GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*

1 INTRODUCTION

GNS 401 is one of the smallest autonomous GPS receiver solutions, based on the MT3329 single chip, available with a finely tuned, high-sensitivity patch ceramic antenna.
The navigation performance and accuracy is further improved by using the correction data from SBAS (WAAS, EGNOS, GAGAN, MSAS) or DGPS(RTCM).
First fixes after just a few seconds are achieved with the help of AGPS(EPO, Extended Prediction Orbit) algorithm.
The excellent low power design makes it easy to implement this module in power sensitive, battery supplied applications. GNS401 offers the industry's highest level of sensitivity at -165dBm[1]. It has superior dynamic performance at high velocity and provides effective protection against mulipath signals.
Low power requirements (typ. 120mW@ 3.3V) and internal voltage regulator makes it easy to run with various power supplies and allows direct connection to LiIon batteries.

Features

- 66 acquisition-/ 22 tracking GPS channels
- Ultra high tracking/navigation sensitivity : -165dBm[1]
- Smart antenna: finely tuned ceramic antenna
- Extremely fast TTFF at low GPS signal level
- SBAS (WAAS,EGNOS,MSAS,GAGAN) and DGPS(RTCM) correction support
- A-GPS by EPO "Extended Prediction Orbit"™ enables 7/14days prediction
- GPS-in-band jammer rejection
- GPS signal multipath compensation
- GPS fix indication output pin
- NMEA-0183 or binary protocol
- UART(TTL) and USB interface support
- Low backup current consumption 10uA, typical
- SMD type with stamp holes
- Small form factor: 16x16x6 mm
- FCC 911 compliant

[1] based upon chipset specifications

GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*

2 INDEX

GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*

3 FUNCTIONAL DESCRIPTION

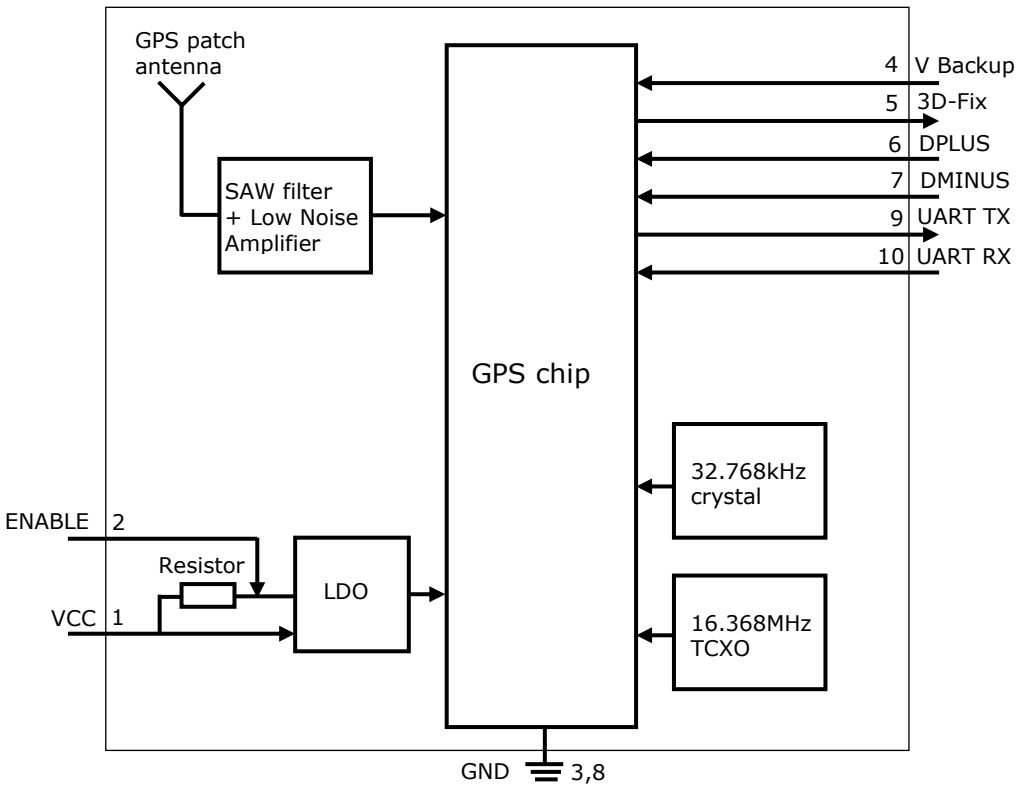
3.1 System description

The GNS401 is a high performance, low power GPS receiver that includes an integrated RF frontend (SAW Filter + LNA) and a finely tuned 15x15x4mm ceramic patch antenna.
Due to high input sensitivity and integrated low noise amplifier (LNA), it can work at very weak GPS signals.

GNS401 is a complete autonomous GPS receiver, including:

- Full GPS processing, without any host processing requirements
- Standard NMEA message output
- A powerful NMEA command and control interface
- All clock sources integrated
- RF frontend integrates a low noise amplifier (LNA) and a SAW filter
- Rich additional features like geofencing, single sentence output, last position retention
- Interface for DGPS(RTCM), PPS output pin, Fix Status Indicator pin

3.2 Block diagram



3.3 AGPS with EPO data

AGPS (assisted GPS) 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.
The GNS AGPS service is based on a short term predicted data service. The predicted data will be fully processed by the GPS engine. The host must load the data from the web and transfer them over the UART into the module:

1. Check GNS401 module EPO (Extended Prediction Orbit) data for validity by comparing the time.
2. Connect to web server through network connection (GPRS, WLAN, LAN,..).
3. Download file. There are just two files, covering all GPS satellites. The first file (MTK7d.EPO) is for 7 days (53kB), the other is 106Kbytes for 14 days (MTK14d.EPO)
4. "Parse" file, using software example. This is quite easy, there must be added some header bytes and a checksum and a control counter. GNS offers software support on this.
5. Download to GNS 401 receiver. please refer to the *NMEAcommandInterface manual* for details.

