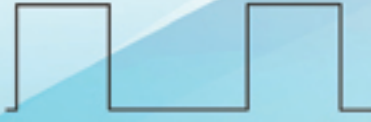


# *PWM Inclinator*



# PWM Inclinometer

## Features

- Both PWM & RS 232 outputs
- High anti-noise capacity
- IP67 protection
- EMI/ESD suppression circuit
- Available directly drive valve with 1A PWM



## Descriptions

PWM inclinometer is based on Vigor patent tilt measurement technology and combined with PWM module with high anti-jamming capability. It focused to hash industry environment. Not only meet to critical null repeatability, also with real high combined accuracy that performs high accuracy data of any angle point. It directly drive hydraulic proportional valve with 1A current, also can offer integrated system including sensor, controlling and driving that drive multiple hydraulic proportional valves, realize for automatic leveling fastly and easily.

PWM inclinometer adopts the PWM pulse width modulation output interface, a linear proportional relationship between the tilt values and duty cycle of PWM wave, has strong anti-interference ability.

PWM inclinometer has strong measuring ability:

- ✓  $\pm 0.02\%$ FS linearity
- ✓  $\pm 0.005^\circ$  Offset
- ✓ Combine with gyro module, realize static/dynamic angle measuring for low/rapid leveling
- ✓ Combine with vibration module, realize FFT computations in-time, output vibration frequency and amplitude data directly, eliminate the influence of environment vibration
- ✓ Further confirmed that offset, repeatability, hysteresis, turn on repeatability etc. parameters which are important influence factors to unit total performance evaluation
- ✓ Internal enhanced advanced intelligent algorithms drastically reduce cross-axis error, upgrades real tilt angle measuring accuracy, abandoned the traditional incomplete understanding for tilt angle measurement precision concept
- ✓ Greatly reduce measuring errors when the real tilt direction not consistent for unit sensitive axis
- ✓ Performs with short-circuit, transient voltage and transposition protection to adapt to industry environment

User can set unit's all kinds of parameters via RS232 interface, such as setup zero point, baud rate, local gravitational acceleration value, zero calibration, vibration suppression filter coefficients, ID address, refresh rate and query factory data.

## Applications

Factory automation, Instrumentation, Agriculture, Engineering machinery, Medical equipment, Security, Rail traffic

|                |           |
|----------------|-----------|
| Zigbee         | RS        |
| Wi-Fi          | CAN       |
| GPRS           | CANopen   |
| CDMA           | EtherCAT  |
| SSI            | DeviceNet |
| PWM            | Profi-bus |
| Vibration-wire | HART      |
| Switch         | Ethernet  |
| Analog         | USB       |

# Performances

Table 1 Specifications

|   |   |           |        |        |         |        |       |
|---|---|-----------|--------|--------|---------|--------|-------|
| Measurement range                               | ±5°   | ±10°      | ±15°   | ±30°   | ±45°    | ±60°   |       |
| Combined absolute accuracy <sup>①</sup> (@25°C) | ±0.01°  | ±0.015°   | ±0.02° | ±0.04° | ±0.06°  | ±0.08° |       |
| Accuracy subroutine parameter                   | Absolute linearity (LSF,%FS)                                  | ±0.06     | ±0.03  | ±0.03  | ±0.03   | ±0.02  | ±0.02 |
|   | Cross-axis sensitivity <sup>②</sup>                           | ±0.1%FS   |        |        |         |        |       |
|   | Offset <sup>③</sup>   | ±0.005°   |        |        | ±0.008° |        |       |
|   | Repeatability   | ±0.0025°  |        |        |         |        |       |
|   | Hysteresis  | ±0.0025°  |        |        |         |        |       |
| Allowed installation misalignment <sup>④</sup>  | ±4.0°   | ±3.0°     | ±2.5°  | ±1.5°  | ±1.2°   | ±1.2°  |       |
| Input-axis mislignment                          | ≤±0.1°  |           |        |        |         |        |       |
| Sensitivity temperature drift coefficient(max.) | ≤100ppm/°C  | ≤50ppm/°C |        |        |         |        |       |
| Offset temperature drift coefficient(max.)      | ≤0.003°/°C  |           |        |        |         |        |       |
| Offset turn on repeatability <sup>⑤</sup>       | ±0.008°   |           |        |        |         |        |       |
| Resolution                                      | 0.0025°   |           |        |        |         |        |       |
| Long-term stability(1 year)                     | ≤0.02°  |           |        |        |         |        |       |
| Measurement axis                                | 1 or 2 axis   |           |        |        |         |        |       |
| Temperature sensor                              | Range: -50~125°C, Accuracy: ±1°C                              |           |        |        |         |        |       |
| Output  | PWM output<br>Output frequency: 1000Hz<br>Duty cycle: 20%~80% |           |        |        |         |        |       |
| Cold start warming time                         | 60s   |           |        |        |         |        |       |
| Response time                                   | 0.3s(@t <sub>90</sub> )                                       |           |        |        |         |        |       |
| Response frequency                              | 3Hz @-3dB   |           |        |        |         |        |       |
| Power supply                                    | 9~36VDC   |           |        |        |         |        |       |
| Power consumption                               | Average working current≤200mA(25°C&24VDC)                     |           |        |        |         |        |       |
| Operation temperature range                     | -40~85°C  |           |        |        |         |        |       |
| Storage temperature range                       | -60~100°C   |           |        |        |         |        |       |
| Insulation resistance                           | 100MΩ   |           |        |        |         |        |       |
| MTBF  | ≥25000 h/times  |           |        |        |         |        |       |
| Shock   | 100g@11ms, three-axis, half-sine                              |           |        |        |         |        |       |
| Vibration                                       | 8grms, 20~2000Hz  |           |        |        |         |        |       |
| Protection                                      | IP67  |           |        |        |         |        |       |
| Connecting                                      | MIL-C-26482   |           |        |        |         |        |       |
| Weight  | 420g(without connector and cable)                             |           |        |        |         |        |       |

