RION TECH

V1.6

INERTIAL MEASUREMENT UNIT

RION IMU570

TECHNICAL MANUAL

PRODUCTION EXECUTION STANDARD REFERENCE

○ Quality management system certification: GB/T19001-2016 idt ISO19001:2015 standard (certificate no.: 128101)

○ High-tech Enterprises（cert. No：GR201844204379）

○ Revised date: 2022-4-23

○ Note: Product functions, parameters, appearance, etc. will be adjusted with the upgrade of the technology. Please contact the pre-sales business of the company for confirmation when purchasing.

▶ PRODUCT DESCRIPTION

IMU570 inertial navigation unit is composed of three-axis gyroscope, three-axis acceleration, temperature sensor and signal processing circuit. The three-axis angular rate of the carrier is measured, and the three angular rate data after error compensation (including temperature compensation, installation misalignment compensation, non-linear compensation, etc.) are output through RS422 / RS485 serial port according to the agreed communication protocol. The product adopts differential gyroscope structure, effectively restrains the influence of linear acceleration and vibration, and adopts full temperature compensation to suit the harsh environment of industrial application.

▶ PRODUCT FEATURES

★ measure triaxial angular velocity of carrier
★ working temperature：-40~85℃
★ storage temperature ：-40~85℃
★ Vibration：10~2000Hz，10g
★ power supply ：+5±0.5V(DC)
★ impact :100g@11ms、3 Axial Direction (Half Sinusoid)

▶ APPLICATION

★ Autopilot Vehicle
★ Unmanned Aerial Vehicle
★AGV
★ SOTM attitude unit
★ POS System for Surveying and Mapping
★ Ship and Marine Engineering
★ Ocean and Underwater Surveying and Mapping
★ Flight Control System
★ High Speed Train Measurement and Control System

▶ SPECIFICATION

IMU570		PARAMETERS
Attitude angle	Roll / Tilt 1σ (Dynamic)	0.5°
	Heading	0.5°
Gyro	Measuring range	1800°/s
	Zero bias instability (@Allan variance)	≤8°/h (-20~70 ℃)
	angle random walk (@Allan variance)	≤0.13°/√h & 0.24°/√h
	Zero Bias Acceleration Sensitivity	≤1°/h/g
	Resolution	≤0.001°/s
	Scale factor nonlinearity	≤100ppm
	Scale factor repeatability	≤100ppm
	Cross-coupling	≤0.1%
	Bandwidth	≥200Hz
Accelerometer	Measuring range	±38g
	Zero bias instability (@Allan variance)	0.019mg
	Zero bias repeatability	0.08mg
	Speed random walk (@Allan variance)	0.04m/s/√h
	Zero Bias Error in Full Temperature Range	0.5mg
Other parameters	Power supply voltage	(+5±0.5) V (DC)
	Power supply Current	Working current < 0.3A
	Working temperature	-40~85℃
	Storage temperature	-40~85℃
	Vibration	10~2000Hz , 10g
	Impact	100g@11ms、3 Axial Direction (Half Sinusoid)
Weight		≤60g (excluding cables)

Note: Roll, Pan is ±180°, Pitch is ±90°.

▶ ORDERING INFORMATION

MODEL	DESCRIBE
IMU570-422	RS422 output
IMU570-485	RS485 output

▶ ELECTRICAL CHARACTERISTICS

IMU570 The electrical connector type of the integrated inertial navigation system is **J30J-15ZKP** , the specific PIN definition is shown in the table below ;