If the host has low memory available, there's no need to save the whole file. The steps 3..5 can be done frame by frame needing less than 2kBytes of buffer memory.

Code samples and support for several platforms are available from GNS (in preparation).
Thanks to the predicted system, download data stay valid for up to 14 days. Therefore, users can initiate the download everytime and benefit from using (W)LAN instead of using expensive GSM.
File size will be ~50kBytes for a one week prediction data set.

AGPS characteristics					
System					6hrs predicted data
File size for data download		53		kB	1 week prediction data
Maximum prediction time	7	14		days	
TTFF		1		sec	Time and last position available
TTFF		15		sec	Last position available

3.4 SBAS (Satellite Based Augmentation) support

GNS401 supports Satellite Based Augmentation for improvement of the navigation precision. Correction data is sent from geostationary satellites to the GPS receiver. GNS401 supports European, US, and Asian augmentation systems (EGNOS, WAAS, GAGAN, MSAS) to enable precision improvements in nearly every region of the world.
SBAS is active by default and will automatically track the available SBAS satellites. It can be disabled by NMEA command. See document *NMEAcommandInterface manual* for details
Note : In SBAS mode, the maximum NMEA sentence update rate is limited to 5 per second.

3.5 DGPS (Differential GPS) support

GNS401 accepts DGPS input in RTCM format. DGPS provides precision position fixes down to centimetres and is used in professional applications like agriculture. The UART interface of the receiver is used to feed the data. DGPS is deactivated by default. For configuration of the UART port, some NMEA commands must be implemented. See *NMEAcommandInterface manual* document for details.
Note : Since SBAS and DGPS both do (different) corrections on the fix position solution, they cannot be used at the same time! SBAS / DGPS usage is programmed via NMEA Interface.

3.6 Single sentence output

GNS401 allows to reduce data transfer to host to a minimum. Reduced data transfer can save host processor activity times and thus reduce system power consumption. All relevant information will be provided in a single sentence output. To save further channel load, the sentence can be formatted as binary. Need of firmware customization.

3.7 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. Last position retention can be enabled or disabled. When enabled, the last known position is outputted in the NMEA sentences. Need of firmware customization.

3.8 Geofencing function

GNS401 has an internal algorithm to determine whether the actual position is within a circular area around a predefined location point. A proprietary sentence indicates the "inside" or "outside" status. Need of firmware customization.

3.9 Distance calculation feature

This feature allows to request the real "line of sight" distance in relation to a predefined position. This feature can remove some load from the host processor. Need of firmware customization.

3.10 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 GNS401 module, even if all power

supplies have been removed. 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.

3.11 Real time clock (RTC)

GNS401 has a real time clock with 32,768Hz crystal onboard. As long as VBACKUP 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 10uA. The RTC will track the current time and enable the module to start from sleep states with very fast time to first Fix (TTFF).

3.12 UART interface

GNS401 core and I/O sections work at 3.3V nominal. Absolute Maximum Ratings should not be exceeded. Should the GNS401 be interfaced to a host with I/O at higher/lower levels, level shifters should be used. UART baud rate is 9600baud by default. The baud rate can be modified to higher/lower rates by a NMEA software command. See document *NMEAcommandInterface manual* for details.

GPS UART Default Settings	
Parameter	**Value**
Baud rate	9600
Data length	8 bits
Stop bit	1
Parity	None

3.13 USB interface

The USB interface provides a Logo certified USB 2.0 full speed interface.

3.14 Module default settings

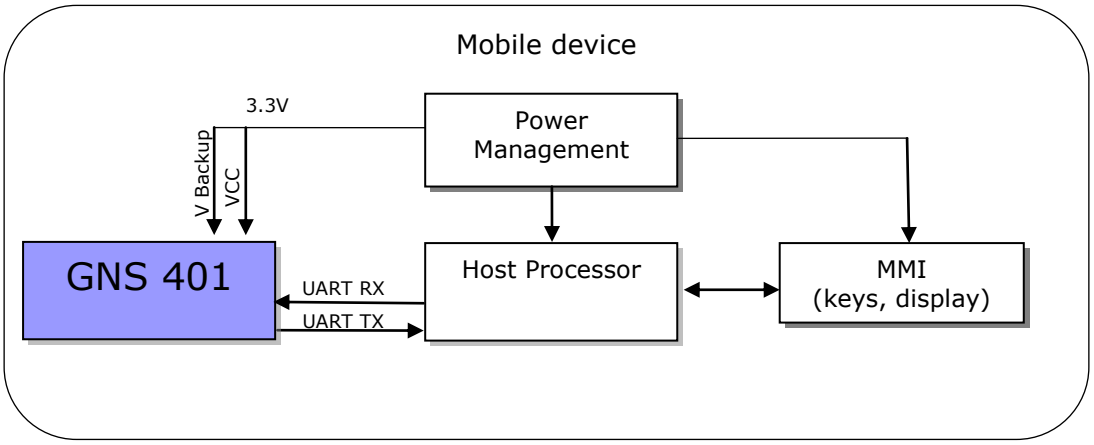
The GNS 401 receiver comes with default settings, which are persistently programmed. Whenever power is removed from the module (both VCC and VBACKUP), the settings will be reset to the values shown in the following table.

