MEMS Inertial Measurement Unit V 1.02.

BS-IC205-M-D6EC

Product characteristics

- Gyroscope measuring range: 500 ~ 2000 °/s optional
- 2 °/H gyroscope bias stability (Allan variance)
- Acceleration range: 16g
- Zero bias stability (Allan variance) for acceleration of 0.1 mg

Field of application

UAVNavigation

hicle & Robot Navigation

/ &ROV

1-General

The BS-IC205-M-D6EC is an inertial measurement unit (IMU) based on micromachining technology (MEMS), with built-in high-performance MEMS gyroscope and MEMS accelerometer, outputting 3 angular velocities and 3 accelerations.

The BS-IC205-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) ± 500º/s dynamic measuring range;
   b) Zero bias stability: 10 °/H (GJB, 10s), 2.0 °/H (ALLAN);
2) Triaxial digital accelerometer:
   a) ± 16 G dynamic measuring range;
   b) Zero-bias stability: 0.5 mg (GJB, 10s), 0.1 mg (ALLAN);
3) High reliability: MTBF > 20000h;
4) Guaranteed accuracy within the full temperature range (-40 ℃ ~ 80 ℃): 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. Product indicators

Parameter		Test conditions	Minimal	Typical value	Max	Unit
Peg-top	Dynamic measuring			500	2000	º/s
		Allan variance		2.0	4.0	º/h
	Zero bias stability	10 s average (-40 ℃ ~ + 80 ℃, constant temperature)		10	20	º/h
	Zero bias	Zero bias range		±0.2	±0.4	º/s
		Zero bias change over full temperature range ○, 1)		±0.1	±0.2	º/s
	Scale factor	Scale factor accuracy		0.3	0.6	%
		Scale factor nonlinearity		0.02	0.04	%FS
	Resolution			3.052×10−7	6.104×10−7	º/s/LSB
	Bandwidth			200	200	Hz

Parameter		Test conditions	Minimal	Typical value	Max	Unit
Accelerometer	Dynamic measuring			16		g
	Zero bias stability	Allan variance		0.1		mg
		10 s average (-40 ℃ ~ + 80 ℃, constant		0.5		mg
	Zero bias	Zero bias range		2		mg
		Change of zero bias in full temperature range, peak-to-peak value ○, 1)		5		mg
	Scale factor	Scale factor accuracy		0.3		%
		Scale factor nonlinearity		0.02		%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		Hz
Electrical characteristics	Voltage		3.0	3.3	3.6	V
	Power consumption				1.5	W
	Ripple	P-P			100	mV
Structural charact	Size			47×44×14		mm
	Weight			50		g
Use environment	Operating temperature		-40		80	℃
	Storage temperature		-45		85	℃
	Vibration			20~2000Hz，6.06g		
	Impact			1000g，0.5 ms		

Parameter		Test conditions	Mini mal	Typical value	Max	Unit
Reliability	MTBF			20000		h
	Continuous working time			120		h

Ошибка!: Calculate the zero deviation of the whole temperature change process, the temperature change rate is ≤ 1 ℃/min, and the temperature range is -40 ℃ ~ + 80 ℃;

4.Electrical interface

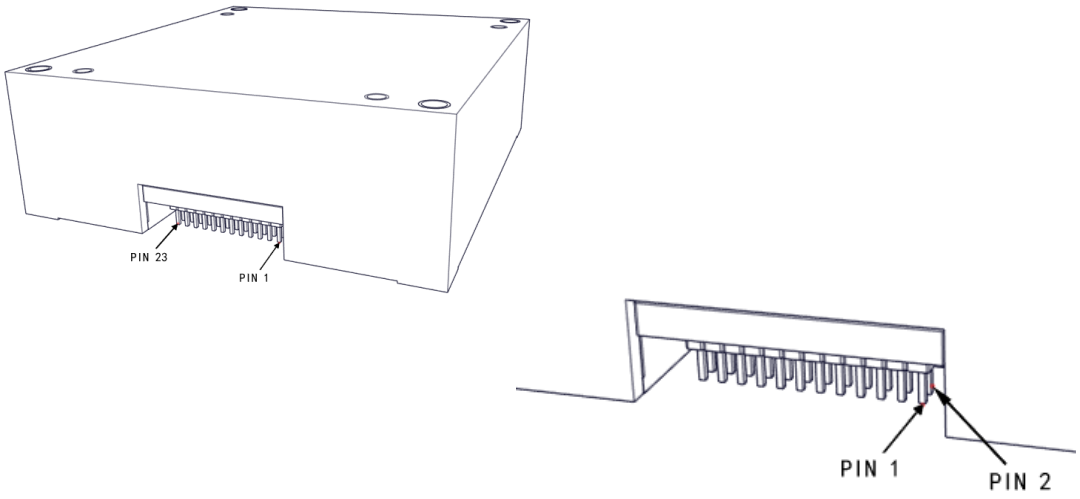

Fig. 1 Pin Description of Butt Connector

Table 3. Pin Function Description

Pin sequence	Name	Type	Description
10, 11, 12	VDD	Power	
13, 14, 15	GND	Power	
9	DIO2	Output	Ready signal, indicating data update
3	SPI-CLK	Input/out	SPI, Slave Mode
4	SPI-MISO	Input/out	
5	SPI-MOSI	Input/out	

