DATASHEET

# IN-PLACE INCLINOMETER 3D WITH X-Y-Z

## MODEL EAN-61MS

## INTRODUCTION

Encardio-rite model EAN-61MS in-place 3D inclinometer with settlement (IPIS) system is used wherever lateral movement along with settlement/heave is to be monitored in a borewell or on a structure. It finds wide application in measurement of lateral movement and settlement in soil, earthworks, slopes or structures like retaining/diaphragm walls, embankment, deep foundations or dams etc. It is also very useful in monitoring landslide areas.

## FEATURES

- Complete 3D (X-Y-Z) profile of gage well/borehole
- Reliable, accurate and simple to read
- Probes can be removed, reconfigured and reused at different projects/boreholes
- Rugged and robust construction
- Excellent temperature stability
- Easy connection to compact datalogger with user friendly configuration software.

## APPLICATION

- To accurately measure lateral movement and settlement/heave of embankment fills and landslide areas above dams, highways, earthworks, structures etc.
- To monitor deformation of embankments, retaining walls etc.
- Construction control, stability investigation and monitoring of ground movement caused by tunnel construction or any such excavation.

## OVERVIEW

The EAN-61MS in-place 3D inclinometer with settlement (IPIS) system provides significant quantitative data on magnitude of lateral movement along with settlement or heave and its variations with time. It also provides the pattern of deformation, zones of potential danger and effectiveness of construction control measures undertaken.

Its data logging and real-time monitoring feature helps to provide early warning in case of failures. It also helps in observing behavior of ground movement after construction and indicates potentially dangerous conditions that may adversely affect stability of the structure.

The real advantage of IPIS is that it allows online monitoring of transverse movement as well as settlement using the same borehole. This was not possible until now using presently available instruments.

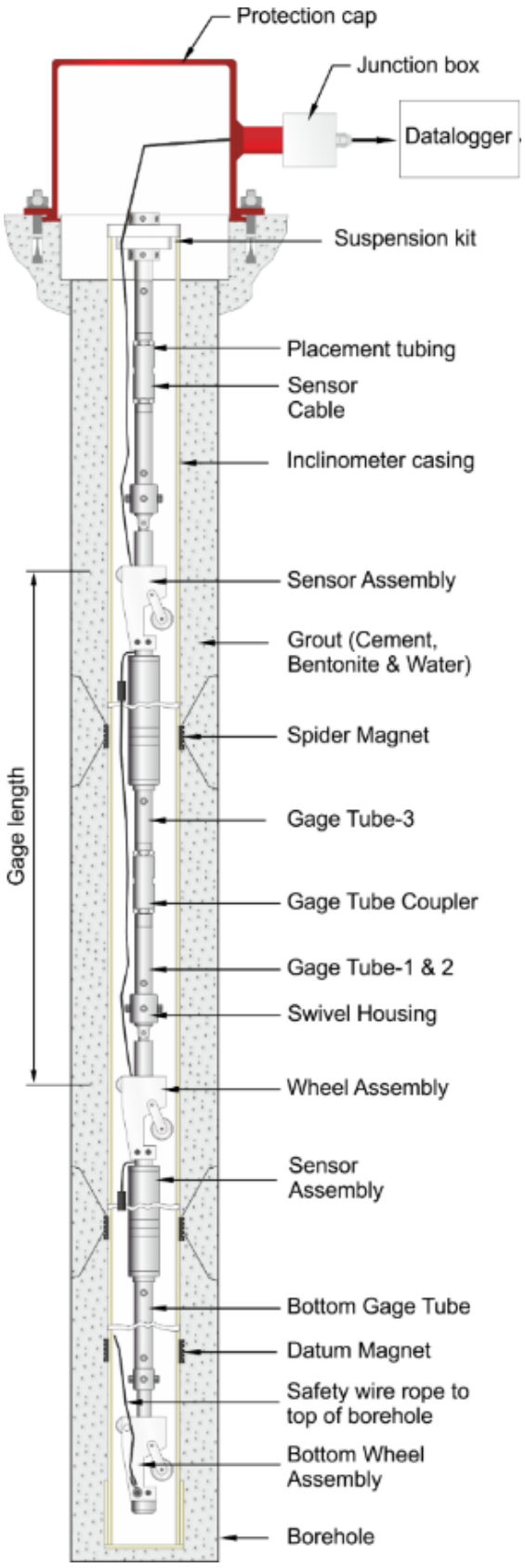
## DESCRIPTION

A series of ABS inclinometer access tubes, attached to each other with telescopic coupling, are installed in a borehole with special magnet rings at desired intervals.

