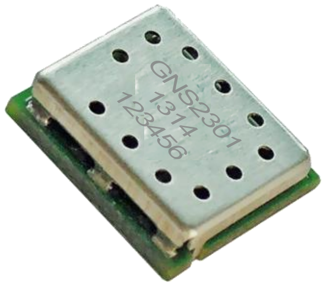
1 INTRODUCTION

The GNS2301 module utilizes the new generation CSR SirF V GNSS chip that supports GPS and GLONASS simultaneously. Upgrading firmware, future GNSS systems like GALILEO can be supported.

Due to its capability to use GLONASS and GPS at the same time, GNS2301 benefits from the higher availability of satellites in critical environments. The navigation performance and accuracy is further improved by using the correction data from SBAS (WAAS, EGNOS, GAGAN, MSAS), QZSS.



First Fixes after just a few seconds are achieved with the help of three different A-GPS technologies. The module supports self prediction and predicted data A-GNSS to cover all needs for fast TTFF performance.

GNS2301 is based on Sirf chipset of the 5th generation. It includes a ROM based software code and a patch RAM for later software improvements.

Several Low Power Mode options make it easy to implement this module in power sensitive, battery supplied applications.
Low power requirements (~90mW@ 3.3V, full activity) and internal voltage regulators make it easy to run the module with various power supplies and allows direct connection to LiIon batteries.

GNS2301 offers the industry's highest level of navigation sensitivity down to -165dBm. It has superior dynamic performance at high velocity and provides effective protection against interference signals. Up to 8 independent channel interference can be eliminated or reduced.

For easy test and evalution, a Starter Kit is available.

Features

- GLONASS and GPS simultaneously, GALILEO and BEIDOU ready
- 52 channels
- Ultra high GPS tracking/navigation sensitivity: -165dBm/-160dBm
- Ultra high GLONASS tracking/navigation sensitivity: -163dBm/-159dBm
- Full sensor support (MEMS) for deep urban canyon positioning accuracy
- Extremely fast TTFF at low signal level
- QZSS, SBAS (WAAS,EGNOS,MSAS,GAGAN) correction support
- A-GPS predicted / self predicted support
- Active Interference Canceller for GPS-in-band jammer rejection
- Embedded logger function (external SPI flash needed)
- High accuracy 1PPS output
- NMEA-0183 or binary protocol
- High update rate (up to 5/s)
- GPS+GLONASS Consumption current(@3.3V):
    - Acquisition: 30mA Typical
    - Tracking: 28mA Typical
- Low Power operating modes
- User selectable host interface : UART / SPI / I^2C
- hibernate current consumption 50uA, typical
- SMD type LGA; a stamp holes adaptor is available for manual solder process
- Small form factor: 10.0x9.3x2.1 mm

Applications:

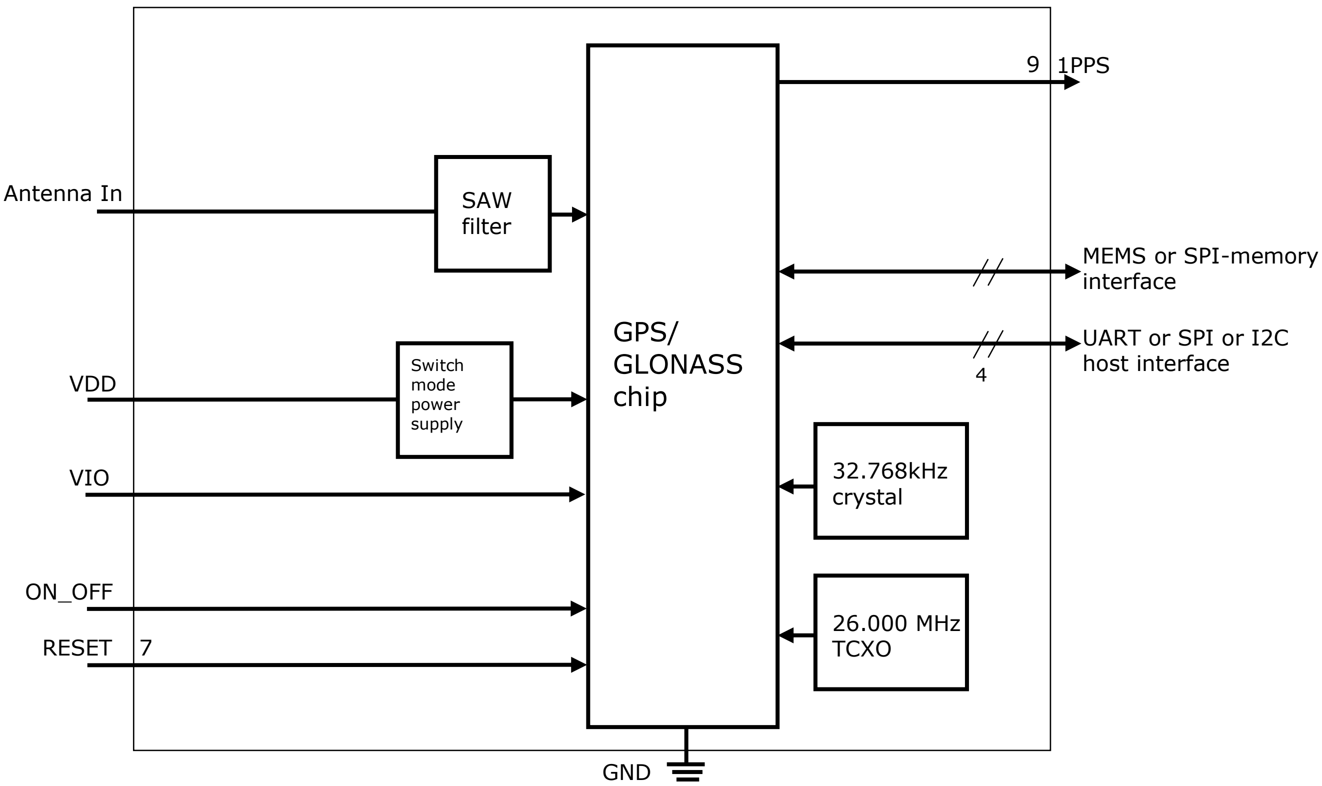
Navigation
In-vehicle Navigation equipment
Dynamic Navigation
Portable ("nomadic") devices
Netbooks, tablet PCs and mobile phones

Location based applications
GPS Logger
GPS Tracker
Security devices
Camera equipment
Geofencing
Health and fitness devices

2 INDEX

3 FUNCTIONAL DESCRIPTION

3.1 Block diagram



3.2 System description

The GNS2301 core is a high performance, low power GPS and GLONASS receiver with Galileo option that includes an integrated RF frontend.
Also GNS2301 provides position, velocity and time measurements without any host loading. This, coupled with the optional built-in power management options, reduces the overall system power budget.
For dead reckoning applications, a MEMS Sensor interface is provided. MEMS information is a third source of information for the module. The receiver can process both GNSS systems and the MEMS sensor information simultaneously, which improves the availability of a usable navigation solution in almost any scenario.
Due to high input sensitivity and integrated low noise amplifier (LNA), it can work directly with a passive antenna.

GNS2301 is a complete GNSS engine, including:

- Full GPS and GLONASS processing without any host processing requirements
- Standard NMEA message output

- A powerful command and control interface
- All clock sources integrated on module
- RF frontend for direct connection of passive or active antennas
- Rich additional features like logger (needs external SPI memory), Sensor support, Self predicted AGPS, last position retention

3.3 GPS and GLONASS simultaneous operation

GNS2301 supports tracking of the GPS and the GLONASS satellite system at one time. This feature enhances the overall performance significantly.

