RION TECH

Appearance patent number: ZL 201730609544.2

V2.0

IMU COMBINED INERTIAL NAVIGATION

IMU560

Technical Manual

PRODUCTION EXECUTION STANDARD REFERENCE

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

○ Quality management system certification: IATF16949: 2016 (Certificate No.: T178487)

○ GJB9001C-2017 Standard Weaponry Quality Management System Certification (Registration number: 02622J31799R0M)

○ Intellectual property management system certification: GB/T29490-2013 standard (Certificate No.: 41922IP00281-06R0M)

○ High-tech Enterprise (Certificate No.: GR201844204379)

○ ShenZhen Professional Dedicated Unique Innovative Enterprice(No.: SZ20210879)

○ CE certification: AT18250EC000560

○ RoSH certification: 18300RC20410801

○ China National Intellectual Property Appearance Patent (Patent No.: ZL 201730609544.2)

○ Revision time:2023-1-12

Note: Product functions, parameters, appearance, etc. will be adjusted as the technology upgrades. Please contact our pre-sales business to confirm when purchasing.

▶ PRODUCT DESCRIPTION

The IMU560 series is a GPS/INS integrated navigation system built by RION.the inertial measurement unit (IMU) is precision calibrated throughout the temperature range to meet performance requirements in different environments. The multi-data Kalman filter fusion algorithm is realized by a built-in navigation computer, and outputs real-time accurate carrier posture, heading information, three-dimensional position and velocity information, and various inertial device information. The appearance is exquisite, the structure is small, the installation is convenient, the use is flexible, and the operation is more stable and reliable.

▶ PRODUCT POSITIONING

The IMU560 series is positioned as a vehicle/shipborne general inertial and integrated navigation product target market:

(1) moving through

(2) Car navigation

(3) Dynamic attitude measurement

▶ PRODUCT FEATURES

★ Gyro bias instability 10°/h (Allan Variance)

★ Accelerometer deviation 1.7mg (less than 4g range)

▶ APPLICATION RANGE

★ High-speed train measurement and control system

★ Marine and underwater surveying and mapping

★ Ship and ocean engineering

★ UAV navigation and control

★ Vehicle navigation and measurement and control system

★ Stable platform

★ Surveying and mapping POS system

★ Vehicle positioning and navigation

★ Mobile communication system

▶ SPECIFICATIONS

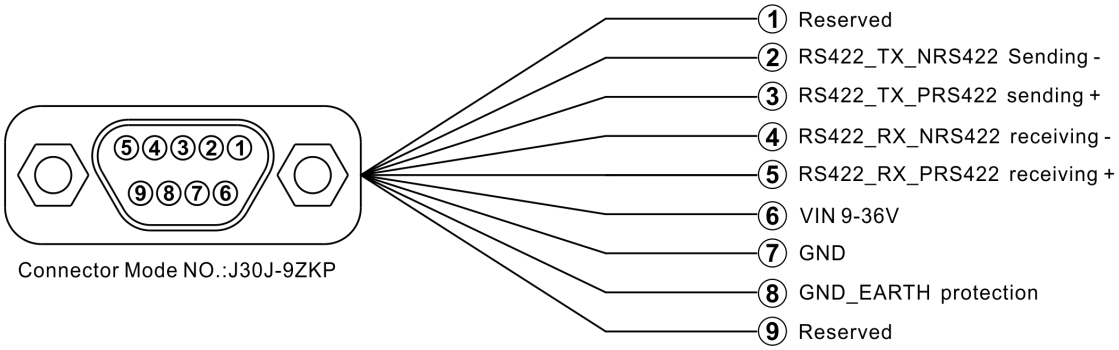
IMU560		PARAMETER	UNIT
Roll/pitch 1σ (dynamic)		0.3	°
HEADING POSITION ESTIMATION ACCURACY	Heading Accuracy 1σ	0.3 ° (GPS effective)	°
		0.5° (GPSunlock 5min)	°
	Pure Inertial Position Estimation Accuracy 1σ	<40m@1min(GPS unlock)	m@1min
	Output Frequency	1~100	Hz
GYRO	Range	±300	°/s
	Zero Bias Instability（Allan）	10	°/h
	Zero Bias Stability(10s Mean)	15	°/h
	Zero Bias Repeatability	15	°/h
	Nonlinear Error	<0.1% of FS	\
	Scale Factor Nonlinearity[1]	<0.02	%
	Scale Factor Change (25 ° C)	±0.3	%
	Resolution	< 0.01	°/s
	Acceleration Sensitivity	<0.0028	°/s/g，rms
	Angle Random Walk	<0.15	°/√hr
	Noise Intensity	0.014	°/s/√hr
	Bandwidth	100	Hz
ACCELEROMETER	Range	±4	g
	Zero Bias Stability	0.2	mg
	Full Temperature Zero Bias	1.7	mg
	Scale Factor Stability	< 0.1	%
	Resolution	0.1	mg
	Nonlinear [2]	0.1	%
	Noise Intensity	200	ug/√hr
	Bandwidth	100	Hz
MAGNETOMETER	Range	±2	Gauss
MAGNETIC AZIMUTH	Range	±180	°
	Accuracy	±1.0	°
Air pressure	Pressure range	1000~120000	\
	Barometric error	±250	Pascal
STANDARD GPS PARAMETERS	Start Time	Cold start: 29s hot start: 1s	
	Sensitivity	-166dBm	
	Speed	0.05m/s	
	Azimuth Accuracy	0.3°,P=50%@30m/s	
	level reckoned accuracy	2m	
ENVIRONMENTAL CHARACTERISTI	Vibration Resistant	10grms、10～1000Hz	
	Impact Resistance	100g@11ms、3 Axial Direction (Half Sinusoid)	

