NOVARENT
LOCATION ET VENTE DE MATÉRIEL DE MESURE

SETTLEMENT MONITORING SYSTEM USING VW SENSORS

MODEL ESM-30V

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Contents

1 INTRODUCTION

The Encardio-rite Model ESM-30V settlement monitoring system is a precision settlement measuring system for remote measurement of small settlements at multiple spots or locations with high resolution.

It employs a number of partially liquid (generally water) filled settlement monitoring sensors connected together with a common liquid line. Each settlement monitoring sensor is equipped with a vibrating wire transducer to measure the level of liquid in the liquid chamber of the settlement sensor. One of the settlement measuring sensors in a system is fixed at a reference location where either no significant settlement is expected or its elevation can be precisely determined by conventional surveying methods. Settlement of all other sensors are measured with reference to this reference sensor.

In practice the liquid vessel of each settlement monitoring sensor in a system are connected together with a liquid line or tubing so the level of liquid in each sensor tries to find a common level. If any settlement monitoring sensor goes up relative to the reference sensor liquid drains out of the liquid chamber to maintain the common liquid level. Similarly, if any of the sensor goes down more liquid fills in the sensor liquid chamber thus raising the level of the liquid inside the sensor. A larger liquid reservoir chamber at the reference location is also connected to the common liquid line to supply or absorb the liquid draining in or out of the sensors due to their upwards or downwards movement thus keeping the common liquid level at more or less the initially fixed level.

Encardio-rite model EDI-54 vibrating wire readout can be used to measure the frequency output of the vibrating wire settlement monitoring sensors. The EDI-54V can be configured to automatically calculate and display the liquid level in the sensors directly in engineering units (in this case in millimetres). For automatic continuous monitoring of the level sensors a data acquisition system like Encardio-rite model ESDL-30/EDAS-10 data loggers can be used.

1.1 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 vibrating wire centre hole load cells in your application.

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

1.2 How to use this manual

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, the working principle of vibrating wire Settlement Monitoring System: See § 2.1 'Operating principle'.

For test certificate: See § 2.4 'Sample test certificate format'.
For essential tools and accessories: See § 3 'Tools and accessories required for installation".
For installation of Settlement Monitoring System: See § 4 'Installation procedure'.
For trouble shooting: See § 4.8 'Trouble shooting'.
For evaluating thermistor data: See § 6 'Thermistor - temperature resistance correlation'

2 VIBRATING WIRE SETTLEMENT MONITORING SENSOR

2.1 Operating principle

The settlement sensor is based on the principle of measurement of apparent weight of a hollow metal float that always remains submerged in liquid inside the settlement monitoring sensor. As the level of liquid in the sensor goes up or down there is a corresponding change in the apparent weight of the float in accordance with the law of buoyancy. A vibrating wire load transducer (force transducer) is used to measure the apparent weight of the float.

