

# ***SST300 Inclinator***



Vigor Technology

# SST300 Inclinometer

## Features

- Highest combined absolute accuracy  $\pm 0.01^\circ @ 25^\circ\text{C}$
- Absolute accuracy combined with absolute linearity, cross axis sensitivity, offset, repeatability, hysteresis
- Cross-axis sensitivity  $\leq \pm 0.1\% \text{FS}$
- Offset  $\leq \pm 0.005^\circ$
- Precise installation & higher actual accuracy
- Adjustable vibration suppression while running
- Temperature drift accuracy(optional):  $\pm 0.05^\circ @ -40 \sim +85^\circ\text{C}$
- Various output interfaces
- EMC certificated



## Description

SST300 inclinometer is excellent tilt device which not only have outstanding performance, but also have simulation & process with advanced EDA&CAE technologies including reliability design, strict process control, structure design, components/materials collection & heat treatment, heat flow analysis, finite element analysis and so on, to achieve high reliability and stability.

Each inclinometer performed with Vigor's patented automatic testing technologies without manual operations and unpredictable random errors occupied. Not only general accuracy test, but also temperature drift compensation, nonlinear correction, cross-axis sensitivity error correction, and/or orthogonal error correction, input-axis misalignment compensation, vertical-axis misalignment compensation, as well as life test, made to reduce additional error caused by filed installation, then realize to installed-to-forgot and acquire accurate data.

## Applications

Vessel, Precision instruments, Security detection, Civil engineering, Military project, Platform leveling, Drilling machines, Hydraulic leveling.

## Referenced Standards

- GB/T 191 SJ 20873 General requirements for Inclinometer & levelmeter (China)
- GBT 18459 Methods for Calculating the Main static performance specifications for transducers(China)
- JJF 1059 Evaluation and Express of Uncertainty in Measurement(China)
- JJF 1094 Evaluation of the Characteristics of Measuring Instruments(China)
- JJF 1116 Calibration Specification for Linear Accelerometer used precision Centrifuger(China)
- QJ 2318 The test method of gyro & accelerometer(China)
- GJB 2786A General Requirements for Military Software Development(China)
- GJB 2884 General Specification for Three-Axis angular motion simulator(China)
- EN61000-4-11 Voltage dips & Voltage variations
- MIL-HDBD-338B
- MIL-STD-810F-510.4
- MIL-STD-810F-507.4
- ISO 5348 IDT
- MIL-STD-810F-514.5
- EN61000-4-4 EFT
- MIL-STD-810F-501.4
- MIL-STD-810F-516.5
- EN61000-4-5 SURGE
- MIL-STD-810F-502.4
- IEC60529 IP
- EN61000-4-6 CS
- MIL-STD-810F-503.4
- EN61000 -4-2 ESD
- EN61000-4-8 PFMF
- MIL-STD-810F-506.4
- EN61000-4-3 RS
- ISTA-2A

## 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	RS232 (optional 25 types, please refer to accessories)						
RS232 data format	115200 baud, 8 data bits, 1 start bit, 1 stop bit, none parity,ASCII						
Cold start warming time	60s						
Response time <sup>⑦</sup>	0.3s(@t <sub>90</sub> )						
Refresh rate(digital output)	5Hz(optional 10Hz,20Hz)						
Response frequency <sup>⑧</sup> (analog output)	3Hz @-3dB						
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						
EMC	According to EN 61000						
Insulation resistance	100MΩ						
MTBF	≥25000 h/times						
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

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

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.

