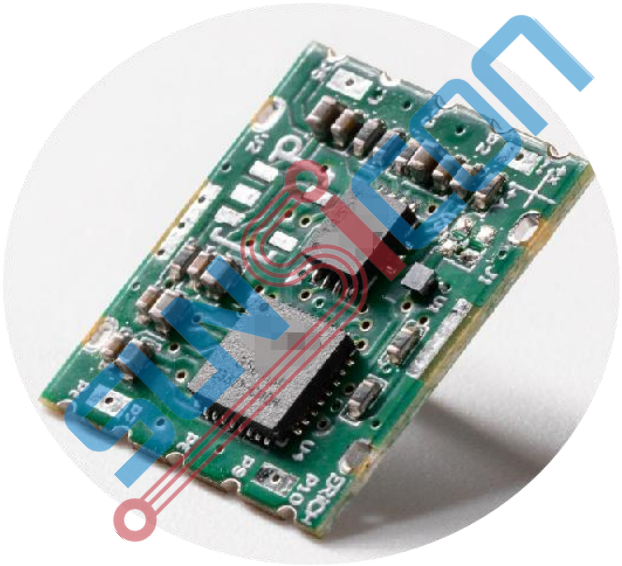
XJ9BT00-STD Module Specification

9-axis IMU module

Version V1.0



Version Revision

Version	date	describe
V1.0	2025.11.30	Initial version

November 30, 2025

1. Module Overview

The XJ9BT00-STD is a 9-axis inertial sensor module based on ARM series high-performance MCU platform and integrates a TDK IMU sensor IMU (three-axis accelerometer/three-axis gyroscope) and TMR (three-axis magnetometer). With the embedded sensor fusion algorithms, it achieves high-precision measurement of the orientation(pitch, roll, yaw) and motion tracking. It can output Euler angles or quaternions real-timely, also supports the output of 9-axis data from the three-axis accelerometer and three-axis gyroscope , making it suitable for various applications.

Except Euler angle output, the module can also detect various motion states, including wakeup-over-motion, tap, gestures, and free-fall. With proper configuration, it can significantly improve the intelligence level of the device and user experience.

Typical application :

- robot
- drones
- Mining equipment
- Smart toys
- Lawn mower, pool sweeper

2. Module features

The XJ9BT00-STD module achieves sensor fusion of 9-axis data, integrates a high-precision dynamic calibration algorithm, which significantly reduced the accumulated angle error during long-term operation. The module provides a UART interface, can be easily integrated into customer’s systems. This simplifies the customer's development process and shortens the development cycle. An evaluation board is also available for customer testing and fast performance evaluation.

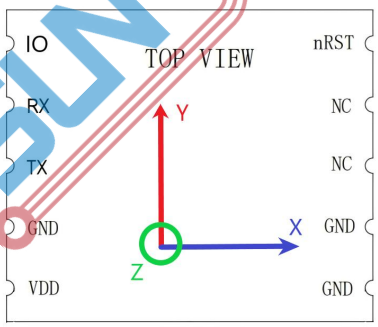
Key features of the module:

- High precision
- Small size
- Cost/performance effective
- Highly integrated and easy to use.
- Built-in high-precision calibration algorithm and sensor fusion algorithm
- Supports feature extensions (such as tap, free fall, etc.).

3. Module Specifications

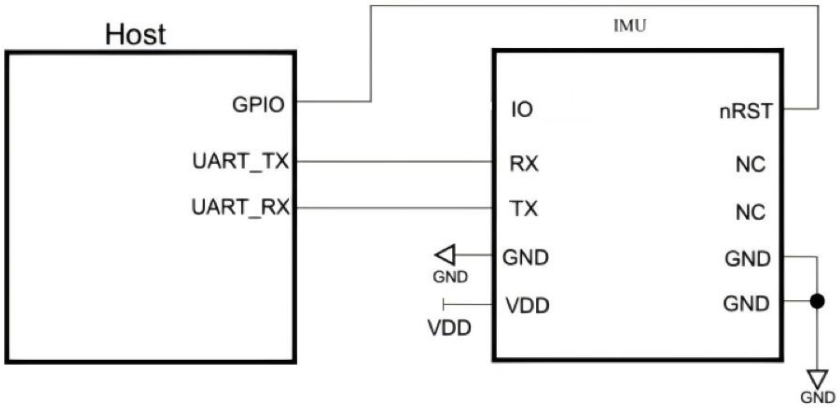
describe	parameter
Euler angle resolution	0.01°
Euler angle range	yaw(±180°) roll(±180°) pitch(±90°)
Accelerometer measurement range	±16g
Accelerometer resolution	0.0001g (max)
Gyroscope measurement range	±2000dps
Gyroscope resolution	0.01 dps(max)
Magnetometer measurement range	±2.4mT
Magnetometer resolution	0.07uT
Operating temperature	-40° ~85°
Power supply voltage	3.0~5.5V
Maximum voltage	-0.3~6V
I/O port voltage	0 ~ vdd+0.3V
Operating current	<9mA
size	15.25mm*18.00mm