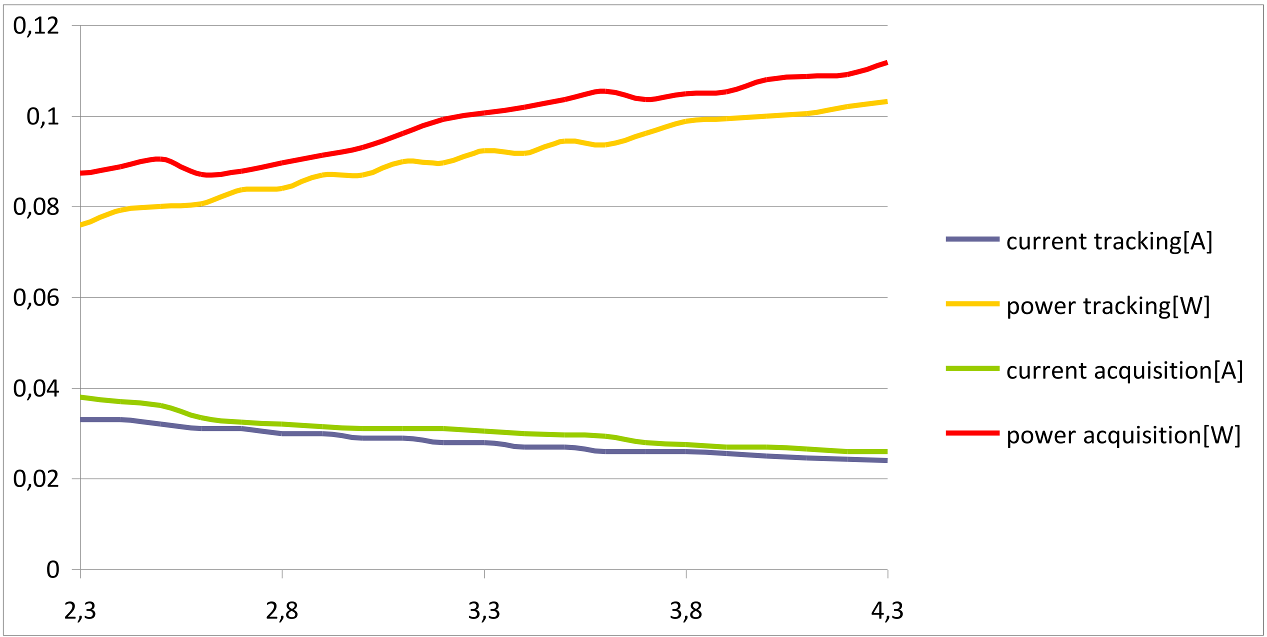
- Increased availability of number of satellites
- Increased spatial distribution allows better geometrical conditions
- Reduced Horizontal (HDOP) and Vertical Dilution of Precision (VDOP) factors

Using a combined receiver, users have an access to potentially 48 or more satellites. This high number of satellites can overcome the typical problems of restricted visibility of the sky, such as in urban canyons or indoor scenarios.

3.4 Power Management Unit

GNS2301 offers exceptional power management options. Main power supply voltage can be chosen freely and can be altered (even during operation) between 2.3V and 4.3V. GNS2301 can be operated directly with a LiIon cell without any need of an LDO.
The integrated SMPS controls the voltage and keeps the power consumption almost at a constant level of ~73..105mW. (See figure 2 below).
Note : On request, GNS2301 is also available for a fixed 1.8V supply. The 1.8V option disables the switching regulator by hardware, restricting the allowed supply voltage to 1.75 to 1.85 V.
I/O pins will be supplied independently through a dedicated V_{IO} pin with a fixed voltage between 1.8 and 3.5V. This saves any need for external I/O level shifters.

Fig. 2. Current consumption and power requirement at full power operation vs. Voltage at V_{DD}. V_{IO} is 3.3V



3.5 Selectable Power management features

GNS2301 can be switched to several power saving functions through the command interface.
An additional ON_OFF pin switches the module between standby and full operation, keeping the Real Time Clock (RTC) and the RAM alive to provide quick hot starts when being waked up again.
Please refer to the *GNS2301NMEAcommandInterface_manual* for detailed information.

- In ***Full Power Mode*** all components are fully active and a position fix is calculated every second.
- ***Push To Fix Mode II*** allows a long duty-cycle operation with periodic maintenance of the position fix. An instant fix can be demanded by the host by sending an appropriate command (see 0) to the GNS2301. Specific periods allow synchronizaion with the GNSS satellites. This minimizes power used searching for framing patterns.
- Using ***The Micro Power Mode with Awareness***, the system is commanded to enter a very low power mode with dynamically scheduled wakeups for updates and when the actual user position changes.
- ***Trickle Power Mode*** saves power by switching the receiver to a slower navigation update. The update rate is selectable. However, when signal conditions do require shorter cycles, the 2301 will increase activity to maintain adequate position accuracy.
- ***Trickle Power II Mode*** implements an additional power reduction by modulating the RF stage power requirements depending on signal conditions.

  In ***Standby mode***, the RF frontend and internal MPU are switched to deep sleep state. Power consumption is reduced to 50µA.This state can be entered by sending the appropriate command or by applying a positive going pulse to the ON_OFF pin.

3.6 Logger function

Together with an externally connected SPI flash memory, GNS2301 provides an autonomous logger function that automatically stores position information. A complete tracking unit can be realized without any external CPU.
The parameters for logging are programmable via the NMEA command interface. The following parameter can be set to optimize logging time:

- logger rate (1..65535 seconds)
- distance threshold for logging (prevents static logs)
- speed threshold for logging (prevents static logs)
- memory management (circular or stop on full)
- record format (position, altitude, speed, accuracy)

The commands for logger include:

- logger status request
- start logging
- stop logging
- erase memory
- readout memory

please refer to chapter 8.2 NMEA command interface for details.

Logger Function					
	Min		Max	Unit	Comment
Logger data rate	1		65535	s	
Logger data memory		User defined		kBytes	External SPI Flash memory
Logger trigger		programmable			Logger can be triggered on time, speed, movement[m]

3.7 Active interference cancellation

Multiple interference mitigation strategies address CW, narrowband and wideband interference, and crosscorrelation and multipath effects.

The primary types of interference caused by jamming signals are:

- CW interference and other sources of interference that are substantially narrower than the nominal receiver IF bandwidth (6 MHz).
- Pulsed interference from sources such as a GSM transmitter.
- Cross-correlation interference from a satellite signal that has a strong C/No, which the GNSS receiver

Even with these features in place, pay close attention to system co-existence and board-level EMC issues, and design to avoid jamming in the GNSS receiver. The above features are only useful if the GNSS receiver remains linear and outside compression. Exercising these features will have an impact on sensitivity and power consumption and should never be used as a substitute for good design practice.

GNS2301 uses the following strategies to handle interference signals. All cancellation features are active by default except the LTE Immunity mode

Bandwidth Restriction

If interference is in the GPS band and falls outside the 2 MHz main-lobe of the GPS signal, then a 2 MHz-wide bandstop filter attenuates the interference. When the filter is used, GPS C/No degrades by approximately 0.3 dB because of the removal of the outer sidebands.

Active Notching

Interference falling within the 2 MHz GPS band and 8 MHz GLONASS band is mitigated with GNS2301 internal filters and tone cancellers. GNS2301 actively detects, tracks and removes the 8 strongest internal or external jamming signals in both GPS and GLONASS bands, without requiring prior knowledge of the jamming signal.

Software Detection

GNS2301 automatically detects and tracks in-band interference without prior knowledge of the jammer signal or its characteristics. Algorithms monitor the behaviour of signals. If a suspect signal is detected, the algorithms clear, reset and restart the channel assigned to track the satellite PRN.

Pulsed-interference Mitigation

GNS2301 contains technology to mitigate pulsed interference from GSM transceivers. When a pulse is detected, the signal path is blocked. When the pulse is no longer detected, the signal path is unblocked.

Cross-correlation Interference

GNS2301 uses cross-correlation mitigation technology. This technology avoids the interference that a strong satellite can cause to a weak satellite.

GPS Active Jamming Removal

GPS active jamming removal detects the 8 strongest jamming frequencies in the ±1 MHz centre band.

GLONASS Active Jamming Removal

This function detects the 8 strongest jammers in the ±4 MHz GLONASS band, by monitoring amplitude and frequency

LTE Immunity Mode

LTE immunity mode is recommended if a LTE transceiver is part of the application. This mode will significantly improve LTE immunity but also reduce the average sensitivity by 1dB. It will be started or stopped through an OSP command.

3.8 Assisted GNSS (A-GNSS)

A-GNSS allows to shorten TTFF (TimeToFirstFix) by injecting ephemeris data from an external source into the module's memory. With the help of these data, the module does not need to acquire satellite positions by receiving the data from the satellites.
Depending on time and position information that is still available in the module memory, the TTFF can be reduced to just a few seconds.
GNS 2301 supports 2 different A-GNSS strategies:

SGEE predicted ephemeris – long prediction periods

Is based on predicted ephemeris data that can be downloaded from a Server. A device that uses SGEE has to connect to the internet from time to time and download a predicted data file. The maximum prediction time frame is up to 31 days. One day will need 11kBytes download for GPS and 9kByte for Glonass prediction data. The TTFF is as short as 5..10 seconds.