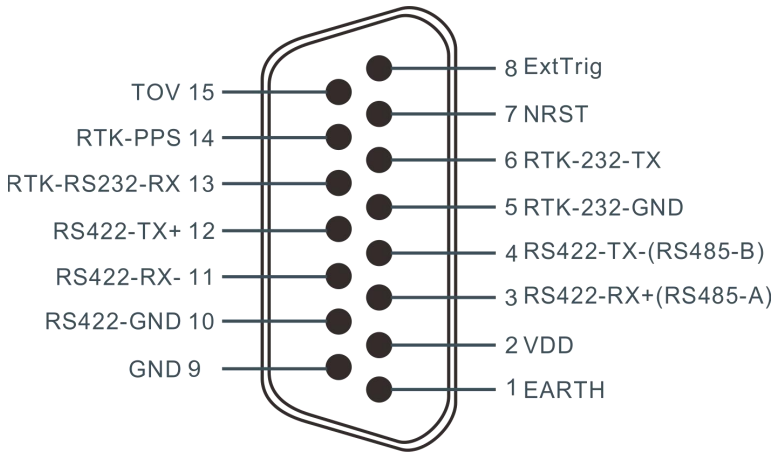
Pin	Pin Definition	Type	Instruction
1	EARTH	IN	Shell connecting pull end, mobile device connecting power GND, fixed equipment connecting housing protection GND (0V)
2	VDD	Power positive	Power positive 4.5VDC~7VDC
3	RS422-RX+(RS485-A)	IN(OUT)	Communication interface（-7V~+12V）
4	RS422-TX-(RS485-B)	OUT(OUT)	Communication interface（-7V~+12V）
5	RTK-232-GND	NC	\
6	NC	NC	\
7	NRST	IN	External reset function（The descending edge is valid and must be enabled by the manufacturer.）(b)
8	ExtTrig	IN	External trigger signal（The descending edge is valid and must be enabled by the manufacturer.）(c)
9	GND	Power negative	Power negative （0V）
10	RS422-GND	IN	RS422(RS485)communication GND（0V）
11	RS422-RX-	IN	Communication interface（-7V~+12V）
12	RS422-TX+	OUT	Communication interface（-7V~+12V）
13	RTK-RS232-RX	NC	\
14	RTK-PPS	NC	\
15	TOV	OUT	Output Co-frequency Signal（a）

NOTE:

1）Synchronization signals need to be specially configured according to requirements. The default IMU integrated inertial navigation system has not this configuration and needs to be suspended.

2）Reset signals need to be specially configured according to requirements. The default IMU integrated inertial navigation system has not this configuration and needs to be suspended.

3）External trigger sources need to be specially configured according to requirements. The default IMU integrated inertial navigation system has not this configuration and needs to be suspended.



▶ SPACE COORDINATE SYSTEM

Right Hand Rule Principle 1

IMU570 contains three DOF gyroscopes, representing three axes of spatial coordinate system, namely X, Y and Z. The X axis positive is directed forward from the connector to the middle mounting hole of the sticker, the Y axis positive is directed right to the IMU, and the Z axis positive is directed downward to the bottom of the IMU, as shown in Figure 1.

Fig. 1 Space coordinate system of micro-gyroscopes

The installation of IMU570 should match the axis of the coordinate system, otherwise the angular velocity data measured are inaccurate. Following Right Hand Rule Principle 1, the axis of the coordinate system can be quickly allocated and determined. Stretch out your right hand and expand your thumb, index finger and middle finger. The direction of thumb finger is X-axis positive; the direction of index finger is Y-axis positive, and the direction of middle finger is Z-axis positive.

Right Hand Rule Principle 2

IMU570 three DOF gyroscope can measure angular velocity in three directions. Following Right Hand Rule Principle 2, the angular velocity direction of axially rotating coordinate axes can be determined quickly. The right hand grasps the rotation axis and extends the thumb. The direction of the thumb finger is the positive direction of the axis, while the direction of the other four fingers bending is the positive direction of the angular velocity on the axis. On the contrary, the right hand grasps the rotation axis and extends the thumb. The direction of the thumb finger is the negative direction of the axis, and the direction of the other four fingers bending is the angle of the axis. Velocity is negative.

