ROHS，TS16949，ISO9001

R9100S

Single Frequency RTK High Precision Positioning Receiver Manual

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Revision History

Ver. NO.	Description	Date
V.1	Initial Establish	April 2021

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Catalogue

1. Product Description

1.1 Overview

R9100S multi-mode singe-frequency high-precision GNSS/MEMS integrated navigation receiver,launched by Shenzhen Simple Technology Electronics Co., LTD. It integrates navigation system based on 6-DOF MEMS sensor and singe-frequency RTK satellite navigation. The RTK algorithm and integrated navigation algorithm run efficiently in on-chip processor. It is a centimetre-level integrated navigation product of 100% navigation availability， with low power consumption, small size, high precision, no need to access odometer assistance, and with urban canyons and long time tunnels.

R9100S adopts advanced MEMS inertial sensor and carrier differential (RTK) satellite navigation integrated navigation technology, making full use of the carrier phase information of satellite navigation and the relative angular motion and linear motion measurement function of inertial devices (three-axis gyro and three-axis accelerometer). The multi-dimensional extended Kalman filter technology and other specific algorithms are used to realize the 3D high-precision navigation and attitude measurement function on the tiny device.

- ✓ RTK difference, open sky centimeter-level accuracy
- ✓ Complex scenes such as underground closed parking lots, tunnels, urban canyons, viaducts, etc., maintain uninterrupted navigation output for the whole section
- ✓ Support the inertial navigation starting
- ✓ No mandatory access requirements for wheel speedometer/odometer auxiliary
- ✓ Free Angle installation
- ✓ Fast online calibration technology, the fastest 30 seconds can be into the integrated navigation state, no need to draw figure-eight and other complex calibration
- ✓ three-dimensional attitude (i.e. heading, pitch, tilt) output, three-dimensional position speed output, uninterrupted distance accumulation
- ✓ 100Hz MEMS sensor, original data output 1
- ✓ GNSS channel original observations (carrier, pseudo distance, satellite coordinates, etc.) output [1]
- ✓ support AGNSS

R9100S can be widely used in intelligent bus, automobile intelligent driving, rail transit, precision agriculture and other fields.

Note 1: The original data is the output of non-standard configuration, please contact the Simple-tech support team for special version support.

1.2 Key Indicators

Frequency	BDS B1I; GPS L1; GLONASS L1	
Refresh rate	Default 1Hz, MAX 20Hz	
Sensitivity	Tracking	-167dBm
	Recapture	-160dBm
	Cold start	-148dBm
	Hot start	-160dBm
Positioning time	Hot Start	1s typ @-130dBm
	A-GNSS Assist [3]	10s
	Cold start	35s typ @-130dBm
Positioning accuracy (1σ)	Open sky	RTK difference: 0.05m +1ppm Autonomous positioning: 2.0m
	Complex urban environment	3.0 m
	Satellite signal outage	60s 12m 120s 25m >120s 2.0% distance traveled 2.0% distance travelled (Access odometer)

Attitude accuracy (1σ)	Angle of inclination 1.50 Pitch Angle 1.50 Heading Angle 3.00
Velocity accuracy (1σ)	0.05 m/s
Sensor online calibration	< 30s
Effective bandwidth	> 100Hz
Gyro	Stability 15°/h
Accelerometer	Stability 10mg
Input protocol	RTCM3.X
Output Protocol	NMEA0183, custom text and binary protocol

2. Electrical characteristics

2.1 Electrical maximum

Parameters	Symbols	Minimum value	Maximum	Units	Conditions
Supply voltage (VCC)	Vcc	0.5	6.0	V	
VCC maximum ripple	Vrpp	0	50	mV	
Storage temperature	Tstg	- 45	85	℃	
ESD	VESD(HBM)		2000	V	

2.2 Operating Conditions

Parameters	Symbols	Minimum value	Typical value	Maximum value	Units	Conditions
Supply voltage (VCC)	Vcc	4.6	5.0	5.5	V	
Peak current	Iccp			100	mA	Vcc = 5.0V
Operating temperature	Topr	- 40		85	℃	

3. Product Functions

3.1 Multi-mode Satellite System

The R9100S receiver can simultaneously receive signals from multiple satellite constellation systems, including the main satellite system and the wide area and local satellite-based augmentation system, as listed in Table 2.1:

	Satellite navigation system	Operation maintenance country/region
Primary navigation system (GNSS)	GPS	United States
	Beidous (BDS)	China
	GLONASS	Russia
	GALIELO	European Union

GPS/BDS is the factory configuration of the R9100S.

3.2 System Enhancements

The R9100S receiver accepts a variety of augmentation AIDS.

