ENCARDIO RITE

ONE STOP MONITORING SOLUTIONS | HYDROLOGY | GEOTECHNICAL | STRUCTURAL | GEODETIC

USERS' MANUAL

TRIAXIAL CRACK/JOINT METER

MODEL EDJ-40T

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1 INTRODUCTION

The Encardio-rite model EDJ-40T triaxial crack/joint meter is designed to measure displacement/movement across joints in X, Y & Z directions such as the joint opening between two concrete/masonry blocks in a dam. It is also used for monitoring of cracks and for displacement in concrete structures, rocks, bridges and pavement slabs, etc.

Surface crack/joint measurements can be made either on the surface or at locations accessible from galleries. The measurement is made by fixing reference points, one on either side of the joint and accurately measuring distance between the two points mechanically or electronically at certain intervals. Full reliance should not be placed on surface measurement. It should be recognized that all parts of a joint do not open at the same time, nor even the same amount. Thus, most information on the joint opening is gained from internally located joint meters. In some cases, where knowledge of shearing movement is desired, surface measurements can be made to advantage where joints are accessible in galleries.

1.1 Features

- Reliable and accurate.
- Simple to install.
- Simple to read.
- Rugged construction.
- Low cost.

1.2 Applications

Triaxial jointmeter to measure mass movement in:

- Construction and submerged joints in concrete dams, structures and bridges.
- Tunnels and shaft linings.
- Rock, soil and masonry structures.

1.3 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.

1.4 How to use this manual

This users' manual is intended to provide sufficient information for making optimum use of tape extensometer in various applications.

NOTE: The installation personnel must have a background of good installation practices and knowledge of the fundamentals of geotechnics. Novices may find it very difficult to carry on installation work. 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, the best of instruction manuals cannot provide for each and every condition in the field, which may affect the performance of the instrument. Also, blindly following the instruction manual will not

guarantee success. Sometimes, depending upon field conditions, the installation personnel will have to consciously depart from the written text and use their knowledge and common sense to find solution to a particular problem.

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

This manual is divided into a number of sections. Each section containing a specific type of information.

It is however recommended that you read the manual from the beginning to the end to get a thorough grasp of the subject. You will find lots of unexpected information in the sections you feel you may skip.

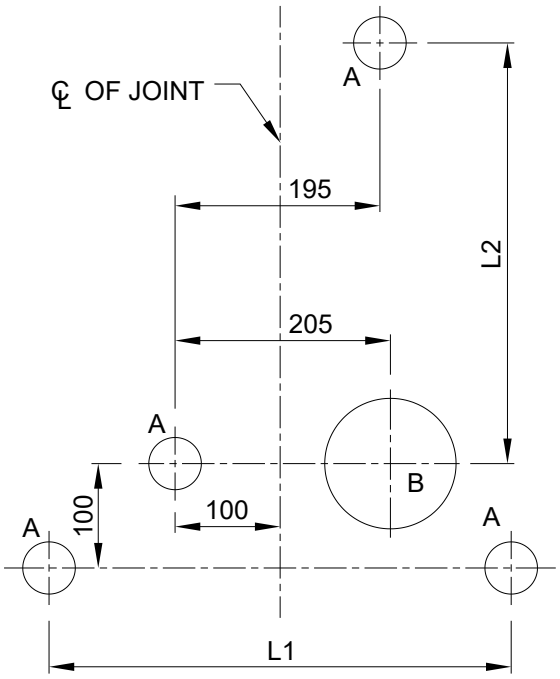
2 TRIAXIAL CRACK/JOINT METER

2.1 General Description

The Encardio-rite model EDJ-40T tri-axial (3-axis) joint meter measures relative movement of two concrete blocks in 3 directions. It uses three independent orthogonally mounted vibrating wire linear displacement transducers with universal joints at ends, anchored to concrete slabs at opposite sides of the joint, to resolve the relative movement along three mutually perpendicular directions (or axes) as follows:

- X-axis: Normal to joint to measure joint opening or closing.
- Y-axis: Parallel to joint (and concrete slab face) to measure joint shear in the plane of concrete face.
- Z-axis: Normal to concrete face to measure relative settlement of the concrete slabs.

