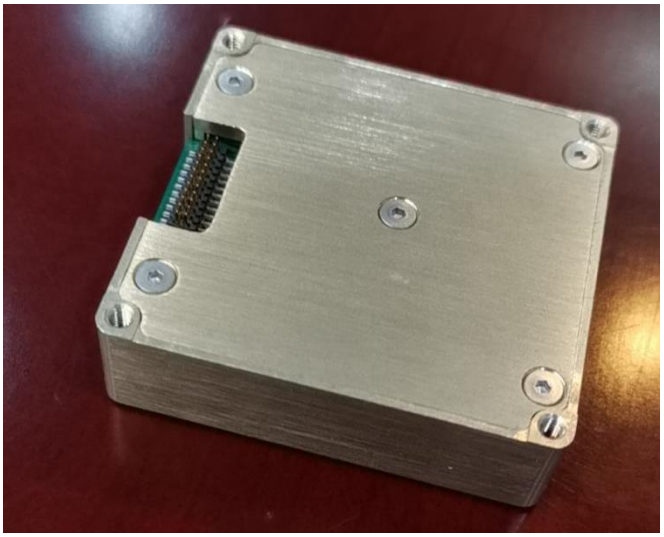
BS-IC24HB-M-D6EC

HIGH ACCURACY IMU MUNAL



1. Product overview

The BS-IC24HB-M-D6EC is an inertial measurement unit (IMU) based on micromachining technology (MEMS), which contains high-performance MEMS gyroscope and MEMS accelerometer, and outputs three angular velocities and three accelerations.

BS-IC24HB-M-D6EC features high reliability and strong environmental adaptability. By matching different software, the product can be widely used in intelligent driving, tactical and industrial UAV, intelligent ammunition, seeker, mobile communication, mapping, stable platform and other fields.

2. Product features

1) Three-axis digital gyroscope:
   a) ± 450º/s dynamic measuring range;
   b) Zero-bias stability: 3 °/H (GJB, 10s, X and Y-axis), 0.8 °/H (ALLAN, Z-axis);
2) Triaxial digital accelerometer:
   a) ± 16 G dynamic measuring range;
   b) Zero-bias stability: 0.2mg (GJB, 10s), 0.03mg (ALLAN);
3) High reliability: MTBF > 20000h;
4) Guaranteed accuracy within the full temperature range (-40 ℃ ~ 70 ℃): built-in high-performance temperature calibration and compensation algorithm;
5) Suitable for working under strong vibration conditions;
6) Interface 1 channel UART, 1 channel SPI, 1 channel CAN

3. Field of application

1) Intelligent driving
2) Tactical and Industrial UAV

3) Smart Munitions
4) Seeker
5) Communication in motion
6) Mapping
7) Stabilize the platform

4. Product indicators

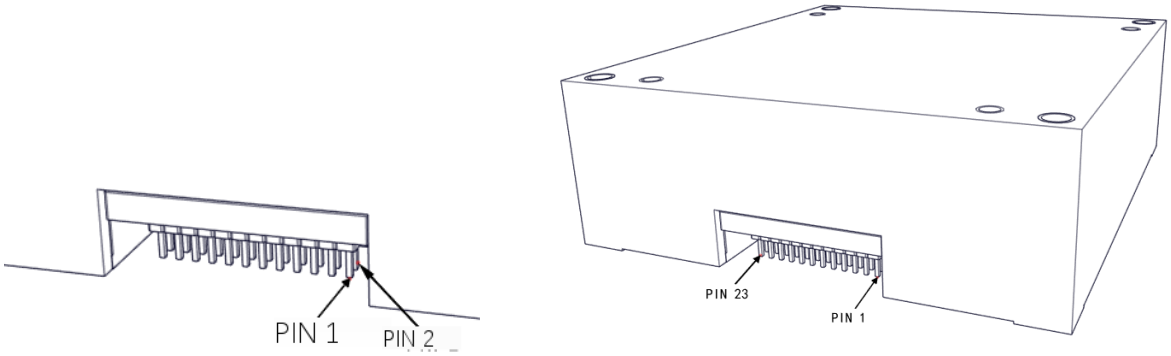
Parameter		Test conditions	Minimum value	Typical value	Maximum value	Unit
Peg-top	Dynamic measuring range				450	º/s
	Zero bias stability	Allan variance, Z-axis		0.8		º/h
		Allan variance, X and Y axis		1		º/h
		10 s average (-40 ℃ ~ + 70 ℃, constant temperature), Z-axis		3		º/h
		10 s average (-40 ℃ ~ + 70 ℃, constant temperature), X axis and Y axis		4		º/h
	Zero bias	Zero-bias range, Z-axis		±0.07		º/s
		Zero-bias range, X-axis and Y-axis		±0.2		º/s
		Zero bias change over full temperature range, Z-axis①		±0.02		º/s
		Zero bias change over full temperature range, X and Y axis①		±0.06		º/s
		Successive Start Repeatability, Z-axis		0.002		º/s
		Successive Start Repeatability, X-Axis and Y-Axis		0.006		º/s
		Day-by-day start repeatability, Z-axis		0.003		º/s
		Start repetition day by day, X axis and Y axis		0.009		º/s
		Ffect of linear acceleration on bias		0.002		º/s/g
		Influence of vibration on zero bias, change before and after vibration②		0.002		º/s/g
		Influence of vibration on zero bias, change before and during vibration②		0.002		º/s/g
	Scale factor	Scale factor accuracy, Z-axis		0.3		%
		Scale Factor Accuracy, X and Y Axis		0.6		%
		Scale factor nonlinearity, Z-axis		0.01		%FS
		Scale Factor Nonlinearity, X and Y Axis		0.02		%FS
	Resolution			3.052×10^{-7}		º/s/LSB
	Bandwidth			200		Hz
Accelerometer	Dynamic measuring range			16		g
	Zero bias stability	Allan variance		0.015		mg
		10 s average (-40 ℃ ~ + 70 ℃, constant temperature)		0.05		mg

Parameter		Test conditions	Minimum value	Typical value	Maximum value	Unit
	Zero bias	Zero-bias range		8	15	mg
		Zero bias change in full temperature range, peak-to-peak value①		5	10	mg
		Repeatability of successive starts			0.5	mg
		Repeatability is initiated on a daily basis				mg
		Zero-bias temperature coefficient		0.05	0.1	mg/℃
	Scale factor	Scale factor accuracy			2	%
		Scale factor nonlinearity			0.1	%FS
	Resolution			1.221×10^{-8}		g/LSB
	Bandwidth			200		Hz
Communication interface	1-way SPI	Baud rate			15	MHz
	1-way UART	Baud rate		230.4		Kbps
	1-way CAN	Baud rate			1	MHz
	Sampling frequency	SPI		200	1000	Hz
		UART		200		Hz
		CAN		200		
Electrical characteristics	Voltage		3.0	3.3	3.6	V
	Power consumption				1.5	W
	Ripple	P-P			100	mV
Structural characteristics	Size			47×44×14		mm
	Weight			50		g
Use environment	Operating temperature		-40		70	℃
	Storage temperature		-45		75	℃
	Vibration			20~2000Hz, 6.06g		
	Impact			1000g, 0.5ms		
Reliability	MTBF			20000		h
	Continuous working time			120		h

