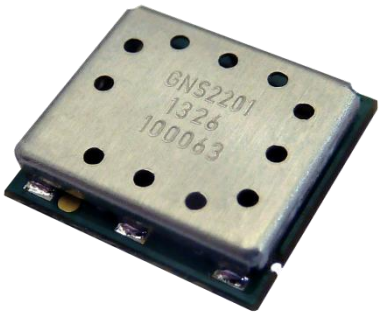
GPS module GNS 2201 Datasheet

***preliminary** specification*

1 INTRODUCTION

The new GNS2201 is a high quality but low budget tiny all-in-one GPS module.
GNS2201 consists of a complete GPS engine, input stage with internal LNA and GPS SAW filter, an ARM7 core and all clocks already integrated.
Adding an (passive) Antenna and a connecting a single power supply is sufficient to make it acquire for satellites and find a position solution.

This module is also available with integrated chip antenna (GNS202).



GNS 2201 is based on the advanced new generation MediaTek MT3337 GPS chip. First Fixes after just a few seconds are achieved with the help of A-GPS using EPO™ (Extended Prediction Orbit).

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

The extremely low power design makes it easy to implement this module in power sensitive, battery supplied applications. Very low power requirements (typ 40mW@ 3.3V) and internal switch mode supply regulator makes it easy to run the module with various power supplies and allows direct connection to LiIon batteries.
Further power savings are possible with AlwaysLocate™ power management feature. 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.

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

GNS2201 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 using AIC (active interference canceller). Up to 12 independent channel interference continuous wave jammers can be eliminated or reduced.

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Features

- 66 acquisition-/ 22 tracking channels
- Ultra high tracking/navigation sensitivity: -165dBm
- Extremely fast TTFF at low signal level
- QZSS, SBAS (WAAS,EGNOS,MSAS,GAGAN) or DGPS(RTCM) correction support
- A-GPS by EPO "Extended Prediction Orbit" ™ enables 7/14days prediction
- 12 Multitone Active Interference Canceller (AIC) for GPS-in-band jammer rejection
- AlwaysLocate ™ : Intelligent Algorithm for power saving
- High accuracy 1PPS output
- NMEA-0183 or binary protocol
- Embedded mini logger function (internal NV RAM of 8kB stores up to ~500 datasamples)
- High update rate (up to 5/s)
- GPS consumption current(@3.3V):
  Acquisition: 15mA typical
  Tracking: 12mA typical
- Low backup current consumption 8uA, typical
- Small form factor: 10x9.3x2.0 mm

Applications

- Navigation
  - In-vehicle Navigation equipment
  - Dynamic Navigation
  - Portable ("nomadic") devices
  - Netbooks, tablet PCs and mobile phones
- Timing
  - Precision timing via GPS
- Location based applications
  - GPS Tracker
  - Security devices
  - Camera equipment
  - Geofencing
  - Infrastructure applications

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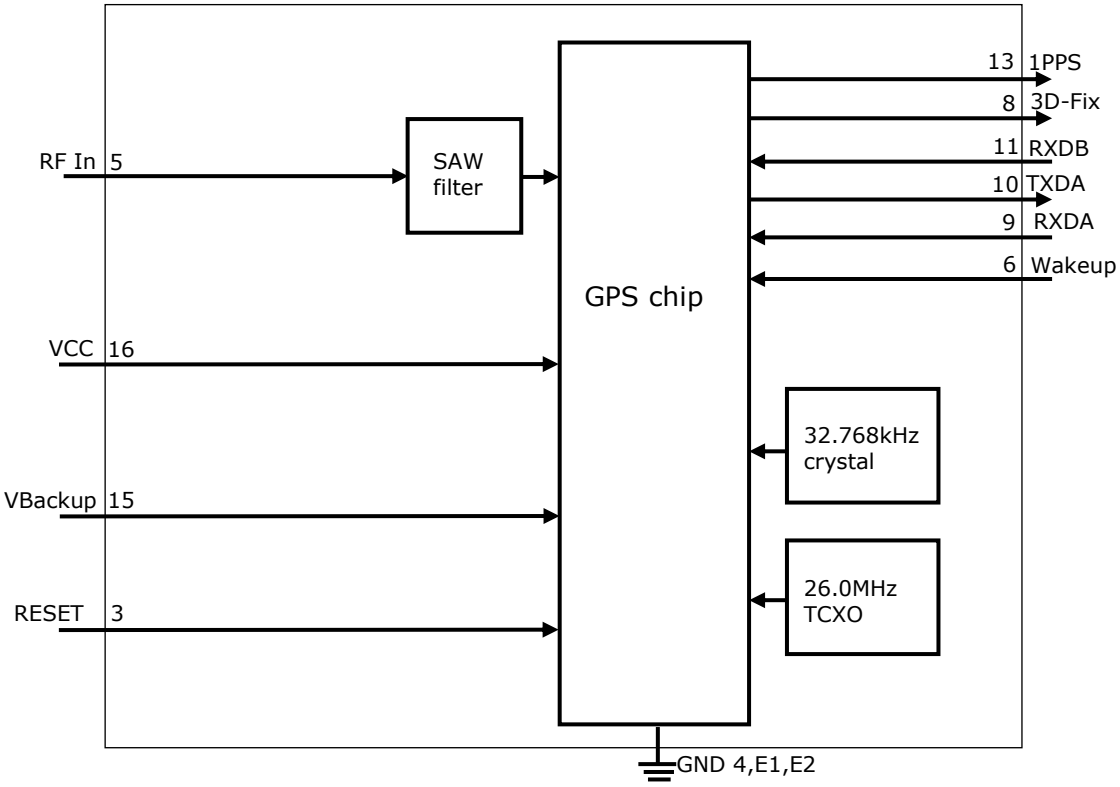
3 FUNCTIONAL DESCRIPTION