▶ DIMENSION

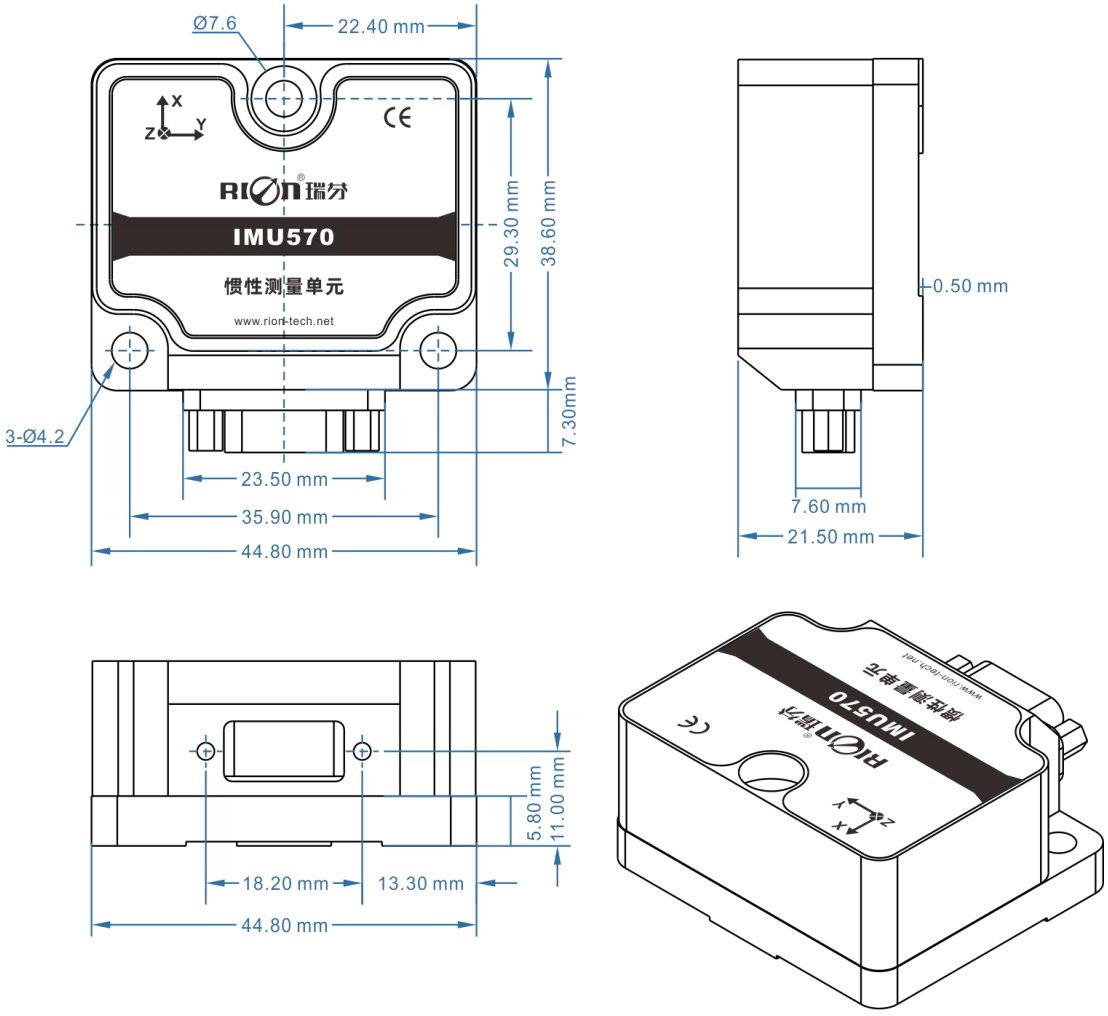


Fig. 4-1 Plug-in Node Configuration Diagram (Outside the Product)

Shell size: L44.8×W38.6×H21.5mm
Installation size: L35.9×W29.3×H5.8mm
ounting screws: 3 M4 screws

▶ COMMUNICATION FRAME FORMAT

1.1 Communication frame format

Domain	Frame sync byte	Frame start byte	CMD Command Domain	LEN Length	DATAs Data cable	CRC	Frame End Byte
No. of bytes	1	1	1	2	0~504	2	1
Instruction	Sync. byte	Start of byte	Command	Length of the Datas	Datas	CRC	End of Tx byte
Value	0xFF	0x02	-	-	-	-	0x03

Notes:

A .LEN Data length domain includes the number of bytes of data domain (Datas). MSB is in the front, LSB is in the back, and length of 0 means no data domain. The longest data domain length is 504 bytes, and the longest frame byte is 512 bytes.

B .The calculation of CRC begins with the CMD command domain, including the length domain and the data domain. MSB is in the front and LSB is in the back. The CRC is calculated according to the following functions:

```
uint16 calcCRC(const uint8 *pBuffer, uint16 bufferSize)
{
	uint16 poly = 0x8408;
	uint16 crc = 0;
	uint8 carry;
	uint8 i_bits;
	uint16 j;

	for (j=0; j<bufferSize; j++)
	{
		crc = crc ^ pBuffer[j];
		for (i_bits=0; i_bits<8; i_bits++)
		{
			carry = crc & 1;
			crc = crc / 2;
			if (carry)
			{
				crc = crc^poly;
			}
		}
	}
	return crc;
}
```

1.2 Data format and end mode

The data output of the device is in the small-end mode (such as integer, floating-point, low byte before, high byte after).

1.3 Serial port default

Default baud rate is 115200 bps, 1 bit start bit, 1 stop bit, no check.

