GPS Receiver GNS502 Datasheet V01

confidential information ***preliminary*** *specification*

1 INTRODUCTION

The GNS 502 is a ultra small outlined module for navigation, package tracking and any other applications where simple, reliable positioning data is a necessity. Since the chip antenna is already on board, there' s no costly implementation work needed. Connecting the 1.8V power supply, a 32768Hz clock and a serial data connection is all that has to be done to put GNS502 to service.

Features

- Improved acquisition performance
- Improved tracking&navigation performance and minimized error in multi-path environments
- Standard NMEA 0183 output
- Pulse Per Second (PPS) output pin
- GPS fix indication output pin
- Push to Fix pin (P2F) for power management
- Automatic Power Management (APM) feature
- Compact design 15.7*10*2 mm
- Single 1.8 VDC supply
- UART interface
- Fast time to market
- RoHS compliant

Applications

- Navigation
  - Dynamic Navigation
  - Portable ("nomadic") devices
  - Netbooks, tablet PCs and mobile phones
  - Low volume applications with short time to market requirement
- Timing
  - Precision timing via GPS
- Location based applications
  - GPS Logger
  - GPS Tracker
  - Security devices
  - Camera equipment

V 0.1, Oct 6 2014

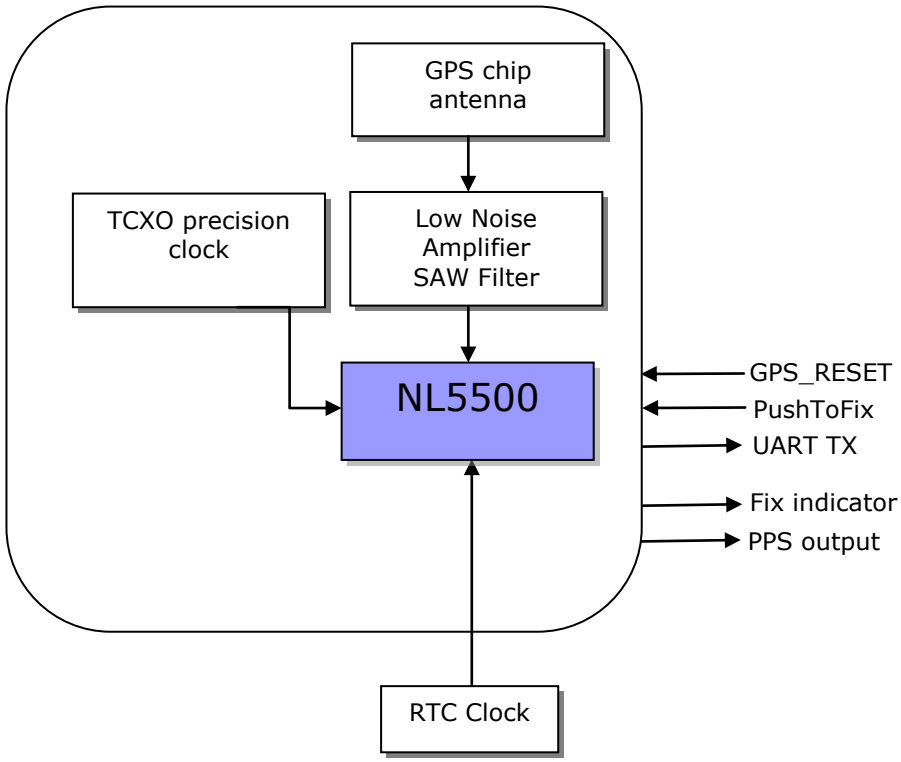
2 INDEX

3 DETAILED FEATURES

3.1 GPS Features

- Significantly improved TTFF at low signal power levels provides the consumer with a compelling GPS experience
- Improved acquisition performance to process position fixes in critical conditions
- Reduced power consumption through improvements to RF architecture, software techniques, receiver core, and RF noise figure partitioning
- Improved tracking performance and minimized error in multi-path environments through increased IF bandwidth and higher sampling rates in tracking channels
- Standard NMEA output
- 1PPS output
- GPS Fix indication output pin
- APM, Automatic Power Management reduces tracking power down to 40mW average.

4 BLOCK DIAGRAM



5 I/O REQUIREMENTS

5.1 I/O levels

GNS502 I/O sections work at 1.8V nominal. Absolute Maximum Ratings should not be exceeded Should the GNS502 be interfaced to a host with I/O at higher levels, level shifters should be used.