CS	Range Of Working Temp.	-40°C~+85°C
ELECTRICAL INTERFACE	Input Current	< 100mA
	Input Voltage	9-36V (Ripple 50mV)
	Interface Type	J30J-9ZKP
COMPATIBLE SATELLITE MODE		GPS L1C/A, SBAS L1C/A, GLONASS L1OF, BEIDOU B1
WEIGHT		≤100g (Excluding cables)

*Factory qualified test indicators

1. 1. Within ±100°/s, the symmetry and nonlinearity are required to be <200ppm, and the test angular rate is 0, ±0.1, ±0.2, ±0.5, ±1, ±2, ±5±n*5, n = 1,2 , 3...
2. Measure within ±1g and full scale separately.

▶ SIGNAL DEFINITION



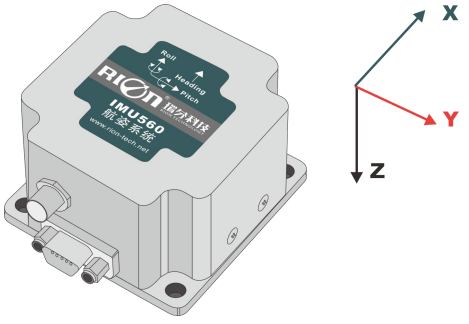
▶ INSTALLATION INSTRUCTIONS

Power Supply Is Dc 9-36V, Ripple <50mv, Current 0.5A At Least. If Power Noise Is Big Or Power Wire Is Long, User Better Use Filter Or Stabilizer.

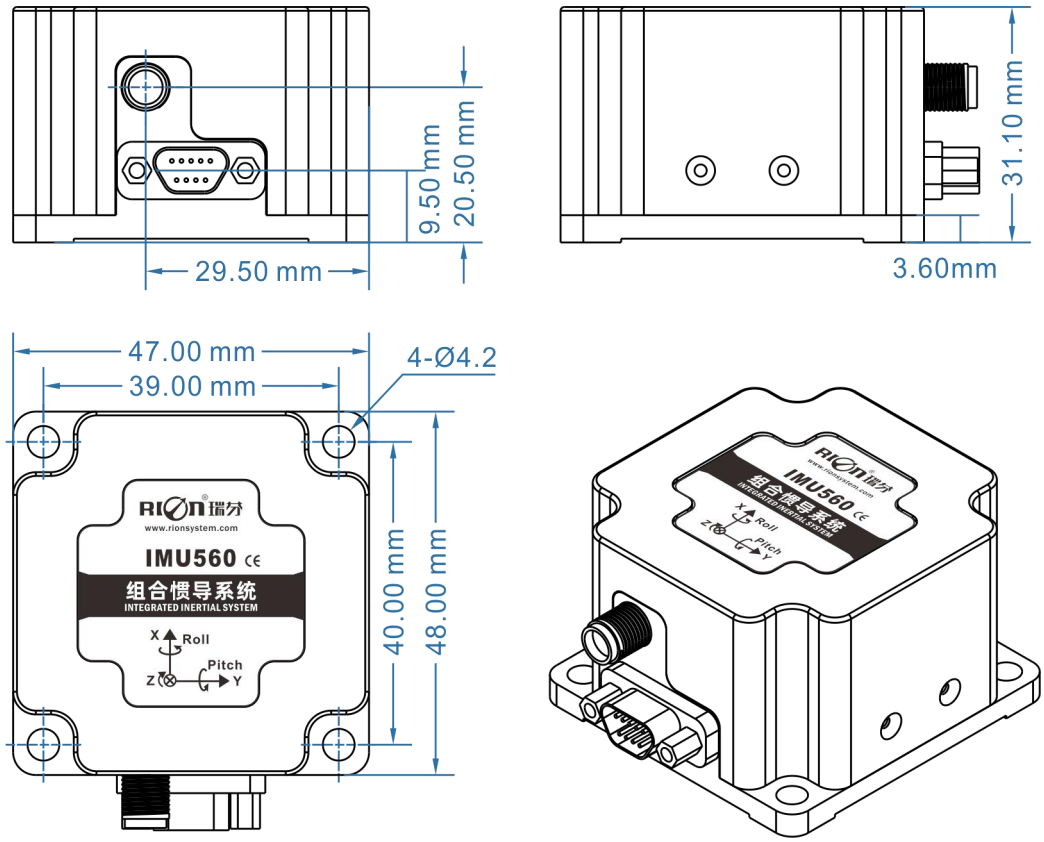
1. Use M4 Half-Round Screw To Fix Imu On Carrier, If It Is Loose, The Accuracy Will Be Affected.
2. Install The Imu In The Center Of Carrier As Much As Possible.
3. Avoid Violent Vibration, Sudden Temperature Change, And Use Buffer If Necessary.
4. Align The Coordinate Axis Of Imu And Carrier As Much As Possible.
5. The Initial Value Of The Azimuth After Power-On Is The Magnetic Direction Angle.