3.1 Block diagram



3.2 System description

The GNS2201 core is a high performance, low power GPS receiver that includes an integrated RF frontend.
Due to high input sensitivity it can work directly with a passive antenna.

GNS2201 is a complete GPS engine, including:

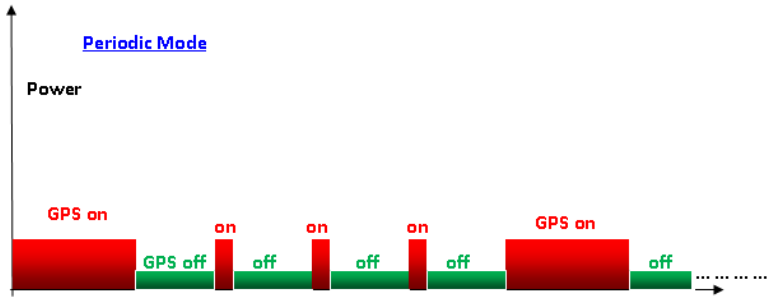
- Full GPS processing without any host processing requirements
- Standard NMEA message output
- A powerful command and control interface
- All clock sources integrated on module
- RF frontend for direct connection of passive or active antennas
- Interfaces for DGPS, PPS, Fix Status Indicator

3.3 Power Management Features

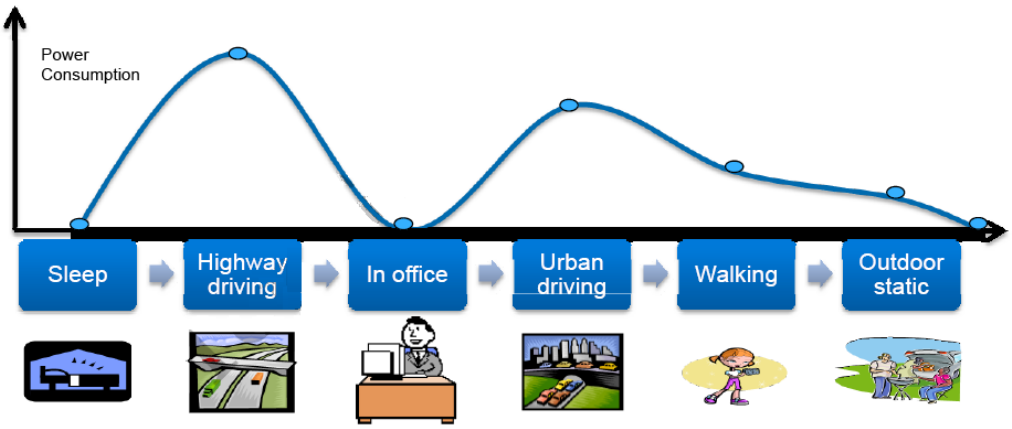
GNS2201 provides full power operation at very low power budget. Further improvement is possible by activating the integrated power saving features.
Selectable Power management features:

- In ***Standby mode*** RF frontend and internal MPU are switched to deep sleep state. Power consumption is reduced to 0.6 mW (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.

- ***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_Vx* for programming details.



- ***AlwaysLocate***™ feature provides an optimized overall GPS system power consumption in tracking mode under open sky conditions. Always Locate is an intelligent control of periodic mode. Depending on the environment and motion conditions, GNS2201 can adjust the on/off time to achieve balance of positioning accuracy and power consumption. The best power saving will be made under good reception in stationary mode. Critical reception conditions and dynamic movements will need full activity of the GPS engine which causes nominal power requirements (12mA typ in tracking mode).