①: Calculate the zero deviation of the whole temperature change process, the temperature change rate is ≤ 1 ℃/min, and the temperature range is -40 ℃ ~ + 70 ℃;

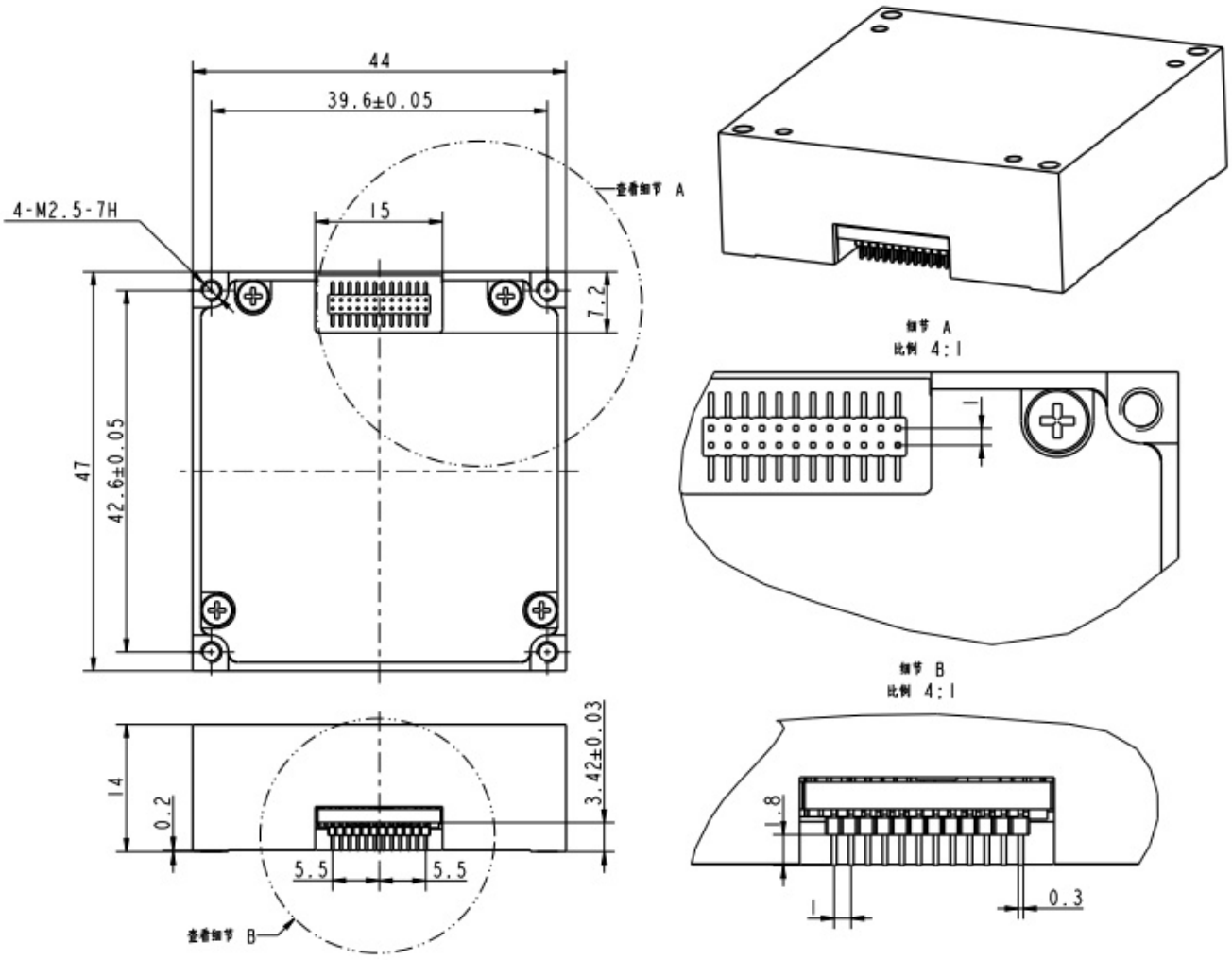
②: Vibration condition is 6.06 G, 20Hz ~ 2000Hz

5. Electrical interface



Pin sequence number	Name	Type	Description
10，11，12	VDD	Power source	
13，14，15	GND	Power source	
7	DIO1	Input/output	General purpose IO, configurable
9	DIO2	Input/output	
1	DIO3	Input/output	
2	DIO4	Input/output	
3	SPI-CLK	Input/output	SPI, master slave mode configurable, default to slave mode
4	SPI-MISO	Input/output	
5	SPI-MOSI	Input/output	
6	SPI-/CS	Input/output	
19	UART-TXD	Output	UART, configurable baud rate, default 230400 bps
21	UART-RXD	Input	
18	CAN-T	Output	
20	CAN-R	Input	
8	RST	Input	Reset
23	VDDRTC	Power source	
Other	NC	Spare	Retained by the manufacturer

