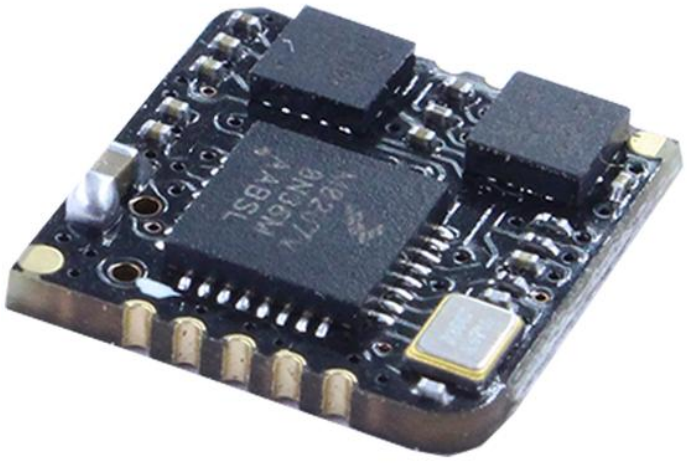
HiPNUC

HI21XX User Guide

VRU/AHRS Module

Document HI2XXUM, Revision A1, 7 June 2017



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1 Introduction

HI21XM series embedded with on-board 3-aixs accelerometer, 3-aixs gyroscope and 3-aixs compass and also RF subsystem and on-board processor。 The embedded algorithm include static drift calibration, dynamic calibration and sensor data fusion. It can output module's orientation information.

HI219M

The MTi-30 AHRS is a full gyro-enhanced Attitude and Heading Reference System (AHRS). It outputs drift-free roll, pitch and true/magnetic North referenced yaw, plus sensors data: 3D acceleration,

HI216M

HI216M is a 3D vertical reference unit (VRU), which means that it outputs the same data as the HI219M, except for the referenced yaw. The yaw is unreferenced, though still superior to just gyroscope integration.

Features

On-board sensors

- 3-aixs gyroscope, maximum range:±2000°/s, maximum output rate: 1000 Hz
- 3-aixs accelerometer, maximum range:±16g, maximum output rate: 1000 Hz
- 3-aixs compass, maximum range:±8 milligauss maximum output rate: 200Hz

Data fusing

- accelerometer and gyroscope has been calibration before shipping
- data fusion algorithm can output quaternion and eular angles under world frame.
- output on-board sensors data

Communication interface

- UART, compatible with 3.3 or 5V system
- Operating voltage ：3.3 (+/- 100 mV)
- Max peak current：25mA

Others

- open source C and C# PC host software
- module parameter is configurable

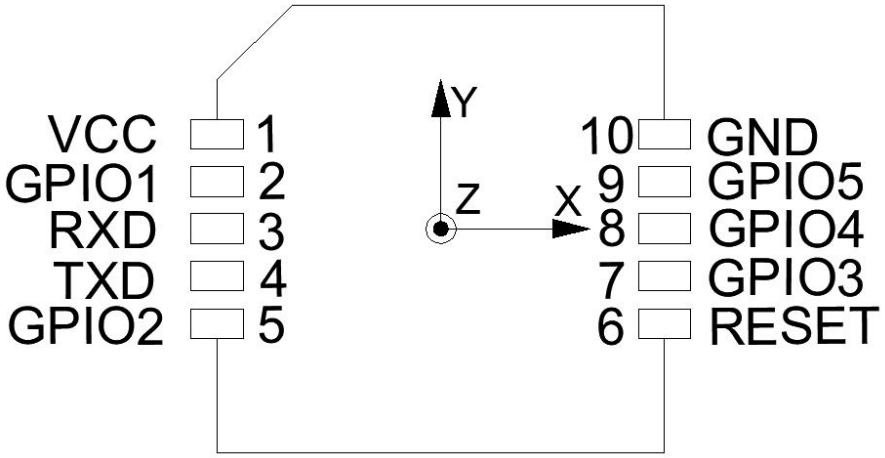
2 Hardware parameter

hardware parameter

	HI216M	HI219M
Data interface:	UART (1.8V-3.3V)	
Other interface:	5x GPIO	
Operation voltage:	3.3 (+/- 100 mV)	
power:	66mW @ 3.3V（varies according to output data rate）	
Temperature range:	0 °C – 85 °C	
Max allowed acceleration:	0-115 m/s	
Size:	12 x 12 x 2 mm (W x L x H)	
On-board sensors	3-aixs accelerometer 3-aixs gyroscope	3-aixs accelerometer 3-aixs gyroscope 3-axis compass

