

**INSTRUCTION MANUAL**

**AUTORANGING  
CONDUCTIVITY / TDS METER  
TCM-15+**

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## **1. INTRODUCTION**

Congratulations on your purchase of the Autoranging Conductivity Meter. The Instrument represents the state of the art in conductivity meters. Each Conductivity meter has been manufactured with utmost care to ensure trouble free performance for years to come.

The autoranging conductivity meter offers all the features you can expect in a top quality conductivity meter. It has many advanced features for ease of operation. It is useful for precision conductivity measurements of liquids without doing manual calculations of cell constant by multiplication. It thus eliminates mathematical calculation. It is autoranging type meter which selects the range automatically. It also provides manual selection of range for particular application. The conductivity meter automatically selects the frequency for proper range. This is very useful for getting accurate readings.

The instrument facilitates range indication by LED'S & digital display of measured conductivity & adjusted cell constant. The instrument has got wide application in research and QC-laboratories, Agriculture & Soil analysis Laboratories, Water testing, Food & beverage & brewery industries, chemical, Pharmaceutical, Petrochemical dyestuff, fertiliser & Petroleum refining industries etc.

This manual helps you to setup & operate the instrument. Please read the manual carefully to learn more about the capabilities of your instrument.

## **2. SPECIFICATION**

- |                    |  |
|--------------------|--|
| 1. RANGE SELECTION | Automatic / Manual   |
| 2. RANGE           | 2 $\mu$ S full scale to 2S full scale in 7 ranges.             |
| 3. ACCURACY        | $\pm$ 0.5% of full scale.                                      |
| 4. TEST FREQUENCY  | 200 Hz or 3 KHz selected automatically to get optimum reading. |

|                          |  |
|--------------------------|--|
| 5. INDICATION            | Direct digital readout of specific conductance in S/cm or mS/cm on a 3½ digit display with range indication by different coloured LED's.   |
| 6. CELL CONSTANT         | Cell constant adjustable from 0.001 to 1.999   |
| 7. RECORDER O/P          | 1.999 Volts full scale.  |
| 8. DIMENSION             | 260mm(W)x280mm(D)x65mm(H)  |
| 9. WEIGHT                | 1.77 KG. (Approx)  |
| 10. POWER                | AC 230 volts/5 Watt ±10%, 50HZ   |
| 11. OPTIONAL ACCESSORIES | (i) Auto Temperature compensation with external PRT probe.<br>Temperature coefficient adjustable from 1.4 to 2.7% per °C.<br>(ii) Conductivity cell - Dip type<br>Cell constant 1.0 ± 10 % |

### 3. INSTALLATION

#### 3.1 INSTALLATION REQUIREMENT

Choose a flat, sturdy surface with enough room for keeping the stand, sample & instrument.

Avoid areas subject to excessive heat, humidity dust, grease, corrosive environment, vibration or exposure to direct sunlight.

Provide a steady source of 220/240 volts electricity. Motors, heaters, refrigerators, air conditioner cause fluctuation in power line. Do not connect your instrument to circuit used by such equipment.

## Installation

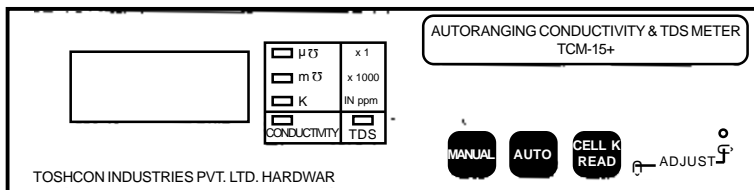
**Installing the power cord** - Make sure the switch is off. Use 3 pin socket to ensure proper earthing of the instrument. Plug the mains cord (Provided on back panel) into the socket.

**Installing the conductivity cell** - Take conductivity cell. Mount it on cell holding clamp. Connect it to socket at back panel. Dip the cell in distilled water.

**Installing the Temp Comp. Probe (Optional accessory)**- Mount the probe on conductivity cell stand. a special hole and bush is provided on cell holding clamp only. Connect the terminals to PRT terminals provided on back panel (see Fig. for details)

**Getting Acquainted-With the Preliminary installation-** let's take a closer look at front and back panel controls to see what they do.

