

SSL300 High-Performance 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
- Carried 50 industry & military standards
- Principle of MEMS accelerometer



Description

SSL300 inclinometer is an excellent tilt device which not only has outstanding performance, but also has 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 is performed with LT'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, are developed to reduce additional error caused by filed installation, and realize care-free installation and accurate data acquisition.

Applications

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|--------------------|-------------------------|----------------------|----------------------|
| - Vessel | - Precision instruments | - Security detection | - Civil engineering |
| - Military project | - Platform leveling | - Drilling machines | - Hydraulic leveling |

Carried Standards

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|---|----------------------|----------------------|
| - 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 Specification

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°
Subroutine parameter	Absolute linearity (LSF,%FS)	±0.06	±0.03	±0.03	±0.03	±0.02	±0.02
	Cross-axis sensitivity ^②	±0.1%FS					
	Offset ^③	±0.005°				±0.008°	
	Repeatability	±0.0025°					
	Hysteresis	±0.0025°					
Input axis misalignment ^④		±4.0°	±3.0°	±2.5°	±1.5°	±1.2°	±1.2°
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 axis or 2 axis					
Temperature sensor		Range: -50~125°C ,Accuracy:±1°C					
Output		RS232 (optional G1~G23, please refer to accessories)					
RS232 data format		115200 baud rate, 8 data bits, 1 start bit, 1 stop bit, none parity					
Cold start warming time		60s					
Response time ^⑦		0.3s(@t ₉₀)					
Refresh rate(digital output)		5Hz(optional 10Hz,20Hz)					
Response frequency ^⑧ (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 and GBT17626					
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 composite value of sensor's absolute linearity, repeatability, hysteresis, offset and cross-axis sensitivity error. (in room temperature condition) as

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

② The cross-axis sensitivity error 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. SSL300'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 SSL300 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 Input axis misalignment means during the installation, the allowable installation angle deviation between actual tilt direction and sensor's nature measurement direction. In general, when installed,SSL300 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.

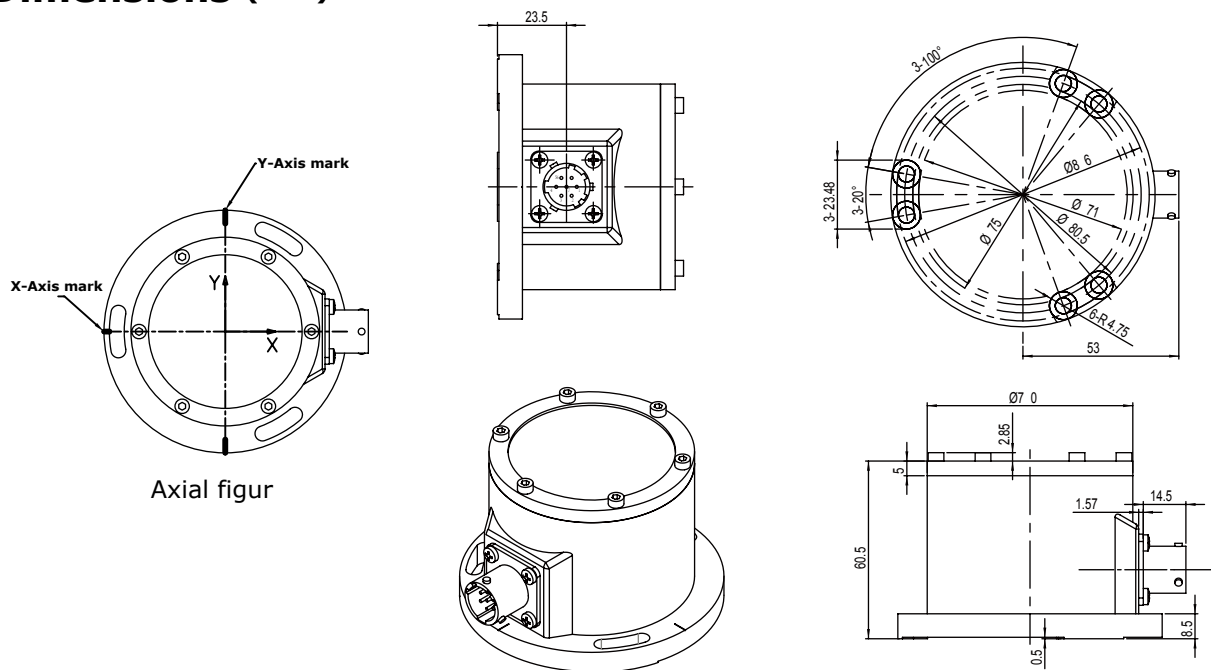
⑤ Offset turn on repeatability means the repeatability of the sensor in repeated by supply power on-off-on many times.

