



# NOVARENT

LOCATION ET VENTE DE MATÉRIEL DE MESURE

## TILT METER & BEAM SENSOR

(BOX TYPE WITH SDI-12 INTERFACE)

MODEL EAN-93M & EAN-93M-B



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## 1 INTRODUCTION

Encardio-rite model EAN-93M/EAN-93M-B (with beam) SDI-12 tilt meter is suitable for long term monitoring inclination and vertical rotation of structures.

Continuous data logging and real-time monitoring helps to provide early warning in case of impending failure allowing time for corrective action to be taken or if necessary for safe evacuation of the area.

Tilt change in a structure may be caused by construction activity like excavation, tunnelling 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-93M 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 tunnelling.
- 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 the regular text to draw the users' attention.

### 1.3 How to use this manual

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

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

**NOTE:** Installation personnel must have a background of good installation practices and knowledge of fundamentals of geotechnics. Novices may find it very difficult to carry on installation work. The intricacies involved in installation are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments will be rendered useless.

A lot of effort has been made in preparing this instruction manual. However best of instruction manuals cannot provide for each and every condition in field that may affect performance of the sensor. Also, blindly following the instruction manual will not guarantee success. Sometimes, depending upon field conditions, installation personnel will have to consciously

depart from written text and use their knowledge and common sense to find solution to a particular problem.

Installation of a tilt meter requires expertise. It is recommended that potential users themselves practice all the operations laid down in this manual by repeated installations.

**NOTE:** The sensor is normally used to monitor site conditions and will record even a minor change that may affect behaviour of structure being monitored. Some of these factors amongst others, are, seasonal weather changes, temperature, rain, barometric pressure, nearby landslides, earthquakes, traffic, construction activity around site including blasting, tides near sea coasts, fill levels, excavation, sequence of construction and changes in personnel etc. These factors must always be observed and recorded as they help in correlating data later on and also may give an early warning of potential danger or problems.

The manual is divided into a number of sections. Each section contains a specific type of information. The list given below tells you where to look for in this manual if you need some specific information.

*For understanding principle of tilt meters: See § 2 'General Description'*

*For specifications of tilt meters: See § 2.1 'Specifications'*

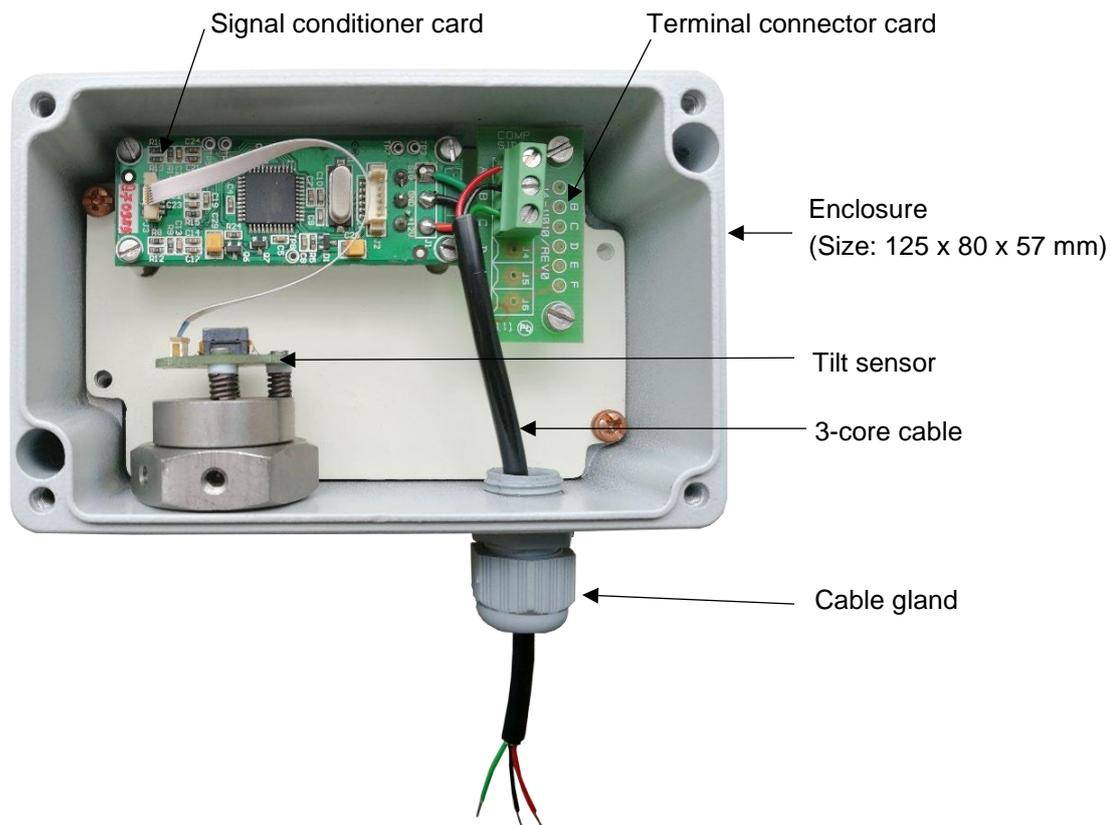
*For installation of tilt meters: See § 3 'Installation procedures'*

*For measurement with datalogger: See § 4*

## 2 GENERAL DESCRIPTION

Model EAN-93M tilt meter (Figure 1) is built around a Micro-Electro Mechanical System (MEMS) technology tilt sensor having range of  $\pm 15^\circ$ , with high sensitivity and accuracy mounted inside a compact weatherproof enclosure. The tilt sensing module provides a bipolar DC voltage output proportional to the sine of tilt angle measured by the beam. It is then digitized through the in-built SDI-12 interface. The output is zero volts for a truly vertical or horizontal position.

SDI-12 is the acronym for "Serial Data Interface at 1200 Baud". SDI-12 is an asynchronous, ASCII, serial



**Figure 1 EAN-93M tilt meter**

communications protocol. These instruments are typically low-power (12 volt), are often used in remote locations, and usually communicate with a data logger or other data acquisition device. In this master-slave configuration, the data logger or data acquisition device typically acts as the master (SDI-12 recorder and interrogator) to the data monitoring instruments, which are the slaves (SDI-12 sensors). One master can communicate with multiple slaves, so the SDI-12 protocol requires that each device in the serial network be identified with a unique address, which is represented by a single ASCII character.

This communication is achieved by digital communications along a single serial line. The digital addressing system allows an SDI-Recorder to send out an address over a single line that is occupied by sensors with only the pre-configured sensor matching that address will respond (handshake), while the other sensors on the same line will not respond until called and typically stay in "sleep mode" (low power mode), until called (often in a sequence) at a later time by the SDI Recorder (Master).