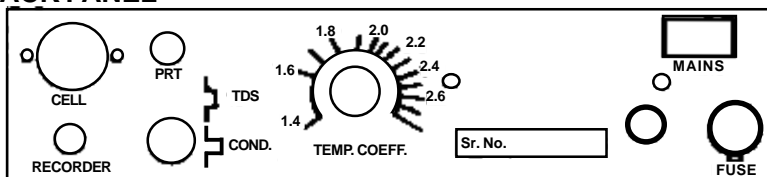
### 3.2 FRONT PANEL



1. 3½ digit display - Normally displays conductivity of solution under measurement. But also display cell constant value adjusted when 'CELL K READ' Key is pressed.
2. 'μS LED' - Indicates the displayed conductivity is in micromho.
3. 'mS LED' - Indicates the displayed conductivity is in millimho.
4. 'K LED' - Indicates the displayed reading is adjusted cell constant value.
5. 'CONDUCTIVITY/ TDS LED' - COND. LED indicates measurement mode is μS or mS & TDS LED indicates measurement mode is ppm.

6. MANUAL Key - This is used for selecting required range manually. With this key you can select any range from  $2\mu\text{S}$  to 2000 mS.
7. AUTO Key - This key facilitates to choose any suitable range for measurement of conductivity automatically.
8. CELL K READ Key - When pressed the digital display Shows adjusted cell constant value.
9. 'ADJUST' preset - This is used to adjust cell constant value (with help of screw driver provided to you) when CELL K READ key is pressed. This increases the cell constant value in clockwise direction & vice versa.

### BACK PANEL



1. MAINS Switch - To turn the power 'ON' & 'OFF' of the instrument.
2. FUSE - This is small 100 mA fuse for mains power.
3. Mains Cord - This is 3 pin 5A mains cord to connect power to the instrument.
4. CELL socket - For connecting cells terminal for solution of which conductivity is to be measured.
5. Recorder - Here external chart recorder can be connected to sockets to record conductivity signal. The available signal 1.99 volts for FSD.

- 6. PRT socket - To connect external temperature compensation probe for automatic compensation.
- 7. Temp. Coefficient Knob - This is to adjust temp. coefficient of solution under test when using auto temperature compensation.
- 8. TDS Switch - To select mode of measurement for solutions (either Conductivity or TDS).

#### 4. OPERATING INSTRUCTIONS

How to operate the instrument for conductivity measurement.

##### 4.1 CONDUCTIVITY MEASUREMENT

After doing the installation of the instrument let us see how to operate the instrument.

1. Switch 'ON' the instrument by switching 'ON' the mains switch at back panel. Keep the instrument 'ON' for 15 mins. (warm up time)
2. Dip the conductivity cell in distilled water for 12 hrs. (approximately) before taking the readings of conductivity.
3. See the cell constant value on conductivity cell and adjust the cell constant (k) by pressing the key "cell k read" on the front panel. The 'K' LED will be 'ON'. The display indicates present adjusted 'K' value. To adjust it to required value adjust the preset located on front panel by using screw driver provided to you & by pressing CELL K Read key. The cell value will increase in clockwise direction (as per installation procedure) required cell is already connected to the instrument.

**Note : The importance of cell constant (k)**

**(How to select required conductivity cell)**

For the conductivity range under consideration, a conventional two electrodes probe with a cell constant (k) is to be selected in such a way, that according to equation (1) the resistance R does not fall below 100 Ohm and does not exceed 100 (k) Ohm. Only then it is guaranteed, that no errors due to the electrode polarization

i.e. cable capacities between probe and instrument will appear. Cell constant (k) is determined by the geometrical structure of measuring distance. The determinant magnitudes are surface area and distance between the electrodes. K has the dimension of  $\text{cm}^{-1}$

The electrodes can be arranged concentrically or parallel towards each other. Probes with high constant ( $k=10\text{cm}^{-1}$ ) can only be realised according to the principle of the long current path.

CONDUCTIVITY =  $K/R$ . ----- Equation no. 1

4. Dip the conductivity cell in the solution of which conductivity is to be measured. The instrument will display conductivity of solution. The unit of measurement indicated by LED on front panel (Micro mho-Red LED, Milli mho - Green LED).

