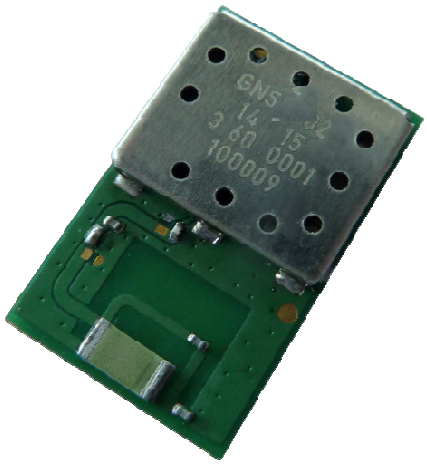
GPS receiver GNS202E Datasheet V1.5

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

1 INTRODUCTION

GNS202E is a small autonomous GPS receiver, based on the MediaTek MT3337 single chip, with a high-sensitivity ceramic chip antenna.
GNS202E is a high performance solution for cost sensitive application. It's attractive price and ready- to run configuration with integrated antenna solution reduces time-to-market to a minimum.



The navigation performance and accuracy is further improved by using correction data from SBAS (WAAS, EGNOS, GAGAN, MSAS), QZSS.

First Fixes after just a few seconds are achieved with the help of A-GPS using EPO™ (Extended Prediction Orbit) .

The extremely low power requirement at full activity makes this receiver an ideal choice for battery supplied applications. The new AlwaysLocate™ power management feature will improve this behaviour additionally. It adaptively adjusts power consumption depending on the environment and motion conditions, in order to achive a balance between fix rate, power consumption and position accuracy.
Very low power requirements (typ 53mW@3.3V, tracking) and internal voltage regulator makes it easy to run the receiver with various power supplies and allows direct connection to LiIon batteries.

GNS202E offers the industry's highest level of navigation sensitivity up to -165dBm[1]. It has superior dynamic performance at high velocity and provides effective protection against interference signals using AIC (active interference canceller). Up to 12 independent channel interference continuous wave jammers <-80dBm can be eliminated or reduced.

V 1.5, dec 21th 2016

In professional timing applications the outstanding high accuracy PPS (pulse per second) hardware pin is used for synchronization to GPS second. Typical accuracy is 10ns RMS.

Note:
Up from September 2015, the chip manufacturer mediatek decided to add the self prediction functionality EASY™ and an improved NMEA vs. PPS alignment to the feature list. At the same time, some minor features are removed to save hardware resources on the chip. GNS will mark the new generation with "**GNS2201E**" on the laser marking. A PCN will be provided for documentation in QMS.

Note: This module is designed to be operated on a mainboard, that provides a minimum of 20mm x 30mm ground plane. Sensitivity will be decreased if no groundplane is provided.

Features

- 66 acquisition-/ 22 tracking channels
- Ultra high tracking/navigation sensitivity: -165dBm[1]
- smart antenna: tuned miniature ceramic chip antenna
- EASY™ 3-day self prediction for fast TTFF without any data from a network
- A-GPS by EPO "Extended Prediction Orbit"™ enables 7/14days prediction
- 12 Multitone Active Interference Canceller (AIC) for GPS-in-band jammer rejection
- High accuracy 1PPS output , PPS vs NMEA feature
- NMEA-0183 or binary protocol
- High update rate (up to 10/s)
- GNSS current consumption (@3.3V):
  Acquisition: 18mA typical
  Tracking: 16mA typical
- Low backup current consumption 8µA, typical
- SMD type
- Small form factor: 15.7x10x2.0mm