Model EAN-61MS in-place 3D inclinometer with settlement system consists of a string of probes positioned inside the inclinometer casing in a continuous array to span the movement zone. Each probe basically comprises of a high accuracy biaxial MEMS sensor to monitor inclination or lateral movement (X-Y) and a contactless magnetic sensor to monitor settlement or heave (vertical movement-Z), housed in a waterproof stainless steel enclosure.

These sensors measure the tilt and settlement in successive segments to accurately monitor a change in the profile (x-y-z) of the inclinometer casing. Each probe is fitted with a pair of pivoted sprung wheels and is connected to each other through gage tubes (with adjustable lengths), which rests inside the grooves of the inclinometer casing. Length of spacer tubing determines the distance between each sensor i.e. length of each segment over which the tilt is monitored.

Each EAN-61MS/1 sensor has a displacement range of 100 mm to measure expected settlement/heave. It is marked at three locations – two ends and the middle for ease in setting. To position the settlement sensor over the ring magnets, a coarse adjustment of 25 mm / 50 mm / 75 mm and a fine adjustment of 50 mm (± 25 mm) is provided in the gage tube. The gage tube is assembled in parts.




EAN-61MS In-place 3D inclinometer with settlement monitoring system with automatic datalogger (with GSM/GPRS modem)

The digital probes have a great advantage over conventional analog probes. For a string of analog probes, routing of individual sensor cable to the top is a cumbersome, costlier affair. It increases the weight of the whole assembly. This limits the number of sensors to be used in a single borehole.

Thus, where large number of sensors are required, SDI-12 equipped 3D probes are a good choice as it will not be possible to accommodate a large number of individual signal cables inside the borehole.

In our IPIS system, only a single 3 conductor bus cable needs to be threaded in a daisy chain fashion connecting each probe to its next immediate neighbor and finally to the top of the borehole and directly to the datalogger (without any multiplexer).

Although the digital probes with SDI-12 interface are a bit costlier, the savings in cable costs and the cost of the required multiplexers in the datalogger, balances the cost to a large extent.

## MEASUREMENTS

Initially, a magnetic probe is used to record the exact location of the magnets mounted on the casing. The location of probes on the string is adjusted accordingly with the help of threads over expandable gage tubes (depending on whether heave of settlement is expected at installation location).

When subsurface movement in the ground occurs, it displaces the inclinometer casing, causing a change in tilt of the in-place tilt sensors. This results in a change in the output of the sensors, proportional to the tilt i.e. the angle of inclination from vertical.

Simultaneously, if any settlement/heave takes place, it is measured by the position change between the contactless magnetic sensors and the magnet rings fixed outside the inclinometer casing. Settlement/heave of all the sensors is thus determined with respect to a reference, which can be the top of the borewell or a datum magnet that can be installed at the bottom of the borewell casing.

Deformation of casing can be calculated by subtracting initial deviation from current deviation. Provided that one end of the access tubing is known to be fixed, it is possible to obtain a complete profile of the access tubing by summing readings of successive sensors and settlement at the desired levels. By comparing these profiles, the lateral displacement (X-Y) of the gage well along with the settlement (Z) at different depths over a period of time may be determined.

It is advisable to determine initial Northing (X) and Easting (Y) positions of casing top (using prism target with adaptor) and elevation of the pipe top (using a settlement marker) after the casing is set, for future correlation/cross reference. Secondly, it is always advised to take a set of initial readings with manual digital inclinometer system and magnetic probe for future reference.

## SYSTEM COMPONENTS

Following sub-assemblies are available in the Encardio-rite model EAN-61MS 3D in-place inclinometer system:

| | |
|---|---|
| EAN-61MS/1 | 3D probe with SDI-12, with pair of wheels. |
| EAN-61MS/2 | Expandable gage coupler tube; minimum 2 m gage length. 3 m to 5 m gage lengths also available. |
| EAN-61MS/3 | Wheel assembly. |
| EAN-61MS/4 | Suspension kit with protective cap. |
| EAN-61MS/5 | Placement tubing (specify length) for placing string of sensors. |
| EAN-61MS/6 | Protective rope to prevent loss of sensor down hole. |
| EAN-61MS/7 | Suspension stainless steel wire rope for positioning single or group of sensors in specific portion of borehole |
| EAN-61MS/8 | Spider magnet ring |
| EAN-61MS/9 | Datum magnet ring |
| EAN-61MS/10 | Battery pack for supply (15 V) |
| CS-0703 | 6 core cable for in-place sensors without SDI-12 |
| CS-1002 | 3 core SDI-12 bus cable for sensors with SDI-12 card. |
| Casings | For casing refer to datasheet 1064 on model EAN-26M Inclinometer system. |
| EDS-91/2.1 | Magnetic probe with cable reel assembly |

## MODEL ESDL-30 DATALOGGER

The model ESDL-30 datalogger is designed to automatically collect data from digital sensors (with SDI-12 interface). It is of durable construction and suitable for unattended application to provide accurate and reliable data.