3.4 Logger function

GNS202 provides an autonomous logger function that automatically stores position information in an internal 8kB NVRam memory. This small memory portion allows 500 position measurements to be stored.
A complete tracking unit can be realized without any external CPU or memory.
The parameters for logging are programmable via the NMEA command interface. The following parameter can be set to optimize logging time:

- logger rate

The commands for logger include:

- start logging
- stop logging
- erase memory
- readout memory

please refer to the *GPS NMEA_Interface_manual_MTK_V* for details.

Internal Logger Function					
	Min	Typ	max	unit	
Logger data rate	1/15		1	1/s	
Logger data memory		8		kBytes	Flash memory

3.5 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.
GNS2201 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.

3.6 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 to the module:

1. Check GNS2201 module EPO data for validity by comparing the time. (time parameters for existing 2201 data can be retrieved through a NMEA command)
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 GNS2201 module. please refer to the *NMEA_Interface_manual_MTK_Vx* for details

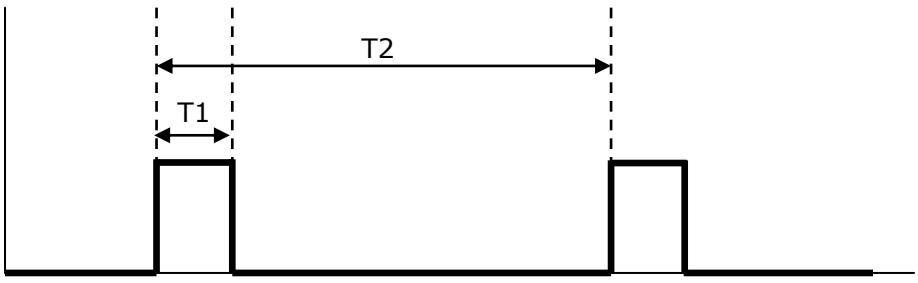
If the host has low memory available, there's no need to save the whole file. The steps 3..5 can be done frame by frame needing less than 2kBytes of buffer memory.

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

3.7 Pulse Per Second (PPS)

GNS2201 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

GNS2201 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 SBAS (Satellite Based Augmentation) support

GNS2201 supports Satellite Based Augmentation for improvement of the navigation precision. Correction data is sent from geostationary satellites to the GPS receiver. GNS2201 supports European, US, and Asian augmentation systems (EGNOS, WAAS, QZSS, 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 *NMEA_Interface_manual_MTK_Vx* for details.

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 GNS2201 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

GNS2201 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)

GNS2201 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 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

GNS2201 core and I/O sections work at 3.3V nominal. Absolute Maximum Ratings should not be exceeded. Should the GNS2201 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 *NMEA_Interface_manual_MTK_Vx* document for details.

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

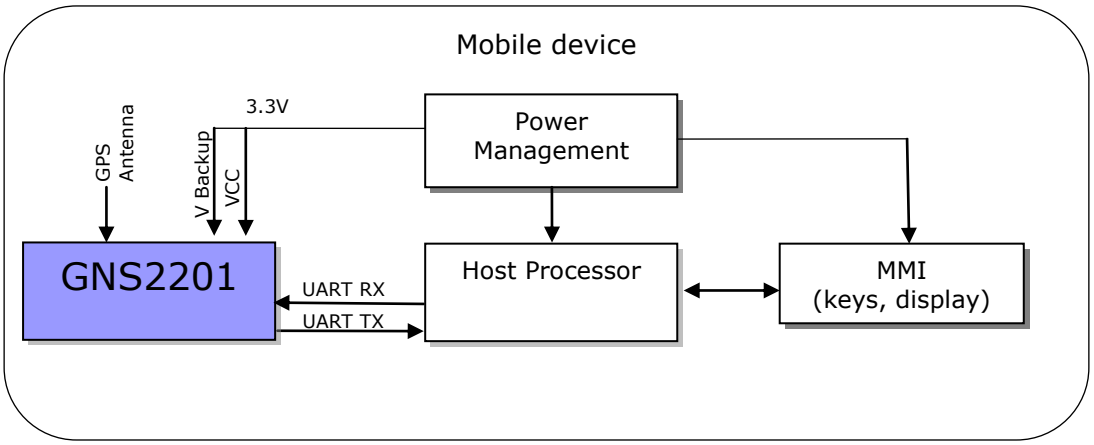
3.13 Module default settings

The GNS2201 module 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.

