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## BWK225S Serials

CAN Bus Dual-Axis Inclinometer Technical Manual

3WM225S
CAN Bus Dual-Axis Inclinometer


## Introduction

Designed by Bewis Sensing Technology LLC, BWK225S is a CAN output low cost dual-axis inclinometer, adopting the latest industrial level MEMS accelerometer. Its measuring range is $\pm 90^{\circ}$, highest accuracy is $0.2^{\circ}$, working temperature is $-40^{\circ} \mathrm{C} \sim+85^{\circ} \mathrm{C}$, the product with a small size and low weight, can meet space-restricted application requirements.

This product converts static gravity field changes into angle changes, It outputs horizontal angle values directly by digital, this product has the advantages of low cost, small temperature drift, simple to use, and strong resistance to external disturbances. It is an ideal option for attitude measurement in photovoltaic power (PV), PTZ control, tower turbines monitoring and other industries.

## Features

- Dual-axis inclinometer measurement
- Resolution: $0.02^{\circ}$
- Voltage input: 9~35V
- Product size: L55mm $\times$ W37mm $\times \mathrm{H} 24 \mathrm{~mm}$ (customizable)
- Accuracy: $0.2^{\circ}$
- Measuring range: $\pm 90^{\circ}$
- Output interface: CAN
- IP67 protection


## Applications

- Industrial automatic leveling
- Medical devices
- PV automatic tracking
- Tower tilt monitoring
- Special valves
- Oil drilling equipment
- Industrial converters
- Crane tilt angle control


## Specifications

Electrical Specifications| Parameters | Conditions | Min | Typical | Max |
| :--- | :--- | :--- | :--- | :--- |
| Power supply |  | 9 | 12 | 35 |
| Operating current | Non-loaded | 20 | 30 | 40 |
| Operating temperature |  | -40 |  | mA |
| Sore temperature |  | -55 |  | +85 |

## Performance Specifications

| Measuring range( ${ }^{\circ}$ ) | Conditions | $\pm 10$ | $\pm 30$ | $\pm 60$ | $\pm 90$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Measuring axis |  | X-Y | X-Y | X-Y | X-Y |
| Accuracy $\left({ }^{\circ}\right.$ ) | Indoor | 0.2 | 0.2 | 0.2 | 0.2 |
| Resolution( ${ }^{\circ}$ ) |  | 0.02 | 0.02 | 0.02 | 0.02 |
| Zero temperature drift( ${ }^{\circ}{ }^{\circ} \mathrm{C}$ ) | $-40 \sim 85^{\circ} \mathrm{C}$ | $\pm 0.01$ | $\pm 0.01$ | $\pm 0.01$ | $\pm 0.01$ |
| Cross axis error $\left({ }^{\circ}\right.$ ) |  | 0.1 | 0.1 | 0.1 | 0.2 |
| Power on time |  | $\leq 50 \mathrm{~ms}$ | $\leq 50 \mathrm{~ms}$ | $\leq 50 \mathrm{~ms}$ | $\leq 50 \mathrm{~ms}$ |
| The highest frequency output(Hz) |  | 100 | 100 | 100 | 100 |
| MTBF | $\geq 30000$ hours/time |  |  |  |  |
| Electromagnetic compatibility | according to GBT17626 |  |  |  |  |
| Insulation resistance | $\geq 100 \mathrm{M} \Omega$ |  |  |  |  |
| Shock resistance | $2000 \mathrm{~g}, 0.5 \mathrm{~ms}, 3$ times/axis |  |  |  |  |
| Weight (g) | 210 (package excluded) |  |  |  |  |

Resolution: The measured minimum change value that the sensor can detect and resolve within the measurement range.
Accuracy: The error between the actual angle and the Root mean square(RMS) of the measured angle of the sensor ( $\geq 16$ times).

## BTHK2258

## $\%$ <br> Mechanical Characteristic

| Connector | Metal connector (standard cable is 1.5m) |
| :--- | :--- |
| Protection level | IP67 |
| Shell material | Magnesium alloy sanding oxidation |
| Installation | Three M4 screws |

Product Size: L55*W37*H24 (mm)

(A)

Bare plate product size
Product size: L33*W27*H6 (mm)
Note: $\pm 1 \mathrm{~mm}$ error for length and width dimensions, please refer to actual size.


## Installation direction

The correct installation method can avoid measurement error. The following points should be made when installing the sensor:
First of all, to ensure that the sensor mounting surface and the measured surface completely close, the measured surface should be as horizontal as possible, can not have the angle shown in Figure $A$ and Figure $C$, the correct installation is shown in Figure $B$ and Figure D.


Secondly, the bottom cable of the sensor and the axis of the measured object shouldn't generate the angle shown in E. When installing, the bottom cable of the sensor should be kept parallel or orthogonal to the rotation axis of the measured object. This product can be installed horizontally or vertically (vertical installation requires customization). The correct installation method is shown in Figure F.