The EAN-93M tilt meter is not intended for absolute determination of tilt of structures. It measures change in tilt of a structure to which it is attached. The initial tilt reading for each tilt sensor is recorded after it has been mounted on the structure to be monitored. Subsequent tilt readings will be displayed w.r.t. initial reading.

## 2.1 Sample test certificates

### TEST CERTIFICATE (for 'A' axis calibration)

Item : Tiltmeter with SDI -12 interface Date : xxxxxxxx  
 Model : EAN-93M-B Temperature : xxxxxxxx  
 Range :  $\pm 15^\circ$   
 Serial No. : xxxxx  
 Next calibration due on : XXXXXX

#### Test data

Test position Arc degrees (A)	Corresponding SinA	Observed SinA A' axis	Offset corrected SinA A' axis	Non-conformance (% fs) 'A' axis
15	0.2588	0.2588	0.2587	0.0383
12	0.2079	0.2078	0.2077	0.0895
9	0.1564	0.1563	0.1562	0.1060
6	0.1045	0.1047	0.1046	0.0354
3	0.0523	0.0523	0.0522	0.0641
0	0.0000	0.0001	0.0000	0.0000
-3	-0.0523	-0.0522	-0.0523	0.0178
-6	-0.1045	-0.1044	-0.1045	0.0226
-9	-0.1564	-0.1562	-0.1563	0.0520
-12	-0.2079	-0.2077	-0.2078	0.0432
-15	-0.2588	-0.2588	-0.2589	0.0351

Max non-conformance (% fs) : 0.11

Calculation of tilt value (arc degree) :

$$A = \sin^{-1}(\text{observed output})$$

Wiring colour code :

Wire colour	Signal
Red	+ 12 V (supply)
Black	0 V (supply)
Green	Output signal

Tested by :

**TEST CERTIFICATE**  
(for 'B' axis calibration)

Item : Tiltmeter with SDI -12 interface Date : xxxxxxxx  
 Model : EAN-93M-B Temperature : xxxxxxxx  
 Range :  $\pm 15^\circ$   
 Serial No. : xxxxx  
 Next calibration due on : XXXXXX

**Test data**

Test position Arc degrees (B)	Corrosponding SinA	Observed SinA B' axis	Offset corrected SinA B' axis	Non-conformance (% fs) 'B' axis
15	0.2588	0.2588	0.2588	0.0201
12	0.2079	0.2080	0.2079	0.0122
9	0.1564	0.1566	0.1565	0.0253
6	0.1045	0.1044	0.1043	0.0844
3	0.0523	0.0525	0.0524	0.0209
0	0.0000	0.0001	0.0000	0.0000
-3	-0.0523	-0.0522	-0.0522	0.0371
-6	-0.1045	-0.1044	-0.1045	0.0187
-9	-0.1564	-0.1563	-0.1564	0.0326
-12	-0.2079	-0.2079	-0.2080	0.0341
-15	-0.2588	-0.2588	-0.2589	0.0351

Max non-conformance (% fs) : 0.08

Calculation of tilt value (arc degree) :

$$B = \sin^{-1}(\text{observed output})$$

Wiring colour code :

Wire colour	Signal
Red	+ 12 V (supply)
Black	0 V (supply)
Green	Output signal

Tested by :

### 3 INSTALLATION PROCEDURE

The EAN-93M tilt meter (uniaxial) is used to measure simple rotation of structures in a single plane known as plane of rotation. The plane of rotation is a plane parallel to the back side (surface) of the tiltmeter. Biaxial tiltmeter also measures rotation in the plane perpendicular to the above.

Depending on monitoring requirement the tiltmeter can be mounted in two different ways as described below.

#### 3.1 Pre-installation checks

- 3.1.1 Connect the 3-core cable to the tilt meter through screw terminal as per wiring details shown in Figure 1.
- 3.1.2 Connect the tilt meter to the datalogger or data acquisition system and configure to display the readings on the PC (refer to § 4.4/§ 4.5)
- 3.1.3 Tilt the sensor towards +ve side (counter clockwise) on the swivel bracket provided (Figure 8), output of the sensor will increase in positive direction (+ve sign is marked on the right side of top of enclosure). Similarly, the output will decrease when sensor is tilted in - ve direction (clockwise).

#### 3.2 Installation on a vertical surface

##### 3.2.1 Installation of tilt meter on the swivel bracket

###### 3.2.1.1 Installation parallel to the wall

If the structural rotation is expected to be in the plane of the surface of the wall, the tilt meter is mounted directly on the wall using the wall mounting bracket as shown in Figure 2. The use of wall mounting bracket allows coarse levelling of the tilt meter and the alignment of the anchors need not be very precise. The wall mounting bracket is fixed to the wall using any commercially available 8 mm anchors/fasteners suitable for brick or concrete wall.

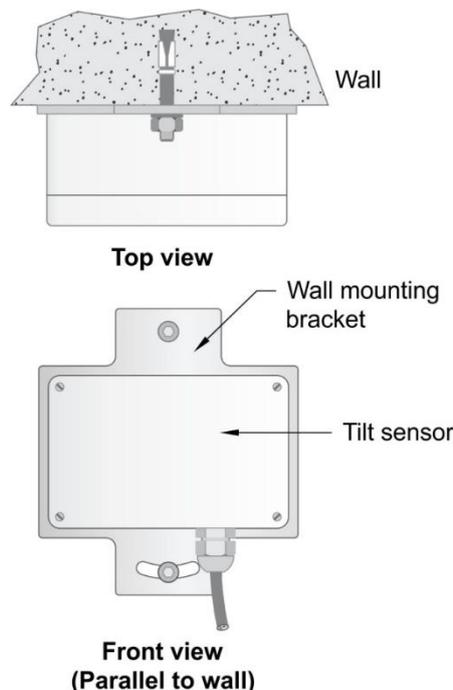
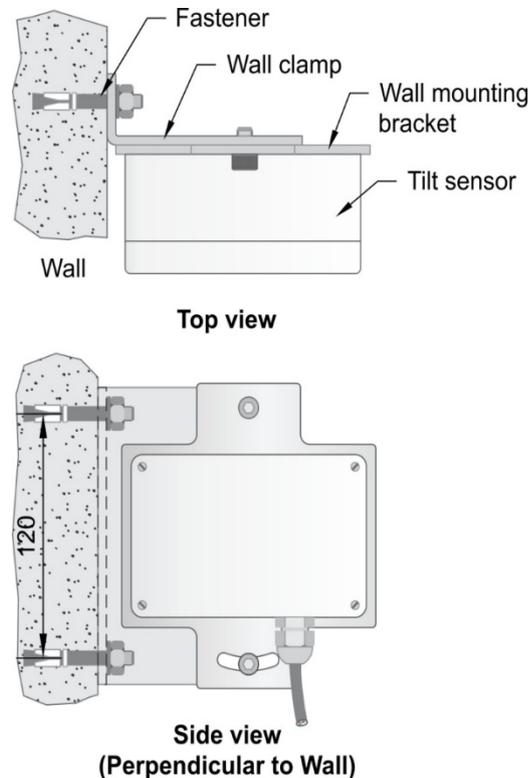


Figure 2 Installation parallel to the wall

### 3.2.1.2 Installation perpendicular to the wall

If the surface of the wall is expected to rotate in a vertical plane perpendicular to the wall, the tilt meter should be mounted in an orientation as shown in the Figure 3. The use of a mounting kit is recommended, as this allows easy adjustment of the tilt meter orientation.



