LPMS-IG1 Series
Hardware Manual ver. 1.2

LPMS-IG1-CAN

LPMS-IG1P-CAN

LPMS-IG1-RS232

LPMS-IG1P-RS232

LP-Research Inc.

http://www.lp-research.com

Version History

Date	Version	Details
2020-01-21	ver. 1.2	- revision on magnetometer parameters - update of cable data
2019-12-19	ver. 1.1	- add detailed information of the waterproof connector
2019-05-23	ver. 1.0	- Initial release，compatible with firmware version IG1-3.0.3-20190508 or above

Table of Contents

1. Introduction

LPMS-IG1 series include two models, LPMS-IG1 (without GPS) and LPMS-IG1P (with GPS). Both models offer the following communication methods: USB+RS232 or USB+CAN. For details on how to use the communication interfaces, please refer to the relevant sections below. LPMS-IG1 series come in a waterproof metal housing with a flat bottom profile and mounting holes for easy installation.

For more information please refer to related datasheets and user manuals, available from the LP-RESEARCH website at the following address: http://www.lp-research.com.

Main features:

- High precision and stability
- Dual 3-axis general purpose gyroscope, 3-axis accelerometer, 3-axis magnetometer
- GyroI: High precision 3-axis gyroscope
- GyroII: 3-axis general purpose gyroscope
- Realtime output: Raw and calibrated sensor data, quaternion, Euler angles, temperature, GPS (LPMS-IG1P)
- Communication method：USB+RS232 or USB+CAN

Table 1-1. LPMS-IG1 series part number information

Part Number	Communication Interface			GPS Antenna
	USB	RS232	CAN	
LPMS-IG1-RS232	✓	✓	✗	✗
LPMS-IG1-CAN	✓	✗	✓	✗
LPMS-IG1P-RS232	✓	✓	✗	✓
LPMS-IG1P-CAN (not released yet)	✓	✗	✓	✓

