441 Conductivity Meter

Instruction Manual

This manual contains complete instructions for setting up and using the 441 conductivity meter.

Applications information is also available.

The information contained in this manual was correct at the time of going to print. However, we continue to improve products and reserve the right to change specifications, equipment and maintenance procedures at any time.

The power supply unit is classed as IEC Class II equipment (equipment providing an adequate degree of protection against electric shocks, in which additional safety precautions, for example, double or reinforced insulation, are included). The 441 is intended for use by persons knowledgeable in safe laboratory practices. If the 441 is not used in accordance with these instructions for use, the protection provided by the equipment may be impaired.

The 441 is suitable for direct current only.

This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference with radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

There are no user replaceable parts in the 441 or power supply unit. Do not remove the covers.

Contents

1.1 Unpacking and Installation

1. The main carton will contain the following:

   Meter
   Meter Dust Cover
   Power Supply
   This Instruction Manual
   Warranty Card
   Memo Cards, English, French, German, Italian, Spanish
   Calibration Certificate
   Guide to Conductivity/Dissolved Oxygen

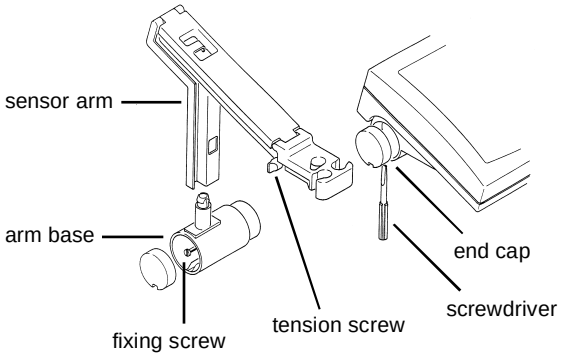
2. If you ordered the meter with sensor, sensor arm and accessories, the top tray of the main carton will contain these items. Refer to the accessories packing sheet for a list of the additional components.

3. To attach the sensor arm to the conductivity meter:

   a. The sensor arm can be attached to the left or right-hand side. Using the screwdriver supplied remove the appropriate end cap from the conductivity meter.

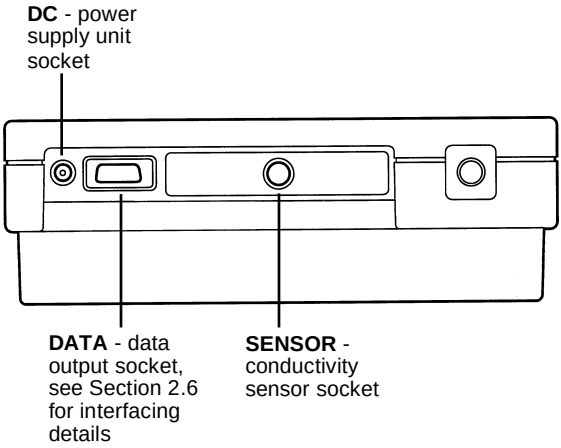
   b. Slide the arm base into the recess and tighten the fixing screw. Replace the end cap.

   c. Fit the sensor arm onto the post. Adjust the tension screw as required.



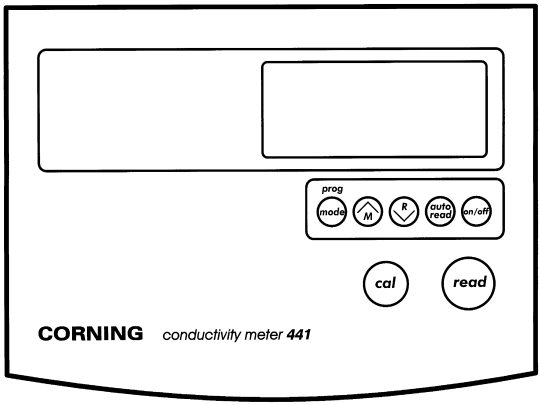
4. Fill in and return the warranty card. For your record make a note of the serial number, date of purchase and supplier on the inside front cover of this manual.