4. Pin definition and coordinate system



pin	name	type	Function Description
1	IO	-	Function customization
2	RX	Input	Module serial port input
3	TX	Output	Module serial port output
4	GND	-	power ground
5	VDD	-	Power supply （3.0~5.5V）
6	GND	-	power ground
7	GND	-	power ground
8	REV	-	-
9	REV	-	-
10	NRST	Input	Module reset, active low, the pin needs to be pulled up

5. Hardware connection



6. Module usage

1）Register Description

register	address	byte	property	data	illustrate
ID	0	1	W/R	0-255	Module model
uart_baud_rate	1	1	W/R	0-4	The default baud rate for serial ports is 2. 0:9600 1:38400 2:115200 3:460800 4:920600
data_rate	2	1	W/R	0-5	Data output rate default 1 0:5HZ 1:10HZ 2:25HZ 3:50HZ 4:100HZ 5:200HZ
fsr	3	1	W/R	uint8_t	The range selection is 0 by default. The highest 4 bits (7:4) 0: gyro ±2000dps 1: gyro ±1000dps 2: gyro ±500dps 3: gyro ±250dps The lower 4 bits (3:0)

register	address	byte	property	data	illustrate
					0: accle ±16g 1: Accle ±8g 2: accle ±4g 3: accle ±2g
reset	10	1	W/R	0/1	Reset module: write 1 to reset and automatically clears to zero
algo_rest	11	1	W/R	0/1	IMU fusion algorithm reset, write 1 to reset, auto clear to zero.
software_version	80	2	R	int16_t	Software version.
gyro_accuracy	90	1	R	0-3	The gyroscope calibration accuracy indicator; the higher the value, the more accurate the gyroscope.
mag_accuracy	91	1	R	0-3	The magnetometer calibration accuracy indicator;the higher the value, the more accurate the magnetometer.
quat_x	92	2	R	int16_t	Quaternion multiplication factor 10000
quat_y	94	2	R	int16_t	Quaternion multiplication factor 10000
quat_z	96	2	R	int16_t	Quaternion multiplication factor 10000
quat_w	98	2	R	int16_t	Quaternion multiplication factor 10000
yaw	100	2	R	int16_t	Yaw angle multiplication factor 100. A value of 100 represents 1°.
roll	102	2	R	int16_t	Roll angle multiplication factor 100. A value of 100 represents 1°.
Pitch	104	2	R	int16_t	Pitch angle multiplication factor 100. A value of 100 represents 1°.

register	address	byte	property	data	illustrate
acc_x	106	4	R	int32_t	Acceleration X-axis data multiplication factor 1000. Value 1000 represents 1g.
acc_y	110	4	R	int32_t	Acceleration Y-axis data multiplication factor 1000. Value 1000 represents 1g.
acc_z	114	4	R	int32_t	The Z-axis acceleration data multiplication factor is 1000. A value of 1000 represents 1g.
gyro_x	118	4	R	int32_t	Gyroscope X-axis data, multiplication factor 1000. A value of 1000 represents 1 dps.
gyro_y	122	4	R	int32_t	Gyroscope Y-axis data, multiplication factor 1000. A value of 1000 represents 1 dps.
gyro_z	126	4	R	int32_t	Gyroscope Z-axis data, multiplication factor 1000. A value of 1000 represents 1 dps.
mag_x	130	4	R	int32_t	Magnetometer X-axis data multiplication factor 1000. A value of 1000 represents 1 ut.
mag_y	134	4	R	int32_t	Magnetometer Y-axis data multiplication factor 1000. A value of 1000 represents 1 ut.
mag_z	138	4	R	int32_t	The magnetometer Z-axis data multiplication factor is 1000. A value of 1000 represents 1 ut.
temperature	142	2	R	int16_t	A temperature multiplication factor of 100 means 1° C.
acc_offset_x	144	4	W/R	int32_t	Acceleration X-axis zero bias data multiplication factor 1000. Value 1000 represents 1g.
acc_offset_y	148	4	W/R	int32_t	Acceleration Y-axis zero bias data multiplication