① Combined absolute accuracy means the compositive value of sensor's absolute linearity, repeatability, hysteresis, offset and cross-axis sensitivity error. (in room temperature condition) as  

$$\Delta = \pm \sqrt{\text{absolute linearity}^2 + \text{repeatability}^2 + \text{hysteresis}^2 + \text{offset}^2 + \text{cross-axis sensitivity error}^2}$$

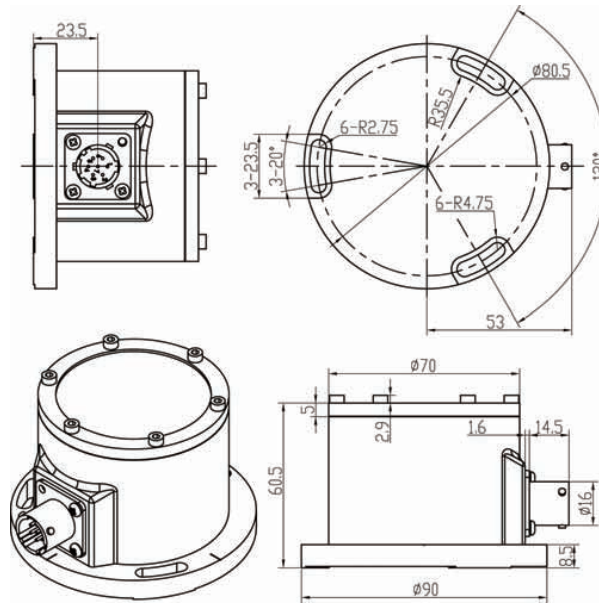
② The cross-axis sensitivity means the angle that the tilt sensor may be banked to the normal tilt direction of sensor. The cross-axis sensitivity (±0.1%FS) shows how much perpendicular acceleration or inclination is coupled to the inclinometer output signal. For example, for the single-axis inclinometer with range ±30° (assuming the X-axis as measured tilt direction), when there is a 10° tilt angle perpendicular to the X-axis direction (the actual measuring angle is no change, example as +8.505°), the output signal will generate additional error for this 10° tilt angle, this error is called as cross-axis sensitivity error. SST300's cross-axis sensitivity is 0.1%FS, the extra error is 0.1%×30°=0.03°(max), then real output angle should be +(8.505°±0.03°). In SST300 series, this error has been combined into the absolute accuracy

③ Offset means that when no angle input (such as the inclinometer is placed on an absolute level platform), output of sensor is not equal to zero, the actual output value is zero offset value.

④ Allowed installation misalignment means during the installation, the allowable installation angle deviation between actual tilt direction and sensor's nature measurement direction. In general, when installed, SST300 sensor is required that the measured tilt direction keep parallel or coincident with sensor designated edge, this parameter can be allowed a certain deviation when sensor is installed and does not affect the measurement accuracy.

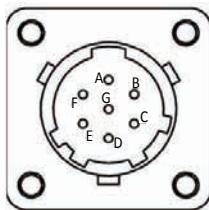
⑤ Offset turn on repeatability means the repeatability of the sensor in repeated by supply power on-off-on many times.

## Dimensions (mm)



Picture 1 Housing with MIL class connector

## Wiring

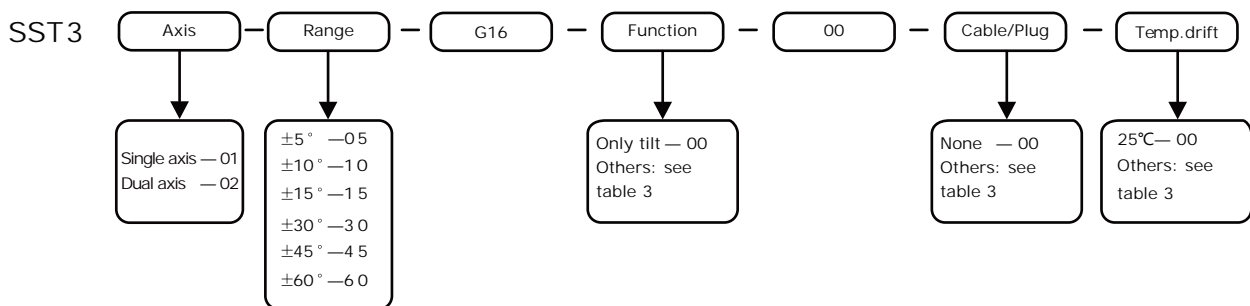


Picture2 MIL connector socket (View from outside)

