High Performance Inertial Measurement Unit S488B-IMU

S488B-IMU is a high performance MEMS Inertial Measurement Unit, which MEMS gyroscope have 2°/h bias stability and MEMS accelerometer have 50μg bias stability.

It can precisely measure the angular velocity and acceleration information of the moving carrier in harsh environments.

Can be used for precise navigation, control and dynamic measurement.

This series of products adopt high-precision MEMS inertial devices, which have high reliability and high robustness, and can precisely measure the angular velocity and acceleration information of the moving carrier in harsh environments.

Applications:

Intelligent driving, unmanned aerial vehicles, unmanned surface ships, platform stabilization, industrial robotics, High-speed railway track inspection, etc.

Main parameters:

1 Precision MEMS Inertial Measurement Unit
2 Dynamic range: Gyro ±450°/s, Acc ±18g
3 Bias Stability: Gyro: 2°/h, Acc 50μg (Allan)
4 Temperature compensation, installation misalignment angle compensation, nonlinear compensation
5 Working temperature: -40 … +75°C

Table 1. Main Electrical parameters

Parameter	Test conditions	Value			Unit
		Min	Typ	Max	
Voltage		3	3.3	3.6	V
Power Consumption				1.5	W
Ripple Wave	P-P			100	mV

Table 2. Physical parameters

Parameter	Test conditions	Value			Unit
		Min	Typ	Max	
Dimension			47*44*14		mm
Weight					g

Note: Product images may not highlight current product markings

Table 3. Electrical and technical parameters

Parameter	Test conditions	Value			Unit
		Min	Typ	Max	
Gyroscopes					
Dynamic Range		±400	±450		°/s
Bias Stability	Allan variance		2		°/h
Radom Walk			0.1		°/√h
Zero bias repeatability	Full temperature range −40°C ≤ TA ≤ +85°C		0.1	0.2	°/s
Scale factor repeatability	Full temperature range −40°C ≤ TA ≤ +85°C		0.2	1	%
Scale factor nonlinearity	FS=450º/s		0.1	0.2	%FS
Bandwidth				400	Hz
Accelerometer					
Dynamic Range			±6	±18	g
Bias Stability			0.1		mg
Radom Walk			0.02	0.02	m/s/√h
Zero bias repeatability	Full temperature range −40°C ≤ TA ≤ +85°C		±5		mg
Scale factor repeatability	Full temperature range −40°C ≤ TA ≤ +85°C		0.5	1	%
Scale factor nonlinearity			0.1 FS=6g	0.2 FS=18g	%FS
Bandwidth				200	Hz
Magnetometer					
Dynamic Range		±2.5			Gauss
Resolution			120		μGauss
Noise density			50		μGauss
Bandwidth			200		Hz
Barometer					
Pressure Range		450		1100	mbar
Resolution			0.1		mbar
Absolute Accuracy			1.5		mbar
Communication Interface					
1 Channel SPI	Baud rate			15	MHz
1 Channel UART	Baud rate				
Working Environment					
Working Temperature		-40		75	°C
Storage Temperature		-45		85	°C
Vibration Resistance			10...2000Hz 3g		
Shock Resistance			30g, 11ms		
Overload	Half-sine 0.5msec		1000		
Reliability					
MTBF			20000		h
Continuous working time			120		h

Pins definition

Table 4. Pins definition

Pins No.	Name	Type	Description
10, 11, 12	VDD	Power supply	
13, 14, 15	GND	Power ground	
7	DIO1	Input/output	General IO, configurable
9	DIO2	Input/output	
1	DIO3	Input/output	
2	DIO4	Input/output	
3	SPI-CLK	Input	SPI master-slave mode is configurable, the default is slave mode
4	SPI-MISO	Output	
5	SPI-MOSI	Input	
6	SPI-CS	Input	
8	RST	Input	Reset
23	VDDRTC	Power supply	Not available currently
16...19, 21, 24	NC	Reserved	Reserved by factory