6. Fabric interface

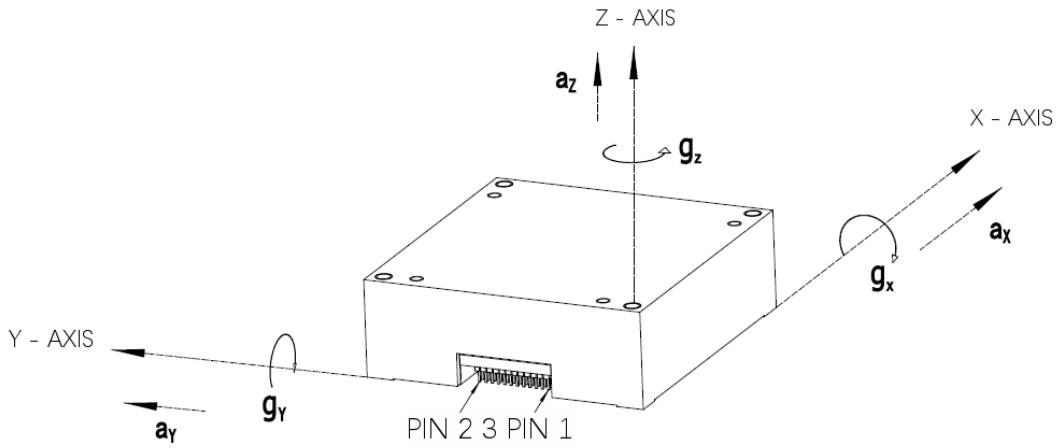


Schematic diagram of structure outline

7. Instructions for use

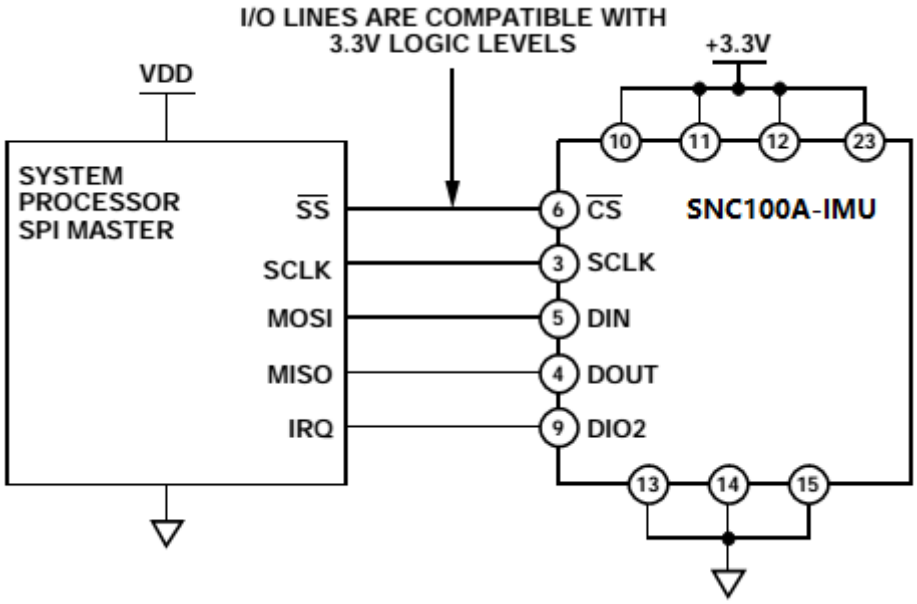
7.1. Coordinate system definition

3 gyros (g_x , g_y , g_z) and 3 accelerometers (a_x , a_y , a_z) is defined as shown in the figure below, and the direction of the arrow is positive.



7.2. SPI reads and writes data

The BS-IC24HB-M-D6EC is an autonomous sensor system that is automatically activated when a valid power source is present. After the initialization process is complete, it begins sampling, processing, and loading the calibrated sensor data into the output registers, which is accessible through the SPI port. The SPI port is typically connected to a compatible port on an embedded processor, see Figure 1 for a connection diagram.Four SPI signals support synchronous serial data transfer. In the factory default configuration, the DIO2 pin provides the data ready signal. This pin goes high when new data is available in the output data register.



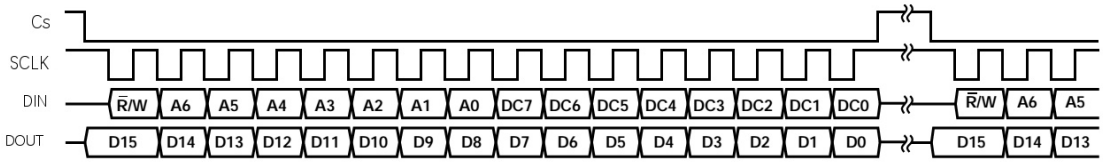
Schematic diagram of connection with external equipment

7.2.1. Generic Host Processor SPI Settings

Processor settings	Explain
Host	BS-IC24HB-M-D6EC as Slave
SCLK ≤ 15 MHz	Maximum serial clock ratio
SPI Mode 3	CPOL = 1 (polar), CPHA = 1 (phase)
MSB first mode	Bit Order
16-bit mode	Shift register/data length

7.2.2. SPI communication

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



SPI Read and Write Timing

7.2.3. Read the sensor data

BS-IC24HB-M-D6EC is automatically started and activates Page 0 for data register access. After accessing any other page, write 0x00 to the PAGE _ ID register (DIN = 0x8000) to activate Page 0 in preparation for subsequent data accesses. A single register read requires two 16-bit SPI cycles. In the first cycle, a read of the contents of a register is requested using the bit assignment function in fig. 1;In the second cycle, the register contents are output on DOUT. The first bit of the DIN command is 0, followed by the high or low address of the register. The last eight bits are don't care, but the SPI requires the full 16 SCLKs to receive the request. The following figure shows two consecutive register reads, first with DIN = 0x1A00, requesting the contents of the Z _ GYRO _ OUT register, and then with DIN = 0x1800, requesting the contents of the Z _ GYRO _ LOW register.

SPI Read Example

7.2.4. User Register Memory Map (N/A = Not Applicable)

Name	R/W	PAGE_ID	Address	Default	Register description
TEMP_OUT	R	0x00	0x0E	N/A	Temperature
X_GYRO_LOW	R	0x00	0x10	N/A	X-axis gyroscope output, low word
X_GYRO_OUT	R	0x00	0x12	N/A	X-axis gyroscope output, high word
Y_GYRO_LOW	R	0x00	0x14	N/A	Y-axis gyroscope output, low word
Y_GYRO_OUT	R	0x00	0x16	N/A	Y-axis gyroscope output, high word
Z_GYRO_LOW	R	0x00	0x18	N/A	Z-axis gyroscope output, low word
Z_GYRO_OUT	R	0x00	0x1A	N/A	Z-axis gyroscope output, high word
X_ACCL_LOW	R	0x00	0x1C	N/A	X-axis accelerometer output, low word
X_ACCL_OUT	R	0x00	0x1E	N/A	X-axis accelerometer output, high word
Y_ACCL_LOW	R	0x00	0x20	N/A	Y-axis accelerometer output, low word
Y_ACCL_OUT	R	0x00	0x22	N/A	Y-axis accelerometer output, high word
Z_ACCL_LOW	R	0x00	0x24	N/A	Z-axis accelerometer output, low word
Z_ACCL_OUT	R	0x00	0x26	N/A	Z-axis accelerometer output, high word
PROD_ID	R	0x00	0x7E	102	Product identification (102) output

7.2.5. Transformation formula

Current Temp = 25 + TEMP _ OUT * 0.00565

X-axis gyro value = 0.02 * X _ GYRO _ OUT
Y-axis gyro value = 0.02 * Y _ GYRO _ OUT
Z-axis gyro value = 0.02 * Z _ GYRO _ OUT
X-axis accelerometer value = (long) (X _ ACCL _ OUT * 65536 + X _ ACCL _ LOW) * 0.00001220703125 * 0.001
Y-axis accelerometer value = (long) (Y _ ACCL _ OUT * 65536 + Y _ ACCL _ LOW) * 0.00001220703125 * 0.001
Z-axis accelerometer value = (long) (Z _ ACCL _ OUT * 65536 + Z _ ACCL _ LOW) * 0.00001220703125 * 0.001

