博盛尚

BROADGNSS

# RAC High Precision Satellite Positioning Receiver Specification

## RAC high precision GNSS receiver

Achieve high-precision satellite positioning without differential stations and ground-based augmentation networks

## Real-time Array Calibration

Product Model:RAC-GRPM1

**Document Revision History**

| Version | Revision Date | Version Description |
|---|---|---|
| V1.0 | 2023/12/01 | New Document |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# Disclaimer

Shenzhen BroadGNSS Technology Co., Ltd. reserves the right to modify this manual at any time without prior notice. The company does not assume any form of warranty and assumes no responsibility for errors contained in this manual or for incidental or consequential damages caused by this manual.

**Table of contents**

## 1. Product Description

### 1.1 Product Overview

**Product Name: RAC-GRPM1 High-precision satellite positioning receiver**

RAC-GRPM1 High Precision Satellite Positioning Receiver Appearance

This product is a G-MOUSE-like satellite receiver, a complete GPS satellite positioning receiver, with an integrated satellite receiving antenna. It features full-range high-precision positioning capabilities, with positioning accuracy reaching dynamic levels of less than 1.5 meters. It meets the strict requirements of industrial-grade positioning while also satisfying personal usage needs.

Through technological innovation, this product offers two core competitive advantages: it does not require differential stations and does not use L2 or B3 precise signals, which significantly reduces its cost. Unlike traditional high-precision satellite positioning technologies, our solution does not rely on differential technology, drastically lowering costs. This is our most important advantage, positioning our product ahead of similar global offerings.

This product is characterized by high precision, high sensitivity, low power consumption, and compact size. Its extremely high tracking sensitivity greatly extends its positioning coverage area.

### 1.2 Product Features

RS232 Output: Faster application integration.

KDS 0.5PPM High-Precision TCXO: Ensures stable and accurate time performance.

Data Output Rate and Frequency: 115200bps, 10Hz.

Output Protocol: UBX protocol.

Custom-Designed Antenna Resonator: Ensures the phase center and geometric center are aligned, minimizing the impact of antenna measurement errors.

GPS, BD, GLONASS Hybrid Engine: Selectable for enhanced positioning accuracy.

Lead-Free Manufacturing: Complies with RoHS standards.

### 1.3 Certification Testing

Positioning Chip: AEC-Q100 certified, ensuring automotive-grade quality and reliability.

Positioning Module: Passed ISO16750 testing, meeting automotive environmental and performance standards.

Positioning Product: Passed ISO7637 testing, ensuring immunity to electrical disturbances in automotive environments.

Production Line: Complies with ISO/TS-16949 certification, ensuring high-quality manufacturing processes in the automotive industry.

### 1.4 Application

Applied in vehicle navigation and law enforcement equipment, as well as other portable devices.

Used in trajectory tracking products for drones and vehicle anti-theft systems.

Applied in surveying products for area and distance measurement.

High-precision positioning applications in shared electric bikes, shared cars, etc.

High-precision applications in the agricultural plant protection machinery field.

Used in synchronization, UTC, timekeeping, and time calibration fields.

Lane-level trajectory recording and GPS data point calibration applications.

### 1.5 Performance Indicators

| | | |
|---|---|---|
| Sensitivity | track | - 165dBm |
| | capture | - 148dBm |
| TTFF (Time to First Fix) | Cold Start | average28S(Open Sky) |
| | Warm start | Average<5S |
| | Hot Start | Average<1S |
| Type | 22 Tracking channels, 56 Capture channels | |
| | Frequency GPS L1 1575.42MHz BDS B1 1561.75MHz C/Acode | |
| Positioning accuracy | - | Static |
| | <1.5m | dynamic |
| | Coordinate system | Coordinate basis:WGS-84 |
| Speed accuracy | 0.1m/s | |

| | | |
|---|---|---|
| Update rate | 10HZ | |
| PPS | 100ms（1pps=1Hz=1times/second) | |
| Operational restrictions | High | <18000m |
| | Speed | <100m/s |
| | Acceleration | <8g |
| Data Format | UBX protocol, 115200 Baud rate, Refresh rate 10HZ | |