register	address	byte	property	data	illustrate
					factor 1000. Value 1000 represents 1g.
acc_offset_z	152	4	W/R	int32_t	Acceleration Z-axis zero bias data multiplication factor 1000. Value 1000 represents 1g.
gyro_offset_x	156	4	W/R	int32_t	Gyroscope X-axis zero bias data multiplication factor 1000. A value of 1000 represents 1 dps.
gyro_offset_y	160	4	W/R	int32_t	Gyroscope Y-axis zero bias data multiplication factor 1000. A value of 1000 represents 1 dps.
gyro_offset_z	164	4	W/R	int32_t	Gyroscope Z-axis zero bias data multiplication factor 1000. A value of 1000 represents 1 dps.
mag_offset_x	168	4	W/R	int32_t	Magnetometer X-axis zero bias data multiplication factor 1000. A value of 1000 represents 1 ut.
mag_offset_y	172	4	W/R	int32_t	Magnetometer Y-axis zero bias data multiplication factor 1000. A value of 1000 represents 1ut.
mag_offset_z	176	4	W/R	int32_t	Magnetometer Z-axis zero bias data multiplication factor 1000. A value of 1000 represents 1ut.

Note: The current version does not have write protection for read-only registers. Do not perform write operations on read-only or reserved registers.

2）Communication Protocol

Communication protocol format:

type	byte	illustrate
Head	2	The frame header is fixed at 0XA5 0X5A
Len	1	Frame length excluding frame header
Cmd	1	function code 0x50 Read register - send and receive 0x51 Write to register for one send and one receive

		0x5F Reporting Enable: Reporting data is configurable; data output rate is configurable.
Reg_addr	1	Register address
Reg_len	1	The length of the register being read is not needed when writing data.
Status	1	Returns the write status. This bit is not needed when sending read data. 0: Read/write successful; 1: Verification error; 2: Length error; 3: Command error; 4: Data error;
Check_sum	2	CRC check. CRC-16/CCITT uses the polynomial G(x) = x16+x12+x5+1 as the calculation formula, with an initial value of 0 to calculate the check value.

Communication uses little-endian mode, for example:

Read the temperature register (hexadecimal) , because the temperature register has two bytes, i.e., reg_len_ is 2.

Command to sensor module:

HEAD	LEN	CMD	REG_ADDR	REG_LEN	CHECK_SUM
A5 5A	06	50	8E	02	38 50

Response from sensor module:

HEAD	LEN	CMD	REG_ADDR	REG_DATA	CHECK_SUM
A5 5A	07	50	84	89 09	00 30

The temperature register value read is 2441. A temperature register value of 100 represents 1℃. Therefore, the actual temperature is 24.41℃.

Write to multiple registers (hexadecimal)

Command to sensor module:

HEAD	LEN	CMD	REG_ADDR	REG_DATA	CHECK_SUM
A5 5A	09	51	84	01 02 03 04	D5 3E

Response from sensor module:

HEAD	LEN	CMD	STATUS	CHECK_SUM
A5 5A	05	51	00	BA 36

If the status returns 0, it means the write was successful.

Read the software version number:

Command to sensor module:

HEAD	LEN	CMD	REG_ADDR	REG_LEN	CHECK_SUM
A5 5A	06	50	50	02	13 95

Response from sensor module:

HEAD	LEN	CMD	REG_ADDR	REG_DATA	CHECK_SUM
A5 5A	06	50	50	04 10	DE 66

The version data read is converted to decimal as 4100, where 4 represents the module model XJ9DT00-STD and 100 represents the software version number 1.0.0.

Actively reported data format:

type	byte	illustrate
head	2	The frame header is fixed at 0XA5 0X5A
len	1	Length excluding frame header
index	1	0-255, increment by 1 with each send.
reg_addr	1	First register address
reg_data	1-50	Register bytes
check_sum	2	CRC check

Upon receiving the reporting enable command, the system periodically reports the configured reporting data according to the data rate register configuration. Reporting stops upon receiving another read/write command. The default data rate is 10Hz, data will be reported every 100ms.

