FFT Inclinometer

SST300 Inclinometer

Range: ±15°
Output:RS232
Supply:9~36VDC
Protection IP67

CE RoHS

Vigor Technology

C4504C615R

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Vigor Technology

FFT Inclinometer

Features

- Simultaneously measuring inclination and vibration value,
  can be real-time and post-processing
- Tri-axis 0~±20g vibration detection, frequency response ≤5 kHz
- Programmable filter, 11 rate settings
- Real-time FFT, 512 points
- Programmable FFT averaging, programmable alarms,
  6 spectral bands
- Can inhibit vibration acceleration interference
- Patented real high accuracy inclination measuring
- Highest combined absolute accuracy ±0.01°@25℃
- Customizable all kinds of low-frequency vibration tilt
  products

Descriptions

FFT inclinometer solves attitude detection which affect by strong vibration interfere, output stable & accurate roll/pitch tilt angle. This device made FFT vibration analysis on three-axis in-time, such as time domain & frequency domain signal analysis, real time data collection, etc. To improve the platform leveling efficient while motor/hydraulic device running, also suit for static /dynamic measuring.

Most moving or rotating equipment (such as motor) will produce acceleration/vibration, this noise produced by vibration and movement, will disturb real inclination measuring. Due to this random vibration and vibra directions can not perpendicular to inclinometer sensitive axis, will produce larger cross-axis error. Especially inclinometer cross-axis sensitivity around 3%, the error should be very larger to about 5 degree or more.

On the market, most inclinometer is based on MEMS capacitance acceleration principle. This product has higher sensitivity with vibration; so that it is difficult to perform high measurement accuracy with internal hardware/software filtering technology. Also electrolyte principle tilt sensor can not avoid the influence from low frequency vibration noise. So should consider the influence of vibration to get higher accuracy tilt angle value in vibration environment.
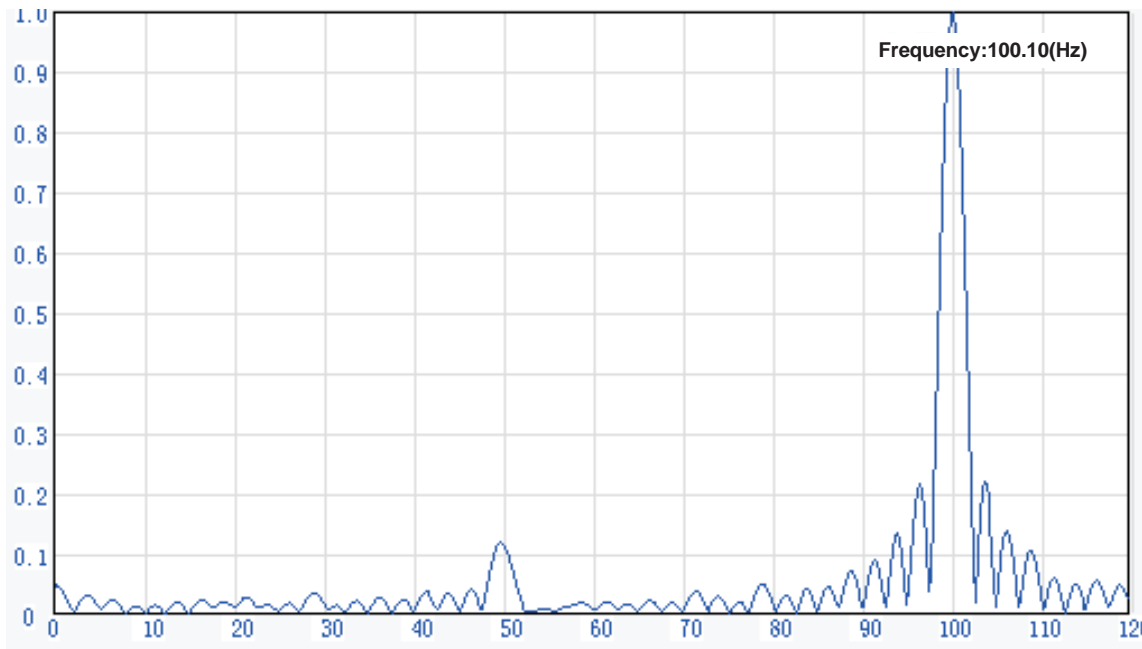
In order to ensure coincidence between inclination direction and vibration direction during measuring process, vigor adopts special assembly technology to realize very high axis alignment and orthogonal between tilt measuring axis and X/Y/Z vibration axis, to ensure vibration data has greatest confidential.