Power Specifications

| | |
|---|---|
| Power supply | DC 12V |
| Working current | 30mA |
| Functional Interface | RS 232 |

Physical properties

| | | |
|---|---|---|
| Temperature | Operating temperature | - 30℃~80℃ |
| | Storage temperature | - 40℃~85℃ |

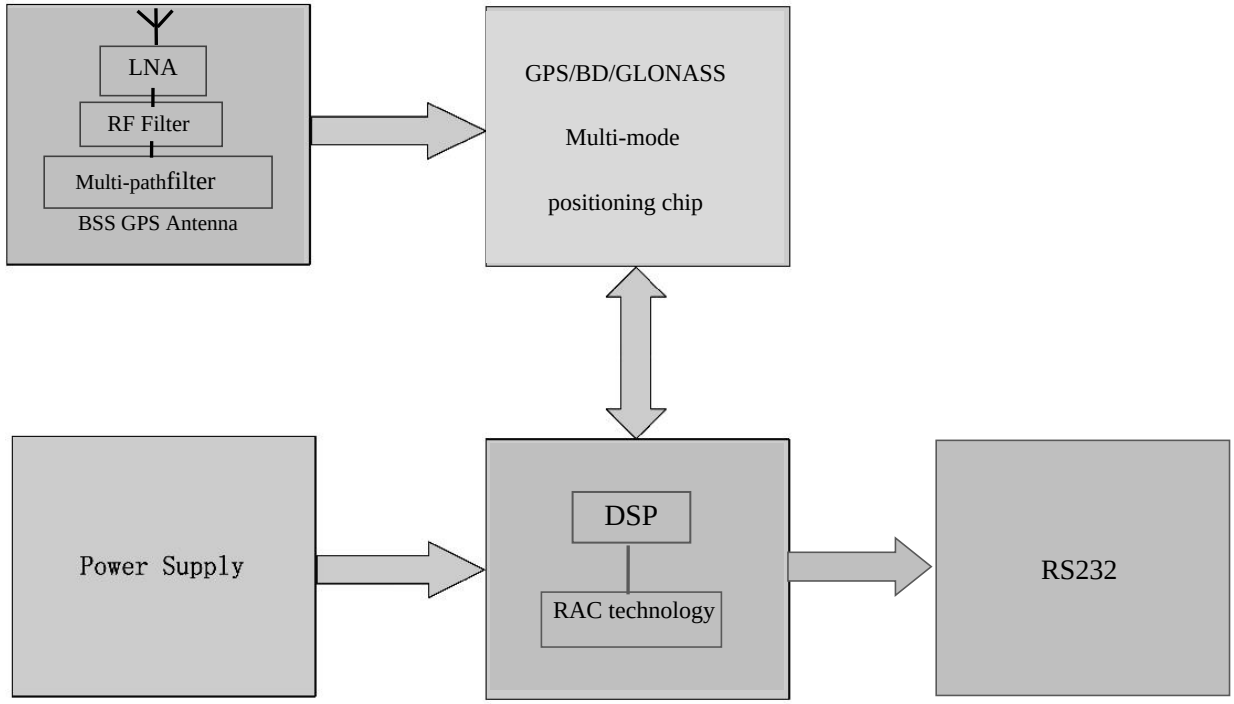
### 1.6 Product port definition

Connectors:AMP/TEAMP connector, connector model:282089-1

| Pin NO. | Pin Name | I/O | Remark |
|---|---|---|---|
| 1 | VCC | Power supply | DC 12 V |
| 2 | TX | Output | RS232Serial port |
| 3 | RX | Enter | RS232 Serial port receiving |
| 4 | PPS | Output | PPS Pulse Per Second |
| 5 | GND | Land | land |

Port Definition

### 1.7 Functional Block Diagram




The RAC-GRPM1 positioning receiver uses a high-precision antenna and independently developed antenna oscillators to minimize the impact of the antenna on measurement errors. The antenna receives satellite signals in the air and transmits them to the chip RF unit, which transmits the signals to the chip baseband unit. After a series of analysis, high-precision positioning data is output through the RS232 interface.