[1] **Note: Measured navigation sensitivity at RF input of chipset**

2 INDEX

3 FUNCTIONAL DESCRIPTION

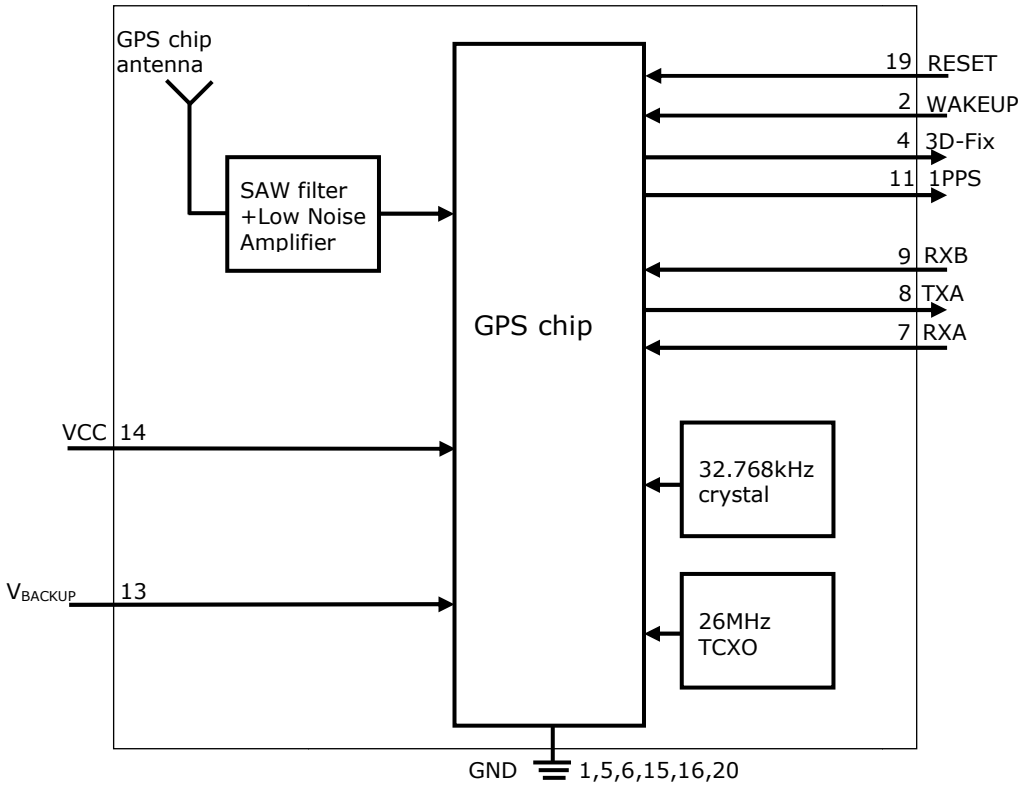
3.1 System description

The GNS202E is a high performance, low power GPS receiver that includes an integrated RF frontend (SAW Filter + LNA) and a ceramic chip antenna.
Due to high input sensitivity and low noise amplifier (LNA), it can work at weak GPS signals.

GNS202E 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) a SAW filter and a high performance chip antenna
- Interface for UART, PPS output pin, Fix Status Indicator pin

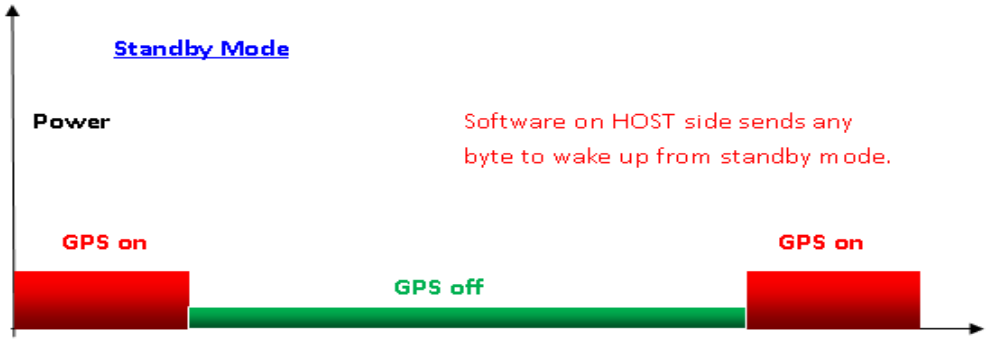
3.2 Block diagram



3.3 Power Management Features

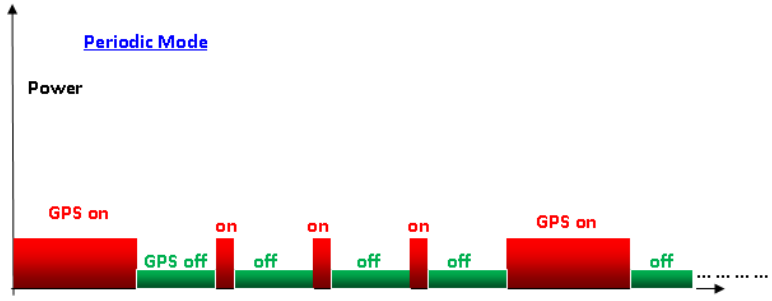
Power management schemes implemented for any GPS system requires an optimally tuned performance for both accuracy of the position fixes and the average power consumed for best user experience. GNS202E architecture achieves these both aspects by providing flexibility and design choices for the system integration, based on wide range of use cases and by leveraging on the proven silicon methodologies. Also GNS202E 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.
Selectable Power management features:

- In ***Standby mode*** RF frontend and internal MPU are switched to deep sleep state. Power consumption is reduced to 200µA.This state can be entered by sending the NMEA command: $PMTK161,0*28<CR><LF>.
  Leaving standby mode and resuming to normal operation will be managed by sending any byte to the module.



- ***Backup mode*** can be entered by sending NMEA command: $PMTK225,4*2F<CR><LF>. The GPS core will shut down autonomously to backup state, Vcc supply can now be switched off by an external power supply switch.

- ***Periodic mode*** describes a power mode, which will autonomously power on/off the module in programmable time slots with reduced fix rate. Periodic mode is useful during stationary operation or if position fixes are just needed from time to time. Since power consumption in GPS off times is nearly zero, the power consumption in periodic mode can be estimated by $P_{tracking} * (t_{on}/(t_{on}+t_{off}))$.
  Periodic mode is controlled with NMEA command $PTMK225. See document *NMEA_Interface_manual_MTK_V01 f*or programming details.



3.4 Active interference cancellation (AIC)

Because different wireless technologies like Wi-Fi, GSM/GPRS, 3G/4G, Bluetooth are integrated into portable systems, the harmonic of RF signals may influence the GPS reception.
The multi-tone active interference canceller can reject external RF interference which come from other active components on the main board, thus improving the performance of GPS reception. GNS202E can cancel up to 12 independent continuous wave (CW) channels having signal levels of up to -80dBm. The functionality is enabled by default and increases power consumption by about 1mA.

3.5 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 GNS202E 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 GNS202E receiver. Please refer to the *NMEA_Interface_manual_MTK_V01* for details.