For example:

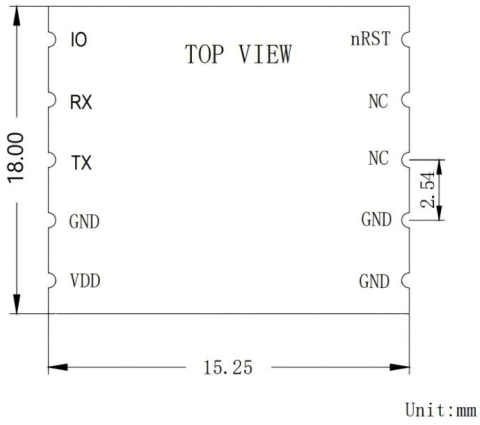
Send data and report Euler angles. (in hexadecimal)

HEAD	LEN	CMD	REG_ADDR	REG_LEN	CHECK_SUM
A5 5A	06	5F	64	06	32 48

Proactively report: (hexadecimal)

HEAD	LEN	INDEX	REG_ADDR	REG_DATA	CHECK_SUM
A5 5A	0B	0	64	01 02 03 04 05 06	A4 E4
A5 5A	0B	1	64	01 02 03 04 05 06	EB 65
A5 5A	0B	2	64	01 02 03 04 05 06	CB EF
...	...	...	...	...	...

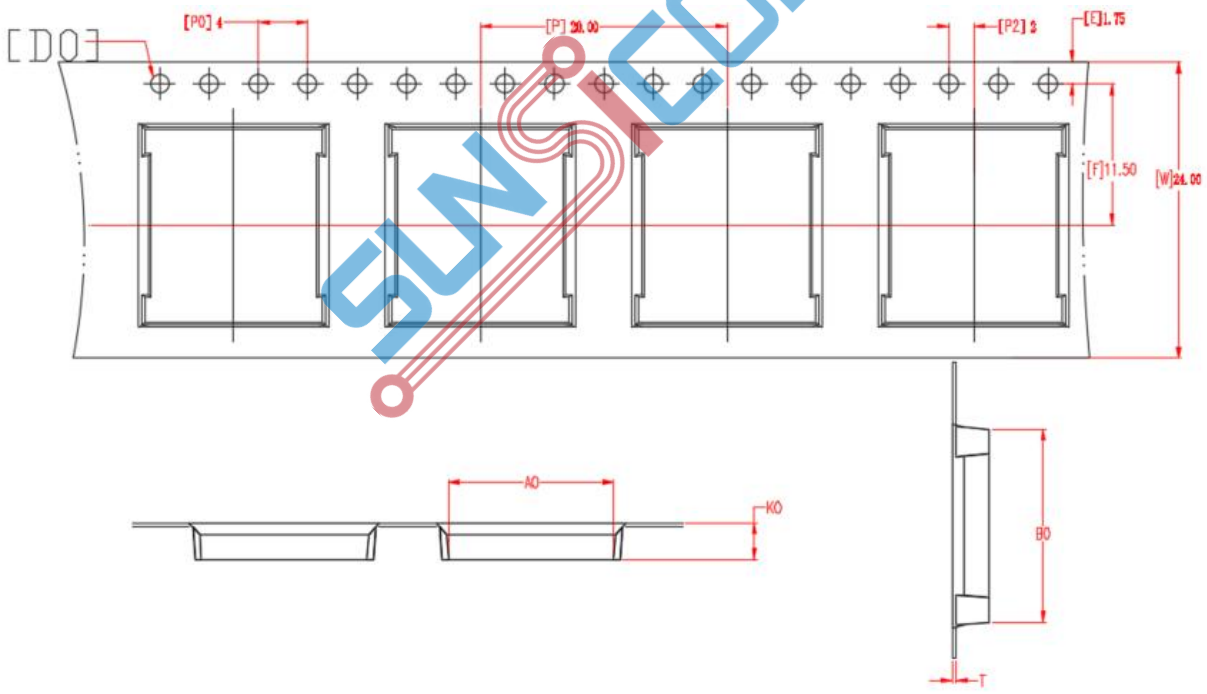
7. Module size



It measures 15.25mm in length, 18.00mm in width, and has a pin pitch of 2.54mm.