The datalogger features wide operating temperature range, low power consumption, compatibility with many

telecommunication options. It can be programmed to take measurements from once every 5 seconds to once every 168 hours in linear mode. The number of measurements taken per day should however be kept to a minimum as higher frequency of measurement drains the battery at a faster rate.

The measured data is stored, together with the current date, time and battery voltage, as a data record in the internal non-volatile memory (2 million data points) of the datalogger.

## DATA RETRIEVAL AND TRANSMISSION

### Telemetry through GSM/ GPRS modem

In a location covered by any GSM/GPRS service provider, the data from the automatic datalogger can be transmitted remotely to a PC at a central location. The user will need to arrange a data SIM card for each datalogger.

### Data retrieval using laptop

The logged data from datalogger in field can be directly downloaded to a laptop/PC. Data can be transferred to central PC/server through Internet/pen drive.

## DATA PRESENTATION, ARCHIVING AND WORLD WIDE ACCESS THROUGH ENCARDIO-RITE PUBLIC CLOUD SERVICE

Encardio-rite offers public cloud based web monitoring service to its customers for retrieving data from dataloggers, archiving the retrieved data in a SQL database, processing the data and presenting the processed data in tabular and most suitable graphical forms for easy interpretation of logged data. The data can be accessed by authorized personnel by using a unique login ID and password from anywhere in the world over the internet using any popular web browser like Microsoft Internet Explorer, Mozilla Firefox, Google Chrome etc. Encardio-rite cloud services work on a rental model. User has to pay a small setup fee for first time and then a monthly rental has to be paid for accessing the data over the cloud as long as required.

Features of the data management software can be summarized as follows:

- Data from multiple sensor types is converted into meaningful information in graphical as well as numerical format
- Layout plan can be incorporated with locations of each monitoring sensor.
- Access to all sensors in one platform
- Instant automatic alerts via SMS or email to authorized personnel
- Generate combined charts of related parameters
- Create graphs from any combination of parameters and time period
- Variety of visualization and analysis tools to identify potential failure scenarios
- No special software required for accessing the user sites as information can be viewed using most standard and popular web browsers
- Can be accessed using tablets and smartphone

## SPECIFICATION

### EAN-61MS/1 3D probe

| | |
|---|---|
| Probe | Biaxial MEMS sensor (monitor X-Y); contactless magnetic sensor (monitor Z); with SDI-12 digital interface |
| Measuring range | ± 15° (X-Y), 100 mm (Z) |
| Accuracy[1] | ± 0.1% fs |
| Temperature range | -20°C to 80°C |
| Output | SDI-12 digital (serial) output |
| Speed | Speed: 1200 bits/sec |
| Supply operating range | 12 – 16 V<br>Separate battery pack (power supply) required of ~15 V |

*[1] As tested under lab conditions*

### EDS-91/2.1 magnetic probe with cable reel assembly

| | |
|---|---|
| Length 'L' (m) | 30, 50, 100, 150, 200, 300 (Metric) with resolution 1 mm |
| Length 'L' (ft) | 50, 100, 150, 300, 500 (Imperial) with resolution 0.01 in |

### ESDL-30 Datalogger

| | |
|---|---|
| Input | Sensor with SDI-12 signal interface |
| No. of channels | 3 |
| No. of sensors per channel | 61 |
| Scan/upload interval | 5 seconds to 168 hours |
| Memory capacity | Flash Memory (64-Mbit); 2 Million data points |
| Data output format | CSV text file. Can be easily imported in many third party applications like Microsoft® Excel |
| SDI-12 version | Version 1.3 |
| Communication port | RS-232 (Standard) 115 kbps |
| Temp. measurement range | -20 to +70°C with 0.1°C resolution |
| Operating temperature range | - 30 to 70°C |
| Humidity | 100 % |
| Power supply | 2 x D size 3.6 V/19 Ah Lithium cells, or 2 x D size 1.5 V Alkaline high power cells, or 12 V SMF battery chargeable from AC mains or solar panel |
| Housing | Corrosion resistant weather proof enclosure |
| Antenna (in telemetry option) | Built-in or separately mounted antenna |
| Dimensions LxWxH | 220 x 140 x 90 mm |

**All specifications are subject to change without prior notice*



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