NMEA output sentences	
Setting	**Default value**
UART setting	9600,8,N,1
Fix frequency (update rate)	1/sec
NMEA sentences	$GPRMC,$GPGSA,$GPGGL,$GPGSV,$GPVTG
NMEA rate	Once a second: RMC,GSA,VTG every 5 sec :GSV sentences
DGPS option	SBAS enabled
Datum	WGS 84
Single sentence output	Customized firmware
Last position retention	Customized firmware
Geofencing function	Customized firmware
Distance calculation feature	Customized firmware

On request, other options can be selected as preprogrammed (persistent default) options.
Please contact the GNS support for your project requirements.
Note : Customized options are solely available for fixed order lots.

4 TYPICAL APPLICATION BLOCK DIAGRAM

4.1 Typical System Overview



GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*

5 GPS characteristics

5.1 GPS characteristics

Parameter	Min	Typ	Max	Unit	Note
general					
Frequency		1575.42		MHz	GPS L1 C/A code
SBAS					WAAS,EGNOS,MSAS,GAGAN
Datum					WGS84
AGPS	7		14	days	Configurable
Output data frequency	1/10	1	10	1/sec	
Navigation&tracking sensitivity[1]		-165		dBm	autonomous
Acquisition sensitivity[1]		-148		dBm	
Reacquisition sensitivity[1]		-160		dBm	
TTFF hotstart[1]		1		sec	All SVs @-130dBm
TTFF autonomous warm start[1]		34		sec	All SVs @-130dBm
TTFF autonomous cold start[1]		35		sec	All SVs @-130dBm
Reacquisition time[1]		<1		sec	All SVs @-130dBm
Number of channels tracking		22			
Number of acquisition channels		99			
Dimension		16x16x6		mm	Tolerance is 0.2 mm
Weight		6		g	
Power consumption					
GPS ACTIVE (acquisition)	43	48	53	mA	NMEA frequency = 1/sec, 3.3V
GPS ACTIVE (tracking)	32	37	42	mA	
Backup current @ 3V		10		uA	
Shut-down Power		15		uA	via ENABLE pin

Accuracy					
Position error	-	3	-	m	Without aid 2D-RMS
Position error	-	2.5	-	m	Using (SBAS) 2D-RMS
Velocity error	-	0.1	-	m/s	Without aid
velocity error	-	0.05	-	m/s	Using (SBAS)

ITAR limits					
Operation altitude		-	18,000	m	
Operation velocity	-	-	515	m/s	
Operation acceleration	-	-	4	G	

[1] note: based on chip specifications

6 DESIGN GUIDELINES

Although GNS401 GPS receiver provides best performance at low power consumption. Special care should be taken to provide clean signal and clean power supplies. Power lines should be blocked near to the receiver with low ESR capacitors.
Radiated noise from neighbour components may also reduce the performance of the receiver.
Please refer to "GNS401 Starter Kit User Manual" for more informations, downloadable at the GNS forum: www.forum.gns-gmbh.com .

7 ELECTRICAL SPECIFICATION

7.1 Absolute Maximum Ratings

Parameter	Value	Unit
Supply voltage range: Vcc	3.2 to 5	V
Backup voltage: VBACKUP	2 to 4.3	V
Operating ambient temperature range	–40 to +85	°C
Storage temperature range	–50 to +90	°C

7.2 Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Note
V_{cc}	3.2	3.3	5.0	V	supply voltage
V_{cc} ripple voltage				50	mVpp
VBACKUP	2.0	3.0	4.3	V	Backup voltage for RTC and memory retention, must be available during normal operation
RX/TX High level output voltage V_{OH}	2.1		2.8	V	Condition Vcc=3.2~5.0V
RX/TX Low level output voltage V_{OL}	0		0.8	V	Condition Vcc=3.2~5.0V
USB differential "1"	(D+)-(D-) >200			mV	Condition Vcc=3.2~5.0V
USB differential "0"	(D-)-(D+) >200			mV	Condition Vcc=3.2~5.0V
Operating temperature	-40		85	°C	Full specified sensitivity

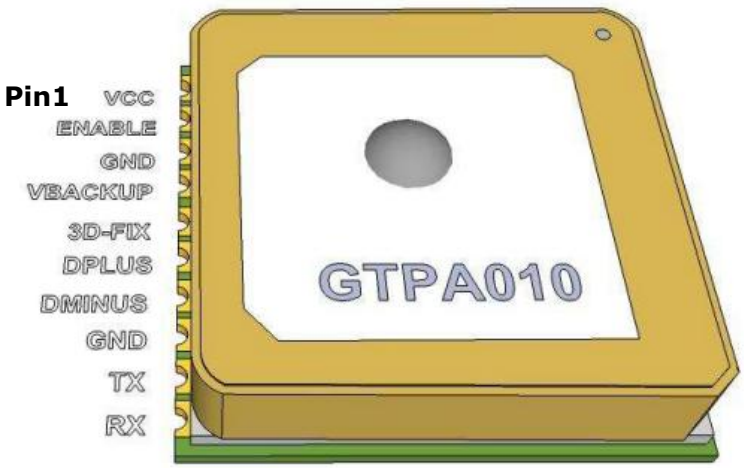
GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*