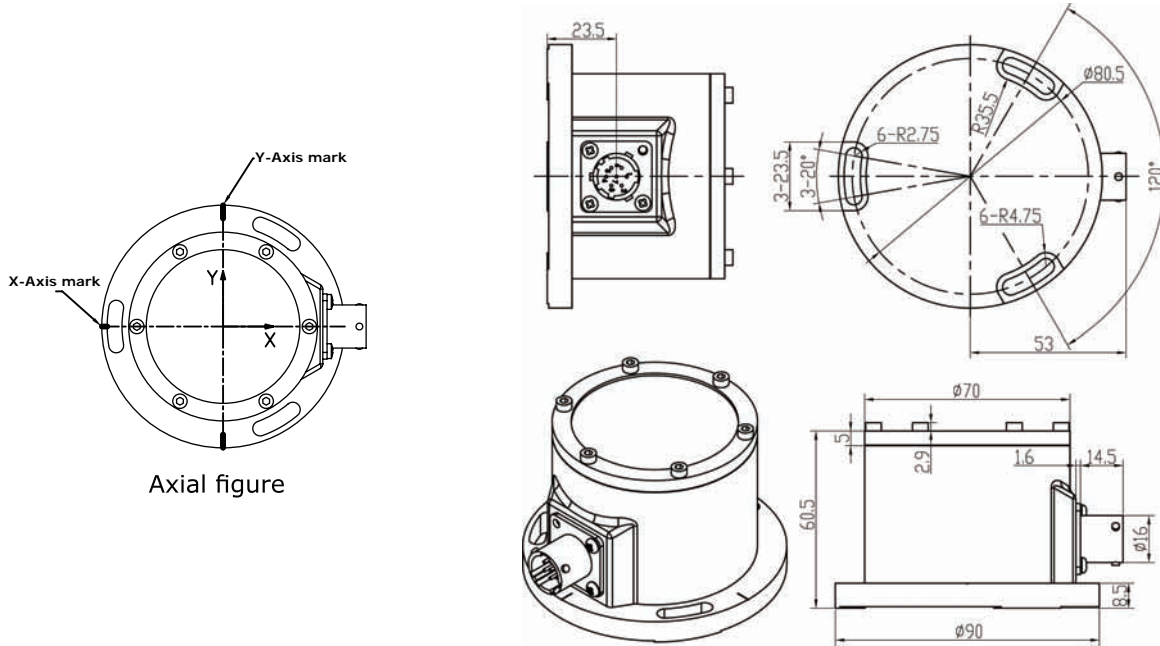
⑤ Offset turn on repeatability means the repeatability of the sensor in repeated by supply power on-off-on many times.

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 .

⑦ The response time refers to the angle sensor in a step change (such as the angle changes from -10 ° to +10 °within 5ms), the time required that output of the sensor achieved to the standard value of 90%. The index is different from the sensor set-up time

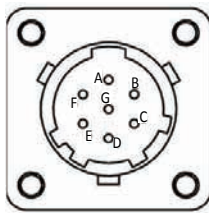
⑧ Response frequency is for the limitation of the dynamic measurement range, when the dynamic measurement exceeds 3 Hz, because of centripetal force, the output occupied additional random error,this error is difficult to define.

## Dimensions (mm)



Picture 1 Housing with MIL class connector

## Wiring

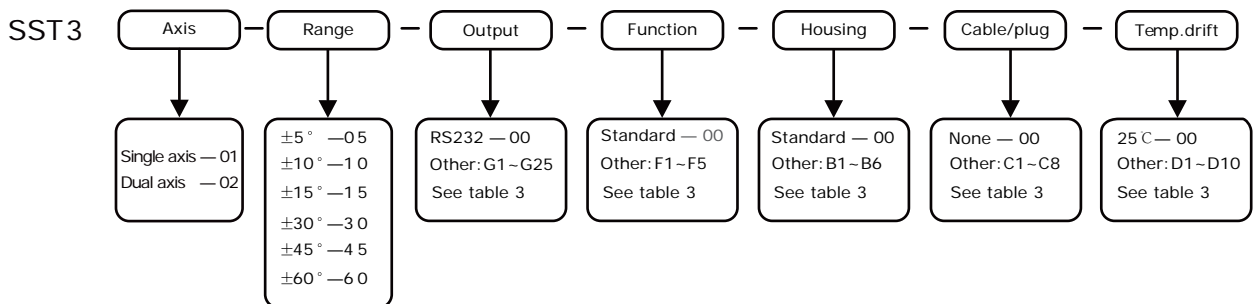


Picture2 MIL connector socket (View from outside)

Table 2 MIL connector socket pin definition

Pin	Signal (RS232)
A	Power +
B	Power -
C	Signal GND
D	NC
E	NC
F	RS232--TXD
G	RS232--RXD

## Ordering



For example, if order a dual-axis inclinometer, with range  $\pm 15^\circ$ , Output Zigbee Wi-Fi transmission, two meters cable with plug, vibration suppression function, anti-explosion housing, the model should be chosen as: SST302-15-G8-F5-B5-C1.