6	SPI-/CS	Input/out	
19	UART-TXD	Output	UART, configurable baud rate, default is 230400 bps
21	UART-RXD	Input	
18	CAN-T	Output	
20	CAN-R	Input	
8	RST	Input	Reset
23	VDDRTC	Power	
Other	NC	Spare	Retained by the manufacturer

5. Structural interface

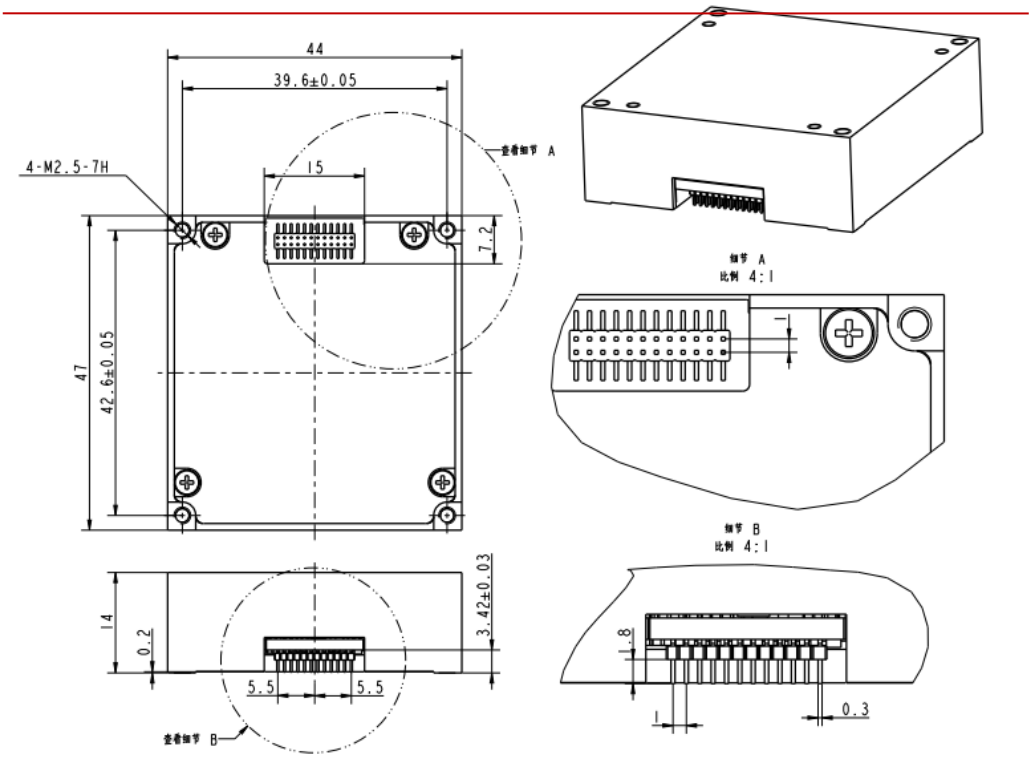

Figure 2. Schematic diagram of structure outline

6.Instructions for use

6.1 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.

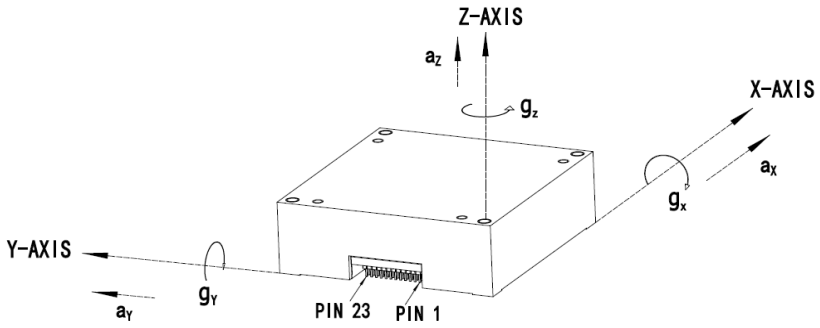

Figure 3 BS-IC205-M-D6EC Axis Direction Reference Diagram

6.2 SPI read and write data

The BS-IC205-M-D6EC is an autonomous sensor system that automatically starts when a valid power source is present. When 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, as shown in Figure 1. Four SPI signals support synchronous serial data transfer. In the factory default configuration, the DIO2 pin provides a data-ready signal that goes high when new data is available in the output data register.