1.4 Default output rate is 200Hz .

2 .Continuous Data Item Output

*** IMU_CONTINUOUS_DEFAULT_OUTPUT------(0x90)**

Function: Continuous output of data items.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	See below	1	1	1
0xFF	0x02	0x90	0x00	0x24	See below	0xXX	0xXX	0x03

Data parts as following (total length: 0x0018) :

Name	Roll	Pitch	Yaw	Gx	Gy	Gz	Ax	Ay	Az
Size (bytes)	4	4	4	4	4	4	4	4	4
	12			12			12		

The attitude angle includes Roll, Pitch, and Yaw. It is represented by real32 (float), 12 bytes, and the unit is radians .

Storage format :

Roll	Pitch	Yaw

Angular rate of triaxial gyroscope Gx, Gy and Gz, Represented by real32(float)， 12 bytes， unit is rad.S-1(Radius/second).

Storage format :

Gx	Gy	Gz

Triaxial accelerations Ax, Ay and Az, expressed in real 32 (float), are 12 bytes in $m.S^{-2}$.
Storage format :

Ax	Ay	Az

E.g : FF 02 90 00 24 BD C9 DC 3B 69 27 65 3B 1C D9 56 3F C0 C2 10 BA C0 4A B8 37 B5 6F E1 B9 F1 31 18 3D 6E 86 82 BD 6C 65 1D C1 D0 2C 03

Count domain	real32	float	unit
Roll	BD C9 DC 3B	0.006738	radian
Pitch	69 27 65 3B	0.003497	radian
Yaw	1C D9 56 3F	0.839250	radian
Gx	C0 C2 10 BA	-0.000552	Radians / second
Gy	C0 4A B8 37	0.000022	Radians / second
Gz	B5 6F E1 B9	-0.000430	Radians / second
Ax	F1 31 18 3D	0.037157	$m.S^{-2}$
Ay	6E 86 82 BD	-0.063733	$m.S^{-2}$
Az	6C 65 1D C1	-9.837261	$m.S^{-2}$

3. Output mode setting

Ouptut working mode 。

Modes come in two ways, the following two:

IMU_NORMAL_MODE(Normal working mode or call-and-answer mode) ：0x00

IMU_CONTINUOUS_MODE (Continuous output mode) :0x01

In which CONTINUOUS_MODE (Continuous output mode) , different Divider values correspond to the following different output frequencies:

Divider	OUT(Hz)
0	INVALID
1	200
2	100
4	50
8	25
10	20
20	10
40	5
200	1

Note：Default is IMU_CONTLNUOUS_MODE(Continuous output mode)，output rate 200Hz。

3.1Setting Output Command

*** IMU_SET_CONTINUOUS_MODE------(0x53)**

Function: Set output mode;

Note: Power-off saving function is not available. Only by executing the save setting command can power-off saving function be achieved.

The frame format is as follows:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end syte
1	1	1	1	1	3	1	1	1
0xFF	0x02	0x53	0x00	0x03	As following	0xXX	0xXX	0x03

In which：DATA

DATA		
Reserved.Leave to 0(bytes)	Mode	Divider
1	1	1
0	1	1

Note：above Mode = 1, Continuous output，Divider = 1, output power：200Hz.

Reply：

IMU_ACK

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x01	0x00	0x01	ERROR_ CODE	0xXX	0xXX	0x03

4. Communication parameter setting

Baud rate，It is a 32-bit integer with the following valid values：9600, 19200, 38400, 57600, 115200, 256000。

4.1 Baud rate setting

*** IMU_SET_PROTOCOL_MODE-----(0x12)**

Function：Used to set the communication baud rate；(default 115200)

Note：Without power-down saving function, power-down saving function can only be achieved by executing the save setting command.

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	5	1	1	1
0xFF	0x02	0x12	0x00	0x05	As following	0xXX	0xXX	0x03

In whchic：DATA parts

DATA	
Reserved.Leave to 0(bytes)	Baudrate (uint32)
1	4
0	115200

Note ：Baud rate(uint32) is small-end mode, low bytes are in front and high bytes are in the back.