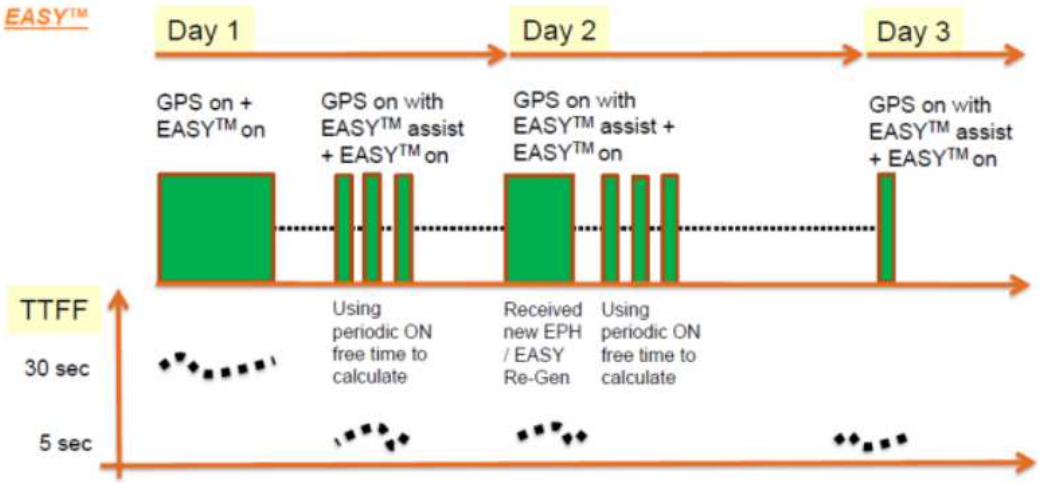
If the host has low memory available, there's no need to save the whole file. The steps 3..5 can be done frame by frame needing less than 2kBytes of buffer memory.

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					
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

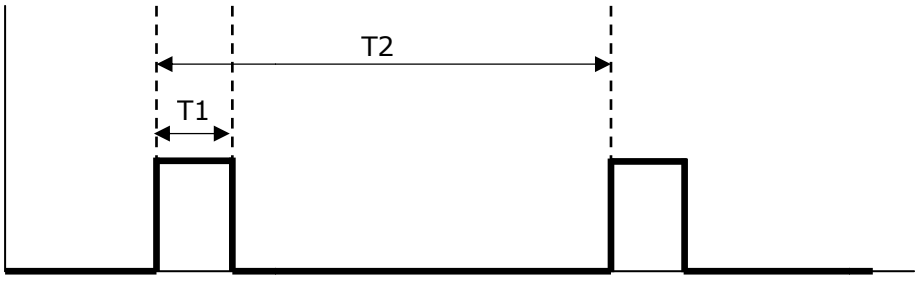
3.6 EASY™ self generated prediction data feature

GNS2201E includes an internal prediction system, that allows to sample satellite orbit data during operation and use that data to speed up TTFF on later starts.The prediction time frame is up to three days forward.
Although this prediction feature does not provide the very short TTFF that is achieved using AGPS, it can help to find a fix solution faster and in weak signal condition scenario. Prediction data will be kept in memory as long as V_{BACKUP} is present. This option is activated by default.
Note: The EASY functionality is only supported, if "V_{BACKUP}" pin is conntected and the NMEA update rate is 1Hz.



3.7 Pulse Per Second (PPS)

GNS202E provides a Pulse Per Second (PPS) hardware output pin 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 approximately 100 milliseconds in duration and the repetition rate is 1 second. On request PPS output can activated on a 2D- fix or after power-up of the module, providing a time accuracy decreased PPS signal.



T1 = 100ms T2 = 1sec

GNS202E module provides an exceptionally low RMS jitter of typical 10 nanoseconds.

PPS characteristics based upon a 3D-fix					
1PPS pulse duration	-	100	-	msec	
1PPS time jitter	-	10		nsec RMS	Pulse rising edge deviation from expected pulse time, measured with full 3D fix
1PPS rise and fall time		5		nsec	10%..90%, load is 10k||5pF

3.8 PPS Sync NMEA function

This function ensures a fixed time gap between PPS pulse and NMEA UTC output of 170..180ms. Specification to be defined.

3.9 GPS almanac and ephemeris data

For quick re-acquisition of the GPS receiver after off-times, the GPS engine should have access to almanac and ephemeris data. This data is permanently stored inside GNS202E module, even if all power supplies have been removed. When the receiver 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.

3.10 DGPS (Differential GPS) support

GNS202E accepts DGPS input in RTCM format. DGPS provides precision position fixes down to centimetres and is used in professional applications like agriculture. The second UART (UART_B) of the module is used to feed the data in. DGPS is deactivated by default. For configuration of the UART port, some NMEA commands must be implemented. See NMEA_Interface_manual_MTK_Vx 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 through the NMEA Interface.

3.11 Real time clock (RTC)

GNS202E has a real time clock with 32,768Hz crystal on board. As long as V_{BACKUP} 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 7uA. 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

GNS202E core and I/O sections work at 3.3V nominal. Absolute Maximum Ratings should not be exceeded. Should the GNS202E 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 rates by a NMEA software command. See document *NMEA_Interface_manual_MTK_Vx* for details.

UART Default Settings	
Parameter	**Value**
Baud rate	9600
Data length	8 bits

Stop bit	1
Parity	None

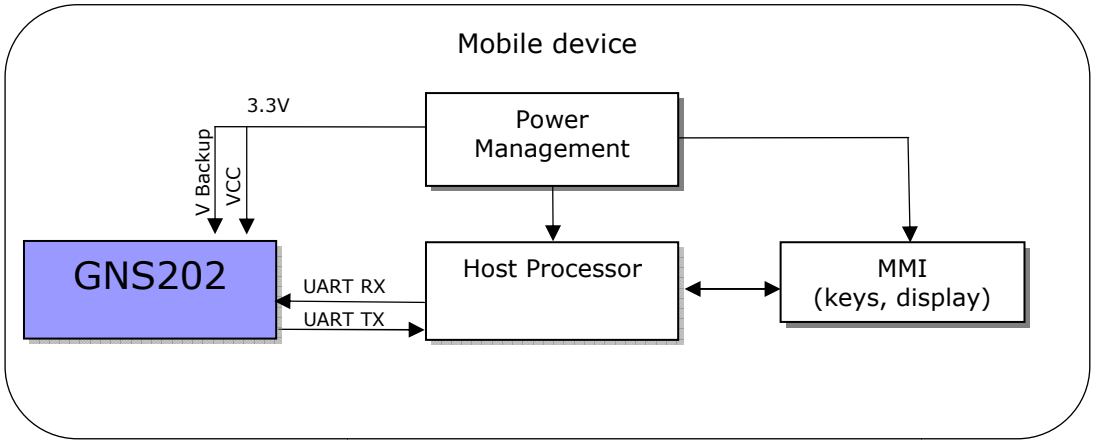
3.13 Module default settings

The GNS202E receiver comes with default settings, which are persistently programmed. Whenever power is removed from the module (both VCC and V_{BACKUP}), the settings will be reset to the values shown in the following table.