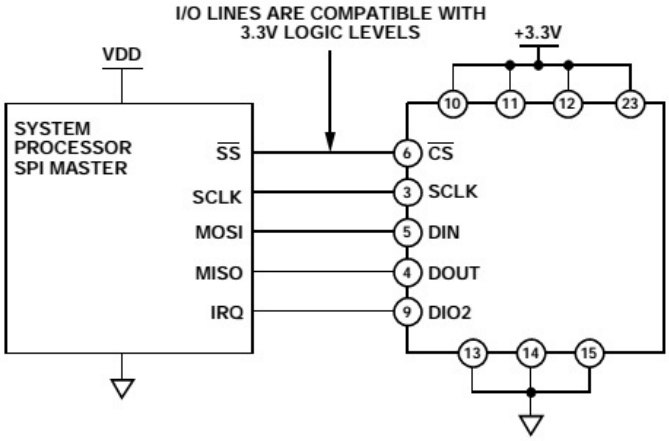

Fig. 4 Schematic diagram of connection with external equipment

6.2.1 Generic Host Processor SPI Settings

Table 4. Generic Host Processor SPI Settings

Processor settings	Explain
Host	BS-IC205-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

6.2.2 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.

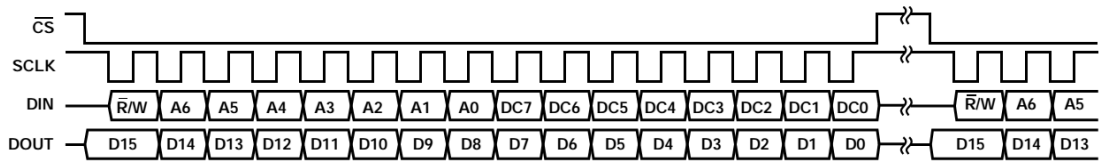

Figure 5. SPI Read and Write Timing

6.2.3 reads sensor data

BS-IC205-M-D6EC automatically starts 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 Figure 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 a full 16 SCLKs to receive the request. The following figure shows two sequential register reads, one with DIN = 0x1A00 requesting the contents of the Z _ GYRO _ OUT register, and the other with DIN = 0x1800 requesting the contents of the

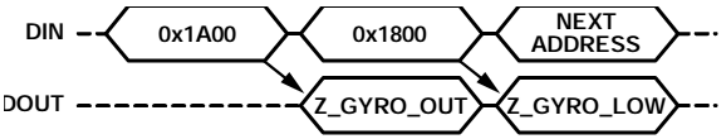

Figure 6. SPI Read Example

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

A delay of not less than 5 us shall be inserted between reading two data registers.

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	Alarm error flag output
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
X_MAGN_OUT	R	0x00	0x28	N/A	X-axis magnetometer output, high word
Y_MAGN_OUT	R	0x00	0x2A	N/A	X-axis magnetometer output, high word
Z_MAGN_OUT	R	0x00	0x2C	N/A	X-axis magnetometer output, high word
BAROM_LOW	R	0x00	0x2E	N/A	Barometer Output, Low Word
BAROM_OUT	R	0x00	0x30	N/A	Barometer Output, High Word
PROD_ID	R	0x00	0x7E	102	Product identification (102) output

User register memory map

6.2.5 transformation formula

Current temperature = 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

6.3 UART read-write data

6.3.1 interface

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

6.3.2 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) $GPRATIOxx

Configure the output frequency command. When the sampling frequency is 200Hz, the output frequency = 200/XX

7) $GPINF

View configuration information

6.3.3 standard protocol format

It is divided into protocol head, protocol body and protocol tail; 200 Hz; the coordinate axis is defined as front upper right

Table 6. Standard Protocol Format

Agreement	Byte sequence	Data	Unit	Data type	Remark
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 plus	g	float	
	18~21	Y-axis plus	g	float	
	22~25	Z-axis plus	g	float	
	26~29	X-axis	mgauss	float	
	30~33	Y-axis	mgauss	float	
	34~37	Z-axis	mgauss	float	
	38~41	Spare			
	42~45	Spare			
	46~49		℃	float	
	50~53	Spare			
	54~57	Spare			
End of	58	Checksum			Accumulate

7. Instructions for using the evaluation board

The EVAL-ADis evaluation board from Analog Devices, Inc., is available for the 7.1