7.3. UART reads and writes data

7.3.1. Interface

Default configuration: 230400bps, 8 data bits, 1stop bit, no parity;

7.3.2. Configuration commands

1) $GPENB
   Enable UART power-on automatic output
2) $GPDIS
   Close UART power-on automatic output
3) $GPSER
   View the serial number
4) $GPCOM1
   Configure the baud rate to 115 200 bps
5) $GPCOM2
   Configure the baud rate to 230400 bps
6) $GPHIGH
   Configure the output frequency as 1000Hz and the baud rate as 921600 bps
7) $GPLOW
   Configure the sampling frequency as 200Hz
8) $GPRATIOxx
   Configure the output frequency command. When the sampling frequency is 200Hz, the output frequency = 200/XX
9) $GPINF
   View configuration information

7.3.3. Protocol format

A delay of not less than 5us is inserted between reading the two data registers

Table 1 User register memory mapping

Name	R/W	PAGE_ID	Address	Default	Register description
DIAG_STS	R	0x00	0x0A	0x0000	Self-test error flag output
ALM_STS	R	0x00	0x0C	0x0000	Self-test error flag output
TEMP_OUT	R	0x00	0x0E	N/A	Temperature
X_GYRO_LOW	R	0x00	0x10	N/A	X-axis gyroscope output, low bit word
X_GYRO_OUT	R	0x00	0x12	N/A	X-axis gyroscope output, high bit word
Y_GYRO_LOW	R	0x00	0x14	N/A	Y-axis gyroscope output, low bit word
Y_GYRO_OUT	R	0x00	0x16	N/A	Y-axis gyroscope output, high bit word
Z_GYRO_LOW	R	0x00	0x18	N/A	Z-axis gyroscope output, low bit word
Z_GYRO_OUT	R	0x00	0x1A	N/A	Z-axis gyroscope output, high bit word
X_ACCL_LOW	R	0x00	0x1C	N/A	X-axis accelerometer output, low bit word
X_ACCL_OUT	R	0x00	0x1E	N/A	X-axis accelerometer output, high bit word

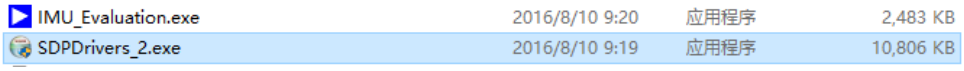
Y_ACCL_LOW	R	0x00	0x20	N/A	Y-axis accelerometer output, low bit word
Y_ACCL_OUT	R	0x00	0x22	N/A	Y-axis accelerometer output, high bit word
Z_ACCL_LOW	R	0x00	0x24	N/A	Z-axis accelerometer output, low bit word
Z_ACCL_OUT	R	0x00	0x26	N/A	Z-axis accelerometer output, high bit word
X_MAGN_OUT	R	0x00	0x28	N/A	X-axis magnetometer output, high bit word
Y_MAGN_OUT	R	0x00	0x2A	N/A	X-axis magnetometer output, high bit word
Z_MAGN_OUT	R	0x00	0x2C	N/A	X-axis magnetometer output, high bit word
BAROM_LOW	R	0x00	0x2E	N/A	Barometer output, low bit word
BAROM_OUT	R	0x00	0x30	N/A	Barometer output, high bit word
DEC_RATE	R/W	0x03	0x0C	0x0000	Control, output sample rate decimation
PROD_ID	R	0x00	0x7E	102	Product identification (102) output

8. Instructions for using the evaluation board

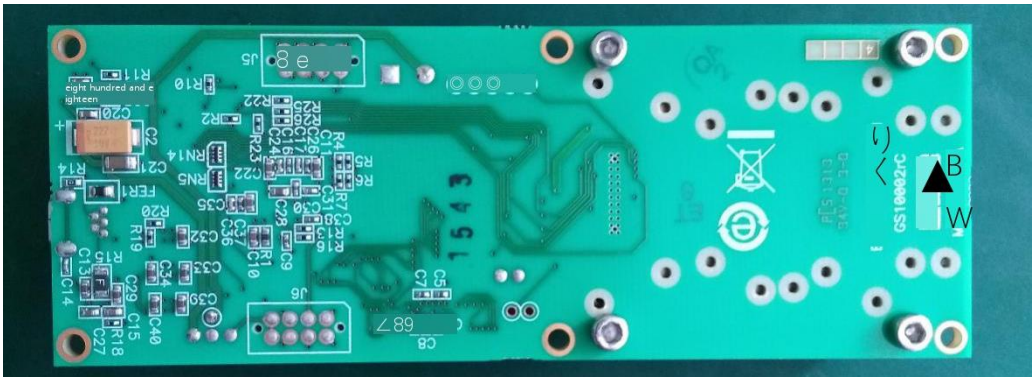
8.1. Using the EVAL-ADIS Evaluation Board from Analog Devices

The evaluation board is capable of acquiring raw data from the BS-IC24HB-M-D6EC. Supported operating systems include Win10 and Win7. See the EVAL-ADIS User Guides. PDF for details. The main operation steps are as follows:

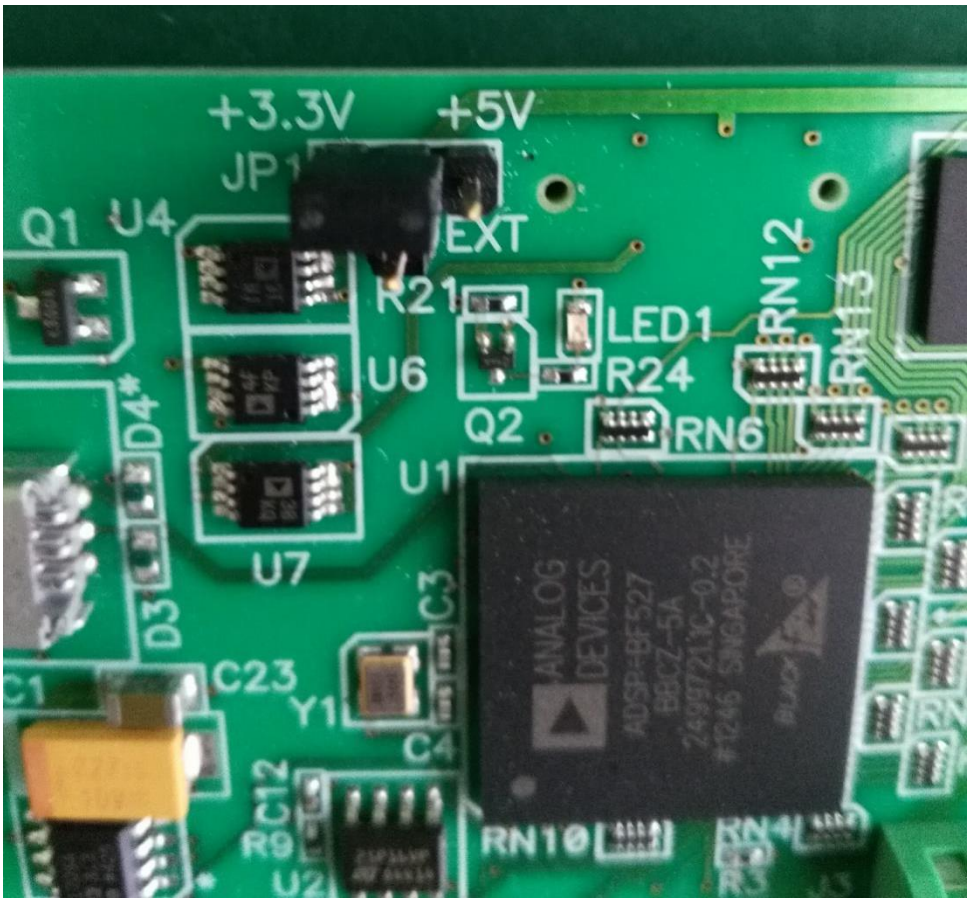
1) Install the evaluation board driver, SDPDrivers _ 2.exe.