**Figure 3 Installation perpendicular to the wall**

### 3.2.2 Installation procedure on wall (parallel or perpendicular)

Installation procedure for both type of installations will be same and is mentioned below:

- For installation parallel to the wall - using the wall mounting swivel bracket as a template, mark locations of two mounting holes. Visually ensure that position of the two holes are aligned vertically using a spirit level.
- For installation perpendicular to the wall - using the wall mounting swivel bracket as a template, mark locations of two mounting holes. Visually ensure that position of the two holes are aligned vertically using a spirit level.
- Drill two holes for 8 mm diameter anchors/fasteners and depth suitable for the type of anchor to be used.
- Fix the mounting anchors in holes following the manufacturer's recommendation.
- Mount the tilt meter on the wall mounting bracket.
- Fix the wall mounting bracket with the tilt meter to the anchors on the wall.

### **3.3 Installation of horizontal beam sensors**

#### **3.3.1 Mounting the sensor assembly on the beam**

The EAN-93M-B, MEMS beam tilt sensor is generally supplied as EAN-93M tiltmeter mounted on a beam of customer specified length. However, on specific customer request the tiltmeter and the beams may be supplied separately. In such cases the sensor has to be mounted on the beam before the beams are fixed.

#### **3.3.2 Installing the anchors**

Horizontal beam sensors are used to find the relative vertical displacement of the two anchors at its ends. The distance between the two anchors is known as the gauge length of the beam sensor. The beam sensors are generally supplied in standard gauge lengths of 1, 2 or 3 m, but other customer specified lengths are also available.

The beam sensors are generally used in a string with two beam sensors sharing a common anchor for fixing.

- Using a chalk-line and suitable colored chalk mark a straight line along which the beam sensors would be fixed. For wall mounting use a spirit level and a beam to ensure that the line is as horizontal as possible. For floor mounting the line should be aligned along the direction in which the vertical settlement profile is desired.
- With a tape measure, on the above line, mark off distances corresponding to the gauge length of the beams to be fixed. It may be noted that the beams are slightly longer than their gauge length. If required, beams of different gauge lengths may be used in the same string. Each mark corresponds to an anchor position.
- Drill 12mm diameter anchor holes to a depth of about 100 mm at the marked position. Ensure that the holes are as perpendicular to the wall or floor surface as possible.
- Clear the hole of debris by blowing air or brushing.
- Fix the longer (148 mm) anchors of the mounting kits with suitable epoxy grout in these holes such that around 50mm length of anchors project out of the surface after fixing. Follow epoxy manufacturer's recommendation for fixing the anchors.
- Allow the grout to set for the recommended time before handling.
- Measure and record the exact centre distances between each anchor in the string. Hint: As the anchor centres may be difficult to locate, measure the distance between the left side of each anchor.

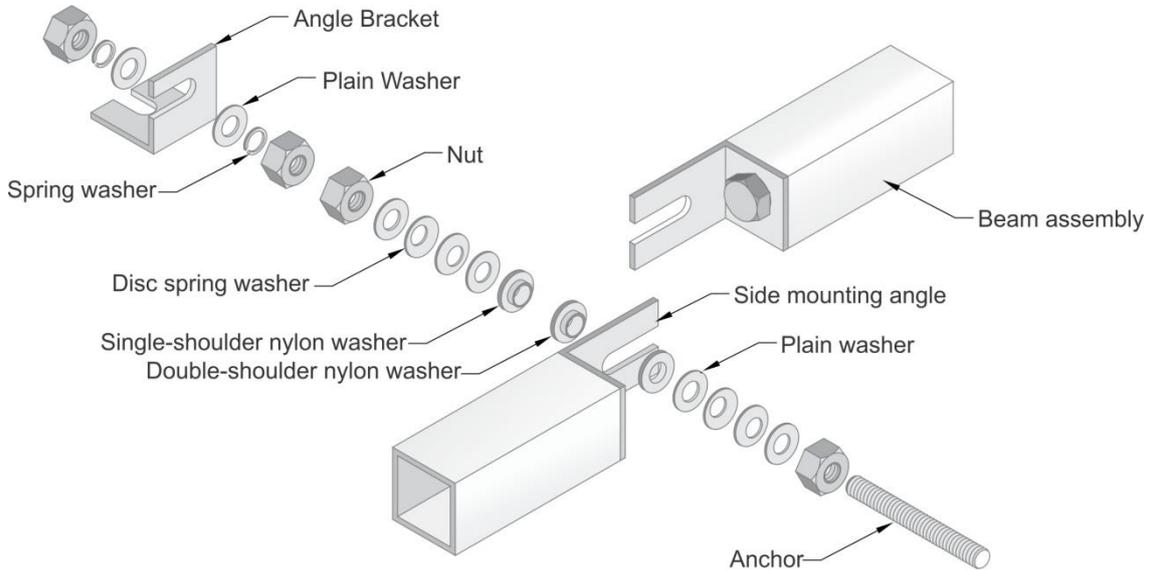
#### **3.3.3 Fixing the beams**

The beam tilt sensors are provided with two mounting angles on each side. The beams can be fixed to the anchors directly using these mounting angles. However, if the strings of beams are subject to any torsional movement the beam mounting kits provide more flexibility and are strongly recommended.

The Figure 4 below shows the correct position of each component of the kit while mounting the beams.