Meanwhile some options (See table 4):

4 channels hub — order number SST003-05-06

Fixed installation base — order number SST003-01-05

Zigbee LCD display with lithium battery — order number SST003-04-07

Complementary power combined with solar and wind energy — order number SST003-09-03

Field calibration equipment (accuracy  $\pm 30''$ ) — order number SST003-10-02

# Accessories & Options

Table 3 Accessories

Item	Order Code	Accessories name	Function
Output interface	G1	RS485 output	Standard industrial ModBus protocol, can be connected to PLC
	G2	RS422 output	Standard industrial interface,can be connected to PLC
	G3	CAN output	Standard industrial interface, can be connected to PLC
	G4	CAN open output	Standard industrial interface, can be connected to PLC
	G5	Ether CAT output	Standard industrial interface, can be connected to PLC
	G6	Device Net output	Standard industrial interface, can be connected to PLC
	G7	Profi-bus output	Standard industrial interface, can be connected to PLC
	G8	HART interface	Standard industrial interface, can be connected to PLC
	G9	TCP/IP interface	Standard industrial TCP/IP interface
	G10	USB2.0 interface	Standard industrial USB interface
	G11	Zigbee interface	Standard industrial 2.4GHz interface
	G12	Wi-Fi interface	Standard industrial interface
	G13	GPRS interface	Standard industrial level
	G14	CDMA interface	Standard industrial level
	G15	SSI output	Standard encoder interface
	G16	PWM output	Standard industrial level
	G17	Vibration string type output	Standard civil engineering industry interface
	G18	Fiber Interface	Single/multimode fiber, industrial level
	G19	4~20mA output	Standard industrial level
	G20	0~5VDC output	Standard industrial level
	G21	-5~+5VDC output	Standard industrial level
	G22	0~10VDC output	Standard industrial level
	G23	-10~+10VDC output	Standard industrial level
	G24	mV output	Standard industrial level
	G25	Switch output	Emergency alarm can be set,2 points/axis
Functional module(built-in)	F1	Single GPS module integrated	Single GPS antenna,positioning accuracy less 3m, gravity correction and time synchronization function
	F2	GPS+Gyro module integrated	Heading accuracy: $\leq 0.5^{\circ}$ RMS(including no GPS signals within 60s, no speedometer signal input), $\leq 0.3^{\circ}$ RMS(including Gasman speedometer signal input), Output: PPS, longitude and latitude, heading angle(relative to the arctic), Z axis angular rate data, X/Y acceleration data
	F3	Electronic compass module integrated	Plane compass(accuracy $\pm 5^{\circ}$ when angle changed within 30 degrees, 0.5 degrees when levels)
	F4	Gyro module integrated	Measuring Z axis Angle rate, Measuring X, Y axis dynamic Angle rate
	F5	Vibration module integrated	Measuring Z axis vibration value (0~500 Hz), Resistance to vibration (for compensation)
Housing	B1	Transient high temperature isolation housing	Withstand impact temperature up to 1200°C within 5 minute duration
	B2	Underwater housing	3000m underwater application, with connector
	B3	Nuclear radiation resistance housing	Apply to nuclear power plants, Anti-radiation $10^7$ rads Gamma
	B4	Beam type housing	Hard aluminum alloy, optional 1~3m length
	B5	Anti-explosion housing	According to ATEX Zone2 (Europe), Class I, Division 2(Canada & USA) dIIBT4,dIICT6,ibIIBT4,iaIIBT4,iaIICT6(China)
	B6	Constant temperature housing	Suitable for low temperature,5mins duration from -60 to +25°C
Cable/Plug	C1	Standard Cable with plug	Military class connector(meet MIL-C-26482),Standard 2M cable,IP67 protection, heavy duty up to 30kg
	C2	Tensile reinforced shield cable	Heavy duty up to 50kg
	C3	High temperature cable	Up to 250°C
	C4	Armor cover cable	Increasing mechanical strength, erosion and anti-interference ability.
	C5	Watertight cable with plug	3000m underwater with special plug
	C6	Standard plug	According to MIL-C-26482,IP67 protection
	C7	Compatible with Amphenol plug	Compatible with the standard of SST300 outlet, manufactured by Amphenol
	C8	Corners plug	90° corner,according to MIL-C-26482,IP67 protection