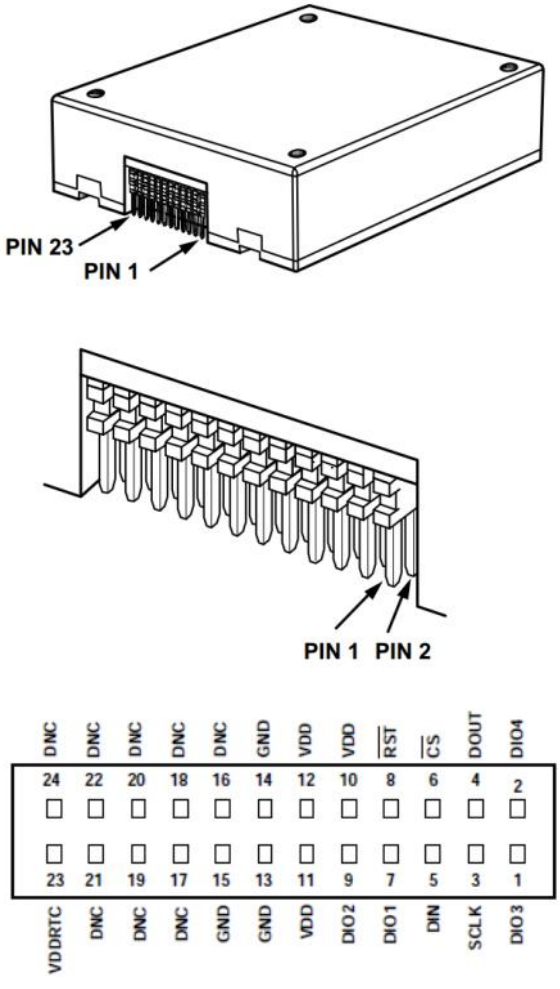

Fig 1. Pins definition

Dimension & Package

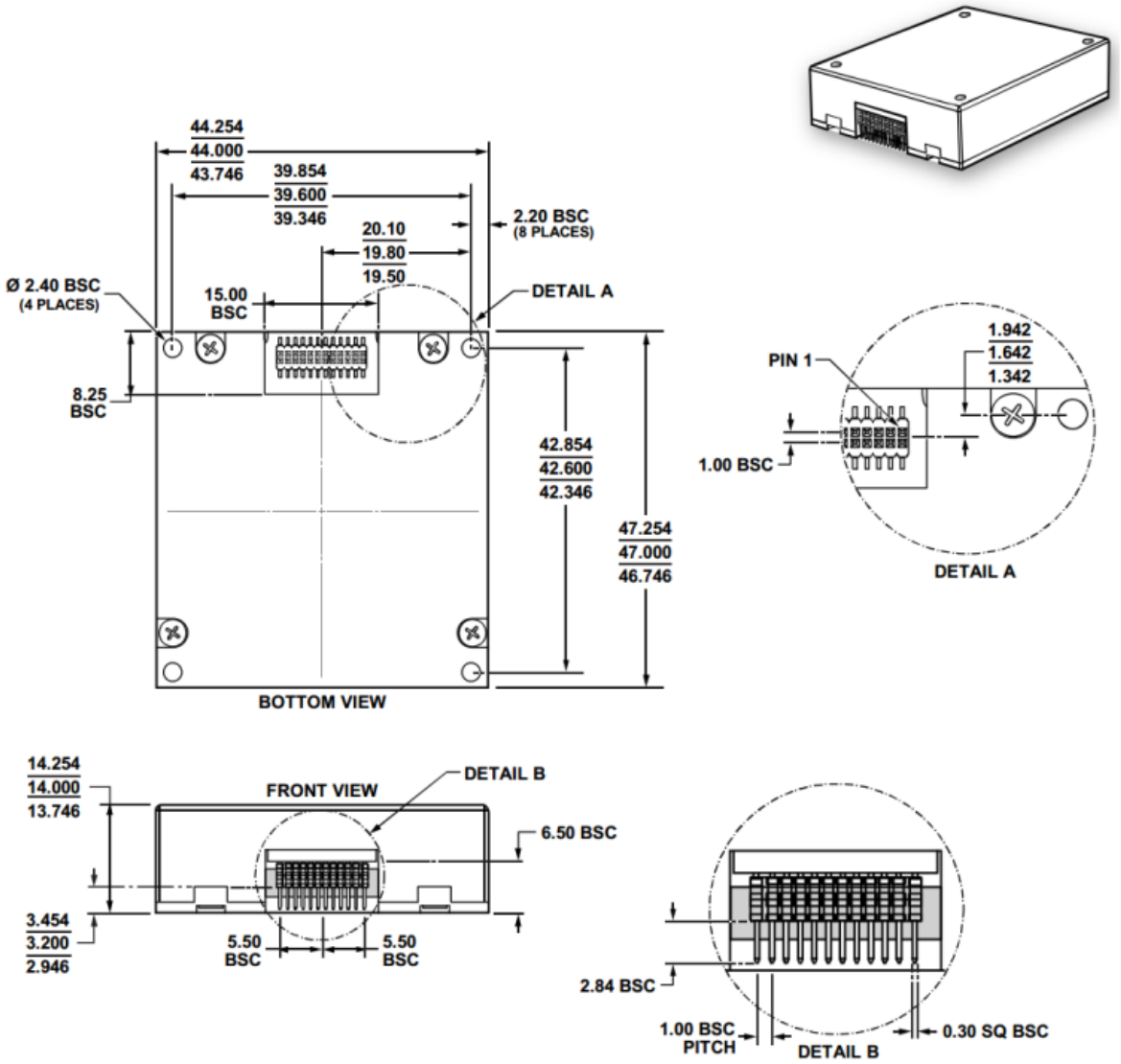

Fig 2. Drawing of S488B-IMU

Definition of yaw angle, pitch angle and roll angle

Definition of heading angle: take the Z axis as the rotation axis, counterclockwise is positive, north is zero, and the range is [- 180º, 180º]

Pitch angle definition: take the X axis as the rotation axis, counterclockwise is positive, horizontal is zero, and the range is [- 90º,90º]

Definition of roll angle: take the Y axis as the rotation axis, counterclockwise is positive, horizontal is zero, and the range is [- 180º, 180º]