The evaluation board is capable of acquiring raw data from the BS-IC205-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;

Instructions for installing the program

2) Install the BS-IC205-M-D6EC on the evaluation board;

Figure 8. Analog Devices EVAL-ADis Evaluation Board Front Mounted

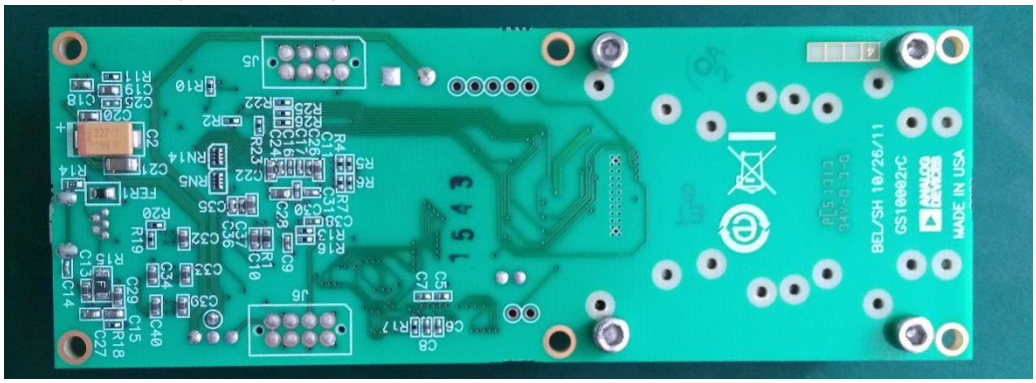

Figure 9. Back of Analog Devices EVAL-ADis Evaluation Board

3) The power supply jumper on the evaluation board is selected to be 3.3 V;

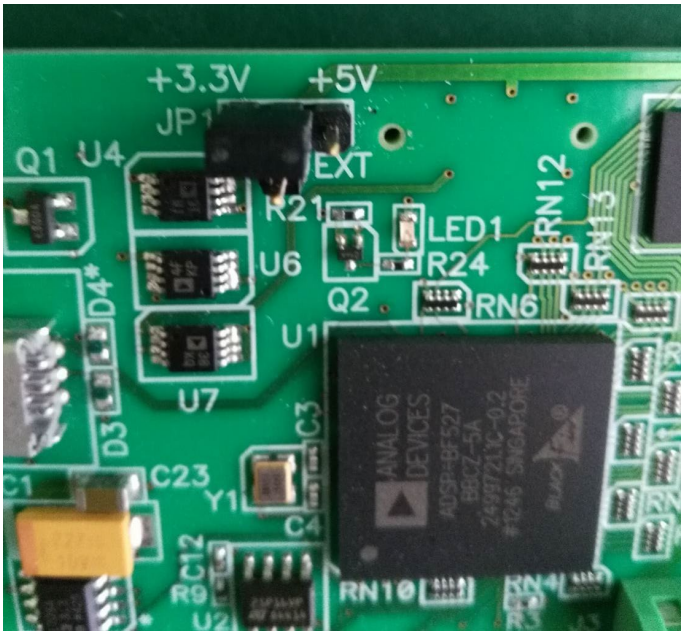

Figure 10. Analog Devices EVAL-ADis Evaluation Board 3.3 V Power Supply

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 connected to the PC successfully;

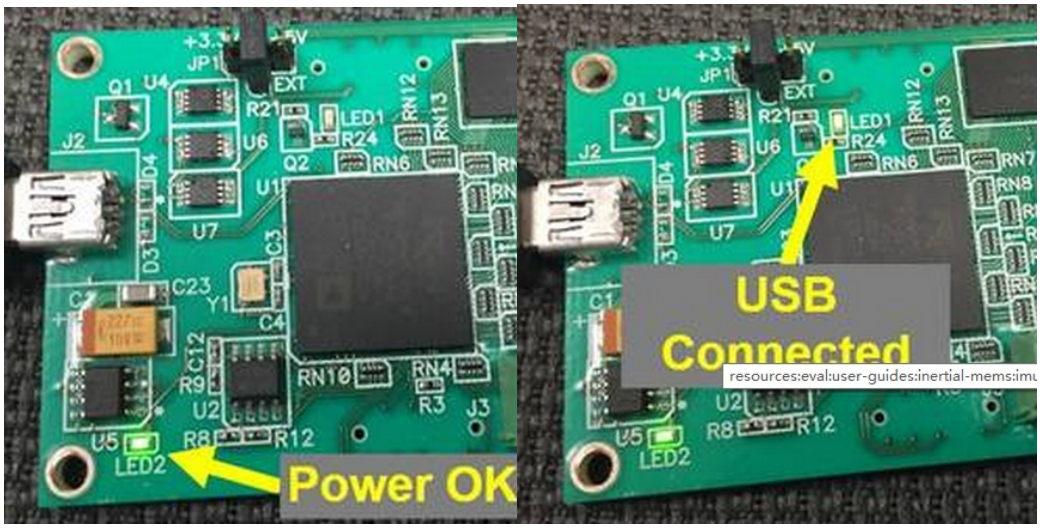

Figure 11. Analog Devices EVAL-ADis Evaluation Board Operational Status Indicator

