

Gyro Inclinometer



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Features

- Gyro range: $\pm 100/\pm 250/\pm 400^\circ/s$
- Gyro In - run bias: $\pm 0.02^\circ/s$
- Gyro nonlinearity: 0.1%FS
- Gyro bandwidth: 50Hz
- Three axis angular rate & relative angle increment measurement
- Tilt range(X&Y axis): $\pm 5^\circ \sim \pm 60^\circ$
- Up to $\pm 0.01^\circ$ combined absolute accuracy



Descriptions

Gyro - inclinometer not only provide roll, pitch attitude angle in static, but also output relative roll, pitch & heading increment angle or angular rate in high dynamic test.

General inclinometer which based on accelerometer or electrolyte principle, will be affected much by additional axial acceleration and centripetal acceleration from rapid movement, and take measurement accuracy down. But gyroscope has good dynamic characteristics, not affected by acceleration, and output angular rate and relative angle increment under dynamic moving. In the low - frequency quasi - static conditions, the inclinometer will have accurate measurement, while gyroscope drift timely.

Based on good quasi - static characteristics of inclinometer and good dynamic characteristics of gyroscope, gyro - inclinometer combined gyroscope and inclinometer perfectly, to adapt to both dynamic and quasi - static angle measurement.

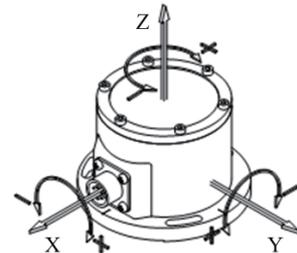
Gyro - inclinometer have more choices as:

- Single inclinometer + Z axes gyroscope with analog/digital output
- Dual inclinometer + Z axes gyroscope with analog/digital output
- Dual inclinometer + Y axes gyroscope with analog/digital output
- Dual inclinometer + X/Y axes gyroscope with analog/digital output
- Dual inclinometer + X/Y/Z axes gyroscope with analog/digital output

Also, Vigor may provide customized gyro's performance as demand

Gyro inclinometer has strong measuring ability:

- ✓ $\pm 0.02\%FS$ linearity and $\pm 0.005^\circ$ Offset, higher zero accuracy with large measurement range
- ✓ Gyro bias stability $\pm 0.02^\circ/s$ & 50Hz bandwidth, has quick & accurate relative angle & angular rate measuring ability
- ✓ Relative angle & angle rate not affected by additional acceleration
- ✓ With static/dynamic angle measuring ability, suite to low/rapid platform leveling
- ✓ Combine with vibration module, realize FFT computations in-time, output vibration frequency and amplitude data directly, eliminate the influence of environment vibration
- ✓ Inclination axial and gyro axial have precisely aligned & calibrated, to ensure all measurement data simultaneous sampling in the same coordinate system
- ✓ 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 sensitivity, 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's actual sensitive axis
- ✓ Short-circuit, transient voltage and transposition protection to adapt to industry environment
- ✓ User can set unit's all kinds of parameters and query factory data via digital interface.



Applications

Factory automation, Agricultural machinery, Construction machinery, Rail transportation, Road traffic, Robots, Vehicle system, Weapons platform, Satellite communication, Photoelectric platform, etc

Performances

Table 1 Specifications

| Inclinometer specifications | | | | | | |
|--|---|-----------|--------|--------|---------|--------|
| Measurement range | ±5° | ±10° | ±15° | ±30° | ±45° | ±60° |
| Combined absolute accuracy ^① (@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 |
| | Cross - axis sensitivity ^② | ±0.1%FS | | | | |
| | Offset ^③ | ±0.005° | | | ±0.008° | |
| | Repeatability | ±0.0025° | | | | |
| | Hysteresis | ±0.0025° | | | | |
| Allowed installation misalignment ^④ | ±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 ^⑤ | ±0.008° | | | | | |
| Resolution | 0.0025° | | | | | |
| Long-term stability(1 year) | ≤0.02° | | | | | |
| Measurement axis | 1 or 2 axis | | | | | |
| Response time | 0.3s(@t ₉₀) | | | | | |
| Refresh rate | 5Hz(optional 10Hz or 20Hz) | | | | | |
| Response frequency | 3Hz @-3dB | | | | | |
| Angular rate/different angle | | | | | | |
| Measurement axis | 1 axis(Z), 2 axis(X,Y), 3 axis(X,Y and Z) | | | | | |
| Measurement range | ±100°/s, ±250°/s, ±400°/s | | | | | |
| In-Run bias stability bias | ±0.02°/s ±0.03°/s | | | | | |
| Offset temperature drift | ±0.004°/s/°C | | | | | |
| Sensitivity temperature drift coefficient | ±0.004°/s /°C | | | | | |
| Nonlinearity | ±0.1% | | | | | |
| Noise density | 0.02°/√Hz @ ±100°/s range 0.03°/√Hz @ ±250°/s or ±400°/s range | | | | | |
| Bandwidth | 50HZ | | | | | |
| Total specifications | | | | | | |
| Misalignment | ±0.1° (Inclinometer axial & gyro axial) | | | | | |
| Power supply | 9~36VDC | | | | | |
| Output | RS232, RS422,CAN,0~5VDC | | | | | |
| Output parameter | Single/dual axis tilt angle data Single/dual/tri axis different angle data Single/dual/ tri axis different angular rate data inner temperature data(only for digital output) | | | | | |
| Functions (only for digital output) | set zero point, baud rate, local gravitational acceleration value, zero calibration, vibration suppression filter coefficients, ID address, refresh rate, etc | | | | | |
| Refresh rate | 5Hz, 10Hz, 20Hz, 50Hz,100Hz(only for digital output) | | | | | |
| Power consumption | Average working current≤150mA(25°C&24VDC, double axis tilt, tri-axis gyroscopes)) | | | | | |
| Operation temperature range | -40~85°C | | | | | |
| Storage temperature range | -40~85°C | | | | | |
| Insulation resistance | 100MΩ | | | | | |
| MTBF | ≥25000 h/times | | | | | |
| Shock | 100g@11ms,three - axis, half - sine | | | | | |
| Vibration | 8grms, 20~2000Hz | | | | | |
| Protection | IP65(optional IP67) | | | | | |
| Connecting | Military class connector | | | | | |
| Weight | 450g(without connector and cable) | | | | | |