2. System Overview

2.1 Sensor Structure

5V~24V DC

```
┌─────────────────────────────────────────────────────────┐
│                  Voltage Regulator                         │
│                                                            │
│  ┌──────────────┐    ┌────────────┐  ┌────────────┐      │
│  │   X-axis     │    │ Temperature│  │    GPS     │      │
│  │ ┌─────┬─────┐│    │  Sensor    │  │ (Optional) │      │
│  │ │Y-axis│Z-axis││   └────────────┘  └────────────┘      │
│  │ └─────┴─────┘│         ┌──────────────────┐           │
│  │   GyroI      │         │                  │           │
│  └──────────────┘         │      MCU         │           │
│  ┌──────────────┐         │                  │           │
│  │ IMU(6-axis)  │ ◄────►  │                  │           │
│  │ (Acc + GyroII)│        │                  │           │
│  └──────────────┘         └──────────────────┘           │
│  ┌──────────────┐            Data/Command                │
│  │   3-axis     │ ◄────►                                  │
│  │ Magnetometer │                                         │
│  └──────────────┘                                         │
│  ┌──────────────────────────────────────────────┐        │
│  │              USB/RS232/CAN                     │        │
│  └──────────────────────────────────────────────┘        │
└─────────────────────────────────────────────────────────┘
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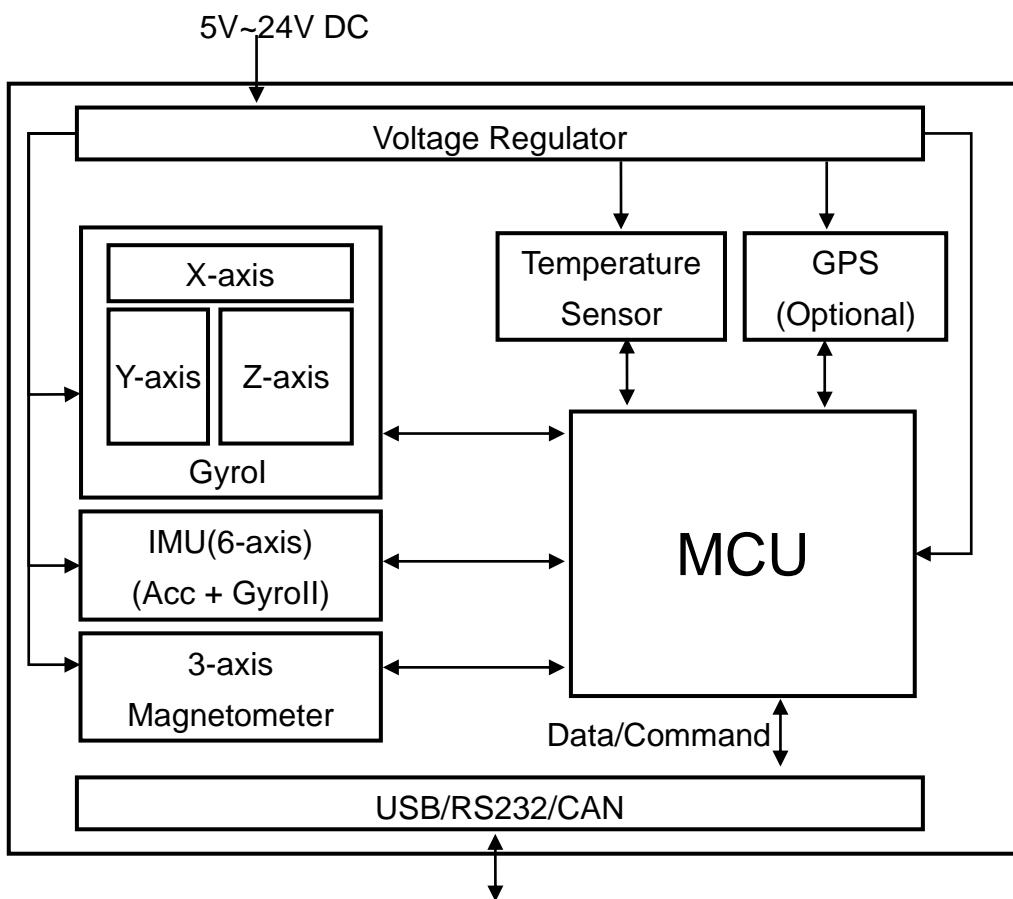
Fig. 2.1. LPMS-IG1 series sensor structure

## 2.2 Pin Out Configuration
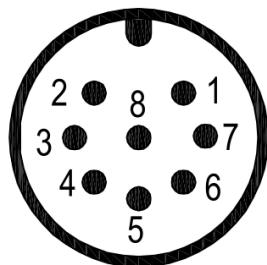
Fig. 2.2. Sensor waterproof connector pin out

(M12 8-pin A-coded male connector)

Fig. 2.3. Paired cables (left: cable connections for RS232/CAN;

right: USB connection)

Table 2-1. Connector pin out introduction

Pin No.	Signal	Name	Remark	Paired Cable Color
1	Power	VIN	+5V~+24V DC	White
2		GND	Ground	Brown
3	RS232/CAN	TX/CAN+	-	Green
4		RX/CAN-	-	Yellow
5	-	RES	Float	-
6	USB	D-	-	-
7		D+	-	-
8	IO	EN	Sensor enabled floating: enable; pulled to ground: disabled	Red

Communication setting in default:

- CAN: 500kbps, no termination resistor
- USB: COM mode, 921600bps, 8N1
- RS232: 921600bps, 8N1

3. Coordinate