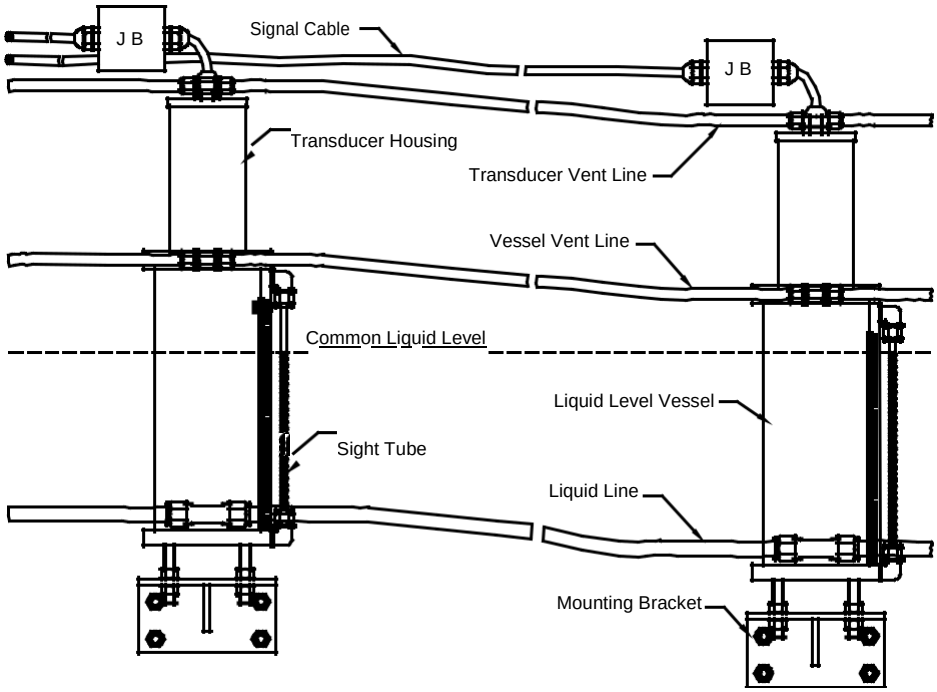

Figure 2-1 Schematic diagram of ESM-30V settlement monitoring system

The settlement sensor consists of a liquid filled cylindrical vessel at bottom with a vibrating wire load transducer fixed above it. A smaller diameter cylindrical stainless-steel float is suspended from this load transducer. The weight of this float is so adjusted that it always remains partially submerged in the liquid contained in the bottom vessel. If level of liquid in the bottom vessel rises the apparent weight of the float measured by the load transducer reduces. Similarly, if there is a fall in liquid level in the bottom vessel, the apparent weight of the float as measured by the load transducer goes up. As the apparent load on load transducer increases or decreases the frequency of the output signal from the vibrating wire load transducer also changes accordingly.

The vibrating wire load transducer essentially consists of a stretched magnetic wire that carries entire load of the float. The transducer has two opposing electromagnet coils around the middle of the stretched wire. Initially a plucking signal is applied to the coils which sets the vibrating wire to vibrate at its natural (also known as resonant) frequency. The vibrating wire induces a corresponding ac voltage across the magnet coils which can be measured to find the frequency of the vibrating wire. The square of the frequency of the vibrating wire is proportional to the applied load. The exact relationship for each settlement-monitoring sensor is determined during calibration of the load transducer at the factory and supplied as a test certificate, together with the settlement-monitoring sensor. This allows the user to measure the transducer output frequency and calculate the level of liquid in the sensor.

2.2 How to calculate the level of liquid in sensor

The frequency of the VW level sensor output can be measured with most commercially available vibrating wire indicators. Most VW indicators can display the output of the VW sensors in terms of square of the measured frequency. However, as the square of the measured frequency is a large figure, for ease of display most indicators divide this figure by 1000 before showing it on the display. The modified display units will be referred to as digits. For example, if the sensor output is 2500 Hz, the VW indicator will show the sensor output as

(2500 x 2500) / 1000 = 6250 digits.

The calibration certificate provided by Encardio-rite report the sensor output in terms of digits.

The ER calibration certificate provides two sets of calibration coefficients. For general use a linear approximation known as end point fit straight line coefficients are provided. To calculate the height of liquid level in the sensor the following equation is used.

$$H \text{ (in mm)} = G\,(R0 - R1)$$

Where H is height of level of liquid inside the sensor liquid chamber, G is linear gauge factor and R0 is the reading in digits corresponding to '0' mm in the test certificate. R1 is current reading in digits (as measured by user).

If best possible resolution and accuracy is required, the polynomial calibration constants can be used. However, the calculation is bit more involved and uses the following equation.

$$H \text{ (in mm)} = A\,(R1)^2 + B\,(R1) + C$$

Where H is height of level of liquid inside the sensor liquid chamber, A, B and C are the three polynomial coefficients, and R1 is current reading in digits (as measured by user).

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

The model EDI-54V vibrating wire indicator (figure 2-2) 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.

Figure 2-2 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 ESM-30V liquid level system is given in the test certificate provided with every supply. The initial reading IR will be the actual reading in digits from the vibrating wire liquid level system after it is installed at the desired location.

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.