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

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

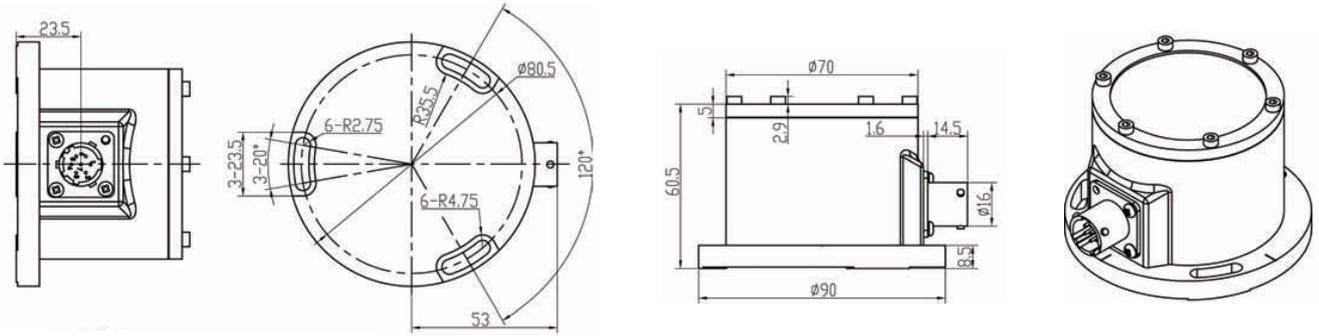
② The cross-axis sensitivity means the angle that the tilt sensor may be banked to the normal tilt direction of sensor. The cross-axis sensitivity (±0.1%FS) shows how much perpendicular acceleration or inclination is coupled to the inclinometer output signal. For example, for the single-axis inclinometer 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 allow able 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.

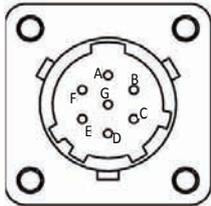
Dimensions (mm)



Picture 1 Housing with MIL class connector

Wiring

Table 2 Pin definitions for analog and digital interface



Picture2 MIL connector socket (View from outside)

| Socket pin | Any combination of gyro - inclinometer | | | Single tilt | Dual tilt | Dual tilt | Dual tilt | Dual tilt |
|------------|--|-----------|------------|-------------|------------|------------|------------|-------------|
| | Digital output | | | +Z gyro | +Z gyros | +Y gyro | +X/Y gyro | +X/Y/Z gyro |
| | RS232 | CAN | RS422 | 0~5VDC | | | | |
| A | Power + | Power + | Power + | Power + | Power + | Power + | Power + | Power + |
| B | Power GND | Power GND | Power GND | Power GND | Power GND | Power GND | Power GND | Power GND |
| C | Signal GND | NC | Signal GND | Signal GND | Signal GND | Signal GND | Signal GND | Signal GND |
| D | NC | CAN-H | RS422-RXD+ | Voutx-T | Voutx-T | Voutx-T | Voutx-T | Voutx-T |
| E | NC | CAN-L | RS422-RXD- | NC | Vouty-T | Vouty-T | Vouty-T | Vouty-T |
| F | RS232-TXD | NC | RS422-TXD+ | Voutz-R | Voutz-R | NC | Voutx-R | Voutx-R |
| G | RS232-RXD | NC | RS422-TXD- | NC | NC | Vouty-R | Vouty-R | Vouty-R |
| H | --- | --- | --- | --- | --- | --- | --- | Voutz-R |
| I | --- | --- | --- | --- | --- | --- | --- | NC |

Note:

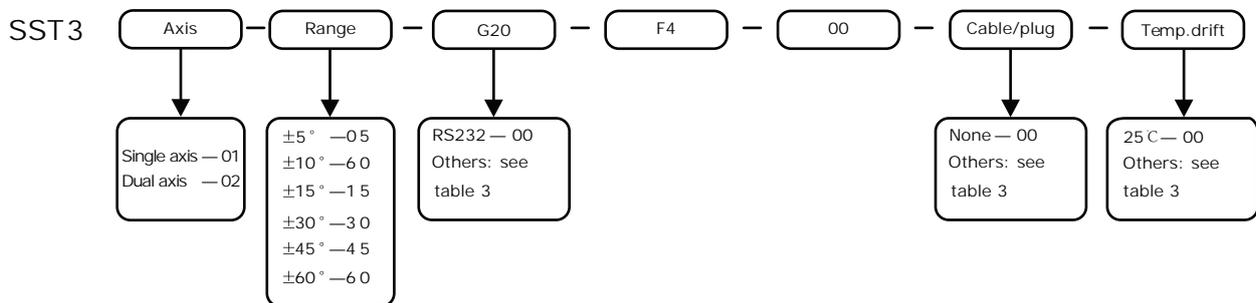
1. Voutx - T means X axes voltage output of tilt;

Voutz - R means Z axes voltage output of angular rate;

2. Only <Dual tilt +X/Y/Z axis gyro> adopt 9-pin connector, others adopt 7-pin connector

3. For digital output, housing, see Picture 2 as standard; but for 0~5VDC output, please ask Vigor when order.

Ordering



For example, if order one Gyro-inclinometer, with tilt range ±60°, dual axis, absolute tilt accuracy±0.08°, -20~60C tilt temperature compensated accuracy ±0.02°, X & Y axis gyroscope(X axis range ±100°/s, Y axis range±250°/s), 2m cable with plug, 0~5VDC output, the final model should be chosen as : SST302 - 60 - G20 - F4 - 00 - C1 - D3(gyroscopes with X axis range ±100°/s, Y axis range ±250°/s)

Other options (see Table 4) :

Magnetic base——order number SST003-01 - 01

Accessories & Options

Table 3 Accessories

| Item | Order Code | Accessories name | Function |
|-------------------|-------------------|---|--|
| Output interface | 00 | RS232 | Directly angle output Data format: Baud rate: 115200(adjustable), 8 data bits, 1 start bit, 1 stop bit, none parity Refresh rate: 5Hz, optional: 10Hz, 20Hz |
| | G2 | RS422 | Isolated, Compatible with half-duplex or full-duplex communication; $\pm 15\text{kV}$ ESD protection Compatible with ANSI/TIA/EIA-485-A-98 & ISO8482: 1987(E) Comply with UL1577---2500V rms for 1min ; Transmission rate up to 500 kbps, support max 256pcs node High common mode transient suppression ability $>25\text{kV/us}$; Support Modbus-RTU, sensor supply HEX or ASCII communication |
| | G3 | CAN | Compliance with ISO/DIS 11898, twisted-pair output Support CAN2.0A, CAN2.0B protocol Build-in high-speed photo isolators Support 15 baud rates from 5k to 1000Kbps Transmission distance: 10km Max |
| | G20 | 0~5VDC | Linearity: 0.02%FS max Output impedance 100Ω , output current $\pm 10\text{mA}$ max |
| Cable/Plug | 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 0~60°C, accuracy $\pm 0.01^\circ @ \leq \pm 30^\circ$ |
| | D2 | Temperature drift | Temperature compensation range 0~60°C, accuracy $\pm 0.01^\circ @ > \pm 30^\circ$ |
| | D3 | Temperature drift | Temperature compensation range -20~60°C, accuracy $\pm 0.02^\circ @ \leq \pm 30^\circ$ |
| | D4 | Temperature drift | Temperature compensation range -20~60°C, accuracy $\pm 0.02^\circ @ > \pm 30^\circ$ |
| | D5 | Temperature drift | Temperature compensation range -30~60°C, accuracy $\pm 0.03^\circ @ \leq \pm 30^\circ$ |
| | D6 | Temperature drift | Temperature compensation range -30~60°C, accuracy $\pm 0.03^\circ @ > \pm 30^\circ$ |
| | D7 | Temperature drift | Temperature compensation range -40~65°C, accuracy $\pm 0.05^\circ @ \leq \pm 30^\circ$ |
| | D8 | Temperature drift | Temperature compensation range -40~65°C, accuracy $\pm 0.05^\circ @ > \pm 30^\circ$ |
| | D9 | Temperature drift | Temperature compensation range -40~85°C, accuracy $\pm 0.05^\circ @ \leq \pm 30^\circ$ |
| D10 | Temperature drift | Temperature compensation range -40~85°C, accuracy $\pm 0.05^\circ @ > \pm 30^\circ$ | |

Table 4 Options

| Item | P/N | Option 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 |
| Power | SST003-09-02 | The portable rechargeable lithium battery packs | Output 24VDC, Continuous work 24 hours , IP65, rechargeable |
| Test report | SST003-11-02 | Absolute linearity | Average 21 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 |