Pins

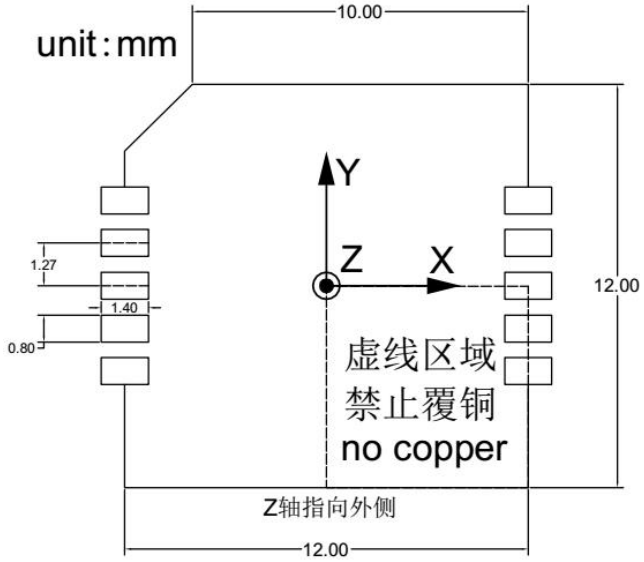
Pin definition as follow, GPIO can be floating when not used



Pins	Name	Description
1	VCC	Power
2	GPIO1	Magnetic filed warning
3	RXD	UART RX(1.8V - 3.3V)
4	TXD	UART TX(1.8V - 3.3V)
5	GPIO2	GPIO2
6	RESET	Reset, Low pulse(20uS)
7	GPIO3	GPIO3

8	GPIO4	GPIO4
9	GPIO5	GPIO5
10	GND	GND

Mechanical size and placement advice



Because of manufacture issue, XY and Z aixs performance does not to be identical. We recommend when install the module, put to Z aixs to be parallel to gravity to get the best performance. If using compass. Put the module at least 10cm from any magnetized materials such as microphone and motors. HI21XXM use JEDED PLCC28 package.

3 Output Specification

Fusion output specification

		HI216M		HI219M	
		Typ	Max	Typ	Max
(Roll)/(Pitch)	static	0.2º	0.4º	0.2º	0.4º
	dynamic	0.5º	2.0º	0.5º	2.0º
(Yaw)		No Reference		1.0º ~2.0º (Absolute)	

Gyroscope

	Hi216M	HI219M
Range	±2000°/s (±250 ±500 ±500 ±2000 selectable)	
Non-Linear	±0.1% (25°Best)	
Noise density	0.08°/s/√Hz	
Output frequency	1KHz	

Accelerometer

	Hi216M	HI219M
Range	±16G (1G = 1xGravity ±2 ±4 ±8 ±16 可选)	
Non-Linear	±0.5% (25°Best)	
Max zero output drift	60mG	
Noise density	250uG/√Hz	
Output frequency	1Khz	

Compass

	Hi216M	HI219M
Range	N/A	±8Gauss
Non-Linear	N/A	0.1%
Output frequency	N/A	200Hz

Data interface

	Hi216M	HI219M
Baud rate	9600 - 921600bps	
Output data rate	0 - 1Khz	

4 Communication interface

Packet format

We provide C and C# data decode demo for reference. After powered up module. The module output data packet at an default 60Hz ODR. And packet format as follow:

PRE	TYPE	LEN	CRC	ID1	DATA1	ID2	DATA2	IDn	DATAn..

Filed	Len	Description
PRE	1 byte	header → (0x5A)
TYPE	1 byte	Packet type → (0xA5)
LEN	2 byte	Frame length
CRC	2 byte	CRC
ID	1 byte	Packet item ID
DATA	1 - 255 byte	Packet item data

(PRE)

Fixed to 0x5A

(TYPE)

Fixed 0xA5 indicate data frame

(LEN)

total frame length, unit in byte, LSB

(CRC)

all frame data CRC result except CRC itself. 16,bit LSB. The example code will provide demo for this.