Temperature drift	D1	Temperature drift	Temperature compensation range 0~60°C, and temperature drift accuracy $\pm 0.01^\circ @ \leq \pm 30^\circ$
	D2	Temperature drift	Temperature compensation range 0~60°C, and temperature drift accuracy $\pm 0.01^\circ @ > \pm 30^\circ$
	D3	Temperature drift	Temperature compensation range -20~60°C, and temperature drift accuracy $\pm 0.02^\circ @ \leq \pm 30^\circ$
	D4	Temperature drift	Temperature compensation range -20~60°C, and temperature drift accuracy $\pm 0.02^\circ @ > \pm 30^\circ$
	D5	Temperature drift	Temperature compensation range -30~60°C, and temperature drift accuracy $\pm 0.03^\circ @ \leq \pm 30^\circ$
	D6	Temperature drift	Temperature compensation range -30~60°C, and temperature drift accuracy $\pm 0.03^\circ @ > \pm 30^\circ$
	D7	Temperature drift	Temperature compensation range -40~65°C, and temperature drift accuracy $\pm 0.05^\circ @ \leq \pm 30^\circ$
	D8	Temperature drift	Temperature compensation range -40~65°C, and temperature drift accuracy $\pm 0.05^\circ @ > \pm 30^\circ$
	D9	Temperature drift	Temperature compensation range -40~85°C, and temperature drift accuracy $\pm 0.05^\circ @ \leq \pm 30^\circ$
	D10	Temperature drift	Temperature compensation range -40~85°C, and temperature drift accuracy $\pm 0.05^\circ @ > \pm 30^\circ$

Table 4 Options

Item	P/N	Option name	Function
Display & Software	SST003-04-01	Remote single-axis inclination display instrument	LED display tilt angle data, range setup, sensor power supply, RS485 output, suitable for analog output single-axis inclinometer
	SST003-04-02	Remote dual-axis inclination display instrument	LED display tilt angle data, range setup, sensor power supply, RS485 output, suitable for analog output dual-axis inclinometer
	SST003-04-03	Remote single-axis inclination display & Control instrument	Alarm settings (2 points/axis), relay output, LED display, sensor power supply, RS485 output, suitable for analog output, single-axis inclinometer
	SST003-04-04	Remote dual-axis inclination display & Control instrument	alarm setting (2 points/axis), relay output, LED display, sensor power supply, RS485 output, suitable for analog output dual-axis tilt sensors
	SST003-04-05	LCD display	4½ LCD display, single/dual axis
	SST003-04-06	Zigbee LCD display	External power supply, with AC/DC regulator, single/dual axis, 200m distance
	SST003-04-07	Zigbee LCD display	Built-in lithium battery to 8 hours supply, single/dual axis, 200m distance
	SST003-04-08	Zigbee LCD display/alarm	Built-in lithium battery to 8 hours supply, single/dual axis, sound/light alarm, emergency alarm can be set up, 200m distance
	SST003-04-09	Application software with PC	Functions: serial port setting, control, diagnose, record, adjustable sampling, zero setting and zero recovery, adjustable vibration suppression filter parameters
	SST003-04-10	Application software	The same function as SST003-04-09, can run in iPhone, iPad
	SST003-04-11	Three-dimensional angle display, measurement software	Can cooperate with inclinometer, which including compass, gyro, GPS, and also can run in iPhone, iPad, PC
	SST003-04-12	Display software with 8 channels	Can combined with SST003-04-09, each channel can achieve independence, can run in iPhone, iPad, PC
	SST003-04-13	Flatness measuring software	Measure and display the surface flatness of object, can run in iPhone, iPad, PC
	SST003-04-14	Verticality measuring software	Through multiple of sensors, to realize the whole object`s vertical degree measurement and display, can run in iPhone, iPad, PC