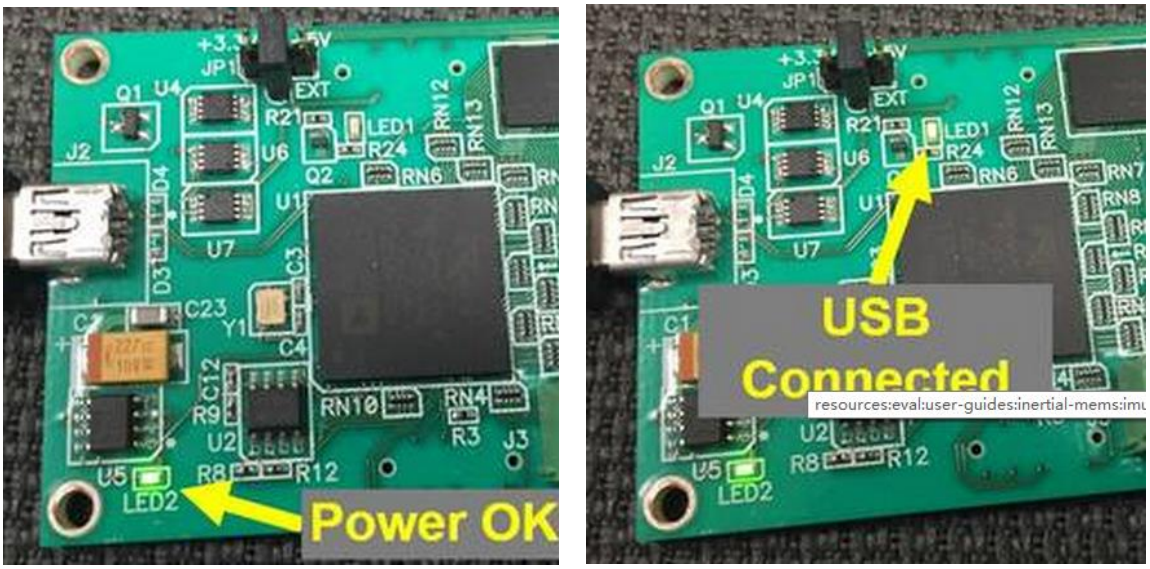
2) Install the BS-IC24HB-M-D6EC on the evaluation board.



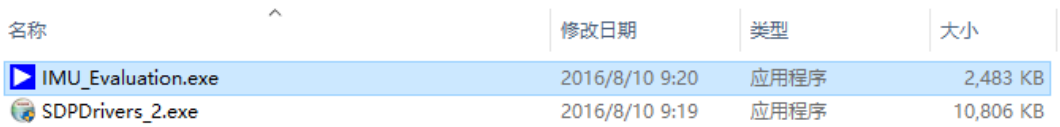
3) The power jumper selection on the evaluation board is 3.3 V;

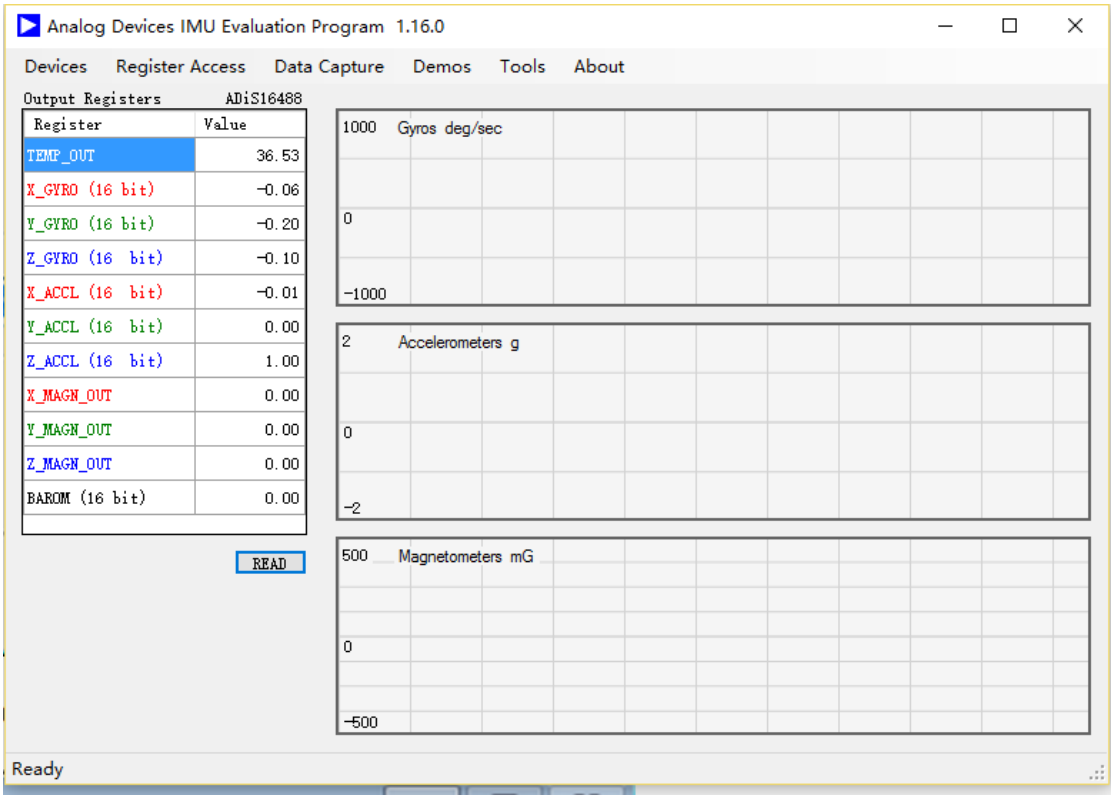


4) Connect the evaluation board and the PC with USB. If LED2 lights up first, it indicates that the power supply of the evaluation board is normal. After about 5 to 10 seconds, LED1 lights up, it indicates that the USB port of the evaluation board is successfully connected to the PC.