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
DGPS option	SBAS enabled
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
DGPS	SBAS, enabled
Initial position output	Lat.:90° Lon. : 0°
QZSS,EPO	Enabled
Logger	
Logger mode	Overlap (memory handlesd as a ring buffer, overwrite if full)
Content	Basic (UTC, position)
Memory	Internal 8k NV RAM
Memory size	8kB (500 datasamples)
Mode	Logging if fix available and movement >50m

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
SV Numbers					GPS #1~32
DGPS					SBAS[QZSS,WAAS,EGNOS, MSAS,GAGAN], RTCM
AGPS					Internal processing of predicted orbit data. Service available via ftp. 6hrs prediction interval
Output data frequency	1/1000	1	10	1/sec	Configurable
Navigation&tracking sensitivity		-165	-167	dBm	
Acquisition sensitivity		-148		dBm	autonomous
TTFF hotstart		<1		sec	All SVs @-130dBm
TTFF autonomous cold start		34		sec	All SVs @-130dBm
Number of channels tracking		22			
Number of acquisition channels		66			
Dimension		10x9.3x2.0		mm^3	Tolerance is 0.2 mm
Weight		0.41		g	
Power consumption					
acquisition		15.3*		mA	NMEA frequency = 1/sec*,SBAS enabled, MTAIC enabled, Vdd = 3.3V
tracking		11.9*		mA	NMEA frequency = 1/sec*, SBAS enabled, MTAIC enabled, Vdd=3.3V
Backup current @ 3V		8		µA	

*note: further power savings are possible using AlwaysLocate or periodical modes. Actual possible savings depend on use cases.

Accuracy					
Position error CEP50	-	3	-	m	Without aid
Position error CEP50	-	2.5	-	m	Using (SBAS)
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	

6 DESIGN GUIDELINES

6.1 General

Although GNS2201 GPS module provides best performance 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.
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

6.2 GPS antenna

GNS2201 contains all input circuitry needed to connect a passive GNS antenna directly.
If there is a long wire between GNS2201 RF input and antenna, there should be an LNA (on the antenna side) to compensate for cable losses ("active" antenna).
More information about connecting and implementing a GPS antenna to an application PCB, please refer to *GPS Antenna Design Guide.pdf***.**

7 ELECTRICAL SPECIFICATION

7.1 Absolute Maximum Ratings

Parameter	Value	Unit
Supply voltage: Vcc	–0.5 to 4.3	V
Backup voltage: VBACKUP	–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

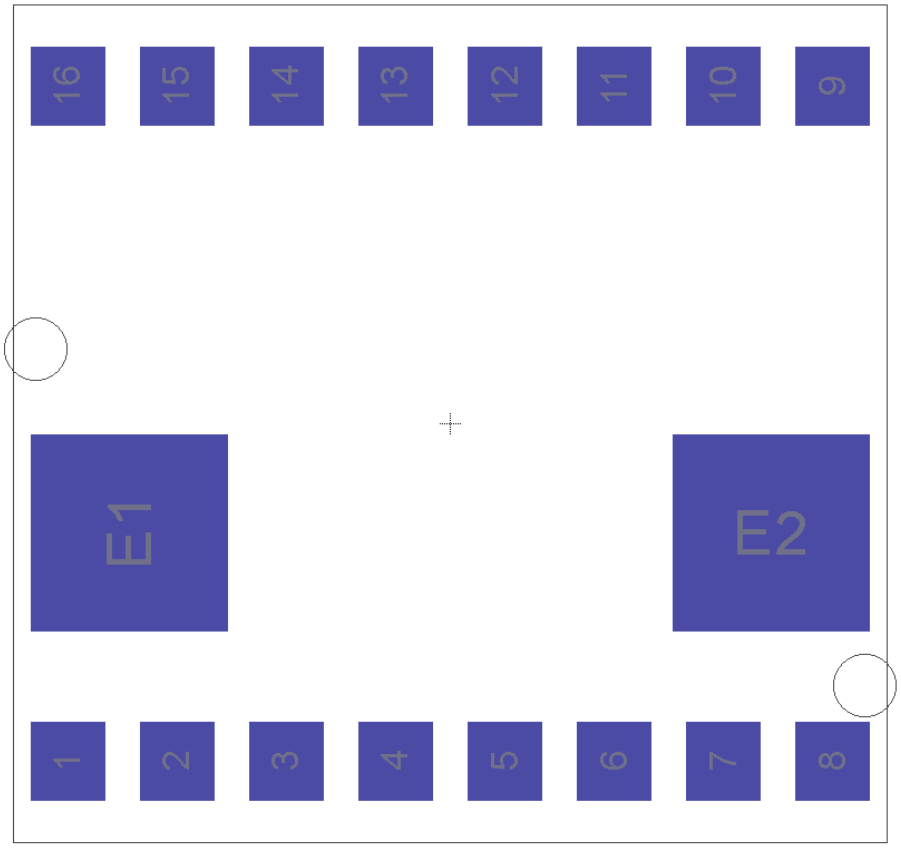
7.2 Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Note
V_{cc}	2.8	3.3	4.3	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
High level output voltage V_{OH}	0.8 * V_{cc}		V_{cc}	V	
Low level output voltage V_{OL}	0		0.2*V_{cc}	V	
High-level input voltage VIH	0.80* V_{cc}		V_{cc}	V	
Low-level input voltage VIL	0		0.2* V_{cc}	V	
Operating temperature	-40		85	°C	Full specified sensitivity