6 GPS characteristics

Parameter	Min	Typ	Max	Unit	Note
general					
Frequency		1575.42		MHz	GPS L1 C/A code
Output data frequency	1/60	1	1	1/sec	Configurable
Navigation&tracking sensitivity		-161	-162	dBm	At LNA input, Note1
Acquisition sensitivity		-145	-146	dBm	autonomous , at LNA input, Note 1
TTFF hotstart			1	sec	All SVs@-130dBm, Note 1
TTFF hotstart			10	sec	All SVs @-155dBm, Note 1
TTFF autonomous cold start		34		sec	All SVs @-130dBm, Note 1
TTFF autonomous cold start		45		sec	All SVs @-142dBm, Note 1
Number of channels tracking		16			
Number of acquisition channels		40			
Power consumption					
GPS ACTIVE (acquisition)		72	83.6	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)		50	58.8	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)	25			mA	NMEA frequency=1/sec, -130dBm, APM feature active
GPS shutdown		181		µA	GPS_RESET → GND
GPS deep sleep (RTC running)		81		µA	PTF → GND

Note 1: Measured by conductive measurement

Accuracy					
Static position error CEP68	-	2	-	m	**Normal open sky in Field** Horizontal position accuracy using open sky roof-top antenna
Static position error CEP95	-	3	-	m	**Normal open sky in Field** Horizontal position accuracy using open sky roof-top antenna
Static position error CEP68	-	-	2	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
Static position error CEP95	-	-	3	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
dynamic position error CEP68	-	-	3	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
dynamic position error CEP95	-	-	4	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
velocity error CEP68	-	-	0.1	m/s	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
velocity error CEP95	-	-	0.7	m/s	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level, Note 1
Accuracy for timepulse signal					
1PPS pulse duration	-	1	-	msec	
1PPS time jitter	-	15	100	nsec	Pulse rising edge deviation from expected pulse time, measured in a 300 seconds interval with full 3D fix @-130dBm, Note 1
1PPS rise and fall time			10	nsec	10%..90%
1PPS output impedance	-	10kΩ//20pF	-		
TCXO					
TCXO output frequency	-	26.000	-	MHz	±2.5 ppm
TCXO output impedance	-	1MΩ//5pF	-	-	

Note 1: Measured by conductive measurement

ITAR limits					
Operation altitude	-5,000	-	18,288	m	
Operation velocity	-	-	514	m/s	
Operation acceleration	-	-	-	m/s^2	No limit set

6.1 Automatic Power Management (APM) feature

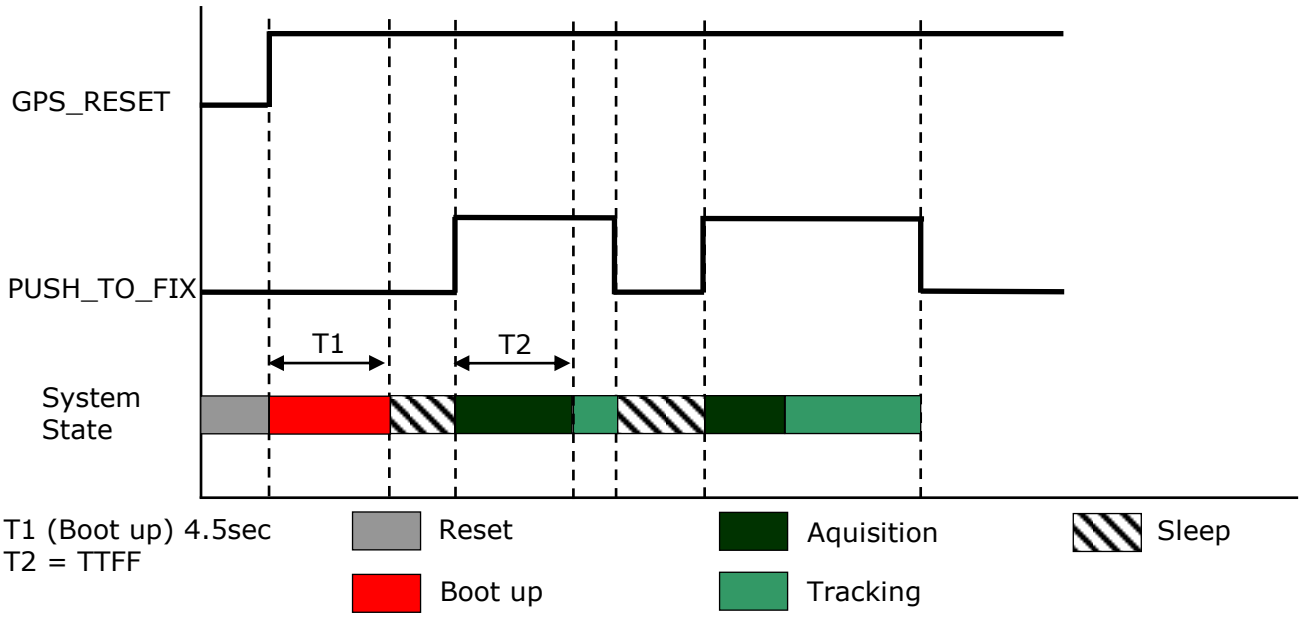
GNS502 provides APM feature as as a user selectable option.
APM dynamically controls the GPS internal function blocks to achieve the lowest power consumption in a gives GPS signal condition. APM will work at full power during acquisition and go down to 80mW in tracking mode and reduce the power further to below 50mW (min 27mW) when satellite signal is unobstructed in an open sky scenario.

- However – same as for any GPS device - the accuracy and stability will be lowered due to reduced activity of the positioning algorithms. Since working parameters of APM are not adjustable, a field test is recommended to confirm usability of power saving algorithm.

By default, APM is set to inactive. Please refer to Section 13 for more information.