FFT inclinometer combines vibration analysis function with advanced time domain and frequency domain signal processing, real time data collection& alarms and storage. Time domain signal processing includes a programmable binary filter and selectable windowing function. Frequency domain processing includes a 512-point, real-valued FFT for each axis, along with FFT averaging. FFT system offers users the ability to work ordering starting up FFT mode, auto FFT mode, ordering starting up time domain capture mode, real time mode, etc., meanwhile can configure vibration measurement bandwidth and alarm points.

√ Tri-axis vibration range adjustable from 0g to ±1g/±5g/±10g/±20g, response frequency≤5 kHz

√ Real-time sample rate 20.48kSPS, provide timing trigger and external trigger, programmable filter
   11 rate settings

√ FFT function, 512-point, real valued, all three axes (x, y, z), 3 windowing options: rectangular,
   Hanning, flat top

√ Programmable alarms, 6 spectral bands, dual alarm settings (warning and failure), response time
   (adjustable)

FFT inclinometer except output real-time original vibration acceleration and FFT data, furthermore has strong tilt measuring ability:

√ ±0.02%FS
√ ±0.005°Offset
√ Combine with gyro module, realize static/dynamic angle measuring for low/rapid leveling
√ 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 precision 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 direction
√ Additional to short-circuit, transient voltage and transposition protection to adapt to industry environment
√ User can set zero point, baud rate, local gravitational acceleration value, zero calibration, vibration suppression filter coefficients, ID address, refresh rate, etc.

Frequency:100.10(Hz)

Applications

Railway track inspection instrument, Construction machinery, Mining machinery, Agricultural machinery, Train control, Test equipment, Movement or rotational vibration occasions

Performances

Table 1 Specifications

Inclination specifications							
Measurement range		±5°	±10°	±15°	±30°	±45°	±60°
Combined absolute accuracy① (@25℃)		±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 sensitivity②	±0.1%FS					
	Offset③	±0.005°			±0.008°		
	Repeatability	±0.0025°					
	Hysteresis	±0.0025°					
Allowed installation misalignment④		±4.0°	±3.0°	±2.5°	±1.5°	±1.2°	±1.2°
Input-axis mislignment		≤±0.1°					
Sensitivity temperature drift coefficient(max.)		≤100ppm/℃	≤50ppm/℃				
Offset temperature drift coefficient(max.)		≤0.003°/℃					
Offset turn on repeatability⑤		±0.008°					
Resolution		0.0025°					
Long-term stability(1 year)		≤0.02°					
Measurement axis		1 or 2 axis					
Cold start warming time		60s					
Vibration specifications							
Frequency range ±5%		0~5kHz					
Resonance frequency		5.5kHz					
Measurement range		0g/±1g/±5g/±10g/±20g, adjustable					
Nonlinearity		0.2%					
Measurement axis		Tri-axis (X/Y/Z)					
Cross-axis sensitivity		2.6%					
Noise density		0.248mg/√Hz					
Bandwidth		10Hz~10.240kHz, adjustable					
FFT analysis		512 points					
FFT data storage		14-groups (X/Y/Z)					
Real-time sample rate		20.48kSPS					
Vibration acceleration resolution		0.16mg(best)					
Recovery time		54ms					
Maximum overload		2000g					
Misalignment		0.5°					
General specifications							
Output data		FFT data, X/Y/Z vibration acceleration value, X/Y tilt angle value					
Output		CAN, RS232, RS485, RS422, Ethernet					
Power supply		9~36VDC					
Power consumption		Average working current≤120Ma(25℃&24VDC)					
Operation temperature range		-40~85℃					
Storage temperature range		-60~100℃					
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(MIL-C-26482)					
Weight		600g(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