### 1.8 Product size

Shell size: Diameter80mm*high15mm

Bottom case screws: diameter16mm*high10mm


## 2. Output Statement

### 2.1 Output Statement

#### 2.1.1 UBXprotocol

The UBX protocol is a proprietary protocol from u-blox, and it has the following key features:

Compact: It uses 8-bit binary data.
Checksum protection: It employs a low-overhead checksum algorithm.
Modular: It uses a two-stage message identifier (Class and Message ID).

The UBX protocol packet structure, as shown in the figure, is composed of three parts: the frame header, data, and checksum. From the diagram, we can observe the following:

Frame Header: Consists of two bytes: 0xB5 0x62. These bytes identify the beginning of a UBX protocol data transmission.
CLASS: One byte, indicating the category of the message (e.g., a test data message).
ID: One byte, representing a specific parameter output under a given CLASS.
LENGTH: Indicates the length of the data section (i.e., the number of bytes).
CK_A and CK_B: Two checksum bytes that validate the data from CLASS to the Payload section.

| SYNC Char1 | SYNCChar2 | CLASS | ID | LENGTH (little endian) | PayLoad | CK_A | CK_B |
|---|---|---|---|---|---|---|---|

The following introduces the commonly used UBX data packets.

### 1. UBX-NAV-POSLLH (0x01 0x02)

| Message | NAV-POSLLH | | | | | |
|---|---|---|---|---|---|---|
| Description | Geodetic Position Solution | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x02 | 28 | see below | CK_A CK_B |

| Payload Contents: | | | | | |
|---|---|---|---|---|---|
| Byte Offset | Number Format | Scaling | Name | Unit | Description |
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | I4 | 1e-7 | lon | Deg | Longitude |
| 8 | I4 | 1e-7 | lon | Deg | Latitude |
| 12 | I4 | - | height | mm | Height above ellipsoid |
| 16 | I4 | - | oeLh | mm | Height above mean sea level |
| 20 | U4 | - | Hc | mm | Horizontal accuracy estimate |
| twenty four | U4 | - | vv | mm | Vertical accuracy estimate |

### 2. UBX-NAV-STATUS (0x01 0x03)

| Message | NAV-STATUS | | | | | |
|---|---|---|---|---|---|---|
| Description | Receiver Navigation Status | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x03 | 16 | see below | CK_A CK_B |

| Payload Contents: | | | | | |
|---|---|---|---|---|---|
| Byte Offset | Number Format | Scaling | Name | Unit | Description |

| | | | | | |
|---|---|---|---|---|---|
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | U1 | - | gpsFix | - | GPSfix Type, this value does not qualify a fix as<br>valid and within the limits. See note on flag<br>gpsFixOk below.<br>0x00 = no fix<br>0x01 = dead reckoning only<br>0x02 = 2D-fix<br>0x03 = 3D-fix<br>0x04=GPS+dead reckoning combined<br>0x05 = Time only fix<br>0x06..0xff = reserved |
| 5 | X1 | - | flags | - | Navigation Status Flags |
| 6 | X1 | - | fixStat | - | Fix Status Information |
| 7 | X1 | - | flags2 | - | further information about navigation output |
| 8 | U4 | - | ttff | ms | Time to first fix (millisecond time tag) |
| 12 | U4 | - | msss | mm | Milliseconds since Startup/Reset |

### 3. UBX-NAV-DOP (0x01 0x04)

| Message | NAV-DOP | | | | | |
|---|---|---|---|---|---|---|
| Description | Dilution of precision | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x04 | 18 | see below | CK_A CK_B |
| Payload Contents: | | | | | | |

| Byte Offset | Number Format | Scaling | Name | Unit | Description |
|---|---|---|---|---|---|
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | U2 | 0.01 | gDOP | - | Geometric DOP |
| 6 | U2 | 0.01 | pDOP | - | Position DOP |
| 8 | U2 | 0.01 | TDOP | - | Time DOP |
| 10 | U2 | 0.01 | vDOP | - | Vertical DOP |
| 12 | U2 | 0.01 | HkDOP | - | Horizontal DOP |
| 14 | U2 | 0.01 | nDOP | - | Northing DOP |
| 16 | U2 | 0.01 | eDOP | - | Easting DOP |