1.2 Input and Output Connections



1. Connect the sensor to the **SENSOR** socket.
2. Connect the power supply unit to the **DC** socket.

1.3 Display and Controls



1.3 Display and Controls (cont)

Selects conductivity or TDS mode. Hold down for 2 seconds to enter Program Menu.

Stores result in memory. Increases displayed value in Program Menu.

Recalls result from memory. Decreases displayed value in Program Menu. Hold down for 2 seconds to turn continuous data transfer on/off.

Selects automatic endpoint detection.

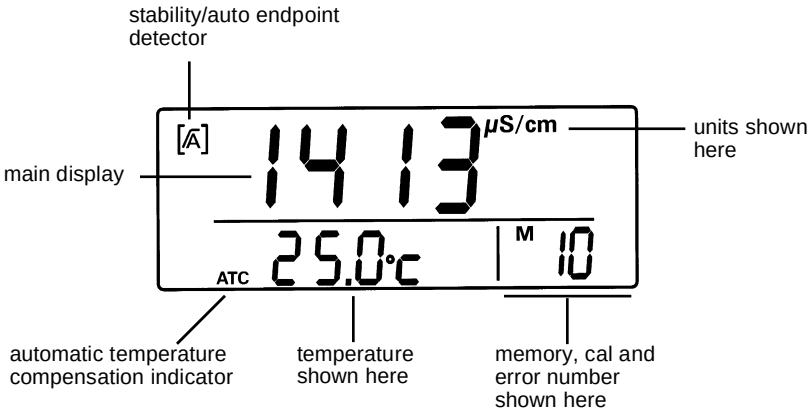
Places the meter in standby mode/wakes meter up.

Starts a calibration sequence.

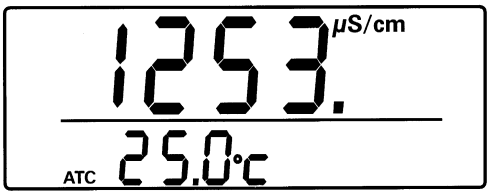
Starts sample measurement. Press again to freeze display in manual endpoint mode.

1.3 Display and Controls (cont)

441 Display



Example Conductivity Reading



2.1 Calibrating a Conductivity Sensor

Press (mode) to select conductivity or TDS mode.

1-point calibration

Hold the sensor in air and press (cal)

If you have the '**auto read** ' feature (see Section 2.3) turned on, the meter will automatically endpoint when the reading is stable.

If you don't have '**auto read** ' on, press (read) when the stability indicator [⌐] appears.

Goto Measuring samples (Section 2.2) or 2-point calibration.

2-point calibration

Place the tip of the sensor in the conductivity standard and press (cal)

If you have the '**auto read** ' feature (see Section 2.3) turned on, the meter will automatically endpoint when the reading is stable.

If you don't have '**auto read** ' turned on, press (read) when the stability indicator [⌐] appears.

Rinse the sensor with distilled or deionized water and goto Measuring samples (Section 2.2).

NOTE For maximum accuracy, samples and standards should be at the same temperature, preferably the reference temperature (see Section 3.2).

2.2 Measuring Samples

NOTE Good laboratory practice dictates that sensors should be calibrated at least daily.

Place the sensor in the sample and press (read) to start the measurement. The decimal point will be flashing whenever the sensor is reading.

If you are using the '**auto read**' function the display freezes when a stable endpoint is reached (see Section 2.3). To manually freeze the display when the stability indicator appears

press **read**

2.3 Automatic Endpoint (Auto Read)

The '**auto read**' function checks the sensor output for stability and automatically freezes the display when the reading appears stable. It can be used during calibration and routine measurements.

Turn auto endpoint on by pressing **auto read**

The auto endpoint indicator **A** will appear at the top left of the meter display. While the meter is reading, the decimal will flash. When the endpoint is reached, it will stop flashing and the stable endpoint indicator [A] appears.

To start another reading press **read**

To cancel auto endpoint press **auto read** again.

2.4 Memory

Up to 10 results can be stored in the 441.

Before a result can be stored it must have reached a stable endpoint, using either manual or auto endpoint.

To store a result in memory:

press **M** the result is stored and the display shows ***M 1***.