CGEE self predicted Ephemeris – works autonomously on module

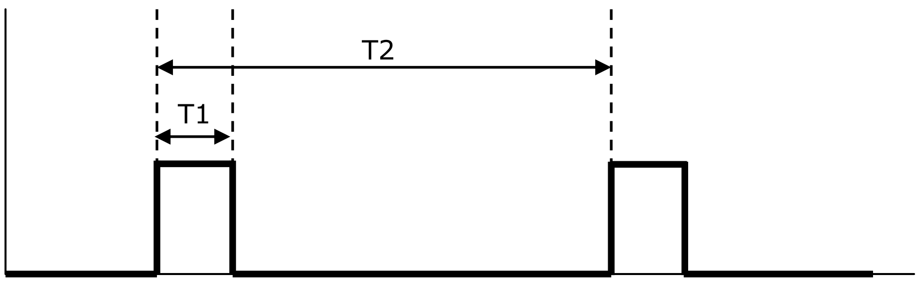
The GNSS engine can predict ephemeris data based on actually collected satellite data. The prediction period is up to three days. The main advantage of self prediction is that no server connection and no additional hardware is needed. TTFF is 5..10 seconds.
Note:
Predicted ephemeris data is stored in the RAM memory area. It will be lost, whenever power is removed from the chip. Use ON_OFF feature to power down the 2301.

SUPL A-GNSS – ultra low TTFF

Is a real time ephemeris, time and almanac download. It needs 1.5kByte for GPS and 3kBytes for Glonass. The valid period is up to 4 hours. SUPL A-GNSS provides the best performance, but needs a network connection whenever the aiding is needed. TTFF is almost the same as for hot fix, ~ 1 second. This option is not free of charge and may require invidual programming.

3.9 Pulse Per Second (PPS)

GNS2301 provides a Pulse Per Second (PPS) hardware output pin (GPIO 5, pin 13) for timing purposes. After calculation of a 3D position fix (default setting), the PPS signal is accurately aligned to the GPS second boundaries. The pulse generated is 250 milliseconds in duration and the repetition rate is 1 second.
No pulse will be generated when there's no fix available.
After having had a stable 3D fix and the PPS synchronized, a 2D- fix (3 satellites in fix solution) will be sufficient to keep the PPS working.



T1 = 250ms T2 = 1sec

GNS2301 module provides an low RMS jitter of typical 30 nanoseconds.

PPS characteristics based upon a 3D-fix					
	min	**typ**	**max**	**Unit**	**comment**
1PPS pulse duration	249	250	251	msec	
1PPS time jitter	-	±30	-	nsec RMS	Pulse rising edge jitter from average pulse, measured with full 3D fix, -130dBm , 4SVs
1PPS time deviation from GPS second	-90	-	+90	nsec	Pulse rising edge deviation from expected (GNS) pulse time, measured with full 3D fix, -130dBm , 4SVs
1PPS rise and fall time	-	5	-	nsec	10%..90%, load is 10k||5pF

table 1

3.10 SBAS (Satellite Based Augmentation) support

GNS2301 supports Satellite Based Augmentation for improvement of the navigation precision. Correction data is sent from geostationary satellites to the GPS receiver. GNS2301 supports European, US, and Asian augmentation systems (WAAS, MSAS,GAGAN and EGNOS) to enable precision improvements in nearly every region of the world.
SBAS is inactive by default and must be activated after the module is power-cycled. See 0 for command details.

3.11 Last position retention

Depending on the application, it might be useful to retain the last position or to clear the position when having no fix solution. Storage of last position data needs a permanent connection of power on V_{DD} pin.

3.12 GPS almanac and ephemeris data

For quick re-acquisition of the GPS after off-times, the GPS engine should have access to almanac and ephemeris data. This data is permanently stored inside GNS2301 module, as long as a battery is connected to V_{DD}. When the GPS is powered-up again, the data will be used to allow a quick re-acquisition, as soon as a coarse time information is available. Time will be available immediately, when RTC is kept running.

3.13 Real time clock (RTC)

GNS2301 has a real time clock with 32,768Hz crystal onboard. As long as V_{DD} is connected to a power source, the real time clock and the module memory can be kept alive at very low power consumption of just 50uA. The RTC will track the current time and enable the module to start from sleep states with very fast Time To First Fix (TTFF).

3.14 Host interface

The host interface is used for GNSS data reports and receiver control

GNS2103 provides three different options for interfacing a host system.

1. The UART interface with selectable baudrates
2. SPI interface : 4 wire with additional Interrupt line
3. I^2C interface : 2 wire , slave device

The kind of Interface is selected through external resistors on pins 11 and 12.
Pull up and pull down must be performed over a 10kΩ resistor

Interface selection through bootstrap resistors		
	11	**12**
UART	Pull up	-
SPI	-	-
I^2C	-	Pull down

table 2

GNS2301 core works at 1.2V/1.8V internally. A flexible I/O supply structure allows to select the I/O interface voltage by connecting the desired voltage to the VIO input.
The maximum voltage at VIO is limited to 3.5V.

UART interface

The UART interface can be used with or without hardware handshake. The baudrate of the UART can be selected over a software command or via hardware. The maximum baudrate is 1.2288 Mbps. Hardware handshake is available through CTS and RTS pins.

UART default settings	
Baud rate	See below table
Data byte	8 Bit
Stop bit	1
Parity	None

table 3

The hardware baud rate selection supports 4 standard values that can be selected through GPIO 0 and 1 on pins 7 & 8.

UART baud selection through bootstrap resistors		
	7	**8**
4800	Pull up	Pull up
9600	Pull down	Pull up
38400	Pull up	Pull down
115200	Pull down	Pull down

table 4

SPI interface

The SPI interface is configured as a slave and uses 4-wires. An additional interrupt is used to for signaling data availability

I²C interface

The I²C interface can be operated at max. 100kbps or 400kbps. It operates in multi master mode.

Multi-master Mode

Multi-master mode requires that hardware detect and arbitrate between collisions for master status and data direction. Master or slave mode is determined from clock contention, whichever device is generating the clock is the master and all other devices are slave.
In the event of contention time-out, the master device must take control of the error detection and retries.

I2C Addresses

Address format is 7-bit by default and can be set to 10-bit. I2C supports multiple masters and multiple slaves. GNS2301 address as master/sending is 0x62 and as slave/receiving is 0x60.

Access Contention

When GNS2301 operates in multi-master mode on the I2C bus, contention is managed by all connected master devices. Hardware resolves contention and collision retries. You must ensure that the bus capacity is adequate for the bus data transfer load peaks and that resulting latencies are not detrimental to system performance.

I^2C Interface requirements

I2C requirements	
Data frame size	8 bit octets
Data bit order	MSB first
Maximum bytes per transfer	No limit
Clock rate	Max 400kbps, When GNS2301 is master, the rate can be set using OSP message
Bus contention timeout	30ms, fixed

table 5

notes:
1. GNS2301 may either lose or garble serial messages if the host does not poll often enough to fetch all messages. The system design assumes unrestricted outflow of serial messages.

2. When switching GNS2301 to HIBERNATE mode, using an orderly shutdown with an ON_OFF pulse or by OSP/NMEA command message, GNS2301 continues to run until I^2C transmit/output buffers are empty. At slow I_2C serial port speeds, with a high volume of data, time-to-turn-off may be up to one second even with no throttling or pacing from bus contention. If multi-master mode contention or clock stretching on the I2C bus stops output of data from GNS2301, GNS2301 takes longer to turn off. If the I2C bus is inadvertently seized, or another device holds the clocks or data line low and never releases, GNS2301 does not turn off until all pending messages have been sent.

3.15 HW operation control

GNS2301 should be switched from active to hibernate through the ON_OFF pin. The pin toggles the power state whenever a positive going edge is supplied.
After powering up the module, it remains in hibernate until the rising edge is seen on ON_OFF pin.
A time gap of 500ms should be between power on and issueing the ON_OFF pulse.

Alternatively, the module can be started automatically by connecting the WAKEUP pin to the ON_OFF pin over a 10k resistor.
Notes:
1. **This auto start configuration is not yet qualified by the chip manufacturer CSR**
2. **This option can not be used in conjunction with power saving trickle modes (see 3.5)**

GNS2301 can be put to hibernate state (RTC on, last position and ephemeris is retained) at any time with a positive edge on ON_OFF.

3.16 Module default settings

The GNS2301 module comes with default settings, which are persistently programmed in ROM. Whenever all power is removed from the module (VIO and VDD), the settings will be reset to the values shown in the following table.
Some settings (as host interface type and baud rate setting) can be selected through pull-ups and pull-downs on ome GPIO pins. Please refer to table 2,table 3,table 4.
The following table shows the defaults with all configuration pins left open.

