Patent No.: ZL 202030439670.X

CE :AT18250EC001210

RoSH:18300RC20410801

V2.7

Anti-Impact Dynamic Inclinometer

HDA436T-CANBUS

Technical Manual

RION QUALIFICATION CERTIFICATION

○ Quality management system certification: GB/T19001-2016 idt ISO19001:2015 standard (certificate no.: 128101)

○ Quality management system certification: IATF16949: 2016 (certificate number: T178487)

○ Intellectual property management system certification: GB/T29490-2013 standard (certificate number: 41922IP00281-06R0M)

○ GJB9001C-2017 Standard Weaponry Quality Management System Certification (Registration number: 02622J31799R0M)

○ High-tech enterprise (Certificate No.: GR201844204379)

○ shenzhen professional dedicated unique innovative enterprice

○ China National Intellectual Property Appearance Patent (Patent No.: ZL 202030439670.X)

○ CE certification: registration No.:AT18250EC001210

○ RoSH certification: registration No.:18300RC20410801

○ Revision date: 2023-6-8

Note: Product functions, parameters, appearance, etc. will be adjusted as the technology upgrades. Please contact our pre-sales business to confirm when purchasing.

▶ PRODUCT DESCRIPTION

HDA436T/HDA437T A new generation of digital MEMS dynamic tilt sensor launched by RION Technology. It can measure the attitude parameters (roll, pitch, and azimuth) of a moving carrier, and suitable for tilt angle measurement under motion or vibration.

HDA436T has a built-in high-precision acceleration and gyro sensor, and integrates the Carman filter algorithm, which can measure the real-time motion data of the carrier under motion or vibration. The product has dual CAN (CAN2.0A / CAN2.0B) mode, which is highly scalable.

This product adopts non-contact measuring principle, which can output the current attitude and inclination in real time. It is simple to use and does not need to retrieve the relative changes of the two surfaces.

Internally integrated high-precision AD and high-precision gyro units to compensate for non-linear, orthogonal coupling, temperature drift and centrifugal acceleration in real time; greatly eliminate centrifugal errors caused by motion acceleration interference, improve product dynamic measurement accuracy; adapt to long-term complex movements Work in places and harsh environments.

The product is a dynamic and static dual-mode measurement sensor with strong resistance to external electromagnetic interference.It is suitable for all kinds of large-scale and high-strength shock and vibration industrial environments, and is an ideal choice for industrial automation control and measurement of attitude.

▶ KEY FEATURES

★ Range (Roll angle ± 180 °, pitch angle ± 90 °, azimuth angle ± 180 °)
★ Dynamic accuracy: ± 0.1 °
★ DC 9~36V wide voltage input
★ Wide temperature operation -40~+ 85 ℃
★ Resolution 0.01 °
★ CAN2.0A/CAN2.0B output Optional
★ High anti-vibration performance> 2000g
★ IP67/IP67 Protection level Optional

▶ PRODUCT APPLICATION

★ High vibration impact gravel equipment
★ Railway locomotive monitoring
★ Oil drilling equipment
★ Shield pipe jacking application
★ Shield pipe jacking application
★ Geological equipment tilt monitoring
★ Underground drilling rig attitude navigation
★ Ship navigation attitude measurement
★ Satellite communication vehicle attitude detection
★ Orientation measurement based on inclination angle
★ Various engineering machinery inclination measurement