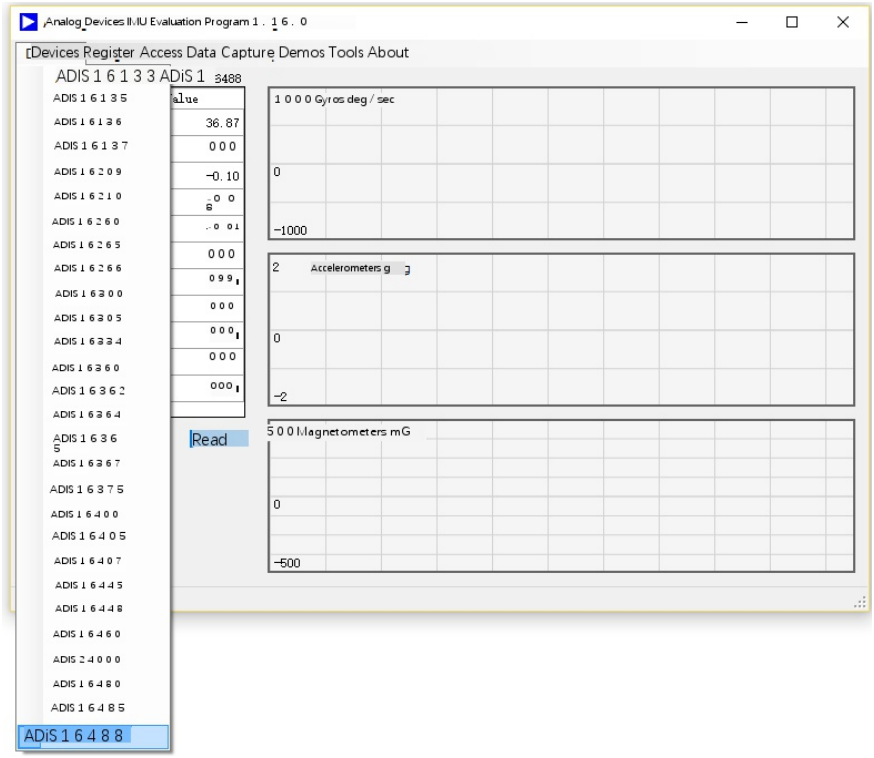


5) Open the evaluation board test software IMU _ Evaluation. Exe.

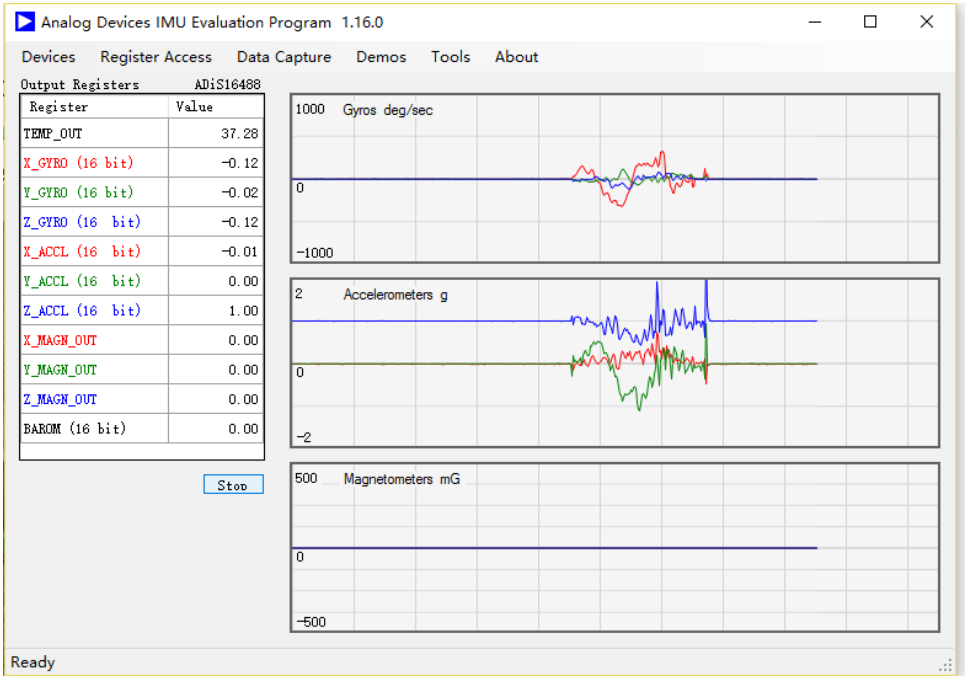




6) Select ADIS16488 in Devices;



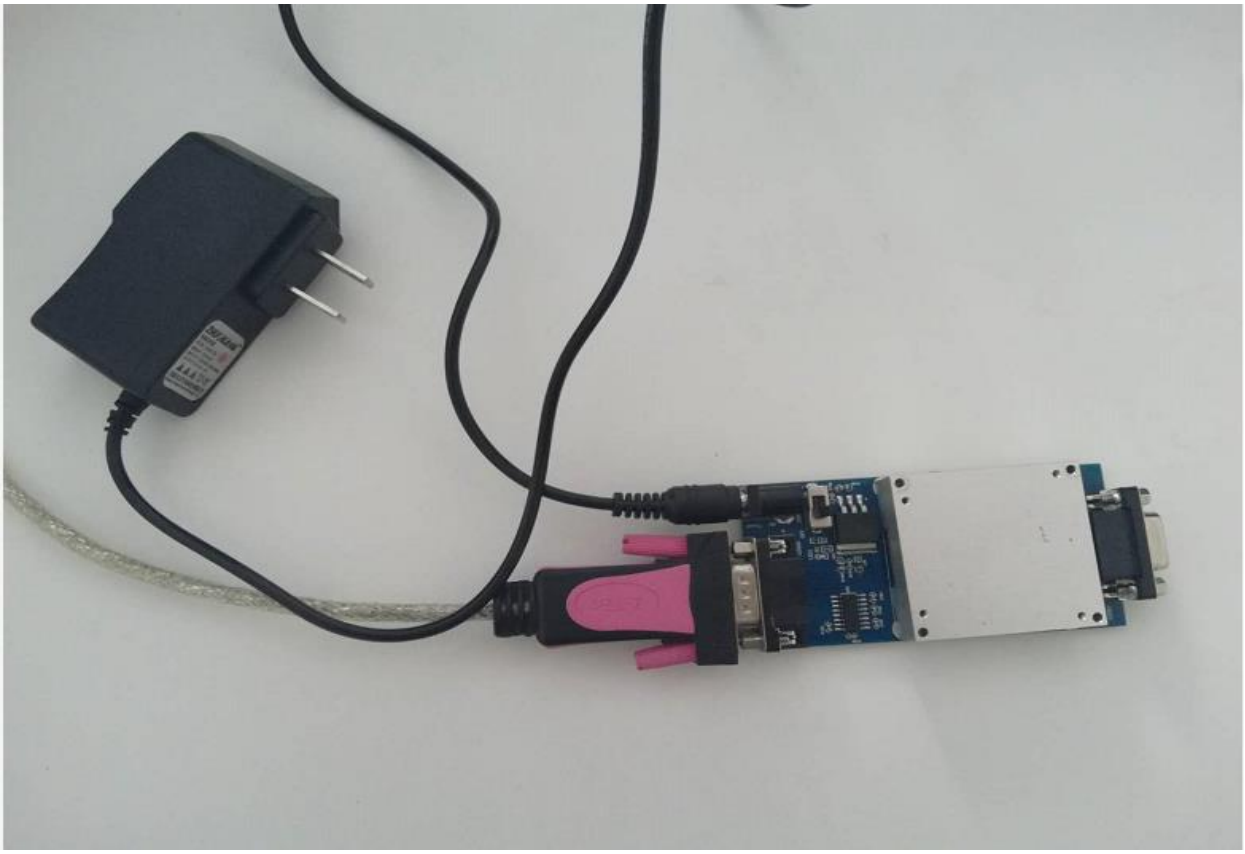
7) Click Read to read the data and display it on the interface.