The LPMS sensor calculates the orientation difference between a fixed sensor coordinate system **(S)** and a global reference coordinate system **(G)**. Both coordinate systems are defined as right-handed Cartesian coordinate systems. The sensor coordinate system **(S)** can be referred to the sticker information on the sensor enclosure.

The global reference coordinate system **(G)** can be divided into two different cases. While the orientation calculation is using all acceleration, gyroscope and magnetic data (sensor filter mode set at acc+gyr+mag), **(G)** system is defined as following:

- X positive when pointing to the magnetic north
- Y positive when pointing to the magnetic west
- Z positive when pointing up (gravity points vertically down with -1g)

While the orientation calculation is using only acceleration and gyroscope data (sensor filter mode set at acc+gyr), **(G)** system is defined as following:

- X positive aligned to ground plane horizontal projection of x axis of **(S)** when sensor powered on
- Y positive based on right-handed Cartesian coordinate definition
- Z positive when pointing up (gravity points vertically down with -1g)

4. Specification

4.1 Overall Parameters

Table 4-1. Overall parameters

Parameter		Condition	Value			Unit
			Min.	Typ.	Max.	
Power supply			5	12	24	V
Size				51 x 45 x 24		mm
Wight		LPMS-IG1		74		g
		LPMS-IG1P		76		
Euler angle range		roll	-180		+180	deg
		pitch	-90		+90	deg
		yaw	-180		+180	deg
Angle resolution				0.01		deg
Power consumption*		LPMS-IG1		0.36 (0.03A@12V)		W
		LPMS-IG1P		0.48 (0.04A@12V)		W
Output data frequency			5	100	500	Hz
Working temperature			-20	20	80	°C
Waterproof level				IP67		
Gyro characteristics* (BW=10Hz)	Bias stability	< 400 dps		4		deg/hr
		> 400 dps		6		
	ARW	< 400 dps		0.12		deg/$\sqrt{\text{hr}}$
		> 400 dps		0.24		
	Noise density	< 400 dps		0.002		dps/$\sqrt{\text{Hz}}$
		> 400 dps		0.004		
	Noise RMS	< 400 dps		0.01		dps
		> 400 dps		0.03		
	P-P noise	< 400 dps		0.05		dps
		> 400 dps		0.15		
	Bandwidth	< 400 dps		10		Hz
		> 400 dps	5	10	92	
Accelerometer characteristics* (BW=10Hz)	Bias stability			25		ug
	VRW			0.045		m/s/$\sqrt{\text{hr}}$
	Noise RMS			0.4		mg
	Noise			100		ug /$\sqrt{\text{Hz}}$

density					
Bandwidth		5	10	100	Hz

* Tests are under room temperature +25°C, and the reference values might be changed under different operation conditions.

4.2 Gyroscope Parameters

Table 4-2. GyroI parameters[**]

Parameter	Condition	Value			Unit