Encardio-rite model EDI-54V readout unit is able to display/record measured displacement directly in engineering units. The sensors can also be connected to a multiplexer of model EDAS-10 data acquisition system.



Drilling Plan
(Holes for anchor & sensor)

Hole for	Hole size x depth	Qty.
A (anchor)	Ø50 x 200	4
B (sensor)	Ø125 x L3	1

Range	L1	L2	L3

Figure 2-1 – Drilling plan

3 TOOLS & ACCESSORIES REQUIRED FOR INSTALLATION

The following tools and accessories are required for proper installation of the tri-axial joint meter:

1. Spanner size 8,13 & 14 no.
2. Cable ties
3. Measuring steel tape
4. Thread sealant (Loctite 290 or equivalent)
5. Cable jointing compound (MS 853 & hardener MSH 283 – 3M or equivalent)
6. Acetone (commercial)+
7. Spirit level
8. Hacksaw with 150 mm blade
9. Cable Cutter
10. Surgical blade with holder
11. Wire Stripper
12. Pliers 160 mm
13. Screw driver set
14. Stainless steel rod 5 mm dia x 150 mm length
15. Spatula
16. Rotary tin cutter
17. Cloth for cleaning (lintless)
18. Adjustable spanner
19. EDI-51V read-out logger
20. Multimeter

4 PRE-INSTALLATION CHECK

The displacement transducers should be checked for proper operation (including the thermistor) before installation.

CAUTION: The displacement sensor is a delicate and sensitive instrument. It should be handled with care. Twisting or applying too much force on the shaft with respect to the sensor body may result in a zero shift or even permanent damage. Always displace shaft axially while checking or installing sensor.

The shaft end is provided with an alignment pin that sits inside an alignment slot on sensor body. When not in use or while tightening sensor against a shaft mounting object, keep the pin engaged inside the slot to prevent any damage to the sensor by rotation of sensor against shaft body.

- Check the sensors before installation. Four core signal cable from the displacement sensor has red and black cores for frequency signal; green and white for temperature monitoring through a thermistor. Check working of sensor as follows:
  - Connect sensor to model EDI-51V readout unit. With displacement shaft in retracted position enter sensor constants from Test Certificate and set reading in engineering units at zero mm.
  - Using a scale, pull the shaft by about 5 mm. The readout unit should read around 5 mm. This change in reading ensures proper functioning of displacement sensing system.
  - Check the coil resistance by the digital multimeter, value should lie between 130-180 Ohm.
  - Switch EDI-54V indicator to temperature mode, the displayed temperature should be near to the ambient temperature.

5 INSTALLATION PROCEDURE

The displacement sensor is provided with universal joints and threaded end studs at both ends. The threaded studs have two sets of nut and washer each. While fixing, locate inner nut and washer on one side of the bracket plate and other washer and nut on other side of the bracket plate, tightening the bracket in between.

1. The joint meter group shall be installed at

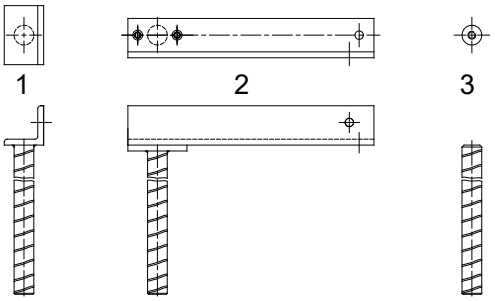


Figure 2 – Mounting brackets

the joint of the concrete blocks. One end of each joint meter shall be installed on one concrete block and other end on the second concrete block.

2. At location where joint meters have to be installed, prepare surface for installation. Both blocks must be exactly at same elevation level.
3. For installation of joint meters at the specified elevation EL NNN, the rock surface is levelled with cement mortar up to the desired elevation i.e. EL NNN.
4. Check tag numbers of instruments to be installed.
5. Mark location on surface of blocks very carefully.