▶ INSTALLATION AXIS

IMU560 use NED coordinate, right hand coordinate, axis direction above.
By the rotation direction Z-Y-X, when X forward direction point to the front of carrier, then the angle rotating Z axis is yaw, Y axis pitch, X axis roll.



▶ DIMENSION



Shell size：L47×W48×H31.1mm

Installation size：L39×W40×H3.6mm

Installation crews：4 M4 screws

▶ COMMUNICATING PROTOCOL

1. Communication frame format

1.1 Communication frame format

Domain	Frame sync byte	Frame start byte	CMD Command domain	LEN length	DATAs Data domain	CRC	Fame ending byte
Byte no.	1	1	1	2	0 to 504	2	1
Description	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 byte number of data domain (Datas), MSB at front, LSB at back, length is 0 means no data domain, the longest data domain length is 504 bytes, the longest frame byte is 512 bytes.

B. CRC calculation start from CMD command domain, including length domain and data domain, LSB at back, calculating CRC by function below:

```
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 endian mode

The data output of equipment is small endian mode (such as integer type, floating point type, low byte at front, high byte at back).

1.3 serial port default

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

1.4 default as continuous data output, refer to 4.2.2.1.

2. Communication mode

The equipment has two mode: normal mode (inquiry-response mode) and continuous mode (output data at a frequency). During continuous mode, normal mode is operative as well.

2.1 normal mode

In normal mode, user send inquiry or setting command, the device response accordingly. The device response has two formats: response (CMD=ASK) and reply (CMD=RET), for detail, please refer to chapter 4 command list.

2.1.1 response

Response frame format as below：

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

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

IMU_Error Code	Value	Description
IMU_NO_ERROR	0x00	Command is executed
IMU_ERROR	0x01	Command is not executed correctly
IMU_INVALID_FRAME	0x04	Invalid command
IMU_INVALID_PARAMETER	0x09	Invalid parameter
IMU_NOT_READY	0x0A	Sensor not ready

remarks：The error code constitutes the data domain of the frame(DATA).

2.1.2 reply

The reply is a one-to-one response to the user command. The CMD and data domain of different query commands are different. Please refer to the command list in Chapter 4.。

3. Output MASK and output BUFFER

3.1 Output MASK

The IMU560 protocol uses output masks (uint32) to set the output data items and formats. The user can use or disable the following data items:

Description	order	Support or not	Mask value	Description
IMU_OUPUT_QUATERNION	Four elements of attitude angle	1	Not support	0x00000001
IMU_OUTPUT_EULER	attitude angle	2	support	0x00000002
IMU_OUTPUT_MATRIX	Attitude rotation matrix	3	Not support	0x00000004
IMU_OUTPUT_GYROSCOPES	3 axis angular rate after calibration	4	support	0x00000008
IMU_OUTPUT_ACCELEROMETERS	3 axis acceleration after calibration	5	support	0x00000010
IMU_OUTPUT_MAGNETOMETERS	3 axis magnetic field after calibration	6	support	0x00000020
IMU_OUTPUT_TEMPERATURES	Temperature after calibration	7	support	0x00000040

IMU_OUTPUT_GYROSCOPES_RAW	Original gyro value	8	Not support	0x00000080
IMU_OUTPUT_ACCELEROMETERS_RAW	Original acceleration value	9	Not support	0x00000100
IMU_OUTPUT_MAGNETOMETERS_RAW	Original magnetic field value	10	Not support	0x00000200
IMU_OUTPUT_TEMPERATURES_RAW	Original temperature value	11	Not support	0x00000400
IMU_OUTPUT_TIME_SINCE_RESET	Time after re-set	12	support	0x00000800
IMU_OUTPUT_DEVICE_STATUS	Device status	13	Not support	0x00001000
IMU_OUTPUT_GPS_POSITION	GPS original position	14	Not support	0x00002000
IMU_OUTPUT_GPS_NAVIGATION	GPS original speed and yaw	15	Not support	0x00004000
IMU_OUTPUT_GPS_ACCURACY	GPS original horizontal, vertical and yaw accuracy	16	Not support	0x00008000
IMU_OUTPUT_GPS_INFO	GPS status (valid, star number)	17	support	0x00010000
IMU_OUTPUT_BARO_ALTITUDE	Sensor raw air pressure altitude value	18	support	0x00020000
IMU_OUTPUT_BARO_PRESSURE	Sensor Raw Air Pressure (Pascal)	19	support	0x00040000
IMU_OUTPUT_POSITION	3D position after Kalman filter	20	support	0x00080000