8 PIN CONFIGURATION

Top View



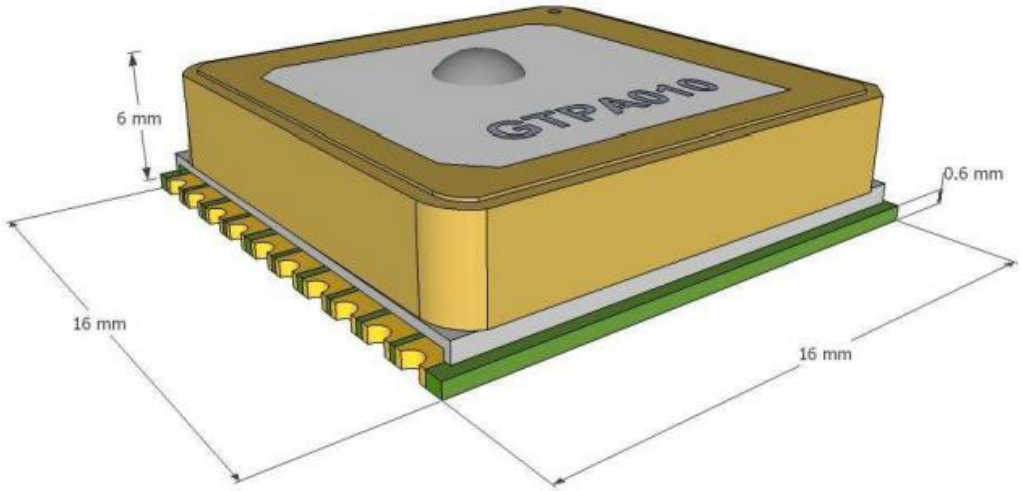
Pin	Name	I/O	Description & Note
1	VCC	P	Main DC power input The main DC power supply for the module. The voltage should be kept between from 3.2V to 5.0V. The ripple must be limited under 50mVpp (Typical: 3.3V). Please refer also to pin 4 "VBackup" for normal operation.
2	ENABLE	P	High active, or keep floating for normal working Enable (High): 1.8<=V_{enable}<=VCC Disable (Low): 0V<=V_{enable}<=0.25V
3	GND	P	Ground
4	VBACKUP	P	Backup power input for RTC & navigation data keep This connects to the backup power of the GPS module. Power source (such as battery) connected to this pin will help the GPS chipset in keeping its internal RTC running when the main power source is turned off. The voltage should be kept between 2.0V~4.3V, Typical 3.0V. IF VBACKUP power was not reserved, the GNSS module will perform a lengthy cold start every time it is powered-on because previous satellite information is not retained and needs to be re-transmitted. **This pin must be connected for normal operation.**
5	3D_FIX	O	3D-Fix Indicator The 3D_FIX is assigned as a fix flag output. If not used, keep floating. Before 2D Fix The pin will continuously toggle with 1Hz. output one second high-level and one-second low-level signal After 2D or 3D Fix The pin will continuously output low-level signal. **This pin may not connected to high-level at power-on sequence.**
6	DPLUS	I/O	USB port D+ USB port D+ signal.
7	DMINUS	I/O	USB port D- USB port D- signal.
8	GND	P	Ground .
9	TX	O	Serial Data Output A for NMEA output (TTL) This is the UART-A transmitter of the module. It outputs GPS information for application.
10	RX	I	Serial Data Input A for Firmware update (TTL) This is the UART-A receiver of the module. It is used to receive commands from system.

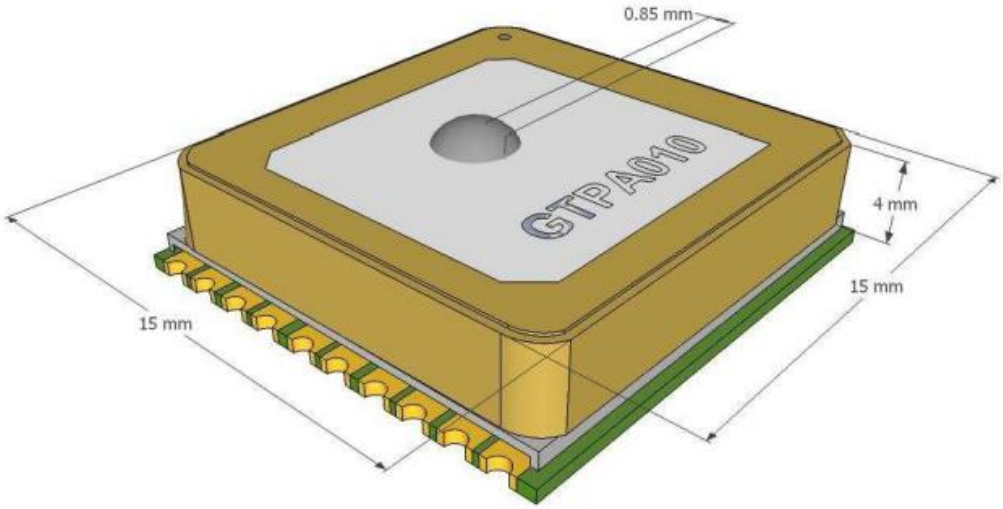
(1) I = INPUT; O = OUTPUT; I/O = BIDIRECTIONAL; P = POWER PIN; ANA = ANALOG PIN.