Setting	Default value	Modification options
UART setting	9600,8,N,1	Bootstrap, see 0 , command via OSP or NMEA, see0
Host interface	-	Bootstrap option, see 3.14
Fix frequency (update rate)	1/sec	Selectable through OSP or NMEA, see 8.2
NMEA sentences	RMC,GSA,GSV,GSV,VTG,GGA	Selectable through OSP or NMEA, see 0
NMEA rate	Once a second: RMC,GSA,VTG,GGA every 5 sec :GSV sentences	Selectable through OSP or NMEA, see 0
Self prediction mode	tbd	
Active interference cancellation	enabled	fixed
SBAS option	disabled	Selectable through OSP
Datum	WGS 84	Selectable through OSP or NMEA, see 8.2
PPS pulse output length	250ms	fixed
Logging parameters		Adjustable through OSP or NMEA, see 0

table 6

3.17 GNS2301 feature selection

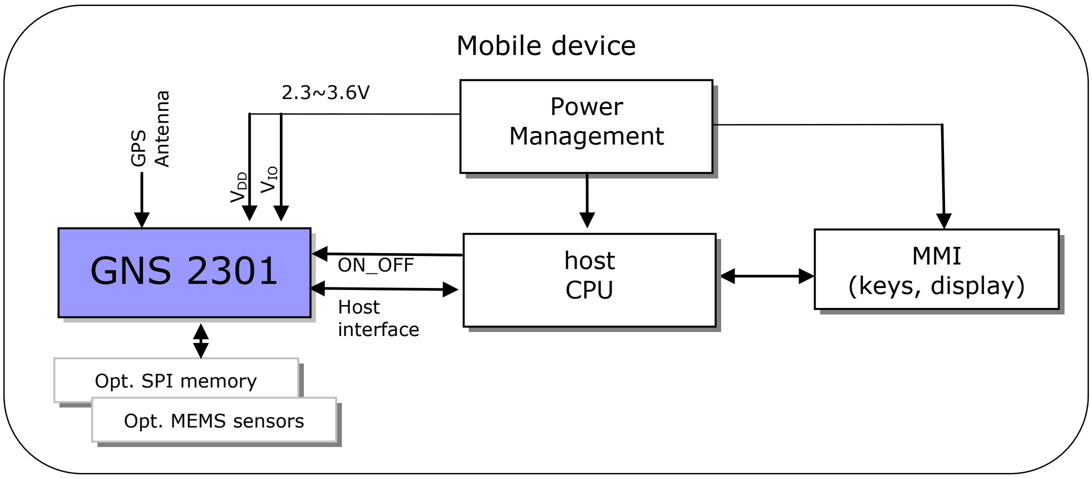
GNS2301 provides a lot of interfacing and functional options. However, to keep the pin count low, not all options can be used in any combination.

For the host connection, you can only choose one of the three options:
UART (2-wire or 4-wire) **or** I2C **or** SPI.
The option is selected via bootstrap resistors as described in3.14.

For the second SPI (I2C), you can connect
MEMS sensors for dead reckoning (DR) **or** an external memory for logging option.

4 TYPICAL APPLICATION BLOCK DIAGRAM

4.1 Typical System overview



5 Electrical characteristics

5.1 GNSS characteristics

Parameter	Min	Typ	Max	Unit	Note
general					
Frequency		1575.42		MHz	GPS L1
		1598.0625~ 1609.3125		MHz	GLONASS L1
		1575.42		MHz	GALILEO E1 L1,optional
SV Numbers					GPS #1~32 GLONASS #65~96 GALILEO #201~253*
DGPS					SBAS[QZSS,WAAS,EGNOS, MSAS,GAGAN]
AGPS					Self prediction, injected prediction
Number of channels		52			
Output data frequency	1	-	5	1/sec	Configurable, see 8.2
sensitivity					
Navigation sensitivity		-160		dBm	GPS
Navigation sensitivity		-159		dBm	GLONASS
tracking sensitivity		-165		dBm	GPS
tracking sensitivity		-163		dBm	GLONASS
Acquisition sensitivity		-146		dBm	autonomous
Start times (TTFF)					
TTFF hotstart		<1		sec	All SVs @-130dBm
TTFF autonomous cold start		35		sec	All SVs @-130dBm
TTFF Warm Start		30		sec	All SVs @-130dBm
accuracy					
Horizontal static		2.5		m	-130dBm
Velocity		0.01		m/s	At 30m/s
Heading		0.01		°	
Dimension		9.3 *10.0*2.1		mm^3	Tolerance is 0.2 mm
Weight		~0.4		g	
Power consumption					
GPS/GLONASS ACTIVE (acquisition)		30		mA	NMEA frequency = 1/sec*,SBAS enabled, VDD=3.3V, VIO=3.3V
GPS/GLONASS ACTIVE (tracking)		28		mA	NMEA frequency = 1/sec*, SBAS enabled, VDD=3.3V, VIO=3.3V
hibernate @ 3.0V		50		µA	

*note: further power savings are possible using power saving modes as described under *Selectable Power management features*

ITAR limits					
Operation altitude		-	Tbd	m	
Operation velocity	-	-	Tbd	m/s	
Operation acceleration	-	-	Tbd	g	
GPS/GLONASS input characteristics					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Maximum input level	0	Tbd		dBm	
Input return loss		Tbd		dB	
Input impedance		Tbd			

5.2 Absolute Maximum Ratings

Parameter	Value	Unit
Supply voltage range: V_{DD}	−0.5 to 4.5	V
Interface voltage: V_{IO}	−0.5 to 3.6	V
Input voltage to analog pins	−0.5 to 3.3	V
Operating ambient temperature range	−40 to +85	°C
Storage temperature range	−40 to +85	°C

5.3 Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Note
V_{DD}	2.3		4.3	V	supply voltage at pin V_{DD}*
V_{IO}	1.75	1.8V / 3.3V	3.5	V	I/O voltage that defines the interface to the host processor
High level output voltage V_{OH}	0.8 * V_{IO}		V_{IO}	V	
Low level output voltage V_{OL}	0		0.2*V_{IO}	V	
High-level input voltage V_{IH}	0.75* V_{IO}		V_{IO}	V	
Low-level input voltage V_{IL}	0		0.30* V_{IO}	V	
Operating temperature	-40		85	°C	Full specified sensitivity

*note: on request, a 1.8V version is available. In this case, the supply range (V_{DD}) is restricted to 1.75..1.85V. V_{IO} can still be varied as specified above.

5.4 Electrical characteristics

Parameter	Min	Typ	Max	Unit	Note
Current consumption V_{DD}			38	mA	@2.3V, full operation, see Fig 2
Current consumption V_{DD}			27	mA	@4.3V, full operation, see Fig 2
Current consumption V_{DD}		50		µA	@2.3V, hibernate mode, RTC and RAM powered
Power consumption	78		110	mW	
Current consumption V_{IO}		Tbd			
Current consumption V_{IO}		Tbd			

6 DESIGN GUIDELINES

6.1 General

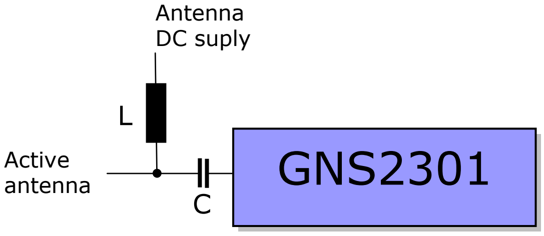
Although GNS2301 GNSS module provides best performance and active jamming cancellation algorithms at low power consumption, special care should be taken to provide clean signal and clean power supplies. A multi layer carrier board with solid power- and ground planes is recommended. Power lines should be blocked near to the module with low ESR capacitors. Radiated noise from neighbour components may also reduce the performance of the module. Special care must be taken when designing the RF input tracks and antenna connection.

6.2 GPS and GLONASS antenna

GNS2301 contains all input circuitry needed to connect a passive antenna directly. A special GPS & GLONASS antenna that covers both frequencies must be chosen.
If there is a long wire between GNS2301 RF input and antenna, there should be an LNA (on the antenna side) to compensate for cable losses ("active" antenna).
When using an active antenna, a DC supply for antenna must be connected via an inductor. The DC must e kept away from RF input by inserting a capacitor in the RF signal line. The DC power supply voltage should match the active antenna specified voltage.
More information about connecting and implementing a GNSS antenna to an application PCB, please refer to *GPS Antenna Design Guide.pdf*.

6.3 GPS Antenna supply

For an active antenna configuration, the antenna supply DC must be blocked from the antenna signal line with a inductor **L** of 100nH and a 100pF capacitor **C** as shown in the diagram below.