### NOTES

1. The instrument will start scanning the ranges in following cases.
  - When mains is switched 'ON' & cell is dipped in the solution.
  - When "Auto" key is pressed.
  - When cell K is pressed.
  - When conductivity under test beyond the selected range.

Conductivity meter has got 7 different ranges, from  $2\mu\text{S}$  to 2000 mS. The default range is  $2\mu\text{S}$ . In the scanning mode it starts scanning from  $2\mu\text{S}$  and goes to next higher range and so on until the reading is optimum in the range. During the above operation it will automatically change the frequency from 200 Hz to 3 KHz depending upon the range to provide more accurate reading.

2. The above automatic range selection operation can be overridden and a pre determined range can be selected by using the Key 'manual'. Pressing this key once selects the next higher range. However if the reading goes out of selected range will go into auto mode and searches for a proper range.
3. Pressing the key auto will put the instrument into auto mode to select a range in which the reading is optimum.

Incase of instrument with auto temperature compensation procedure shall be adopted. (see section 4.3)



## **4.2 TOTAL DISSOLVED SOLIDS (TDS)**

In most natural water it has been found that when conductivity (in  $\mu$  siemens/cm at 25°C) is multiplied by a factor ordinarily in the range of 0.55 to 0.70 the product is equal to mg/litre total filterable residue. For waters that contain appreciable concentration of free acid or caustic alkalinity the factor may be much lower than 0.55 and for highly saline waters it may be much higher than 0.70.

### **TOTAL DISSOLVED SOLIDS - IN NATURAL WATERS**

The various salts and minerals dissolved in natural waters are reasonably uniform in their contribution to conductivity at the concentration normally encountered. This means that a reading of electrical conductivity can be used as an indicator of the total amount of dissolved material in solution. For water taken from a single source, this relationship is quite repeatable and accurate and provides a means of controlling the upper allowable solids limit in industrial heating and cooling systems utilizing re-circulating water. The water is re-circulated for reasons of economy, but if evaporation losses allow solids levels to use too high, scaling and precipitation of various salts will occur. Conductivity control of the system bleed valve thus allow the user to achieve maximum economy while preventing equipment damage. Cooling towers and boilers are common application for the measurement, but it may also find use in swimming pools, fountains and other closed water systems.

## **4.3 CONDUCTIVITY MEASUREMENT USING AUTOMATIC TEMPERATURE COMPENSATION**

1. Connect PRT Which is provided with instrument to the PRT socket on instrument back panel. Mount PRT on cell holding clamp. Dip the PRT into the solution under measurement.
2. Set the temperature coefficient pot knob corresponding to the coefficient of the solution under measurement. But if this figure is not known for the measuring solution, then accurate graph of unknown solution conductivity v/s temperature will give us the temperature coefficient of the solution.

(Temperature coefficient is a ratio of % change in conductivity from 25°C to the change in temperature from 25°C).

3. The display indicates conductivity corresponding to 25°C. The unit of the displayed conductivity is indicated for unit LED'S i.e.  $\mu\text{S}$  - Red LED or  $\text{mS}$  - Green LED.

• **IMPORTANT** •

For auto temperature compensation instrument PRT used must be proper.