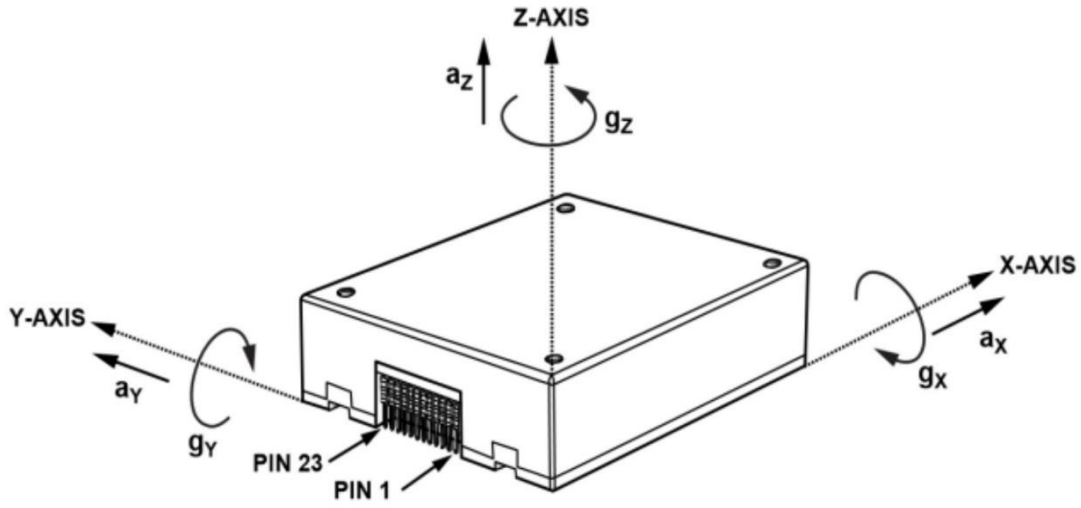

Fig 3. Coordinate System Definition

SPI. Communication Protocol

S488B-IMU is an autonomous sensor system, it will automatically start with a valid power supply. After completing the initialization process, it starts sampling, processing and loading the calibrated data into the output register, which can be accessed through the SPI interface. The SPI port is usually connected with the compatible port of the embedded processor. The connection diagram refers to the following figure. Four SPI signals support synchronous serial data transmission. In the factory default configuration, the DIO2 pin provides a data ready signal. When new data is available in the output data register, this pin will turn to high level.

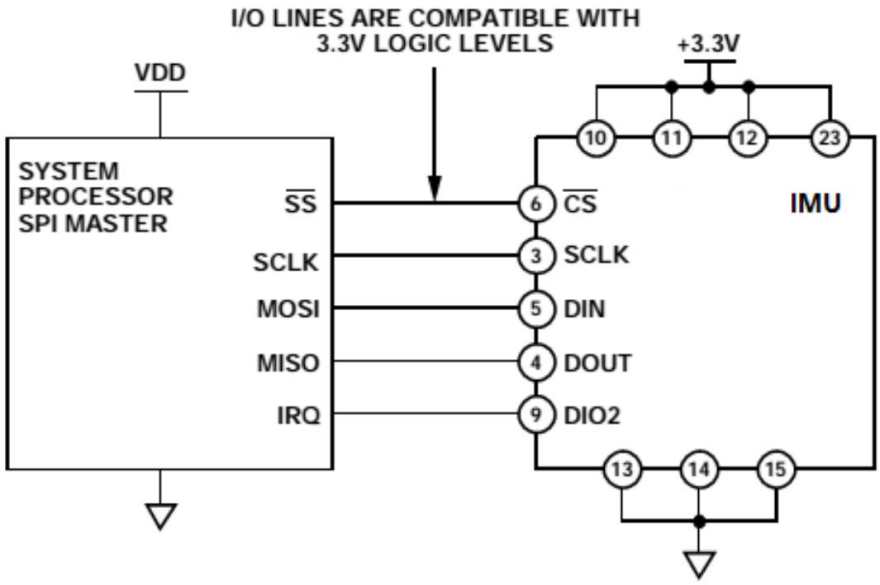

Fig 4. Connection diagram with external device

Table 5. General-purpose host processor SPI settings

Processor Setting	Description
Host	S488B-IMU is used as slave
SCLK ≤ 15 MHz	Serial clock rate
SPI mode 3	CPOL = 1 (polarity), CPHA = 1 (phase) Bit Order Shift Register/Data Length

SPI. Communication

If the previous command is a read request, then the SPI port supports full-duplex communication, and the external processor can write to DIN while reading DOUT, as shown in the figure below.

