EDGE DEVICES - WIRELESS SENSORS

Tilt90

LS-G6-TIL90-X / LS-G6-TIL90-I

LS-G6-TIL90-X
Tilt90 with an external antenna

LS-G6-TIL90-I
Tilt90 with an internal antenna

Tiltmeters for monitoring applications provide measurements of changes from the vertical level, either on the ground or in structures. This makes them key sensors to monitor inclinations, movements and differential settlements of slopes or infrastructures.

For example they can be applied to vertical structures as columns, piers, pylons, facades or retaining walls to track the changes in inclinations and detect differential settlement; or they can be installed to verify over time the geometry and stability of tunnels, railway tracks (cant, twist and vertical alignment) or bridges decks.

Tiltmeters have been as well extensively used in landslides, embankments and mines monitoring to control the stability of the slopes.

Variants

The Tilt90 wireless sensors are now available with an external antenna for full range capabilities or with an internal antenna for applications as railway tracks where it's important to minimise the potential risk for external parts.

Measure tilt from different angles

The Tilt90 has an extremely accurate tri-axis sensor with an extended range of up to 90 degrees. This provides additional flexibility and multiple orientation options during installation.

Long-range and low-power

The Tilt90s is capable of transmitting data via long-range radio to a gateway up to 15 km/9 miles aways. It is also extremely low power and robust and can operate for several years unattended relying solely on the replaceable internal batteries.

Easy and Efficient Network Management

One Worldsensing Gateway can support hundreds of Worldsensing edge devices in the same network that are also measuring other sensors installed in the monitoring sections. Worldsensing edge devices can also be easily configured and connected with a USB cable and an Android phone. The device network can also be easily managed through the Connectivity Management Tool.

FEATURES

Wireless sensor. An integrated unit (2-in-1 sensor + data logger).
3-axis inclination with respect to gravity's direction and a range of ± 90º
Long-range communications (up to 15km / 9 miles).
Long battery life (> 10 years @ 1h / 6h sampling rate).
High accuracy and repeatability.
Reduced size (103x100x61 mm, internal antenna version).
Two versions available - external and internal antenna.
Robust, small and weather-proof box.
Easy configuration.

APPLICATIONS

Railway track monitoring.
Building response to tunneling and excavation-induced ground movements.
Foundations and deep excavations.
Landslides and slope stability.
Bridge and structural health monitoring.
Embankments.

Main specifications

TILTMETER

Type	Tilt angle calculated from 3-Axis MEMS Accelerometer	
Range[2]	±90°	
Axes	3-axis inclination measurement with respect to gravity's direction. Reports the two axes of rotation from the horizontal plane in any orientation	
Node	**LS-G6-TIL90-X**	**LS-G6-TIL90-I**
Accuracy within ± 2º	± 0.0025°	± 0.0045°
Accuracy within ± 4º	± 0.005°	± 0.006°
Accuracy within ± 15º	± 0.013°	± 0.013°
Accuracy within ± 45º	± 0.08°	± 0.08°
Accuracy within ± 85º	± 0.23°	± 0.23°
Resolution	0.0001°	0.0001°
Repeatability	<0.0003°	<0.0015°
Offset Temperature dependency	± 0.002°/°C	± 0.005°/°C
Stability @ 14 h	<0.003°	<0.010°
Time required for a reading	9.6 s	
Measure of dispersion	Standard deviation of the set of measurements collected during the reading and transmitted with each tilt measurement. It can be used to filter noisy data.	
Temperature sensor resolution	0.1 ºC	
Temperature sensor accuracy	±0.5 ºC	

BATTERIES

	Sampling Rate	**Barcelona** temperature profile	**Singapore** temperature profile
Battery life estimation[1]	30 s	4.8 months	4.5 months
	5 min	3.3 years	3 years
	1 h / 6 h	>10 years	>10 years
Battery type	2 x 3.6V C-Size user replaceable high energy density batteries (recommended Saft LSH 14)		
Sampling rate	30 s to 1 d		

1 Typical Europe radio configuration. Spreading factor 9, radio transmit power 14dBm; considering Barcelona and Singapore temperature profiles; consumption varies depending on sampling rate and environmental and wireless network conditions. Estimations for Saft LSH 14 batteries based on the life time mathematical model.

2 The recommended measuring range is ±85°. Outside of this range, the margin of error increases. However, when one of the axes is close to 90°, the other axis will be close to 0° and measuring the same inclination.