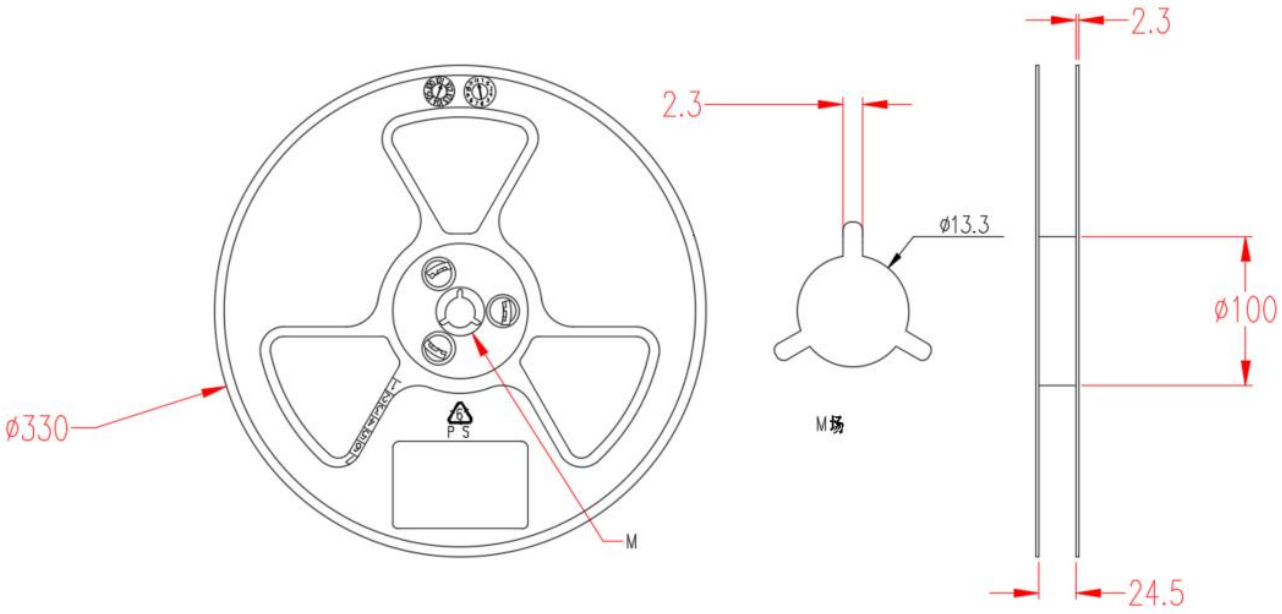
8. Product Packaging

The modules are shipped in strip and roll packaging. The packaging is designed to protect the modules from damage that may occur during routine handling and transportation. Information about the packaging carriers is as follows .



D0	Φ 1.50	T	0.30±0.05	P0	4±0.10
W	24±0.30	F	11.5±0.10	P2	2±0.10
E	1.75±0.10	P	20.0±0.10		
A0	13.40±0.10	K0	3.0±0.10	B0	15.65±0.10

(Unit: mm)



The module packaging is shown in the figure. A 13-inch plastic tray and a 24mm wide carrier tape are used to braid the modules. The modules are then wrapped with anti-static foam and edge sealing strips, followed by the addition of desiccant, and finally placed in an anti-static bag and vacuum-sealed. The minimum package quantity is 1000 modules.

9. Installation Recommendations

1) Determine the module's mounting orientation: The IMU's attitude and motion measurements are related to the IMU module's mounting orientation. Typically, the module needs to be mounted at the center of the robot, and its orientation should be aligned with the robot's axis of symmetry.

2) Avoid mechanical vibration: IMU modules are sensitive to mechanical vibration, so they should not be installed in environments with frequent vibration. In addition, the module needs to be securely fixed to prevent displacement during movement.

3) Calibration module: The module has been calibrated at the factory. It is recommended to perform another calibration after installing if high performance required.

4) Avoid magnetic field interference: Module measurement posture and movement can also be affected by magnetic fields, so it is necessary to avoid areas with strong magnetic fields. At the same time, the module needs to be isolated from other magnetic sensors to avoid mutual interference.

5) Module protection: The module needs to be protected from mechanical shock or immersion in liquids such as water and oil. When not in use, it is recommended to store the IMU module in a dry box to ensure long-term stability.

6) The module should be installed as far away as possible from the heat source and vibration source of the equipment.

7) The module is sensitive to mechanical stress, so it is not recommended to place the module near screw holes.