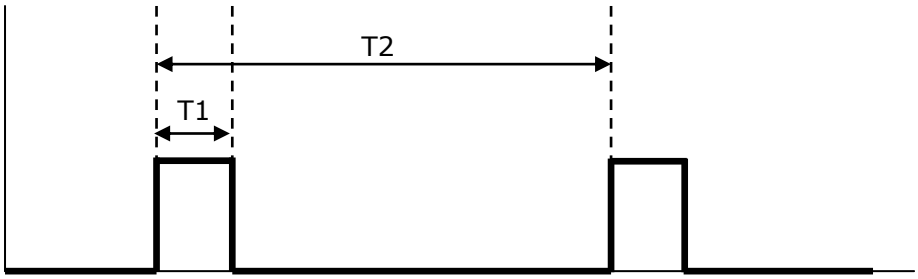
6.2 Push to fix (PTF)

The *PTF* signal pin is used to control the power state of the receiver. If PTF is high, the receiver is under full operation.
When PTF is going to low level, a *deep sleep* state is entered, only the memory and the real time clock will be powered to preserve almanach, ephemeris and real time.
Reactivating the receiver by setting PTF to high within a short period of time (up to 2 hours) will allow the receiver to re-fix within a few seconds or less.



6.3 Pulse Per Second (PPS)

TC6000GN provide a so called Pulse Per Second (PPS) for timing purposes. After calculation of a 3D postion fix, the PPS signal is accurately aligned to the GPS seconds boundaries. The pulse generated is approximately 1 millisecond in duration and the repetition rate is 1 second.



T1 = 1ms T2 = 1sec

More information about the accuracy of the time pluse, please refer to http://processors.wiki.ti.com/index.php/CC4000_GPS_for_MCU "**GPS PPS Timing Application Note**".

6.4 Fix Available

The *FIX AVAILABLE* signal is used to indicate the availability of GPS postion information. This is typically used to drive an LED buffer so that the state of the device can be easily indicated. The table below lists the various states.

State	Indication
Initial boot up	low
PTF low	low
PTF on and aquisition	Toggling (900ms low and 100ms high)
PTF on and loss of fix	Toggling (900ms low and 100ms high)
PTF on and postion fix	continuously high

6.5 GPS Antenna

GNS502 contains all input circuitry including a high performance chip antenna. This antenna is finely tuned and provides the best performance at small outline.
When mounting the module, any metal , metalized or (ESD-) coated materials should be avoided !
A plastic (ABS,PC or similar) cover of up to 2mm should be ok in any case.
Please keep an air gap of 2..3mm between antenna surface and cover whenever possible.

7 ELECTRICAL SPECIFICATION

7.1 Absolute Maximum Ratings

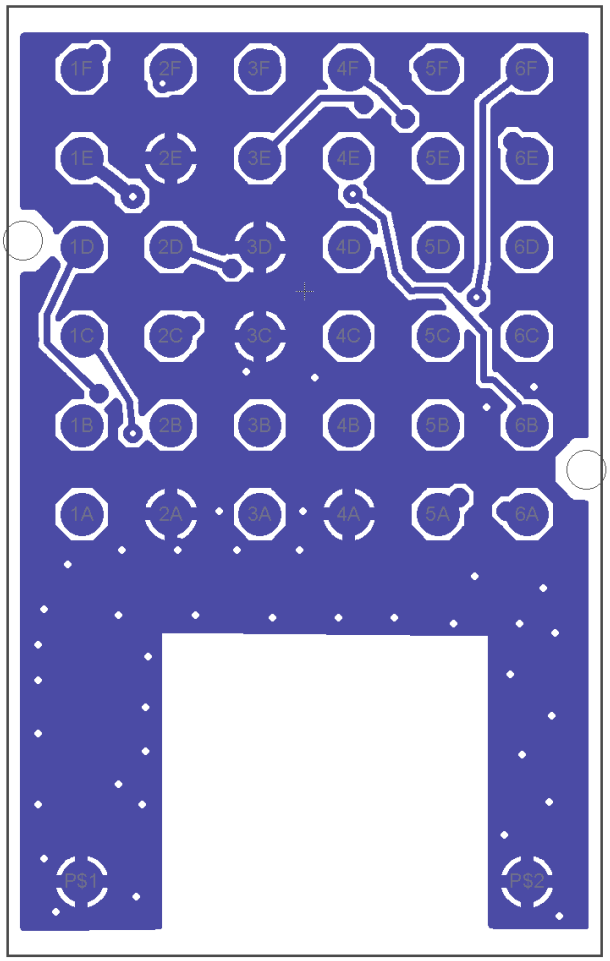
Parameter	Value	Unit
Supply voltage range: VDD	–0.5 to 2.1	V
Input voltage to all other pins	–0.5 to (VDD + 0.5)	V
Operating ambient temperature range	–40 to +85	°C
Storage temperature range	–40 to +85	°C

7.2 Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Note
VDD	1.7		1.95	V	Power-supply voltage
High level output voltage V_{OH}	0.8 * V_{DD}		V_{DD}	V	IOUT = 4 mA
Low level output voltage V_{OL}	0		0.2*V_{DD}	V	IOUT = 4 mA
High-level input voltage V_{IH}	0.65x VDD		VDD	V	
Low-level input voltage V_{IL}	0		0.35x VDD	V	
Operating temperature	-40		85	°C	Full specified performance