### 4. UBX-NAV-SOL (0x01 0x06)

| Message | NAV-SOL | | | | | |
|---|---|---|---|---|---|---|
| Description | Navigation Solution Information | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x06 | 52 | see below | CK_A CK_B |

Payload Contents:

| Byte Offset | Number Format | Scaling | Name | Unit | Description |
|---|---|---|---|---|---|
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | I4 | - | f | ns | Fractional part of iTOW (range: +/-500000). The precise GPS time of week in seconds is: (iTOW * 1e-3) + (fTOW * 1e-9) |
| 8 | I2 | - | week | weeks | GPS week number of the navigation epoch |
| 10 | U1 | - | gpsFix | - | GPSfix Type, range 0..5 0x00 = No Fix |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 0x01 = Dead Reckoning only<br>0x02 = 2D-Fix<br>0x03 = 3D-Fix<br>0x04 = GPS + dead reckoning combined<br>0x05 = Time only fix<br>0x06..0xff: reserved |
| 11 | X1 | - | flags | - | Fix Status Flags |
| 12 | I4 | - | eX | cm | ECEF X coordinate |
| 16 | I4 | - | eCE | cm | ECEF Y coordinate |
| 20 | I4 | - | eCEf | cm | ECEF Z coordinate |
| twenty four | U4 | - | pAcc | cm | 3D Position Accuracy Estimate |
| 28 | I4 | - | xvX | cm/s | ECEF X velocity |
| 32 | I4 | - | VxD | cm/s | ECEF Y velocity |
| 36 | I4 | - | VxD | cm/s | ECEF Z velocity |
| 40 | U4 | - | sAcc | cm/s | Speed Accuracy Estimate |
| 44 | U2 | 0.01 | pDOP | - | Position DOP |
| 46 | U1 | - | Reserved1 | - | Reserved |
| 47 | U1 | - | numSV | - | Number of SVs used in Nav Solution |

**5. UBX-NAV-PVT (0x01 0x07)**

| Message | NAV-PVT | | | | | |
|---|---|---|---|---|---|---|
| Description | Navigation Position Velocity Time Solution | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x07 | 92 | see below | CK_A CK_B |
| Payload Contents: | | | | | | |
| Byte | Number | Scalin | Name | Unit | Description | |

| Offset | Format | g | | | |
|---|---|---|---|---|---|
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | U2 | - | year | y | Year (UTC) |
| 6 | U1 | - | month | month | Month, range 1..12 (UTC) |
| 7 | U1 | - | day | d | Day of month, range 1..31 (UTC) |
| 8 | U1 | - | hour | h | Hour of day, range 0..23 (UTC) |
| 9 | U1 | - | min | min | Minute of hour, range 0..59 (UTC) |
| 10 | U1 | - | sec | s | Seconds of minute, range 0..60 (UTC) |
| 11 | X1 | - | valid | - | Validity flags (see graphic below) |
| 12 | U4 | - | tAcc | ns | Time accuracy estimate (UTC) |
| 16 | I4 | - | nano | ns | Fraction of second, range -1e9 .. 1e9 (UTC ) |
| 20 | U1 | - | fixType | - | GNSSfix Type:<br>0: no fix<br>1: dead reckoning only<br>2: 2D-fix<br>3: 3D-fix<br>4: GNSS + dead reckoning combined 5: time only fix |
| 21 | X1 | - | Flags | - | Fix status flags |
| 22 | X1 | - | flags2 | | Additional flags |
| 23 | U1 | - | numSV | - | Number of satellites used in Nav Solution |
| 24 | I4 | 1e-7 | lon | deg | Longitude |
| 28 | I4 | 1e-7 | lat | deg | Latitude |
| 32 | I4 | - | height | mm | Height above ellipsoid |
| 36 | I4 | - | oeLh | mm | Height above mean sea level |

