ROHS, TS16949, ISO9001

ST702G-25N40

GNSS Receiver Specification

FOR APPROVAL

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Contents

1 Overview

1.1 Description

- ST702G-25N40 is a GNSS receiver build-in high sensitivity chip on board. Featuring U-blox single die high performance and low power consumption positioning engine, ST702G-25N40 provides excellent sensitivity and short TTFF with no host interaction needed. ST702G-25N40 is suitable for vehicle or position devices requiring for high sensitivity and need fast TTFF in weak signal environments. ST702G-25N40 provides maximum sensitivity while maintaining low system power.

- All ST702G-25N40 series use GNSS chips qualified according to AEC-Q100, are manufactured in ISO/TS 16949 certified sites, and fully tested on a system level. Qualification tests are performed as stipulated in the ISO16750 standard: “Road vehicles – Environmental conditions and testing for electrical and electronic equipment”.

1.2 GNSS Features

- UBLOX high sensitivity solution
- 56-Channel u-blox 7 engine
- Supports Assisted GPS Online and offline Operation
- High Sensitivity acquisition , re-acquisition and tracking sensitivity
- Supports standard NMEA-0183 and UBX protocol
- Hybrid GPS/SBAS engine (WAAS, EGNOS, MSAS)
- High immunity to jamming
- Up to 10Hz update rate
- GPS receiver With Patch Antenna
- RoHS Compliant (lead-free)

1.3 Product Applications

- Automotive application
- Positioning devices

1.4 Product Picture

The picture is only for reference and might be changed due to different specific ordering codes.

2 Technical Information

2.1 Supported GNSS Constellations

ST702G-25N40 are GNSS receivers and can singly receive and track GPS (including SBAS and QZSS) and GLONASS signals. QZSS and SBAS signals (by default) can be received concurrently with GPS signals.

2.1.1 GPS

ST702G-25N40 is designed to receive and track the L1 C/A signals provided at 1575.42 MHz by the Global Positioning System (GPS).

2.1.2 GLONASS

ST702G-25N40 can receive and process the GLONASS satellite system as an alternative to the US-based Global Positioning System (GPS). It is designed to receive and track the L1OF signals GLONASS provides at 1602 MHz + k*562.5 kHz, where k is the satellite's frequency channel number (k =–7... 5, 6). The ability to receive and track GLONASS L1OF satellite signals allows design of GLONASS receivers where required by regulations. GLONASS and GPS signals cannot be received and tracked simultaneously by ST702G-25N40 modules.

2.2 Assisted GNSS (A-GNSS)

A-GPS improves GNSS performance by delivering aiding data to the GNSS receiver via wireless networks or the Internet. Supplying information such as ephemeris, almanac, approximate last position, time and satellite status and an optional time synchronization signal significantly reduces Time to First Fix (TTFF) and improves acquisition sensitivity.
AssistNow Online and AssistNow Offline are u-blox' end-to-end A-GPS services for devices with or without network connectivity. AssistNow Online and AssistNow Offline can either be used alone or in combination. They are very easy to implement, require no additional hardware, and generate virtually no CPU load. All ST702G-25N40 modules support u-blox' AssistNow Online, AssistNow Offline and AssistNow Autonomous A-GPS services, and are OMA SUPL compliant.

2.2.1 AssistNow™ Online

With AssistNow Online, an internet-connected GNSS device downloads assistance data from u-blox' AssistNow Online Service at system start-up. AssistNow Online is network operator independent and globally available. U-blox only sends ephemeris data for those satellites currently visible to the device requesting the data, thus minimizing the amount of data transferred.

2.2.2 AssistNow™ Offline

With AssistNow Offline, users download u-blox' Differential Almanac Correction Data from the Internet at their convenience. The correction data can be stored in the memory of the application processor. Therefore, the service requires no connectivity at system start-up and enables a position fix within seconds, even when no network is available.

2.2.3 AssistNow™ Autonomous

AssistNow Autonomous provides functionality similar to Assisted GNSS without the need for a host or external network connection. It is an embedded feature available free-of-charge that accelerates GNSS positioning by capitalizing on the periodic nature of GPS satellite orbits. GPS orbit predictions are directly calculated by the GNSS receiver and no external aiding data or connectivity is required. AssistNow Autonomous can be used alone, or together with AssistNow Online or AssistNow Offline for increased positioning speed and accuracy.

AssistNow™ is Ublox trademark.