8 DEVICE PINOUT DIAGRAM

8.1 Pin configuration

(TOP view)



8.2 Pin assignment

Pin	Name	I/O	Description & Note
1	NC		Not conected
2	NC		Not conected
3	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.
4	RF_GND	A	RF Ground Ground connection of antenna should be connected at this pin.
5	RF_IN	A	RF input connection forGPS antenna. Supports passive antenna.
6	WAKEUP	I	Wakeup input This pin indicates activity of the GPS and can be used to activate GPS module
7	NC		Not conected
8	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 be low After 2D or 3D Fix The pin will toggle between high and low at a frequency of 1/s **This pin must not be connected to high-level at power-on sequence.**
9	RXA	I	Serial Data Input A for Firmware update 1. This is the UART-A receiver of the module. It is used to receive commands from system
10	TXA	O	Serial Data Output A for NMEA output This is the UART-A transmitter of the module. It outputs GPS information for application.
11	RXB	I	Serial Data Input B This is the UART-B receiver of the module. It is used to receive RTCM data from system
12	NC		Not conected
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.
14	NC		Not conected
15	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 2.8V~4.3V, Typical 3.3V. If VBACKUP 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.**
16	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).
E1	GND	P	Ground
E2	GND	P	Ground

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

9 NMEA DATA interface

GNS2201 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. GNS2201 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.

9.1 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.

9.2 NMEA command interface

GNS2201 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 Vcc or VBACKUP. (f.e. : setting of a new baud rate). After removing Vcc and VBACKUP, all settings are reset to their default values.

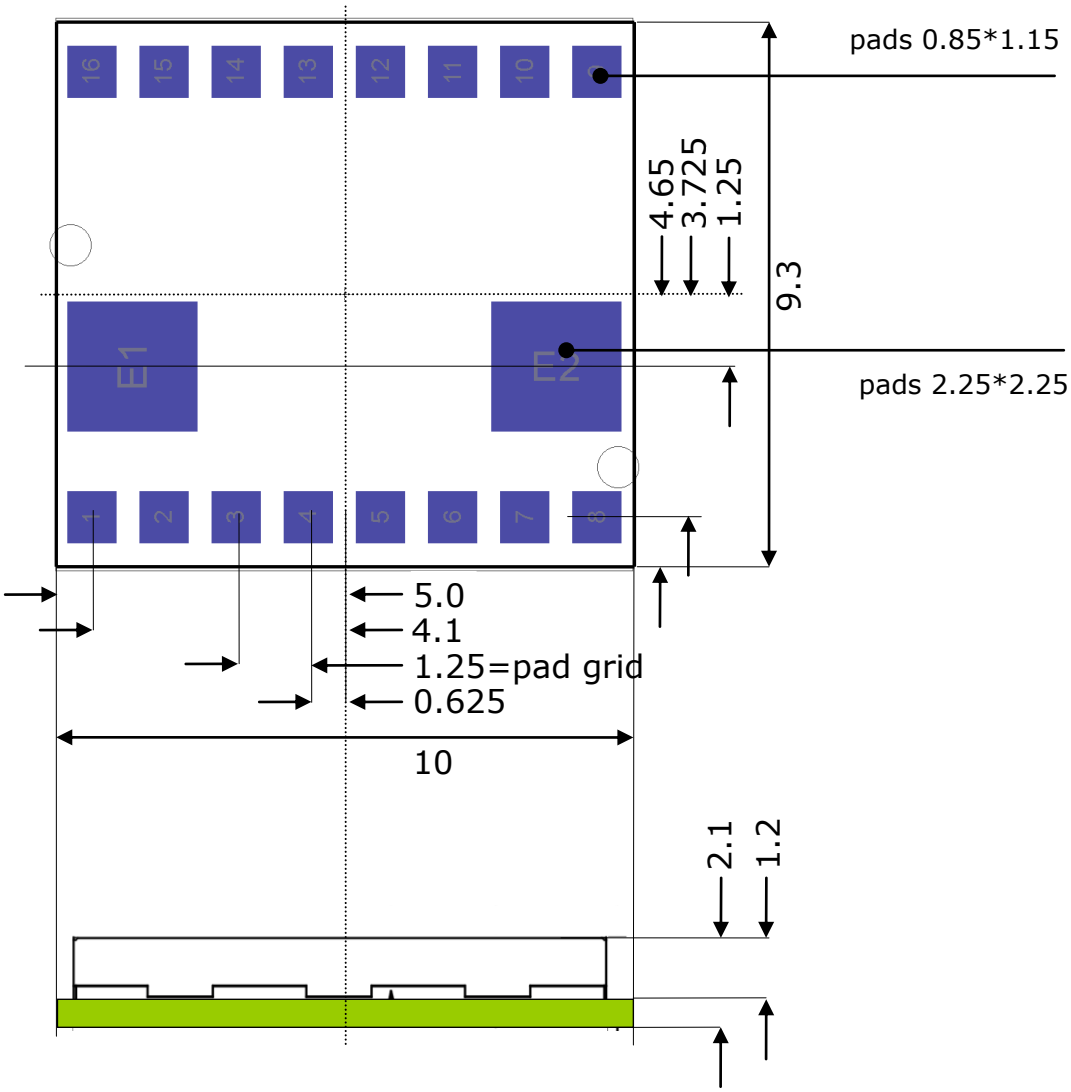
Action commands will perform the specified action one time after the command has been received. (f.e. : request for cold start)

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.