Finally, the installation surface of the sensor must be fixed with the measured surface tightly and smoothly, to avoid measurement error that may be caused by the acceleration and vibration.

BUK 2255
CAN Bus Dual-Axis Inclinometer

## Electrical connections

| Electrical interfaces |  |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Cable color | RED | BLUE | BLACK | GREEN | YELLOW |  |
| $\&$ <br> function | 1 | 2 | 3 | 4 | 5 |  |
|  | VCC <br> DC 9-35V | NC | GND | CAN L | CAN H |  |



CAN BUS wiring diagram

3UK 225 S
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## Protocol

CAN includes 8 bytes. It will adds 0 to it when the date bytes is not enough. Sending the first byte $0 \times 40$ indicates a write command, returning the first byte $0 \times 40$ indicates that the write was successful. The ID is the CAN communication node number.

## 1)Modify the nodes

(ID=0x01~0x7F), default ID=0x05

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 10$ | $0 \times 10$ | $0 \times 00$ | ID | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times 580+0 \times$ ID | $0 \times 40$ | $0 \times 10$ | $0 \times 10$ | $0 \times 00$ | ID | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |

Note: If the controller send CAN-ID=0x600+0x05(default), send data:40 10100010000000
If the sensor return CAN-ID=0x580+0x10, return data:40 10100010000000
The CAN-ID is $0 \times 590(0 \times 580+0 \times 10)$, indicating that the ID modification is successful. At this time, the CANID needs to be changed to $0 \times 590$ to send the other naming.
2) Set CAN's baud rate

|  | CAN-ID | The first byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | 0x20 | $0 \times 10$ | $0 \times 00$ | Baud | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response |  |  |  |  |  |  |  |  |  |

Note: The fifth byte (Baud) means 0x01,0x02, 0x03, 0x04. $0 \times 01$ means to set 500 k bps as the baud rate. $0 \times 02$ means to set 250 k bps as the baud rate. $0 \times 03$ means to set 125 k bps as the baud rate. $0 \times 04$ means to set 100 k bps as the baud rate.

The default baud rate is 125 k bps. Once you revise the baud rate and want to make a success revise, the sensor need to be re-powered.
3) Set relative / absolute zero

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 05$ | $0 \times 10$ | $0 \times 00$ | Type | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times 580+0 \times 05$ | $0 \times 40$ | $0 \times 05$ | $0 \times 10$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |

Note: The fifth byte means $0 \times 00$ and $0 \times 01$.
$0 \times 00$ indicates the setting is an absolute zero,0x01 indicates a relative zero.
After setting the zero point, you need to enter the save command to set it successfully. (Default is absolute zero)
Absolute zero: Based on the factory-calibrated zero point.
Relative zero: Reference to the zero after the current installation.

3WK 2258
CAN Bus Dual-Axis Inclinometer
4) Query relative/ absolute zero

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 0 \mathrm{~d}$ | $0 \times 10$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times 580+0 \times 05$ | $0 \times 40$ | $0 \times 05$ | $0 \times 10$ | $0 \times 00$ | Type | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |

Note: The fifth byte means $0 \times 00$ and $0 \times 01$. $0 \times 00$ indicates an absolute zero and $0 x 01$ indicates a relative zero.

## 5) Save the setting

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh |
| :--- | :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Note: For some parameter, revised parameter doesn't work until you send the saving command.

## 6) Read angle of X -axis and Y -axis

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 04$ | $0 \times 10$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times 580+0 \times 05$ | Xsign | XH | XL | Ysign | YH | YL | $0 \times 00$ | $0 \times 00$ |

Note: Reading angle command can be effective under the response mode.
$X$ sign and $Y$ sign are the sign positions of the X and Y axis, 00 is positive and 10 is negative;
XH and YH are integer numbers of X -axis and Y -axis angles, respectively;
$X L$ and $Y L$ are the decimal places of the $X$-axis and $Y$-axis angles, respectively.
For example, if the return date is 585001234501012340000 , the angle of X -axis is $+12.34^{\circ}$.

## 7) Set the output mode

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 0 \mathrm{c}$ | $0 \times 10$ | $0 \times 00$ | mode | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times 580+0 \times 05$ | $0 \times 40$ | $0 \times 0 \mathrm{c}$ | $0 \times 10$ | $0 \times 00$ | mode | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |

Note: The fifth byte mode is $0 \times 00$ : answer mode,
0x01: 5 Hz Data Rate,
0x02: 10Hz Data Rate
0x03: 20Hz Data Rate,
0x04: 25 Hz Data Rate,
0x05: 50Hz Data Rate,
0x06: 100Hz Data Rate (default)

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## 8) Inclinometer sensor automatically outputs the angle

When the sensor is set to automatic mode output, there will be an angle output after the sensor is powered on. Default is automatic mode.