8 DEVICE PINOUT DIAGRAM

TOP VIEW



F	VBAT	VDD_IO	GPS_UART_TX	GPS_UART_RX	GPS_RESET	RTC_CLK
E	TCXO_CLK	GND	GPS_UART_CTS	NU12	NU10	ON_THE_FLY_PRG
D	DB_1	DB_2	GND1	NU7	NU8	NU9
C	DB_3	DB_4	GND3	NU13	NU11	NU6
B	NU1	NU2	NU3	NU4	NU5	GPS_PPS
A	NU12	GPS_GND1	NU14	GPS_GND2	FIX_AVAILABLE	PUSH_TO_FIX
	1	**2**	**3**	**4**	**5**	**6**

NO	NAME	TYPE[1]	DESCRIPTION
		Power-Management Signals	
2F	VDD_IO	P	1.8V I/O power supply voltage
1F	VBAT	P	1.8V main power supply voltage
3D	GND1	P	Common Ground
2E	GND2	P	Common Ground
3C	GND3	P	Common Ground
		Clock Signals	
1E	TCXO_CLK	O	TCXO_CLK signal output. This Pin delivers the high stable TCXO frequency of 26.000 MHz for external components. Although the output is buffered, do not load this pin below 20kOhms // 10pF(TBD). Leave open if not used.
6F	RTC_CLK	I	Clock input: 32.768 kHz. Input for an external low frequency clock signal. A clock must be provided at this pin to operate the module. See chapter "RTC CONNECTION"
		GPS Signals	
2A	GPS_GND1	P	GPS RF Ground
4A	GPS_GND2	P	GPS RF Ground
6B	GPS_PPS	O	This output delivers a high-precision pulse-per-second signal that is synchronized to the GPS time reference. The pulse precision is better than $1*10^{-7}$ seconds. Although the output is buffered, do not load this pin below 10kOhms // 47pF (TBD). Leave open if not used .
6E	ON_THE_FLY_PRG	I	This input determines operation after reset. Internally pulled up for normal operation. pull low for re- programming firmware or reconfiguring the module. Leave open in normal operation.
6A	PUSH_TO_FIX	I	Input signal to switch between operation and deep sleep mode. internally pulled down. pull high (with less than 4.7kOhm) during operation. pull low (or leave open) to set the module to deep sleep. Internal RTC continues to work in deep sleep.
5A	FIX_AVAILABLE	O	This pin indicates a fix position. Leave open if not used.
5F	GPS_RESET	I	Main Reset for the receiver. Internally weak pulled down. Pull high with less than 100kOhm for operation. pull to GND (or leave open) during power – up.
		NOT USED PINs DO NOT CONNECT	
1A	NU12		do not connect or connect to GND
1B	NU1		do not connect or connect to GND
2B	NU2		do not connect or connect to GND
3B	NU3		do not connect or connect to GND
4B	NU4		do not connect or connect to GND
5B	NU5		do not connect or connect to GND
5E	NU10		do not connect or connect to GND
4D	NU7		do not connect or connect to GND
5D	NU8		do not connect or connect to GND
6D	NU9		do not connect or connect to GND
5C	NU11		do not connect or connect to GND
6C	NU6		do not connect or connect to GND
4E	NU12		do not connect or connect to GND
4C	NU13		do not connect or connect to GND
3A	NU14		do not connect or connect to GND
		UART	
3F	GPS_UART_TX	O	Main UART TX.
4F	GPS_UART_RX	I	Main UART RX.
3E	GPS_UART_CTS	I	Main UART CTS. CTS not used. Leave open
		I2C	
1D	DB_1		must be connected to DB_2
2D	DB_2		must be connected to DB_1
1C	DB_3		must be connected to DB_4
2C	DB_4		must be connected to DB_3
		Chip Antenna grounding	
P$1	GND		Must be firmly connected to ground plane (see chapter *PCB mounting*)
P$2	GND		Must be firmly connected to ground plane (see chapter *PCB mounting*)

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

9 POWER MANAGEMENT

For quick re-acquisition after power-on, the GNS502 should stay tied to Vdd during off-times to keep it's RTC clock running. The receiver is put in sleep mode by holding the *PTF* pin low. The pin may be controlled by the host controller or by another power management circuitry, which might be also a simple electromechanical switch.
A static low level on *PTF* will keep the GNS502 in a deep sleep with power consumption at 81µA.

10 HARDWARE HOST INTERFACE

GNS502 is connected to host system by a UART Interface.
Since GNS502 is used only to deliver NMEA to the host only a single data line from the receiver to the host is necessary. The interface requires 1.8V I/O. The idle state of the lines is positive voltage. To interface a standard RS232 UART (e.g. a PC serial interface), please add an inverting level shifter. To interface processors that have a different interfacing voltage level, level shifters are required.

10.1 GPS UART Interface details

- The UART interface is used to send NMEA messages and control data.
- The default baud rate is 9600, other baud rates can be selected by ordering option.
- The maximum baud rate deviation supported is ±2%.

