

# SGP501 Protocol

## Abstract

This document defines the data input and output protocols for the SGP501 product.

© 2025 Pinnobot. All rights reserved.

By accessing or using this document, you agree to comply with the Pinnobot Confidentiality Agreement.

## Revision History

| Version | Date    | Description                                         |
|---------|---------|-----------------------------------------------------|
| 1       | 2023.09 | First edition of the SPG501 data protocol           |
| 2       | 2023.12 | Added separate configuration for PBSOL              |
| 3       | 2024.02 | Added configuration for low-speed vehicle platforms |
| 4       | 2024.08 | Added configuration for dual-antenna installation   |

### Disclaimer:

This protocol may be updated or improved without widespread notice. To safeguard your interests, please contact our support team or your vendor to ensure you have the latest version of this protocol.

Pinnobot respects intellectual property rights. To the best of our knowledge, the contents of this document do not infringe upon any third-party intellectual property. We assume no liability for any infringement arising from improper use. We will not provide support to third parties engaged in intellectual property infringement. The contents of this document are considered trade secrets. Authorized users are prohibited from disclosing any information contained herein in any form. Any reproduction, citation, or redistribution, in whole or in part, constitutes an infringement. Nothing in this document implies, defaults to, or grants any transfer of Pinnobot's patents, trademarks, copyrights, ownership, or any associated rights or licenses.

This product is not intended for use in applications related to human life or safety.

## Contents

|     |                                               |    |
|-----|-----------------------------------------------|----|
| 1.  | Output Messages .....                         | IV |
| 1.1 | NMEA .....                                    | IV |
| 1.2 | Proprietary Navigation Result -- \$PBSOL..... | IV |
| 1.3 | Proprietary IMU -- \$PSNSR,21 .....           | V  |
| 2.  | Configuration Command .....                   | VI |

## 1. Output Messages

Messages are in ASCII format. Two types: NMEA and custom format.

### 1.1 NMEA

GGA, RMC, GSA, GSV – format omitted

### 1.2 Proprietary Navigation Result -- \$PBSOL

| Field Name                  | Field Type | Description                                                                                                                                                                                                                                                                  |
|-----------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Message Name                | —          | \$PBSOL                                                                                                                                                                                                                                                                      |
| Message Sub-Name            | Integer    | 0x01                                                                                                                                                                                                                                                                         |
| UTC Year                    | Integer    |                                                                                                                                                                                                                                                                              |
| UTC Month                   | Integer    |                                                                                                                                                                                                                                                                              |
| UTC Day                     | Integer    |                                                                                                                                                                                                                                                                              |
| UTC Hour                    | Integer    |                                                                                                                                                                                                                                                                              |
| UTC Minute                  | Integer    |                                                                                                                                                                                                                                                                              |
| UTC Millisecond             | Integer    |                                                                                                                                                                                                                                                                              |
| Sensor Time                 | Integer    | Unit: milliseconds                                                                                                                                                                                                                                                           |
| GPS Week                    | Integer    | GPS week                                                                                                                                                                                                                                                                     |
| Week Seconds                | Integer    | Week seconds, unit: milliseconds                                                                                                                                                                                                                                             |
| Positioning Mode            | Integer    | Value 0x00: Invalid positioning<br>Bit 0: Reserved<br>Bit 1: GNSS only<br>Bit 2: IMU only<br>Bit 3: Combined positioning<br>Bits 4–11: Reserved<br>Bit 12: DGNSS<br>Bit 13: RTK fixed solution<br>Bit 14: RTK float solution<br>Bit 16: PPP solution<br>Bits 15–31: Reserved |
| Latitude                    | Double     | Unit: degrees, 8 decimal places                                                                                                                                                                                                                                              |
| Longitude                   | Double     | Unit: degrees, 8 decimal places                                                                                                                                                                                                                                              |
| Ellipsoid Height            | Double     | Unit: meters, 3 decimal places                                                                                                                                                                                                                                               |
| Height Above Mean Sea Level | Double     | Unit: meters, 3 decimal places                                                                                                                                                                                                                                               |
| North Velocity              | Integer    | Unit: cm/s                                                                                                                                                                                                                                                                   |
| East Velocity               | Integer    | Unit: cm/s                                                                                                                                                                                                                                                                   |
| Vertical Velocity           | Integer    | Unit: cm/s                                                                                                                                                                                                                                                                   |
| Ground Speed                | Integer    | Unit: cm/s                                                                                                                                                                                                                                                                   |