$$\Delta = \pm\sqrt{\text{absolute linearity}^2 + \text{repeatability}^2 + \text{hysteresis}^2 + \text{offset}^2 + \text{cross-axis sensitivity error}^2}$$
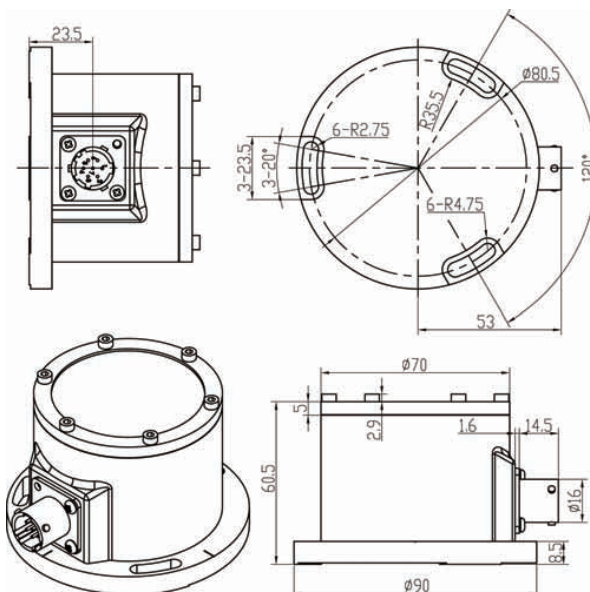
② The cross-axis sensitivity means the angle that the tilt sensor may be banked to the normal tilt direction of sensor. The cross-axis sensitivity (±0.1%FS) shows how much perpendicular acceleration or inclination is coupled to the inclinometer output signal. For example, for the single-axis inclinometer 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.
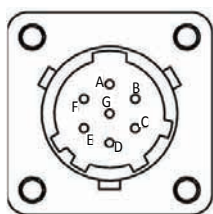
⑤ Offset turn on repeatability means the repeatability of the sensor in repeated by supply power on-off-on many times.

Dimensions (mm)

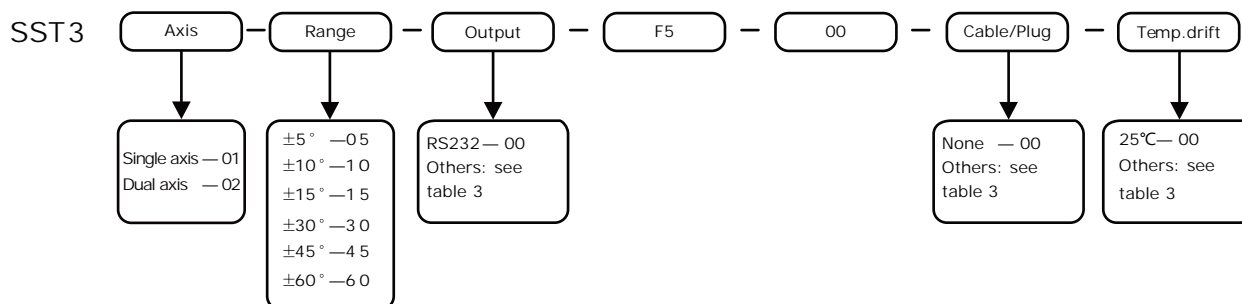Picture 1 Housing with MIL class connector

Wiring

Picture2 MIL connector socket (View from outside)

Table 2 Pin definition

Pin	CAN(G3)	RS232(00)	RS422(G2)	RS485(G1)	Ethernet(G9)
A	Power+	Power+	Power+	Power+	Power+
B	Power GND	Power GND	Power GND	Power GND	Power GND
C	Signal GND	Signal GND	Signal GND	Signal GND	Shield GND
D	CAN-H	NC	RXD+	NC	E-RXD+
E	CAN-L	NC	RXD-	NC	E-RXD-
F	NC	TXD	TXD+	RS485-A	E-TXD+
G	NC	RXD	TXD-	RS485-B	E-TXD-