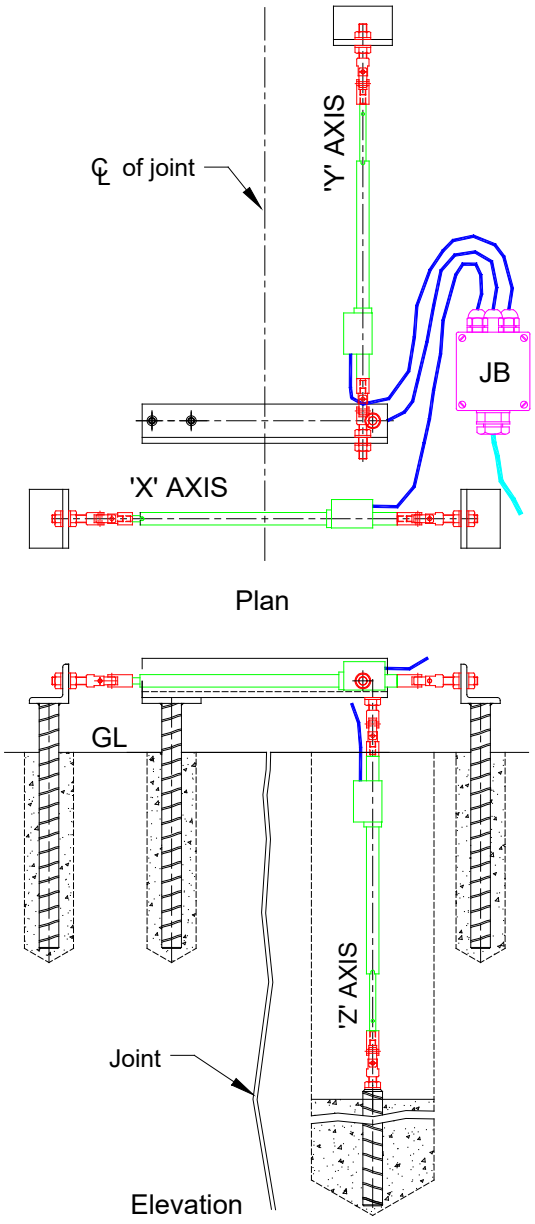


Figure 3 – Installation plan & elevation

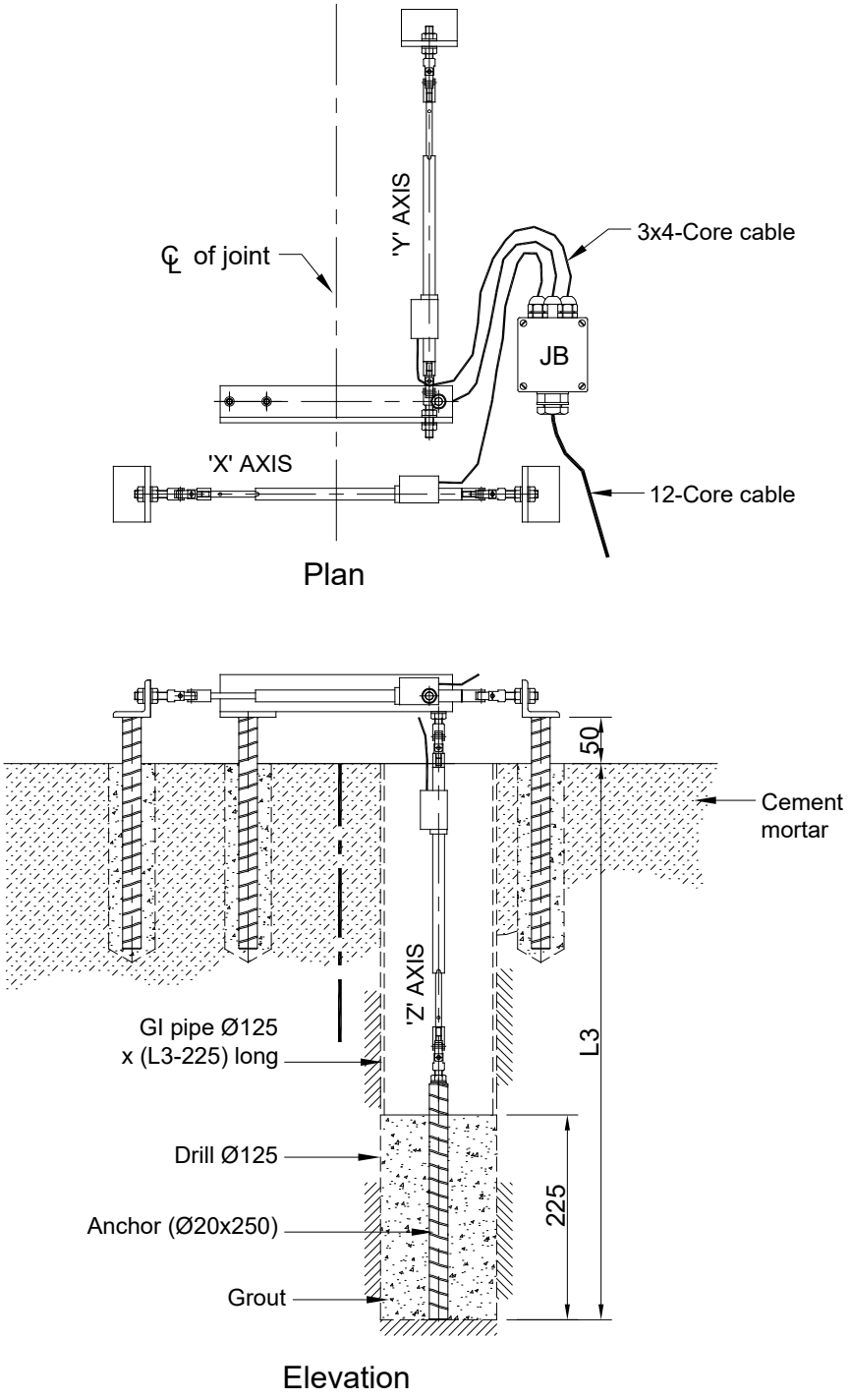


Figure 4 – **Installation plan & elevation**

6. Hole centre lines can be marked with pigment impregnated cords, that will allow marking to be carried over small projections, and right angles can be checked with a mason's square. The dimensions given in the drilling plan only serve as a guide for finding the initial location of the mounting brackets. For subsequent drilling, the brackets should be used as drilling templates. Similarly, the dummy sensors should be used to locate the position of the brackets at the other side of the joint.

7. Drill holes as per marked drilling plan in figure 3.

8. Four holes "A" to be drilled with diameter 50 mm and depth 200 mm. For Z direction installation hole with diameter 125 mm and depth L3 mm (figure 3) is required. While fixing brackets with more

