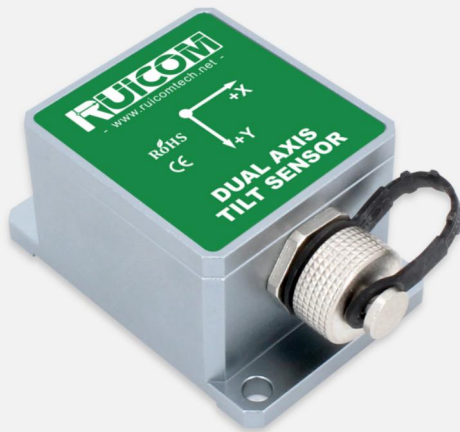




NTS6 CAN bus output tilt sensor

Product manual

V2.7-20240412



Technical Highlights

- ❖ CANopen/CAN2.0A/CAN2.0B outputs selectable;
- ❖ Measurement range $\pm 10^{\circ}$ ~ $\pm 90^{\circ}$ selectable;
- ❖ Resolution 0.02°;
- ❖ Standard DC 5V power supply;
- ❖ IP67 protection rating.

Product Introduction

The NTS6 series is a new generation of digital miniature MEMS tilt sensors developed by RUICOM Technology. It integrates a dual-channel Earth gravity tilt sensing unit, measuring static gravitational acceleration and converting it into tilt angle changes, thereby obtaining the sensor's output roll and pitch angles relative to the horizontal plane. This series supports multiple output protocols including CAN OPEN, CAN2.0A, and CAN2.0B. With the built-in MCU control system, the sensor output linearity is secondary-calibrated, effectively improving the accuracy loss caused by insufficient correction in analog products.

This product uses a non-contact measurement principle, providing real-time output of the current attitude tilt angle. It is easy to operate and does not require relocating two opposing mounting surfaces. Suitable for industrial automation control and attitude measurement scenarios, it possesses excellent resistance to external electromagnetic interference and is primarily suitable for static or slowly changing dynamic measurement environments. It is not suitable for rapidly changing dynamic conditions and can maintain long-term stable operation under harsh industrial conditions.

Application Scope

- ❖ Angle control for various engineering machinery
- ❖ Four-wheel alignment and control for automobiles
- ❖ Chassis measurement for automobiles
- ❖ Satellite antenna positioning
- ❖ Leveling of medical beds
- ❖ Monitoring of gimbal operation



Performance Parameters

NTS6-C1/C2/C3	Condition	Parameter				Unit
Measurement Range		±10	±30	±60	±90	°
Measurement Axis		X Y	X Y	X Y	X Y	Axis
Resolution		0.02	0.02	0.02	0.02	°
Measurement Accuracy	@25°C	0.1	0.1	0.1	0.1	°
Zero-Point Temp Coefficient	-40~85°C	±0.02	±0.02	±0.02	±0.02	°/°C
Sensitivity Temp Coefficient	-40~85°C	≤150	≤150	≤150	≤150	ppm/°C
Power-On Startup Time		0.5	0.5	0.5	0.5	S
Response Frequency		20	20	20	20	s
Output Rate	5Hz / 15Hz / 35Hz / 50Hz Configurable					
Output Signal	CAN OPEN / CAN2.0A / CAN2.0B					
Electromagnetic Compatibility	According to EN61000 and GBT17626					
Insulation Resistance	≥100 megohms					
Shock Resistance	100g@11ms, triaxial (half-sine wave)					
Vibration Resistance	10grms, 10~1000Hz					
Waterproof Rating	IP67					
Cable	Standard config: 2m shielded cable, weight ≤123g					
Weight	≤112g					

Ordering and Selecting

Model	Housing	Axis	Range	Signal Output	Installation Method
NTS	3: PCBA	X: X Axis	10: ±10°	C1: CANopen	H: Horizontal installation
	6: Shell	Y: Y Axis	15: ±15°	C2: CAN2.0A	HD: Horizontal downwards
		D: Dual Axis	30: ±30°	C3: CAN2.0B	V: Vertical installation
			45: ±45°		VD: Vertical downwards
			60: ±60°		VL: Vertical leftwards
			90: ±90°		VR: Vertical rightwards
			180: ±180° (only X axis)		

E.g: NTS3X10-C1-H: PCBA, X axis, ±10° measurement range, CANopen signal output, horizontal installation.