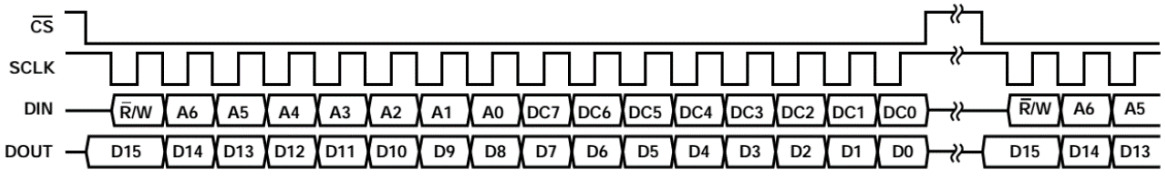

Fig 5. SPI read and write time sequence

SPI. Read sensor data

S488B-IMU automatically starts and activates page 0, which make it convenient to access data register. After accessing any other pages, should write 0x00 into the PAGE_ID register (DIN = 0x8000) to activate page 0, and prepare for subsequent data access. A single register read operation requires two 16-bit SPI cycles. In the first cycle, use the bit allocation function (in the following figure) to request to read the register's content; in the second cycle, the register's contents is outputted through DOUT. The first bit of the DIN command is 0, and then the high or low address of the register. The last 8 bits are don't care bit, but SPI requires a full 16 SCLK to receive the request. The following figure shows two consecutive register read operations. First, DIN = 0x1A00, requesting the contents of the Z_GYRO_OUT register, and then DIN = 0x1800, requesting the contents of the Z_GYRO_LOW register.

Fig 6. Example of SPI read operation

SPI. User register memory mapping

Table 6. User register memory mapping (N/A means not applicable)

R/W	Page_ID	Address	Default	Register Description
R/W	0x00	0x00	0x00	page identification
R	0x00	0x0E	N/A	temperature
R	0x00	0x10	N/A	x axis gyroscope low byte output
R	0x00	0x12	N/A	x axis gyroscope high byte output
R	0x00	0x14	N/A	y axis gyroscope low byte output
R	0x00	0x16	N/A	y axis gyroscope high byte output
R	0x00	0x18	N/A	z axis gyroscope low byte output
R	0x00	0x1A	N/A	z axis gyroscope high byte output
R	0x00	0x1C	N/A	x axis accelerometer low byte output
R	0x00	0x1E	N/A	x axis accelerometer high byte output
R	0x00	0x20	N/A	y axis accelerometer low byte output
R	0x00	0x22	N/A	y axis accelerometer high byte output
R	0x00	0x24	N/A	z axis accelerometer low byte output
R	0x01	0x26	N/A	z axis accelerometer high byte output
R/W	0x03	0x00	0x00	page identification
R/W	0x03	0x06	0x000D	control, I/O pins, function definition
R/W	0x03	0x08	0x00X0	control, I/O pins, general purpose
R/W	0x04	0x00	0x00	page identification
R	0x04	0x20	n/a	serial number

SPI. Conversion formula

Current temeperature		= 25+TEMP_OUT* 0.00565
X Gyro example	X_GYRO_OUT	X_GYRO_LOW
	1LSB=0.02°/S	The weight of MSB is 0.01°/S, and the weight of subsequent bits is half of the previous one
	0.02*X_GYRO_OUT	0.01*MSB+0.005*.....

The calculation method of YZ gyro is similar to that of X axis gyro

X-axis accelerometer example	X_ACCL_OUT	X_ACCL_LOW
	1LSB=0.8mg	The weight of MSB is 0.4mg, and the weight of subsequent bits is half of the previous one
	0.8*X_ACCL_OUT	0.4*MSB+0.2*.....

The calculation method of YZ accelerometer is similar to X axis accelerometer

UART. Communication Protocol

UART interface default settings: 230400bps, 8 data bit, 1 stop bit, no parity

Divided into protocol header, protocol body and protocol tail; 200Hz; coordinate axis is defined as right front upper

Table 7. UART Protocol Format

Protocol	Byte No.	Data	Unit	Data Type	Remarks
Protocol Header	0	0x5a			
	1	0x5a			
Protocol Body	2...5	X axis gyro	°/s	float	
	6...9	Y axis gyro	°/s	float	
	10...13	Z axis gyro	°/s	float	
	14...17	X axis accelerometer	g	float	
	18...21	Y axis accelerometer	g	float	
	22...25	Z axis accelerometer	g	float	
	26...29	heading angle	rad	float	
	30...33	pitch angle	rad	float	
	34...37	roll angle	rad	float	
	38...41	temperature	°C	float	
	42...45	barometer	mbar	float	
	46...49	X axis magnetometer	uT	float	
	50...53	Y axis magnetometer	uT	float	
	54...57	Z axis magnetometer	uT	float	
Protocol End	58	Checksum			Accumulate and sum from 2 to 57 bytes, take the low byte