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| send |  |  |  |  |  |  |  |  |  |
| response | $0 \times 580+0 \times 05$ | Xsign | XH | XL | Ysign | YH | YL | $0 \times 00$ | $0 \times 00$ |

Note: The resolution of the output angle format is the same as that of the response mode to read the X and Y axis.

## 9) Factory setting command

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| send |  |  |  |  |  |  |  |  |  |
| response | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 0$ | $0 \times 10$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |

Note: All parameters are changed to the factory defaults, and some of the return values need to be powered off before being output.

## 10) Set the type of CAN-ID

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 70$ | $0 \times 10$ | $0 \times 00$ | XX | $0 \times 00$ | $0 \times 00$ | $0 \times 00$ |
| response |  |  |  |  |  |  |  |  |  |

Note: XX means 00 and 01.00 means the standard ID type ( 11 bits) and 01 means extended ID type (27 bits). The default is standard.

## 11) Set the standard address of CAN-ID

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 71$ | $0 \times 10$ | $0 \times 00$ | XH | XL | $0 \times 00$ | $0 \times 00$ |
| response | $0 \times X H X L+0 \times 05$ |  |  |  |  |  |  |  |  |

Note: The default standard CAN-ID is $0 \times 580+05$ and the maximum is not more than 7FF. Here we revise'580' in ' $0 \times 580+05$ ', 05 can be modified through the front nodes. After revise, the CAN-ID will become $0 \times X H X L+0 \times 05$ when re-powered on.
For example, send the data: 60540711000012300 00, the CAN-ID will become $123+5=128$ when it is repowered on.

## 12) Set the extended address of CAN-ID

We need to divide the address into two when setting the address of extended CAN-ID. First send high 16 address, then send the low 16 address. The CAN-ID address will change into new one (here the CAN-ID address we receive do not need to add the nodes) after being re-powered on. The maximum can not be more than 7FFFFFF. The default is $0 \times 18 f a 0216$.

I Set high 16 extended address of CAN-ID

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 72$ | $0 \times 10$ | $0 \times 00$ | XH | XL | $0 \times 00$ | $0 \times 00$ |
| response |  |  |  |  |  |  |  |  |  |

Note: the high 16 address can not surpass 7FF.

Set low 16 extended address of CAN-ID

|  | CAN-ID | The first <br> byte | second | third | fourth | fifth | sixth | seventh | eighth |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| send | $0 \times 600+0 \times 05$ | $0 \times 40$ | $0 \times 73$ | $0 \times 10$ | $0 \times 00$ | XH | XL | $0 \times 00$ | $0 \times 00$ |
| response |  |  |  |  |  |  |  |  |  |

Note: Low 16 address can not surpass FFFF.
For example, send the data respectively as follows, 6054072100001230000 and 6054073100045670000 . CAN-ID will change into 01234567 after being re-powered on.

3WK225S
CAN Bus Dual-Axis Inclinometer

## Ordering Information

| Product number | Way of communication | Package condition |
| :---: | :---: | :---: |
| BWK225S-90-CAN | CAN | IP67 Package/Metal Connector |

## Executive standard

- Enterprise Quality System Standard: ISO9001:2008 Standard (Certificate No.: 10114Q16846ROS)
- CE certification (certificate number: 3854210814)
- ROHS (certificate number: SO81426003)
- GB/T 191 SJ 20873-2003 General specifications for tiltmeters and spirit levels
- GBT 18459-2001 sensor main static performance index calculation method
- JJF 1059-1999 Evaluation and Expression of Measurement Uncertainty
- GBT 14412-2005 mechanical vibration and shock mechanical installation of accelerometer
- General requirements for GJB 450A-2004 equipment reliability
- Quality control of key parts and important parts of GJB 909A
- GJB 899 Reliability Qualification and Acceptance Test
- GJB 150-3A high temperature test
- GJB 150-4A low temperature test
- GJB 150-8A rain test
- GJB 150-12A dust test
- GJB 150-16A vibration test
- GJB 150-18A impact test
- GJB 150-23A Tilt and Swing Test
- GB/T 17626-3A RF electromagnetic radiation immunity test
- GB/T 17626-5A surge (hit) impulse immunity test
- GB/T 17626-8A power frequency magnetic field immunity test
- GB/T 17626-11A voltage dips, short interruptions and voltage changes immunity


## BWK225S Serials <br> CAN Bus Dual-Axis Inclinometer

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[^0]:    Note: The 5 Hz Data Rate means that 5 times of data is automatically output every second. Sending other names should be done in the question and answer mode (automatic mode is to continuously output the current angle of the axis according to the specific frequency, and it is easier to see other commands in the answer mode. value).

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