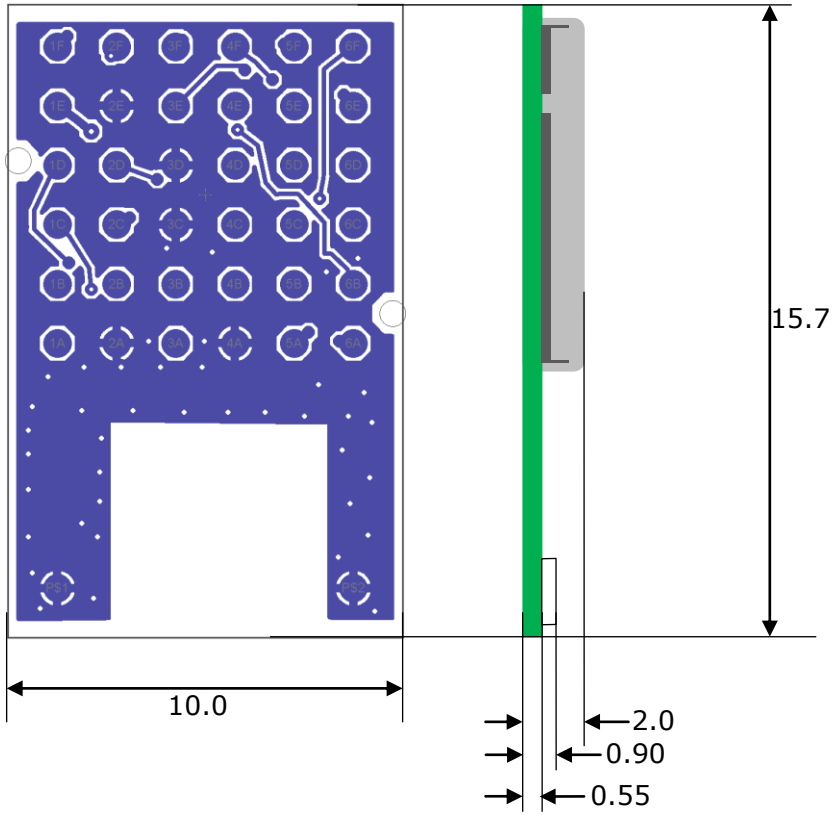
GPS UART Default Settings	
Parameter	**Value**
Baud rate	9600
Data length	8 bits
Stop bit	1
Parity	None

11 NMEA DATA

The GNS502 provides NMEA (National Marine Electronics Association) 0183 compatible data.
The following table shows the available NMEA sentences. All active NMEA sentences are sent at the selected baud rate.

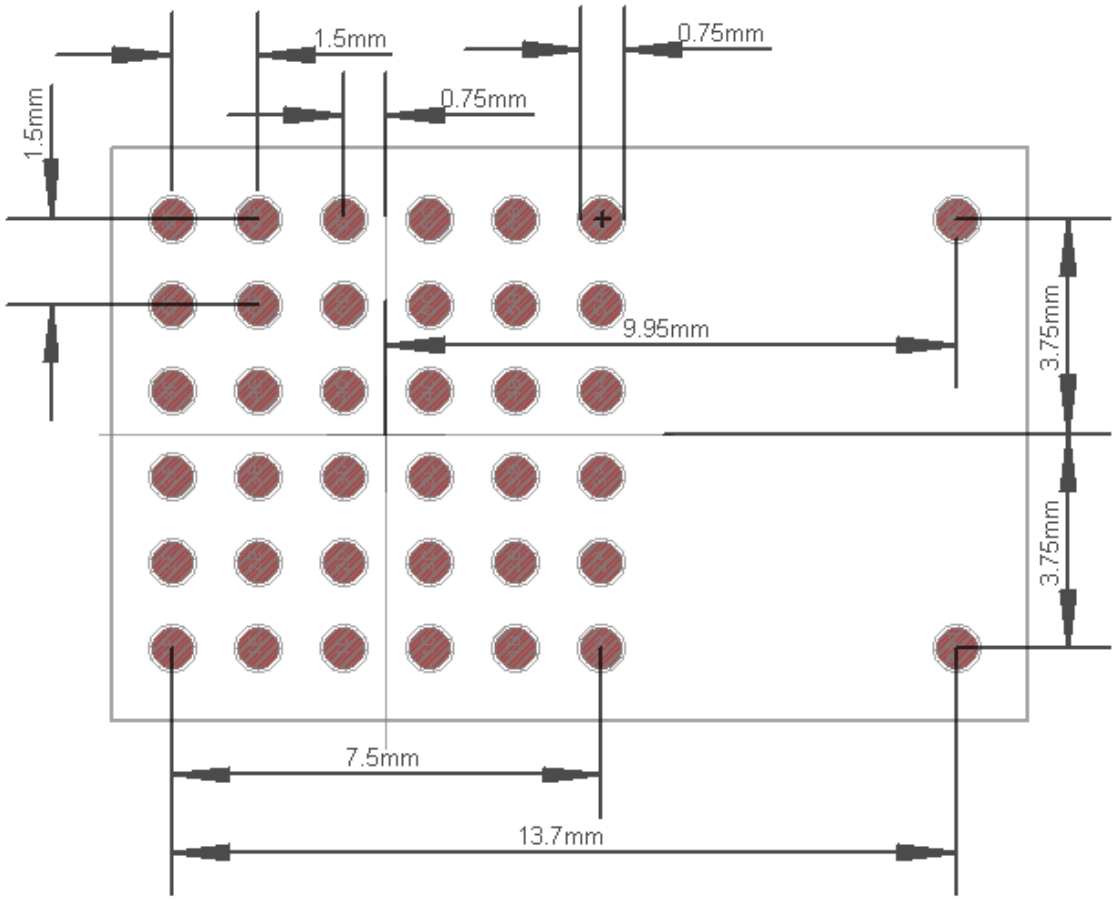
NMEA available sentences	
Type	**content**
$GPRMC	Recommended Minimum Navigation Information
$GPGGA	Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver
$GPGSV	Satellites in view
$GPGLL	Geographic Position - Latitude/Longitude
$GPGSA	GPS DOP and active satellites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

