

IN-PLACE INCLINOMETER

DATASHEET

MODEL EAN-52M



OVERVIEW

The Encardio Rite EAN-52M Vertical In-Place Inclinometer measures lateral movement and deformation of earthworks and structures. It provides significant quantitative data on the magnitude of inclination or tilt of a foundation, embankment or slope and its variations over time. The system measures sub-soil ground displacement profiles, identifying deformation patterns and zones of potential danger, assessing the effectiveness of construction control measures.

The EAN-52M IPI system consists of a series of inclinometer access tubes installed in a borehole or embedded in earth/rock fill or concrete structures and an IPI chain positioned inside it to span the movement zone. The IPI chain consists of digital tilt sensors fitted with a pair of pivoted sprung wheels and connected to rigid bars (gage tube) of desired length. A single 3-conductor bus cable connects each sensor in a daisy chain to the datalogger at the top of the borehole.

When sub-soil ground displacement occurs, the inclinometer casing changes shape with ground movement, and the IPI chain (of tilt sensors) measures the deviation of the casing as a series of connected straight lines (gage length). The tilt sensor measurements i.e. the angle of inclination from the vertical is converted to lateral deviation using " $L \sin \theta$ " where L is gage length, and θ is the angle of tilt from vertical. By summing readings of successive sensors, a complete profile of the access tubing is obtained. By comparing these profiles, the horizontal displacement of the gage well at different depths over a period of time may be determined.

Applications include monitoring lateral movement in embankment fills, earthworks, landslide areas, deflection in retaining and diaphragm walls, piles, and the stability of dams and tailings. The data can be transmitted in real-time to data management platforms via IoT dataloggers, providing instant alarms and early warnings to facilitate timely decisions and actions.

FEATURES

- **Accurate measurement:** Precisely measures lateral movement and inclination of structures based on established and reliable measurement principles.
- **Plug and play:** Easy installation and configuration with minimal maintenance.
- **Flexible gage length:** Gage length can vary from 1 to 3 meters or 3 to 5 feet.
- **Temperature stability:** Excellent stability across a wide temperature range.
- **IP 68 Rating:** Durable and reliable design suitable for harsh environments; water-protection upto 100 mwc.
- **Long-term stability:** Delivers reliable performance over extended periods, crucial for long-term structural health monitoring.
- **Versatile datalogging:** Compatible with any manufacturer's Datalogger and Data Management system for continuous monitoring.

Encardio Rite offers a range of NexaWave dataloggers equipped with GSM/GPRS or RF communication capabilities, ensuring reliable and efficient data transmission.

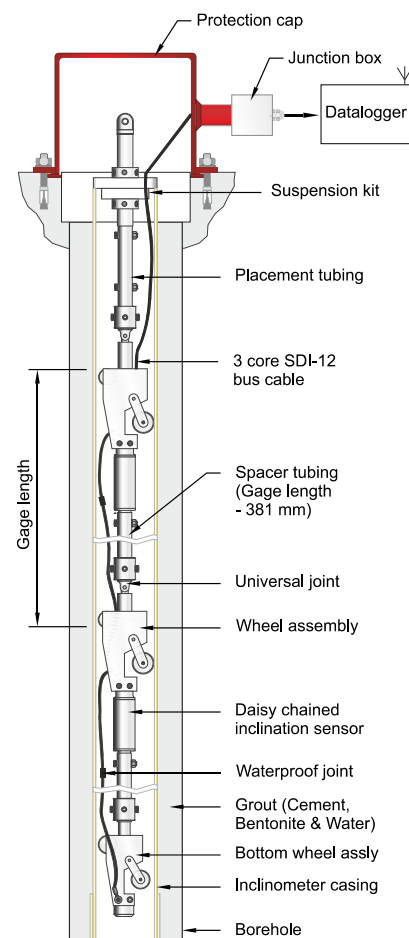
- **Infrastructure data intelligence platform:** Transmit data to a local or cloud server hosting the Proqio platform for 24/7 insights. Proqio enables efficient data processing, analysis and real-time visualization.

Benefit from instant alerts for critical events and automated reports, supporting informed decision-making.

SYSTEM COMPONENTS

The Encardio Rite in-place inclinometer system includes the following sub-assemblies:

EAN-52M/1.1	Uniaxial sensor with SDI-12, with pair of wheels.
EAN-52M/1.2	Biaxial sensor with SDI-12, with pair of wheels.
EAN-52M/2-X	Gage tube for 1 m, 1.5 m, 2 m and 3 m gage length. 'X' suffix represents gage length required. <i>The total length of tilt sensor plus the length of gage tube forms the gage length for that particular tilt sensor.</i>
EAN-52M/3	Bottom wheel assembly.
EAN-52M/4	Suspension kit with protective cap.
EAN-52M/5	Placement tubing (specify length) for placing string of sensors.
EAN-52M/6	Protective rope to prevent loss of sensor down hole.
EAN-52M/7	Suspension stainless steel wire rope for positioning single or group of sensors in specific portion of borehole
CS-1002	3 core SDI-12 bus cable for sensors with SDI-12 card.
Casings	For casing refer to datasheet 1918 on inclinometer casing