		Min.	Typ.	Max.	
Scale factor	24bit		17920		LSB/dps
Scale factor error	+25°C	-2		+2	%
Scale factor change vs. temperature		-3		+3	%
Offset tolerance	+25°C	-1		+1	dps
Offset change vs. temperature		-1		+1	dps
Measurement range		-400		+400	dps
non-linearity	+25°C	-0.5		+0.5	%FS
Cross axis sensitivity	+25°C	-5		+5	%

Table 4-3. GyroII parameters[**]

Parameter	Condition	Value			Unit
		Min.	Typ.	Max.	
Scale factor	1±1000dps		32.8		LSB/dps
	±2000dps		16.4		
Initial scale factor tolerance	+25°C		±1		%
Scale factor change vs. temperature			±2		%
Offset tolerance	+25°C		±1		dps
Offset change vs. temperature			±0.01		dps/°C
Measurement range			±2000		dps
non-linearity	+25°C		±0.1		%
Cross axis sensitivity			±1		%

** Tests are under room temperature +25°C, and the reference values might be changed under different operation conditions.

* Tests are under room temperature +25°C, and the reference values might be changed under different operation conditions.

4.5 GPS Parameters

Only for modules LPMS-IG1P.

Table 4-6. GPS parameters

Parameter	Values
Receiver type	72-channel, GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1-SAIF, GLONASS L1OF, BeiDou B1I, Galileo E1B/C