Reply：

IMU_ACK

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x01	0x00	0x01	ERROR _CODE	0xXX	0xXX	0x03

5. Saving settings

5.1 setting saving commands * IMU_SAVE_SETTINGS------(0x24)

Function: Used to save all setting parameters to EEPROM, with power-down saving function. There is no data domain, and the frame format is as follows:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x24	0x00	0x00	NULL	0xXX	0xXX	0x03

Reply:

IMU_ACK

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x01	0x00	0x01	ERROR _CODE	0xXX	0xXX	0x03

Remarks:EERROR CODE refer 6 contents;

6. Answer Frame analysis

Answer frame format as below :

Domain	Synchro nization Bytes	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
Byte No. (byte)	1	1	1	1	1	1	1	1
Value	0xFF	IMU_ACK (0x01)	0x00	0x01	ERROR CODE	0xXX	0xXX	0x03

Response is the reply of command. Error code reflects the execution of command. Error code (ERROR CODE) determines the response of device to inquiry instruction. The following is a list of error codes.

IMU_Error Code	Value	Description
IMU_NO_ERROR	0x00	The command has been executed correctly
IMU_ERROR	0x01	Improper execution of commands
IMU_INVALID_FRAME	0x04	Invalid commands
IMU_INVALID_PARAMETER	0x09	Invalid parameters

Note: Error codes make up the frame's data domain(DATA).

7. Query data items(when output Mode = 0, Question-and-answer mode)

*** IMU_GET_DEFAULT_OUTPUT------(0x56)**

Function:Gets the current default output data item

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x56	0x00	0x00	NULL	0xXX	0xXX	0x03

Response:

***IMU_RET_DEFAULT_OUTPUT------(0x57)**

Function: return default data item output

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame end byte
1	1	1	1	1	36	1	1	1
0xFF	0x02	0x57	0x00	0x24	See below	0xXX	0xXX	0x03

Data parts as below （total length: 0x0024）:

Name	ROLL	PITCH	YAW	Gx	Gy	Gz	Ax	Ay	Az
Size (bytes)	4	4	4	4	4	4	4	4	4
	12			12			12		

▶ FUNCTIONAL TESTING

1. Required test equipment and instruments

The equipment and instruments needed in the test are: DC regulated power supply, computer, turntable, test fixture and test cable.

2. Functional testing

The product is in a static state. The DC regulated power supply is used to supply power to the product. The power supply requirement meets the requirement of 1.2.2. The specific connection mode of the product is as follows: Fig. 6-1. According to the communication protocol, the data is received and the angular velocity output of the product is displayed by the host computer receiving software.

Forward Rotating Gyroscopes Around X, Y and Z (When conditional, you can use turntable input, unconditional, you can use hand rotation), the angular velocity output of the corresponding axis can be monitored as positive angular velocity. Reverse rotating products around X, Y and Z respectively, the angular velocity output of the corresponding axis can be monitored as negative angular velocity. Under static conditions, the three angular rate values of product output should be near 0 deg/s.

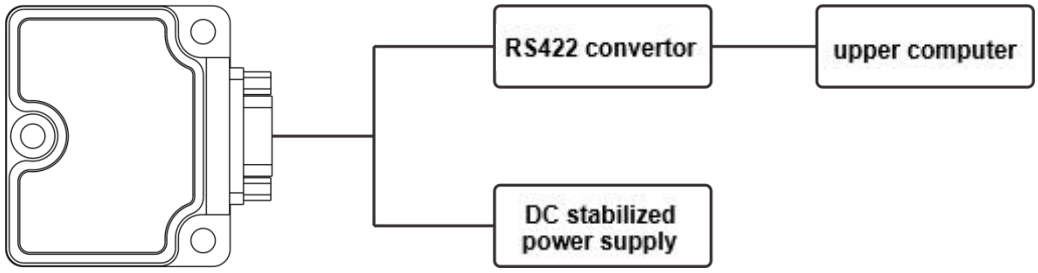


Fig. 6-1 Connection schematic diagram of gyroscope combination test

▶ USE AND MAINTENANCE REQUIREMENTS

◎ Before use, the installation location of the system must be checked to ensure that the installation is correct. Check the connection of each signal line carefully to ensure that the connection is correct.

◎ Before power-up, check the cable PIN connection, power supply, and the polarity of power supply should not be reversed.

◎ During using, the system mechanically GND should ensure good GND connection.

◎ This product contains precision instruments, no knocking and falling.

◎ The product should be stored in a warehouse with temperature of (15-35)℃, relative humidity of not more than 75%, no acid, alkali, no corrosive gas and good ventilation.

Add: Block 1, COFCO(FUAN) Robotics Industrial Park , Da Yang Road No. 90,

Fuyong Distict, Shenzhen City, China

Tel: (86)755-29657137 (86) 755-29761269

Fax: (86)755-29123494

E-sales: sales@rion-tech.net

Web: www.rionsystem.com