

# ***GPS Inclinometer***



# GPS Inclinometer

## Features

- Output data: position, speed, PPS clock, X & Y axis tilt angle
- Level position accuracy: 2.5 m CEP, 2.0 m @ SBAS
- PPS clock accuracy: 30ns RMS
- Speed accuracy: 0.1m/s
- Tilt repeatability:  $\pm 0.0025^\circ$
- Local gravity acceleration value adjust automatically, ensure accurate zero at any place of world
- Radio: GPS L1 band, C/A code, GALILEO Open Services  
GLONASS FDMA; SBAS: WAAS, EGNOS, MSAS
- Available to API for Google maps



## Descriptions

GPS inclinometer is a new attitude measurement product, creatively designed by Vigor. It combines GPS module and unique tilt measurement technology, not only provides roll & pitch angle data, but also position, time and speed information available. It meets the requirement of that, many sensors work synchronically in static situation, and positioning and synchronization in dynamic situation.

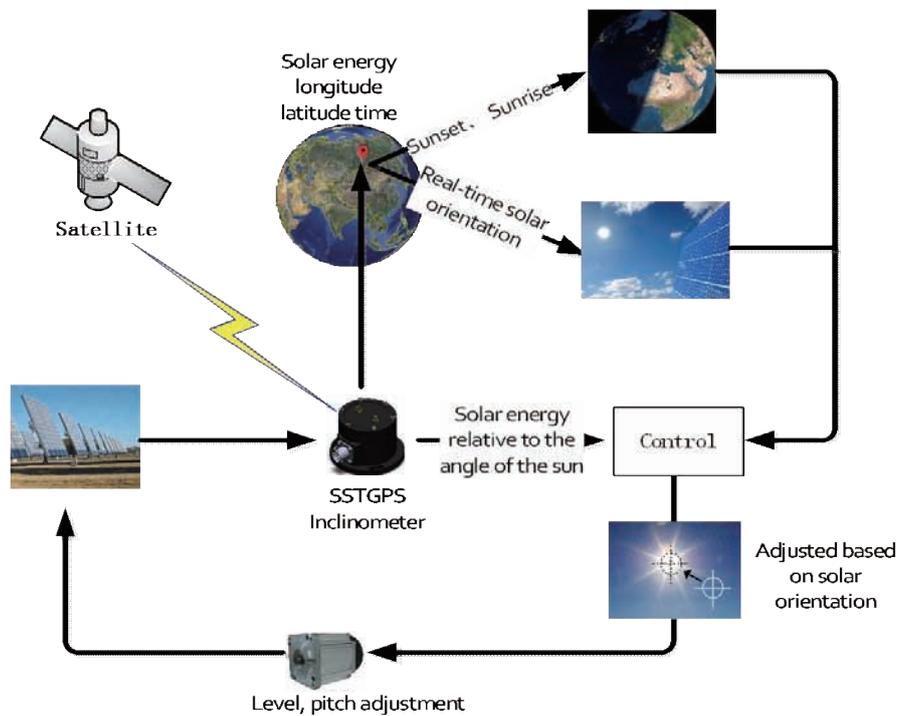
Local latitude & longitude information are provided by internal GPS module, and the inclinometer can use these to adjust the gravity acceleration value automatically, so as to ensure accurate tilt angle data. Also with the GPS information, end-user can install many sensors in proper places to realize attitude monitoring of mountain or other fields.

GPS inclinometer has added time-stamp on angle data, 30ns accuracy can meet most of data synchronization analysis and acquisition requirements.

For mobile devices, GPS inclinometer not only provides high accurate X & Y axis angle data, but also the latitude & longitude data, sea level elevation and moving speed data. If GPS base stations available, it will realize 40cm positioning accuracy. For more details, please contact Shanghai Vigor.

GPS inclinometer has strong tilt measuring ability:

- ✓  $\pm 0.02\%$ FS linearity
- ✓  $\pm 0.005^\circ$  Offset and local gravity acceleration automatically compensated via GPS latitude & longitude data, realize high accuracy of zero and wide-range measurement
- ✓ No location limit to GPS inclinometer. Synchronize to each GPS inclinometer and other equipments by GPS clock
- ✓ 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. upgrade real tilt angle measuring accuracy. Abandoned the traditional incomplete understanding for tilt angle measurement accuracy concept
- ✓ Patent error calculation and test calibration method, greatly upgrades real tilt angle measuring accuracy and reliability
- ✓ Greatly reduce measuring errors when the real tilt direction not consistent to inclinometer sensitive axis
- ✓ Additional to short-circuit, transient voltage, Overheat protection and transposition protection to adapt to industry environment
- ✓ User can set parameters of inclinometer and query factory data