IMU_OUTPUT_VELOCITY	3D speed after Kalman filter	21	support	0x00100000
IMU_OUTPUT_ATTITUDE_ACCURACY	Attitude accuracy after Kalman filter	22	Not support	0x00200000
IMU_OUTPUT_NAV_ACCURACY	Position and speed accuracy after Kalman filter	23	Not support	0x00400000
IMU_OUTPUT_GYRO_TEMPERATURES	Inner gyro sensor temperature after calibration	24	Not support	0x00800000
IMU_OUTPUT_GYRO_TEMPERATURES_RAW	Inner gyro sensor original temperature	25	Not support	0x01000000
IMU_OUTPUT_UTC_TIME_REFERENCE	UTC time	26	support	0x02000000
IMU_OUTPUT_MAG_CALIB_DATA	Magnetometer after calibration	27	Not support	0x04000000
IMU_OUTPUT_MAG_HEADING	MAGNETIC azimuth	28	support	0x08000000
IMU_OUTPUT_ODO_VELOCITY	Odometer original speed	29	Not support	0x10000000
IMU_OUTPUT_DELTA_ANGLES	Enable delta angle output from coning integration	30	Not support	0x20000000
IMU_OUTPUT_HEAVE	Enable Heave output	31	Not support	0x40000000

3.1.1 Attitude output

IMU_OUT_EULER

Attitude angle includes Roll, Pitch and Yaw, use real32(float) to indicate, 12 bytes, unit is radians.

Store format:

Roll	Pitch	Yaw

3.1.2 Sensor output after calibration

IMU_OUTPUT_GYROSCOPES

3 axis gyro angular rate after calibration Gx, Gy and Gz, use real32(float) to indicate, 12 bytes, unit is rad.S^{-1}(radian/second).

Store format:

Gx	Gy	Gz

IMU_OUTPUT_ACCELEROMETERS

3 axis acceleration after calibration Ax, Ay and Az, use real32(float) to indicate, 12 bytes, unit is m.S^{-2}。

Store format:

Gx	Gy	Gz

IMU_OUTPUT_TEMPERATURES

Acceleration or gyro built-in temperature sensor or temperature measured by the sensor, use real32(float) to indicate, 8 bytes, unit is ℃。

Store format:

T0	T1

3.1.3 3D magnetic field output after calibration

IMU_OUTPUT_MAGNETOMETERS

3D magnetic field strength output, using real32 (float), representing 12 bytes, the unit is uT.

Store format:

Mx	My	Mz

3.1.4 Relative time output

IMU _OUTPUT_TIME_SINCE_RESET

The time out is from re-set till present, uint32 integer type, 4 byte, unit is mS.

Store format:

time

3.1.5 GPS original output

IMU_OUT_GPS_INFO

The output mainly includes basic GPS status below:

* GPS period time iTOW, uint32 integer type, 4 bytes, unit ms;
* GPS positioning information, unit 8 integer type, 1 byte;
* GPS satellites numbers, the satellites numbers for navigation;

Store format:

iTOW	GPSFlags	NumSV

GPSFlags: include sign below, explanation as below:

bit	7	6	5	4	3	2	1	0
domain	Ext Fix info		GPS_TRUE_HEAD_VALID	GPS_VALID_UTC	GPS_VALID_WKN	GPS_VALID_TOW	GPS Fix info	
Description	00 = GPS_STD_FIX 01= GPS_DGPS_FIX 10 = GPS_FRTK_FIX 11=GPS_RTK_FIX		1=Valid true heading data	1=Valid UTC data(leap seconds known)	1=Week number known	1=Time of week known	00=IMU_NO_FIX 01=IMU_TIME_ONLY 10=IMU_2D_FIX 11=IMU_3D_FIX	

3.1.6 Navigation output after Kalman filter compensation

IMU_OUTPUT_POSITION

3D position information is WGS84 format：latitude, longitude and altitude, use real64(double) to indicate, 24 bytes, latitude and longitude unit is degree, altitude unit is m.

Store format：

Lat.	Longi.	Alt.

3.1.7 magnetic azimuth(Heading) output

IMU_OUTPUT_MAG_HEADING

The magnetic azimuth(heading) calculated from the three-axis magnetic field, real32 (float), 4 bytes, unit is Deg.

Storage format:

HEADING

Note: The accuracy of the magnetic azimuth is greatly affected by the magnetic field of the external environment. Please perform magnetic field calibration before installation. For details, please refer to 4.1.5. Please re-calibrate after changing the environment. To ensure the accuracy of the magnetic azimuth, make sure there is no external magnetic interference source during use.

3.1.8 GPS UTC Output

IMU_OUTPUT_UTC_TIME_REFERENCE

Output by the GPS module, including the following:

Year: Increase to get the current UTC year, range [0-65535]， 2 byte(uint16_t)

Month: UTC Month，Range【1-12】, 1 byte

Day: UTC Day，Range【1-31】, 1 byte

Time: UTC Hours，Range【0-23】, 1 byte

Minute: UTC Min，Range【0-60】, 1 byte

Second: UTC Second，Range【0-60】, 1 byte

Storage format:

Year	Month	Day	Time	Minute	Second

3.1.9 Pressure altitude and pressure output

IMU_OUTPUT_ BARO_ALTITUDE