(ID) and (DATA)

One packet may contain many data item and in different orders. One item contain item ID and it's data:

ID	DATA Len	Meaning	Units	Description
0x90	1 byte	User ID	N/A	ID value can be set by AT command
0xA0	6 byte	Raw Acc	0.001G	int16，3-axis，2bytes per aixs，X、Y、Z totally 6bytes，LSB。
0xA5	6 byte	Liner acceleration	0.001G	int16，3-axis，2bytes per aixs，X、Y、Z totally 6bytes，LSB。
0xA6	6 byte	Gravity	0.001G	int16，3-axis，2bytes per aixs，X、Y、Z totally 6bytes，LSB。
0xB0	6 byte	Raw Gyro	0.1°/s	int16，3-axis，2bytes per aixs，X、Y、Z totally 6bytes，LSB。
0xC0	6 byte	Raw Mag	0.001Gauss	int16，3-axis，2bytes per aixs，X、Y、Z totally 6bytes，LSB。

0xD0	6 byte	Eular (integer output)	degree	Integer output, format as int16, totally 3-aixs, 3 value, each value contain 2 bytes, order as Pitch/Roll/Yaw, LSB. Roll, Pitch is the actual value multiply by 100. Yaw is actual value multiply by 10.
0xD9	12 byte	Eular (floating output)	degree	Single float format total 4 values (Pitch/Roll/Yaw),each value contain 4 bytes,LSB
0xD1	16 byte	Quaternion	N/A	single float format, total 4 values(W,X,Y,Z) each value contain 4 bytes,LSB
0xF0	4 byte	Pressure	Pa	Not supported

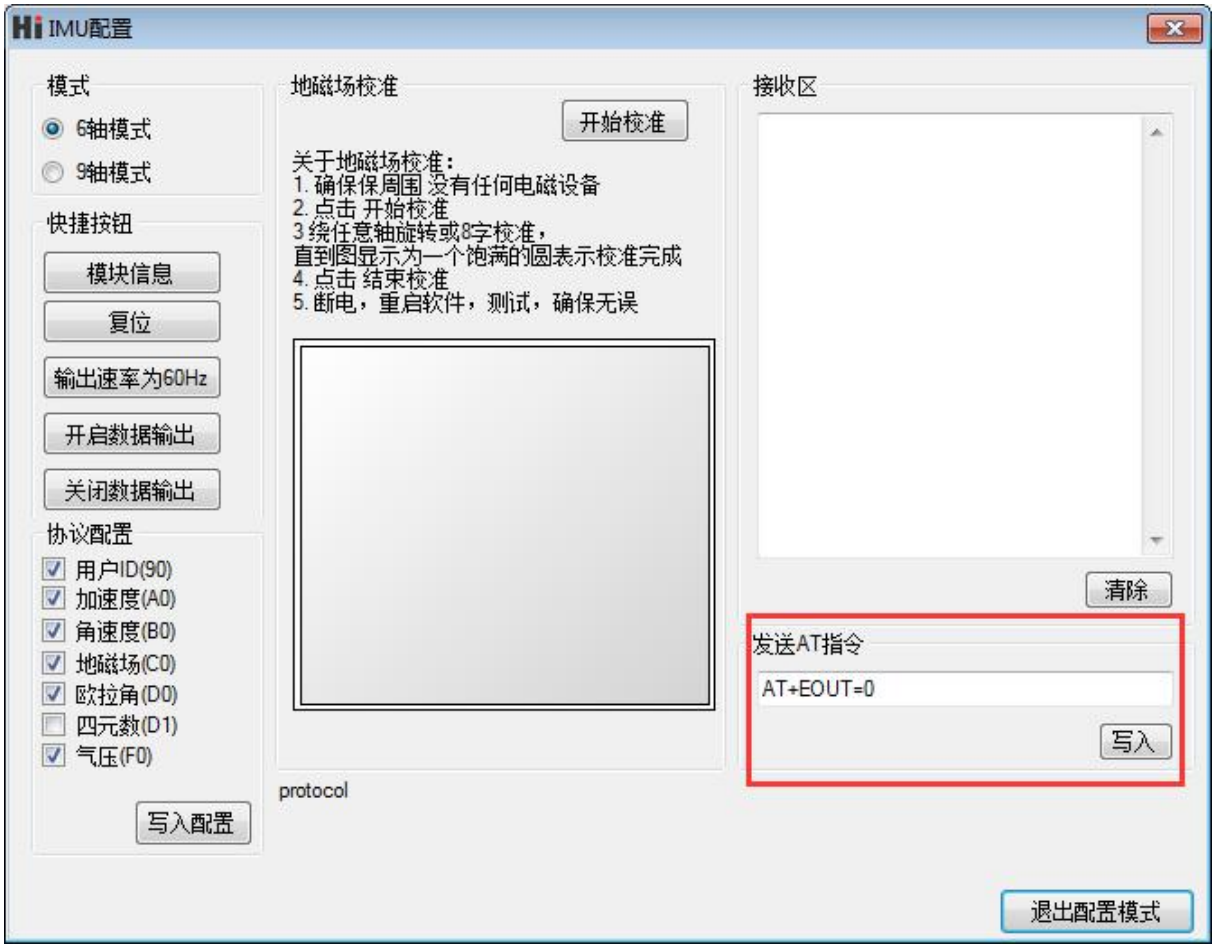
Default data item in output packet

Data item in one packet can be configured by PC software, by default, the data item include:

Order	Item ID	Description
1	0x90	User ID
2	0xA0	Raw acc
3	0xB0	Raw gyro
4	0xC0	Raw mag
5	0xD0	Eular angles
6	0xF0	Pressure

5 AT command set

AT command can be used as set/get module parameters. AT command always start at ASCII "AT", following with control characters. Following with "\r\n", AT command can be tested with COM assists tool or putty.



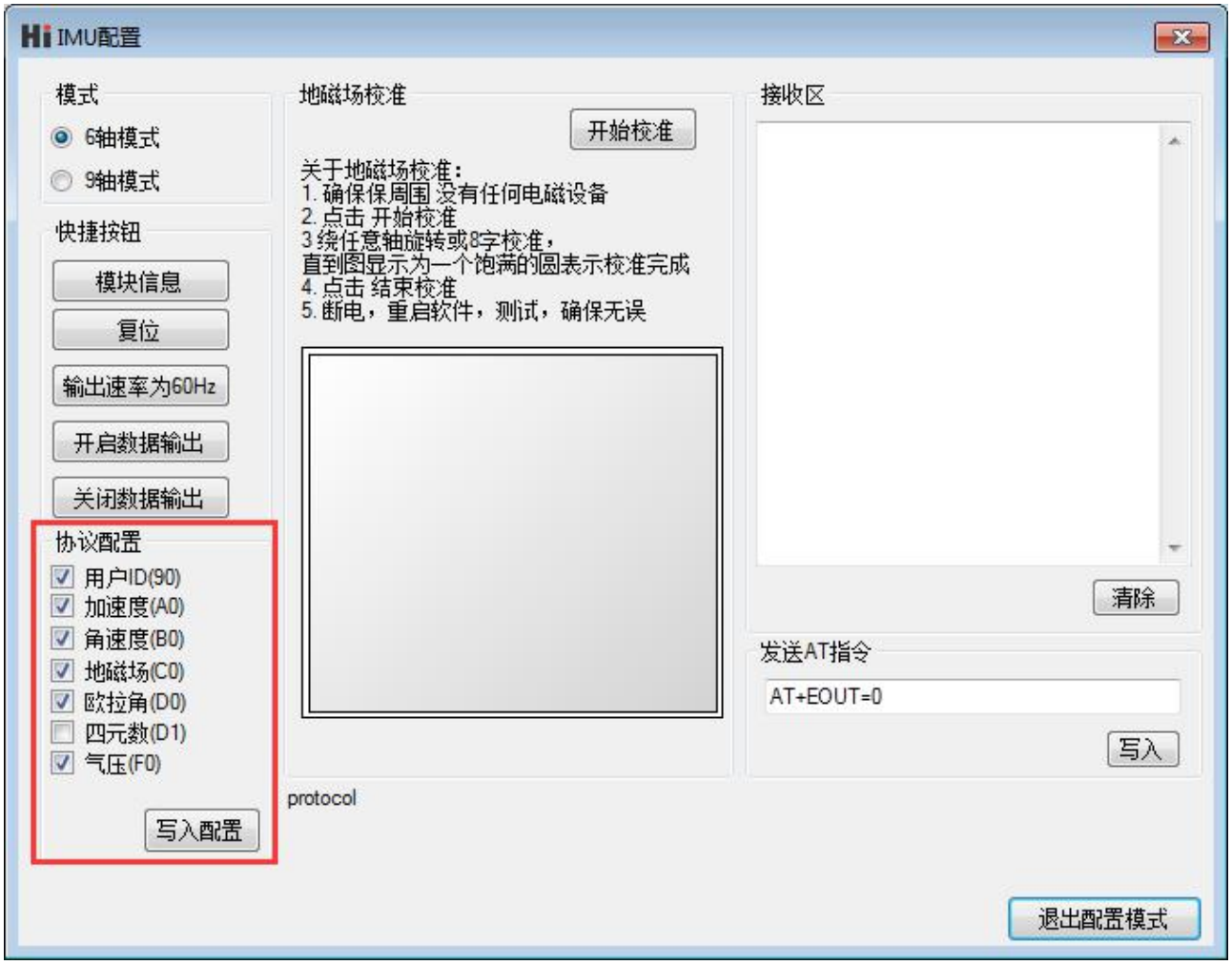
Supported AT commands:

AT	Save	Default	Description	Demo
AT+INFO	N	N/A	List module firmware info	AT+INFO
AT+ODR	Y	60	set out data rate	AT+ODR=60
AT+BAUD	Y	115200	Set serial baud rate	AT+BAUD=115200
AT+MODE	Y	0	Set operation mode:(Only HI219M) AT+MODE=0 6 Axis mode AT+MODE=1 9 Axis mode	AT+MODE=0
AT+EOUT	N	1	:Set data output enable AT+EOUT=0 Disable AT+EOUT=1 Enable	AT+EOUT=0
AT+RST	N	N/A	Reset	AT+RST

AT+ID	Y	0	Set module ID AT+ID Read ID AT+ID =x Set ID value 0-255	Set ID 为 100 AT+ID=100
AT+SETPTL	Y	N/A	See “Configure package data item” chapter	

6 Configure Packet data item

Packet date item can be configured by using AT command, recommend use PC software to configure.



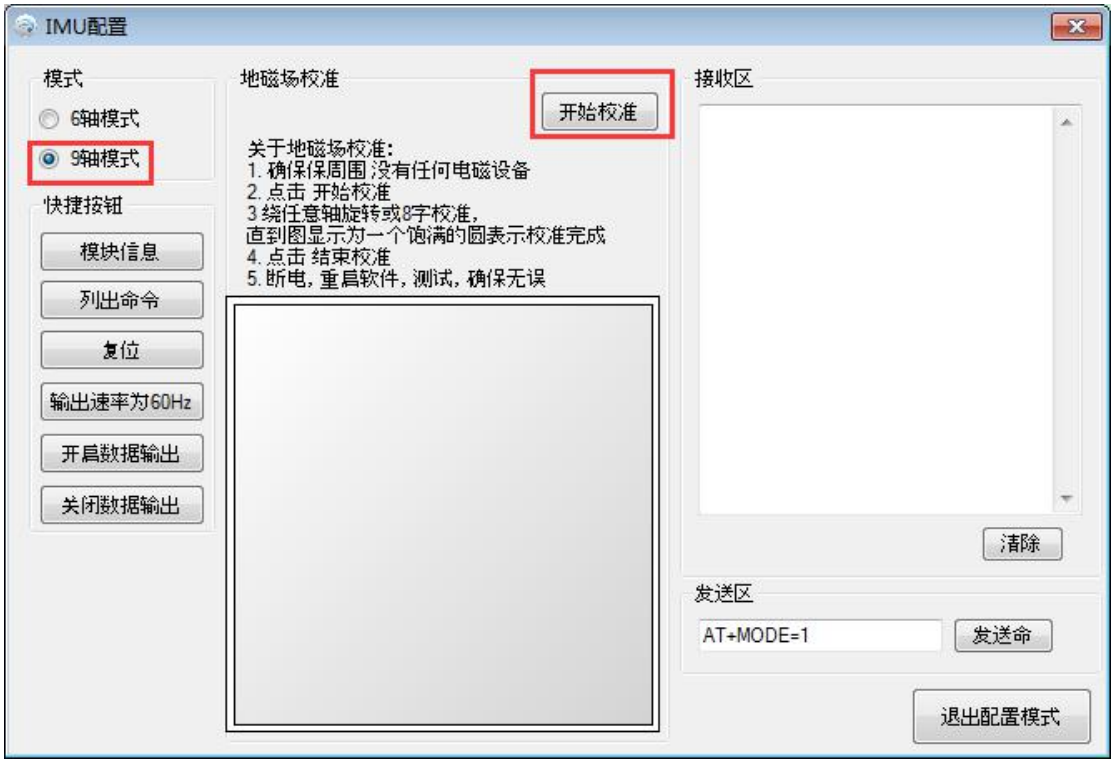
7 Calibration and fusion algorithm

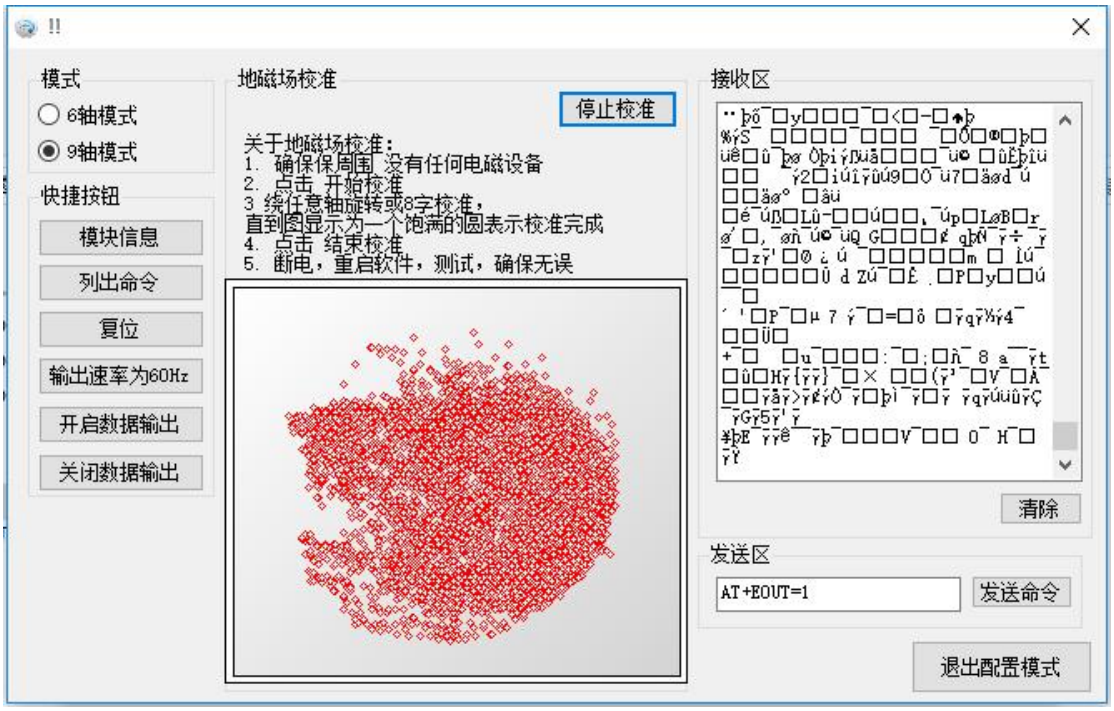
Calibration

Each HI21XX series has been calibrated before shipped out. And the calibration parameters has been saved to module's internal EEPORM. In normal cases, user does not need to calibrate accelerometer and gyroscope.

Compass is not like accelerometer and gyroscope, the output of compass is heavily influenced by surround magnetized things and also influenced by PCBA. So that need user to calibrate compass before use it. To calibrate compass, following below methods:

- Open PC software tool, connect the module, make sure the module is work fine.
- Switch to IMU configuration page. Click "开始校准"
- Make sure the module is in a clean magnetic environments. Put the module is all 3xies in as many possible direction as much. Until the drawing area show a relative round circle. After calibration complete, click "停止校准" button, the calibration process is complete.





Fusion output