3.2.1 Carrier Phase Difference (RTK)

R9100S has the function of multi-mode singe-frequency carrier phase differential, and the received input base station information must follow the RTCM3.2 protocol. The base station can be a direct connection station or a virtual CORS station. The supported differential message types are listed in the table.

RTK Supports Message Types

Massage Types	Descriptions
1005 or 1006	Location massage of the base station antenna
1074	Base station GPS observation electronic text group
1084	Base station GLONASS observation electronic text group
1124	Base BDS observation electronic text group

When the observation quantity and Kalman filter meet certain conditions, the whole cycle ambiguity of the carrier is solved to realize the FIXED carrier positioning solution (FIXED). When the whole cycle ambiguity cannot be determined, the floating point solution (FLOAT) result or the code difference (DGNSS) calculation result is provided.

3.2.2 Code Difference (DGNSS)

When the use of RTK is limited, the R9100S can also be downgraded to use the code difference function, which can access the pseudo-range correction information in RTCM2.3 or defined format. Custom input protocols can be obtained by contacting the Simple-tech Technical support team when using custom formats.

3.2.3 Precision Single Point Positioning (PPP)

R9100S can receive PPP correction input in user-defined format, and PPP positioning capability is realized by on-chip algorithm. More information about PPP service partners and custom formats can be obtained by contacting the Simple-tech Technical Support team.

3.2.4 Common satellite-based Difference

The R9100S has the capability of satellite-based differential positioning. Depending on the user's geographical location, WAAS (effective in coverage area) or EGNOS (effective in coverage area) will be used.

3.2.5 Fast Ephemeris Assisted Positioning (AGPS)

R9100S is with AGPS capability. The user host can send AGPS information to R9100S to speed up the first positioning time, only valid for auxiliary GPS ephemeris.

3.2.6 Odometry

Unlike traditional DR Products, there is no mandatory requirements for odometer access to the R9100S. However, in the vehicle carrier application, the R9100S receiver can also accept the odometer/wheel speed data protocol input mode for further improving the accuracy. Odometry input for integrated navigation system forms the carrier prior to constraint, increases the observability combination filtering, and increase the speed, position and heading accuracy about 20% to 30%.

3.3 Fast Online Calibration

The zero bias of inertial devices is one of the main error sources of integrated navigation system. The power-on repetition performance of low-cost MEMS sensors cannot be compared with the traditional liquid float, mechanical or optical inertial devices. The zero bias after each power-on is very different, and it is impossible and meaningless to use off-line turntable calibration to reduce. Therefore, the R9100S receiver adopts the on-line calibration technology, that is, the zero bias is estimated with the help of gravity field information and single-dimensional Kalman filter technology after each power-on, and the satellite navigation information is used to accelerate the filter convergence.

The fast online calibration technology of R9100S receiver does not require a special trajectory or curve in the form of carrier, and can be calibrated under normal driving or riding state, so that the system can enter the integrated navigation state.

In addition, because the R9100S receiver accepts free Angle installation, the zero bias will form a coupling relationship with the gravitational field projection, and the fast calibration technology also includes this decoupling process.

3.4 Free Installation

The R9100S receiver does not require the installation position in the carrier, and can be freely installed in 360 degrees. The adaptive algorithm can automatically identify and filter the wave to estimate the installation error Angle, and compensate it in the basic inertial navigation calculation equation. However, in order to maintain the optimal performance of the system, it is recommended that the Angle between the module and the carrier along the pitch direction should be less than 20 degrees (the front and back direction is not required) at the completion of the installation, so as far as possible to ensure that the mathematical model of small-angle linearization can be established.

Please note that although the R9100S receiver can be freely installed, but because of the characteristics of inertial navigation determines that the use of the module must be fixed with the carrier, so please be sure to pay attention to the tight installation of the R9100S receiver during use, do not move and shake to ensure the performance of the R9100S receiver.

3.5 Navigation data rate

The R9100S receiver accepts the user input configuration, and can realize the navigation rate of 1Hz, 10Hz, 20Hz. The filter state of the corresponding integrated navigation system will change according to the configured