Table2 Pin definition

| Pin | Function     |
|-----|--------------|
| A   | Power +      |
| B   | Power GND    |
| C   | Signal GND   |
| D   | PWM (X axis) |
| E   | PWM (Y axis) |
| F   | RS232-TXD    |
| G   | RS232-RXD    |

## Ordering



For example, if order a dual axis PWM inclinometer, with range  $\pm 15^\circ$ , room temperature accuracy  $\pm 0.02^\circ$ ,  $-20$ – $60^\circ\text{C}$  total drift accuracy  $\pm 0.02^\circ$ , 2 meters cable with plug, with X axis and Y axis gyro, the model should be chosen as: SST302-15-G16-F4 -00-C1-D3 (2m)

Other options (see table 4):

Magnetic base—order number SST003-01-01

## Accessories & Options

Table 3 Accessories

| Item                        | Order Code | Accessories name         | Function   |
|-----------------------------|------------|--------------------------|--|
| Functional model (built-in) | F4         | Gyro module              | ±100/250/400°/s, X/Y/Z axis dynamic angular rate<br>In-run bias: ±0.02°/s, Non-linearity: 0.1%FS<br>Bandwidth: 50Hz, Noise density : 0.02°/s/√Hz<br>Higher accuracy gyro module available  |
|                             | F5         | Vibration module         | Three-axis vibration detection, frequency response ≤5 kHz<br>Range: 0g~±1g/ ±5g/ ±10g/ ±20g, adjustable<br>Sampling(real-time): 20.48 kSPS<br>Filter programmable, 11pcs set points<br>FFT, 512-point, real valued, all three-axis(x, y, z)<br>Storage: 14 FFT records on all three-axis(x, y, z)<br>Alarm programmable, 6 spectrums |
| Plug/cable                  | C1         | Standard Cable with plug | Military class connector(meet MIL-C-26482), Standard 2M cable, IP67 protection, heavy duty up to 30kg  |
|                             | C4         | Armoured cables          | Increase cable mechanical strength, anti-erosion and anti-jamming capability   |
|                             | C6         | Standard plug            | According to MIL-C-26482, IP67 protection  |
| Temperature drift           | D1         | Temperature drift        | Temperature compensation range is 0~60°C, accuracy ±0.01°@≤±30°  |
|                             | D2         | Temperature drift        | Temperature compensation range is 0~60°C, accuracy ±0.01°@>±30°  |
|                             | D3         | Temperature drift        | Temperature compensation range is -20~60°C, accuracy ±0.02°@≤±30°  |
|                             | D4         | Temperature drift        | Temperature compensation range is -20~60°C, accuracy ±0.02°@>±30°  |
|                             | D5         | Temperature drift        | Temperature compensation range is -30~60°C, accuracy ±0.03°@≤±30°  |
|                             | D6         | Temperature drift        | Temperature compensation range is -30~60°C, accuracy ±0.03°@>±30°  |
|                             | D7         | Temperature drift        | Temperature compensation range is -40~65°C, accuracy ±0.05°@≤±30°  |
|                             | D8         | Temperature drift        | Temperature compensation range is -40~65°C, accuracy ±0.05°@>±30°  |
|                             | D9         | Temperature drift        | Temperature compensation range is -40~85°C, accuracy ±0.05°@≤±30°  |
|                             | D10        | Temperature drift        | Temperature compensation range is -40~85°C, accuracy ±0.05°@>±30°  |

Table 4 Options

| Item                  | P/N          | Options name                                      | Function  |
|-----------------------|--------------|---|---|
| Installation tools    | SST003-01-01 | Magnetic base                                     | 50kg suction, permanent magnet, stainless steel materials                             |
|                       | SST003-01-04 | Adjustable base with micrometer screw             | Three-points adjustment, resolution 0.001mm, stainless steel materials                |
| Calibration equipment | SST003-10-04 | Cross-axis test equipment                         | Mechanical, manual, accuracy ±30", measurement range ±15°                             |
|                       | SST003-10-05 | Adjustable field level platform                   | Mechanical, manual, 3kgs payload, level accuracy ±10", adjustable range(X/Y) ±1°      |
| Test report           | SST003-11-01 | Test report for cross-axis sensitivity            | Test report under banking tilt, average 11 points of full range                       |
|                       | SST003-11-03 | Test report for Allowed Installation misalignment | Axis migration test report for vertical and horizontal axis of inclinometer, 3 angles |
|                       | SST003-11-04 | Test report for response time and hysteresis      | The report for time response curve/ data and hysteresis characteristics               |
|                       | SST003-11-05 | Test report for vibration                         | According to inclinometer's standard vibration characteristic                         |
|                       | SST003-11-06 | Test report for mechanical shock                  | According to inclinometer's standard shock characteristic                             |