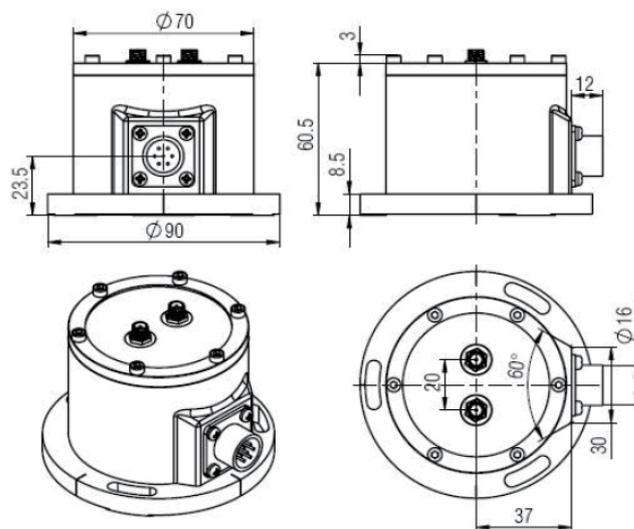


Picture 1 GPS inclinometer in solar energy automatic control application

## Applications

Agricultural & construction machinery, Trucks, Buses, Trains  
 Other outdoor ground mobile devices  
 Track inspection instrument, field geological exploration  
 Instruments and other operation equipment  
 Field synchronous test system(rely on tilt angle & PPS clock)  
 Vessel and other marine equipment  
 Geological disaster long-term monitoring system

## Dimensions (mm)



Picture 2 Housing with MIL class connector

# Performances

Table 1 Specifications

Tilt 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
	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	≤50 ppm/°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) <sup>⑥</sup>	≤0.02°					
Measurement axis	1 or 2 axis					
Cold start warming time	60s					
<b>GPS specifications</b>						
Level position accuracy	2.5m@CEP/2.0m @ SBAS					
PPS clock accuracy	30ns RMS					
Radio	50 channels, GPS L1 band, C/A code ; GALILEO Open Services GLONASS FDMA ; SBAS: WAAS, EGNOS, MSAS					
Speed accuracy	0.1m/S					
Max speed	500m/S					
Cold start warming time	26s					
Warm-start	1s					
GPS antenna	Active, frequency: 1575 M ± 3 MHz, polarity: RHCP, standard length 3 M					
<b>Others</b>						
Output data	Position(longitude and latitude), speed, PPS clock, X & Y axis tilt angle					
Output interface	CAN, RS232, RS485, RS422					
Refresh rate	5Hz,10Hz,20Hz					
Power supply	9~36VDC					
Power consumption	Average working current≤50mA, average power≤1.5W(25°C&24VDC)					
Operation temperature range	-40~85°C					
Storage temperature range	-60~100°C					
Insulation resistance	100MΩ					
MTBF	≥25000 hours					
Shock	100g@11ms , three-axis, half- sine					
Vibration	8grms, 20~2000Hz					
Protection	IP67					
Connecting	Military class connector(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

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

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

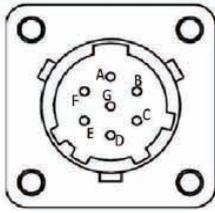
③ Offset means that when no angle input (such as the inclinometer is placed on an absolute level platform), output of sensor is not equal to zero,the actual output value is zero offset value.

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.

⑥ Long-term stability means the deviation between the statistics of the maximum and the minimum output value after a year of continuous power supply when the sensor is at 20°C .

## Wiring

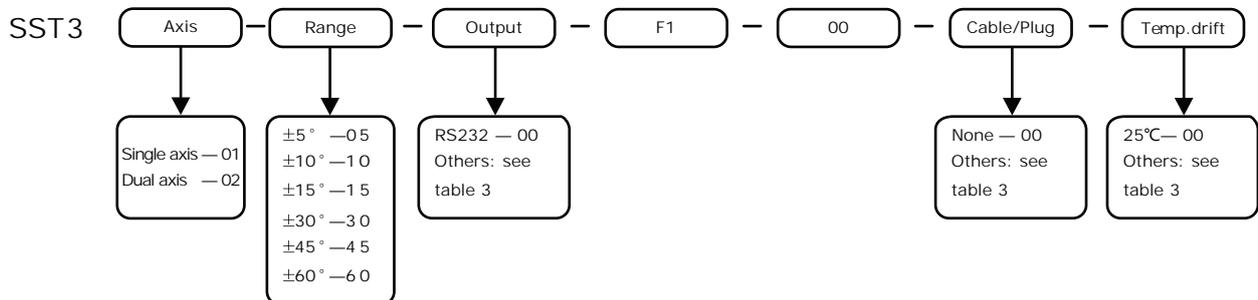


Picture 3 Connector  
(View from outside)