For operating complete operating procedure please refer 'Doc. # WI 6002.112'

2.4 Sample Test Certificate Format

TEST CERTIFICATE

Customer			
P.O.no.			
Instrument	Vibrating wire sensor for settlement monitoring system		
Model	ESM-30V	Date	05.08.2018
Sensor serial number	08015	Temperature	32°C
Range	150 mm		
Float serial number	08015		
Float detail	a) Weight (kg) :		
	b) Length (mm) :		
	c) Outer diameter (mm) :		

Change in water head	Observed value (Digit) Increasing	Decreasing	Increasing	Average (Digit)	End Point Fit	Poly Fit
(mm)	C-1	C-2	C-3	(C1+C3)/2	(mm)	(mm)
0.0	11019.9	11012.2	11012.2	11016.1	0.00	0.01
30.0	10267.5	10273.6	10271.6	10269.5	29.93	29.84
60.0	9507.8	9511.1	9511.3	9509.6	60.40	60.27
90.0	8761.9	8770.2	8775.7	8768.8	90.11	89.99
120.0	8023.5	8035.8	8033.5	8028.5	119.79	119.76
150.0	7276.8	7276.8	7273.2	7275.0	150.00	150.12
				Error (%FS)	0.27	0.18

Digit $f^2/1000$

Linear gage factor (G) 4.0x095E-02 mm/digit

(Use gage factor with minus sign with our read out unit)

Polynomial constants

A=5.6158E-08 B=-4.1150E-02 C=4.4651E+02

Height of liquid level in sensor chamber "H" is calculated with the following equation:

Linear H (mm) =G (R0-R1)

Polynomial $H (mm) = A(R1)^2 + B(R1) + C$

R1 = current reading & R0 is initial reading in digit.

Zero reference (initial position) in the field must be established by recording the initial reading R0 (digit).

Note: Zero reading given in above calibration chart is taken when ~5 mm of float length is submerged in water.

Pin configuration/wiring code:

Red & black: Signal

Green & white: Thermistor

Checked by Tested by

3 TOOLS & ACCESSORIES REQUIRED FOR INSTALLATION

The following tools and accessories are required for installation of the settlement monitoring system.

- Small spirit level (preferably bubble type)
- Screw drivers with 4 mm flat blade.
- Spanner 13 mm
- Impact or percussion electric drill with 8mm and 5 mm drill bit for drilling in concrete or masonry (for fixing fasteners)
- Cable Cutter
- Wire Stripper
- 3½ digit digital multimeter
- Portable vibrating wire indicator (e.g. Encardio-rite model EDI-54V)

4 INSTALLATION PROCEDURE

The settlement monitoring sensors uses a high precision vibrating wire transducer that is very fragile. The sensor is supplied in semi assembled state and has to be finally assembled at site before fixing. Great caution should be exercised while assembling or fixing the sensor to avoid any damage to the load transducer.

Please read and understand this section fully before attempting to set up the liquid level settlement monitoring system.

4.1 Decide the location of the reference sensor

The first step is to decide the location of the reference sensor. The reference sensor and the liquid reservoir should be fixed at a location where no settlement is expected or, if that is unavoidable, at a place where the elevation of the reference sensor can be accurately surveyed using conventional surveying practice.

The level sensors have a small measuring range and the range of adjustment possible is also very small so all the sensors need to be initially mounted at the same elevation. Choose an elevation such that all the level sensors of that particular measurement group can be fixed at the same elevation at the chosen locations.

4.2 Installation of mounting brackets

The next step is to fix the mounting brackets on which the level sensors would be fixed. The mounting brackets are designed for fixing to a vertical surface like a wall. Using conventional surveying or other available means mark a short horizontal line at the same elevation at all locations where the level sensors are to be mounted.

The mounting brackets are fixed to the wall using a set of four anchors bolts that are generally supplied with the brackets. Epoxy fixed threaded anchors can also be used if required. The brackets should be fixed such that the bottom edge of the bracket is visually aligned with the horizontal survey mark line put earlier.

4.3 Fixing the settlement monitoring sensor to the bracket

It is very important that the sensor body be kept absolutely vertical while in operation. A tilted sensor will give erratic readings.