▶ SPECIFICATIONS

HDA436T		Condition	Index
Measure range		\	Roll ± 180 °, pitch ± 90 °, azimuth ± 180 ° (initial value at power-down is 0 °)
Measure axis		\	X axis / Y axis / Z axis
Resolution		\	0.01°
Static accuracy		@25℃	± 0.05°
Dynamic accuracy		@25℃	± 0.1°
Gyro	range	-	±250°/s
	Zero bias stability (10s mean)	-	8.5°/h
	Zero Bias Instability(allan)	-	4.5°/h
	Angle random walk coefficient(allan)	-	0.25°/sqrt(h)
Acceleration	range	-	±8g
	Bias stability(10s mean)	-	0.02mg
	Bias instability(allan)	-	0.005mg
	Speed random walk coefficient(allan)	-	0.005m/s/sqrt(h)
Zero point temp. coefficient		-40～85℃	±0.01°/℃
Sensitivity temp. coefficient		-40～85℃	≤100ppm/℃
Power-on startup time		1S	
Response time		0.01S	
Output signal		CAN2.0A/CAN2.0B	
Electromagnetic compatibility		According to EN61000 and GBT17626	
MTBF		≥ 98000 hours / time	
Insulation resistance		≥100 Megohm	
Impact resistance		100g @ 11ms, 3 axial direction (half sinusoid)	
Anti-vibration		10grms、10～1000Hz	
Waterproof level		standard configuration: IP67 optional configuration: IP68 or IP68 with anti-corrosion cable	
Cable		Standard without wiring, optional 2m M12 aviation plug with PVC unshielded cable	
Weight		Single connector ≤165g / double connector ≤180g (Without cable)	

KEY WORDS

Resolution : It refers to the smallest change in the measured value that can be detected and resolved by the sensor within the measurement range.

Accuracy: refers to the root mean square difference between the measured and actual angle value by multiple measurements (>16 times) under normal temperature.

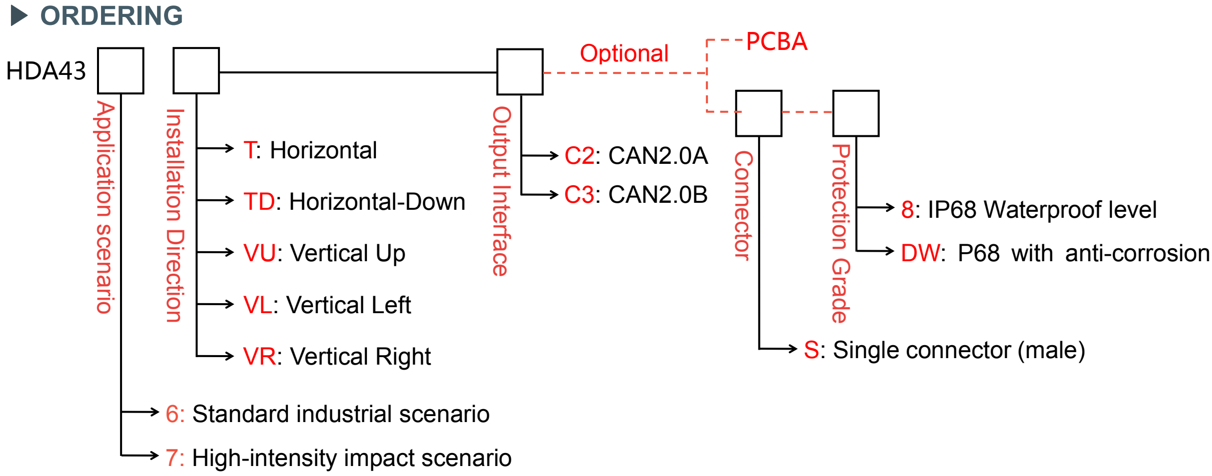
Zero temperature drift coefficient: the change rate of the indication value relative to normal temperature within the rated operating temperature range of the sensor at the zero degree.

Sensitivity temperature drift coefficient: The percentage change rate with temperature of the full-scale indication relative to the full-scale indication at room temperature of the sensor in its rated operating temperature range.

▶ ELECTRICAL PARAMETERS

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Supply voltage	standard	9	12 24	36	V
Working current	without load		60mA(12V)		mA
Operating temp		-40		+85	℃
storage temp		-40		+85	℃

▶ ORDERING



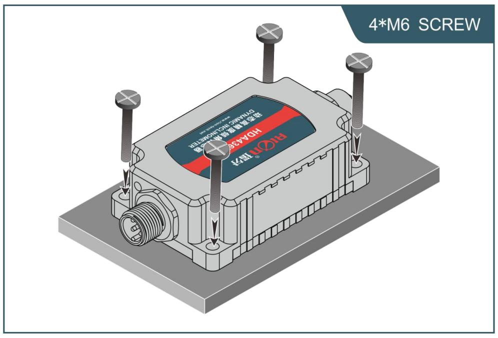
E.g: HDA436T-C2-S-8 : Standard industrial scenario / Horizontal Installation / CAN 2.0A output interface / Single connector (male).