Data update rate	1Hz
Max. horizontal position accuracy	2.5 m (Autonomous)
Velocity accuracy*	0.5 m/s (50% @ 30 m/s)
Heading accuracy*	1º (50% @ 30 m/s)
Cold start time**	30s (GPS)
Tracking sensitivity***	-160 dBm (GPS)
Max. operational altitude	50 km
Max. operational velocity	500 m/s

* 50% @ 30 m/s

** All satellites at -130 dBm, except Galileo at -127 dBm

*** Demonstrated with a good external LNA

4.6 Allan Chart
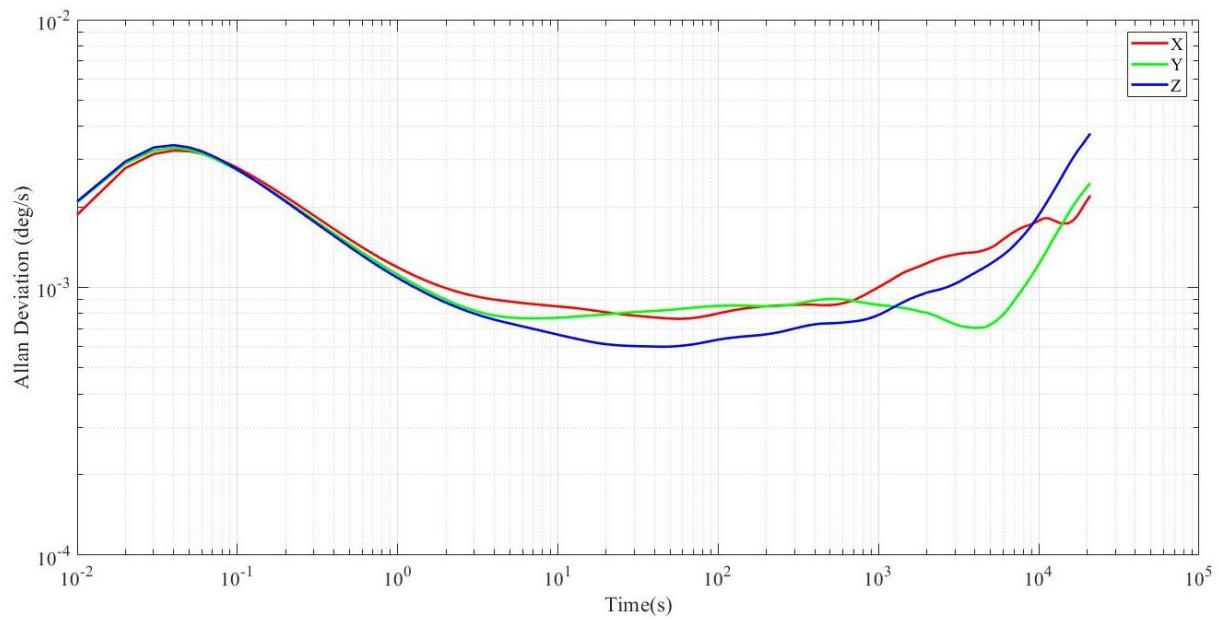
Fig. 4.1. GyroI Allan parameters
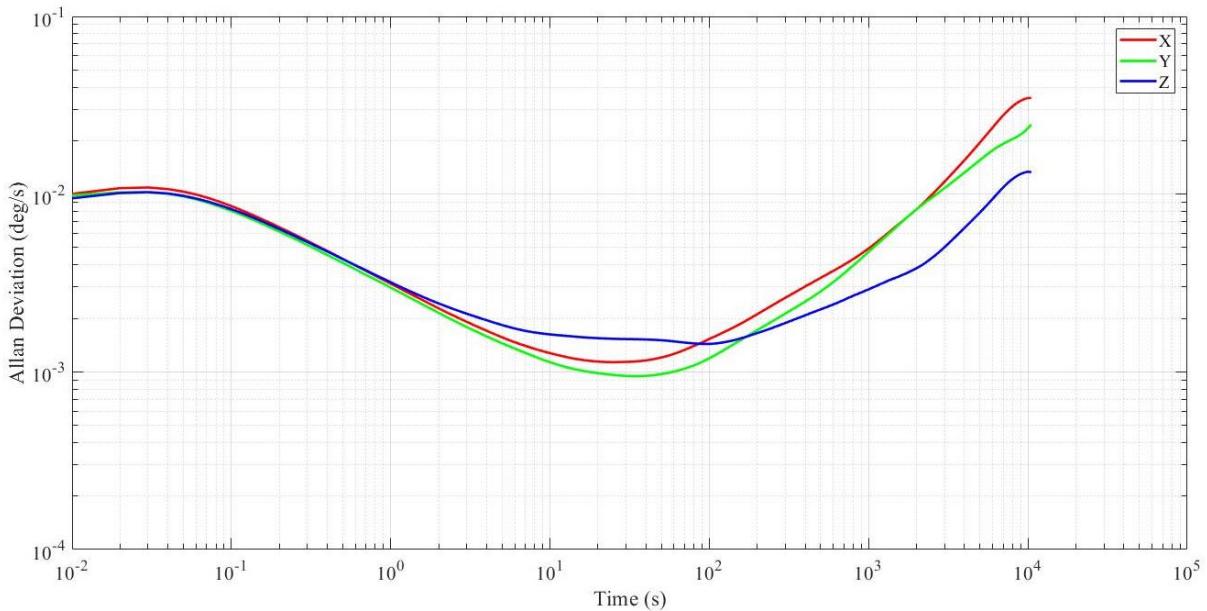

Fig. 4.2. GyroII Allan parameters
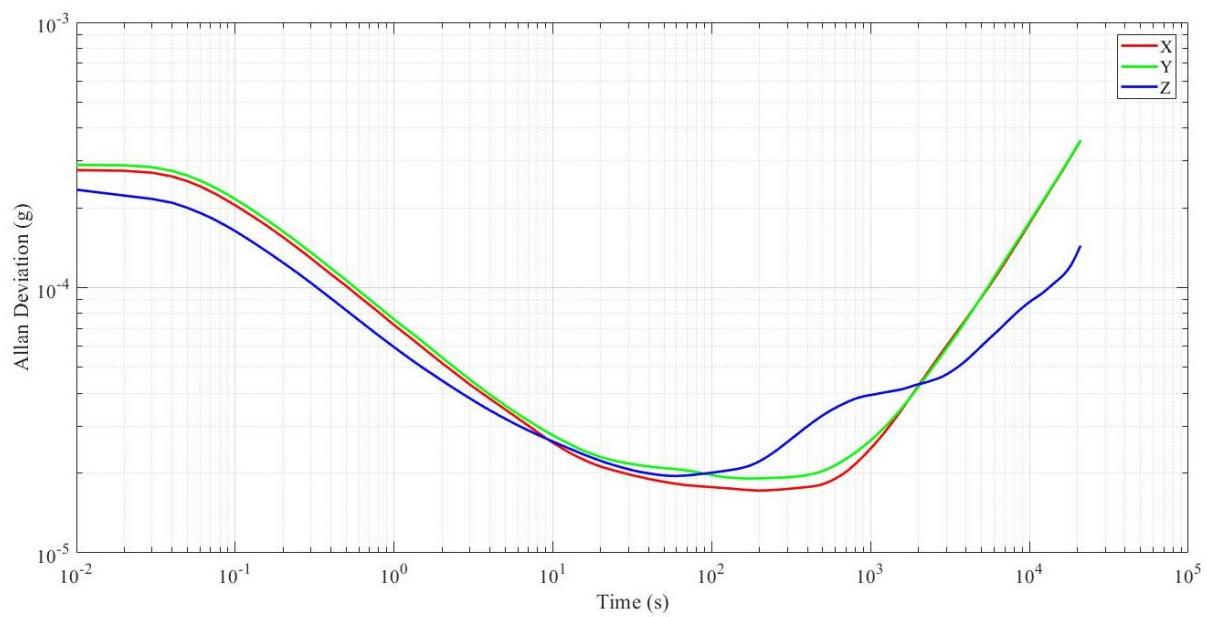
Fig. 4.3. Accelerometer Allan parameters

## 4.7 Temperature-Current-Voltage Characteristics
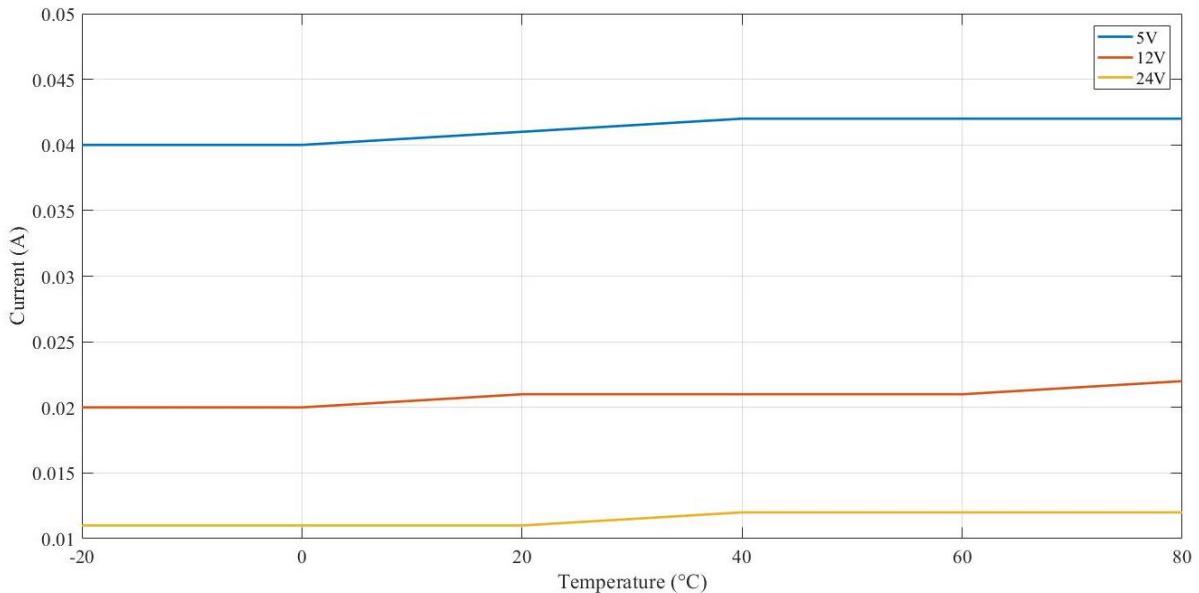
Fig. 4.4. LPMS-IG1 temperature-current-voltage characteristics
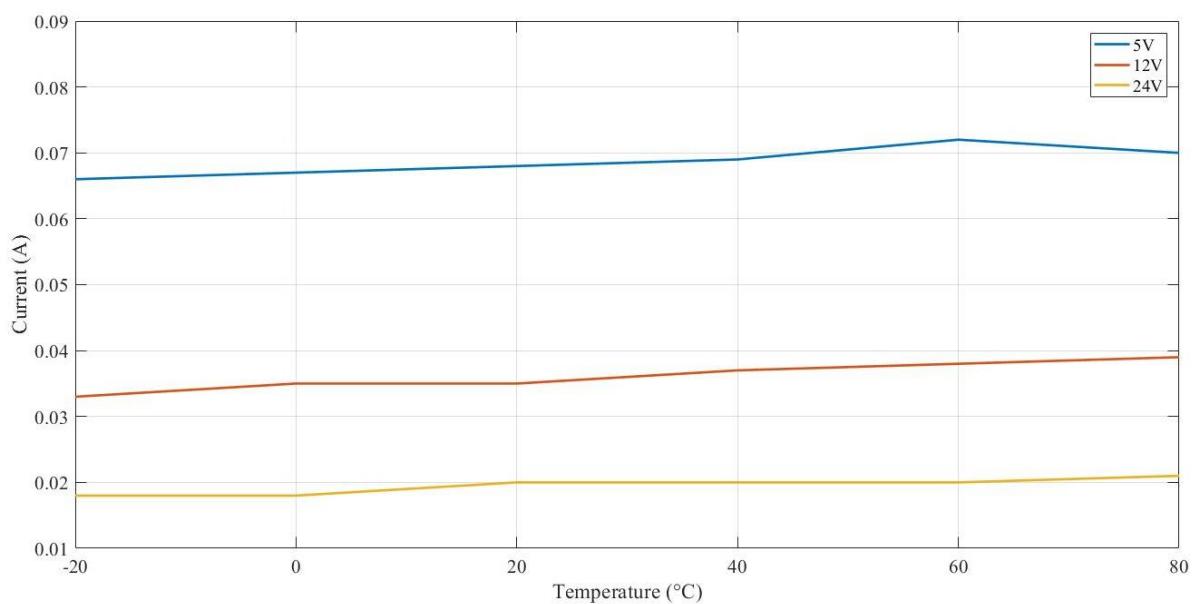
Fig. 4.5. LPMS-IG1 temperature-current-voltage characteristics

5. Mechanical Information
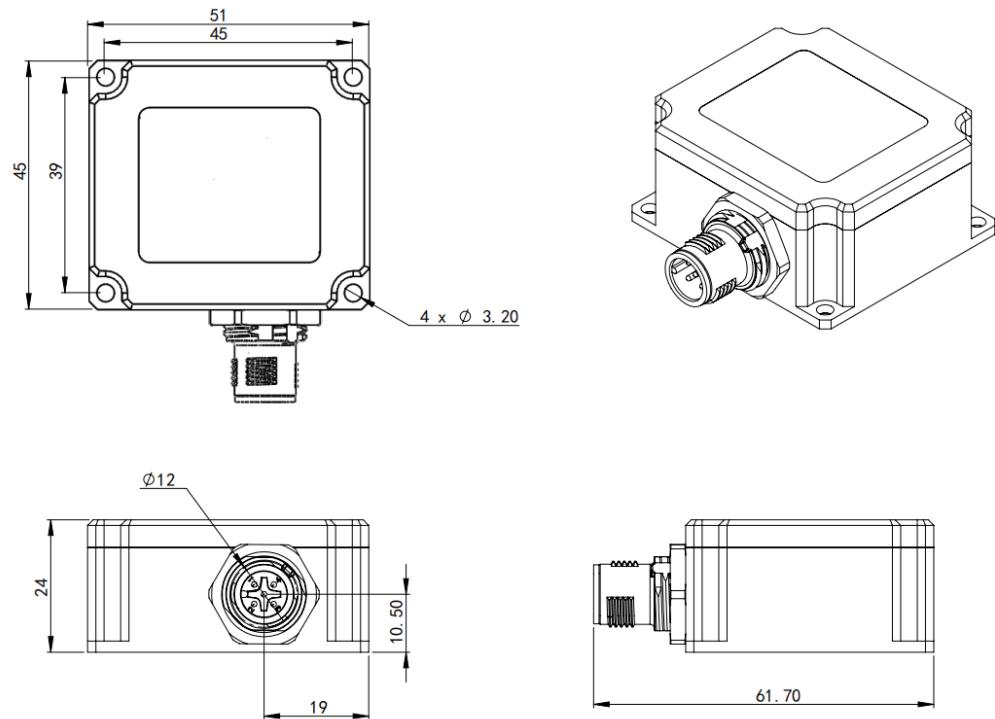
Fig. 5.1. LPMS-IG1 dimension (unit: mm)
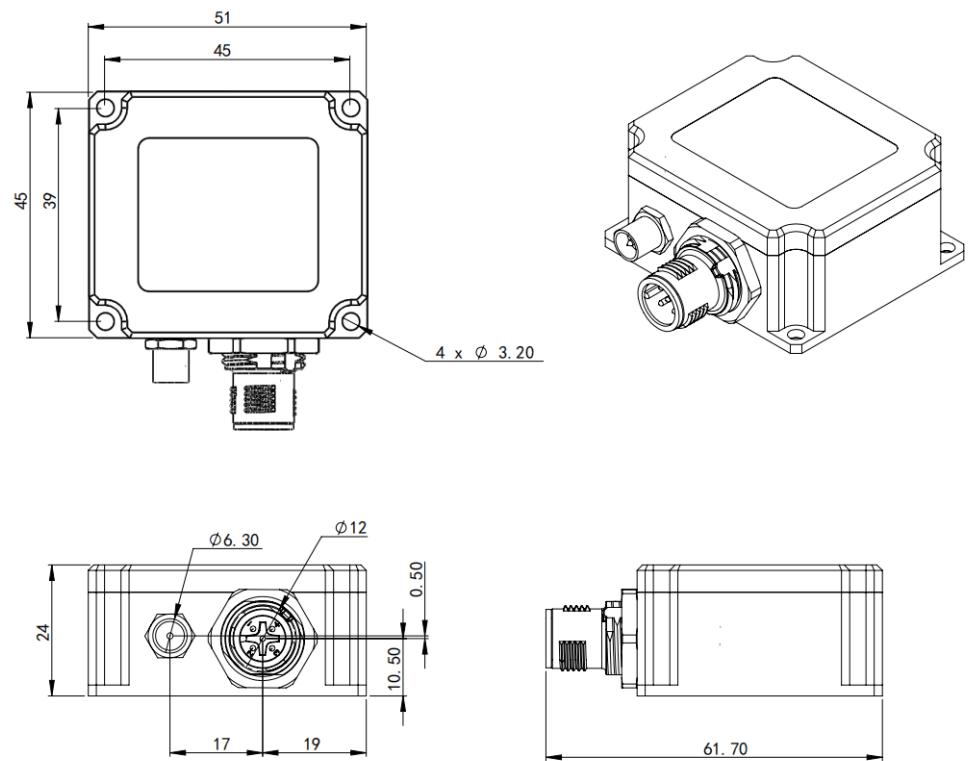
Fig. 5.2. LPMS-IG1P dimension (unit: mm)

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