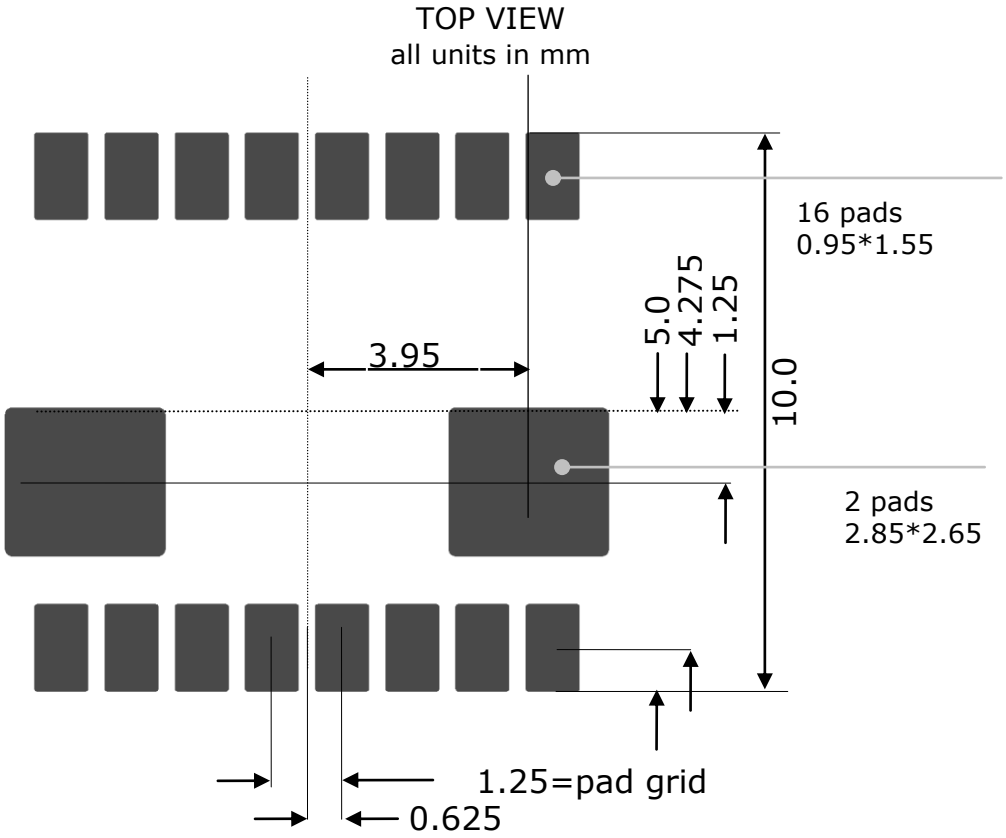
10 PHYSICAL DIMENSIONS

TOP VIEW

all units in mm, tolerance is ±0.2mm



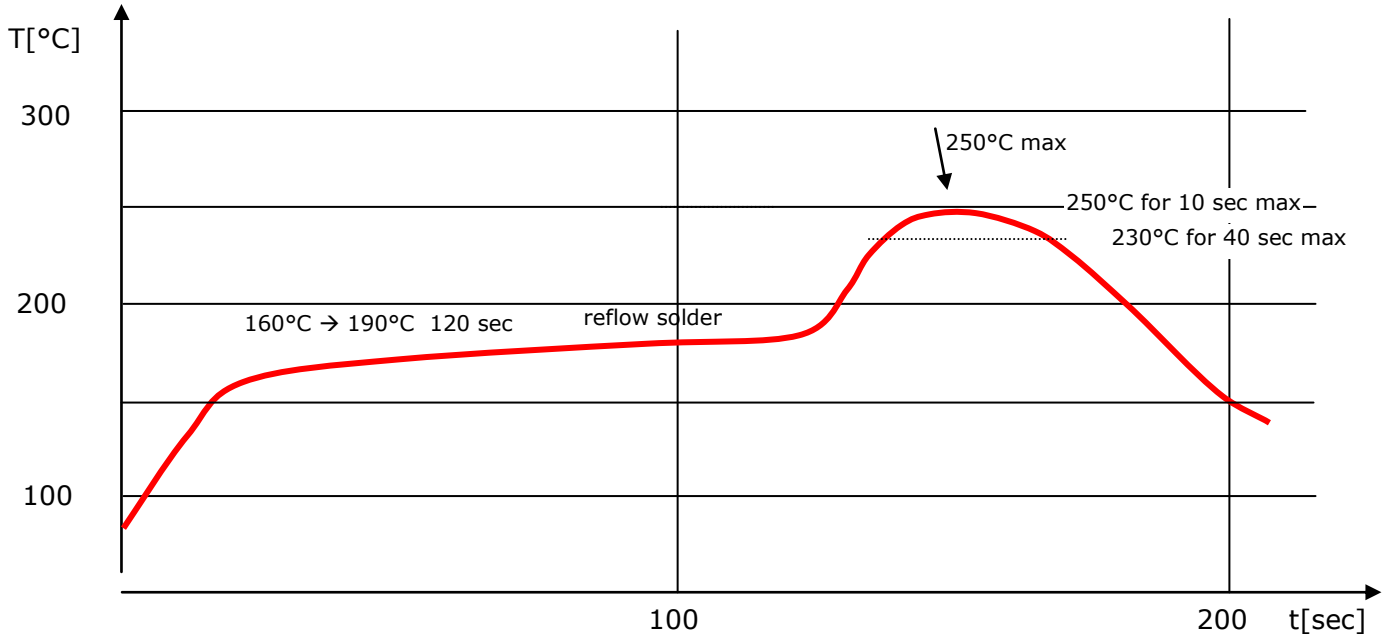
11 RECOMMENDED PAD LAYOUT



12 MATERIAL INFORMATION

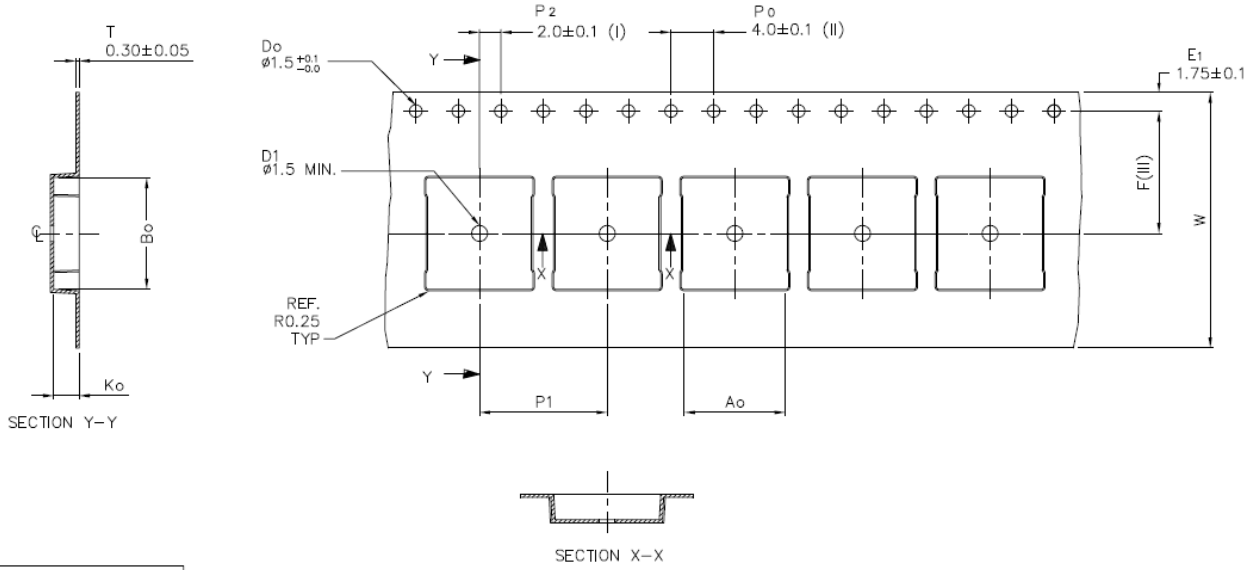
Complies to ROHS standard
ROHS documentations are available on request
Contact surface: gold over nickel

13 RECOMMENDED SOLDERING REFLOW PROFILE



Notes:
1. GNS2201 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / GNS2201 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 not applicable for solder iron process