12 PHYSICAL DIMENSIONS



all units in mm
tolerance for <5mm : ±0.1mm ; for >5mm ±0.2mm

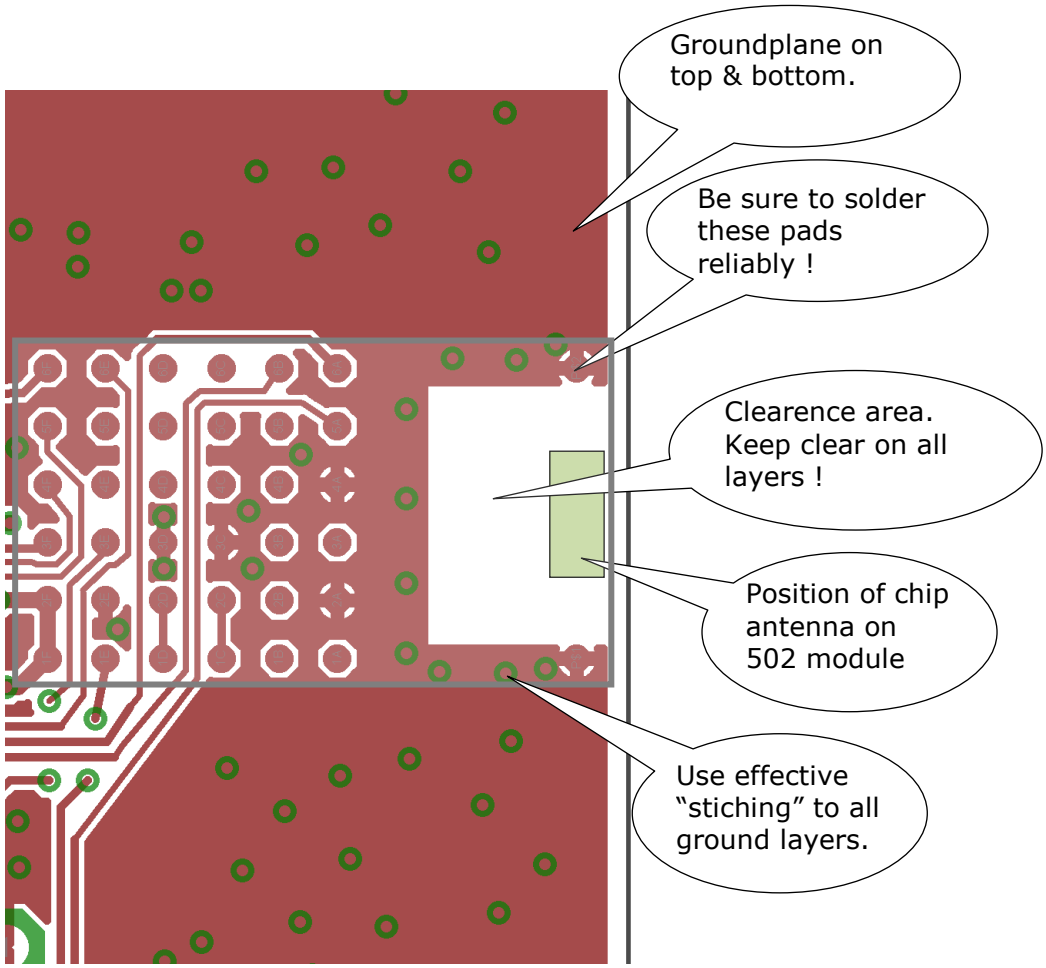
13 RECOMMENDED PAD LAYOUT



14 DESIGN GUIDELINES

Although GNS502 GPS receiver provides a good performance, 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 be aware, that the most sensitive parts – the antenna and the first LNA – are part of the module !