Ordering

SST3

Axis	—	Range	—	Output	—	F5	—	00	—	Cable/Plug	—	Temp.drift

Axis:
Single axis — 01
Dual axis — 02

Range:
±5° —0 5
±10° —1 0
±15° —1 5
±30° —3 0
±45° —4 5
±60° —6 0

Output:
RS232— 00
Others: see table 3

Cable/Plug:
None — 00
Others: see table 3

Temp.drift:
25℃— 00
Others: see table 3

For example, if order a dual axis FFT inclinometer, with range ±30°, room temperature accuracy ±0.02°, -20~60℃ accuracy ±0.02°, output CAN2.0, 5 meters cable with plug，vibration function module, the model should be chosen as: SST302-30-G3-F5 -00-C1-D3 (5m)
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 output	Angle data output Data format: ASCII, 115200 baud (adjustable), 8 data bits, 1 start bit, 1 stop bit, none parity
	G1	RS485 output	Isolated, Compatible with half-duplex or full-duplex communication ±15kV ESD protection Compatible with ANSI/TIA/EIA-485-A-98 and ISO8482:1987(E) Comply with UL1577---2500V rms for 1min
	G2	RS422 output	Transmission rate up to 500 kbps, support max 256pcs nodes High common mode transient suppression ability >25kV/us Supports Modbus-RTU, sensor supply HEX or ASCII communication
	G3	CAN	According to ISO11898-2 standard, twisted-pair output CAN2.0A,CAN2.0B protocol Built-in high-speed optoelectronic isolation 5k~1 MBit/s, 15 kinds of CiA recommended Baud rate Longest transmitting distance achieves 10 Km
	G9	Ethernet	10/100M, Ethernet interface self-adaption AUTO MDI/MDIX available, use either cross-ruling or parallel cable Baud rate is adjustable in 300bps~230.4Kbps Kinds of operating model, TCP Server, TCP Client, UDP and Real COM driver, etc. Automatically connection after network disconnect Support DNS, satisfy the communication needs by domain name UDP mode support single or multiple machine communication POE power supply device available
Temperature drift	D1	Temperature drift	Temperature compensation range 0~60℃, accuracy ±0.01°@≤±30°
	D2	Temperature drift	Temperature compensation range 0~60℃, accuracy ±0.01°@>±30°
	D3	Temperature drift	Temperature compensation range -20~60℃, accuracy ±0.02°@≤±30°
	D4	Temperature drift	Temperature compensation range -20~60℃, accuracy ±0.02°@>±30°
	D5	Temperature drift	Temperature compensation range -30~60℃, accuracy ±0.03°@≤±30°
	D6	Temperature drift	Temperature compensation range -30~60℃, accuracy ±0.03°@>±30°
	D7	Temperature drift	Temperature compensation range -40~65℃, accuracy ±0.05°@≤±30°
	D8	Temperature drift	Temperature compensation range -40~65℃, accuracy ±0.05°@>±30°
	D9	Temperature drift	Temperature compensation range -40~85℃, accuracy ±0.05°@≤±30°
	D10	Temperature drift	Temperature compensation range -40~85℃, 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
	C12	Ethernet cable with pug	Military class connector , standard 2m cable, RJ-45 port, IP67 protection, heavy duty up to 30kg
	C13	CAN/CANOPEN cable with plug	Military class connector , standard 2m cable, CAN/CANOPEN special cable, DB-9 port, IP67 protection, heavy duty up to 30kg

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	SST003-09-04	POE power supply	802.3af standard: PI(Power interface: PSE/PD network cable interface);Alternative A(1,2,3,6,singal line) and Alternative B(4,5,7,8, free line)power type
Test report	SST003-11-01	Test report for cross-axis error	Accuracy test report under banking tilt, average 11 points of full range
	SST003-11-03	Test report for Allowed Installation 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℃ /minute rate