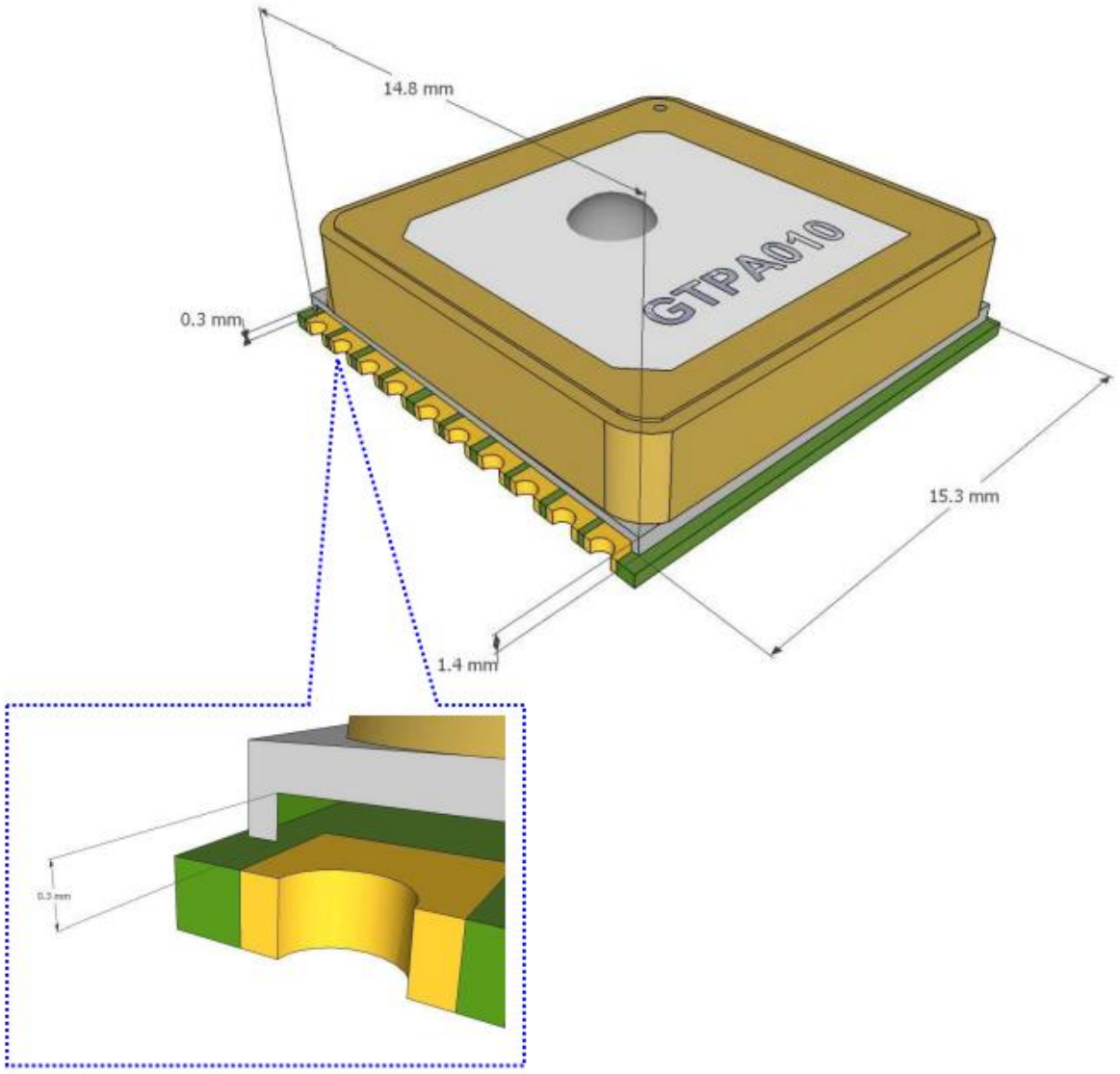
9 PHYSICAL DIMENSIONS

TOP VIEW

all units in mm, tolerance is ±0.2mm



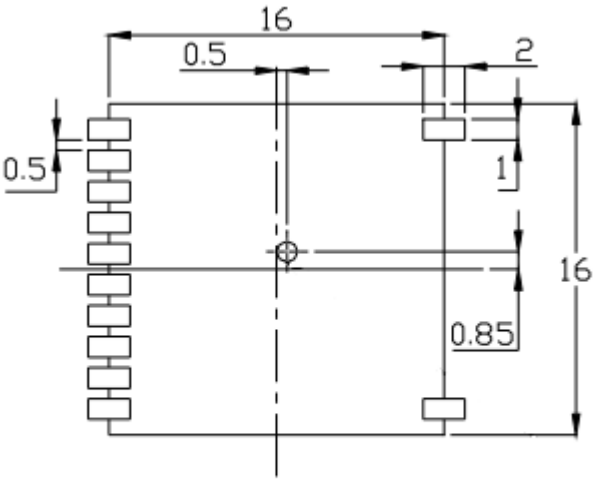




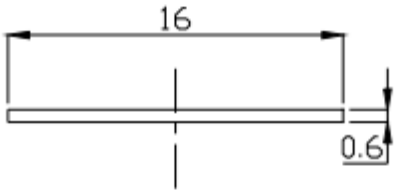
10 RECOMMENDED PAD LAYOUT

all units in mm

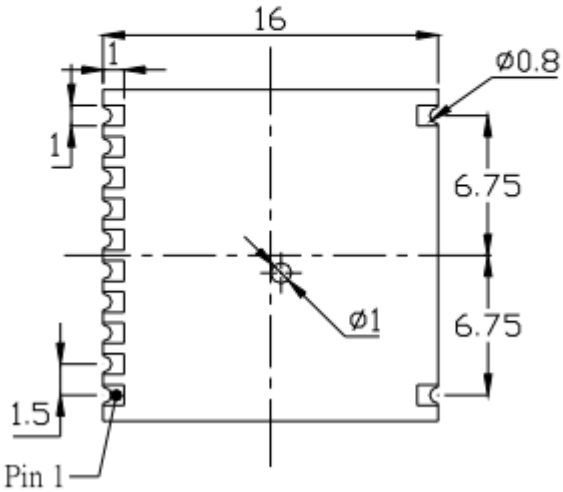
Footprint Top View



Side View

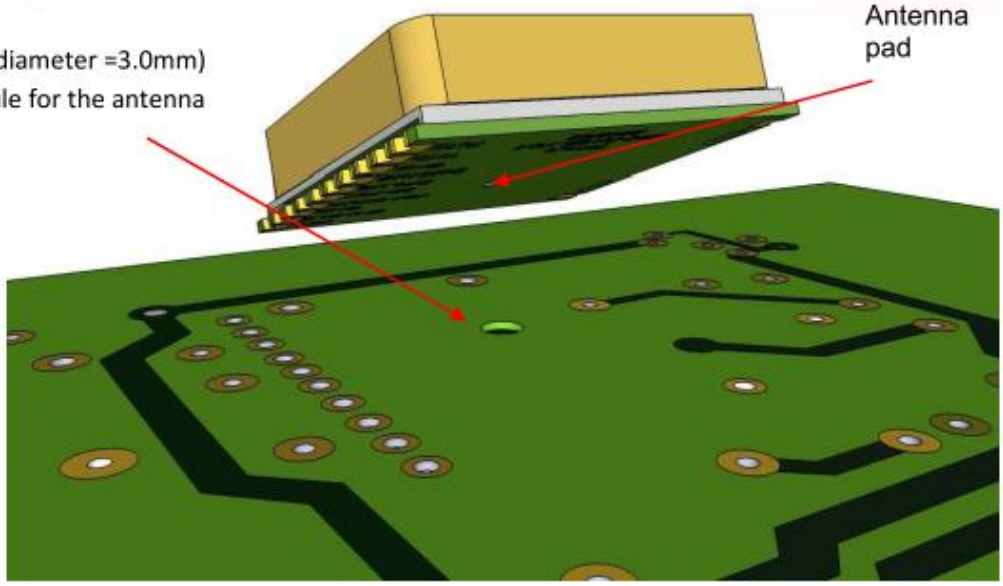


PCB Bottom View



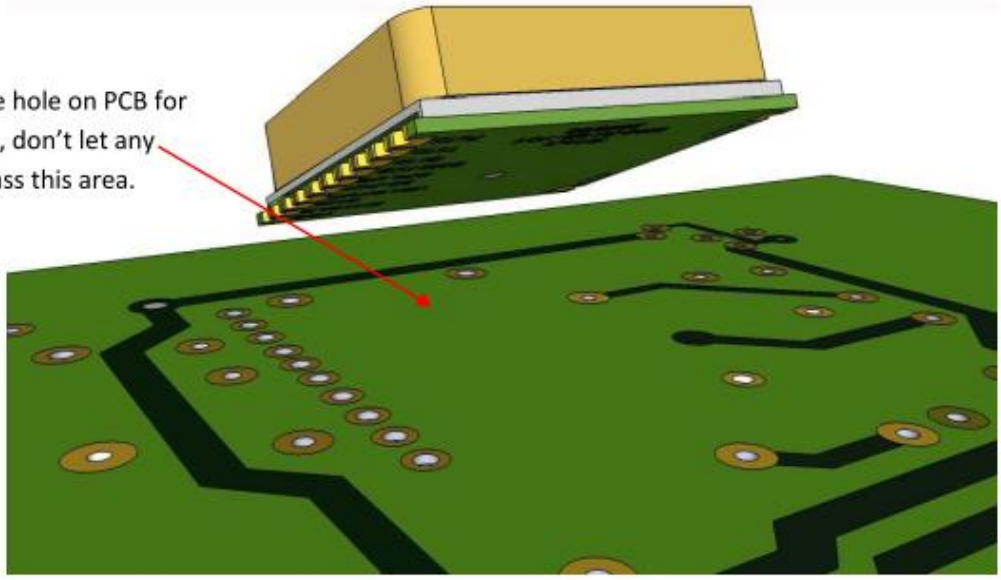
Note:

Place one hole (diameter =3.0mm) under this module for the antenna pad.



Note:

If can't place one hole on PCB for the antenna pad, don't let any trace and vias pass this area.



11 NMEA DATA interface

GNS401 provides NMEA (National Marine Electronics Association) 0183 compatible data.
A set of proprietary NMEA commands are available to send control messages to the receiver.
These commands are described in a separate document: *NMEAcommandInterface manual*.
For standard operation, no commands are needed; the module will start outputting NMEA sentences after power supply has been attached. GNS401 will always start communication output with 9600 bit per second.
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 is removed. A backup supply at VBACKUP will be sufficient to keep them.