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

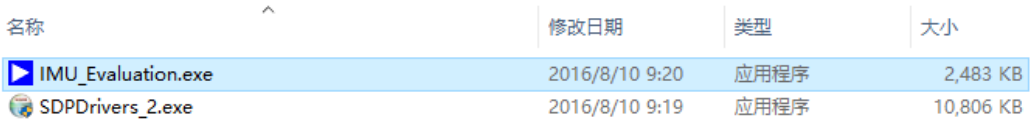

Figure 12 Analog Devices EVAL-ADis Evaluation Board Test Software

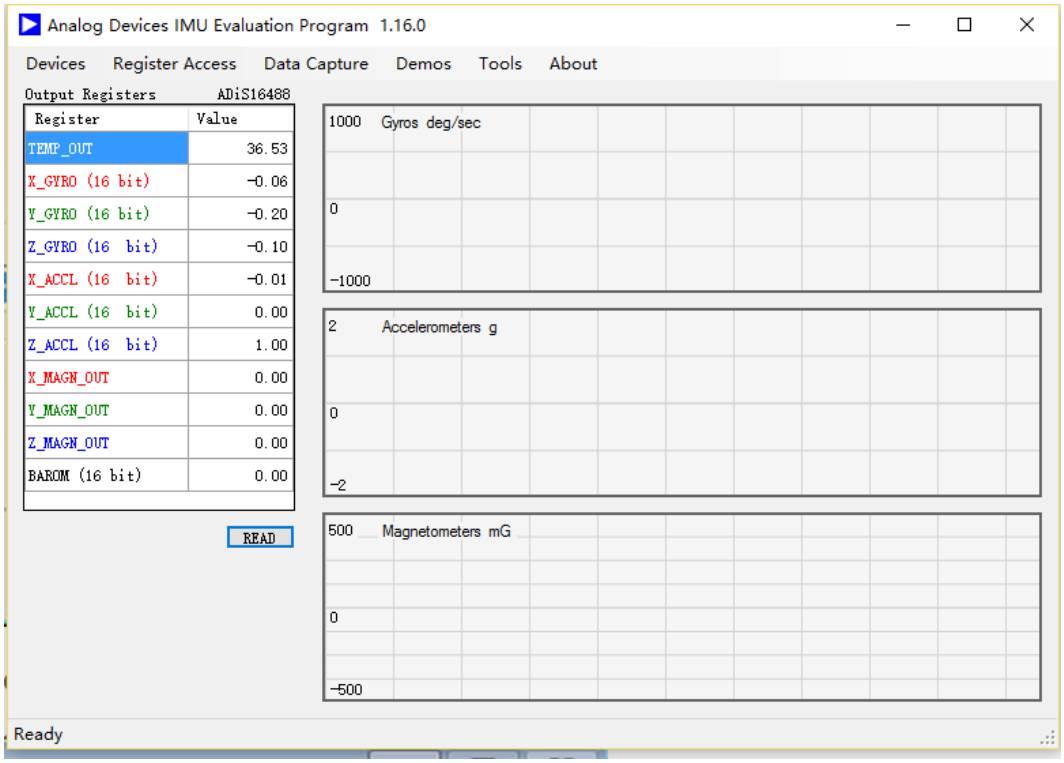

Figure 13. Analog Devices EVAL-ADis Evaluation Board Test Interface

6) Select ADIS16488 in Devices;

