sensitivity settings
GPSMODE3 (P13)	
GPSMODE4 (P14)	This pin (NAADET1) is used as active antenna supervisor input and not used for GPSMODE configuration.
GPSMODE5 (P17)	Serial I/O configuration
GPSMODE6 (P19)	
GPSMODE7 (P23)	USB Power Mode
GPSMODE8 (P24)	General I/O Configuration
GPSMODE9 (P25)	This pin (NAADET0) is used as active antenna supervisor input and not used for GPSMODE configuration.
GPSMODE10 (P26)	General I/O Configuration
GPSMODE11 (P27)	
GPSMODE12 (P29)	Serial I/O configuration

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11. Baud Rate Setting

Serial I/O Configuration

The ATR06XX features a two-stage I/O message and protocol selection procedure for the two available serial ports. At the first stage, a certain protocol can be enabled or disabled for a given USART port. Selectable protocols are RTCM, NMEA and UBX. At the second stage, messages can be enabled or disabled for each enabled protocol on each port. In all configurations discussed below, all protocols are enabled on all ports. But output messages are enabled in a way that ports appear to communicate at only one protocol. However, each port will accept any input message in any of the three implemented protocols.

Table Serial I/O Configuration

GPSMODE12 (Reset = PU)	GPSMODE6 (Reset = PU)	GPSMODE5 (Reset = PD)	USART1 (Output Protocol/ Baud Rate (kBaud))	USART2 (Output Protocol/ Baud Rate (kBaud))	Messages	Information Messages
0	0	0	UBX/57.6	NMEA/19.2	High	User, Notice, Warning, Error
0	0	1	UBX/38.4	NMEA/9.6	Medium	User, Notice, Warning, Error
0	1	0	UBX/19.2	NMEA/4.8	Low	User, Notice, Warning, Error
0	1	1	–/Auto	–/Auto	Off	None
1	0	0	NMEA/19.2	UBX/57.6	High	User, Notice, Warning, Error
1	0	1	NMEA/4.8	UBX/19.2	Low	User, Notice, Warning, Error
1	1	0	NMEA/9.6	UBX/38.4	Medium	User, Notice, Warning, Error
1	1	1	UBX/115.2	NMEA/19.2	Debug	All

Both USART ports accept input messages in all three supported protocols (NMEA, RTCM and UBX) at the configured baud rate. Input messages of all three protocols can be arbitrarily mixed. Response to a query input message will always use the same protocol as the query input message.

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12. Message

Table Supported Messages at Setting *Low*

NMEA Port	Standard	GGA, RMC
UBX Port	NAV	SOL, SVINFO

Table Supported Messages at Setting *Medium*

NMEA Port	Standard	GGA, RMC, GSA, GSV, GLL, VTG, ZDA
UBX Port	NAV	SOL, SVINFO, POSECEF, POSLLH, STATUS, DOP, VELECEF, VELNED, TIMEGPS, TIMEUTC, CLOCK

Table Supported Messages at Setting *High*

NMEA Port	Standard	GGA, RMC, GSA, GSV, GLL, VTG, ZDA, GRS, GST
	Proprietary	PUBX00, PUBX03, PUBX04
UBX Port	NAV	SOL, SVINFO, POSECEF, POSLLH, STATUS, DOP, VELECEF, VELNED, TIMEGPS, TIMEUTC, CLOCK
	MON	SCHD, IO, IPC

Table Supported Messages at Setting *Debug* (Additional Undocumented Message May be Part of Output Data)

NMEA Port	Standard	GGA, RMC, GSA, GSV, GLL, VTG, ZDA, GRS, GST
	Proprietary	PUBX00, PUBX03, PUBX04
UBX Port	NAV	SOL, SVINFO, POSECEF, POSLLH, STATUS, DOP, VELECEF, VELNED, TIMEGPS, TIMEUTC, CLOCK
	MON	SCHD, IO, IPC
	RXM	RAW (RAW message support requires an additional license)

The following settings apply if GPSMODE configuration is not enabled, that is, GPSMODE = 0 (*ROM-Defaults*):

Table Serial I/O Default Setting if GPSMODE Configuration is Deselected (GPSMODE0 = 0)

	USART1/USB NMEA	**USART2 UBX**
Baud Rate (kBaud)	57.6, Auto enabled	57.6, Auto enabled
Input Protocol	UBX, NMEA, RTCM	UBX, NMEA, RTCM
Output Protocol	NMEA	UBX
Messages	GGA, RMC, GSA, GSV	NAV: SOL, SVINFO
Information Messages (UBX INF or NMEA TXT)	User, Notice, Warning, Error	User, Notice, Warning, Error

13. USB Power Mode

USB Power Mode

For correct response to the USB host queries, the device has to know its power mode. This is configured by use of GPSMODE7. If set to *bus powered*, an upper current limit of 100 mA is reported to the USB host; that is, the device classifies itself as a "low-power bus-powered function" with no more than one USB power unit load.