MEMORY - CIRCULAR BUFFER STRUCTURE

Memory records: Up to 140 000 readings including time and 3 axes.

MECHANICAL

Node	**LS-G6-TIL90-X**	**LS-G6-TIL90-I**
Box dimensions (WxLxH)	100x100x61 mm	100x100x61 mm
Overall dimensions	150x120x61 mm (excluding antenna)	103x100x61 mm
Operating temperature	-40 °C to 80 °C (-40 °F to 175 °F)	
Weather protection	IP68 (at 2 m for 2 h)	
Weight (excluding batteries)	606 g	390 g
Antenna	External: 100 mm length (including connector)	Internal
Mounting options	Clearance holes for M4 hexagon socket head cap screws in bottom. Blind holes for M5 screws on the lateral side.	
Configuration	Internal mini USB.	
Box material	Aluminium alloy	Aluminium alloy
Lid material	Aluminium alloy	Polycarbonate
Batteries	from 1 up to 2	
Vibration resistance	Do not subject the device to accelerations that exceed higher levels of accelerations than ±8g For higher levels we recommend to use the LS-G6-TIL90-I	Do not subject the device to accelerations that exceed higher levels of accelerations than ±80g Test: random vibration test railroad profile according to level C.2 (on sleeper) of EN 50125-3:2003 CORR:2010 standard and methodology of EN 60068-2-64:2008 standard
Impact resistance[3]	Drop from 1 meter onto a concrete surface (20 000g)	

CONNECTIVITY

Web browser software
CMT Edge - from version 2.5 onwards
CMT Cloud - from version 1.4.0 onwards
Standard CSV download, FTP push, Modbus TCP, MQTT[4] and API access.

Works with the new Worldsensing Android app. To download, paste this link in your browser https://info.worldsensing.com/mobileapp.

[3] The tiltmeter has good impact resistance. However it should be treated carefully like any precision instrument.
[4] MQTT available upon request

RADIO

Radio band	ISM sub 1GHz
Operating frequency bands	Ajustable
Bidirectional communications	Remote sampling rate change / Clock synchronization
Maximum link budget	151 dB / 157 dB
Configuration	Star (no repeaters needed)

Radio range[5]

	Antena Externa (LS-G6-TIL90-X)	Antena Interna (LS-G6-TIL90-I)
Open sight	15 km	10 km
City street	4 km	2 km
Manhole in a city street	2 km	1 km
Tunnel	4 km	2 km

ACCESSORIES[6]

LS-ACC-IN15-VP	Mounting plate for vertical mounting; attachment option: anchor rods.
LS-ACC-IN15-HP	Versatile plate for horizontal surface mounting; attachment option: anchor rods or glue; includes a threaded hole available for installing a monitoring prism or a button head screw for precise levelling.
LS-ACC-IN-HPTM	Horizontal surface mounting plate for track monitoring; attachment option: glue.
LS-ACC-IN15DP	Versatile double plate for horizontal surface mounting; suitable for applications that need to eliminate the need to open the casing during installation; attachment option: glue; includes a threaded hole available for installing a monitoring prism or a button head screw for precise levelling.
LS-ACC-ANC-H[7]	Kit of 3 anchor rods for injection M8, 110 mm length. Nuts and washers included.
LS-ACC-ANTC	Antenna cable extension RP-SMA to RP-N, 2.5 m, compatible with Edge devices.
LS-ACC-CELL-1C	Saft LSH 14 C-size spiral cell (5.8 Ah).
LS-ACC-MAG8	Kit of 3 magnets, Ø 32 mm, strength approx. 30 kg, screws included.

[5] The distances have been tested by Worldsensing and have been accomplished in actual projects using the standard antenna. However, radio range depends on the environment so these distances are only indicative. Consult with us for your application.
[6] Other mounting brackets and accessories available upon request. Magnetic mounting options undergoing development.
[7] The kit can be used to fix the following mounting kits: LS-ACC-IN15-HP, LS-ACC-IN15-VP, LS-ACC-LAS-AP, LS-ACC-LAS-SB.
[8] The kit of 3 magnets can be used to fix the LS-ACC-IN15-VP mounting plate. Only available within Europe.

An inner view of the Tilt90s.
The nodes are autonomous battery-powered devices with C-size batteries that can last several years with minimal to zero maintenance required.