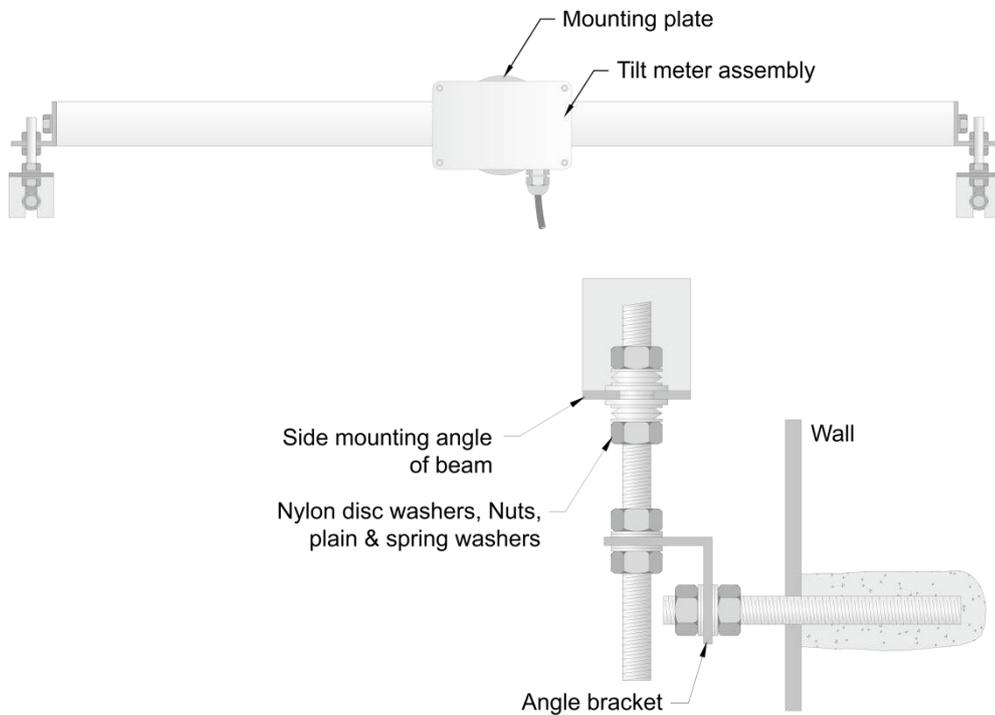
- Fasten angle brackets to the already grouted anchors. Check the relative position of the nuts, washers and angle brackets from the drawing.
- Fix the 72 mm stud anchors on the angle brackets fixed to the grouted anchors.
- Slightly loosen the mounting angle at both sides of each beam by loosening the hex nut holding it to the beam.
- Fix the beams on the 72 mm stud anchors as shown in drawing. Use the double-shouldered nylon washer between the mounting angles of two adjacent beams.

- Lightly tighten the nuts so that the spring washers are slightly compressed.
- Tighten the bolt head holding the mounting angles to the beam-ends.
- Put a drop of Loctite 290 (post assembly thread locking compound) at the accessible junction of each nut on the studs to lock them in place.



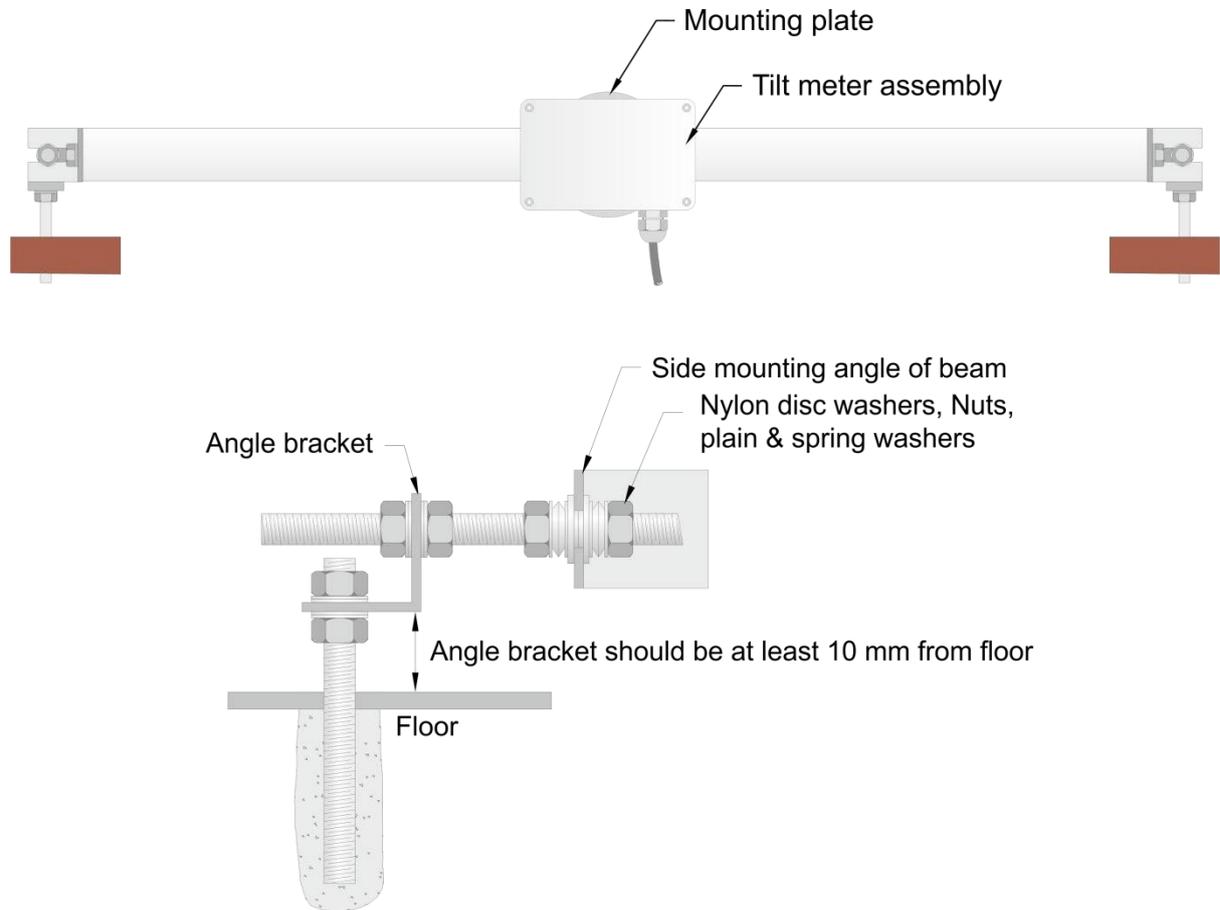
**Figure 4 Installation of the anchor and the nuts & washer set**

Figure 5 below shows how to mount the EAN-93M-B horizontal beam sensor on wall using the standard mounting kit.



**Figure 5 Installation of the EAN-93M-B sensor horizontally on the wall**

Figure 6 below shows how to mount the EAN-93M-B horizontal beam sensor on floor using the standard mounting kit.