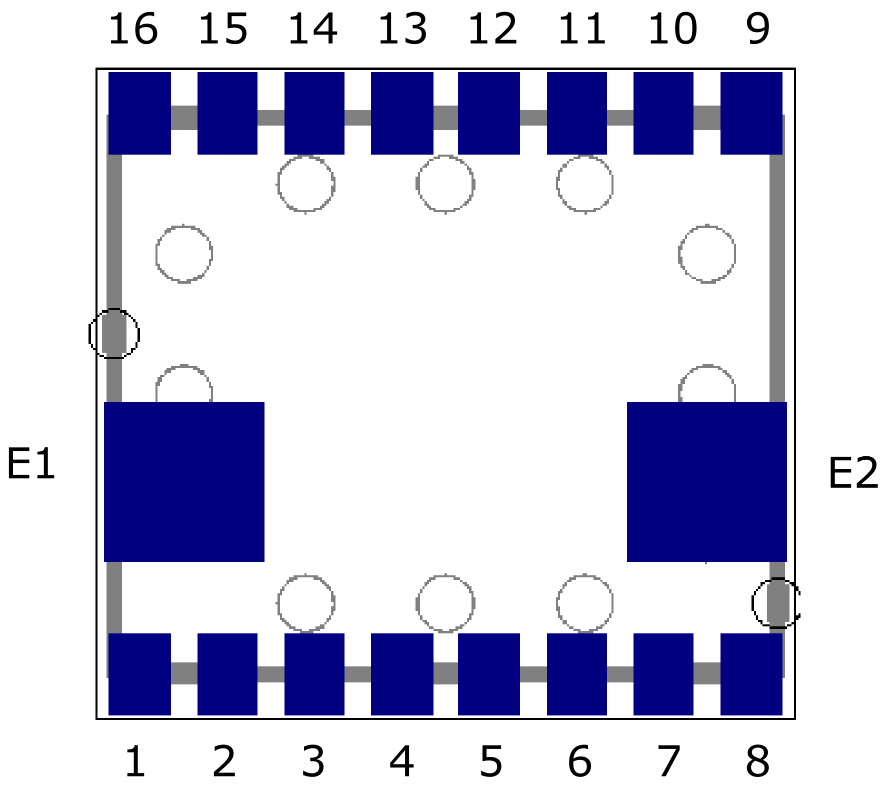


More information about connecting and implementing a GPS antenna to an application PCB, please refer to *Antenna Design Guide.pdf***.**

7 DEVICE PINOUT DIAGRAM

7.1 Pin configuration

Top view



7.2 Pin assignment

Pin	Name	I/O	Description & Note
1	GPIO 4	I/O	Multipurpose pin #4 1. SPI for Logger memory :MOSI
2	GPIO 3	I/O	Multipurpose pin #3 1. Message waiting , Host Wakeup , signals availability of data 2. SPI for Logger memory :CS
3	RESET	P	System reset pin An external reset applied to this pin overrides all other internal controls. RESET# is an active low signal. Pulling this pin low for at least 20 µs causes a system reset.
4	RF_GND	A	RF Ground Ground connection of antenna should be connected at this pin.
5	RF_IN	A	RF input connection for antenna. Supports passive antenna.
6	WAKEUP	O	Wakeup output This pin indicates activity of the GPS and can be used to activate external system components
7	GPIO 1	I/O	Multipurpose pin #1 1. SPI for Logger memory :CLK_out 2. MEMS output I^2C :SCL
8	GPIO 0	I/O	Multipurpose pin #0 1. SPI for Logger memory :MISO 2. MEMS I^2C :SDA
9	RXD	I	Serial Data Input 1. This pin receives UART commands from the host system 2. In SPI mode, this is the MOSI pin
10	TXD	O	Serial Data Output 1. This is the UART-A transmitter of the module. It outputs GPS information for application. 2. In SPI mode, this is the MISO pin
11	GPIO 6	I/O	Multipurpose pin #6 1. SPI host interface : CS 2. CTS for UART
12	GPIO 7	I/O	Multipurpose pin #7 1. SPI host interface : CLK_in 2. RTS for UART
13	1PPS	O	1PPS Time Mark Output 2.8V CMOS Level This pin provides one pulse-per-second output from the module and synchronizes to GPS time. Keep floating if not used. Pulse length is 250ms
14	ON_OFF	I	Input for activity control a low-to-high input rising edge initiates system transitions from the keep-alive/start-up or HIBERNATE state to the RUN state. A subsequent low-to-high rising edge initiates an orderly shutdown
15	VIO	P	I/O System supply Supply pin for the input / output system. Apply a voltage for the I/O lines , here (1.8 to 3.5V)
14	VDD	P	Main power supply Apply the main operating voltage, here. Since the module has an internal switch mode regulator, the supply voltage can be 2.3 to 4.3V
E1	GND	P	Ground
E2	GND	P	Ground

(1) I = INPUT; O = OUTPUT; I/O = BIDIRECTIONAL; P = POWER PIN; A = ANALOG PIN.

8 NMEA DATA interface

GNS2301 provides NMEA (National Marine Electronics Association) 0183 compatible data. Additionally, a set of proprietary NMEA commands are available to send control messages to the module.
Since GNS2301 is a GNSS multisystem module, it supports extended NMEA sentence structure to indicate GPS, GLONASS and resulting GNSS positioning solutions.
For standard operation, no commands are needed; the module will start outputting NMEA sentences after power supply has been attached. GNS2301 will always start communication output with 9600 bit per second. Other rates can be hardware selected, following table
If non-standard options are needed (f.e. other baud rate , other NMEA sequence) they can be programmed from host controller during runtime.
Important note : options set by using NMEA command interface are not persistent! They will be lost when power V_{DD} is removed.

8.1 NMEA output sentences for GPS and GLONASS

NMEA output sentences	
Type	**content**
Common sentences	
RMC	Recommended Minimum Navigation Information
GGA	Fix Data, Time, Position and fix related data for a GPS receiver
GLL	Geographic Position - Latitude/Longitude
GSA	GLONASS DOP and active satellites
VTG	Course and Speed Information relative to the Ground
GSV	Satellites in view
GNS	GNSS Navigation data

NMEA output sentences indentifier, related to GNSS system:

NMEA output identifier					
System	**GGA**	**GSA**	**GSV**	**RMC**	**VTG**
GPS	GPGGA	GPGSA	GPGSV	GPRMC	GPVTG
GPS+GLONASS	GPGGA	GNGSA	GPGSV GLGSV	GPRMC[1] or GNRMC	GPVTG

Note1: Before 3D fix RMC output is GPRMC, after 3D fix is achieved, it changes to GNRMC.

For more information, please refer to the *NMEA protocol* document.

8.2 NMEA command interface

GNS2301 NMEA command interface allows to control settings and some of the extended functions.

Each command must be terminated with a '*', a checksum and <CR><LF>.
The checksum (CS) must be calculated as a XOR of all Bytes excluding the $ and *.

ReceiverOff		
$PSRF117	**Receiver off command**	Puts the receiver to deep sleep.* Memory and RTC will be kept alive, allowing the receiver to start again with a short TTFF
Structure	$PSRF117,16 *0B<CR><LF>	
Fields	SID	16 (fixed)
	Checksum (0B)	Calculated from all datafields (XOR'ed)
Example	$PSRF117,16*0B<CR><LF>	Puts the receiver to deep sleep

***note: this command needs patch version 5.5.10 or later**

PollSW_Version		
$PSRF125	**Retrieve the receiver firmware version**	Returns the version in a $PSRF195 sentence
Structure	$PSRF125*21<CR><LF>	
Fields	-	
	Checksum (21)	Calculated from all datafields (XOR'ed)
Example	$PSRF125*21<CR><LF>	A version string is sent.

Set Serial Port		
$PSRF100	**Set Serial Port**	Defines SiRF or NMEA protocol, baud rate, DataBits, StopBits, Parity
Structure	$PSRF100, protocol, Baud, DataBits, StopBits, Parity, Checksum*CS, <CR><LF>	
Fields	protocol	0 = SiRF binary 1 = NMEA
	Baud	1200,…,115200 (all standard rates)
	DataBits	8
	StopBits	1
	Parity	0
	Checksum	Calculated from all datafields (XOR'ed)
Example	$PSRF100,0,9600,8,1,0*CS<CR><LF>	Sets serial port to SiRFbinary,9600bd,8,N,1
Default setting after power cycle	NMEA,9600bd,8,N,1	(bootstrap pull-up, pull-down can modify default baud rate to other value)

Navigation Initialization		
$PSRF101	**Navigation Initialization**	Defines receiver restart options with or without Initialization data. Correct Initialization data can speed up data acquisition and TTFF. Coordinates must be given in ECEF format
Structure	$PSRF101, Xcoord, Ycoord, Zcoord, ClkDrift, TimeOfWeek, WeekNo, ChannelCt, ResetCfg, Checksum*CS, <CR><LF>	
Fields	Xcoord	ECEF X in meters
	Ycoord	ECEF Y in meters
	Zcoord	ECEF Z in meters
	ClkDrift	Use 0 for last saved value if available, use 96250 else
	TimeOfWeek	GPS Time Of Week
	WeekNo	GPS Week Number
	ChannelCt	1..12
	ResetCfg	1 : HotStart 2 : WarmStart (no Init) 3 : WarmStart (use init params) 4 : ColdStart (no Init) 8 : Factory reset (no Init)
	Checksum	Calculated from all datafields (XOR'ed)
Example 1	$PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*CS<CR><LF>	Start the receiver in WarmStart mode using the parameters
Example 2	$PSRF101,0,0,0,0,0,0,12,4*CS<CR><LF>	Perform a ColdStart without using parameters. Please use the zeroes for the GPS params and set the ChnCt to 12 !
Example 3	$PSRF101,0,0,0,0,0,0,12,8*CS<CR><LF>	Perform a Factory reset. This will select SiRf binary protocol at 115200baud. All stored parameters will be deleted.