Tilt90-x mounted on a vertical mounting plate (LS-ACC-IN15-VP) for wall mounting.

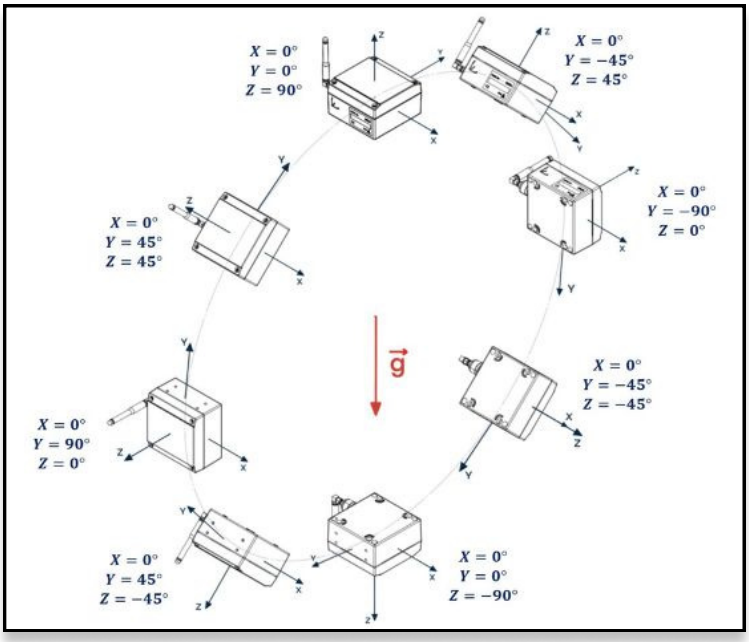
The Tilt90s mounted on a versatile horizontal surface mounting plate (LS-ACC-IN15-HP). The plate has three clearance holes for M8 anchor rods and an M8 threaded hole available for installing a monitoring prism or a button head screw for precise levelling.

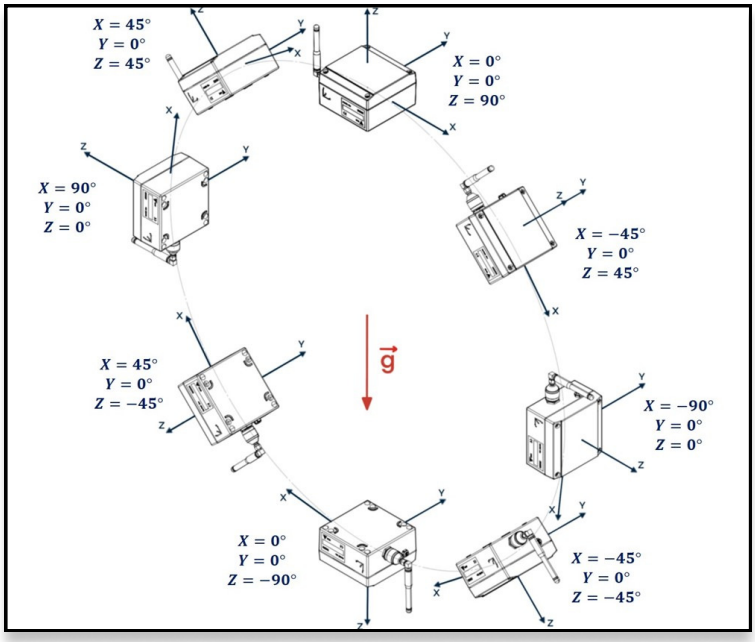
The Tilt90-i with the LS-ACC-IN-HPTM horizontal surface mounting plate for track monitoring.

SERVICES

WS-S-TILT-CAL	Wireless Tiltmeter Recalibration Service. Includes the replacement of the screws and the verification of the different mechanical elements. Shipment to and from Worldsensing warehouse excluded.
WS-S-PRECON-SEN	Device Pre-configuration (Wireless Sensors)

Installation orientation options based on the x, y and z axes





Tilt90-x mounted on a vertical mounting plate (LS-ACC-IN15-VP) for wall mounting through the magnets (LS-ACC-MAG).

The Tilt90-i mounted on a double plate for horizontal surface mounting (LS-ACC-IN15DP). This is suitable for applications that need avoid opening the casing during installation. The plate includes a threaded hole available for installing a monitoring prism or a button head screw for precise levelling.