| | | | | | |
|---|---|---|---|---|---|
| 40 | U4 | - | Hc | mm | Horizontal accuracy estimate |
| 44 | U4 | - | vv | mm | Vertical accuracy estimate |
| 48 | I4 | - | Nv | mm/s | NED north velocity |
| 52 | I4 | - | ewE | mm/s | NED east velocity |
| 56 | I4 | - | D | mm/s | NED down velocity |
| 60 | I4 | - | gSpeed | mm/s | Ground Speed (2-D) |
| 64 | I4 | 1e-5 | headMot | deg | Heading of motion (2-D) |
| 68 | U4 | - | sAcc | mm/s | Speed accuracy estimate |
| 72 | U4 | 1e-5 | headAcc | deg | Heading accuracy estimate (both motion and vehicle) |
| 76 | U2 | 0.01 | pDOP | - | Position DOP |
| 78 | U1[6] | - | reserved1 | - | Reserved |
| 84 | I4 | 1e-5 | headVeh | deg | Heading of vehicle (2-D) |
| 88 | I2 | 1e-2 | magDec | deg | Magnetic declination |
| 90 | U2 | 1e-2 | magAcc | deg | Magnetic declination accuracy |

### 6. UBX-NAV-VELNED (0x01 0x12)

| Message | NAV-VELNED | | | | | |
|---|---|---|---|---|---|---|
| Description | Velocity Solution in NED | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x12 | 36 | see below | CK_A CK_B |
| Payload Contents: | | | | | | |
| Byte Offset | Number Format | Scaling | Name | Unit | Description | |
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. | |
| 4 | I4 | - | Nv | cm/s | North velocity component | |

| | | | | | |
|---|---|---|---|---|---|
| 8 | I4 | - | ewE | cm/s | East velocity component |
| 12 | I4 | - | D | cm/s | Down velocity component |
| 16 | U4 | - | speed | cm/s | Speed (3-D) |
| 20 | U4 | - | gSpeed | cm/s | Ground speed (2-D) |
| twenty four | I4 | 1e-5 | heading | deg | Heading of motion 2-D |
| 28 | U4 | - | sAcc | cm/s | Speed accuracy Estimate |
| 32 | U4 | 1e-5 | cC | deg | Course/Heading accuracy estimate |

## 7. UBX-NAV-SAT (0x01 0x35)

| Message | NAV-SAT | | | | | |
|---|---|---|---|---|---|---|
| Description | Satellite Information | | | | | |
| Message Structure | Header | Class | ID | Length (Bytes) | Payload | Checksum |
| | 0xB5 0x62 | 0x01 | 0x35 | 8+12*numxD | see below | CK_A CK_B |

Payload Contents:

| Byte Offset | Number Format | Scaling | Name | Unit | Description |
|---|---|---|---|---|---|
| 0 | U4 | - | iTOW | ms | GPS time of week of the navigation epoch. |
| 4 | U1 | - | version | - | Message version (1 for this version) |
| 5 | U1 | - | numSvs | - | Number of satellites |
| 6 | U2 | - | reserved1 | - | Reserved |
| 8 + 12*N | U1 | - | gnssId | - | GNSS identifier for assignment |
| 9 + 12*N | U1 | - | svId | - | Satellite identifier for assignment |
| 10+ 12*N | U1 | - | cno | dBHz | Carrier to noise ratio (signal strength) |
| 11+ 12*N | I1 | - | elev | deg | Elevation (range: +/-90), unknown if out of range |
| 12+ 12*N | I2 | - | azim | deg | Azimuth(range 0-360), unknown if elevation is out of range |

| | | | | | |
|---|---|---|---|---|---|
| 14+ 12*N | I2 | 0.1 | prRes | m | Pseudo range residual |
| 16+ 12*N | X4 | - | flags | - | Bitmask |

## 2.2 Reference Program

### 2.2.1 UBXProtocol Verification Reference Program

```
//fromCLASSarrivePayLoadAll data
unsigned int CalcCheckAB(unsigned char *Bytes, unsigned char len) {

        unsigned char i,a,b ;
        unsigned int result;
result = 0;
a = 0;
b = 0;
    for ( i = 0; i < len ; i++) {

a+=Bytes[i];
b+=a;
    }
result = a<<8|b;
return result;
}
```

## 3. Contact Us

Shenzhen BroadGNSS Technology Co., Ltd.

BroadGNSS Technology Co.,Ltd.

Contact: Mr. Li Mobile phone: 18988798557 QQ: 843570942

Address: Room 402, Shengye Space, No. 52, Tiezai Road, Bao'an District, Shenzhen