Default settings	
interface	
UART setting	9600,8,N,1
Fix frequency (update rate)	1/sec
NMEA sentences	$GPRMC,$GNGSA,$GPGSV,$GPGGA
NMEA rate	Once a second: RMC,GSA,VTG ,GSV
navigation	
Active interference cancellation:MTAIC	enabled
Fix interval	1 sec
Datum	WGS 84
PPS pulse output length	100ms
Fix interval	1 sec
Fix LED	100ms on time 900ms off time
Static navigation	Disabled
Datum	WGS84
Initial position output	Lat.:90° Lon. : 0°
QZSS,EPO	enabled
EASY self prediction	enabled

4 TYPICAL APPLICATION BLOCK DIAGRAM

4.1 Typical System Overview



5 GPS characteristics

5.1 GPS characteristics

Parameter	Min	Typ	Max	Unit	Note
general					
Frequency		1575.42		MHz	GPS L1
Datum		WGS84			
AGPS	7		14	days	Configurable
Output data frequency	1/1000	1	10	1/sec	
Navigation&tracking sensitivity[1]		-165		dBm	autonomous
Acquisition sensitivity[1]		-148		dBm	Cold start
TTFF hotstart		1		sec	All SVs @-130dBm
TTFF autonomous warm start		33		sec	All SVs @-130dBm
TTFF autonomous cold start		35		sec	All SVs @-130dBm
Reacquisition time		<1		sec	All SVs @-130dBm
Number of channels tracking		22			
Number of acquisition channels		66			
Dimension		15.7x10x2.0		mm	Tolerance is +/-0.2 mm
Weight		0.49		g	
Power consumption					
GPS ACTIVE (acquisition)		18		mA	TBD NMEA frequency = 1/sec,SBAS enabled, MTAIC enabled
GPS ACTIVE (tracking)		16		mA	TBD NMEA frequency = 1/sec, SBAS enabled, MTAIC enabled
GPS standby			200	µA	After $PMTK161 command
Backup current @ 3V		7		µA	

Accuracy					
Position error (50%CEP)	-	3	-	m	Without aid 2D-RMS
Position error (50%CEP)	-	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 ELECTRICAL SPECIFICATION

6.1 Absolute Maximum Ratings

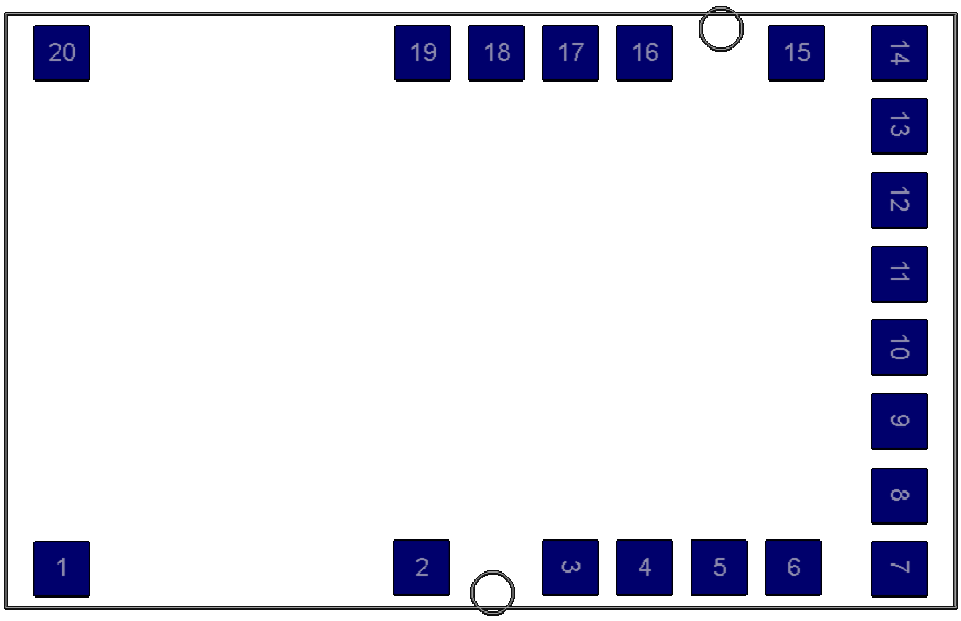
Parameter	Value	Unit
Supply voltage: Vcc	–0.5 to 4.3	V
Backup voltage: V_{BACKUP}	–0.5 to 4.3	V
Input voltage to analog pins	–0.5 to 3.3	V
Input voltage to all other pins	–0.5 to Vcc	V
Operating ambient temperature range	–40 to +85	°C
Storage temperature range	–50 to +125	°C