Note1: If there are no special request, the default configuration is IP67 protection.

Note 2: High-strength impact scenario: vibro-replacement stone column equipment, etc.

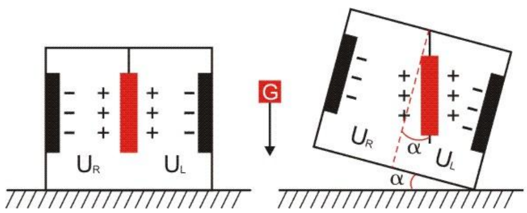
▶ MECHANICAL PARAMETERS

- ○ Connector: M12 aviation plug 5P connector
- ○ Protection level: IP67
- ○ Shell material: frosted aluminum alloy
- ○ Installation: Four M4 screws



▶ WORKING PRINCIPLE

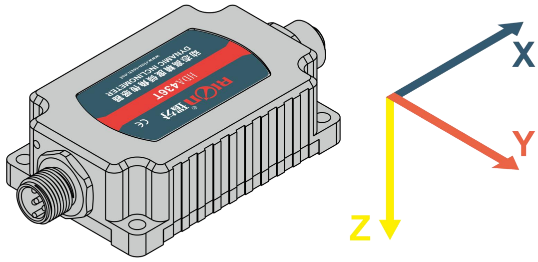
Adopt imported core control unit and apply the principle of capacitive miniature pendulum. Using the earth's gravity principle, when the tilt unit tilts, the earth's gravity will produce a gravitational component on the corresponding pendulum, and the corresponding capacitance will change. By amplifying and filtering the capacitance, the inclination will be obtained after conversion.



U_R, U_L are the voltage between the left and right pole plates of the pendulum and their corresponding electrodes,when the tilt sensor is tilted, U_R, U_L will change according to a certain rule, so ∫ (U_R U_L) is a function on α of tilt angle : $\alpha = \int (U_R, U_L)$.

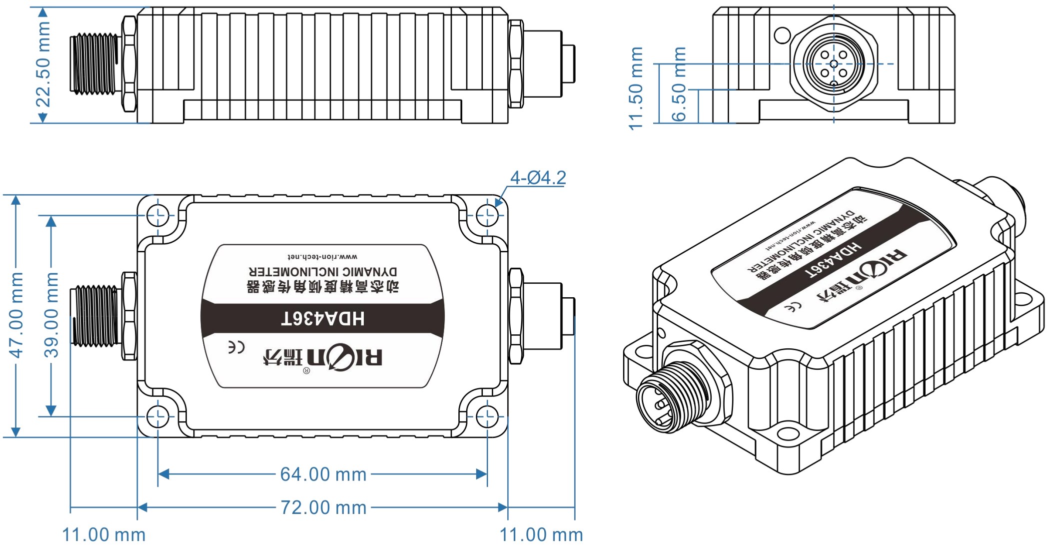
▶ INSTALLATION AXIAL

HDA436T follows the NED coordinate system, right-handed. According to the rotation sequence of ZYX, when the positive direction of the X axis is directed to the front of the carrier, the rotation angle around the Z axis is the heading angle, the rotation angle around the Y axis is the pitch angle, and the rotation angle around the X axis is the roll angle.