The barometric altitude calculated from the information output by the barometric pressure sensor, int32, 4 bytes, the unit is cm.

Storage format:

altitude

IMU_OUTPUT_ BARO_PRESSURE

The intensity of the air pressure calculated by the air pressure sensor, uint32, 4 bytes, the unit is Pascals.

Storage format:

P

3.2 Output BUFFER

According to different value of output masks(uint32)K, IMU560 will produce responding output BUFFER, e.g. Default output MASK as below:

IMU_OUTPUT_EULER|IMU_OUTPUT_GYROSCOPES|IMU_OUTPUT_ACCELEROMETERS|IMU_OUTPUT_MAGNETOMETERS|IMU_OUTPUT_TEMPERATURES|IMU_OUTPUT_TIME_SINCE_RESET|IMU_OUTPUT_GPS_INFO|IMU_OUTPUT_BARO_ALTITUDE|IMU_OUTPUT_BARO_PRESSUREIMU_OUTPUT_POSITION|IMU_OUTPUT_VELOCITY|IMU_OUTPUT_UTC_TIME_REFERENCE|IMU_OUT

PUT_MAG_HEADING；

Then corresponding BUFFER output as：

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

Mx	My	Mz	T0	T1	Time	iTOW	GPSFlags	numSV
4	4	4	4	4	4	4	1	1
12			8		4	6		

Baro_Alt	Baro_P	Lati	Longi	Alti	VelN	VelN	VelN	UTC	Heading
4	4	8	8	8	4	4	4	7	4
4	4	24			12			7	4

4. IMU560 Command list

4.1 Set command

4.1.1 normal setting

4.1.1.1 save setting

4.1.1.1.1 set save command

* **IMU_SAVE_SETTINGS------(0x24)**

purpose: to save all setting to EEPROM, as power off save function. With no data domain, frame format as below:

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

note: EEROR CODE refer to 2.1.1 content；

4.1.2 output setting

4.1.2.1 default output MASK setting

4.1.2.1.1 set default output MASK

***IMU_SET_DEFAULT_OUTPUT_MASK------(0x50)**

purpose: to set output MASK(output mask(uint32)), that is output data type (Buffer)。

Note: with no power off save function, need execute save setting command.

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	5	1	1	1
0xFF	0x02	0x50	0x00	0x05	DATA	0xXX	0xXX	0x03

And: DATA part

DATA	
Reserved.Leave to 0(bytes)	Default output mask(uint32)
1	4

Noticed: output mask is uint32，little endian mode storage，the value refers to the contents of Table 3.1.

Reply:

IMU_ACK

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

Eg: TXD: FF 02 50 00 05 00 **5A 08 19 00** A7 FD 03 (output mask= 0x0019085A)

RXD: FF 02 01 00 01 00 05 63 03

4.1.2.1.2 get default output MASK

***IMU_GET_DEFAULT_OUTPUT_MASK------(0x51)**

purpose: to read output MASK(output mask(uint32)), then get output data type (Buffer) ;

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x51	0x00	0x00	NULL	0xXX	0xXX	0x03

Reply:

* **IMU_RET_DEFAULT_OUTPUT_MASK------(0x52)**

purpose: back output mask;

Frame format as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	4	1	1	1
0xFF	0x02	0x52	0x00	0x04	DATA	0xXX	0xXX	0x03

therein: DATA part

DATA
Default output mask(uint32)
4

Eg: TXD: FF 02 51 00 00 D9 3F 03

RXD: FF 02 52 00 04 **5A 08 19 00** E5 97 03 (output mask= 0x0019085A)

4.1.2.2 Continuous mode

Used to query for continuous mode information, or to set continuous mode, mainly to set the output working mode.

Mode can be used in two ways as follows:

IMU_NORMAL_MODE (normal working mode or called question and answer mode): 0x00

IMU_CONTINUOUS_MODE (continuous output mode): 0x01

Among them CONTINUOUS_MODE (continuous output mode) has different Divider values, corresponding to the following different output frequencies:

Divider	OUT(Hz)
0	Invalid
1	100
2	50
3	35
4	25
5	20
6	15
10	10
20	5
100	1

Note: The default is IMU_CONTLNUOUS_MODE (continuous output mode) with a frequency of 100Hz.

4.1.2.2.1 Setting the continuous mode

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

Function: set the output mode;

Note: with no power-down save function, you must execute the save settings command to save.

The frame format is as follows:

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

therein: DATA part

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

reply:

IMU_ACK

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

Eg1: Set to one question-one answer mode:

TXD: FF 02 53 00 03 00 00 00 69 D1 03

RXD: FF 02 01 00 01 00 05 63 03

Eg2: Set to continuous output mode(100Hz):

TXD: FF 02 53 00 03 00 01 01 61 80 03

RXD: FF 02 01 00 01 00 05 63 03

4.1.2.2.2 Acquiring continuous mode