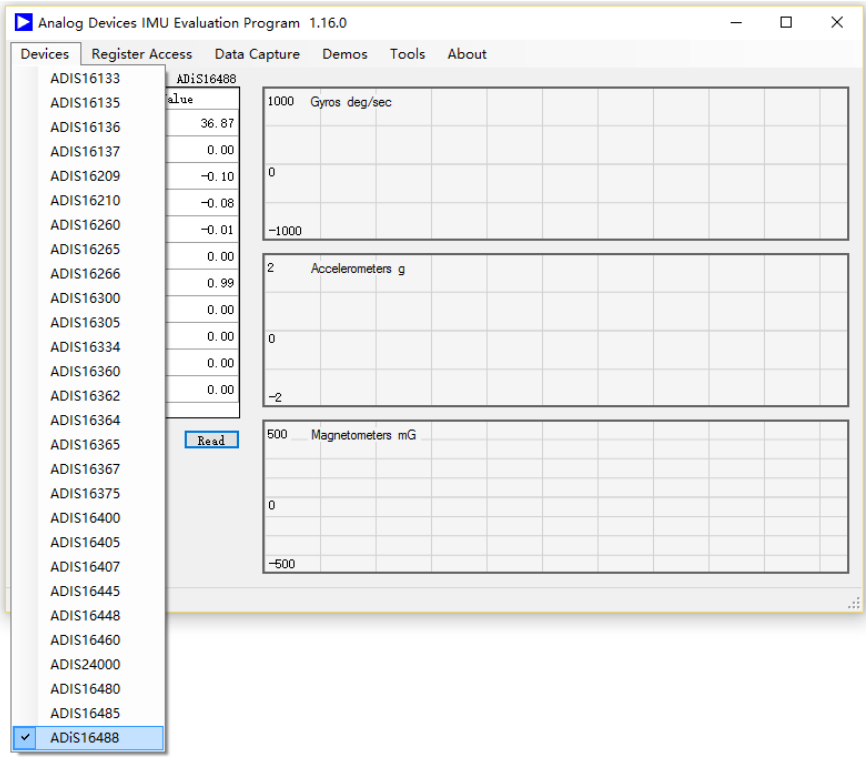

Figure 14 Analog Devices EVAL-ADis Evaluation Board Test Software Model Selection

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

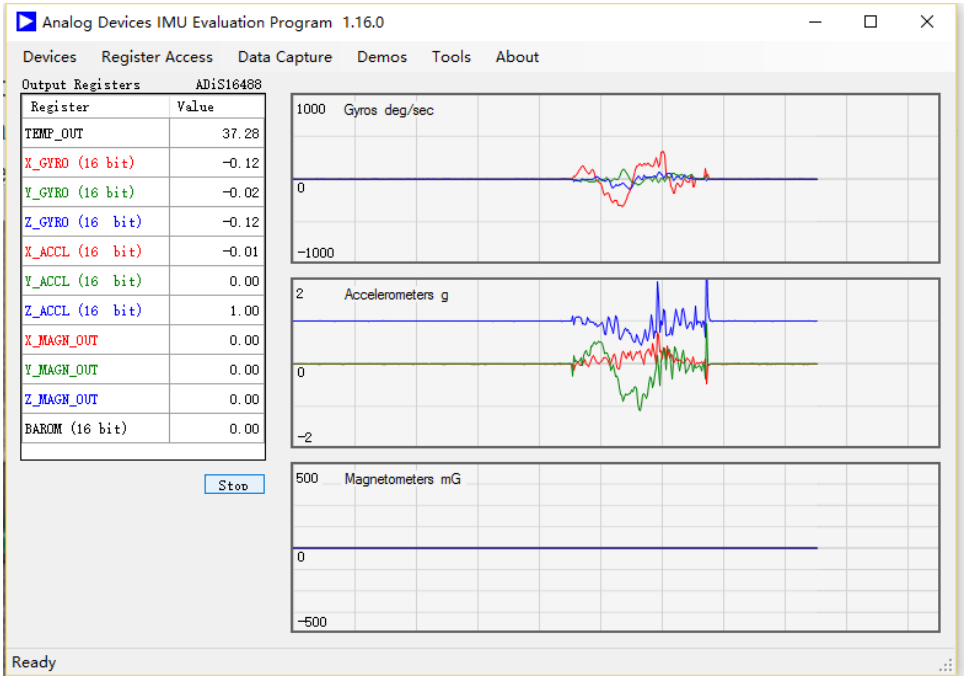

Figure 15. Analog Devices EVAL-ADis Evaluation Board Test Interface Display

The 7.2 adopts the BS-IC205-M-D6EC/TEST _ A evaluation board independently developed by the company.