The liquid level vessel of the sensor has three threaded studs fixed to its bottom surface which are used for precise levelling of the sensor. Put a nut and a washer (supplied) on the three studs and pass the studs through the three corresponding holes in the mounting bracket. Put a washer and a nut on each of the three studs projecting out of the bracket.

Put a small spirit level (preferably bubble type) on the top horizontal surface of the liquid level vessel. Adjust the nuts on the top side of the brackets so that the spirit level shows a perfect horizontal alignment. Then tighten the bottom nuts on each stud to secure the sensor to the bracket.

4.4 Connecting the liquid line

Each level sensor has a T connector at its bottom for connecting the liquid to other sensors and reservoir. A 12mm OD, 10 mm ID nylon tubing is used to connect the sensors and liquid reservoir together. The T connectors have compression fittings suitable for use with 12/10 mm semi rigid plastic tubing.

Attach the liquid line from the reservoir to the reference level sensor and then to all the other sensors in sequence from the nearest to the farthest.

4.5 Filling the liquid in liquid lines

After all the sensors' liquid vessels are connected to the liquid reservoir, the sensor positioning and any leakages can be checked by filling the reservoir so that the liquid level in the sensors rise to around 25 mm mark on the transparent liquid level sight tube fixed to each sensor. The reservoir should be hand filled

with liquid very slowly till the liquid level in all the sensors have risen by approximately 25 mm. Care should be taken while filling to ensure that no air is seen trapped in the liquid lines. Also check for any leakages near tubing/T-joint and the proper elevation of each sensor.

The sensors are calibrated in the factory using distilled water (specific gravity taken as 1000 kg/m^3) and so the calibration coefficients given in the test certificate are valid when the fill liquid is plain distilled water. In general using distilled water as fill fluid will serve most installations. However, if required, other fill fluids can also be used provided the supplied calibration coefficients are adjusted for the different density of that fill fluid.

4.6 Fixing the float to the load transducer

As the vibrating wire load transducer is a very delicate assembly, the float is removed from the load transducer hook and packed separately for shipping. The next step is to fix the float to the load transducer.

The sensor liquid vessel, the load transducer housing and the floats are not interchangeable and hence are marked with a number for ease of identification. When fixing the float ensure that the number on the float is same as that on the sensor housing.

The load transducer is fixed to the upper lid of the liquid vessel using three M3 screws with slot head. A paint mark is put on the vessel lid containing the load transducer and the vessel body to help in re-alignment of the two halves during reassembly. Remove the three screws and raise the load transducer housing vertically upwards.

Unscrew the nut on the hook holder stud (marked N1 in the figure alongside) by two complete turns.

Identify the correct float and gently suspend the float from hook of the sensor assembly as shown in figure. Then carefully and slowly lower the load transducer housing (i.e. the vessel lid) back on the top of the sensor vessel taking care that the paint mark on the lid and the vessel are properly aligned before finally placing the lid on the vessel. Fix the lid to the vessel using the three screws removed earlier.

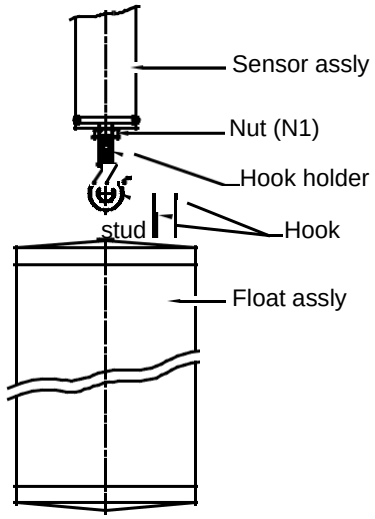

Figure 4-1

4.7 Completing the installation

The level sensors are provided with T-connections for two sets of air vent lines, one on the lid of the liquid vessel and one at the top of the load sensor housing.

The vessel air vent ports are connected together to ensure that the pressure above the fill liquid is same in all the vessels.