This product embedded with sensor fusion algorithm and digital filtering system, those software will fuse the sensor output data and compute final module orientation and putout stable Euler angles.

HI219M will use 3-aixs accelerometer, 3-aixs gyroscope and 3-aixs compass data and output module orientation under world frame and (referenced) absolute yaw.

HI216M will use 3-aixs accelerometer, 3-aixs gyroscopes data and output module orientation under world frame and unreferenced yaw.

8 Firmware update and restore default settings

Firmware update

This product support on-line firmware update, please log on to HiPNUC web side www.hipnuc.com to get latest firmware version.

To update firmware:

- Got firmware from web side, the Windows extension name should be ".hex".
- Connect the module, open PC host software, setting the module and PC software's serial communication baud rate to be 115200. Change to firmware update window.
- Click connect button, if module return the bootloader information, it indicate that module is connected with PC and it's ready to update. Click "开始编程" to download, if update successful, close PC software and repower the modue.。
- Note: any firmware update may lose user settings

Restore default settings

If module has been configured with wrong baud rate, it will cause module cannot received correct AT command and cannot communicate with PC software. To restore with factory settings. Use following method:

- Power down the module, connect GPIO2 to GND.
- Repower the module, then disconnect GPIO2 with GND, now the module is restored with factory settings.

9 History

Revision	Date	By	Changes
A	20170612	YANDLD	Initial release
A1	20170630	YANDLD	Index fix, and EN version