|                            |         |                                                                                                 |
|----------------------------|---------|-------------------------------------------------------------------------------------------------|
| Travelled Distance         | Integer | Unit: cm                                                                                        |
| Roll Angle                 | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Pitch Angle                | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Heading Angle              | Integer | Unit: degrees (0–360), scaled $\times 100$                                                      |
| Reserved Field             | Integer |                                                                                                 |
| Reserved Field             | Integer |                                                                                                 |
| North Position Error       | Integer | Unit: cm                                                                                        |
| East Position Error        | Integer | Unit: cm                                                                                        |
| Vertical Position Error    | Integer | Unit: cm                                                                                        |
| North Velocity Error       | Integer | Unit: cm/s                                                                                      |
| East Velocity Error        | Integer | Unit: cm/s                                                                                      |
| Vertical Velocity Error    | Integer | Unit: cm/s                                                                                      |
| Roll Angle Error           | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Pitch Angle Error          | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Heading Error              | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Installation Error Roll    | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Installation Error Pitch   | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Installation Error Heading | Integer | Unit: degrees, scaled $\times 100$                                                              |
| Reference Station ID       | Integer |                                                                                                 |
| Age of Differential        | Integer | Unit: seconds                                                                                   |
| Attitude Validity Status   | Integer | Value 0x00: Invalid attitude<br>Bit 0: Roll valid<br>Bit 1: Pitch valid<br>Bit 2: Heading valid |
| Reserved                   | —       |                                                                                                 |
| Reserved                   | —       |                                                                                                 |
| Reserved                   | —       |                                                                                                 |
| Checksum                   | *Hex    |                                                                                                 |

### 1.3 Proprietary IMU -- \$PSNSR,21

| <i>Field</i>                        | <i>Data Type</i> | <i>Description</i>          |
|-------------------------------------|------------------|-----------------------------|
| Message String ID                   | String           | \$PSNSR                     |
| Message String sub-ID               | Integer          | 21                          |
| Number of Data Sets (num)           | Integer          |                             |
| Repeated num times, N = 0 ~ (num-1) |                  |                             |
| Timestamp[N]                        | Integer          | Unit: ms                    |
| Gyro X [N]                          | Integer          | Unit: deg/s, scaled by 1000 |
| Gyro Y [N]                          | Integer          | Unit: deg/s, scaled by 1000 |
| Gyro Z [N]                          | Integer          | Unit: deg/s, scaled by 1000 |

|             |         |                                         |
|-------------|---------|-----------------------------------------|
| Accel X [N] | Integer | Unit: m/s <sup>2</sup> , scaled by 1000 |
| Accel Y [N] | Integer | Unit: m/s <sup>2</sup> , scaled by 1000 |
| Accel Z [N] | Integer | Unit: m/s <sup>2</sup> , scaled by 1000 |
| Reserved[N] | Integer |                                         |
| Reserved[N] | Integer |                                         |
|             |         |                                         |
| Checksum    | *Hex    |                                         |

## 2. Configuration Command

The input configuration command is sent in **hexadecimal**, using the following fixed format:  
8 bytes, unsigned, little-endian encoding.

| Sync-1 | Sync-2 | Type  | Group | Reserved | cmd-1 | cmd-2 | Sync-3 |
|--------|--------|-------|-------|----------|-------|-------|--------|
| 0x50   | 0x42   | Class | Group | 0x00     | Cmd-1 | Cmd-2 | 0x00   |

### (1) Restore Factory Settings

50 42 **E0** 01 00 81 81 00

### (2) Query Software Version and Current Configuration

50 42 **E3** 01 00 00 00 00

Response: \$PBCFG,FA,A,B,C,D,E,F,G,H,I,J

Where:

A: Vehicle platform configuration — 0: Standard; 1: Low-speed

B: Odometer configuration — 0: No odometer or serial input; 1: Pulse input

D: IMU axis configuration — see Table 1

F: Dual-antenna orientation configuration — see Table 2

### (3) Solution Rate

1Hz: 50 42 **E4** 01 00 80 80 00 (default)

10Hz: 50 42 **E4** 01 00 82 82 00

20Hz: 50 42 **E4** 01 00 83 83 00

50Hz: 50 42 **E4** 01 00 84 84 00

### (4) Vehicle Platform Dynamics

Regular: 50 42 **E5** 01 00 80 80 00 (default)

Low-Speed: 50 42 **E5** 01 00 81 81 00

(5) Enable all messages

50 42 **E7** 01 00 80 80 00 (default)