6.2 Electrical characteristics

Parameter	Min	Typ	Max	Unit	Note
V_{cc}	2.8	3.3	4.3	V	supply voltage
V_{cc} ripple voltage			50		mVpp
V_{BACKUP}	2.0	3.0	4.3	V	Backup voltage for RTC and memory retention, must be available during normal operation
High level output voltage V_{OH}	2.38		2.9	V	
Low level output voltage V_{OL}	0		0.42	V	
High-level input voltage VIH	2.1		3.5	V	
Low-level input voltage VIL	-0.3		0.7	V	
Operating temperature	-40		85	°C	Full specified sensitivity

7 PIN CONFIGURATION

Top View



Pin	Name	I/O	Description & Note
1	GND		Ground
2	WAKEUP	I	Wakeup input (TBD) leave open
3	NC		Not conected
4	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 1 Hz. output 100ms high-level and 0.9s 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.**
5	GND		Ground
6	GND		Ground
7	RXA	I	Serial Data Input A for NMEA commands (TTL) This is the UART-A receiver of the module. It is used to receive commands from system
8	TXA	O	Serial Data Output A for NMEA output (TTL) This is the UART-A transmitter of the module. It outputs GPS information for application.
9	RXB	I	Serial Data Input B This is the UART-B receiver of the module. It is used to receive RTCM data from system
10	NC		Not connected
11	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.
12	NC		Not conected
13	V_{BACKUP}	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 2.8V~4.3V, Typical 3.3V. If V_{BACKUP} power was not reserved, the GPS receiver 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.**
14	VCC	P	Main DC power input The main DC power supply for the module. The voltage should be kept between from 2.8V to 4.3V. The ripple must be limited under 50mVpp (Typical: 3.3V).
15	GND		Ground
16	GND		Ground
17	NC		Not conected
18	NC		Not conected
19	RESET	I	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.
20	GND		Ground

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

8 NMEA DATA interface

GNS202E provides NMEA (National Marine Electronics Association) 0183 compatible data.
A set of proprietary NMEA commands are available to send control messages to the module.
These commands are described in a separate document: *NMEA_Interface_manual_MTK_Vx* manual.
For standard operation, no commands are needed; the module will start outputting NMEA sentences after power supply has been attached. GNS202E 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 V_{BACKUP} will be sufficient to keep them.

8.1 NMEA command interface

GNS202E NMEA command interface allows to control settings and the extended functions. The command interface specification is available in an extra document:
NMEA_Interface_manual_MTK_Vx 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 V_{BACKUP}. (f.e. : setting of a new baud rate). After removing V_{BACKUP}, all settings are reset to their default values.

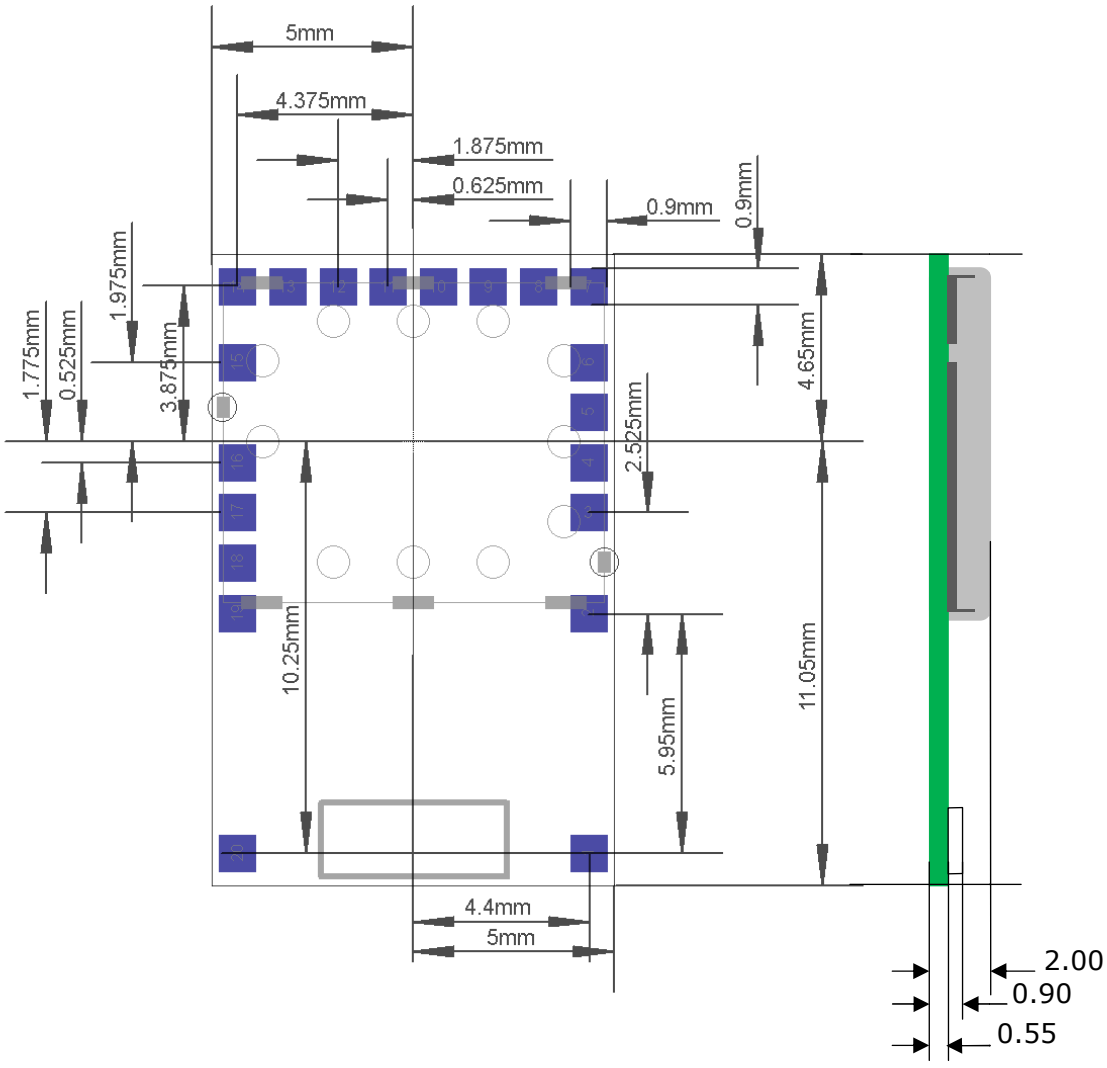
Action commands will perform the specified action one time after the command has been received. (f.e. : request for cold start)

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.