than one fixing hole, first drill one hole and mount bracket. Align bracket as specified in drawing. Then using bracket itself as a template, drill the additional holes and fix the anchors one at a time.

9. For installation of Joint meter at EL nnn in the Z direction, install a G.I. pipe of o.d. 125 mm of required length (L3-225 mm) in the drilled hole (flush with the mouth of the drilled hole) as shown in figure 6.

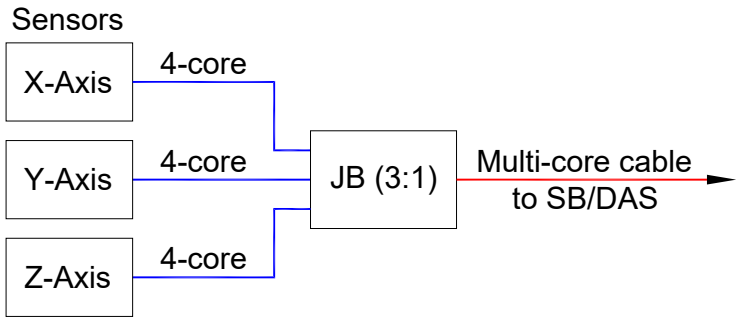


Figure 5 – Sensor connection to junction box

10. Mounting brackets can be identified as per figure 5. Fix and grout brackets 1, 2 & 3 with the help of dummy sensor as per figure 6. The grout depth/height for 1 & 2 brackets is 200 mm and for bracket no. 3 depth/height of grout is 240 mm. Take precaution in grouting such that dummy sensor threads are not jammed as it is to be replaced by actual sensor.