LLA Navigation Initialization		
$PSRF104	**Navigation Initialization**	Defines receiver restart options with or without Initialization data. Correct Initialization data can speed up data acquisition and TTFF. This message is quite similar to $PSRF101, but Coordinates must be given in **degrees** format and altitude in **meters**
Structure	$PSRF104, Lat, Lon, Alt, ClkDrift, TimeOfWeek, WeekNo, ChannelCt, ResetCfg, Checksum*CS, <CR><LF>	
Fields	Lat	Latitude in decimal degrees North +90..-90
	Lon	Longitude in decimal degrees East +90..-90
	Alt	Altitude in meters
	ClkDrift	Use 0 for last saved value if available, use 96250 else
	TimeOfWeek	GPS Time Of Week
	WeekNo	GPS Week Number
	ChannelCt	1..12
	ResetCfg	1 : HotStart 2 : WarmStart (no Init) 3 : WarmStart (use init params) 4 : ColdStart (no Init) 8 : Factory reset (no Init)
	Checksum	Calculated from all datafields (XOR'ed)
Example 1	$PSRF104,-56.6757,6.009834,120,96250,497260,921,12,3*CS<CR><LF>	Start the receiver in WarmStart mode using the parameters
Example 2	$PSRF104,0,0,0,0,0,0,12,4*CS<CR><LF>	Perform a ColdStart without using parameters. Please use the zeroes for the GPS params and set the ChnCt to 12 !
Example 3	$PSRF104,0,0,0,0,0,0,12,8*CS<CR><LF>	Perform a Factory reset. <u>This will select SiRf binary protocol at 115200baud</u>. All stored parameters will be deleted.

Query / Rate Control		
$PSRF103	**Query / Rate Control**	Defines output rate of the NMEA messages, Navigation rate. Allows to query a message at any time. Defines whether a checksum should be attached to NMEA messages.
Structure	$PSRF103, MsgToControl, Mode, Rate, ChkSumEnable, *CS, <CR><LF>	
Fields	MsgToControl	0 : GGA 1 : GLL 2 : GSA 3 : GSV 4 : RMC 5 : VTG

	Mode	0 : Set Rate 1 : Query one time 2 : ABP on 3 : ABP off (default) 4 : Reverse EE on 5 : Reverse EE off (default) 6 : 5Hz navigation on 7 : 5 Hz navigation off (default) 8 : SBAS ranging on 9 : SBAS ranging off (default) 10:FTS (FastTimeSync) on 11:FTS (FastTimeSync) off
	Rate	1 .. 255 seconds between messages. Only if Mode field is 0, otherwise ignored
	ChkSumEnable	0 : ChkSum enable (default) 1 : ChkSum disable
Example 1	$PSRF103,00,06,00,01*CS<CR><LF>	Set navigation update rate to 5 per second. **Note: select an appropriate serial baud rate (see 0) when using high update rate!**
Example 2	$PSRF103,00,09,00,01* CS<CR><LF>	Set SBAS support active
Example 3	$PSRF103,03,00,01,01* CS<CR><LF>	Set GSV rate to every second (default is once/5 seconds)

DataLoggingCommand		
$PSRF121	**Data Logging Command**	1. Starts or stops the data logger function and defines the logging data rate. 2. Clears memory 3. Allows readout of the data 4. provides Logger Status report
Structure	$PSRF121, Command, Logging Interval* CS, <CR><LF>	
Fields	Command	0 : Start logging 1 : Stop logging 2 : Clear memory 3 : retrieve logged data (response will be $PSRF190<data>,<data>,….) 4 : retrieve logger status (response will be $PSRF192<status data>
	Logging Interval	1 .. 65535 [sec]
	Checksum	Calculated from all datafields (XOR'ed)
Example	$PSRF121,0,5*CS<CR><LF>	Starts the logger and records a sample every 5 seconds.

DataLoggingIntervalCommand		
$PSRF122	**Data Logging Interval Command**	sets the data logger interval. This message overrides the interval defined in command 121. The command can be sent any time, even during a logging is active.
Structure	$PSRF122, Interval*CS, <CR><LF>	
Fields	Interval	0..65535 [sec]
	Checksum	Calculated from all datafields (XOR'ed)
Example	$PSRF122,12*CS<CR><LF>	Sets the logger interval to 12 seconds

DataLoggingThresholds		
$PSRF123	**Data Logging Threshold Definition**	The logging can becontrolled by thresholds. As long as at least one of the two thresholds is not met, there will be no data logged. The command can be applied any time, even during a logging is active. By default, both thresholds are 0.
Structure	$PSRF123, DistanceThreshold, SpeedThreshold* CS, <CR><LF>	
Fields	DistanceThreshold	0..65535 [meters]
	SpeedThreshold	0 ..515 [m/sec]
	Checksum	Calculated from all datafields (XOR'ed)
Example	$PSRF123,15,2*CS<CR><LF>	Starts the logger and records a sample every 5 seconds.

DataLogging Memory Management		
$PSRF124	**Data Logging memory management Definition**	This command defines the memory handling and the kind of information, that is logged into the memory. The command must be issued before starting the logger.
Structure	$PSRF124, StopOnFull, RecordType* CS, <CR><LF>	
Fields	StopOnFull	0 : No, use circular buffering (default). When memory is full, new data will overwrite the oldest existing data 1 : Stop, when memory is full
	RecordType	0 : compatibility format 1 : position 2 : position + altitude 3 :position altitude speed 4 : position altitude speed accuracy
	Checksum	Calculated from all datafields (XOR'ed)
Example	$PSRF124,15,2*CS<CR><LF>	Starts the logger and records a sample every 5 seconds.

There are some more NMEA commands available for A-GPS Extended Ephemeris data download from host to GNS2301.
Please refer to the *GNS2301_ AGPS_manual* for detailed information.

