



ENCARDIO RITE

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USERS' MANUAL

TILTMETER MODEL EAN-90M



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1 INTRODUCTION

Encardio-rite model EAN-90M tilt meter is suitable for monitoring inclination and vertical rotation of structures. It is a high resolution tilt meter, is rugged in construction and has excellent temperature stability.

Tilt change in a structure may be caused by construction activity like excavation, tunneling or de-watering that may affect the ground supporting the structure. Change in tilt could also result from loading of the structure, such as loading of a dam during impoundment, loading of a diaphragm wall during excavation or loading of a bridge deck due to wind and traffic. Data from the tilt meter provides early warning of threatening deformations, allowing time for corrective action to be taken or if necessary for safe evacuation of the area.



1.1 Applications

EAN-90M tilt meter is widely used in following applications:

- Monitoring vertical rotation of retaining walls.
- Monitoring inclination and rotation of dams, piers, piles and other structures.
- Monitoring stability of structures in landslide areas.
- Monitoring tunnels for convergence and other movement.
- Monitoring safety of structures around zones of excavation or tunneling.
- Monitoring deflection in bridges and struts under different loading conditions.

1.2 Conventions used in this manual

WARNING: Warning messages calls attention to a procedure or practice, that if not properly followed could possibly cause personal injury.

CAUTION: Caution messages calls attention to a procedure or practice, that if not properly followed may result in loss of data or damage to equipment.

NOTE: Note contains important information and is set off from regular text to draw the users' attention.

This users' manual is intended to provide you with sufficient information for making optimum use of tilt meters and beam sensors in your applications.

To make this manual more useful we invite valuable comments and suggestions regarding any additions or enhancements. We also request you to please let us know of any errors that may be found while going through the manual.

1.3 How to use this manual

The manual is divided into a number of sections. Each section contains a specific type of information. The table of contents tell you where to look for in this manual if you need some specific information.

2 MODEL EAN-90M TILTMETER

2.1 Principle of operation

Model EAN-90M tilt meter is built around a precision accelerometer and suitable signal conditioning circuit mounted inside a stainless steel housing. The accelerometer senses force of acceleration due to gravity which is maximum when accelerometer is rotated to full 90 degree tilt position and is zero (minimum) when tilt angle of accelerometer is zero. For in-between tilts, force experienced by accelerometer is equal to product of sine of tilt angle and acceleration due to gravity. The tilt sensor thus provides a bipolar DC voltage output proportional to the sine of tilt angle measured by the tilt meter. The output is zero volts for a truly vertical position.

The sensor provides a relatively low cost tilt measurement solution but still offers excellent resolution, long term stability and a low thermal sensitivity.

The tilt meter can be fixed to any vertical surface, horizontal floor or ceiling by means of suitable mounting accessories consisting of brackets and anchors. These are available separately when ordered.

The EAN-90M is not intended for absolute determination of tilt of structures. Tilt meter measures change in tilt of a structure to which the sensor is attached.

The initial tilt reading for each tilt sensor is recorded after it has been mounted on the structure to be monitored. Subtracting initial tilt reading from subsequent tilt reading gives change in tilt of structure over a period of time.

2.2 Tool and accessories

Following tools and accessories are required for proper installation of tilt meter.

- 1 Power drill
- 2 Concrete / Masonry drill bit 8 mm
- 3 Spanner 8/9, 12/13 mm
- 4 Allen key 5 mm
- 5 Cloth for cleaning