## 5. SERVICING

### 5.1 TROUBLE SHOOTING

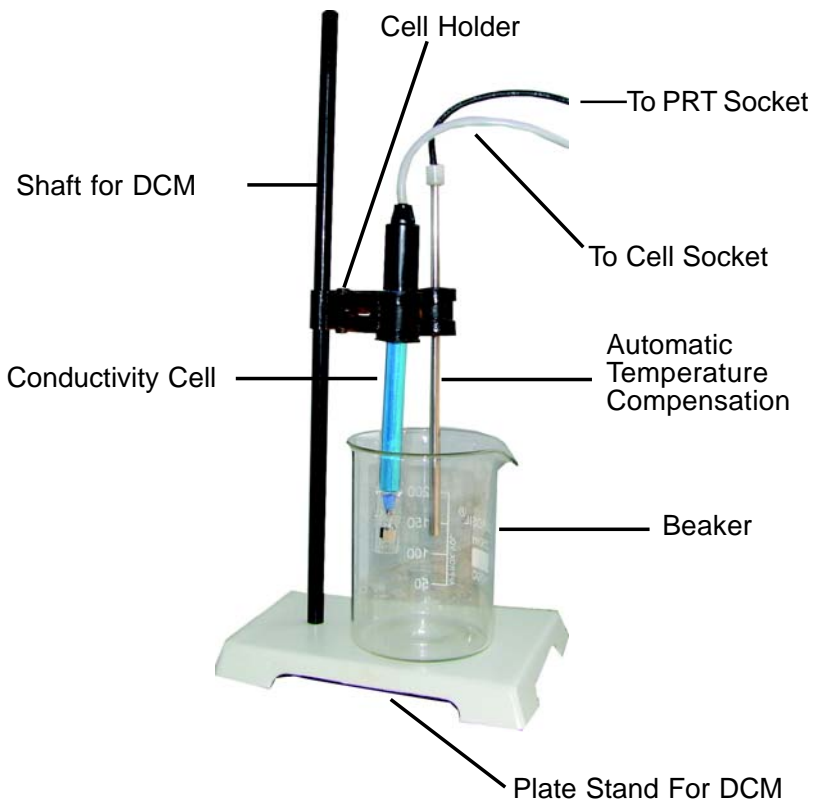
- 1) ***Instrument not getting Switch 'ON'.***  
Check for 100 mA glass fuse on back panel.  
Mains cable not connected properly.
- 2) ***Readings not getting within tolerance.***  
Cell constant not set as per cell constant Value.  
Check cell connections from back panel of instrument to conductivity cell cap.  
Cell may require recalibration.
- 3) ***Autoranging not working.***  
Check for PRT (PT 100) connections.  
Check cell terminals to cell contacts.  
Contact branch office.
- 4) ***Instrument gets flung & showing-1 Display.***  
Contact branch office.
- 5) ***Instrument reading shows fluctuations.***  
Check for mains earthing.  
Check cell connections
- 6) ***Instrument not holding particular range.***  
Check reed relay connections.  
Contact branch office.

## 5.2 LIST OF CONSUMABLES & SPARES.

|    | Item                                      | Qty.      |
|----|---|-----------|
| 1) | Fuse Glass 100 mA                         | - 02 nos. |
| 2) | PT 100 (Optional)                         | - 01 no.  |
| 3) | Cell holder                               | - 01 no.  |
| 4) | Shaft for DCM                             | - 01 no.  |
| 5) | Base Plate                                | - 01 no.  |
| 6) | Conductivity Cell (low & normal) Optional | - 01 no.  |

## 5.3 CIRCUIT DIAGRAM

|    |                       |          |
|----|-----------------------|----------|
| 1) | Block Diagram         | - 01 no. |
| 2) | Cell with cell holder | - 01 no. |



## BLOCK DIAGRAM OF DIGITAL CONDUCTIVITY METER

### **Block Diagram Description**

The instrument consists of solid state devices which ensure reliable and stable operation over wide variations in supply voltage ( $\pm 10\%$ )

The A.C. voltage to be supplied to the cell system is generated by an amplitude stabilised Wien bridge oscillator, the frequency of which is selected automatically (200 Hz or 3 KHz) by switching in proper Wien components to the oscillator. Output impedance of the oscillator is reduced by an impedance matching transformer (x), the secondary of this transformer is fed to the cell system. The stable oscillator output of any selectable frequency thus obtained is independent of loading effects in all the ranges of the instrument.

As shown in the block diagram, the cell system is connected between the secondary of oscillator transformer and the input of 'Operational Amplifier' of the measuring system to accommodate various conductivity ranges. The range resistance is varied appropriately in the 'feedback path of the 'Operational Amplifier.' circuit.

The output of the 'Operational Amplifier' is fed to the 'Cell comp' pot and then to the amplifier circuit. Thus, the signal fed to the amplifier is a measure of conductivity in mhos/cm. and does not require multiplication by the cell constant k. The output of the amplifier is passed through active filters to remove the mains frequency pick ups and other noise signals.

The A.C. Signal (free of main frequency and other noise) thus obtained is passed through an active rectifier which behaves linearly even upto very small signal. This improves the instrument's accuracy considerably.