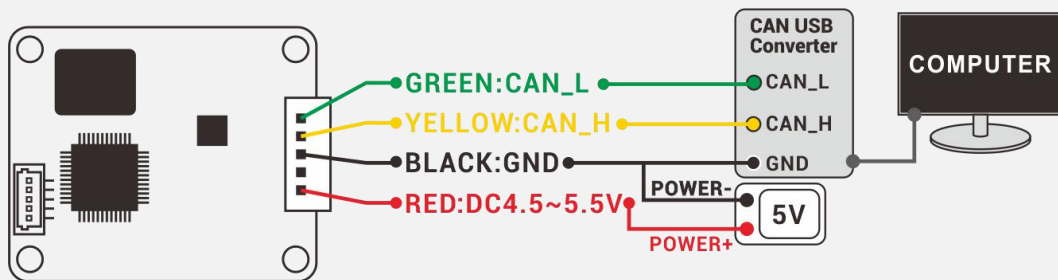
Note: Measurement range ±180° is limited to single-axis X-axis only.

✓ Electrical Parameters

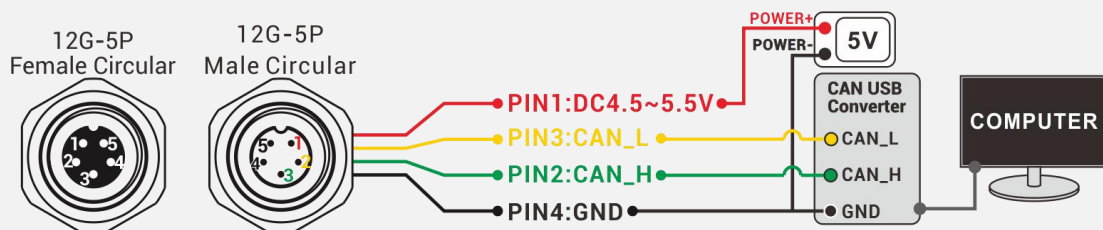
Parameter	Condition	MINI	TYP	MAX	Unit
Power supply voltage	Standard	4.5	5	5.5	V
	Customizable	9	12 24	36	V
Operating current	Standard		5		mA
	Customizable	9	12 24	36	mA
Operating temp		-40		+85	°C
Storage temp		-40		+85	°C

✓ Interface Definition

Wire color	Pin Definition	Description
Red	DC4.5~5.5V	Positive power supply terminal
Black	GND	Negative power supply terminal
Yellow	CAN_H	High-level line
Green	CAN_L	Low-level line

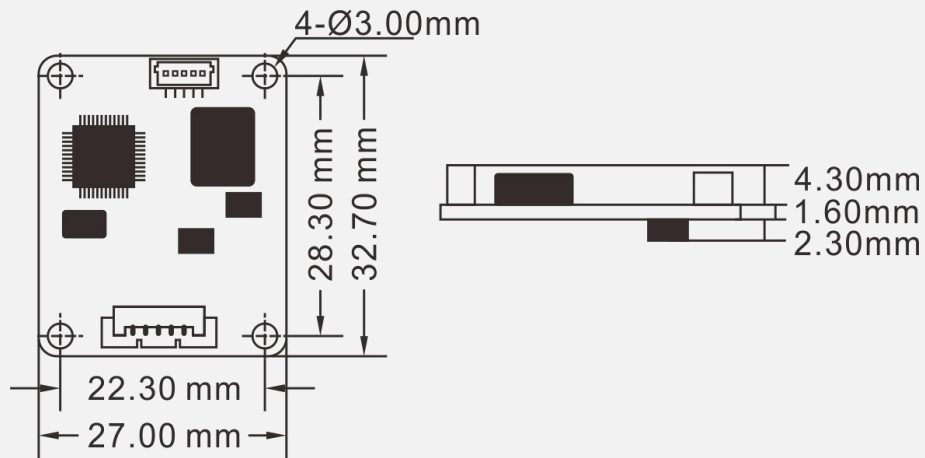


Connector pin/wire colors	Pin Definition	Description
PIN1/Red	DC4.5~5.5V	Positive power supply
PIN2/Yellow	CAN_L	Low-level line
PIN3/Green	CAN_H	High-level line
PIN4/Black	GND	Negative power supply
PIN5/--	NC	No connection