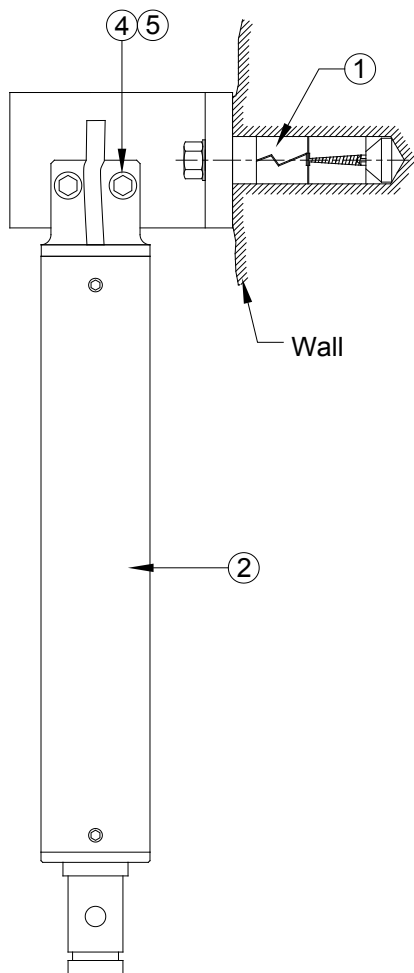
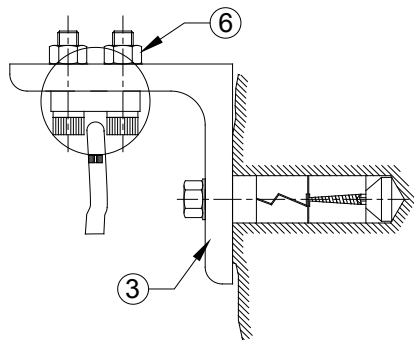
2.3 Installation of Tiltmeter

Model EAN-90M tilt meter can be fixed to a vertical surface, suspended from ceiling or mounted on the floor with help of suitable mounting arrangement/bracket available from Encardio-rite as optional accessories.



2.3.1 Installation on vertical surface

- 1 Drill a 8 mm Φ x 50 mm deep hole for Hilti anchor HSA M8 x 75 or equivalent on the wall of which change in tilt has to be measured.
- 2 Insert anchor in the drilled hole.
- 3 Mount tilt meter bracket on the anchor and tighten slightly.
- 4 Fix tilt meter on the mounting bracket with two M6 x 20 mm Allen bolts.
- 5 Connect tilt meter with read-out unit.
- 6 Tighten anchor and Allen bolts/nuts so that the tilt meter reads almost vertical on the read-out unit.



Item	Description	Qty.
1	Anchor (HSA M8 x 75 Hilti)	1
2	Tilt meter	1
3	Wall mounting bracket	1
4	Allen bolt, SS, M6 x 20	2
5	Plain washer, SS	2
6	Hex. nut, SS, M6	2

Figure 1: Tiltmeter on vertical surface

2.3.2 Installation on horizontal surface

- 1 Using mounting bracket as a template, mark position of two mounting holes.
- 2 Visually ensure that the two hole positions are almost aligned along the axis at which tilt has to be measured.
- 3 Drill two 8 mm Φ x 50 mm deep holes for Hilti anchor HAS M8 x 75 or equivalent.
- 4 Insert anchors in drilled holes.
- 5 Mount tilt meter bracket on the anchors and tighten slightly.
- 6 Fix the tilt meter on mounting bracket with two M6 x 20 mm Allen bolts.
- 7 Connect tilt meter with read-out unit.
- 8 Tighten anchors and Allen bolts/nuts so that the tilt meter reads almost vertical on the read-out unit.