* IMU_GET_CONTINUOUS_MODE------(0x54)

Function: used to read the current mode;

The frame format is as follows:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x54	0x00	0x00	NULL	0xXX	0xXX	0x03

reply:

* **IMU_RET_CONTINUOUS_MODE------(0x55)**

Function: used to return Mode and Divider;

The frame format is as follows:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	2	1	1	1
0xFF	0x02	0x55	0x00	0x02	DATA	0xXX	0xXX	0x03

Therein: DATA part

DATA	
Mode(uint8)	Divider(uint8)
1	1

Eg: TXD: FF 02 54 00 00 E0 82 03

RXD: FF 02 55 00 02 **00 00** E6 8E 03(one question-one answer mode working)

4.1.3 Protocol Settings

4.1.3.1 Protocol mode

The main command is related to setting or reading the baud rate. The baud rate is a 32-bit integer. The valid values are as follows: 9600, 19200, 38400, 57600, 115200, 230400.

4.1.3.1.1 Setting the protocol mode

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

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

Note: with no power-down save function, you must execute the save settings command to save.

The frame format is as follows:

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

Therein: DATA part

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

Reply:

IMU_ACK

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

Eg: TXD: FF 02 12 00 05 00 00 C2 01 00 E2 6A 03 (Baudrate= 0x0001C200)

RXD: FF 02 01 00 01 00 05 63 03

4.1.3.1.2 Obtaining the protocol mode

* IMU_GET_PROTOCOL_MODE------(0x13)

Function: used to obtain the communication baud rate;

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x13	0x00	0x00	NULL	0xXX	0xXX	0x03

Reply:

***IMU_RET_PROTOCOL_MODE------(0x14)**

Function: return the current baud rate;

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	4	1	1	1
0xFF	0x02	0x14	0x00	0x04	DATA	0xXX	0xXX	0x03

Therein: DATA part

DATA
baudrate
4

Eg: TXD: FF 02 13 00 00 6A F1 03

RXD: FF 02 14 00 04 00 C2 01 00 51 55 03 (Baudrate= 0x0001C200)

4.1.3.2 Output mode

The main command is related to setting the data format of the output. For example, the big endian or little-endian mode, the output is fixed point or floating point number, etc., pay special attention: IMU560 only supports little-endian mode and floating point number.

Different output modes (as below) can be combined (Ored):

IMU_OUTPUT_MODE_DEFAULT 0x00
IMU_OUTPUT_MODE_BIG_ENDIAN 0x00
IMU_OUTPUT_MODE_LITTLE_ENDIAN 0x01 (default)
IMU_OUTPUT_MODE_FLOAT 0x00
IMU_OUTPUT_MODE_FIXED 0x02

4.1.3.2.1 Setting the output format

*** IMU_SET_OUT_MODE------(0x15)**

Note: This command is not supported by the IMU560.

4.1.3.2.2 Obtaining the output format

*** IMU_GET_OUTPUT_MODE------(0x16)**

Function: read the format of the current output;

Note: with no power-off save function, you must execute the save settings command to save.

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x16	0x00	0x00	NULL	0xXX	0xXX	0x03

Reply:

*** IMU_RET_OUTPUT_MODE------(0x17)**

Function: returns the current output format;

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x17	0x00	0x01	mode	0xXX	0xXX	0x03

Eg: TXD: FF 02 16 00 00 53 4C 03

RXD: FF 02 17 00 01 01 9C D1 03(output mode=little endian)

4.1.4 GPS and navigation settings

4.1.4.1 gravity Level Configuration

These commands are mainly used to set or get the current gravity level. An invalid or inappropriate gravity level will cause the IMU560 to make errors in speed and position calculation.

Gravity level unit m.s-2, default value is 9.8m.s-2.

4.1.4.1.1 Setting the heavy power level

*** IMU_SET_GRAVITY_MAGNITUDE------(0xB1)**

Function: set the current gravity level;

Note: with no power off save function, you must execute the save settings command to save.

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	5	1	1	1
0xFF	0x02	0xB1	0x00	0x05	DATA	0xXX	0xXX	0x03

Therein: DATA part

DATA	
Reserved.Leave to 0(bytes)	magnitude (real32)
1	4

Reply:

IMU_ACK

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x01	0x00	0x01	ERRO R_CO DE	0xXX	0xXX	0x03

Eg: TXD: FF 02 B1 00 05 00 CD CC 1C 41 C3 81 03 (gravity = 411CCCCD = 9.8)

RXD: FF 02 01 00 01 00 05 63 03

4.1.4.1.2 Obtaining heavy power