11.1 NMEA output sentences

NMEA output sentences	
Type	**content**
Common GPS sentences	
$GPRMC	Recommended Minimum Navigation Information
$GPGGA	Fix Data, Time, Position and fix related data for a GPS receiver
$GPGLL	Geographic Position - Latitude/Longitude
$GPVTG	Track made good and Ground speed
$GPGSV	GPS Satellites in view
$GPGSA	DOP and active satellites

11.2 NMEA command interface

GNS401 NMEA command interface allows to control settings and the extended functions. The command interface specification is available in an extra document: *NMEAcommandInterface manual.*

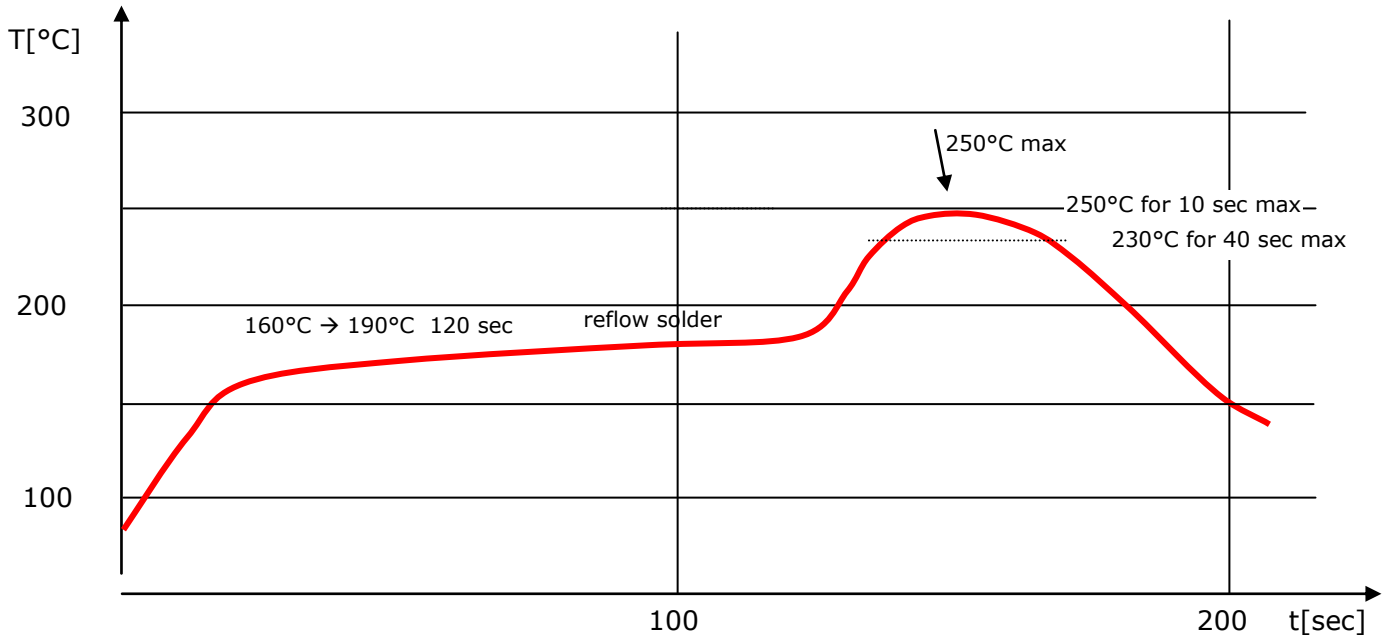
Two groups of commands are available:
Setting commands do modify the behavior of the module.
Note : Modified settings will be valid as long as the module is powered through VCC or VBACKUP. (f.e. : setting of a new baud rate). After removing VCC and VBACKUP, all settings are reset to their default values.
Action commands will perform the specified action one time after the command has been received. (f.e. : request for cold start)

Commands are always started with $PTMK, directly followed by the command number 000..999.
Each command must be terminated by *<chksum>and a <CR><LF>.
The checksum calculation is simple, just XOR all the bytes between the $ and the * (not including the delimiters themselves). Then use the hexadecimal ASCII format.

12 MATERIAL INFORMATION

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

13 RECOMMENDED SOLDERING REFLOW PROFILE



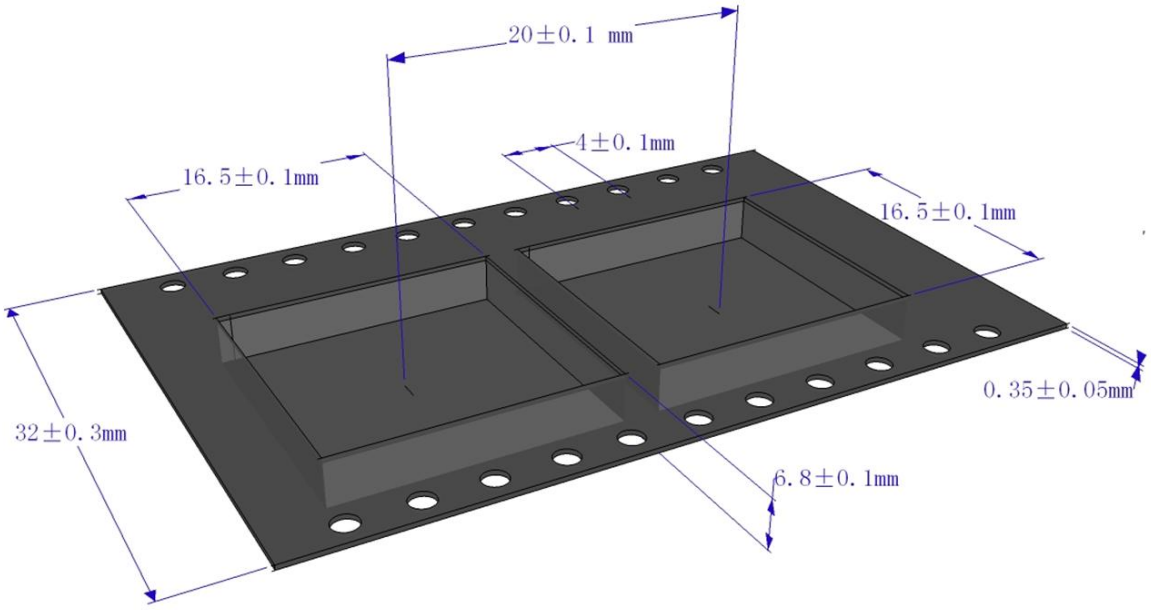
Notes:
1. GNS401 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS401 receiver from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. Do not solder with Pb-Sn or other solder containing lead (Pb)
5. This device is not applicable for flow solder processing
6. This device is not applicable for solder iron process