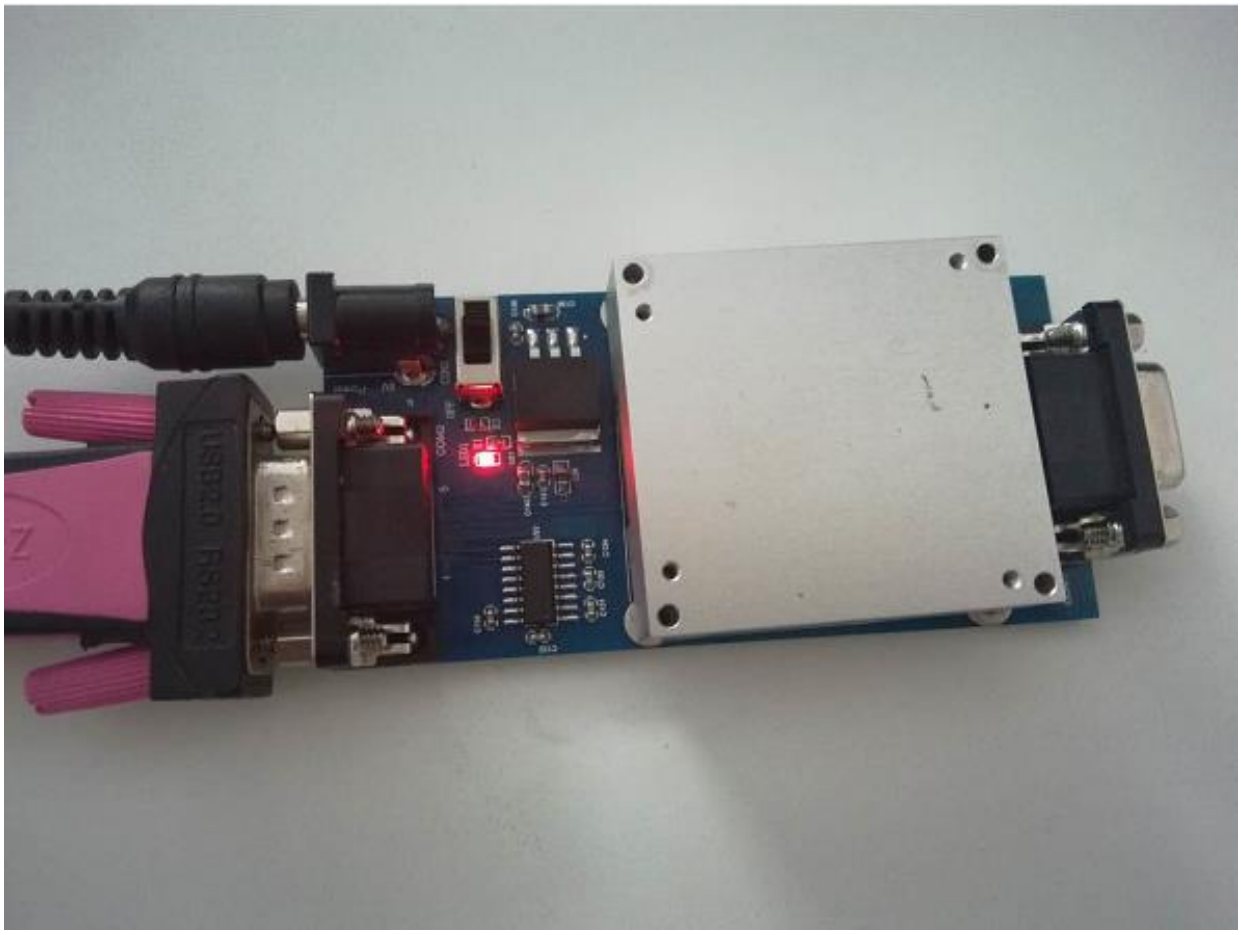
8.2. Adopt the BS-IC24HB-M-D6EC/TEST _ A evaluation board independently developed by the company

The evaluation board is capable of collecting raw data for BS-IC24HB-M-D6EC and supports Win10, Win8, and Win7 operating systems. The main operation steps are as follows:

1) Install the BS-IC24HB-M-D6EC on the evaluation board.