*** IMU_GET_GRAVITY_MAGNITUDE------(0xB2)**

Function: get the current gravity level;

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0xB2	0x00	0x00	NULL	0xXX	0xXX	0x03

Reply:

*** IMU_RET_GRAVITY_MAGNITUDE------(0xB3)**

Function: get the current gravity level;

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	4	1	1	1
0xFF	0x02	0xB3	0x00	0x04	ERROR _CODE	0xXX	0xXX	0x03

Therein: DATA part

DATA
magnitude (real32)
4

Eg: TXD: FF 02 B2 00 00 3F FA 03

RXD: FF 02 B3 00 04 CD CC 1C 41 A5 FA 03 (gravity = 411CCCCD = 9.8)

4.1.5 Magnetic field calibration and setting

4.1.5.1 Magnetic field calibration-----（0x70)

Function: For horizontally calibrate magnetic field strength to improve magnetic azimuth accuracy, Perform this calibration when you first install or replace the installation environment.

Note：Rotate the platform clockwise or counterclockwise, at least one revolution, and the completed time in more than 30 seconds.

4.1.5.1.1 Horizontal calibration start

IMU_CALIB_MAG_START-----(0x08)

Function: Start horizontal calibration. After successfully executing this command, start to rotate the platform.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x70	0x00	0x01	0x08	0xXX	0xXX	0x03

reply:

IMU_ACK

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

Eg: TXD: FF 02 70 00 01 08 CF D5 03

RXD: FF 02 01 00 01 00 05 63 03

4.1.5.1.2 horizontal calibration stop

IMU_CALIB_MAG_STOP-----(0x0A)

function：Stop the horizontal calibration. When you have completed at least one revolution, execute this command to end the calibration and the relevant magnetic field parameters will be saved.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x70	0x00	0x01	0x0A	0xXX	0xXX	0x03

reply:

IMU_ACK

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

Eg: TXD: FF 02 70 00 01 0A EC C7 03

RXD: FF 02 01 00 01 00 05 63 03

4.1.5.1.3 horizontal calibration abandon

IMU_CALIB_MAG_ABANDON-----(0x09)

function：After starting the calibration, execute this command to abandon and exit calibration, and the relevant magnetic field parameters will not be saved.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x70	0x00	0x01	0x09	0xXX	0xXX	0x03

reply:

IMU_ACK

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

Eg: TXD: FF 02 70 00 01 09 DE 5C 03

RXD: FF 02 01 00 01 00 05 63 03

4.1.5.2 Magnetic declination setting and reading

4.1.5.2.1 Set the magnetic declination

IMU_SET_MAGNETIC_DECLINATION------（0x40）

function：Set the angle of the magnetic declination.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	5	1	1	1
0xFF	0x02	0x40	0x00	0x05	Datas	0xXX	0xXX	0x03

Therein: DATA part

DATA	
Reserved.Leave to 0 (bytes)	Magnetic_declination（real32)
1	4

reply:

IMU_ACK

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

Eg: TXD: FF 02 40 00 05 00 66 66 06 3F ED 38 03 (magnet dec = 3F066666 = 0.525)

RXD: FF 02 01 00 01 00 05 63 03

4.1.5.2.2 Read current magnetic declination

IMU_GET_MAGNETIC_DECLINATION------（0x41）

function：Get the currently set magnetic declination；

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x41	0x00	0x00	NULL	0xXX	0xXX	0x03

reply:

*** IMU_RET_MAGNETIC_DECLINATION ------(0x42)**

function：Returns the magnitude of the current gravity；

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	4	1	1	1
0xFF	0x02	0x42	0x00	0x04	datas	0xXX	0xXX	0x03

Therein: DATA part

DATA
magnitude（real32)
4

Eg: TXD: FF 02 41 00 00 5C AA 03

RXD: FF 02 42 00 04 66 66 06 3F41 E3 03 (magnet dec = 3F066666 = 0.525)

4.1.6 Sensor software reset

IMU_SOFT_RESET-----(0x88)

function：Perform this command to reset the sensor.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	0	1	1	1
0xFF	0x02	0x88	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 ending byte
1	1	1	1	1	1	1	1	1
0xFF	0x02	0x01	0x00	0x01	ERROR _CODE	0xXX	0xXX	0x03

Eg: TXD: FF 02 88 00 00 CA 2E 03

RXD: FF 02 01 00 01 00 05 63 03

4.2 Data output

4.2.1 Normal mode (question and answer)

The main instruction is used to get the data item output, refer to the output BUFFER part.

4.2.1.1 Getting the default data item output

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