▶ PRODUCT DIMENSION

Double connector Dimension

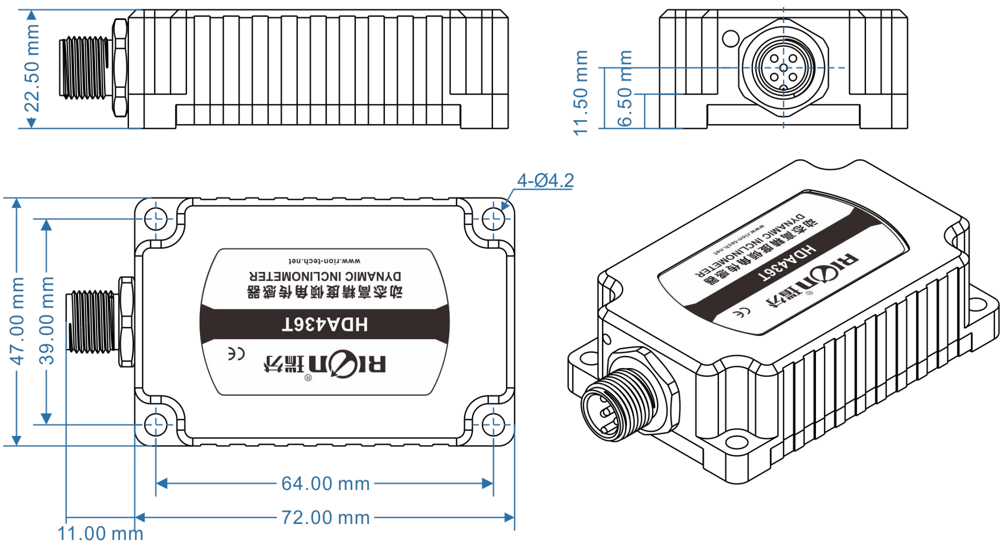


Shell size: 72×47×22.5mm

Installation size: 64×39×6.5mm

Mounting screws: 4 M4 screws

Single connector Dimension



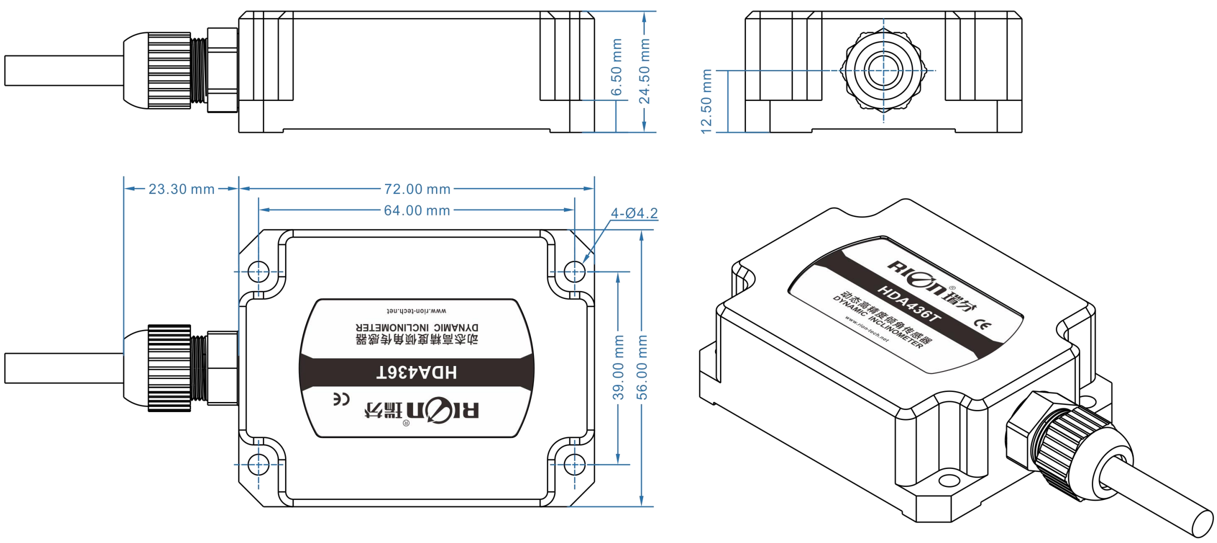
Shell size: 72x47x22.5mm

Installation size: 64x39x6.5mm

Mounting screws: 4 M4 screws

Case material: Aluminum alloy

Dimension of IP68 product with anti-corrosion direct lead out cable



Shell size: 72×56×24.5mm

Installation size: 64×39×6.5mm

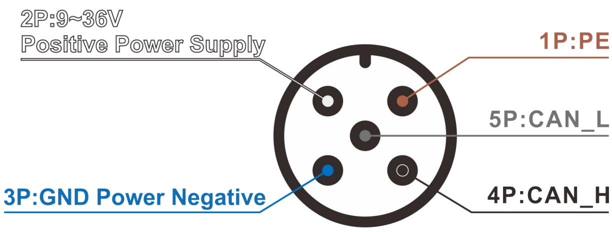
Mounting screws: 4 M4 screws

Case material: 304 alloy steel

▶ ELECTRICAL CONNECTION

Definition of male wiring

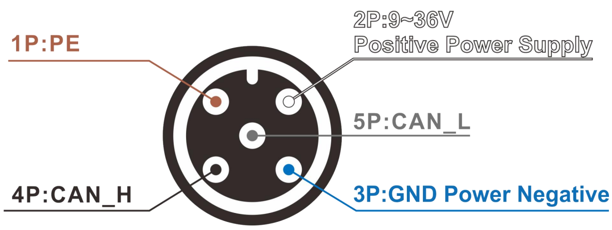
Pin function	1 PIN(BROWN)	2 PIN(WHITE)	3 PIN(BLUE)	4 PIN(BLACK)	5 PIN(GRAY)
	PE	24V	GND	CAN_H	CAN_L