EAN-52M In-place inclinometer system

SPECIFICATIONS

IPI sensor (EAN-52M)

Sensor	Uniaxial or biaxial sensor; with SDI-12 digital interface
Measuring range	± 15°
Accuracy ¹	± 0.1% fs
Resolution	± 0.05 mm/m (8 arc seconds)
Temperature range	-20°C to 80°C
Water protection	Up to 100 mwc

¹As tested under lab conditions

Datalogger (NexaWave Digilog)

Input	Sensor with digital output (SDI-12 interface). Three input channels - can connect three IPI chains of up to 60 tilt sensors.
Scan/upload interval	5 seconds to 168 hours
Memory capacity	Flash Memory (64-Mbit); 2 Million data points
Communication port	RS-232 (Standard) 115 kbps
Temperature limit	-30 to 70°C
Internet connectivity	Built-in 4G modem; built-in or separately mounted antenna
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 12V SMF battery chargeable from AC mains or solar panel
Housing	Corrosion resistant weather proof



EAN-26 Inclinerometer readout (manual readings)



Prism target with adaptor



Settlement point

ESSENTIAL CONSIDERATIONS

Manual readings:

Before installing the IPI chain, take the initial x-y profile of the inclinometer casing with the Encardio Rite model EAN-26M manual inclinometer system. The inclinometer probe gives a true x-y profile of the borewell with a gage length of 0.5 m. This data should be stored properly as reference. If abnormal movement is observed later, the borehole profile can be verified by removing the IPI chain and taking a fresh set of readings manually (and comparing it with the reference readings to check any abnormality).

As-built coordinates:

Determine initial Northing (X), Easting (Y) and Elevation (Z) by surveying of top of inclinometer casing after the casing is set in the borehole. Encardio Rite provides Prism target with adaptor and Settlement point on request, to facilitate this process. The data observed should be stored securely for future reference.

Gage tubes in tension state:

Ensure the IPI chain is hanging so all gage tubes are in tension. Never let the IPI chain rest on the bottom wheel assembly.

Select gage lengths judiciously:

Optimal profiling

Ensure that the entire gage length (distance between the wheel assemblies of adjacent sensors) at each sensor position remains perfectly straight. Significant deformation of the borewell (casing) over any gage length can introduce curvature, causing the sensor gage tubing to touch the inclinometer casing, and introduce a curvature in the gage tubing. This introduces errors in the sub-soil displacement profile, as the plotting assumes that each gage tubing is a perfect straight-line segment.

The diagram and table on next page shows at what deformation limit the gage tubing touches the casing and why.

Deformation limits

If casing deformation exceeds the allowable range, errors will increase while plotting the displacement profile. Below are the allowable deformations for accurate results:

Gage Length L (m)	Maximum measurable angular deviation ΔA (deg)	Maximum allowed displacement over 1 m borehole length ΔA_m (deg/m)	Maximum allowed lateral movement d_{max} (mm per m)
1.0	9.6	9.6	167
1.5	6.4	4.8	111
2.0	4.8	2.4	84
3.0	3.2	1	56

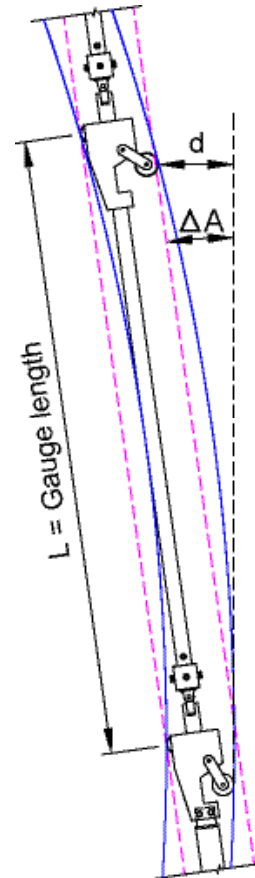
These values are based on EAN-52M IPI chains in 70 mm OD, 58 mm ID inclinometer casing, assuming sub-soil movement causes a circular bend. For 85 mm OD casings, contact the factory for recommendations.

The IPI chain measures displacement at the adjacent sensor points, considering that the gage tube is in a straight line. Any localized displacement between the sensor points will therefore not be measured by the IPI chain.

Considerations

Local displacement: The IPI chain measures displacement at sensor points along a straight gage tube. Localized displacement between sensors is not captured.

Gage length optimization: Shorter gage lengths provide more reliable and accurate data. Optimize gage lengths based on site conditions and critical zones for a cost-effective system. For example, use 3 m gage lengths in stable zones and 1 m in expected slip zones of landslide areas.



*All specifications are subject to change without prior notice

DATASHEET | 1502-22 R02



Dams



Mining



Tunnels



Transportation



Construction



Bridges



Landslides



Energy



Environmental Monitoring



Pipelines



Structural Health Monitoring



Smart Cities

ENCARDIO RITE GROUP - INDIA | BHUTAN | NEPAL | BAHRAIN | QATAR | SAUDI ARABIA | UAE | PERU | GREECE | SPAIN | UK | USA

Encardio-Rite Electronics Pvt. Ltd. A-7, Industrial Estate, Talkatora Road, Lucknow, UP-226011, India | info@encardio.com | T: +91 522 2661039-320