9 PHYSICAL DIMENSIONS

TOP VIEW

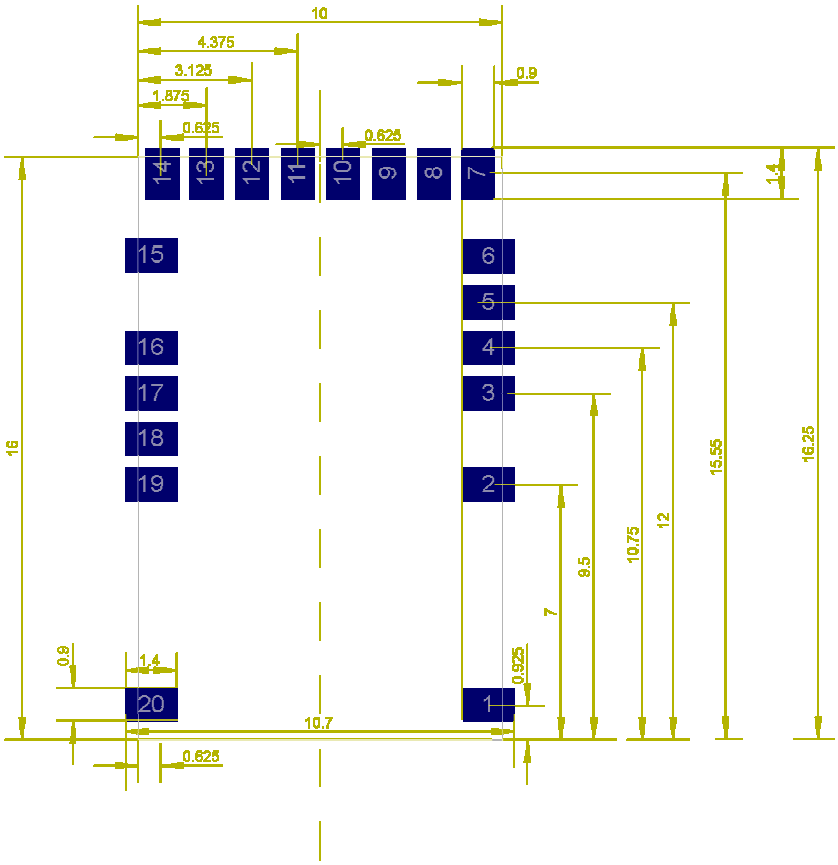
all units in mm, tolerance is ±0.2mm



10 RECOMMENDED PAD LAYOUT

all units in mm

Footprint Top View

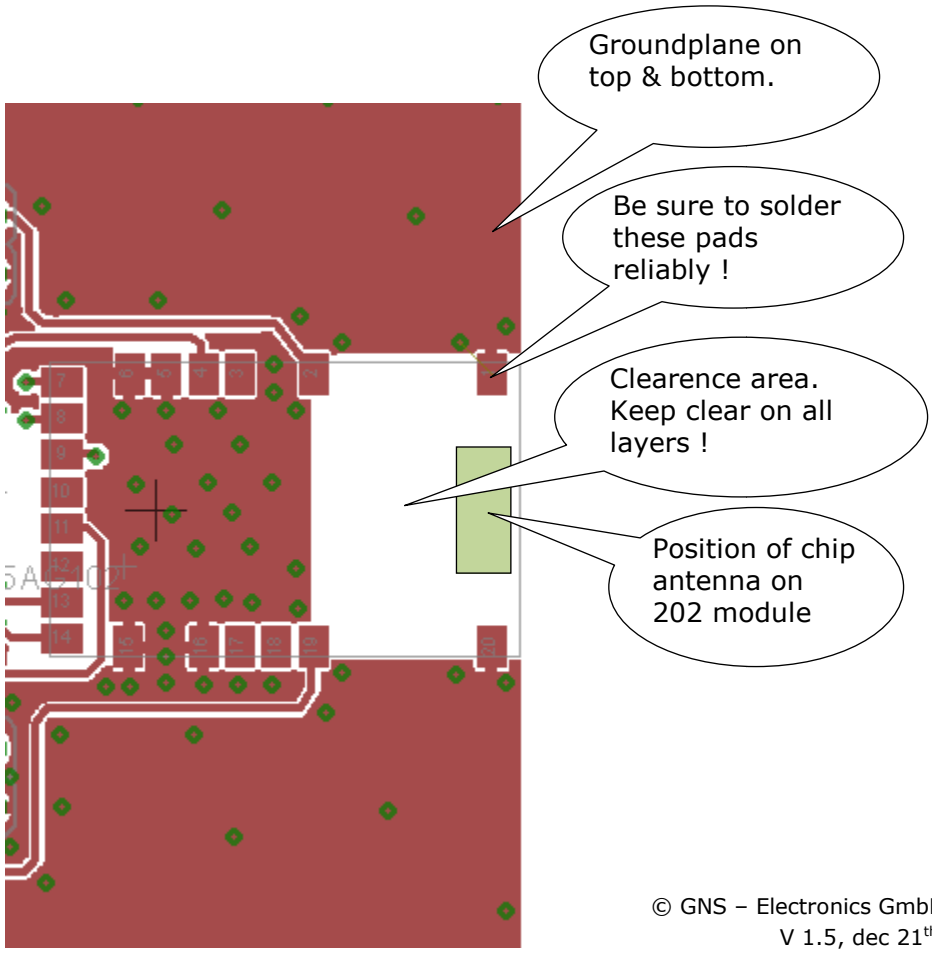


11 DESIGN GUIDELINES

Although GNS202E 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.