Table USB Power Modes

GPSMODE7 (Reset = PU)	Description
0	USB device is bus-powered (max. current limit 100 mA)
1	USB device is self-powered (Default)

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14. FixNow™ Mode

• Continues Tracking Mode

– optimized for position accuracy
– optimized for min. power consumption based on ***Autonomous Power Management***
– is default setting

• FixNow™ Mode
– additional power saving functions
– best mod for applications where low power is primary consideration (tracking units)
– can be configured for different application requirements

Operating modes (recommendation)

Requirements	Recommended Operation Mode
Maximum Accuracy	**Continues Tracking Mode** (default configuration)
Periodic position fix (<10s) Power consumption is of minor concern	**Continues Tracking Mode** (It's possible to change the output rate of the serial Interfaces and to adjust the measurement rate.)
Periodic position fix (<10s) Reduced power consumption required	**Continues Tracking Mode** (It's possible to disable SBAS, unused serial Interfaces and reduce the main power supply voltage)
Periodic position fix (>10s) min. power consumption	**FixNow Mode** Set the on-/off-time as desired
Position fix on demand TTFF as short as possible	**FixNow Mode** Set on-time to 35s and off-time to <1800s (downloading ephemeris data every 30 min)
Position fix on demand min. power consumption	**FixNow Mode** Set on-time to 0s and off-time as required by application

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Appendix A: Data Set

1. GGA data set

The GGA data set (GPS Fix Data) contains information on time, longitude and latitude, the quality of the system, the number of satellites used and the height.

An example of a GGA data set:
$GPGGA,130305.0,4717.115,N,00833.912,E,1,08,0.94,00499,M,047,M,,*58<CR><LF>

The function of the individual characters or character sets is explained in Table 10.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
GGA	Data set identifier
130305.0	UTC positional time: 13h 03min 05.0sec
4717.115	Latitude: 47° 17.115 min
N	Northerly latitude (N=north, S= south)
00833.912	Latitude: 8° 33.912min
E	Easterly longitude (E= east, W=west)
1	GPS quality details (0= no GPS, 1= GPS, 2=DGPS)
08	Number of satellites used in the calculation
0.94	Horizontal Dilution of Precision (HDOP)
00499	Antenna height data (geoid height)
M	Unit of height (M= meter)
047	Height differential between an ellipsoid and geoid
M	Unit of differential height (M= meter)
,,	Age of the DGPS data (in this case no DGPS is used)
0000	Identification of the DGPS reference station
*	Separator for the checksum
58	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 10: Description of the individual GGA data set blocks

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2. GLL data set

The GLL data set (geographic position – latitude/longitude) contains information on latitude and longitude, time and health.

Example of a GLL data set:
$GPGLL,4717.115,N,00833.912,E,130305.0,A*32<CR><LF>

The function of the individual characters or character sets is explained in Table 11.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
GLL	Data set identifier
4717.115	Latitude: 47° 17.115 min
N	Northerly latitude (N=north, S= south)
00833.912	Longitude: 8° 33.912min
E	Easterly longitude (E=east, W=west)
130305.0	UTC positional time: 13h 03min 05.0sec
A	Data set quality: A means valid (V= invalid)
*	Separator for the checksum
32	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 11: Description of the individual GGL data set blocks

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3. GSA data set

The GSA data set (GNSS DOP and Active Satellites) contains information on the measuring mode (2D or 3D), the number of satellites used to determine the position and the accuracy of the measurements (DOP: Dilution of Precision).