Connector model: M12*5P aviation male

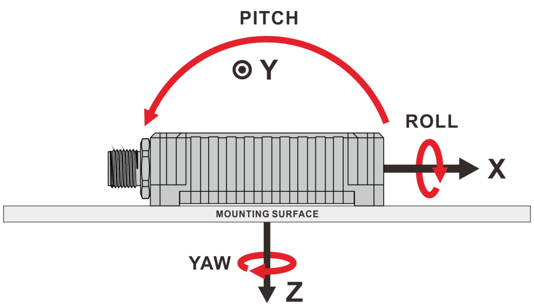
Female connector definition

Pin function	1 PIN(BROWN)	2 PIN(WHITE)	3 PIN(BLUE)	4 PIN(BLACK)	5 PIN(GRAY)
	PE	24V	GND	CAN_H	CAN_L

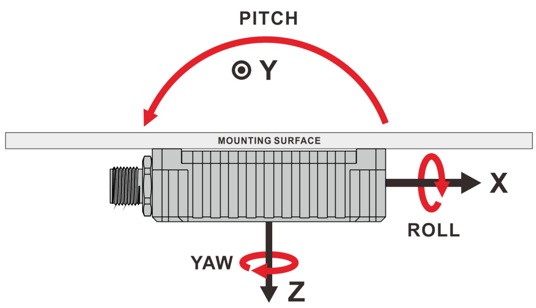


Connector model: M12*5P aviation female

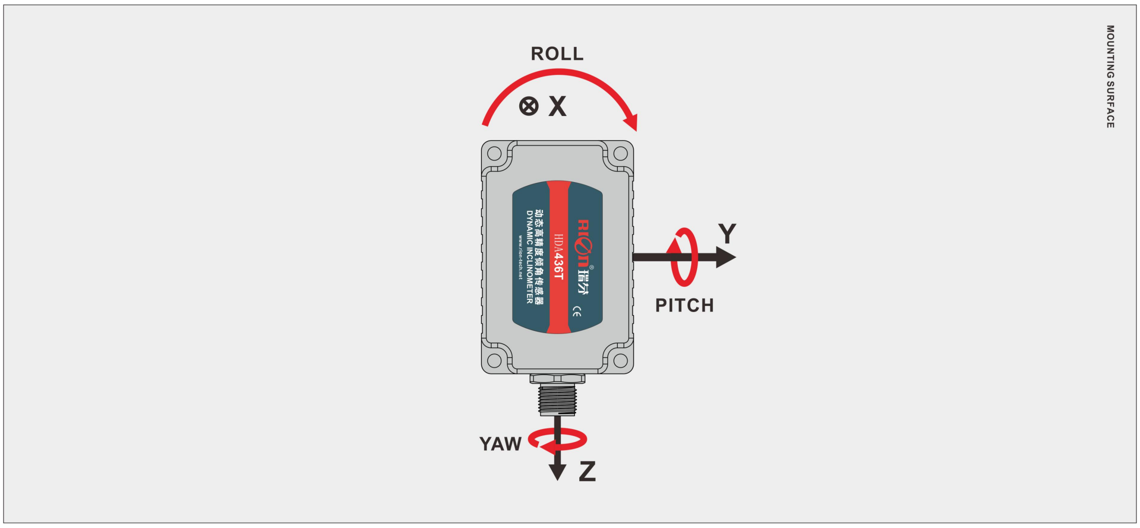
▶ INSTALLATION METHOD



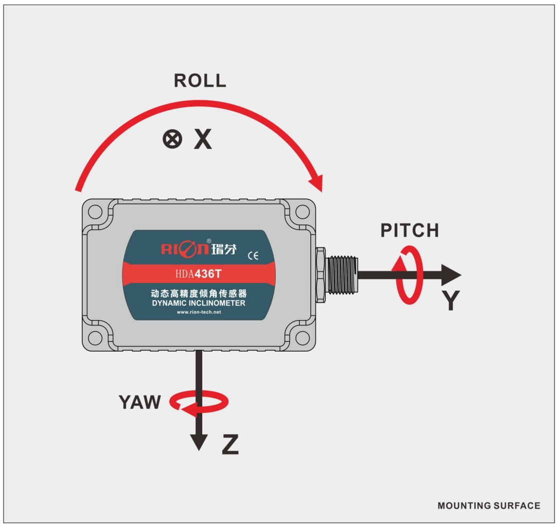
Horizontal Installation



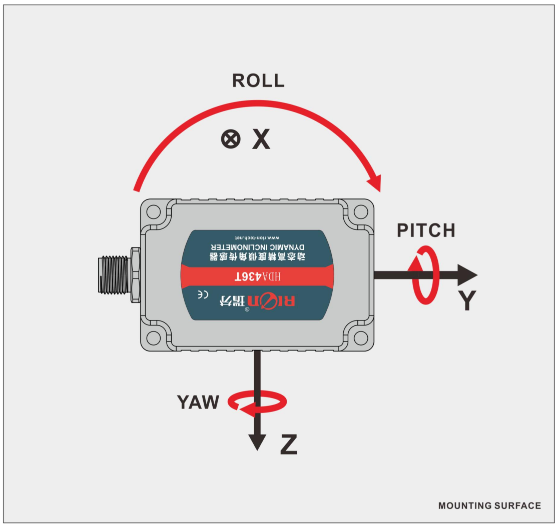
Horizontal-Down Installation



Vertical Installation



Vertical-Left Installation



Vertical-Right Installation

▶ COMMUNICATION FRAME FORMAT

CAN2.0 Protocol support 2.0A(11bit ID)and 2.0B(29 bit ID)

1) Modify the node number. (node range: 0x01-0x7F), the default node number is 0x05

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x600+0x05	0x40	0x10	0x10	0x00	Node_ID	0x00	0x00	0x00

Table1-3 request message format

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+0x05	0x40	0x10	0x10	0x00	Node_ID	0x00	0x00	0x00

Table1-4 response message format

Remark: if controller send CAN-ID=0x600+0x05,sended data：40 10 10 00 10 00 00 00

sensor return CAN-ID=0x580+0x05,returned data:40 10 10 00 10 00 00 00

received frame after restarting ID is 0x590(0x580+0x10), the data represent successful modification of frame ID.