11.1 PCB LAYOUT GUIDELINES

GNS202E 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 GNS202E 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 !
The two ground solder pads near the chip antenna must be reliably soldered to mainboard groundplanes to make the antenna work at high performance.
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
- ➔ 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

12 NMEA DATA interface

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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 V_{BACKUP} will be sufficient to keep them.

12.1 NMEA output sentences

NMEA output sentences	
Type	**content**
RMC	Recommended Minimum Navigation Information
GGA	Fix Data, Time, Position and fix related data
GSA	DOP and active satellites
GSV	Satellites in view

Refer to *NMEA_Interface_manual_MTK_Vx* document for more information.

12.2 NMEA command interface

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Two groups of commands are available:

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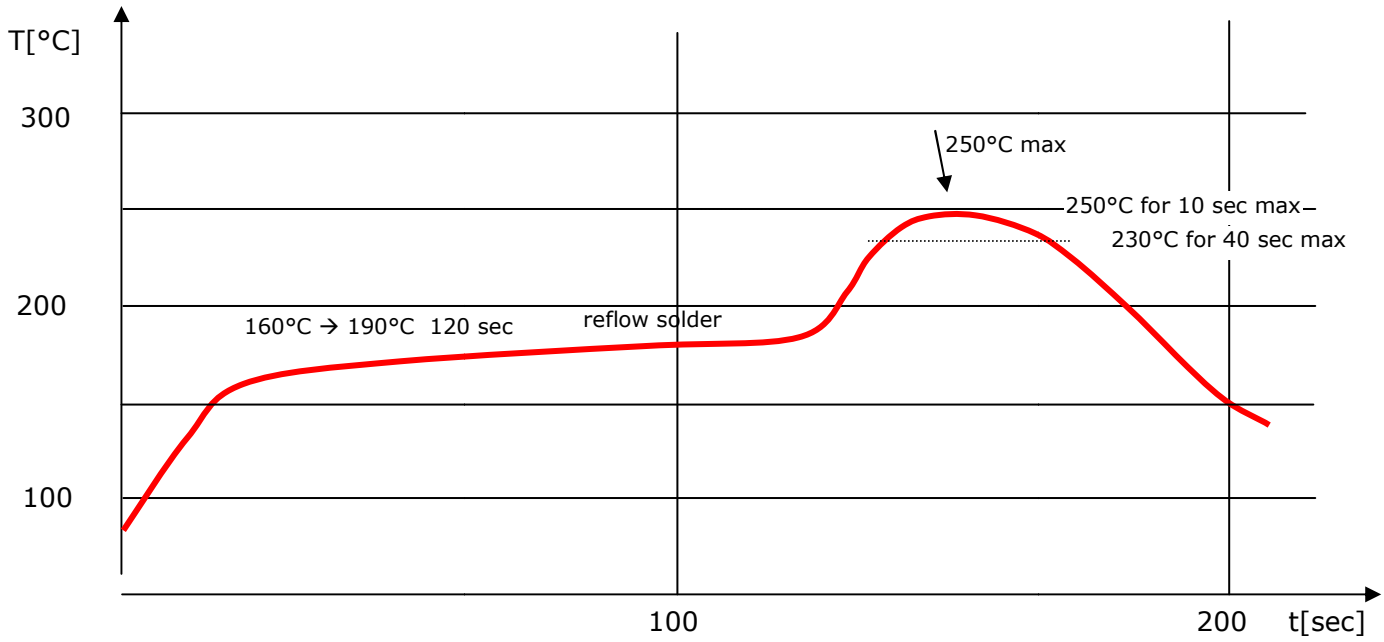
13 MATERIAL INFORMATION

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

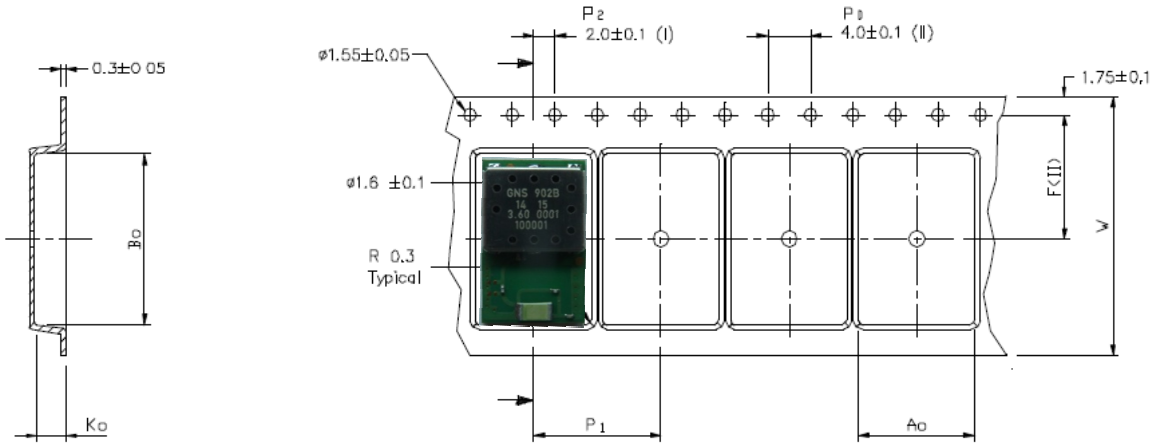
14 RECOMMENDED SOLDERING REFLOW PROFILE



Notes:
1. GNS202E should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS202E receiver from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. RohS compliance status will be lost if soldered with solder containing lead (Pb).
5. This device is not applicable for flow solder processing
6. This device is not applicable for solder iron process