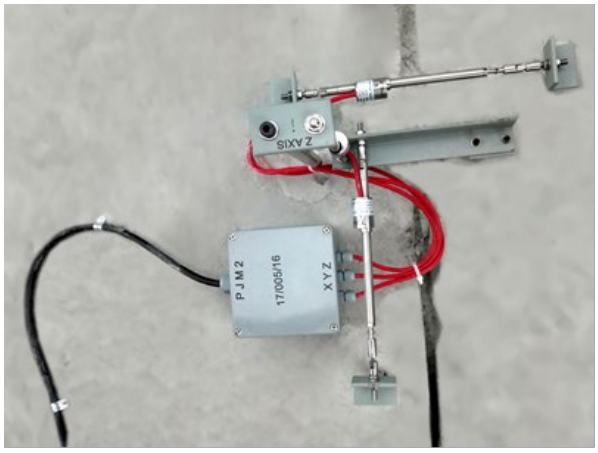


Figure 8 (a): Sensor connection with junction box – Z axis on top of the block

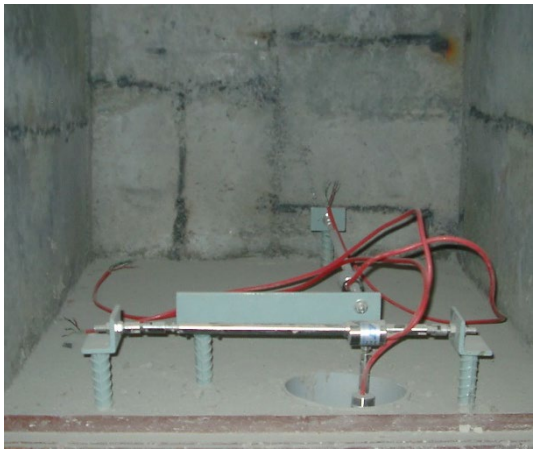


Figure 8 (b): Sensor connection with junction box – Z axis downwards

11. NOTE: Dummy sensors are provided for maintaining correct distance during fixing and alignment of brackets. The actual displacement sensors should not be used during fixing and alignment of brackets as they can get damaged. After the brackets are mounted and aligned, the dummy sensors should be removed and replaced with the actual sensors.

12. After grout is set remove dummy sensors and replace by sensor as per drawing.

13. Connect leads to EDI-51V and take zero reading of each sensor in frequency2 (digits). These readings will form the 'initial reading' to be entered in the EDI-51V for sensor set-up data. Refer to test report supplied with sensor for gage factor. Shift to temperature mode and record the temperature.

14. The sensors are provided with 1 m long leads. Connect these to the three position junction box as per wiring diagram given in figure 7. Connect requisite length of 8 core cable/multi core cable to

the junction box. Fill junction box with cable jointing compound. Recheck working of all the sensors.

15. Cable from junction box can be connect to connector pins in the switch box in case the same is provided which can be connected to a central data acquisition system through a multi core cable or cable from the junction box can be directly extended to central data acquisition system.

16. Crack meters (3D) require free movement for monitoring displacement between blocks. They can therefore not be directly embedded in concrete as this would restrict their movement. A small cavity has to be left around and over them before resuming work on the lifts. Construct by hand and shovelling using same concrete as the mass concrete, leaving a cavity of around 200 mm height over the joint meters such that a free movement of > 50/100 mm (full range of sensor) is allowed to them in all the three X, Y and Z directions. Carefully, manually finish up the lift all around this location and give time to let it set before resuming mass concreting.