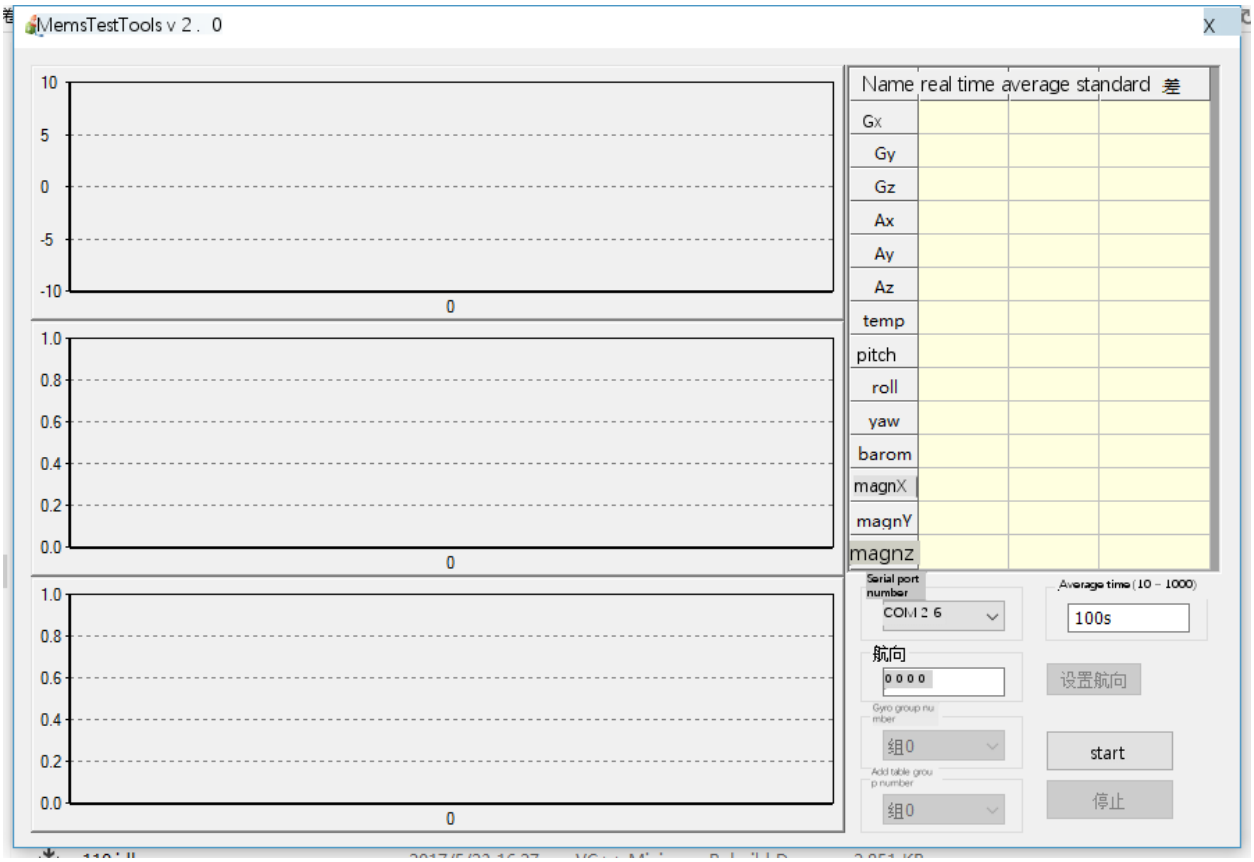


2) Connect the power adapter to 220 AC, turn the switch to the ON position, and the LED is on, indicating that the power supply of the evaluation board is normal;

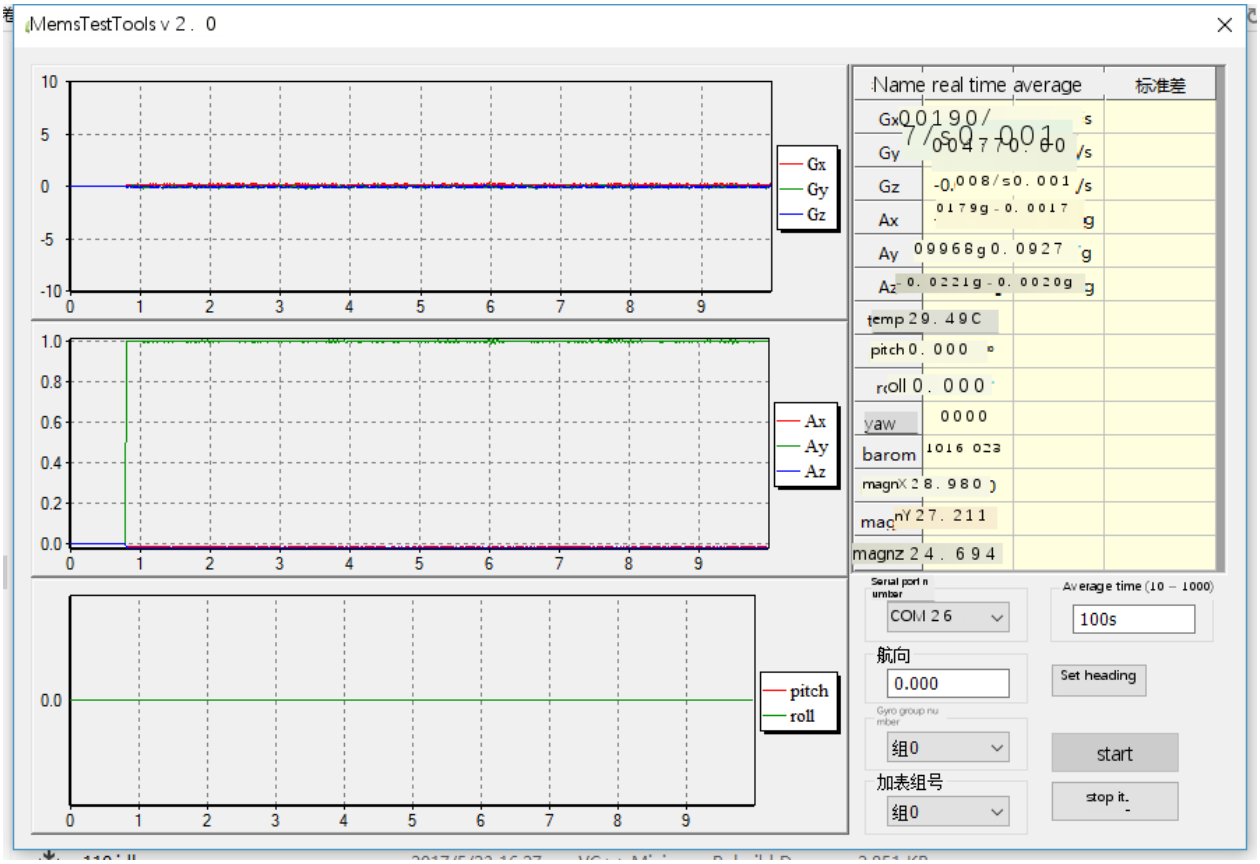


3) Open the evaluation board test software "IMU test software.exe"

CH341SER.EXE	2016/10/5 11:00	应用程序	169 KB
SNC100-IMU测试软件.exe	2016/4/21 18:17	应用程序	10,497 KB



4) Select the correct string number, click "Start", and the software will start to collect data and display it on the interface.



5) The data is automatically saved in the directory where the test software is located, the file name is the time of data acquisition, and the frequency of data storage is 200Hz. The data contents are as follows:

a) X-axis gyroscope, Y-axis gyroscope and Z-axis gyroscope, with the dimension of °/s;

b) X-axis accelerometer, Y-axis accelerometer, Z-axis acceleration, with the dimension of G;

c) Standby 1, standby 2, standby 3, standby 4, standby 5;

d) Temperature, in degrees Celsius

e) Standby 6, Standby 7.