14.1 Pcb layout (example: GNS502 EVB)



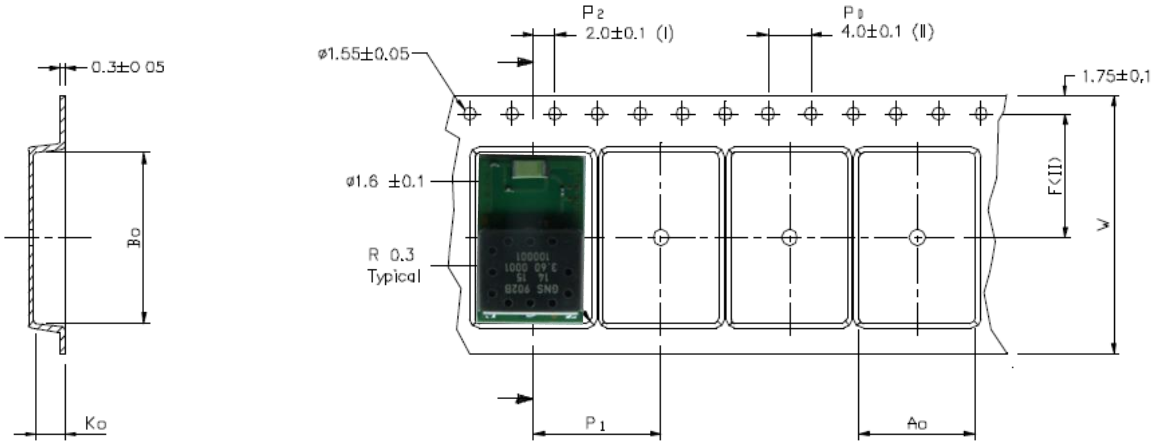
GNS502 uses a high performance chip antenna design.
For optimum performance, a ground plane area is needed on the main board. This area should be at least 20 x 30mm, a larger ground like 30 x 60mm is recommended.
The groundplane can be part of the main ground layer of the mainboard, some (small) components in the neighbourhood of the antenna are acceptable. Do not place any bulky or metallic components near to the antenna (in a distance below 30mm) to avoid unwanted electromagnetic shielding effects.

It's recommended to place GNS502 at the rim of the main PCB, so that the antenna has a wide unobstructed working angle.
The marked clearance area below the antenna must be kept clear in any case ! Do not design any copper tracks or planes in the clearance area ! Do not mount your mainboard directly on a metal surface. There should be 10..15 mm clearance below the main board.
The two ground solder pads near the chip antenna must be reliably soldered to mainboard.
Please do not place any shielding or lids in the area 5mm below your PCB under the Clearance area.
Plastic enclosures can also have impact on the antenna. Avoid that the antenna is in touch with any enclosure parts. Product testing should be performed with the PCB already mounted in the final enclosure.
Generally the rules for good and low noise design should be followed:

- ➔ Use a solid ground plane, best on layer 2 of the mainboard
- ➔ Place enough vias (min 0.3/0.6mm) to ensure proper grounding (see example above).
- ➔ Keep noisy components (µC, switch mode supplies) as far as possible away from sensitive antenna inputs
- ➔ Place decoupling capacitors near to the source of noise and provide a short and low induction connection to ground (use multi-vias if needed)
- ➔ EMC filters or noise filtering coils or beads can help to reduce the noise level further.
- ➔ Select system clocks in a way, that no harmonics will match the GPS frequency of 1575.42 MHz

15 PACKAGE INFORMATION

15.1 TAPE



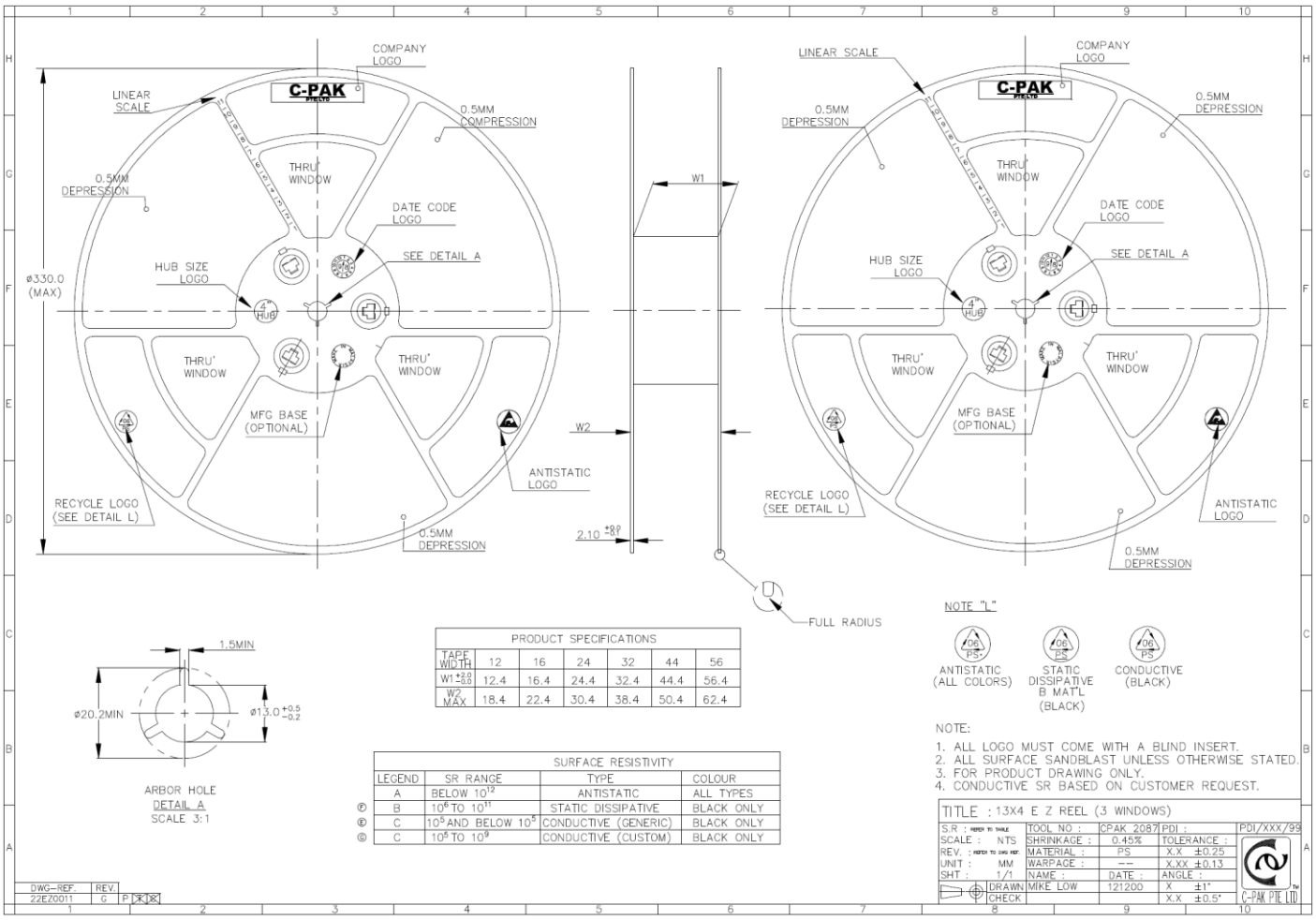
Ao	10.90 +/− 0.1
Bo	15.82 +/− 0.1
Ko	3.00 +/− 0.1
F	11.50 +/− 0.1
P_1	12.00 +/− 0.1
W	24.00 +/− 0.3