17. Care should be taken that no concrete spills into the cavity thus damaging the sensor. The concrete should be compacted with a light duty pneumatic or petrol backfill tamper. The first layer of material over the cavity should be 250 mm high and compacted properly. Similar layers of material should be put over this and compacted properly until at least 1 m of material has been placed.

CAUTION: Never rotate shaft of displacement sensor with respect to the outside body. This will permanently damage the sensor. During installation push or pull shaft only axially. A pin has been provided at the end of displacement sensor that sits flush in a groove in sensor body. During assembly operation and while using spanners for tightening, keep sensor in closed position with pin seated inside groove such that no torque is exerted on its shaft and there is no rotational movement.

CAUTION: Do not use thread sealant on any thread while mounting the sensor as it may have to be replaced at a later date.

5.1 Taking readings with the model EDI-54V vibrating wire indicator

The model EDI-54V vibrating wire indicator (figure 9) is a microprocessor-based read-out unit for use with Encardio-rite's range of vibrating wire sensors. It can display the measured frequency in terms of time period, frequency, frequency squared or the value of measured parameter directly in proper engineering units. It uses a smartphone with Android OS as readout having a large display with a capacitive touch screen which makes it easy to read the VW sensor.

Fig 9 – Vibrating wire indicator

The EDI-54V vibrating wire indicator can store calibration coefficients from 10,000 vibrating wire sensors so that the value of the measured parameter from these sensors can be shown directly in proper engineering units. For transducers with built-in interchangeable thermistor, it can also display the temperature of the transducer directly in degree Centigrade.

The vibrating wire indicator has an internal non-volatile memory with sufficient capacity to store about 525,000 readings from any of the programmed sensors. Each reading is stamped with the date and time the measurement was taken.

Refer instruction manual WI-6002.112 of model EDI-54V for entering the transducer calibration coefficients. The gage factor of the model EDJ-40T is given in the test certificate provided with every supply. The initial reading IR will be the actual reading in digits from the sensors fixed at the concrete blocks/shear zones after the complete assembly, anchors are properly set in grout mixture.

An internal 6 V 4 Ah rechargeable sealed maintenance-free battery is used to provide power to the vibrating wire indicator. A battery charger is provided to charge the internal battery which operates from 90 V to 270 V AC 50 or 60 Hz V AC mains. A fully discharged battery takes around 6 hours to get fully charged. The indicator uses a smartphone as a readout that has its own internal sealed rechargeable Li-ion maintenance battery as a power source. A separate battery charger/adapter unit for the smartphone, operating from universal AC mains supply is supplied with each EDI-54V indicator unit.

The EDI-54V vibrating wire indicator is housed in an impact resistant plastic moulded housing with weatherproof connectors for making connections to the vibrating wire transducer and the battery charger.

5.2 Sample test certificate

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Geotechnical, Structural and Environmental Monitoring Solutions

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P: +91 522 2661039-42 | F: + 91 522 2662403 | Web: www.encardio.com | E-mail: qc@encardio.com
CIN: U32109UP1966PTC003122 | NSIC: NSIC/GP/LKO/2015/0013524 | MSME: 09 02712 00221 dt. 16/01/2008 | D&B Rating: 4A1

TEST CERTIFICATE

Instrument : Model EDJ-40T Tri-axial joint meter
Serial number : xxxxxxxx Date : 19.01.2021
Capacity : 100 mm Temperature : 18 deg C

Input Displacement (mm)	Up1 (Digit)	Observed value (Digit)	Up2 (Digit)	Average (Digit)	End Point Fit (mm)	Poly Fit (mm)
0.00	2474.3	2459.9	2459.9	2467.1	0.00	-0.06
20.00	3388.1	3368.0	3374.8	3381.4	20.20	20.05
40.00	4294.4	4271.5	4284.2	4289.3	40.25	40.08
60.00	5193.5	5177.4	5185.8	5189.7	60.14	60.00
80.00	6085.2	6089.9	6080.5	6082.9	79.87	79.82
100.00	6995.7	6995.7	6992.4	6994.0	100.00	100.10
				Error (%FS)	0.25	0.18