**Figure 6 Installation of the EAN-93M-B sensor on beam horizontally on the floor**

### 3.4 Installation of vertical beam sensors

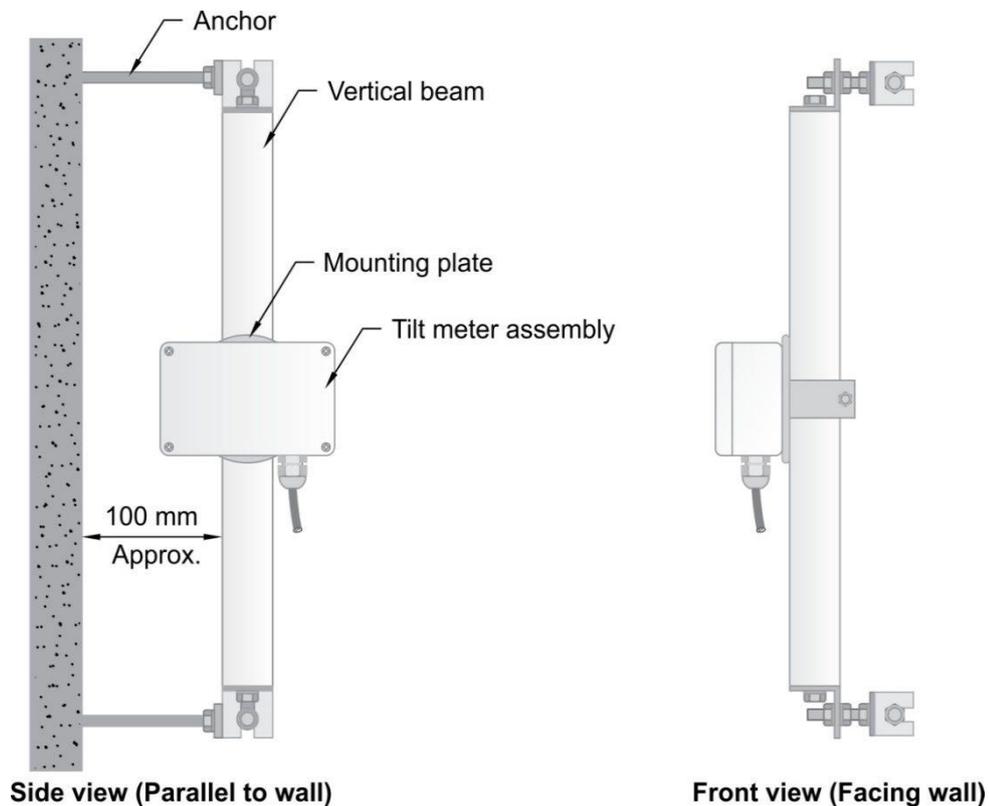
Vertical beam sensors are used to find the relative horizontal displacement of the two anchors at its ends. The distance between the two anchors is known as the gauge length of the beam sensor. Vertical beam sensors are generally supplied in standard gauge lengths of 1, 2 or 3 m, but other customer specified lengths are also available. The beam sensors are generally used in a string with two beam sensors sharing a common anchor for fixing.

Vertical beam sensors consist of a standard EAN-93M tiltmeter, an aluminium beam, 38 mm x 38 mm square and of specified gauge length and mounting hardware for mounting the tiltmeter on the beam.

#### 3.4.1 *Installing the anchors*

- 1 Using a plumb line and suitable colored chalk mark a vertical straight line along which the beam sensors would be fixed.
- 2 With a tape measure, on the above line, mark off distances corresponding to the gauge length of the beams to be fixed. It may be noted that the beams are slightly longer than their gauge length. If required, beams of different gauge lengths may be used in the same string. Each mark corresponds to an anchor position.
- 3 Drill 12 mm diameter anchor holes to a depth of about 100 mm at the marked position. Ensure that the holes are as perpendicular to the wall or floor surface as possible.

- 4 Clear the hole of debris by blowing air or brushing.
- 5 Fix the longer (148 mm) anchors of the mounting kits with suitable epoxy grout in these holes such that around 50 mm length of anchors project out of the surface after fixing. Follow epoxy manufacturer's recommendation for fixing the anchors.
- 6 Allow the grout to set for the recommended time before handling.
- 7 Measure and record the exact centre distances between each anchor in the string. Hint: As the anchor centers may be difficult to locate, measure the distance between the left side of each anchor.



**Figure 7 Installation of EAN-93M-B on a vertical beam**

### 3.4.2 Fixing the beams

The sensor beams are provided with two mounting angles on each side. The beams can be fixed to the anchors directly using these mounting angles. However, if the string of beams are subject to any torsional movement the separately available beam mounting kits provide more flexibility and are strongly recommended.

- Fasten angle brackets to the already grouted 148 mm anchors. Check the relative position of the nuts, washers and angle brackets from the drawing.
- Fix the 72 mm stud anchors on the angle brackets fixed to the grouted anchors.
- Slightly loosen the mounting angle at both sides of each beam by loosening the hex nut holding it to the beam.
- Fix the beams on the 72 mm stud anchors as shown in drawing. Use the double shouldered nylon washer between the mounting angles of two adjacent beams. The beams should be roughly parallel to the wall surface.

- Lightly tighten the nuts so that the spring washers are slightly compressed.
- Tighten the bolt head holding the mounting angles to the beam ends.
- Check that the top of the tiltmeter enclosure is level. If not, then remove cover, loosen the two mounting screws and rotate housing. Tighten mounting screws and replace cover when done.
- Put a drop of Loctite 290 (post assembly thread locking compound) at the accessible junction of each nut on the stud anchors to lock them in place.

### **3.5 Protection of tilt meter**

Avoid installation of tilt meter in parts of the structure exposed to direct sunlight. If this is not feasible, a box made from Thermocole or similar heat insulating material should be installed covering the tilt meter and protecting it from direct sunlight.

If certain degree of mechanical protection is also required, wooden or fibreglass protection boxes may be considered. Heat insulating tape can be fixed to the inner surface of such boxes for thermal insulation.

### **3.6 Other considerations**

Install tilt meter on a structural member of a building and not on the façade or boundary wall which may behave in a different manner than the main building. Do not install it at a location having vibrations, for example caused by a heavy rotary machinery. Avoid installing at location where it can be vandalized or get hit by pedestrians.

## 4 MEASUREMENT OF TILT

The output of model EAN-93M tilt meter can be read or logged from a remote location by an automatic data acquisition system like Encardio-rite model ESDL-30/EDAS-10.

Encardio-rite recommends the termination or extension of the tiltmeter with the 6-core cable to the nearest measurement station through a suitable junction box. We can use 3 core cable as well but 6 core cable has an advantage over 3 core cable.