Converter	SST003-05-01	RS232-USB converter	RS232 convert to USB2.0,external ,industrial-grade
	SST003-05-02	RS232-CAN converter	RS232 convert to CAN2.0B,external, industrial-grade
	SST003-05-03	RS232-GPRS converter	RS232 convert to GPRS Wi-Fi transmission, external ,industrial-grade
	SST003-05-04	4 in1 USB converter	4pcs USB access,1 USB output,external, industrial-grade
	SST003-05-05	4 in 1 RS232 converter	4pcs RS232 access,1 USB output,external, industrial-grade
	SST003-05-06	4 channels hub	Suitable for concentrated power supply and wiring distribution,IP65 protection,glass fiber materials,industrial field application
	SST003-05-07	8 channels hub	Suitable for concentrated power supply and wiring distribution,IP65 protection,glass fiber materials,industrial field application
	SST003-05-08	8 channels analog/digital signal data collection box	16 or 24 bits acquisition module, work independently, USB interface, can be connected with PC, etc
Installation tools	SST003-01-01	Magnetic base	50kg suction, permanent magnet, stainless steel materials
	SST003-01-02	Adjustable base	Three-points adjustment, range $\pm 3^\circ$ , stainless steel materials
	SST003-01-03	Adjustable base with bubble	Three-points adjustment, range $\pm 3^\circ$ , bubble accuracy is $\pm 20''$ , stainless steel materials
	SST003-01-04	Adjustable base with micrometer screw	Three-points adjustment, resolution 0.001mm, stainless steel materials
	SST003-01-05	Fixed installation base	Three-points adjustment, stainless steel materials
	SST003-01-06	Alignment block	Positioning sensor's X\Y axis to align with actual tilt direction
Power	SST003-09-01	AC/DC power supply	Input 220VAC,output 24VDC,output current 2A
	SST003-09-02	The portable rechargeable lithium battery packs	Output 24VDC,Continuous work 24 hours, IP65, rechargeable
	SST003-09-03	Complementary power combined with solar and wind energy	solar and wind energy,output 24VDC@1A, Day & night working
Calibration equipment	SST003-10-01	Field calibration equipment	Mechanical, manual, accuracy $\pm 20''$ , measurement range $\pm 5^\circ$ , single axis
	SST003-10-02	Field calibration equipment	Mechanical, manual, accuracy $\pm 30''$ , measurement range $\pm 30^\circ$ , single axis
	SST003-10-03	High accuracy calibration equipment for lab	Manual, with LED display, accuracy $\pm 5''$ , resolution 0.5", measurement range $\pm 180^\circ$ , single axis, weight 20 kg
	SST003-10-04	Cross-axis test equipment	Mechanical, manual, accuracy $\pm 30''$ , measurement range $\pm 15^\circ$
	SST003-10-05	Adjustable field level platform	Mechanical, manual, 3kgs payload ,level accuracy $\pm 10''$ , adjustable range(X/Y) $\pm 1^\circ$
Test report	SST003-11-01	Test report for cross-axis error	Accuracy test report under banking tilt, average 11 points of full range
	SST003-11-02	Test report for Allowed installation	Average 21 points of full range
	SST003-11-03	Test report for Input-axis misalignment	Axis migration test report for vertical and horizontal axis of inclinometer, 3 angles of point
	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 sensor`s standard vibration characteristic
	SST003-11-06	Test report for mechanical shock	According to sensor`s standard shock characteristic
	SST003-11-07	Test report for temperature shock	Test report of characteristics change under $10^\circ\text{C}$ /minute rate
	SST003-11-08	MTBF analysis report	MTBF Statistical analysis report
	SST003-11-09	FMEA analysis report	FMEA analysis report
	SST003-11-10	Test report for life simulation	Test report for zero position and full range under 7 days continuously power on
	SST003-11-11	Test report for high-low temperature storage	According to MIL standard (meet MIL-810F 501.4, 502.4)
	SST003-11-12	Test report by China National Shanghai Measurement institute	Average 5 points of full range
	SST003-11-13	Test report for salt spray	According to MIL standard(meet MIL-810F 509.4)
	SST003-11-14	Test report for IP protection	According to IEC standard
	SST003-11-15	EMC test report	According to EN6000

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