The force transducer vibrating wire capsule is vented to atmosphere to ensure that the air pressure both inside and outside the capsule are same so that any change in atmospheric pressure does not affect the reading of the transducer.

The force transducer air vent ports are connected together and vented to atmosphere near the fluid reservoir through a desiccant container so that only dry air can enter the transducer vent line. Moisture content in air in the transducer vent line can, in course of time, coalesce to form water droplets and can damage the inside of the transducer.

Both the air vent ports use T-connectors suitable for use with semi rigid nylon tubing of 6 mm OD and 4 mm ID.

After the air vent lines are installed, let the system stabilize for at least 24 hours before filling water in the sensors.

To fill liquid in the level sensors fill the liquid reservoir slowly till the liquid in the sensors rise to the desired level. Initially the liquid vessels should be filled up to the half way mark (i.e. 75 mm mark on the sight tube scale) so that the full range of +/- 75 mm settlement or heave can be measured.

4.8 Troubleshooting

4.8.1 Symptom: Sensor fails to read

- Check if the readout unit works with another good vibrating wire transducer. If not then the readout unit is either faulty or has a low battery. Recharge or replace battery and recheck. If fault still persists, the readout unit may be faulty. Use another readout unit or consult the readout unit user's manual for troubleshooting instructions.
- The cable may be cut or crushed. Check the nominal resistance between the two coil leads (generally red and black conductors if the cable is supplied by Encardio-rite) using an ohmmeter or a multimeter. It should be within 150 – 170 Ohms. If length of connecting cable is large, add the cable resistance to this value. For Encardio-rite model CS 0502 cable, the resistance is 57 Ohms per 1000m. If the observed resistance value is infinity or very high a cut cable should be suspected. If the resistance reading is very low, a short in the cable should be suspected.

4.8.2 Symptom: Sensor reading is noisy or shows fluctuation

- Does the readout work with another known good sensor. If not, the readout unit may have a low battery or be malfunctioning. Consult the manual of the readout unit for charging or troubleshooting instructions.
- Use another readout unit to take the reading.
- Check if there is source of electrical noise nearby. General sources of electrical noise are motors, generators, transformers, arc welders and radio antenna. If so the problem may be reduced by shielding the sensor cables from electrical noise

5 FINDING CHANGE IN ELEVATION

5.1 Calculating change in elevation of the individual level sensors

The level reading obtained from any settlement sensor is the current level of liquid in the sensor liquid chamber. To obtain the value of change in elevation over time, two level readings corresponding to the initial date and end date are required. The difference in the readings has to be corrected for any change in liquid level in the reference sensor. The process is explained in detail in the example given below.

Let us consider a system consisting of three settlement sensors, the first one of which is placed at a reference location and would be considered as the reference sensor (Sensor 1 or ref). We would be measuring the relative settlement at the other two sensor locations (Sensors 2 & 3).

After installation wait for the readings from the sensors to stabilize over a period of say 24 hours. The first set of level readings from all the three sensors are recorded as follows. The liquid used in the system is pure water and the sensor readings in the table below have already been converted to mm of water column.

Sensor	Reading (in mm)
1 (Ref)	74.3
2	79.2
3	71.7

On a subsequent date the observation was as follows:

Sensor	Reading (in mm)
1 (Ref)	72.4
2	78.9
3	68.2

The change in elevation of any sensor is given by:

$$\Delta EL_n = (R1_n – R0_n) – (R1_{ref} – R0_{ref})$$

Where:

ΔEL_n	Change in elevation of the sensor n
$R1_n$	Current reading of sensor n
$R0_n$	Initial reading of sensor n
$R1_{ref}$	Current reading of reference sensor (in our case sensor 1)
$R0_{ref}$	Initial reading of reference sensor

(negative value of ΔEL_n indicates settlement, positive values indicate heave)

Using the above equation we can now calculate the change in elevation for sensor 2 and sensor 3 in our example system.