The evaluation board is capable of collecting raw data from the IMU200A-D0-IMU and supports Win10, Win8, and Win7 operating systems. The main operation steps are as follows:

1) Install the BS-IC205-M-D6EC on the evaluation board;

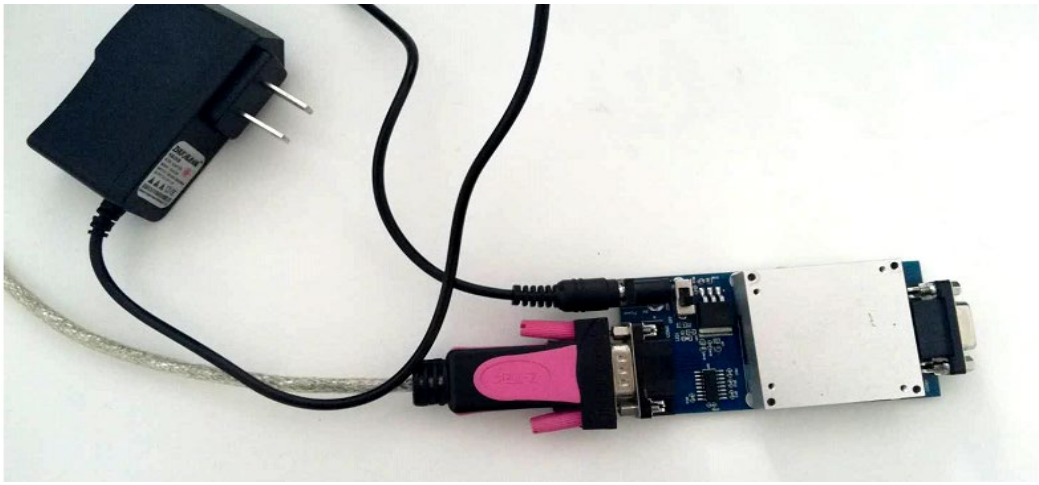

Figure 16 BS-IC205-M-D6EC Evaluation Board

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

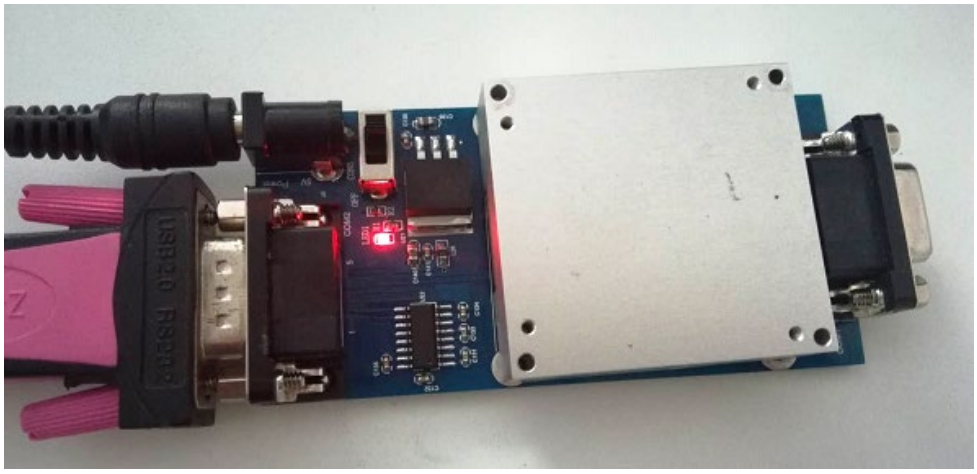

Figure 17 BS-IC205-M-D6EC Evaluation Board Power Supply

Indication 3） Open the evaluation board test software "MemsTest Tools -v 2.3.exe"