Digit : $f^2/1000$
Linear gage factor (G) : 2.2090E-02 mm/digit

Thermal factor(K) : 0.002 mm/°C

Polynomial constants :
A= 3.5825E-08 B= 2.1785E-02 C= -5.4021E+01

Displacement "D" is calculated with the following equation:
Linear : D(mm) =G(R1-R0)-K(T1-T0)
Polynomial : $D(mm) = A(R1)^2 + B(R1) + C - K(T1-T0)-D0$
R1 = current reading & R0 is initial reading in digit.
D0 = Initial reading in mm

Zero reference (initial position) in the field must be established by recording the initial reading R0 (digit) along with temperature T0 (°C) just after installation.

Note : Zero displacement reading given in above calibration chart is taken at around 3 mm from mechanical zero, i.e. slider fully in .

Pin configuration/wiring code:

Red & black : signal Green & white: thermistor

Tested by:

6 TROUBLESHOOTING

The crack/joint meter is installed during construction of the structure. Once installed, the triaxial jointmeter is usually inaccessible and remedial action is limited. Maintenance and troubleshooting is consequently confined to periodic checks of cable connection and functioning of the read-out unit. Refer to the following list of problems and possible solutions if problems arise. For any additional help, consult the factory.

6.1 Symptom: displacement sensor reading unstable

- Check the insulation resistance. The resistance between any lead and the protective armour should be > 500 M Ohm. If not, cut a meter or so from the end of cable and check again.
- Does the read-out work with another crack/joint meter? If not, the read-out may have a low battery or be malfunctioning. Consult the manual of the readout unit for charging or trouble shooting instructions.
- Use another read-out unit to take the reading.
- Check if there is a source of electrical noise nearby. General sources of electrical noise are motors, generators, transformers, arc welders and antennas. If so the problem could be reduced by shielding from the electrical noise.

6.2 Symptom: displacement sensor fails to read

- The cable may be cut or crushed. Check the nominal resistance between the two gage leads using an Ohm meter. It should be within 130 - 180 Ohm. The correct value is given in the test certificate. Please add the cable resistance when checking. If the resistance reads infinite or a very high value, a cut in the cable is suspected. If the resistance reads very low (<100 Ohm), a short in the cable is likely.
- Does the read-out work with another displacement sensor? If not, the read-out may have a low battery or be malfunctioning. Consult the manual of the readout unit for charging or trouble shooting instructions.

Use another read-out unit to take the reading.

7 WARRANTY

The Company warrants its products against defective workmanship or material for a period of 12 months from date of receipt or 13 months from date of dispatch from the factory, whichever is earlier. The warranty is however void in case the product shows evidence of being tampered with or shows evidence of damage due to excessive heat, moisture, corrosion, vibration or improper use, application, specifications or other operating conditions not in control of Encardio-Rite. The warranty is limited to free repair/replacement of the product/parts with manufacturing defects only and does not cover products/parts worn out due to normal wear and tear or damaged due to mishandling or improper installation. This includes fuses and batteries

If any of the products does not function or functions improperly, it should be returned freight prepaid to the factory for our evaluation. In case it is found defective, it will be replaced/repaired free of cost.

A range of technical/scientific instruments are manufactured by Encardio-rite, the improper use of which is potentially dangerous. Only qualified personnel should install or use the instruments. Installation personnel must have a background of good installation practices as 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.

The warranty is limited to as stated herein. Encardio-rite is not responsible for any consequential damages experienced by the user. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. Encardio-rite is not responsible for any direct, indirect, incidental, special or consequential damage or loss caused to other equipment or people that the purchaser may experience as a result of installation or use of the product. The buyer's sole remedy for any breach of this agreement or any warranty by Encardio-rite shall not exceed the purchase price paid by the purchaser to Encardio-rite. Under no circumstances will Encardio-rite reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

A lot of effort has been made and precaution for accuracy taken in preparing instruction manuals and software. However best of instruction manuals and software cannot provide for each and every condition in field that may affect performance of the product. Encardio-rite neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damage or loss that results from use of Encardio-rite products in accordance with the information contained in the manuals or software.

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