An example of a GSA data set:
$GPGSA,A,3,13,20,11,29,01,25,07,04,,,,,1.63,0.94,1.33*04<CR><LF>

The function of the individual characters or sets of characters is decribed in Table 12.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
GSA	Data set identifier
A	Calculating mode (A= automatic selection between 2D/3D mode, M= manual selection between 2D/3D mode)
3	Calculating mode (1= none, 2=2D, 3=3D)
13	ID number of the satellites used to calculate position
20	ID number of the satellites used to calculate position
11	ID number of the satellites used to calculate position
29	ID number of the satellites used to calculate position
01	ID number of the satellites used to calculate position
25	ID number of the satellites used to calculate position
07	ID number of the satellites used to calculate position
04	ID number of the satellites used to calculate position
,,,,,	Dummy for additional ID numbers (currently not used)
1.63	PDOP (Position Dilution of Precision)
0.94	HDOP (Horizontal Dilution of Precision)
1.33	VDOP (Vertical Dilution of Precision)
*	Separator for the checksum
04	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 12: Description of the individual GSA data set blocks

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4. GSV data set

The GSV data set (GNSS Satellites in View) contains information on the number of satellites in view, their identification, their elevation and azimuth, and the signal-to-noise ratio.

An example of a GSV data set:
$GPGSV,2,2,8,01,52,187,43,25,25,074,39,07,37,286,40,04,09,306,33*44<CR><LF>

The function of the individual characters or character sets is explained in Table 13.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
GSV	Data set identifier
2	Total number of GVS data sets transmitted (up to 1 ... 9)
2	Current number of this GVS data set (1 ... 9)
09	Total number of satellites in view
01	Identification number of the first satellite
52	Elevation (0° .... 90°)
187	Azimuth (0° ... 360°)
43	Signal-to-noise ratio in db-Hz (1 ... 99, null when not tracking)
25	Identification number of the second satellite
25	Elevation (0° .... 90°)
074	Azimuth (0° ... 360°)
39	Signal-to-noise ratio in dB-Hz (1 ... 99, null when not tracking)
07	Identification number of the third satellite
37	Elevation (0° .... 90°)
286	Azimuth (0° ... 360°)
40	Signal-to-noise ratio in db-Hz (1 ... 99, null when not tracking)
04	Identification number of the fourth satellite
09	Elevation (0° .... 90°)
306	Azimuth (0° ... 360°)
33	Signal-to-noise ratio in db-Hz (1 ... 99, null when not tracking)
*	Separator for the checksum
44	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 13: Description of the individual GSV data set blocks

5. RMC data set

The RMC data set (Recommended Minimum Specific GNSS) contains information on time, latitude, longitude and height, system status, speed, course and date. This data set is relayed by all GPS receivers.

An example of an RMC data set:
$GPRMC,130304.0,A,4717.115,N,00833.912,E,000.04,205.5,200601,01.3,W*7C<CR><LF>

The function of the individual characters or character sets is explained in Table 14.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
RMC	Data set identifier
130304.0	Time of reception (world time UTC): 13h 03 min 04.0 sec
A	Data set quality: A signifies valid (V= invalid)
4717.115	Latitude: 47° 17.115 min
N	Northerly latitude (N=north, S= south)
00833.912	Longitude: 8° 33.912 min
E	Easterly longitude (E=east, W=west)
000.04	Speed: 0.04 knots
205.5	Course: 205.5°
200601	Date: 20th June 2001
01.3	Adjusted declination: 1.3°
W	Westerly direction of declination (E = east)
*	Separator for the checksum
7C	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 14: Description of the individual RMC data set blocks

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6. VTG data set

The VGT data set (Course over Ground and Ground Speed) contains information on course and speed.

An example of a VTG data set:
$GPVTG,014.2,T,015.4,M,000.03,N,000.05,K*4F<CR><LF>

The function of the individual characters or character sets is explained in Table 15.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
VTG	Data set identifier
014.2	Course 14.2° (T) with regard to the horizontal plane
T	Angular course data relative to the map
015.4	Course 15.4° (M) with regard to the horizontal plane
M	Angular course data relative to magnetic north
000.03	Horizontal speed (N)
N	Speed in knots
000.05	Horizontal speed (Km/h)
K	Speed in km/h
*	Separator for the checksum
4F	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 15: Description of the individual VTG data set blocks

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7. ZDA data set

The ZDA data set (time and date) contains information on UTC time, the date and local time.

An example of a ZDA data set:
$GPZDA,130305.2,20,06,2001,,*57<CR><LF>

The function of the individual characters or character sets is explained in Table 16.

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
ZDA	Data set identifier
130305.2	UTC time: 13h 03min 05.2sec
20	Day (00 … 31)
06	Month (1 … 12)
2001	Year
	Reserved for data on local time (h), not specified here
	Reserved for data on local time (min), not specified here
*	Separator for the checksum
57	Checksum for verifying the entire data set
<CR><LF>	End of the data set

Table 16: Description of the individual ZDA data set blocks

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