### 4.1 Wiring details

Cable colour (Sensor)	Description	Cable Colour (CS-0703)
Red	12V DC	Red, Blue
Black	Ground	Black Brown, White
Green	Output	Green

### 4.2 Sign convention

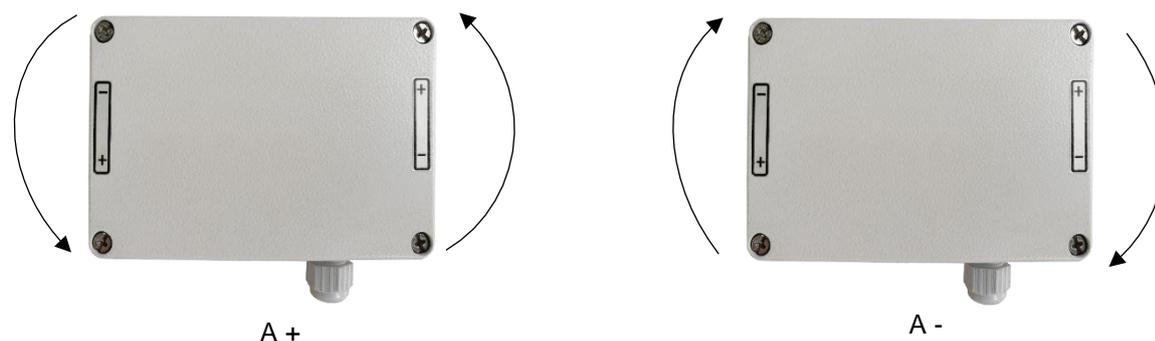
Carefully orient the tilt sensor during installation. A (+) sign is on the top right side of the enclosure. If the enclosure is tilted counter clockwise then readings show an increase (with positive sign)- Figure 8 (left). If the enclosure tilts clockwise then readings show a decrease (with a negative sign)-Figure 8 (right).

If the tilt meter is installed on the plane of a building, the B (+) sign is towards the plane and B (-) sign is away from the plane.

If a uni-axial sensor is installed it measures tilt only along axis 'A'.

Figure 8 below shows view from side and convention used for direction/output signal polarity. After the enclosure is fixed to the structure, the sensor is adjusted to the zero reading (initial). Subtracting the initial tilt reading from the subsequent tilt reading gives change in tilt of structure over a period of time.

### 4.3 Zero adjustment of tilt meter



**Figure 8 Sign Convention of tilt for EAN-93M tilt meter**

Connect the EAN-93M/EAN-93M-B tilt meter with the datalogger and adjust the sensor housing/beam to make it as close to zero and then fix it firmly such that it does not get disturbed.

### 4.4 Measurement using ESDL-30UNI datalogger

ESDL-30UNI, SDI-12 Universal Datalogger is designed to record data produced by the sensors connected to SDI-12 bus. Datalogger is having 3 SDI-12 ports (channels). Sensors having SDI-12 interface can be connected on a common SDI-12 bus. This bus can be connected to any SDI-12 port of the datalogger.

Each reading is stamped with date and time at which the measurement was taken. It has non-volatile flash memory to store up to 2 million data points.

These data files can be downloaded to PC using Configuration Manager software by connecting logger with data cable or Bluetooth. The downloaded readings get stored in the PC's home directory in CSV format. The downloaded files can be transferred to FTP server using internet connection. It can be processed on any common available spreadsheet like Microsoft-Excel.

ESDL-30UNI with built in GSM/GPRS has capability to upload data records directly to remote FTP server. Upload schedule can be set in Data logger using this software for automatic data upload to the FTP server. Schedule can be set as fast as 5 minutes.

SDI-12 inputs should have a unique ID (0-9, a-z or A-Z). Each of the 3 channels of the datalogger can have 61 sensors with ID 1-9 (ID 0 is used for factory purposes, hence not available for use), a-z or A-Z. For a given channel each sensor should have a different ID.

For operational details please refer to the users' manuals of ESDL-30 SDI-12 datalogger and ESDL-30 Configuration Manager.

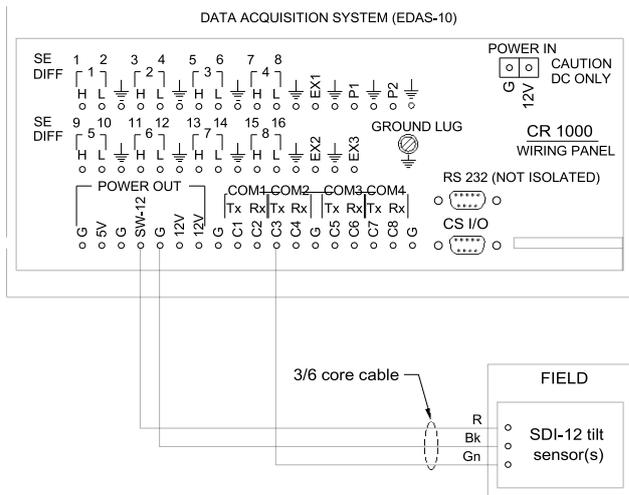
#### **4.5 Measurement using EDAS-10 data acquisition system**

Model EAN-93M tiltmeter having SDI-12 interface requires power source of 12V DC which is provided by EDAS-10 data acquisition system through Encardio-rite power supply model EBP-127AH. Since SDI-12 network is connected in bus mode, only 3 core cable is connected to the data acquisition system. A six core cable can also be used for the connection. Depending upon the application, the data acquisition system can be based on Campbell measurement and control modules CR1000, CR800 or CR200.

**NOTE:** For detailed instructions on configuration of Encardio-rite model EDAS-10 data acquisition systems based on measurement and control modules CR 1000/CR 800/CR 200, refer to Campbell Scientific's relevant Users' Manual.

Typical wiring/connection of in-place inclinometer system to CR1000, CR800 or CR200 based data acquisition systems are shown in the figures on the next page. In case data is to be transmitted via GSM/GPRS or RF modem only the CR 1000 or CR 800 based data acquisition system can be used. The CR 200 does not support transmission of data by GSM/GPRS or RF modem.