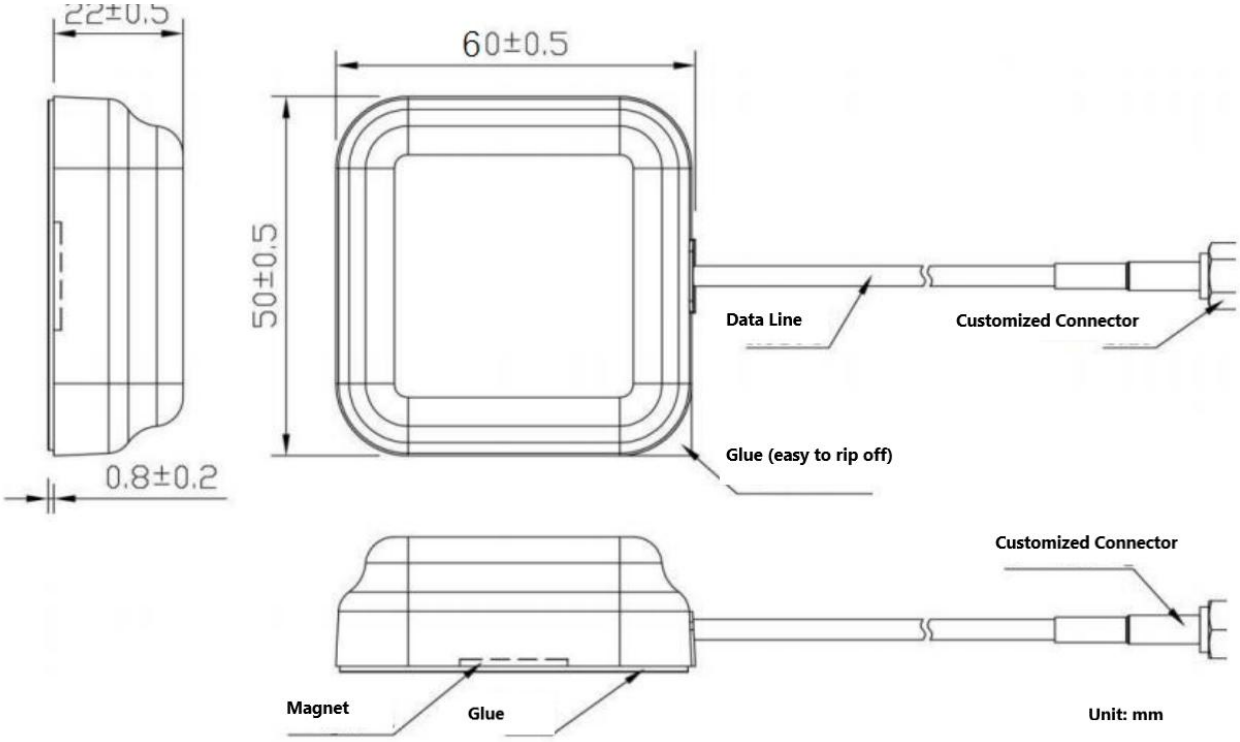
navigation rate. The setting of navigation rate is usually dynamically related to the carrier, and it is not applied to the attitude control platform, so 1Hz navigation rate is recommended.

3.6 Original Data Output of MEMS Sensor

R9100S receiver provides the original data output of gyro and accelerometer, and the data rate is 100Hz; R9100S can provide the original satellite navigation observation data output of base station and mobile station, the data rate is 1Hz; The specific data output protocol can contact the support team, the original data output is non-standard configuration on the R9100S.

4. Overall Dimensions

Parameters	Minimum value	Typical value	Maximum value	Units
Housing length		60		millimeter
Housing width	-	60	-	millimeter
Housing height (without 3M adhesive)	-	22	-	millimeter
3M adhesive thickness	-	1.9	-	millimeter
Cable diameter	-	4.0	-	millimeter
Exposed cable length	1.9	2.0	2.1	meter

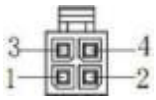


5. Transmission and Interface

Simple-tech high precision series products use analog USB communication or MX3.0 interface RS232 serial port communication by default , using 8 bit data bit, 0 bit parity check bit, 1 bit stop bit (8-N-1) mode. the baud rate default 115200, can be modified according to user requirements, any common baud rate. The external interface adopts the standard universal USB interface, which can be directly connected to the computer, Android mobile phone and other devices for testing and performance experience.

If you need other interfaces, need to be customized. The common interface is as below:

USB-A	Standard	USB	5V
Micro USB	Standard	USB	5V
TYPE-C	Standard	USB	5V
MINI USB	Standard	USB	5V

MX3.0		RS-232	5V

UART/TTL Descriptions

1	VCC	P	Power Supply Voltage (Typ. 5.0V)
2	TXD	O	SerialTX Port (GPS to Host)
3	RXD	I	SerialRX Port(Host to GPS)
4	GND	G	Ground

RS232 Descriptions

1	VCC	P	Power Supply Voltage (Typ. 5.0V)
2	RS232-TXD	O	RS232TX Port (GPS to Host)
3	RS232- RXD	I	RS232RX Port(Host to GPS)
4	GND	G	Ground

6. Order information

Model No.	Description	Interface protocol	Interface configuration	Line length	Baud rate
R9100S	singe frequency RTK High precision positioning receiver	USB	Type-C USB	2m	1 15200
R9100SK	singe frequency RTK high precision integrated navigation positioning receiver	USB	Type-C USB	2m	1 15,200

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