For sensor # 2:

ΔEL_2 = (78.9 – 79.2) – (72.4 – 74.3)
= - 0.3 – (-1.9)
= 1.6 mm (i.e. this sensor shows heave)

For sensor # 3:

ΔEL_3 = (68.2 – 71.7) – (72.4 – 74.3)
= -3.5 – (-1.9)
= -1.6 mm (i.e. this sensor shows settlement)

5.2 Correcting for variation in density of liquid used in the system

The gauge factor supplied in the test certificate of each individual level sensor is for a liquid with a density of 1000 kg/m3 (i.e. pure water at around 5 °Celsius). If a liquid other than water is used, the calculated reading in mm should be multiplied by the specific gravity of the liquid used (ratio of density of liquid used to the density of water taken as 1000 kg/m3) to get the correct reading.

Although the density of water changes with temperature, the effect of such density changes is not very significant for the liquid level settlement measurement system within the ambient temperature limits of 0 to 50 °C. However, if very high precision is required, the obtained elevation readings can be corrected for any change in variation of density of water with ambient temperature using the values shown in table below:

Table 1. Density of pure water as a function of temperature

Temperature	Density
deg C	kg/m^3
0	999.9
5	1000
10	999.7
20	998.2
30	995.7
40	992.2
50	988.1
60	983.2
70	977.8
80	971.8
90	965.3
100958.4	

6 THERMISTOR - TEMPERATURE RESISTANCE CORRELATION

Thermistor type Dale 1C3001-B3

Temperature resistance equation

$$T = 1/[A + B(LnR) + C(LnR)^3] - 273.2\ ^oC$$

T = temperature in ^oC

LnR = Natural log of thermistor resistance

A = 1.4051×10^{-3}

B = 2.369×10^{-4}

C = 1.019×10^{-7}

Ohm	Temp. ^oC	Ohm	Temp. ^oC	Ohm	Temp. ^oC
201.1k	-50	16.60K	-10	2417	+30
187.3K	-49	15.72K	-9	2317	31
174.5K	-48	14.90K	-8	2221	32
162.7K	-47	14.12K	-7	2130	33
151.7K	-46	13.39k	-6	2042	34
141.6K	-45	12.70K	-5	1959	35
132.2K	-44	12.05K	-4	1880	36
123.5K	-43	11.44K	-3	1805	37
115.4K	-12	10.86K	-2	1733	38
107.9K	-41	10.31K	-1	1664	39
101.0K	-40	9796	0	1598	40
94.48K	-39	9310	+1	1535	41
88.46K	-38	8851	2	1475	42
82.87K	-37	8417	3	1418	43
77.66K	-36	8006	4	1363	44
72.81K	-35	7618	5	1310	45
68.30K	-34	7252	6	1260	46
64.09K	-33	6905	7	1212	47
60.17K	-32	6576	8	1167	48
56.51K	-31	6265	9	1123	49
53.10K	-30	5971	10	1081	50
49.91K	-29	5692	11	1040	51
46.94K	-28	5427	12	1002	52
44.16K	-27	5177	13	965.0	53
41.56k	-26	4939	14	929.6	54
39.13K	-25	4714	15	895.8	55
36.86K	-24	4500	16	863.3	56
34.73K	-23	4297	17	832.2	57
32.74K	-22	4105	18	802.3	58
30.87K	-21	3922	19	773.7	59
29.13K	-20	3748	20	746.3	60
27.49K	-19	3583	21	719.9	61
25.95K	-18	3426	22	694.7	62
24.51K	-17	3277	23	670.4	63
23.16K	-16	3135	24	647.1	64
21.89K	-15	3000	25	624.7	65
20.70K	-14	2872	26	603.3	66
19.58K	-13	2750	27	582.6	67
18.52K	-12	2633	28	562.8	68
17.53K	-11	2523	29	525.4	70

6.1 Measurement of temperature

Thermistor for temperature measurement is provided in all liquid level system. The thermistor gives a varying resistance output related to the temperature. The thermistor is connected between the green and white leads. The resistance can be measured with an Ohmmeter. The cable resistance may be subtracted from the Ohmmeter reading to get the correct thermistor resistance. However the effect is small and is usually ignored.

The Encardio-rite model EDI-54V read-out unit gives the temperature from the thermistor reading directly in engineering units.

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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