2.3 Augmentation Systems

2.3.1 Satellite-Based Augmentation System (SBAS)

The modules support reception of SBAS broadcast signals. These systems supplement GNSS data with additional regional or wide area GPS augmentation data. The system broadcasts range correction and integrity information via satellite which can be used by GNSS receivers to improve resulting precision. SBAS satellites can be used as additional satellites for ranging (navigation), further enhancing availability. The following SBAS types are supported: GAGAN, WAAS, EGNOS and MSAS. For more details see the u-blox 8 / u-blox M8 Receiver Description Including Protocol Specification.

2.3.2 QZSS

The Quasi-Zenith Satellite System (QZSS) is a navigation satellite overlay system for the Pacific region covering Japan and Australia which transmits additional GPS L1C/A signals. u-blox MAX-7 positioning modules are able to receive and to track these signals simultaneously with GPS, resulting in better availability, especially under bad signal conditions e.g. in urban canyons.

2.5 Protocols and interfaces

Protocol	Type
NMEA 0183	Input/output, ASCII, 0183, 2.3 (compatible to 3.0)
UBX	Input/output, binary, u-blox proprietary
RTCM	Input message, 1, 2, 3, 9

Table : Available Protocols

2.6 Clock generation

2.6.1 Oscillators

ST702G-25N40 GNSS modules use TCXO versions which allows accelerated weak signal acquisition, enabling faster start and re-acquisition times rather than crystal versions.

Oscillators used on ST702G-25N40 modules are carefully selected and screened for stability and against frequency perturbations across the full operating range (–40° to +85°C). The careful selection and qualification of critical parts, such as GNSS oscillators, has resulted in GNSS modules being the most reliable positioning modules in the industry, particularly in challenging conditions.

2.6.2 Real-Time Clock (RTC)

The RTC is driven by a 32 kHz oscillator using an RTC crystal. If the main supply voltage fails, parts of the receiver switch off, but the RTC still runs providing a timing reference for the receiver. This operating mode is called Hardware Backup Mode, which enables all relevant data to be saved in the backup RAM to allow a hot or warm start later. A “battery” is integrated in ST702G-25N40 to support the function as backup power supply.

2.7 Power management

ST702G-25N40 offers a power-optimized architecture with built-in autonomous power saving functions to minimize power consumption at any given time. Furthermore, the receiver can be used in two operating modes: Continuous mode for best performance or Power Save Mode for optimized power consumption respectively.

2.7.1 DC/DC converter

The ST702G-25N40 modules integrate a DC/DC converter in the chip, allowing reduced power consumption.

2.7.2 Power Mode Setup

ST702G-25N40 can be configured to run in either continuous or a choice of Power Save mode configurations. A template of power mode settings can be used to easily select typical power mode setups to cover the majority of users’ requirements. For specific power saving applications the user has the option to fully configure via the power save mode configuration.
The modules’ power mode setup offers a choice of continuous operation and preset Power Save
Mode Configurations.

- Continuous (default) mode for best GNSS performance vs power consumption
- Continuous with no compromise in power consumption
- A 1Hz cyclic tracking mode for aggressive power reduction
- Choice of 2 or 4 Hz cyclic tracking modes for typical wearable applications
- ON/OFF interval mode

2.7.3 Continuous Mode

Continuous Mode uses the acquisition engine at full performance resulting in the shortest possible TTFF and the highest sensitivity. It searches for all possible satellites until the Almanac is completely downloaded. The receiver then switches to the tracking engine to lower power consumption.
Thus, a lower tracking current consumption level will be achieved when:

- A valid GNSS position is obtained
- The entire Almanac has been downloaded
- The Ephemeris for each satellite in view is valid

2.7.4 Power save Mode

For specific power saving applications outside the typical preset power mode setups, users can configure a tailored Power Save Mode. Power Save Mode provides two dedicated methods, ON/OFF and Cyclic tracking, that reduce average current consumption in different ways to match the needs of the specific application. Power Save Mode is not available in GLONASS mode. These operations can be set by using a specific UBX message.