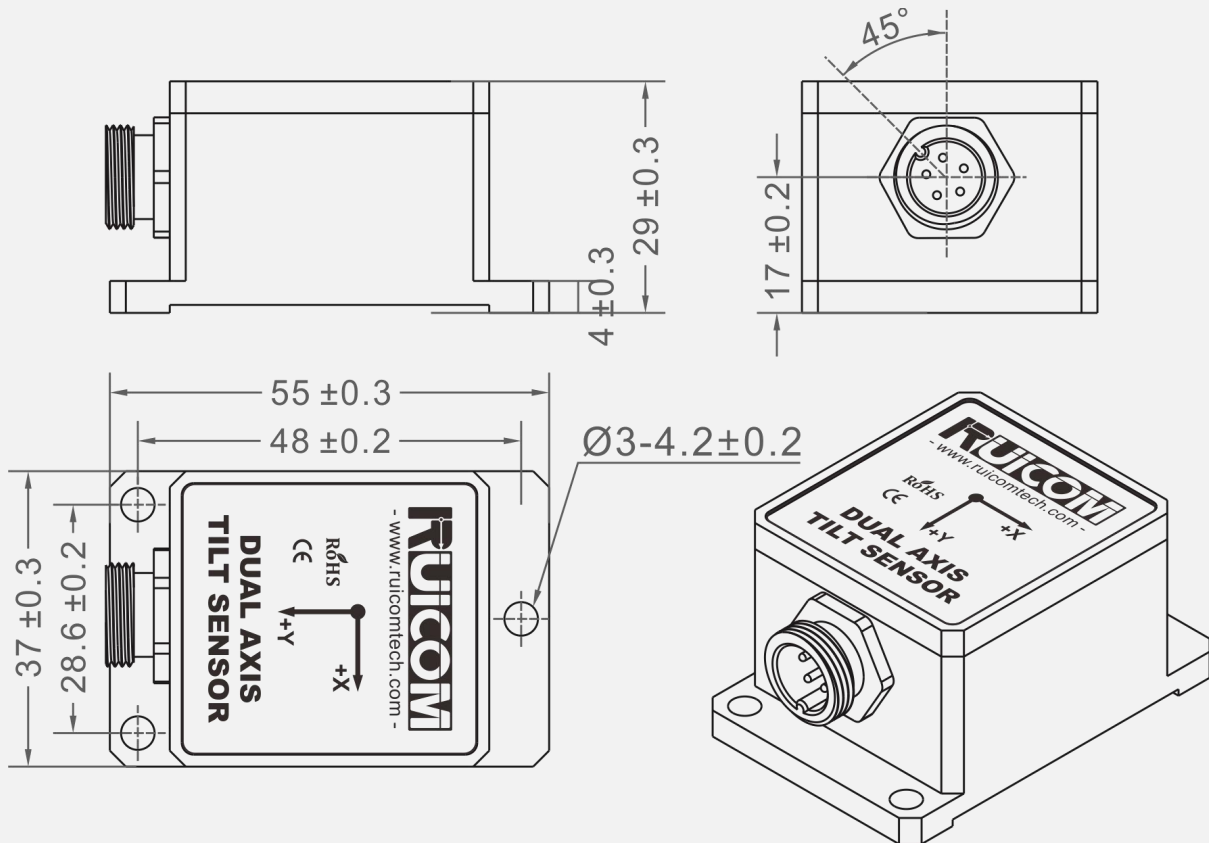
Product Dimensions

PCBA Board Dimensions



PCBA board dimensions: L33 × W27 × H8.2 mm
Recommended screws: 4 × M3 screws

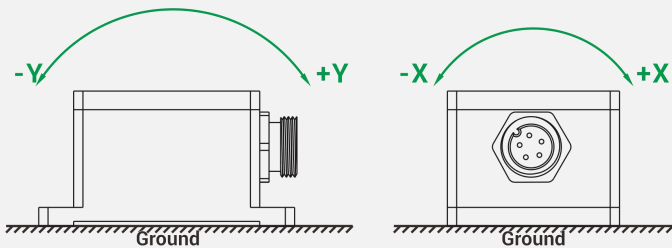
Package dimensions



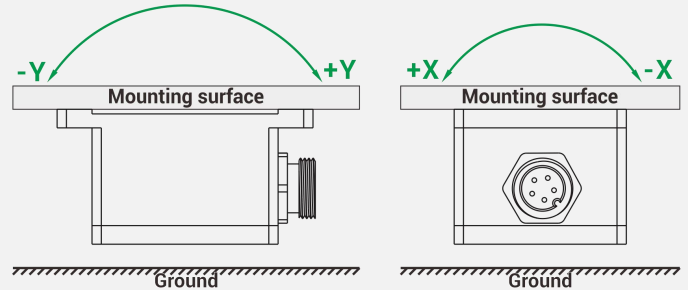
Shell dimensions: L55.5×W37×H29mm
Shell material: anodized aluminum
Connector: aviation plug 12G-5P
Suggested screws: 3 M4 screws

✓ Installation Orientation

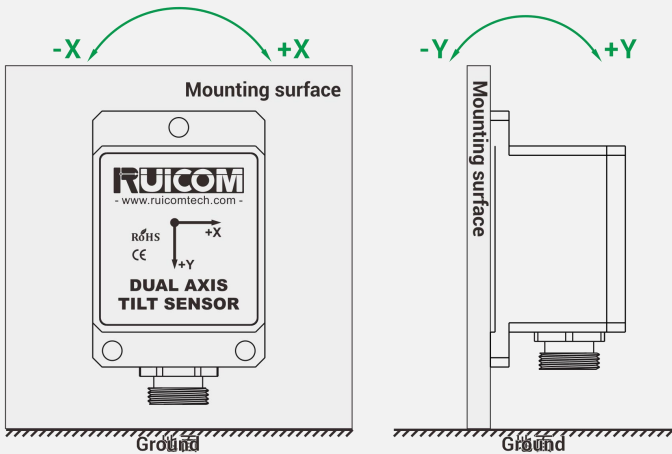
During installation, the sensor mounting surface should be kept parallel to the target surface, and the effects of dynamics and acceleration on the sensor should be minimized. This product can be installed horizontally or vertically; please refer to the diagram below for installation instructions:



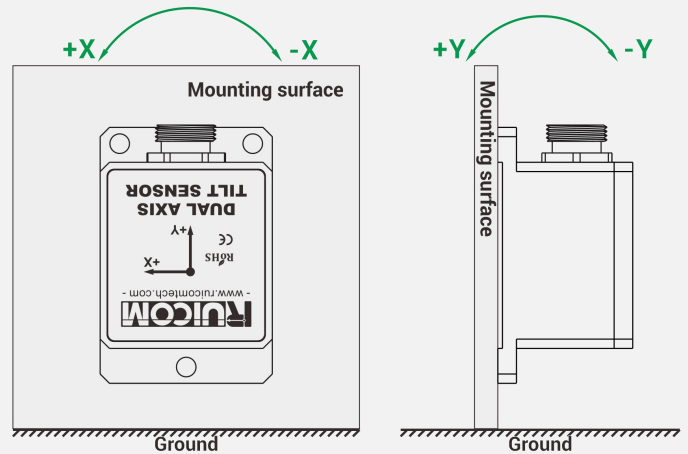
Horizontal installation



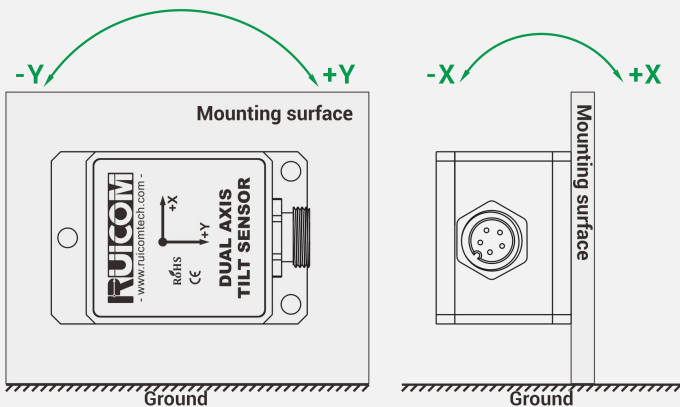
Horizontal downward



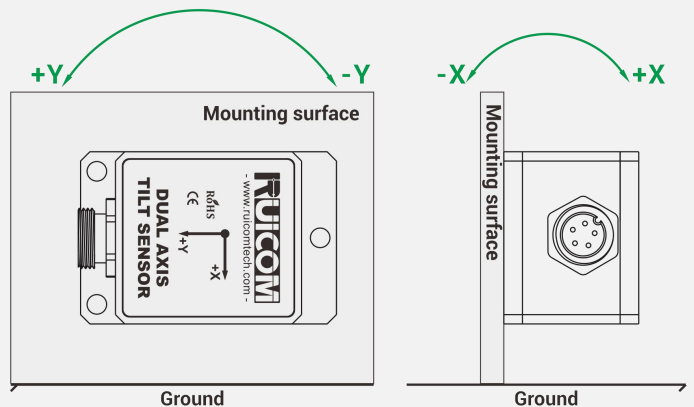
Vertical installation



Vertical downward



Vertical leftward



Vertical rightward

CANOPEN Communication Protocol

SDO messages: SDO request and response messages always consist of 8 bytes, with zeros added at the end if the data bytes are insufficient.

The format and content of Write Object request and response messages are shown in Tables 1-1 and 1-2: Node_ID is the CAN communication node number, Index_LSB is the low byte of the dictionary index, Index_MSB is the high byte of the dictionary index, and Sub_index is the sub-index.

1) BOOT UP

This message is automatically sent after the tilt angle power-on initialization is complete. The message length is 1, and the default node number (Node_ID) is 0x05.

CAN-ID	1st Byte
0x700+ 0x05	0x00

2) Start and stop commands are sent by the master node.

CAN-ID	1st Byte	2nd Byte	Function
00	01	00	Start
00	80	00	Stop

3) Modify the node number (Node_ID = 0x01 ~ 0x7F), the default node number (Node_ID) is 0x05.

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+Node_ID	0x22	0x00	0x30	0x00	New Node_ID	0x00	0x00	0x00

Table 1-3 SDO Request Message Format

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+Node_ID	0x60	0x00	0x30	0x00	0x00	0x00	0x00	0x00

Table 1-4 SDO Response Message Format

Note: If the controller sends CAN-ID=0x600+0x05 (default), the data sent is: 22 00 30 00 10 00 00 00.

The sensor returns CAN-ID=0x580+0x05 (default), and the data returned is: 60 00 30 00 00 00 00 00. After power-on, the received frame ID is 0x590 (0x580+0x10), indicating that the frame ID was successfully modified.

4) Set the CAN baud rate. The factory default baud rate is 125K, and the default node number (Node_ID) is 0x05.

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+Node_ID	0x22	0x01	0x30	0x00	Baud	0x00	0x00	0x00

Table 1-5 SDO Request Message Format

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+Node_ID	0x60	0x01	0x30	0x00	00	0x00	0x00	0x00

Table 1-6 SDO Response Message Format

Note: The fifth byte (Baud) is 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07, or 0x08.

After sending this command and receiving the returned data, the sensor needs to be powered on again for the baud rate modification to succeed.

Baud corresponding baud rate

Catalog	Baud Rate	Catalog	Baud Rate
00	1M	05	100k
01	800K	06	50k
02	500k	07	20k
03	250k	08	10k
04	125k		

5) Set the PDO sending time in a loop

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+Node_ID	0x22	0x00	0x22	0x00	TIME	0x00	0x00	0x00

Table 1-7 SDO Request Message Format

The fifth byte, TIME **only supports two types: 0X32h:50ms and 0X64:100ms. The factory default is 0X64:100ms**

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+Node_ID	0x60	0x00	0x22	0x00	00	0x00	0x00	0x00

Table 1-8 SDO Response Message Format

6) Set relative zero point

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+ Node_ID	0x22	0x03	0x21	0x00	0x01	0x00	0x00	0x00

Table 1-9 SDO request message format

Set the current angle as zero. For example, if the current angle is 0.12 degrees, then all subsequent angles will be calculated by subtracting 0.12 degrees from the absolute angle.