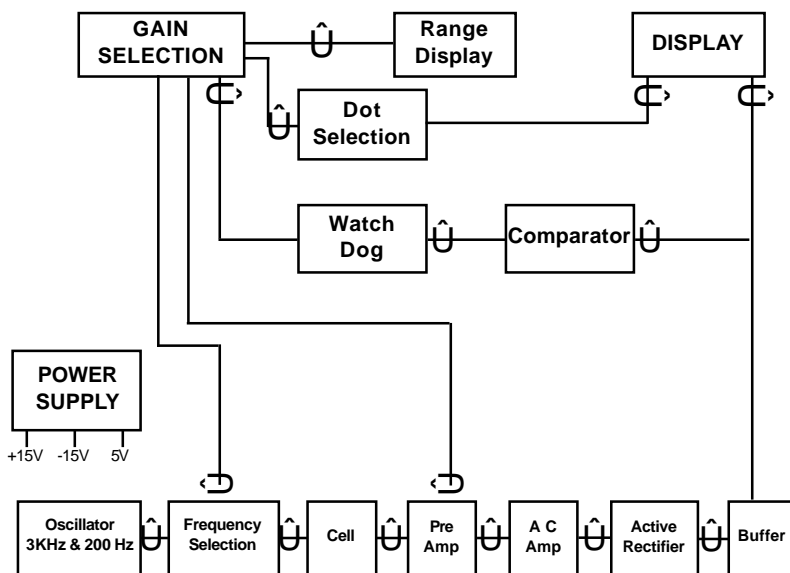
The output of active rectifier is fed to a  $3\frac{1}{2}$  digit panel meter (2000 mV DMP)

### **Temperature Compensation (Optional)**

Whenever this facility is to be added, the active output is fed to this circuit instead of the indicating meter. This block compensates for the conductivity variations vs temp. for various electrolytic

solutions. The temperature compensation, effected automatically by the 'PRT probe' when the latter is dipped into the solution. The control, 'Temp. Coefficient'. (i.e. ratio of % change in conductivity from 25°C to change in temp. from 25°C) offers different 'Temp. Coefficient' to suit for temp. variations of conductivity for various electrolytic solutions. The output signal of this block, thus represent conductivity of unknown solution referred to a reference temp. (25°C)

**Power Supply** : Supplies well regulated  $\pm 15\text{v}$  to the solid state circuit of the instrument. In addition a  $\pm 5\text{v}$  is supplied to the digital panel meter.



**BLOCK DIAGRAM**

How to find out cell constant -

**Preparation of standard solution :**

Weigh accurately 0.745526 gms. of KCL crystals (Analar grade). Take de-ionized or distilled water of very Low conductivity. Dissolve the weighed quantity of KCL into the de-ionized or distilled water so as to prepare 1 Kg. of solution. The solution will have conductivity of 1.409 Milli-mhos/cm. at 25°C.

Also the following table gives the conductivity in mhos per centimeter of KCL solutions for standardization.

**TABLE**

| Gram KCL/Kg.<br>of solution | Conductivity / Cm at |          |
|-----------------------------|----------------------|----------|
|                             | 18°C                 | 25°C     |
| 71.1352                     | 0.19784              | 0.11134  |
| 7.4191                      | 0.01117              | 0.01286  |
| 0.7453                      | 0.001221             | 0.001409 |

#### **5.4 CELL RECALIBRATION PROCEDURE**

After continuous use in chemical solution residue gets accumulated on platinum plates of conductivity cell, the cell constant value changes. To overcome this problem cell needs cleaning & re-calibration. This is achieved by following procedure.

- **Cell cleaning Procedure**

The Conductivity cells are thoroughly cleaned by emulsion in a warm solution of Potassium Dichromate in concentrated Sulphuric Acid and after that clean it with distilled water.

- **Cell Calibration Procedure**

Dip cell 24 hrs. before calibration in distilled water. Put cell into standard solution of KCL (0.01 molar). Connect cell terminals to 1.408 m $\Omega$  at 25°C by varying cell constant preset without pressing CELL K READ key. Then press CELL K READ key & get new cell constant to the cell.