(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.

15.2 REEL

:



PRODUCT SPECIFICATIONS						
TAPE WIDTH	12	16	24	32	44	56
W1 +2.0 -0.0	12.4	16.4	24.4	32.4	44.4	56.4
W2 MAX	18.4	22.4	30.4	38.4	50.4	62.4

SURFACE RESISTIVITY			
LEGEND	SR RANGE	TYPE	COLOUR
A	BELOW 10^{12}	ANTISTATIC	ALL TYPES
B	10^{6} TO 10^{11}	STATIC DISSIPATIVE	BLACK ONLY
C	10^{5} AND BELOW 10^{5}	CONDUCTIVE (GENERIC)	BLACK ONLY
C	10^{5} TO 10^{9}	CONDUCTIVE (CUSTOM)	BLACK ONLY

Number of devices: 1500 pcs/reel

16 ORDERING INFORMATION

Ordering information				
Type	**Part#**	**Marking**		**Description**
GNS502	4037735105324	GNS502 1440 <Serial>	Type Date yyww Serial#	GNS GPS receiver

17 CUSTOMER SPECIFIC FACTORY OPTIONS

Some features of GNS502 are factory presets, that should be added to your order information. Just replace <options> by the **Short** options given in the table below.
Please use a comma "**-**" for separating the options.
You do not need to specify option values that are shown to be default.

Type	**Default value**	**Possible options**	**Short**	**note**
UART baudrate	9,600 baud	Baud=9600bps Baud=19200bps Baud=38400bps Baud=57600bps Baud=115200bps	9 19 38 57 115	The serial output baud rate.
APM feature	Not active	APM active APM not active	A	APM feature allows the GPS engine to save energy under good reception conditions. Please define A , if you wish to have APM activated.
GPS output rate	1 second (R1)	Rate is x seconds (x=1,2,3,4,5,10, 30,60)	R<x>	This option is useful to optimize transfer times by lowering the rate of NMEA messages. Has no influence on the GPS engine activity.
NMEA selection	All 6 types	All combinations possible	RMC GGA GSV GLL GSA VTG	saving unused NMEAs. Please specify all types that should be available
GSV output rate	1	GSV=1 GSV=5	G1 G5	GSV rate can be selected as a multiple of the GPS output rate. This option is used to reduce average data transfer. G5 with a rate of 1 will produce GSV output every 5 seconds
Pulse per second output	active (on)	PPS on PPS off	/P	Activates or deactivates the hardware precision pulse per second. Since active is default, please define /P (no PPS) if PPS should not be available.

For example, if you wish to have a baudrate of 115.2k, and only RMC (once per second) and GSV (every 5 seconds) as output data, please order as follows :

GNS502 115-RMC-GSV-G5

In another example, Baud Rate is 38400bps, all NMEA sentences except GSV and VTG should be sent at a rate of once per 5 seconds. PPS shall be off:

GNS502 38-RMC-GGA-GLL-GSA-R5-/P

18 ENVIRONMENTAL INFORMATION

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

19 DOCUMENT REVISION HISTORY

V0.1	Oct 6 2014	P.Skaliks	initial document

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