2) CAN baud rate setting

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x600+0x05	0x40	0x20	0x10	0x00	Baud	0x00	0x00	0x00

Table1-5 request message format

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+0x05	0x40	0x20	0x10	0x00	Baud	0x00	0x00	0x00

Table1-6 response message format

remark: Fifth byte(Baud) is 0x01 / 0x02 / 0x03 / 0x04. In which 0x00 represent baud rate to be 1000K bps,0x01 represent baud rate to be 500K bps,0x02 represent baud rate to be 250K bps,0x03 represent baud rate to be 125K bps,0x04 represent baud rate to be 100K bps,default baud rate is 125K bps. Send above direct, restart power-on the sensor after receiveing returned data, then modification of baud rate is finished.

3) Set automatic output cycle time (factory default output cycle 100mS)

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x600+0x05	0x22	0x00	0x22	0x00	T_L	T_H	0x00	0x00

Table1-5 request message format

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+0x05	0x22	0x00	0x22	0x00	T_L	T_H	0x00	0x00

The fifth and sixth bytes represent time, the fifth byte is the low byte, and the sixth byte is the high byte.

The time range 10ms~1000ms ；

Eg:10ms TIME_L=0x0A，TIME_H=0x00;

100ms TIME_L=0x64，TIME_H=0x00;

1000ms TIME_L=0xE8，TIME_H=0x03;

Range set 10ms～1000ms， The factory default value 100ms。

4) Set output frame type (factory default output angle frame)

Request message format

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x600+0x05	0x40	0x30	0x10	0x00	MASK	0x00	0x00	0x00

Reply message format

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+0x05	0x40	0x30	0x10	0x00	MASK	0x00	0x00	0x00

The lower 3 bits of the fifth byte Mask are valid. Mask (binary: 0B00000cba).

a: indicates the angle frame, 1: turn on the output, 0: turn off the output.

b: Represents the acceleration frame, 1: turn on the output, 0: turn off the output.

c: Represents the gyro angular velocity frame, 1: turn on the output, 0: turn off the output.

The host sends: 40 30 10 00 07 00 00 00, the angle frame, acceleration frame and gyro angular velocity

frame output will be turned on.
The host sends: 40 30 10 00 05 00 00 00, will turn on the angle frame and gyro angular velocity frame output, and turn off the acceleration frame output.

5) Azimuth clear zero
Request message format

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x600+0x05	0x40	0x10	0x10	0x00	0x10	0x10	0x10	0x10

Reply message format

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+0x05	0x40	0x10	0x10	0x00	0x10	0x10	0x10	0x10

Clear the current azimuth angle to zero.

6) Data analysis
1. Data frame types are divided into three types: angle frames, acceleration frames, and gyro frames.

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	Data0	Data1	Data2	Data3	Data4	Data5	Data6	flag

Data0-Data6: Represents data, and determines whether the data is angle, acceleration, or gyro frame according to the corresponding flag bit.
Flag(ddddccaa): Unsigned single byte, 8bit indicates the data frame type and installation measurement method:
aa: Represent data type of the frame
00: Represent the frame(roll angle±180° ,pitch±90°, heading±180°);
01: represent acceleration(±32.765g);
10: represent gyro(±327.65°/S);
cc: save .
dddd: Represents the installation test method (for specific reference to the measurement installation method illustration):
0000: horizontal installation measurement mode.
0001: vertical upward mounting measurement mode.
0010: vertical left (side to left) installation measurement method.
0011: vertical right (side to the right) installation measurement method.
0100: Indicates the horizontal downward installation measurement method.
The following is a data type frame analysis with different horizontal measurement methods:

A: Angle data frame

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	Temp	0x00

There are eight bytes of data behind CAN-ID. The first two bytes are XL, XH is the inclination of the X axis (ROLL roll angle), the third and fourth bytes are YL, and YH is the Y axis (PITCH pitch angle). The inclination angle is the fifth and sixth bytes ZL, and ZH is the inclination angle of the Z axis (YAW azimuth); the angle is int16_t, the low byte is first, the high byte is last, finally divided by 100 to get the angle floating point number.. The 7th byte is the temperature value, which is a signed single byte integer.
Example of angle conversion:
26 15 DA EA 28 23 19 00
Flag = 0x00, indicating the horizontal installation measurement method, the data is the angle.
The angle data size of the X-axis roll angle is represented by a 16-bit signed binary number, the upper 8 bits are XH, and the lower 8 bits are XL.
This 16-bit signed binary number is converted to a decimal number and then divided by 100. The result is the angle. Eg，XL=0x26，XH=0x15，angle is 54.14°
XH XL
0x15 0x26
0x1526(5414)
Final result:5414/100=54.14°
YH YL
0xEA 0xDA
0xEADA(-5414)
Final result:-5414/100=-54.14°
ZH ZL
0x23 0x28
0x2328(9000)

Final result:9000/100=90.00°
Temp
0x19(25) = 25° Celsius.

B: Acceleration data frame

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	0x00	0x01

There are eight bytes of data behind CAN-ID. The first two bytes are XL, XH is the X-axis acceleration, the third and fourth bytes are YL, YH is the Y-axis acceleration, and the fifth and sixth bytes ZL and ZH are the acceleration of the Z axis; the acceleration is int16_t, the low byte is first, the high byte is last, and then divide by 1000 to get the acceleration floating point number. The seventh byte is reserved.

Example of acceleration conversion:

26 15 DA EA 28 23 19 01

Flag=0x01, which indicates the horizontal installation measurement method, and the data is acceleration.

The X-axis acceleration data size is represented by a 16-bit signed binary number, the upper 8 bits are XH, and the lower 8 bits are XL.

This 16-bit signed binary number is converted to a decimal number, and then divided by 1000. The result is the acceleration.

Eg:XL=0x26 / XH=0x15 / Acceleration is 5.414g

XH XL

0x15 0x26

0x1526(5414)

Final result:5414/1000=5.414g

YH YL

0xEA 0xDA

0xEADA(-5414)

Final result:-5414/1000=-5.414g

ZH ZL

0x23 0x28

0x2328(9000)

Final result:9000/1000=9.000g

C: Gyro data frame

CAN-ID	1st byte	2nd byte	3rdbyte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	0x00	0x02

There are eight bytes of data behind **CAN-ID**. The first two bytes are XL, XH is the size of the X-axis gyro, the third and fourth bytes are YL, YH is the size of the Y-axis gyro, and the fifth and sixth bytes ZL, ZH is the size of the Z-axis gyroscope; the size of the gyroscope is int16_t, with the low byte first and the high byte last.

Finally divide by 100 to get the gyro floating point number. The seventh byte is reserved.

Example of acceleration conversion:

26 15 DA EA 28 23 19 02

Flag = 0x02, indicating the horizontal installation measurement method, the data is a gyro.

The X-axis gyro data size is represented by a 16-bit signed binary number, the upper 8 bits are XH, and the lower 8 bits are XL.

This 16-bit signed binary number is converted to a decimal number and then divided by 100. The result is the gyro value.

For example, XL = 0x26, XH = 0x15, the gyro value is 54.14°/S

XH XL

0x15 0x26

0x1526(5414)

Final result：5414/100=54.14°/S

YH YL

0xEA 0xDA

0xEADA(-5414)

Final result：-5414/100=-54.14°/S

ZH ZL

0x23 0x28

0x2328(9000)

Final result：9000/100=90.00°/S

2. There are three ways of data period output: single frame angle output (period one angle frame output, the default output mode), double frame angle plus indication output (double frame, continuous output double frames by period), three frame angle gyro plus indication Output (three frames, three frames are output continuously by cycle). Can be set at the factory.

A.Single-frame angle output (periodically output one angle frame, the default output mode), the message format is as follows:

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	Temp	0x00

B.The angle plus indication of double frames is output (double frames, double frames are output continuously by cycle). The message format is as follows:

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	Temp	0x00

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	0x00	0x01

C.Three frames of angle gyro plus representative output (three frames, three frames are output continuously by cycle), the message format is as follows:

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	Temp	0x00

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	0x00	0x01

CAN-ID	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte
0x580+Node_ID	XL	XH	YL	YH	ZL	ZH	0x00	0x02

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