



EDGE DEVICES - WIRELESS SENSORS

Biaxial Inclinometer

DP89KWL-X/DP89KWL-I

Dustin Partners Biaxial Inclinometer is a 3-axis wireless inclinometer designed to 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.

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

The sensor is capable of transmitting data via long-range radio to a gateway connected to the Internet up to 9 miles/ 15 km. away.



One data logger can also support hundreds of sensors in the same network, depending on the reporting period, through a star or tree network topology.

In terms of energy consumption, Dustin's inclinometer is an autonomous battery-powered device with C-size advanced chemistry batteries that can last up to 10 years with minimal to zero maintenance required. It is IP68 certified and tested from -40C to +80C.

FEATURES
Wireless 2-1 sensor with logging capability.
3-axis inclination with respect to gravity's direction and a range of $\pm 90^\circ$.
Standard deviation transmitted with each tilt measurement to enable noisy data filtering.
Robust, compact design and IP68 grade weather-proof box.
Long battery life (>17 years @1h sampling rate).
Two versions available - external and internal antenna.
Long range communications through LoRa communications.
SOFTWARE
User-friendly Android configuration app included.
Web browser software for network, device and data management.
Single-logger network setup with Edge software. Dataserver and radio server hosted in the gateway and data access through standard CSV downloads, FTP push, Modbus TCP, API REST and MQTT ¹).
Multi-device network setup with Cloud software and advanced features with data access via standard CSV downloads, FTP push, API REST and MQTT push ¹ .

¹ MQTT available upon request.

APPLICATIONS
STRUCTURAL HEALTH
Cant, twist and vertical alignment in rail track monitoring
Static deflections of piles, piers and decks of bridges and other structures
GEOTECHNICAL MONITORING
Slope movements in landslides, embankments
Ground movements in foundations and deep excavations

ADVANTAGES
High precision due to individual device calibration.
Very low maintenance equipment due to its robustness and low-power consumption.
Provides complementary data for existing geospatial monitoring when high precision and robustness is needed.
Easy configuration through the Worldsensing mobile application
Customer support from a expert team of geotechnical monitoring
Pioneer company in the field, long history in monitoring large-scale civil infrastructure

TECHNICAL SPECIFICATIONS

GENERAL

Sensor type	3-axis MEMS accelerometer
Reporting Period	Selectable from: 30 s 1, 2, 5, 10, 15, 30 min 1, 2, 4, 6, 12, 24 h
Time synchronization discipline by radio	Better than ± 30 seconds
Battery type	2 x 3.6V C-Size user-replaceable, high energy density batteries
Interfaces	Internal mini USB
Device configuration	OverWatch app
App advanced functionalities	<ul style="list-style-type: none"> Field samples and signal coverage test when connected to the app. Set the previous configuration to quickly configure tiltmeters for installation in the same project. Tiltmeter calibration parameters check using the app.

TILTMETER

Sensor Variants	DP6X16K1WL-X	DP6X16K1WL-I
Antenna	External	Internal
Range ²	$\pm 90^\circ$	
Axes	3-axis inclination measurement with respect to gravity's direction. Reports the two axes of rotation from the horizontal plane in any orientation	
Accuracy $f(\alpha)$		
$\pm 2^\circ$	± 0.0025	$\pm 0.0045^\circ$
$\pm 4^\circ$	± 0.005	$\pm 0.006^\circ$
$\pm 45^\circ$	± 0.08	$\pm 0.08^\circ$
$\pm 80^\circ$	± 0.23	$\pm 0.23^\circ$
$\pm 15^\circ$	± 0.013	$\pm 0.013^\circ$
Resolution	0.0001°	0.0001°
Repeatability	<0.0003°	<0.0015°
Offset Temperature dependency	$\pm 0.002^\circ/\text{°C}$	$\pm 0.005^\circ/\text{°C}$
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 °C	

MECHANICAL

Node	DP6X16K1WL-X	DP6X16K1WL-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	<ul style="list-style-type: none"> 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	up to $\pm 8 g$	Up to $\pm 80 g$ 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)	
MEMORY		
Memory Structure	Circular Buffer	
Maximum Memory Records	140 000 readings including time and 3 axis.	

² The recommended measuring range is $\pm 85^\circ$. 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.

³ The tiltmeter has good impact resistance. However it should be treated carefully like any precision instrument.

RADIO SPECIFICATIONS

Radio band	ISM sub 1GHz	
Operating frequency bands	Adjustable	
Bidirectional communications	Remote sampling rate change / Clock synchronization	
Maximum link budget	151 dB / 157 dB	
Configuration	LoRa Star/ LoRa Tree	
Radio range⁵		
	Antena Externa (DP6X16K1WL-X)	Antena Interna (DP6X16K1WL-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

BATTERY LIFE ESTIMATIONS⁶

Battery Model	LSH14		LM26500	
Number of cells	2 cell		1 cell	2 cells
Reporting Period	30 s	4.8 months	3.1 months	6.2 months
	5 min	3.6 years	2.5 years	5.1 years
	1 h	12.9 years	17.2 years	>25 years
	6h	15.5 years	>25 years	>25 years

⁵ The distances have been tested 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 Typical Europe radio configuration. Spreading factor 9, radio transmit power 14dBm. Considering laboratory conditions. Consumption varies depending on the sampling rate, environmental conditions and wireless network conditions.

Battery life estimations based on the lifetime mathematical model using Barcelona weather profile. Average values provided.

ACCESSORIES⁷

LS-ACC-IN15-VP	Mounting plate for vertical mounting; attachment option: anchor rods.
LS-ACC-IN15-HP	Versatile plate for horizontal surface mounting recommended for both horizontal and vertical 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 ⁸	Kit of 3 anchor rods for injection M8, 110 mm length. Nuts and washers included.
LS-ACC-MAG ⁹	Kit of 3 magnets, Ø 32 mm, strength approx. 30 kg, screws included.
WS-ACC-1BEAM	1m Aluminum beam with specific profile to attach a LS-G6-TIL90.
WS-ACC-2BEAM	2m Aluminum beam with specific profile to attach a LS-G6-TIL90.
WS-ACC-BEAMFIX	Fixation kit for beam accessory mounting. Includes: anchors, brackets and washer assembly.
LS-ACC-CELL-1C	Saft LSH 14 C-size spiral cell 5.8 Ah.
WS-ACC-CELL2-1C	Saft LM26500 C-size spiral cell 7.4Ah.
LS-ACC-ANTC	Antenna cable extension RP-SMA to RP-N, 2.5m.
LS-ACC-MUSB-C	Data logger - mobile cable. USB C to mini USB cable, 1 m. Not compatible with LS-G6-TIL90-I.

SERVICES

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

⁷ Other mounting brackets and accessories available upon request. Magnetic mounting options undergoing development.

⁸ 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.

⁹ The kit of 3 magnets can be used to fix the LS-ACC-IN15-VP mounting plate. Only available in Europe.