3 GNSS Performance

Parameter	Specification			
Receiver type	56-channel u-blox 7 engine GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1 SAIF, GLONASS L1OF			
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns		
Frequency of time pulse signal		0.25 Hz…10 MHz (configurable)		
Operational limits [1]	Dynamics Altitude Velocity	4 g 50,000 m 500 m/s		
Velocity accuracy [2]		0.05m/s		
Heading accuracy [2]		0.3 degrees		
GNSS			**GPS**	**GLONASS**
Horizontal position Accuracy [3]			2.5 m	4 m
Max update rate			10 Hz	10 Hz
Time-To-First-Fix [5]	Cold start Hot start Aided starts [6]		29 s 1 s 5 s	30 s 1 s 2 s
Sensitivity[7]	Tracking & Navigation Re-acquisition Cold start Hot start		–162 dBm –160 dBm –148 dBm –156 dBm	-158 dBm -156 dBm -140 dBm -156 dBm

[1] All satellites at -130 dBm
[2] Dependent on aiding data connection speed and latency
[3] 24 hours static average with good coverage
[4] CEP, 50%, 24 hours static, -130 dBm, > 6 SVs
[5] 50% @ 30 m/s
[6] Assuming Airborne < 4 g platform

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Power Supply Voltage	V^{CC}	0	6.0	V
Serial Port Input Voltage	V^{TTL}	-0.5	3.6	V
ESD Contact	V^{ESD}	-	2000	V
Storage Temperature	T^{S}	-40℃	+85℃	℃

Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage.

These are stress ratings only. The product is not protected against over-voltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

4.2 Electrical characteristics

Characteristics	Symbol	Min	Typ	Max	Units
Power Supply Voltage	V^{CC}	3.0	5.0	5.5	V
Supply Peak Current (Tracking)	I^{T}	-	-	45	mA
Supply Peak Current (Acquisition)	I^{A}	-	-	65	mA
Operation Temperature	T^{O}	-30	+25	+80	℃

All specifications are at an ambient temperature of 25°C. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be

Values in Table are provided for customer information only as an example of typical power requirements. Values are characterized on samples, actual power requirements can vary depending on FW version used, external circuitry, number of SVs tracked, signal strength, type of start as well as time, duration and conditions of test.

5 Antenna

5.1 Antenna placement

Antennas are a critical part of any GNSS receiver design and their importance cannot be stated highly enough. The position of the antenna mounting is crucial for an optimal performance of the GPS receiver. The GPS signal is right-hand circular polarized (RHCP). When using patch antennas, the antenna plane should be parallel to the geographic horizon. The antenna must have full view of the sky ensuring a direct line-of-sight with as many visible satellites as possible. Place the antenna as far away as possible from radiating or jamming signals.

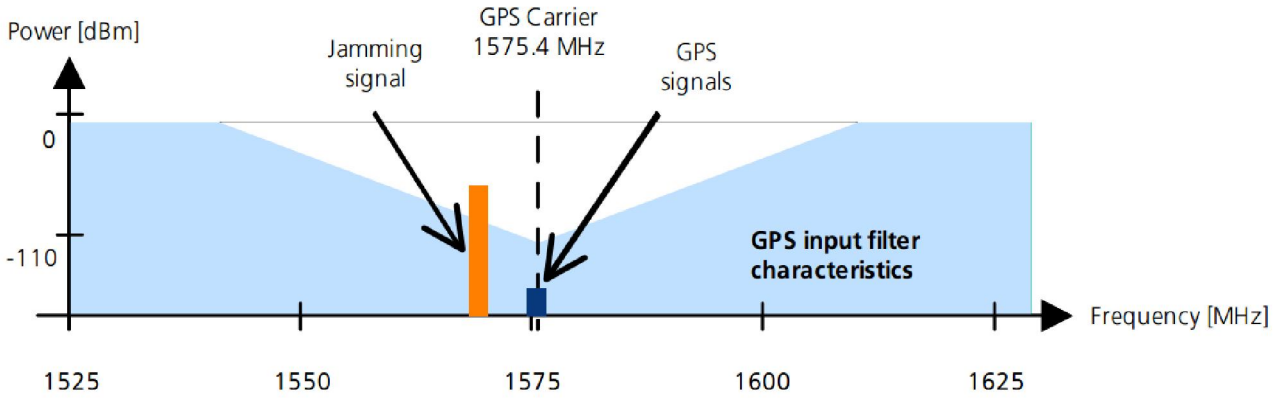
5.2 Antenna Parameters

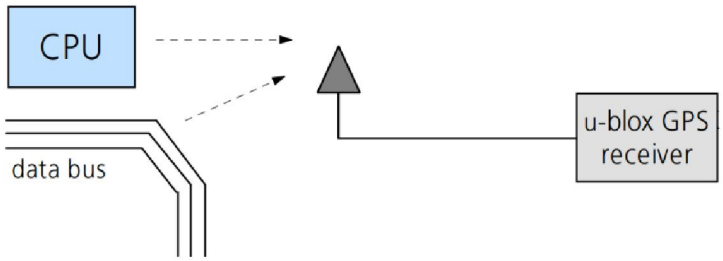
Characteristics	Min	Typ	Max	Units
Range of Receiving Frequency	-	1575.42	-	MHz
Band With(Return loss ≤-10dB)	5	-	-	MHz
V.S.W.R(in Center Frequency)	-	-	1.5	-
Gain(Zenith)	-	2	-	dBi
Axial Ratio	-	-	5	dB
Frequency Temperature Coefficient	-10	0	10	ppm/℃