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+ Node_ID	0x60	0x03	0x21	0x00	0x00	0x00	0x00	0x00

Table 1-10 SDO Response Message Format

7) Cancel relative zero point

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+ Node_ID	0x22	0x03	0x21	0x01	0x01	0x00	0x00	0x00

Table 1-11 SDO Request Message Format

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+ Node_ID	0x60	0x03	0x21	0x01	0x00	0x00	0x00	0x00

Table 1-12 SDO Response Message Format

8) Change the PDO ID. The default value is 0x285.

ID	LEN	DATA0	DATA1	2	3	4	5	6	7
0x600+NodID	8	22	00	18	01	01	00	00	00
Reply command									
0x580+NodID	8	60	00	18	01	00	00	00	00

DATA4 is 1, PDO is 0x185

DATA4 is 0 , PDO is 0X285

9)Set data resolution

Setting instructions:

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x600+0x05	0x22	0x00	0x60	0x00	0x00	resolution	0x00	0x00

Resolution 0a=10 0.01 , 32h=50 0.05 , 64h=100 0.1 , The factory default is 0.01

Reply command:

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+0x05	0x22	0x00	0x60	0x00	0x00	resolution	0x00	0x00

10)Tilt sensor process data object PDO(Process Data Object):

The sensor outputs an angle immediately upon power-up, and the message format is as follows:

CAN-ID	First Byte	Second Byte	Third Byte	Fourth Byte
0x280+Node_ID	XL	XH	YL	YH

The CAN-ID is followed by four bytes of parameters. The first two bytes are the X-axis tilt angle, and the next two bytes are the Y-axis tilt angle, with the low byte first and the high byte last.

Angle conversion example: The X-axis angle data is represented by a 16-bit binary number, with the high 8 bits representing XH and the low 8 bits representing XL.

Convert this 16-bit binary number to a decimal number, then divide by 100 (for a resolution of 0.01; if the resolution is 0.1, divide by 10; if the resolution is 0.05, divide by 20). The result is the angle.

0-0X2328 represents a positive angle of 0~90 degrees.

0XFFFF-0XDCD7 represents a negative angle of -0~-90 degrees.

For example: 285 13 35 1D FF

Id = 0x285 XL=0X13 XH=0X35 YL=0X1D YH=0XFF

This means

X: 0X 3513=13587/100=135.87

Y: FFFF-0XFF1D=226/100 = -2.26 degrees

CAN2.0A/B Communication Protocol

1) Modify the node number (node range: 0x01-0x7F), the default node number is 0x05. The ID bit width of CAN2.0A is 11 bits, and the ID bit width of CAN2.0B is 29 bits.

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	Node_ID	0x00	0x00	0x00

Response 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

Note: If the controller sends CAN-ID=0x600+0x05 and sends data: 40 10 10 00 10 00 00 00, the sensor returns CAN-ID=0x580+0x05 and sends data: 40 10 10 00 10 00 00 00. After power-on, the received frame ID is 0x590 (0x580+0x10), indicating that the frame ID was successfully modified.

2) Set CAN baud rate

Request message format

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

Response message format

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

Note: The fifth byte (Baud) is 0x01, 0x02, 0x03, or 0x04. 0x01 represents a baud rate of 500K bps, 0x02 represents 250K bps, 0x03 represents 125K bps, and 0x04 represents 100K bps. The default baud rate is 125K bps. After sending this command and receiving the returned data, the sensor needs to be powered on again for the baud rate modification to succeed.

3) Angle Data Analysis

The sensor outputs an angle immediately upon power-up, with the following message format:

CAN-ID	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte	8th Byte
0x580+Node_ID	XL	XH	Xsign	YL	YH	Ysign	0x00	0x00

The CAN-ID is followed by eight bytes of parameters. The first three bytes are the X-axis tilt angle parameter, and the next three bytes are the Y-axis tilt angle parameter, with the low byte first and the high byte last.

Angle conversion example:

The X-axis angle data is represented by a 16-bit binary number. The high 8 bits are XH, the low 8 bits are XL, and the sign bit is Xsign.

Convert this 16-bit binary number to a decimal number, then divide by 100. The result is the angle. Xsign=0x00, the angle is positive; Xsign=0x01, the angle is negative.

For example, XL=0x26, XH=0x15, Xsign=0x01, the angle is -54.14.

XH XL

0x15 0x26

0x1526(5414)

5414/100=54.14°