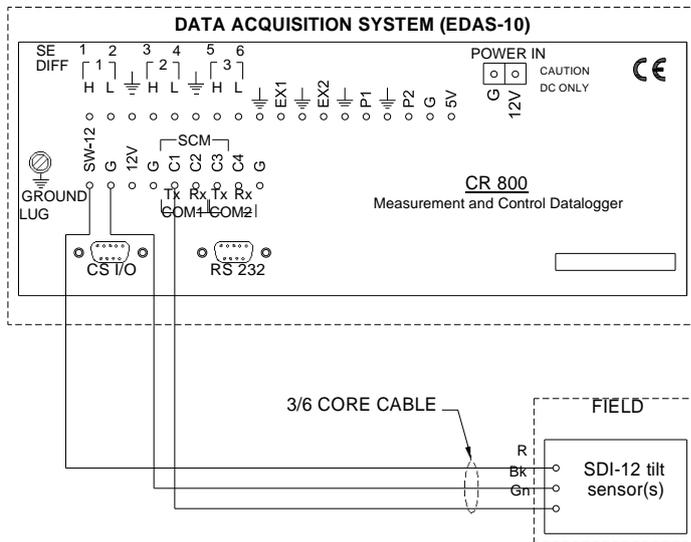
**1) Tilt meter with CR1000 System**



Data transmission via direct RS-232, RF or GSM/GPRS



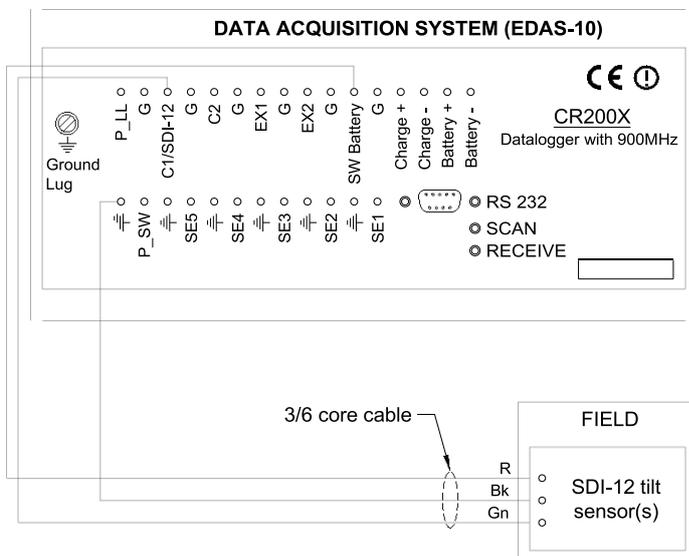
**2) Tilt meter with CR800 System**



Data transmission via direct RS-232, RF or GSM/GPRS



**3) Tilt meter with CR200 System**



Data transmission via direct RS-232

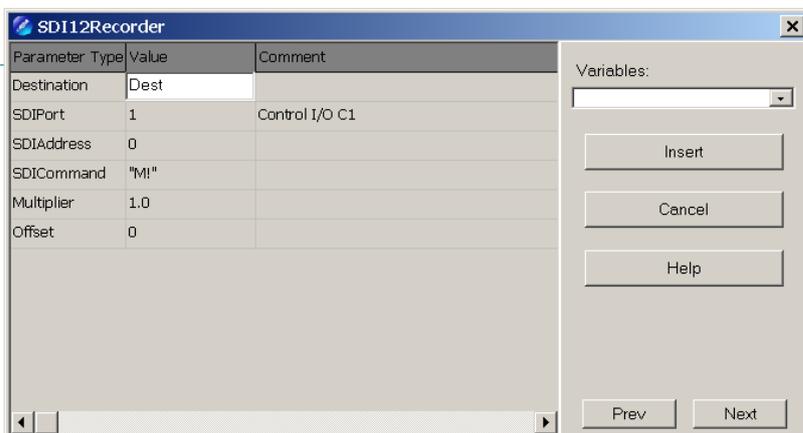


### 4.5.1 Program for SDI-12 sensor

Encardio-rite can supply a program for monitoring SDI-12 tilt meter based on information provided by the customer. For details, contact Encardio-rite's head office in India.

**SDI12 Recorder**-The SDI12 Recorder instruction is used to retrieve the results from an SDI12 sensor.

**Syntax**-SDI12 Recorder (Dest, SDI PORT, SDI Address, SDI Command, Multiplier, Offset)



Where, Destination is the defined address for storage, SDI PORT is the control port connected to sensor, SDI Address is the defined address of the connected sensor, SDI Command is taken as "M!" The Multiplier and Offset have purpose as the name suggests.

**aM1!** - An active sensor responds to each command

The SDI-12 command basically has following three components:

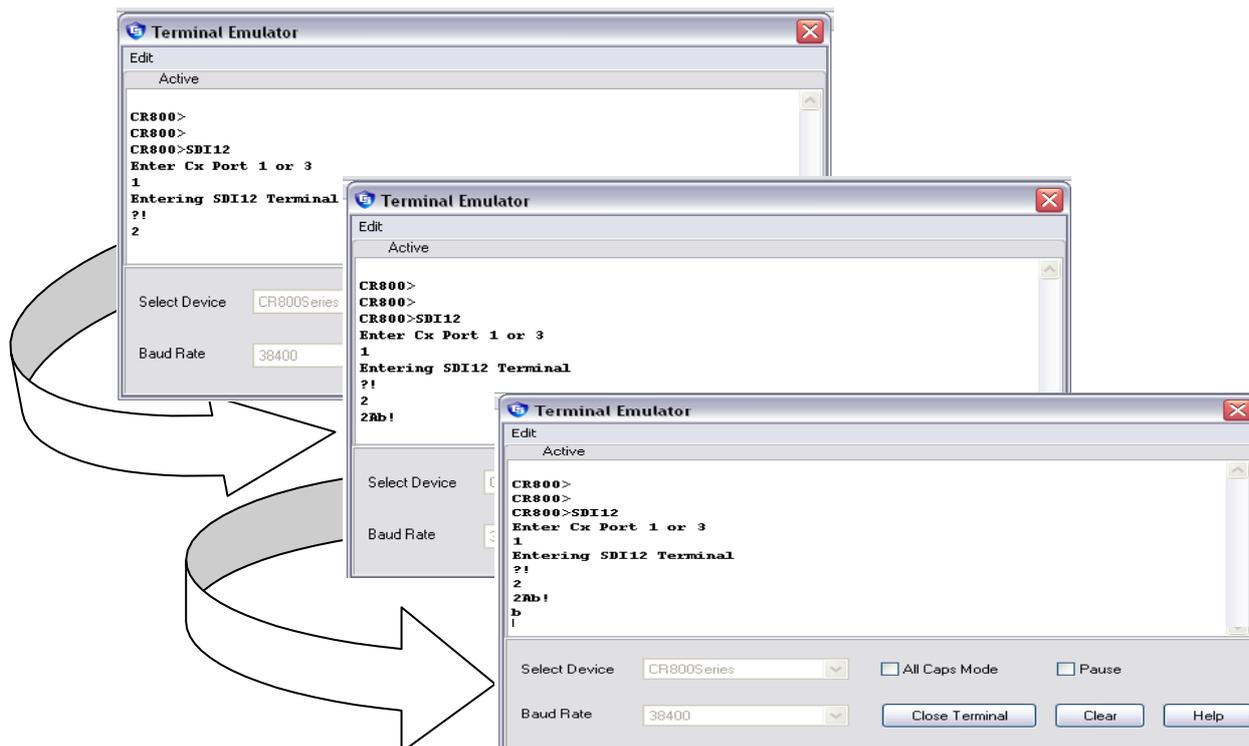
**Sensor address (a)** - a single character, and is the first character of the command