Table 2 Pin definition

PIN	Wi-Fi	CAN	RS232	RS422	RS485
A	Power +				
B	Power GND				
C	Signal GND				
D	NC	CAN-H	NC	RXD+	NC
E	NC	CAN-L	NC	RXD-	NC
F	NC	NC	TXD	TXD+	RS485-A
G	NC	NC	RXD	TXD-	RS485-B

## Ordering



For example, if order a dual-axis GPS inclinometer, with range  $\pm 30^\circ$ , accuracy  $\pm 0.02^\circ$  at room temperature and  $-20\text{--}60^\circ\text{C}$ , CAN2.0 output, 2m cable, the model should be chosen as: SST302-30-G3-F1-00-C1-D3 (2m)

PC application software--- order number SST003-04-09

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
	G1	RS485	Isolated, Compatible with half-duplex or full-duplex communication; ±15kV ESD protection Compatible with ANSI/TIA/EIA-485-A-98 & ISO8482:1987(E) Comply with UL1577---2500V rms for 1min ;
	G2	RS422	Transmission rate up to 500 kbps, support max 256pcs node High common mode transient suppression ability>25kV/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
	G12	WiFi	WLAN protocol: IEEE 802.11b/g, Compatible with Wi-Fi, 2.4G ISM band Output power: 15dBm +/-1.5dBm Wireless data transmission rate: 802.11b: 1, 2, 5.5, 11Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps WLAN setting up: Support AP & Ad-Hoc Encryption: Support WEP40 and WEP104 encryption (64/128 bit) Set-up network time: 3-6s
Temperature drift	D1	Temperature drift	Temperature compensation range 0~60°C, accuracy ±0.01°@≤±30°
	D2	Temperature drift	Temperature compensation range 0~60°C, accuracy ±0.01°@>±30°
	D3	Temperature drift	Temperature compensation range -20~60°C, accuracy ±0.02°@≤±30°
	D4	Temperature drift	Temperature compensation range -20~60°C, accuracy ±0.02°@>±30°
	D5	Temperature drift	Temperature compensation range -30~60°C, accuracy ±0.03°@≤±30°
	D6	Temperature drift	Temperature compensation range -30~60°C, accuracy ±0.03°@>±30°
	D7	Temperature drift	Temperature compensation range -40~65°C, accuracy ±0.05°@≤±30°
	D8	Temperature drift	Temperature compensation range -40~65°C, accuracy ±0.05°@>±30°
	D9	Temperature drift	Temperature compensation range -40~85°C, accuracy ±0.05°@≤±30°
	D10	Temperature drift	Temperature compensation range -40~85°C, accuracy ±0.05°@>±30°
Cable/Plug	C1	Standard Cable with plug	Military class connector(meet MIL-C-26482) Standard 2M cable, IP67 protection, heavy duty up to 30kg
	C6	Standard plug	According to MIL-C-26482, IP67 protection

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
Software	SST003-04-10-01 (Based on iPhone)	iAngle mobile software	The communication distance with inclinometer ≥200m By iPhone or iPad, can directly inspect the data, and do variety of settings, such as: zero, test range, sampling rate, filter coefficient, etc, and have more functions, including alarm, graph, compass chart, bubble chart Sampling rate: 20time/sec.
	SST003-04-10-02 (Based on iPad)		
	SST003-04-09	PC application Software	Setting function, Command function, Tool function Operating platform: windows XP, Windows 7 More information please see datasheet of this options
	SST003-04-12-00	iss8 software	Collecting, preserving and monitoring data of 8pcs SST300 inclinometer max, can display each inclinometer data graph, parameters setting early warming and achieve multiple inclinometer networking Based on windows
Power	SST003-09-02	The portable rechargeable lithium battery packs	Output 24VDC, Continuous work 24 hours , IP65, rechargeable