8.3 Patch download

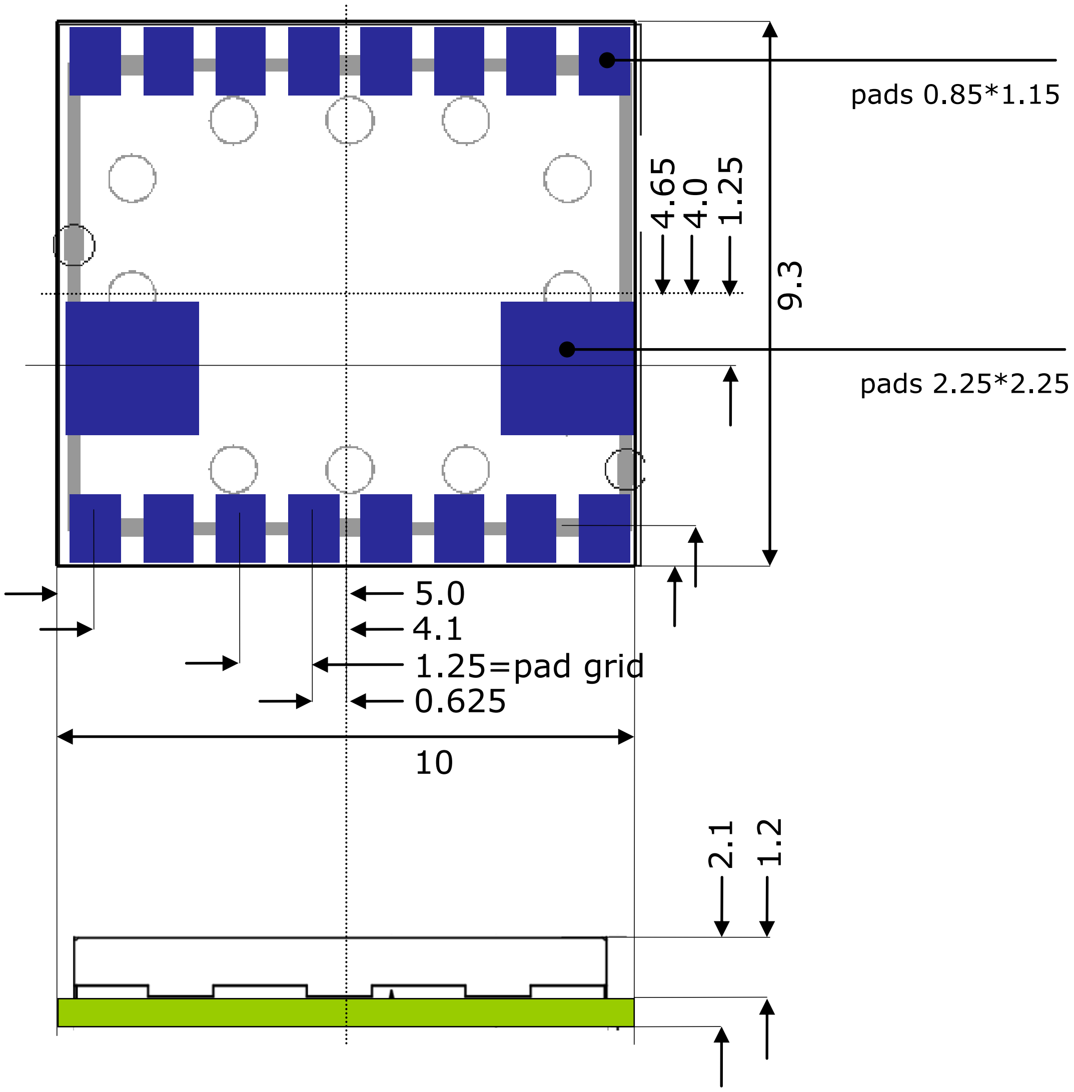
GNS2301 is based on CSR 5th generation SirF chipset. The chip is based on ROM memory that holds the complete firmware. CSR provides updates for the ROM code that must be downloaded to the chip after every time power is supplied to the chip. Patch data, a PC based patch download program and documentation is available on request. GNS provides support for the patch implementation on the customer's host application processor.
Note: GNS2301 is tested to operate properly from ROM only, without any patch.
However, CSR recommends to use always the most up to date patch version for best device performance.

9 GNS2301 STARTER KIT

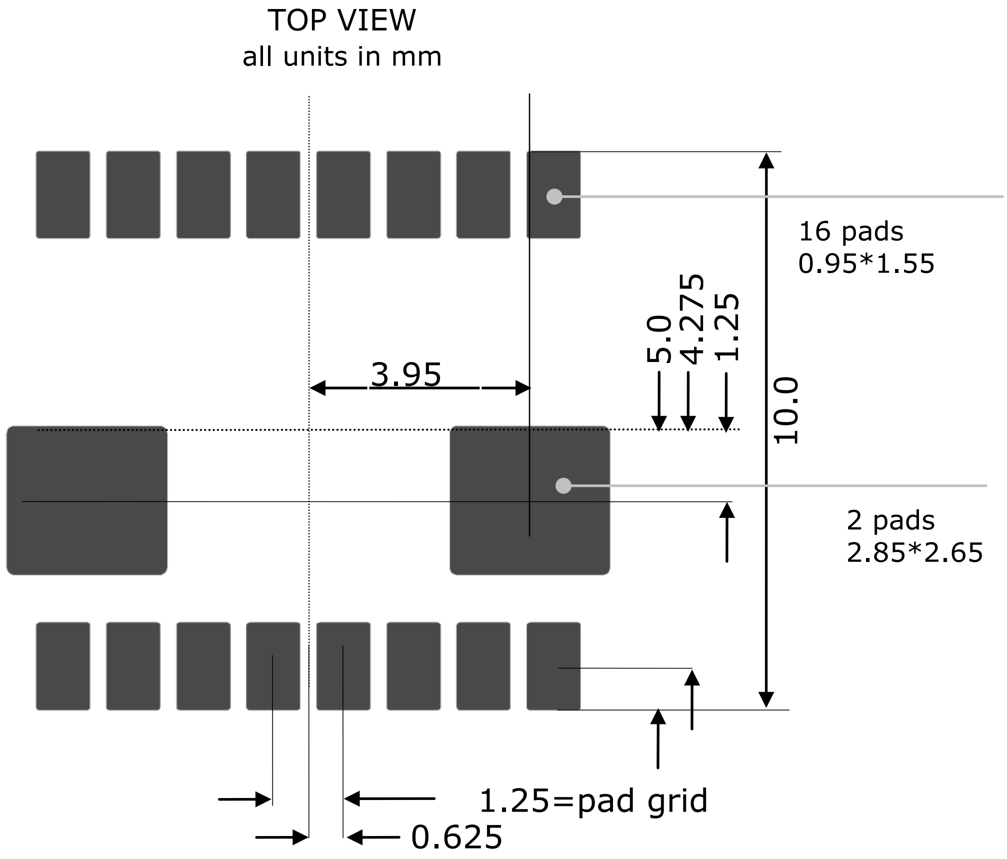
GNS provides a Starter Kit for this module. The GNS2301Starter Kit is ready to run on a PC USB port and allows quick tests. All I/Os are accessible through connectors or pinheaders and extension modules are available to test advanced hardware options like external SPI memory for logging or MEMS support for DR applications. Bootstrap options are available via board jumpers.

10 PHYSICAL DIMENSIONS

TOP VIEW



11 RECOMMENDED PAD LAYOUT

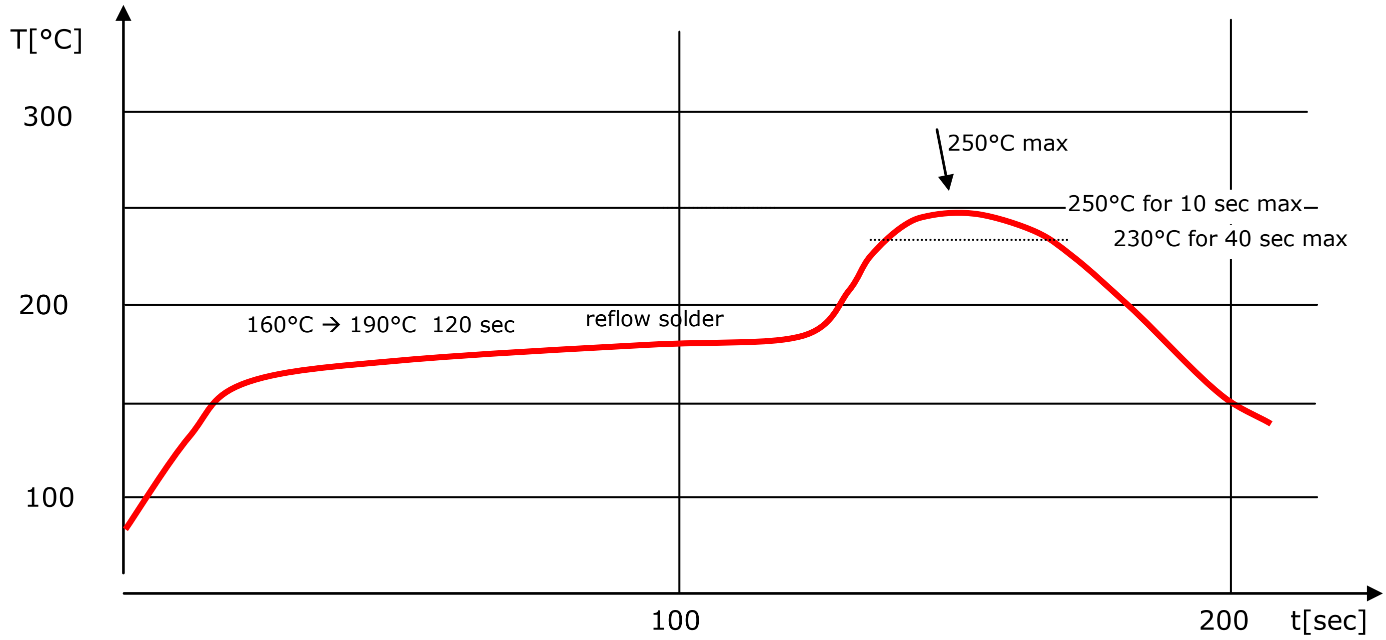


Note: For prototyping, GNS2301 is available on a stamp design adaptor board.
Recommended mainboard pad layout fill fit for both.