Jamming signals come from in-band and out-band frequency sources may reduce the performance.

5.3 In-band jamming

With in-band jamming the signal frequency is very close to the GPS frequency of 1575 MHz. Such jamming signals are typically caused by harmonics from displays, micro-controller, bus systems, etc.



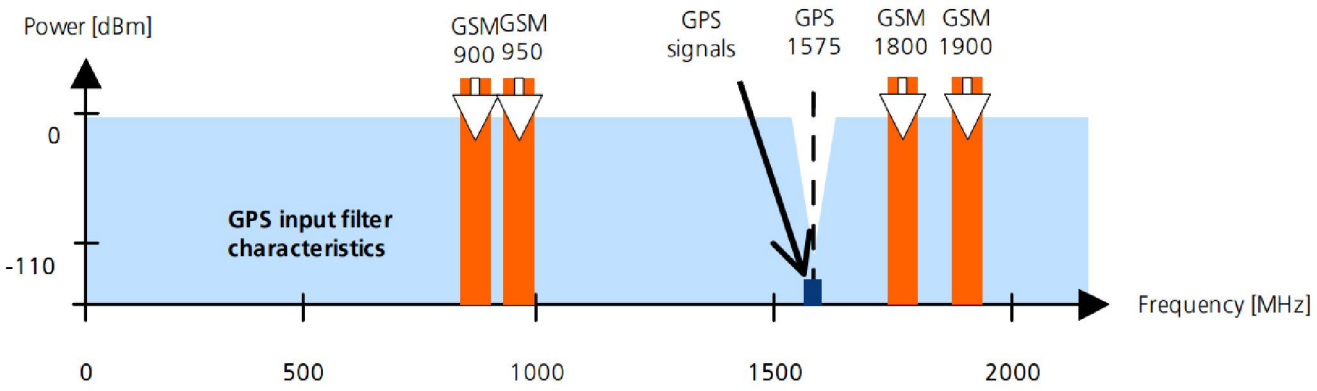


Measures against in-band jamming include:

- Shielding
- Layout optimization
- Filtering
- Placement of the GPS antenna
- Adding a CDMA, GSM, WCDMA band-pass filter before handset antenna

5.4 Out-band jamming

Out-band jamming is typically caused by signal frequencies that are different from the GPS carrier. The sources are usually wireless communication systems such as GSM, CDMA, WCDMA, WiFi, BT, etc..



ST702G-25N40 configured SAW to reduce the out-band jamming by adding SAW filter.

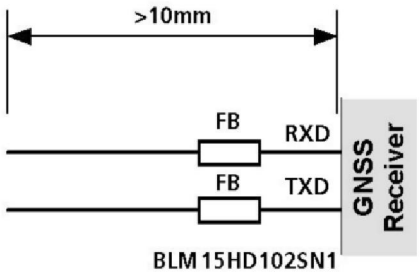
5.5 Electromagnetic interference on I/O lines

Any I/O signal line with a length greater than approximately 3 mm can act as an antenna and may pick up arbitrary RF signals transferring them as noise into the GNSS receiver. This specifically applies to unshielded lines, in which the corresponding GND layer is remote or missing entirely, and lines close to the edges of the printed circuit board.

If, for example, a cellular signal radiates into an unshielded high-impedance line, it is possible to generate noise in the order of volts and not only distort receiver operation but also damage it permanently. On the other hand, noise generated at the I/O pins will emit from unshielded I/O lines. Receiver performance may be degraded when this noise is coupled into the GNSS antenna.