To recall a result from memory:

press R to recall the last stored memory. Press R to scroll through the memories. The display shows **RM** and the appropriate memory number.

To clear the last memory:

press R the last stored memory is displayed. Press M to clear this memory. Only the last memory can be cleared, eg M2 cannot be cleared without first clearing M3.

To clear all memories:

press R until **MC** is displayed, then press M to clear the memories. (Press **read** to exit without clearing the memories.)

2.5 Continuous Data Transfer

In continuous data transfer mode readings are sent to the **DATA** socket approximately every second. If the measurement endpoints (manually, or using auto read) data transfer stops.

To select continuous data transfer mode:

press and hold R for 2 seconds. The continuous data transfer indicator appears 

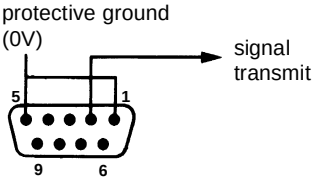
To maintain continuity of sample readings calibration data is only output at endpoint.

2.6 Interfacing via the RS232 Output

The Model 441 can transmit data in RS232C Serial format to compatible devices such as Serial Printers and computers. There is no handshake capability but data can be received and manipulated by most data acquisition software packages.

The cable required for connection to IBM compatible computers is part number 477758 and can be ordered from your distributor. The pin configuration of that connector and Model 441 output protocols are as follows:

Pin	**Signal**
1	device enable (link to pin 5)
2	RS232 Tx (signal transmit)
3	not used
4	not used
5	protective ground (0V)
6 - 9	not used



DATA socket

To enable the RS232 a link is required between pin 1 (device enable) and pin 5 (protective ground).

Type of communication	-	unidirectional
Baud rate	-	2400
Data format	-	7 data bits 1 stop bit even parity

Data is sent to the **DATA** socket at measurement endpoint (manual or automatic) and memory recall.

To use the output to monitor continually, you need to select continuous data transfer mode (see Section 2.5).

3 Meter Programming

The Program Menu allows you to set solids factor; reference temperature; temperature coefficient and TDS units.

You can only enter the Program Menu if the current measurement has endpointed - press **read** if necessary. Press and hold the **mode** key for 2 seconds to access the Program Menu - prog appears.

Press **mode** to scroll through the options and press M and R to change the value. Press **read** to exit the Program Menu at any time. If you press **read** when a value is flashing that value will not be entered.

3.1 Solids Factor

P1 Solids Factor

The solids factor is the ratio of TDS (ppm or mg/L) to conductivity (µS/cm) and can be set between 0.40 and 1.00. The 441 has a preset solids factor of 0.50. Change the value using M and R. Press **mode** to enter the value and move on.

3.2 Reference Temperature

P2 Reference Temperature

The temperature to which measurements are referenced can be set to 20 or 25°C. The 441 has a preset reference temperature of 25°C. Change the temperature using M and R. Press **mode** to enter the value and move on.

3.3 Temperature Coefficient

P3 Temperature Coefficient

Conductivity measurements change with temperature. The temperature coefficient (%/°C) is a measure of this change and can be set between 0.0 and 10.0. The 441 has a preset temperature coefficient of 2.0°C. Change the coefficient using 

and 

. Press 

to enter the value and move on.

3.4 TDS Units

P4 TDS Units

TDS can be measured in mg/L or ppm. (The 441 auto ranges to g/L or ppt). Change the units using 

and 

. Press 

to enter the units and move on.

Press 

to exit the Program Menu.

3

4.1 Basic Theory

Conductivity is the ability of a solution to pass current. It follows that the amount of current flowing is proportional to the number of ions present in the conducting solution. Therefore, a measure of the conductivity will give a direct reading of the solution concentration.

All substances conduct to some extent. In solution the level of ionic strength varies from the low conductivity of ultra pure water to the high conductivity of concentrated chemical samples.

Historically, the measurement of conductivity was made between two platinum plates (1cm x 1cm in size) placed one centimetre apart. This method simplifies the theoretical interpretation of results. However, in practice it results in a plating effect when current flows, and reduces the conductivity electrode performance.