12 MATERIAL INFORMATION

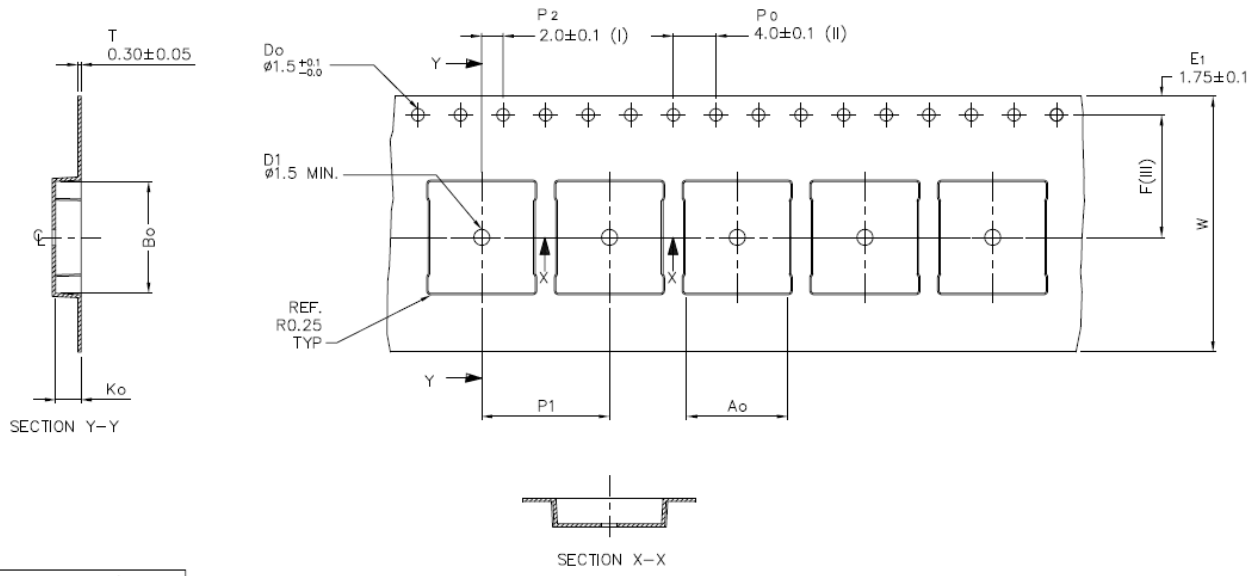
Complies to ROHS standard
ROHS documentations are available on request
Contact surface: gold over nickel

13 RECOMMENDED SOLDERING REFLOW PROFILE



Notes:
1. GNS2301 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS2301 Module from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. Do not solder with Pb-Sn or other solder containing lead (Pb)
5. This device is not applicable for flow solder processing
6. This device is applicable for solder iron process

14 TAPE & REEL PACKAGE INFORMATION

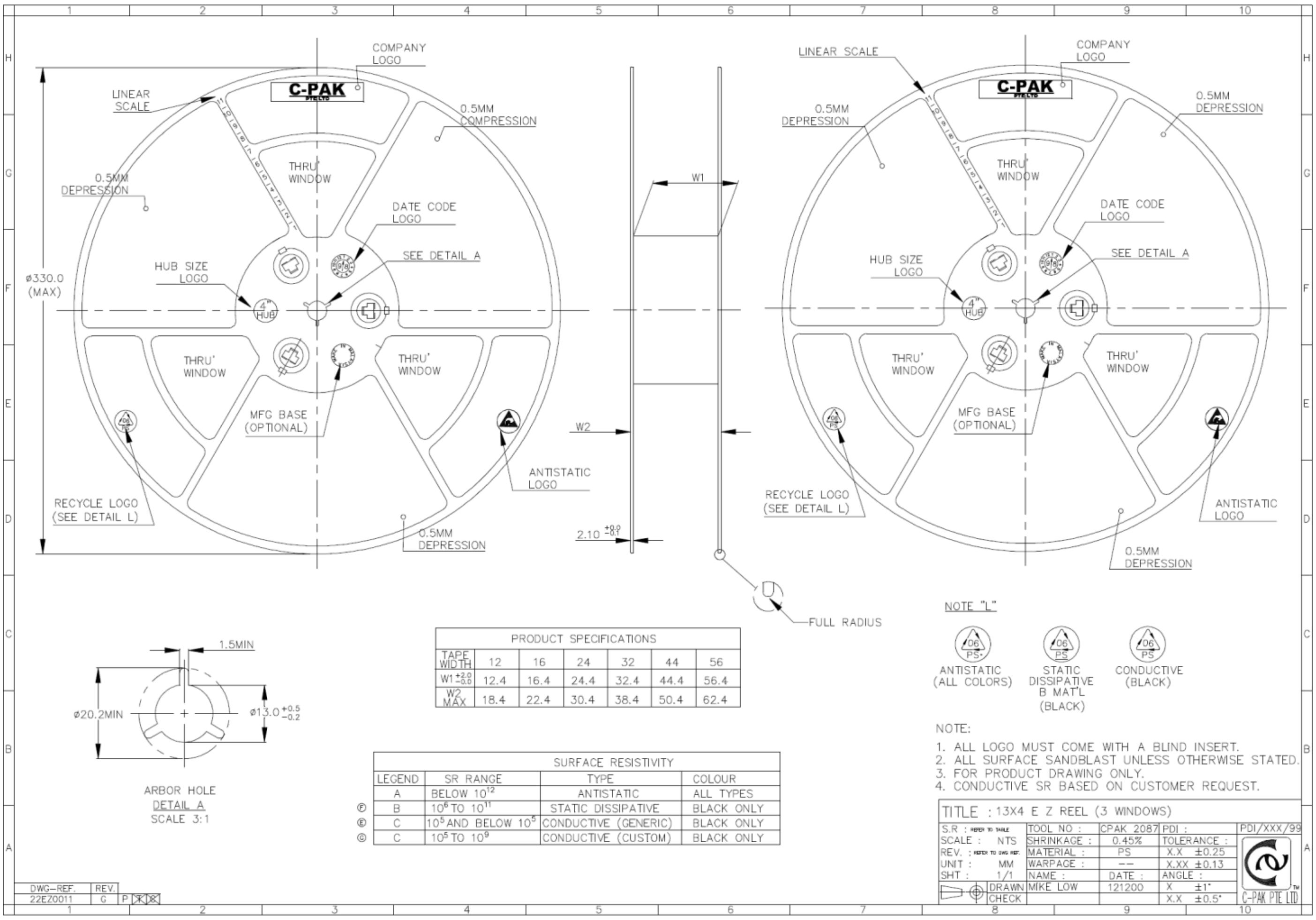


Ao	9.80	+/− 0.1
Bo	10.50	+/− 0.1
Ko	2.40	+/− 0.1
F	11.50	+/− 0.1
P1	12.00	+/− 0.1
W	24.00	+/− 0.3

Forming format : Flatbed
Estimated max. length : 60 meter/22B3 reel

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.



Reel information:

H= 24.5mm

Number of devices: 2000pcs/reel

16 ORDERING INFORMATION

Ordering information			
Type	**Part#**	**label marking**	**Description**
GNS2301	**4037735105010**	GNS2301 ← Type 1314/01 ← Datecode/version 123456 ← serial#	GNS2301 GPS&GLONASS GNSS module

17 FCC AND CE COMPLIANCE

This product has passed FCC and CE pre-tests successfully. The module emission and immunity has been proven to be compliant.
However, applications using this module as a component must pass CE and/or FCC again in whole.

18 ENVIRONMENTAL INFORMATION

This product is free of environmental hazardous substances and complies with 2002/95/EC. (RoHS directive).

RoHS COMPLIANT 2002/95/EC

19 MOISTURE SENSITIVITY

This device must be prebaked before being put to reflow solder process.
Disregarding may cause destructive effects like chip cracking, which leaves the device defective !

Shelf life	6 months , sealed
Possible prebake recommendations	12 hrs @ 60°C
Floor life (time from prebake to solder process)	<72 hrs

20 DOCUMENT REVISION HISTORY

V0.01	June 6 2013	P.Skaliks	initial , internal , not published
V0.2	Sep 10 2013	P.Skaliks	Preliminary, first release
V0.3	Nov 7 2013	P.Skaliks	Prelimanary, added a note under 8.2

21 RELATED DOCUMENTS

Title	**Description / File**		**Available from**
GPS Antenna Design Guide	Design Guide to implement an GPS antenna to an application PCB		www.forum.gns-gmbh.com
GNS2301_StarterKit_UserManual	User manual for the GNS2301 receiver based evaluation kit		www.forum.gns-gmbh.com
NMEA protocol	Detailed description of NMEA protocol		Full version from chip manufacturer CSR available under NDA
GNS2301_ AGPS_manual	Description of AGPS implementation , in preparation		TBA