Function: Get the current default output data item. The data item is set by the IMU_SET_DEFAULT_OUTPUT_MASK command (output masks(uint32)), refer to the output Buffer part.

The frame format is as below:

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

Reply:

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

Function: Returns the default data item output.

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	121	1	1	1
0xFF	0x02	0x57	0x00	0x79	DATA	0xXX	0xXX	0x03

Data part as below (total length: 0x0079):

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

Mx	My	Mz	T0	T1	Time	iTOW	GPSFlags	numSV
4	4	4	4	4	4	4	1	1
12			8		4	6		

BARO_ALt	BARO_P	Lati	Longi	Alti	VelN	VelN	VelN	UTC	Heading
4	4	8	8	8	4	4	4	7	4
4	4	24			12			7	4

Eg: TXD: FF 02 56 00 00 55 3A 03

RXD: FF 02 57 00 6A **8B E9 F2 BB** 8E 69 D6 3A **3F D9 5A BF** 5F 91 85 39 **DA 3A DA B9** 50 80 E5 38 **AE 45 77 3C** 17 73 94 3D **2C 05 1D C1** F5 BE E1 41 **F0 13 C9 41** 5B 77 CA 41 4E B4 FA 41 D3 D4 F7 41 68 25 04 00 78 BA 7C 00 00 00 DA 9D EB 6F E9 B1 36 40 A5 C9 F5 DB D4 73 5C 40 00 00 00 00 00 00 34 40 D1 52 FA BC 3A 27 32 BD 00 00 00 80 5A 0B 44 C2 AF 2B 03

4.2.1.2 Obtaining Specially Specified Data Item Output

*** IMU_GET_SPECIFIC_OUTPUT------(0x58)**

Function: Get a specially appointed MASK data item.

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	4	1	1	1
0xFF	0x02	0x58	0x00	0x04	DATA	0xXX	0xXX	0x03

Therein: DATA part

DATA
Output masks(uint32)
4

Reply:

*** IMU_RET_SPECIFIC_OUTPUT------(0x59)**

Function: Returns the output of a specially appointed data item.

The frame format is as below:

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	121	1	1	1
0xFF	0x02	0x59	0x00	0x79	DATA	0xXX	0xXX	0x03

Data part as below (total length: 0x0079):

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

Mx	My	Mz	T0	T1	Time	iTOW	GPSFlags	numSV
4	4	4	4	4	4	4	1	1
12			8		4	6		

BARO_Alt	BARO_P	Lati	Longi	Alti	VelN	VelN	VelN	UTC	Heading
4	4	8	8	8	4	4	4	7	4
4	4	24			12			7	4

TXD: FF 02 58 00 04 02 00 00 00 B8 45 03 (output mask = 0x00000002(euler))

RXD: FF 02 59 00 0C **AD 0E F0 BB** E0 55 DE 3A **83 20 5B BF** BA 41 03

Note: The above IMU_GET_DEFAULT_OUTPUT (0x56), IMU_GET_SPECIFIC_OUTPUT (0x58) reply RET data items, refer to Output masks (uint32) for the following corresponding BUFFER output: IMU_OUTPUT_EULER|IMU_OUTPUT_GYROSCOPES|IMU_OUTPUT_ACCELEROMETERS|IMU_OUTPUT_MAGNETOMETERS|IMU_OUTPUT_TEMPERATURES|IMU_OUTPUT_TIME_SINCE_RESET|IMU_OUTPUT_GPS_INFO|IMU_OUTPUT_BARO_ALTITUDE|IMU_OUTPUT_BARO_PRESSUREIMU_OUTPUT_POSITION|IMU_OUTPUT_VELOCITY|IMU_OUTPUT_UTC_TIME_REFERENCE|IMU_OUTPUT_MAG_HEADING ;

4.2.2 Continuous output mode

The continuous output mode is output according to the parameters set by IMU_SET_CONTINUOUS_MODE. The IMU560 automatically outputs Output masks (uint32) related data items at a certain frequency after power-on.

4.2.2.1 Continuous data item output

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

Function: The data item is continuously output.

Frame sync byte	Frame start byte	CMD	LEN (MSB)	LEN (LSB)	DATA	CRC (MSB)	CRC (LSB)	Frame ending byte
1	1	1	1	1	121	1	1	1
0xFF	0x02	0x90	0x00	0x79	DATA	0xXX	0xXX	0x03

Data part as below (total length: 0x0079):

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

Mx	My	Mz	T0	T1	Time	iTOW	GPSFlags	numSV
4	4	4	4	4	4	4	1	1
12			8		4	6		

BARO_Alt	BARO_P	Lati	Longi	Alti	VelN	VelN	VelN	UTC	Heading
4	4	8	8	8	4	4	4	7	4
4	4	24			12			7	4

Remarks: Output masks (uint32) is the default BUFFER output below accordingly:
IMU_OUTPUT_EULER|IMU_OUTPUT_GYROSCOPES|IMU_OUTPUT_ACCELEROMETERS|IMU_OUTPUT_MAGNETOMETERS|IMU_OUTPUT_TEMPERATURES|IMU_OUTPUT_TIME_SINCE_RESET|IMU_OUTPUT_GPS_INFO|IMU_OUTPUT_BARO_ALTITUDE|IMU_OUTPUT_BARO_PRESSUREIMU_OUTPUT_POSITION|IMU_OUTPUT_VELOCITY|IMU_OUTPUT_UTC_TIME_REFERENCE|IMU_OUTPUT_MAG_HEADING ;

Eg：FF 02 90 00 6A 9A 8C FA BB 17 FE C4 B8 F2 B3 82 BF 46 CA 5C B9 E4 42 18 39 AE FA B5 B8 23 51 42 BA D8 06 9B 3D E3 09 1D C1 51 02 BB 41 D3 54 E1 41 0A EC CA 41 8E 19 FF 41 CD 8F FB 41 A2 36 18 00 F8 CB 90 00 00 00 A9 F6 FD BA B2 B1 36 40 47 89 35 2B D6 73 5C 40 00 00 00 00 00 00 34 40 BD FD FF BD 51 48 66 3D 00 00 00 80 40 01 6B C2 72 47 03

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