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

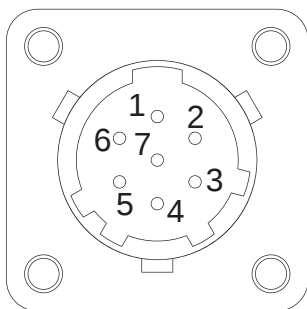
⑧ Response frequency is for the limitation of the dynamic measurement range, when the dynamic measurement exceeds 3 Hz, because of centripetal force, the output occupied additional random error,this error is difficult to defin

Dimensions (mm)



Picture 1 Housing with MIL class connector

Wiring

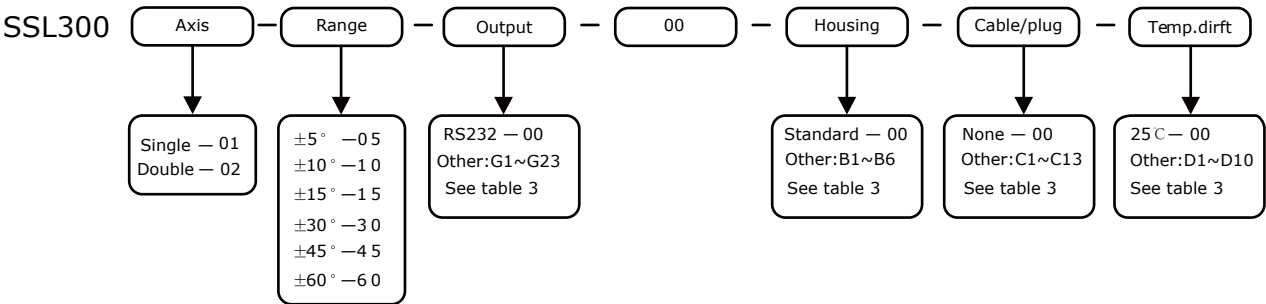


Picture 2 MIL connector socket
(View from outside)

Table 2 MIL connector socket pin definition

Socket Pin	RS232 Output
1	Power+
2	Power-
3	Signal GND
4	NC
5	NC
6	RS232-TXD
7	RS232-RXD

Ordering information



For example, if order a dual-axis inclinometer, with range $\pm 15^\circ$, $\pm 0.02^\circ$ accuracy@-20~60°C, output Wi-Fi wireless transmission, two meters cable with plug, the model should be chosen as: SSL302-15-G12-00-00-C1-D3.

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
	G7	Profi-bus output	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
	G12	Wi-Fi interface	Standard industrial interface
	G13	GPRS interface	Standard 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
Housing	B1	Transient high temperature isolation housing	Withstand impact temperature up to 1200°C within 5 minutes' duration
	B2	Underwater housing	5~3000m 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 SSL300 outlet, manufactured by Amphenol
	C8	Corners plug	90° corner,according to MIL-C-26482,IP67 protection
	C9	Explosion proof connectors and cables	For SSL30X-XX-XXX-00-B5-C9-XX only
	C10	Pigtail connector	Only for beam tilt sensor SSL301-XX-XXX-XX - B4-C10-XX
	C11	USB cable	For SSL30X-XX-G10-00-00-C11-XX only, one end is MIL connector, the other end is USB port.
	C12	Ethernet cable	For SSL30X-XX-G9-00-B5-C12-XX only, one end is MIL connector, the other end is RJ45
	C13	CAN/CANopen cable	Military class connector, standard 2M long, DB-9 interface at the other end, IP67 protection, anti 30KG pull
Temperature drift	D1	Temperature drift	Temperature compensation range is 0~60°C , and temperature drift accuracy $\pm 0.01^{\circ}$ @ $\pm 30^{\circ}$
	D2	Temperature drift	Temperature compensation range is 0~60°C , and temperature drift accuracy $\pm 0.01^{\circ}$ @ $>\pm 30^{\circ}$
	D3	Temperature drift	Temperature compensation range is -20~60°C , and temperature drift accuracy $\pm 0.02^{\circ}$ @ $\pm 30^{\circ}$
	D4	Temperature drift	Temperature compensation range is -20~60°C , and temperature drift accuracy $\pm 0.02^{\circ}$ @ $>\pm 30^{\circ}$
	D5	Temperature drift	Temperature compensation range is -30~60°C , and temperature drift accuracy $\pm 0.03^{\circ}$ @ $\pm 30^{\circ}$
	D6	Temperature drift	Temperature compensation range is -30~60°C , and temperature drift accuracy $\pm 0.03^{\circ}$ @ $>\pm 30^{\circ}$
	D7	Temperature drift	Temperature compensation range is -40~65°C , and temperature drift accuracy $\pm 0.05^{\circ}$ @ $\pm 30^{\circ}$
	D8	Temperature drift	Temperature compensation range is -40~65°C , and temperature drift accuracy $\pm 0.05^{\circ}$ @ $>\pm 30^{\circ}$
	D9	Temperature drift	Temperature compensation range is -40~85°C , and temperature drift accuracy $\pm 0.05^{\circ}$ @ $\pm 30^{\circ}$
	D10	Temperature drift	Temperature compensation range is -40~85°C , and temperature drift accuracy $\pm 0.05^{\circ}$ @ $>\pm 30^{\circ}$