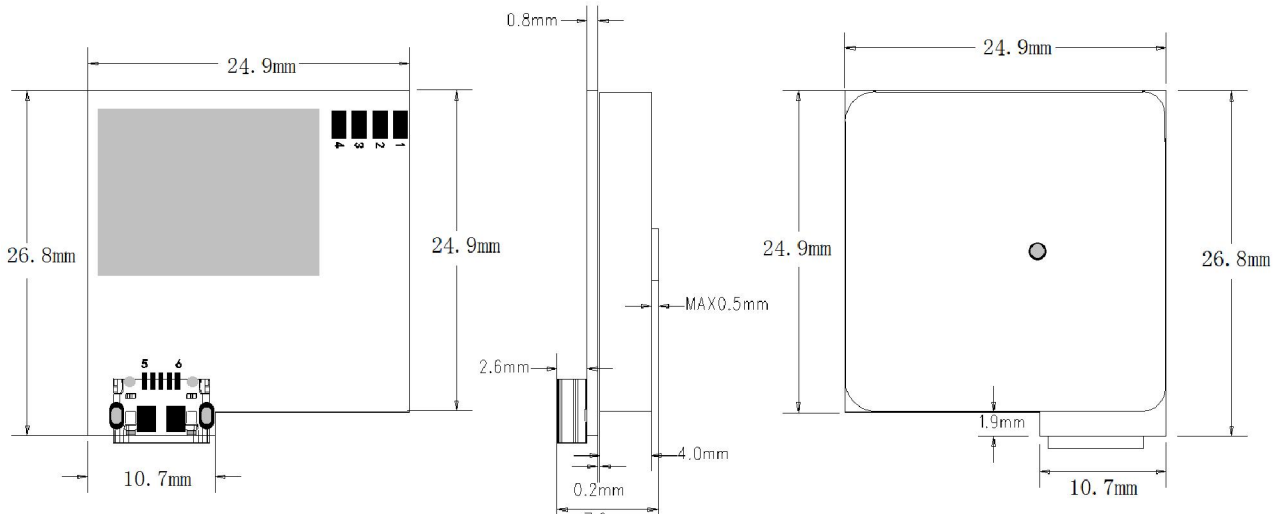
To avoid interference by improperly shielded lines, it is recommended to use resistors (e.g. R>20 W), ferrite beads (e.g. BLM15HD102SN1) or inductors (e.g. LQG15HS47NJ02) on the I/O lines in series. These

components should be chosen with care because they will affect also the signal rise times. The below shows an example of EMI protection measures on the RXD/TXD line using a ferrite bead.



6 Hardware Interface

6.1 Dimensions



Characteristics	Symbol	Min	Typ	Max	Units
Length	L	-	24.9	-	mm
Width	W	-	26.8	-	mm
MAX High	H	-	-	7.9	mm

Tolerance: ±0.3mm

6.2 Definition

※ Type : I (input), O (output), I/O (bidirectional), P (Power), G(Ground)

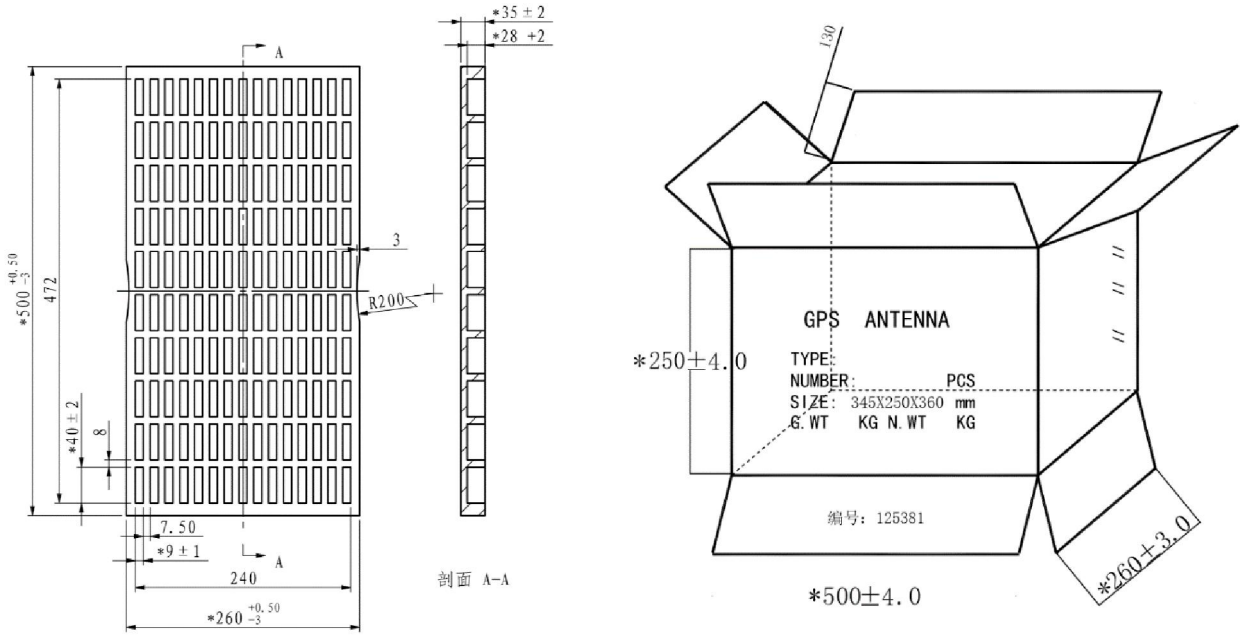
Pin	Name	Type	Pin Description
1	GND	G	Ground
2	VCC	P	Power Supply Voltage (Typ. 5.0V)
3	RXD	I	Serial RX Port (Host to GPS)
4	TXD	O	Serial TX Port (GPS to Host)
5	USB_VCC	P	USB_5V
6	USB_GND	G	GND