14 TRAY PACKAGE INFORMATION

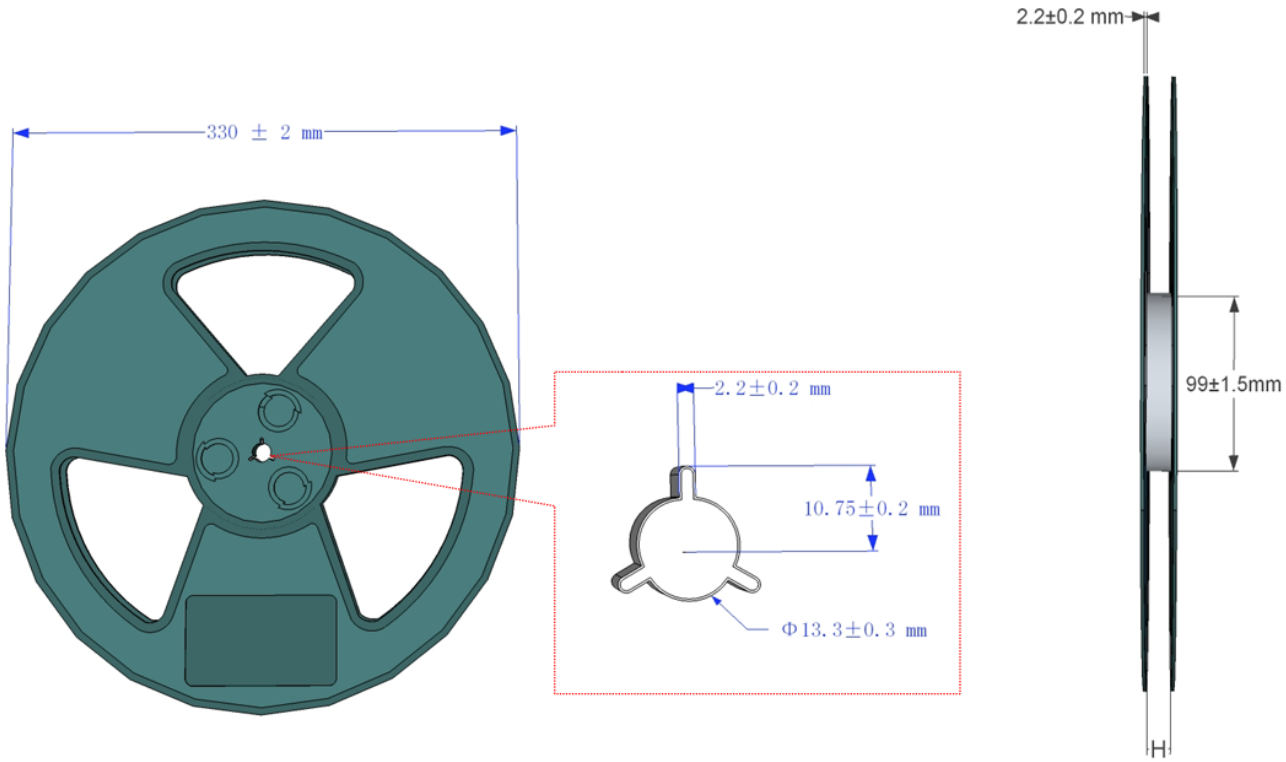
The GPS receivers are placed on a tray for quantities below 100 pieces. The trays will be stacked and packed together.The trays are placed inside an antistatic bag.

15 TAPE&REEL INFORMATION

Tape information:



Reel information:



H= 32.5mm

Number of devices: 250pcs/reel

16 ORDERING INFORMATION

Ordering information			
Type	**Part#**	**label marking**	**Description**
GNS401	**4037735104655**	GNS401QYYWWSN	GNS401receiver YYWW => date code SN => serial number

17 FCC COMPLIANCE

This product has passed FCC 911 compliance 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).

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	Nov 26 2012	M.Reiff	initial document
V0.11	Aug 28 2013	M.Reiff	Pin description corrected; NMEA output sentence GSA added; Tape&Reel information added

21 RELATED DOCUMENTS

title	**Description / file**		**Available from**
NMEAcommandInterface manual	Detailed description of NMEA commands		www.forum.gns-gmbh.com
GNS401 StarterKit user manual	User manual for the GNS401 receiver based evaluation kit		www.forum.gns-gmbh.com

GPS receiver GNS 401

Datasheet V1.1

***preliminary** specification*