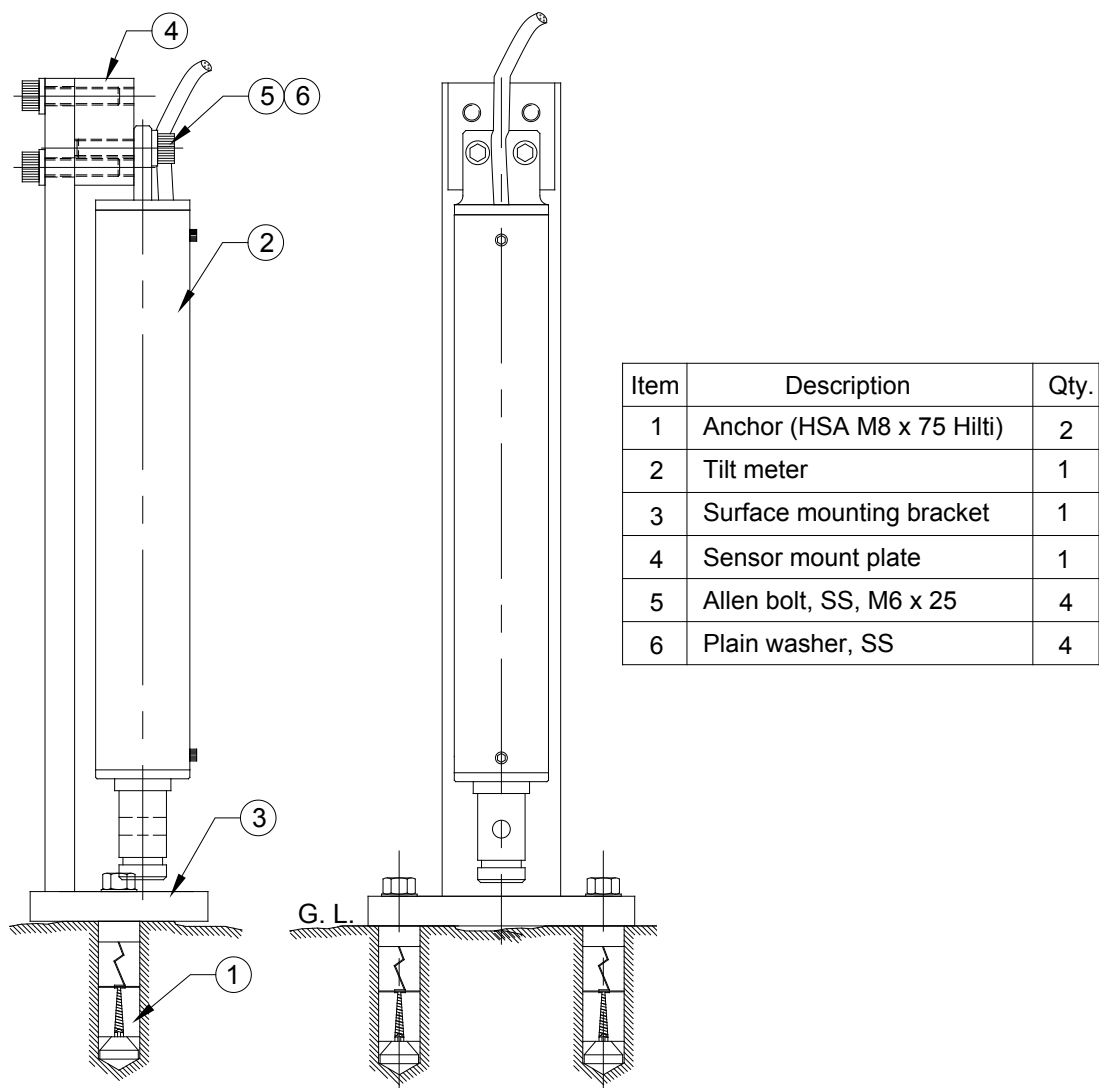
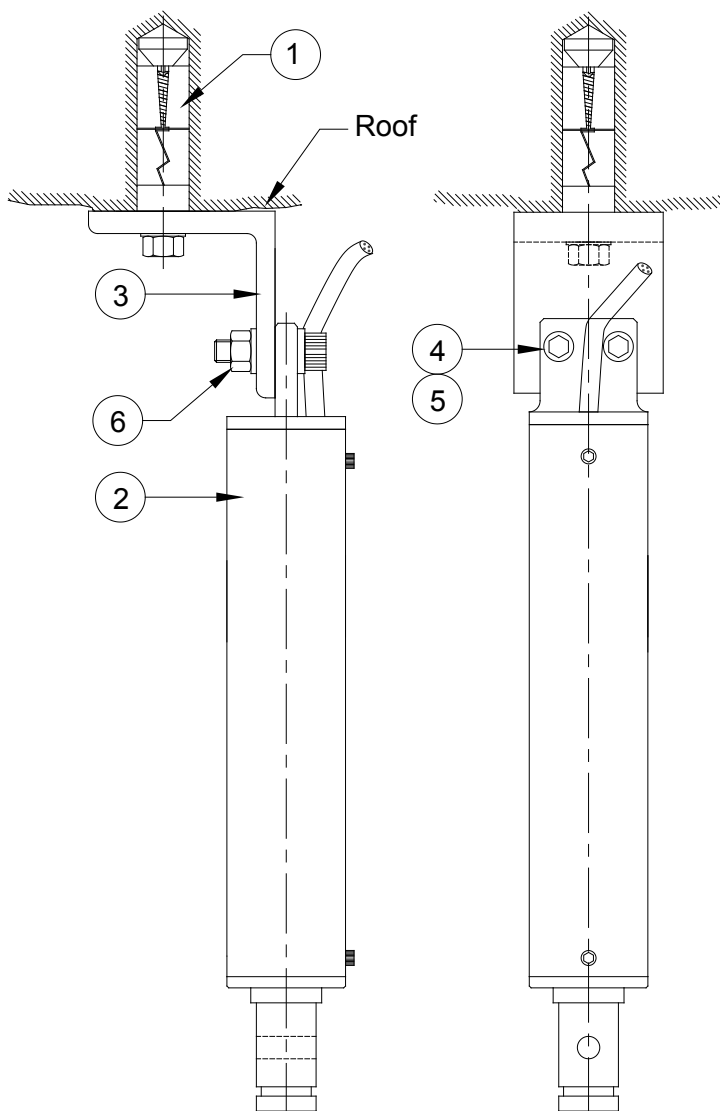