7 Product handling & Delivery

7.1 Packaging

ST702G-25N40 are delivered as boxed sealed in order to enable efficient production, production lot set-up and tear-down. MOQ Package number: 150*8=1200 PCS

NO	Part Name	Q,ty / Ctn	Out Size (mm)
1	Box Carton	1/1	500(W)mm×260(D)×250(H)mm
2	Pad Carton	8/1	-
3	Tray	150/1	-



7.2 ESD handling precautions

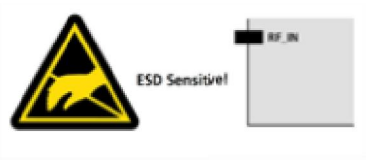
ST702G-25N40 modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GNSS receiver!

GNSS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

Unless there is a galvanic coupling between the local GND (i.e. the work table) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.

Before mounting an antenna patch, connect ground of the device

When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10 pF, coax cable ~50-80 pF/m, soldering iron,)



To prevent electrostatic discharge through the RF input, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non ESD protected work area, implement proper ESD protection measures in the design.

When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron

8 Default messages and Common commands

8.1 Default messages

Interface	Settings
UART Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only the following NMEA (and no UBX) Messages have been activated at start-up **GGA, GLL, GSA, GSV, RMC, VTG, TXT**
UART Input	9600 Baud, 8 bits, no parity bit, 1 stop bit, Auto-bauding disabled Automatically accepts following protocols without need of explicit configuration: UBX, NMEA, RTCM The GNSS receiver supports interleaved UBX and NMEA messages

8.2 Common commands

Function	HEX Commands
Baud rate	9600: B5 62 06 00 14 00 01 00 00 00 D0 08 00 00 80 25 00 00 07 00 07 00 00 00 00 00 A6 CD B5 62 06 00 01 00 01 08 22 115200: B5 62 06 00 14 00 01 00 00 00 D0 08 00 00 00 C2 01 00 07 00 07 00 00 00 00 00 C4 96 B5 62 06 00 01 00 01 08 22
Update rate	1Hz: B5 62 06 08 06 00 E8 03 01 00 01 00 01 39 5Hz: B5 62 06 08 06 00 C8 00 01 00 01 00 DE 6A B5 62 06 08 00 00 0E 30 10Hz : B5 62 06 08 06 00 64 00 01 00 01 00 7A 12 B5 62 06 08 00 00 0E 30
AssistNow Autonomous	B5 62 06 23 28 00 00 00 4C 46 00 00 00 00 00 00 03 10 07 00 00 00 00 00 43 06 00 00 00 00 00 00 01 00 00 78 00 00 00 00 00 00 00 00 00 BF CA
Work mode: GLONASS	B5 62 06 3E 24 00 00 00 16 04 00 04 FF 00 00 00 00 00 01 01 03 00 00 00 00 00 05 00 03 00 00 00 00 00 06 08 FF 00 01 00 00 00 A0 D9 B5 62 06 3E 00 00 42 D2

9 Labeling and Ordering Information

9.1 Product labeling

By default, the labeling of ST702G-25N40 modules is not configured. The reason is for customer EMI/EMC handling or shielding grounding requirement.

9.2 Ordering Information

Module	Description	Default Frequency	Antenna Size	Interface	MAX Height
ST702G-25N40	GNSS Module	GPS	25*25*4 mm	USB-PAD	7.9mm