14 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

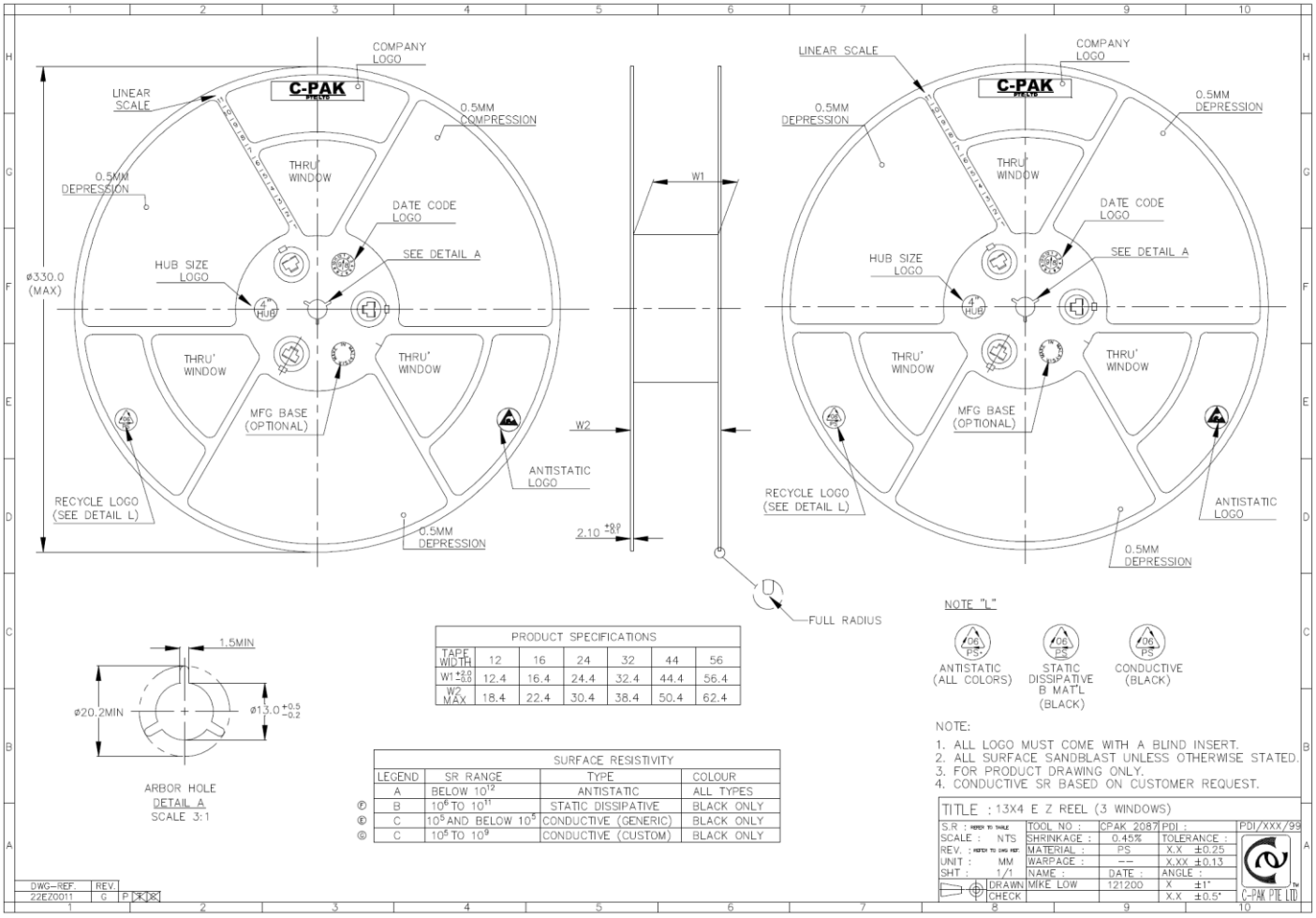
Forming format : Flatbed
Estimated max. length : 60 meter/22B3 reel

(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.

16 REEL INFORMATION

:



PRODUCT SPECIFICATIONS

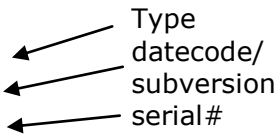
TAPE WIDTH	12	16	24	32	44	56
W1 +2.0 -0.0	12.4	16.4	24.4	32.4	44.4	56.4
W2 MAX	18.4	22.4	30.4	38.4	50.4	62.4

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: 2000pcs/reel

17 ORDERING INFORMATION

Ordering information			
Type	**Part#**	**laser marking**	**Description**
GNS2201	**4037735105287**		GNS2201 GPS module

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

V01	Aug 1st 2014	P.Skaliks	initial preliminary
V11	Oct 24th 2014	P.Skaliks	General review, many corrections

21 RELATED DOCUMENTS

title	**Description / file**		**Available from**
GPS Antenna Connection Design Guide	Design Guide to implement an GPS antenna to an application PCB		www.forum.gns-gmbh.com www.gns-gmbh.com
NMEA_Interface_manual_MTK_Vx	Detailed description of NMEA commands		www.forum.gns-gmbh.com www.gns-gmbh.com
GNS2201 StarterKit user manual	User manual for the GNS2201 receiver based evaluation kit		www.forum.gns-gmbh.com www.gns-gmbh.com

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