Figure 2: Tiltmeter on horizontal surface

2.3.3 Installation on roof

- 1 Drill 8 mm Φ x 50 mm deep hole for Hilti anchor HSA M8 x 75 or equivalent on roof at which change in tilt has to be measured.
- 2 Insert anchor in the drilled hole.
- 3 Mount the tilt meter bracket on anchor and tight it slightly.
- 4 Fix the tilt meter on the mounting bracket with two M6 x 20 mm Allen bolts.
- 5 Connect tilt meter with read-out unit.
- 6 Tighten anchor and Allen bolts/nuts so that the tilt meter reads almost vertical on the read-out unit.



Item	Description	Qty.
1	Anchor (HSA M8 x 75 Hilti)	1
2	Tilt meter	1
3	Roof mounting bracket	1
4	Allen bolt, SS, M6 x 20	2
5	Plain washer, SS	2
6	Hex. nut, SS, M6	2

Figure 3: Tiltmeter on roof

3 MEASUREMENT OF TILT

The output of model EAN-90M tilt meter can be read by Encardio-rite model EDI-53UTM portable digital read-out unit/datalogger. The EAN-90M can also be read or logged from a remote location by automatic data acquisition system like Encardio-rite model EDAS-10. The tilt meter is supplied with 2 m built-in six core cable. The cable can be terminated or extended to the nearest measurement station through a suitable junction box.

Note: For automatic logging by Encardio-rite model ESDL-30 datalogger, model EAN-92M Tiltmeter with in-built SDI-12 digital interface is available.

When using with Encardio-rite model EDI-53UTM portable digital read-out unit, a break-out box (special junction box) having suitable circular connector is available from Encardio-rite.