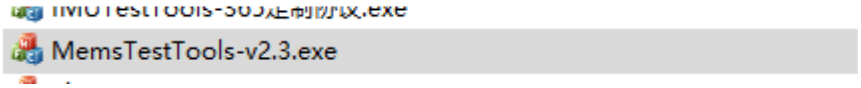

Figure 18 BS-IC205-M-D6EC Evaluation Board Test Software

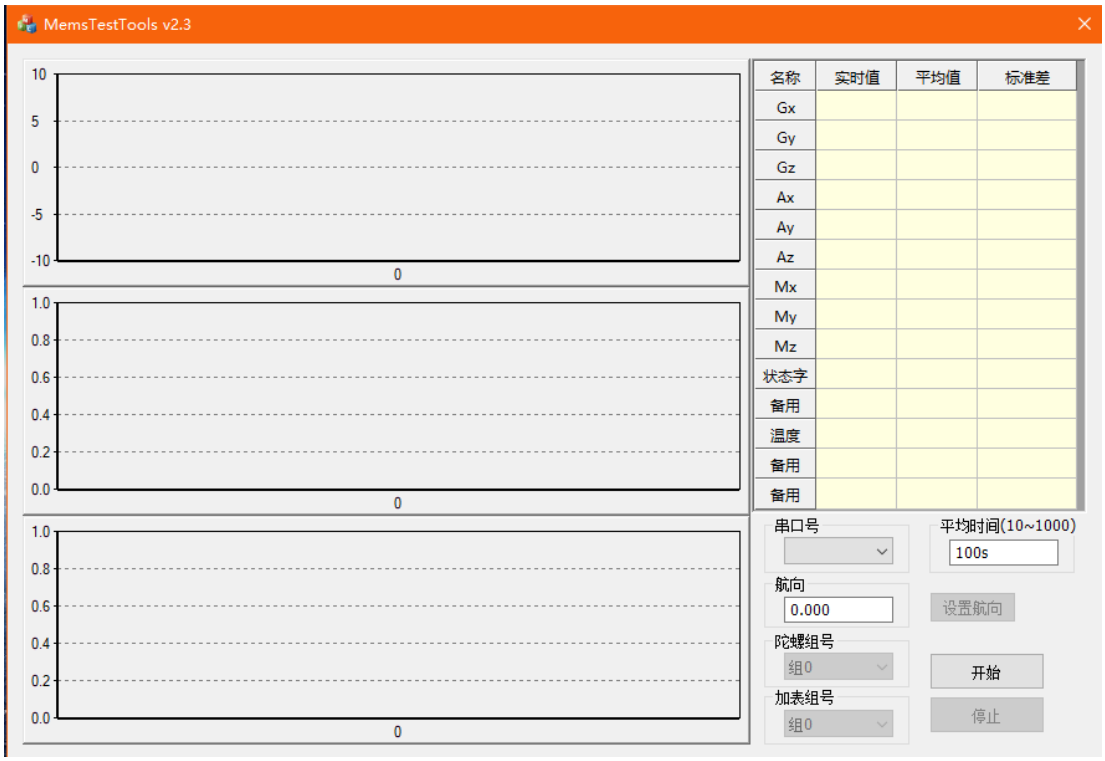

Figure 19 BS-IC205-M-D6EC Evaluation Board Test Software Interface

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

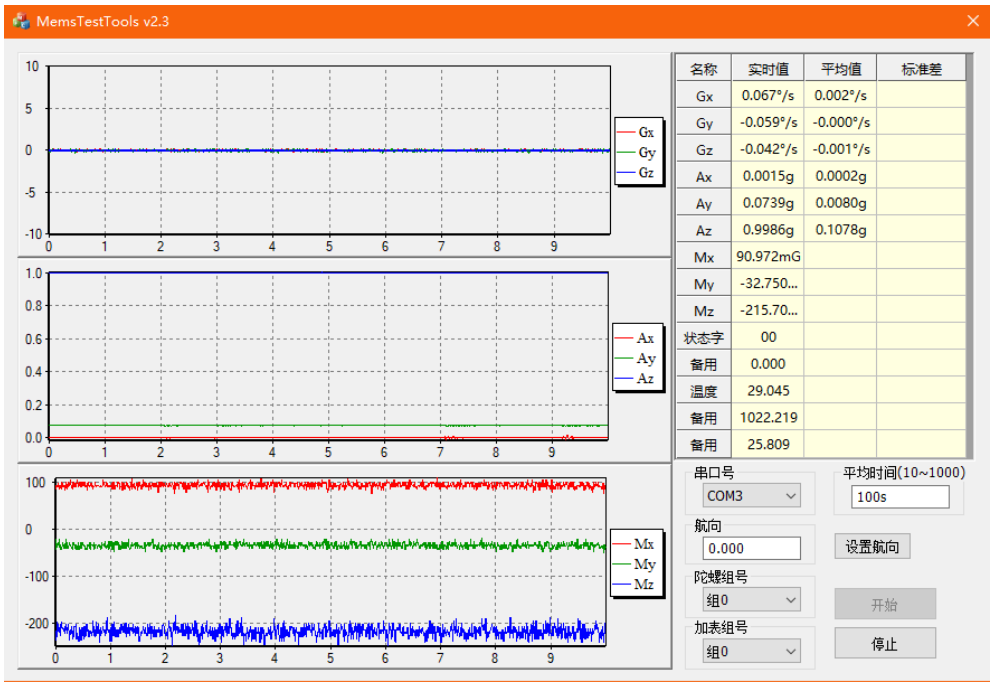

Figure 20 BS-IC205-M-D6EC Evaluation Board Test Software Test Interface

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 and 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.

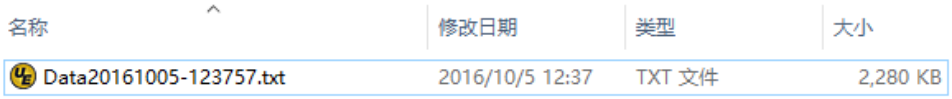

Figure 21 BS-IC205-M-D6EC Evaluation Board Test Data Storage

7. Update records

Serial number	Version	Change the date	Before the change	After the change	Reason for the change	Changed by
1	1.00	20220822		New establishment	New establishment	fyg