**Command body (e.g., M1)** - an upper case letter (the "command") followed by alphanumeric qualifiers.

**Command termination (!)** – Command terminates with an exclamation mark.

#### SDI12 Sensor address change:

To change a sensor's address we need to send a command as given below. Command: **0A2!**



**(Previous\_AddressA**A**New\_Address!)**

Note: Here, 2 = Previous\_Address and b = New\_Address

#### **4.5.1.1 Typical programming for reading one SDI-12 sensor using CRBasic**

The tilt meter response can be checked before installation at site with the help of simple program module:

" SDI-12 Sensor measurements with CR1000 Series Datalogger

'Declare Public Variables

Public batt\_volt

Public PTemp

Public Results(6)

Public Sensor\_ID(2)

Public watchdog

'Declare Other Variables --Sensor name can be changed as required

Alias Results(1)=Sensor\_1

Alias Results(4)=sensor\_2

'Define Data Tables

DataTable (SDI\_DATA,True,-1)

    DataInterval (0,5,min,0)

    Sample (1,batt\_volt,FP2)

    Sample (1,PTemp,FP2)

    Sample (1,Sensor\_1,IEEE4)

    Sample (1,Sensor\_2, IEEE4)

    Sample (1,watchdog,FP2)

EndTable

'Main Program

BeginProg

    watchdog=0

        Scan (10,sec,1,0) ' Scanning Interval Can be changed

        PanelTemp (PTemp,250)

        Battery (batt\_volt)

        'Sensor\_ID(1)=value

        Sensor\_ID(1)=0 'for connected sensor

        Sensor\_ID(2)=1

'SW12(1)

Delay(0,3,sec)

' SDI-12 Sensor measurements

SDI12Recorder (Results(1),3,Sensor\_ID(1),"M!",1.0,0)

SDI12Recorder (Results(4),3,Sensor\_ID(2),"M!",1.0,0)

Delay(0,5,sec)

If watchdog = 0 Then

    watchdog = 10

EndIf

    CallTable(SDI\_Data)

NextScan

EndProg

#### 4.5.1.2 Typical programming for reading one SDI-12 sensor using Terminal Emulator

Terminal Emulator emulates a terminal connected to a datalogger or communications device. On selecting a device and baud rate and clicking Open Terminal causes PC400 to attempt to connect with that device. If the device is a datalogger, PC400 will call the datalogger over whatever communications link has been established and will attempt to get a prompt from that datalogger. The data response through emulator is as per Figure 9:

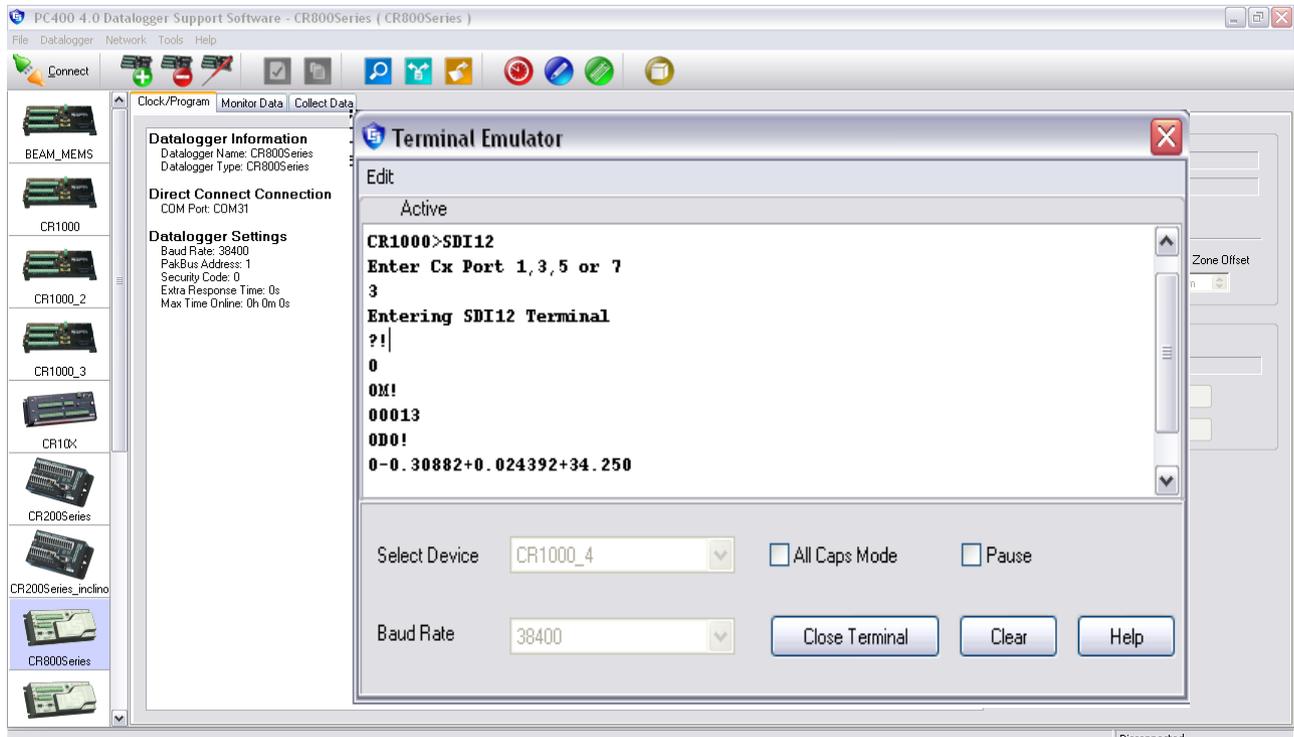


Figure 9 Terminal Emulator

## 4.6 Environmental factors

Several factors can influence the behavior of the structure being monitored for change in tilt using the tilt meter. Having a knowledge of the factors influencing the behavior of the structure is essential for analyzing the tilt meter data. Data related to factors such as rain fall, tidal or reservoir levels, excavation or fill levels, construction activities nearby the structure, movement of traffic near the structure and its type, wind, ambient temperature, barometric pressure etc. should also be observed and collected along with the tilt meter data.