3.1 Wiring details

Cable colour	Description
Red	+ 12V DC
Black	- 12V DC
Green	0 V (Power supply common)
Blue	Output Channel A
Brown	Output Channel B (only for biaxial tilt sensors)
White	Output Common

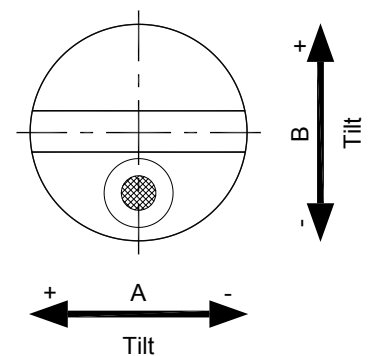


Figure 4: Tiltmeter sign

3.2 Sign convention

Careful orient tilt sensor during installation. Make a note of the orientation. Uni-axial sensor measures tilt only along axis 'A'. Figure 4 shows a view from top and also convention used for direction/output signal polarity.

3.3 Connecting sensor to Encardio-rite Digital readout unit

Tilt meter can be connected to Encardio-rite model EDI-53UTM portable digital read-out unit/datalogger through a break-out box. Break-out box provides the mating circular connector to read-out unit. The cable can also be extended through the break-out box. The breakout box is also equipped with lightning arrester.

Encardio-rite model EDI-53UTM portable digital read-out unit/datalogger reads sine of tilt angle when parameter of typical tilt meter is fed. To read sine of tilt angle, set-up EDI-53UTM channel as follows:

Unit [UNITS]	No units (key 9)
Initial reading [IR]	Set to zero
Gauge factor [GF]	2/tilt meter gage factor in volts/sin 90°
Coeff of X ²	Set to zero
Decimal point [DP]	As required (recommended value is 4)

Tilt angle can be calculated by \sin^{-1} (observed value).

For bi-axial tilt meter, set-up two channels (one for A-axis and one for B-axis) in similar manner.



Breakout box

3.4 Connecting sensor to EDAS-10 data acquisition system

Model EAN-90M tilt meter requires external power source of $\pm 12V$ DC (regulated) when connected to EDAS-10 data acquisition system. For connecting tilt meter, a multiplexer model EAM-616 is required. 16 tilt meters can be connected to each multiplexer model EAM-616.

Maximum input of EDAS-10 is $\pm 2.5 V$; whereas output of tilt meter is $\pm 4 V$ at 15° proportional to Sin of angle. A high precision attenuator is therefore required as shown in diagram below:

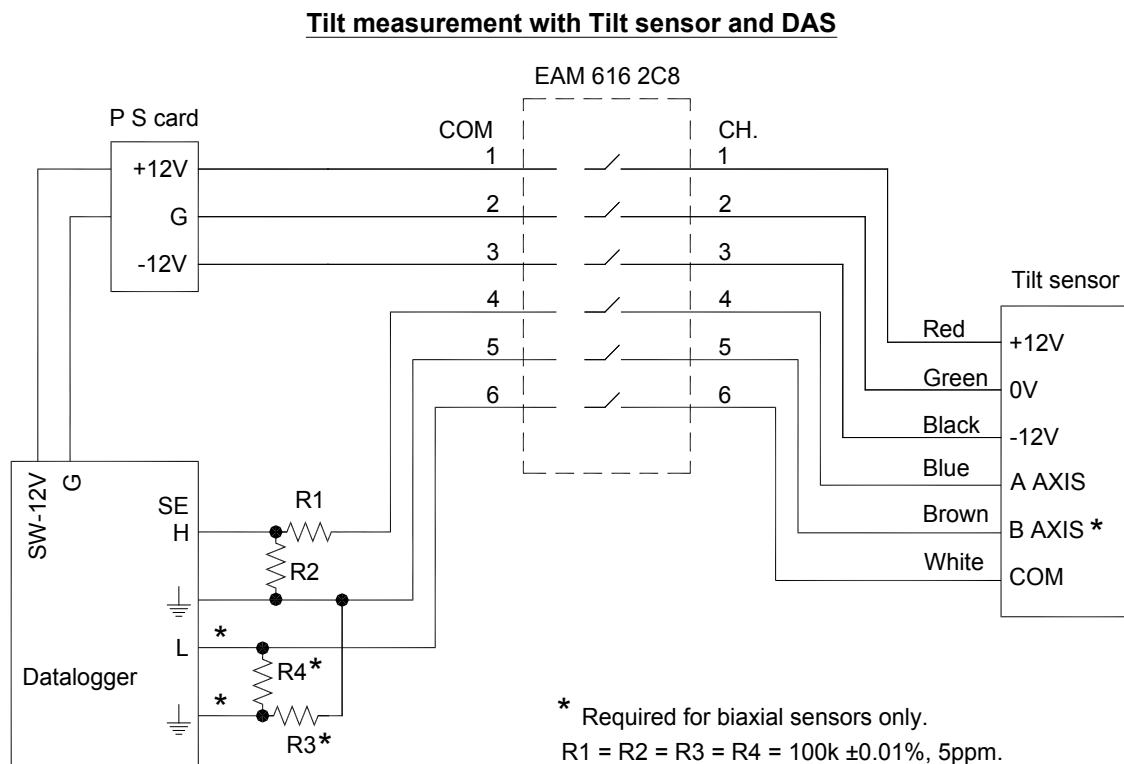


Figure 5: Tiltmeter connected to DAS

Use EDAS-10 function P2 to read output of tilt sensor in terms of 0.5 volts. The multiplier and offset should be kept as 1 and 0 respectively. To get tilt angle refer to typical gage factor and formula given in relevant test certificate. A sample test certificate for uni-axial sensor can be referred to in section 3.5.

3.5 Sample Test Certificate

TEST CERTIFICATE

Item : Tilt meter (Uniaxial) Date : 14.03.2018
 Model : EAN-90M Temperature : 27 °C
 Range : ±15°
 Serial no. : xxxxxxx
 Next calibration due on : 13.03.2019

Test data

Test position Arc degrees	SinA	*Calculated output (V ₁)	**Ideal output (V ₂)	Observed output 'A' axis (V ₃)	Offset corrected output (V ₄)	Error 'A' axis (V ₄ - V ₂)	Non-conformance % fs
(A)		Volts	Volts	Volts	Volts	Volts	
15	0.2588	4.1408	4.1403	4.1404	4.1399	0.0004	0.010
12	0.2079	3.3264	3.3260	3.3259	3.3254	0.0006	0.014
9	0.1565	2.5032	2.5029	2.5027	2.5022	0.0007	0.017
6	0.1046	1.6728	1.6726	1.6721	1.6716	0.0010	0.024
3	0.0524	0.8376	0.8375	0.8372	0.8367	0.0008	0.019
0	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.000
-3	-0.0524	-0.8376	-0.8375	-0.8371	-0.8376	0.0001	0.002
-6	-0.1046	-1.6728	-1.6726	-1.6725	-1.6730	0.0004	0.010
-9	-0.1565	-2.5032	-2.5029	-2.5028	-2.5033	0.0004	0.010
-12	-0.2079	-3.3264	-3.3260	-3.3260	-3.3265	0.0005	0.012
-15	-0.2588	-4.1408	-4.1403	-4.1402	-4.1407	0.0004	0.010

Max non-conformance (% fs) : 0.02

Sensor gauge factor : 15.998 Volts/Sin(90)

Calculation of tilt value (arc degree) :

$$\text{SinA} = \text{Observed output} / \text{gauge factor}$$

$$A = \text{Sin}^{-1}(\text{observed output} / \text{gauge factor})$$

Wiring colour code :

Wire colour	Signal
Red	+12 V (supply)
Black	- 12 V (supply)
Green	0 V (supply)
Blue	Output 'A' axis
Brown	N/A
White	Output common

Note : * Calculated output Voltage (V₁) worked out based on nominal gauge factor of 16.000 V/g (i.e. 16V X Sin A).

** Ideal output Voltage (V₂)' calculated from sine curve passing through sensitivity calibration points (@ ±15°) .

Tested by