(6) Disable Single Message E7

Disable: Set corresponding bit to 1

CMD-1: *bit 7 always 1*; CMD-1 bit 6-0 and CMD-2 bit 7-0 set to disable single Message

| Messages   | Class | Group | Cmd-1<br>bit 6--0 | Cmd-2<br>bit 7--0 | Command                 |
|------------|-------|-------|-------------------|-------------------|-------------------------|
| \$GGA      | 0xE7  | 0x02  | 0x00              | 0x01              | 50 42 E7 02 00 80 01 00 |
| \$RMC      |       |       | 0x00              | 0x02              | 50 42 E7 02 00 80 02 00 |
| \$GSA      |       |       | 0x00              | 0x04              | 50 42 E7 02 00 80 04 00 |
| \$GSV      |       |       | 0x00              | 0x08              | 50 42 E7 02 00 80 08 00 |
| \$PBSOL    |       |       | 0x00              | 0x10              | 50 42 E7 02 00 80 10 00 |
| \$PGNSS,6, |       |       | 0x00              | 0x20              | 50 42 E7 02 00 80 20 00 |
| \$PGNSS,15 |       |       | 0x00              | 0x40              | 50 42 E7 02 00 80 40 00 |
| \$PGNSS,21 |       |       | 0x00              | 0x80              | 50 42 E7 02 00 80 80 00 |
| \$PGNSS,23 |       |       | 0x01              | 0x00              | 50 42 E7 02 00 81 00 00 |
| \$PBLKEND  |       |       | 0x02              | 0x00              | 50 42 E7 02 00 82 00 00 |
| \$HDT      |       |       | 0x04              | 0x00              | 50 42 E7 02 00 84 00 00 |

(7) output Proprietary messages only – E1

Set: 50 42 **E1** 01 00 81 81 00

Clear: 50 42 **E1** 01 00 80 80 00

(8) IMU Axes Setting -- E2

Module Physical Axis or Device Physical Axis



Table 1: IMU axis and config command

| Actual Installation Axis on the Vehicle |         |    | Configuration Command   | Remarks |
|-----------------------------------------|---------|----|-------------------------|---------|
| X                                       | Y       | Z  |                         |         |
| Forward                                 | Left    | Up | 50 42 E2 01 00 80 80 00 | default |
| Right                                   | Forward | Up | 50 42 E2 01 00 82 82 00 |         |
| Back                                    | Right   | Up | 50 42 E2 01 00 83 83 00 |         |
| Left                                    | Back    | Up | 50 42 E2 01 00 84 84 00 |         |

|         |         |      |                         |  |
|---------|---------|------|-------------------------|--|
|         |         |      |                         |  |
| Forward | Right   | Down | 50 42 E2 01 00 85 85 00 |  |
| Right   | Back    | Down | 50 42 E2 01 00 86 86 00 |  |
| Back    | Left    | Down | 50 42 E2 01 00 87 87 00 |  |
| Left    | Forward | Down | 50 42 E2 01 00 88 88 00 |  |

Note: Free-Angle Installation: 50 42 E2 01 00 81 81 00

#### (9) Dual-Antenna config -- E9

Base—baseA; Rover -- rA

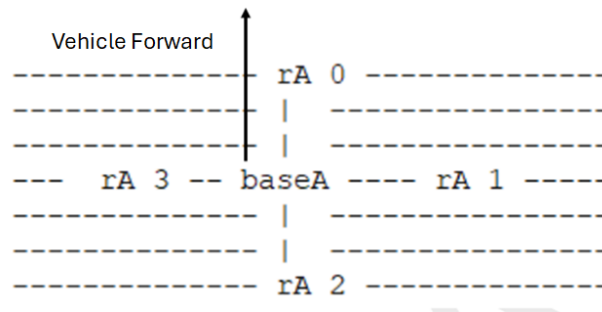


Table 2: dual-antenna configuration command

|   |                                |           |
|---|--------------------------------|-----------|
| 0 | 50 42 <b>E9</b> 01 00 80 80 00 | (default) |
| 1 | 50 42 <b>E9</b> 01 00 81 81 00 |           |
| 2 | 50 42 <b>E9</b> 01 00 82 82 00 |           |
| 3 | 50 42 <b>E9</b> 01 00 83 83 00 |           |

#### (10) Set Odometer input type

No input or by UART: 50 42 **EA** 01 00 80 80 00 (default)

Pulse input: 50 42 **EA** 01 00 81 81 00

#### (11) configuration of Lever arm

Using the receiving antenna as the origin, point to the IMU in a right-handed XYZ coordinate system (X: right, Y: forward, Z: up).

Set: \$SGCFG,SETARM,X,Y,Z,Flag,END\$

Clear: \$SGCFG,SETARM,0,0,0,1,END\$ or \$SGCFG,CLRARM,END\$

XYZ units are in meters.

When Flag = 1, the parameters are stored; Flag = 0 means they are valid only for the current power-on and not stored.

Note: Do not include spaces between commas