15 PACKAGE INFORMATION

15.1 TAPE



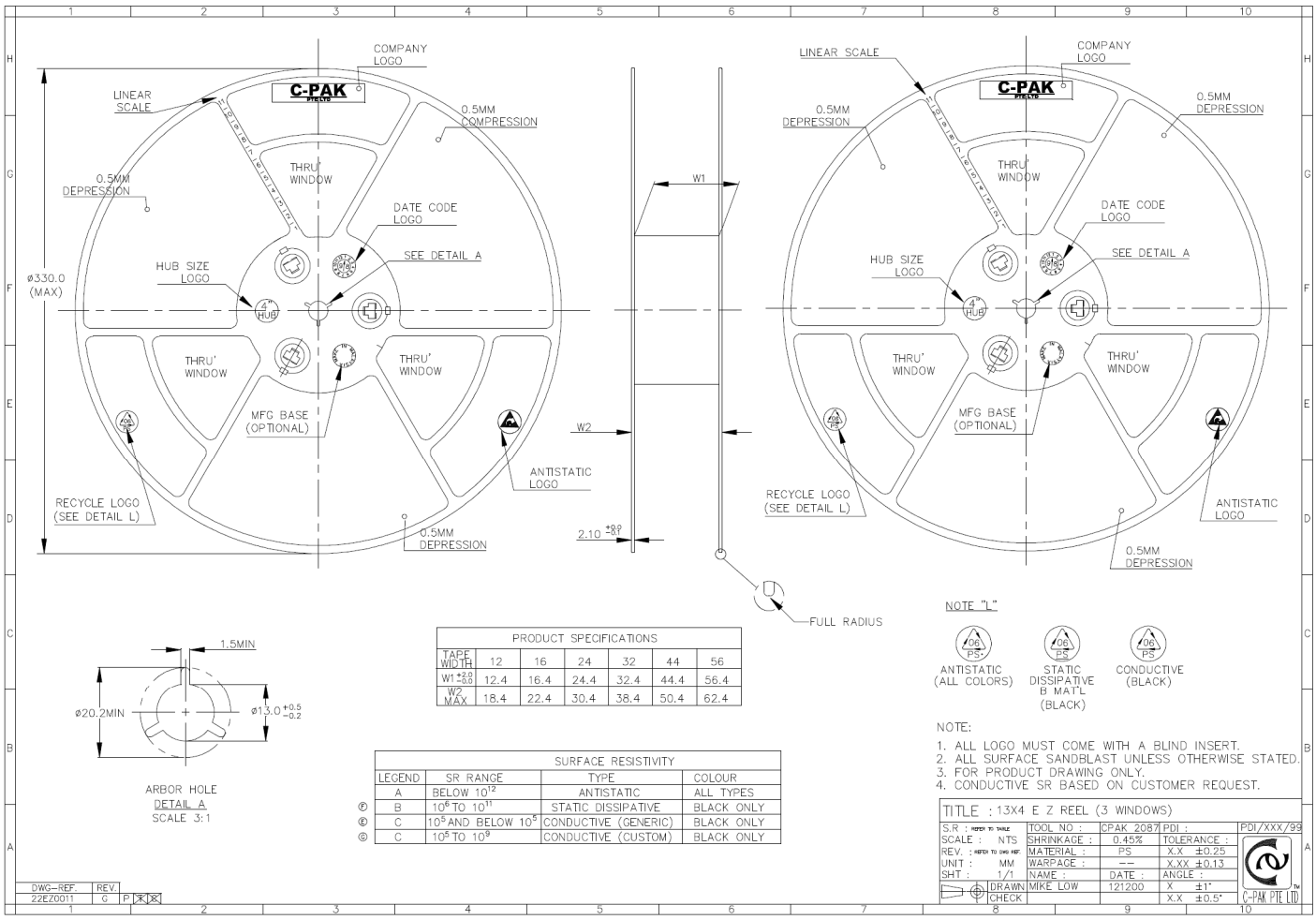
Ao	10.90 +/− 0.1
Bo	15.82 +/− 0.1
Ko	3.00 +/− 0.1
F	11.50 +/− 0.1
P_1	12.00 +/− 0.1
W	24.00 +/− 0.3

(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#**	**label marking**	**Description**
GNS202E	4037735105379	GNS202E YYWW SN	GNS202E GPS receiver YYWW → date code SN → serial number

17 ENVIRONMENTAL INFORMATION

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

18 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

19 DOCUMENT REVISION HISTORY

V1.0	Aug 18 2014	P.Skaliks	initial document
V1.1	Oct 24 2014	P.Skaliks	General review
V1.3	Nov 14 2014	P.Skaliks	Detail review
V1.4	Jun 24 2015	P.Skaliks	New version 202E
V1.5	Dec 21 2016	O.Diegel	Package Information / General review

20 RELATED DOCUMENTS

Title	**Description / file**		**Available from**
NMEA_Interface_manual_MTK_Vx	Detailed description of NMEA commands and protocol		www.forum.gns-gmbh.com www.gns-gmbh.com
GNS202_902_StarterKit user manual	User manual for the GNS202/902 receiver based evaluation kit		www.forum.gns-gmbh.com www.gns-gmbh.com