Because conductivity values are affected by cell geometry, specific conductivity (C) should be used. This compensates for cell geometry and standardises conductivity measurements.

If the cell is filled with a solution of conductance, G, the conductivity between the electrodes is given by the expression

$$C = G.\frac{L}{A}$$

where: C = conductivity in Siemens per cm (S/cm)
G = conductance in Siemens (S)
L = distance between electrodes (cm)
A = plate area of the electrodes (cm^2)

As the cell dimensions change, the cell constant varies as the ratio of L to A.

In the traditional cell using 1 cm squares of platinum, 1 cm apart, the cell constant (L/A) is 1.0 and the conductance reading in microsiemens is numerically equal to the conductivity in µS/cm.

4.1 Basic Theory (cont)

Sensors have been developed to overcome the problems associated with traditional cells. They operate on a four ring principle.

An alternating voltage is applied to the two outer rings. In the sample solution, the voltage induces a current, whose magnitude is dependent upon the number of ions in solution. Therefore, the current measured by the inner sensing rings gives a direct value for the conductivity of the solution.

By relating the conductivity of a standard solution to its concentration, a value for Total Dissolved Solids (TDS) can also be determined.

Total Dissolved Solids (TDS) is a measurement of the total concentration of ionic species in a sample. The measurement of solution conductivity gives a method by which a TDS value for the sample solution can be determined. The 441 includes a user selectable TDS factor in order to give a TDS value referenced to a calibration standard (usually KCl or $CaCO_3$).

The conductivity of a solution will increase with temperature. The effect is usually expressed by a change of conductivity (as a percentage) per degree Celsius.

This is often called the temperature coefficient of the solution.

For example, ultra pure water has a temperature coefficient of 5%/°C whereas that of concentrated samples may be at the 1%/°C level. The 441 has a user selectable temperature coefficient value for accurate readings.

A temperature sensor is incorporated into the conductivity sensor supplied for use with the 441 to determine the exact solution temperature and to display a conductivity reading at a chosen reference temperature (usually 20°C or 25°C).

For accurate measurements, samples and standards should be at a similar temperature, preferably at the chosen reference temperature.

4.2 Operating Hints

This section gives some brief operating hints and good laboratory practices to help assure trouble free conductivity measurements.

Refer to the sensor manufacturer's instructions for proper sensor care and maintenance. See Section 4.3.2 for Sensor maintenance and Section 4.4 for Problem solving.

- When measuring, make sure the solution is above the cell chamber slot.
- Make sure the cell chamber is free of bubbles when measuring. To reduce air bubbles, immerse the sensor at an angle and then raise to the vertical position.
- Allow sufficient time for the sensor to stabilize when measuring samples of different temperatures.
- Rinse sensor with distilled water between measurements, and after use.
- Do not use calibration standards after the expiration date printed on the package. Keep bottles tightly capped and store solutions according to the manufacturer's instructions. Never put used standard back into the bottle.
- For greater accuracy, standards and samples should be at the same temperature.
- For greater accuracy, calibrate using a standard close in value to the sample.

4.3 Maintenance

4.3.1 Meter Maintenance

The Model 441 needs no maintenance except for an occasional wipe with a damp cloth. The front panel is made of polyester and is not affected by most solvents. Polyester is known to be affected by some organic solvents, including toluene, xylene and methyl-ethyl-ketone. It is good laboratory practice to wipe away any spillages as soon as they occur.

4.3 Maintenance (cont)

4.3.2 Sensor Maintenance

To prevent static damage to the 441 avoid touching the cell chamber area of the sensor. **ALWAYS** disconnect the sensor from the 441 meter before cleaning.

Solids build up inside the cell chamber can be carefully removed with a cotton wool bud soaked in detergent solution, then rinse the sensor with distilled water.

Do not use organic solvents to clean the sensor.

4.4 Problem Solving

4.4.1 Meter Error Codes

– – – – + Err 1 - measurement out of range
Check sensor is connected and immersed in sample.

Err 2 - cal 1 out of range
Clean the sensor, or replace.

Err 3 - cal 2 out of range
Check correct standard is being used.
Check correct solids factor is being used - for Corning standards use the following factors
84 µS/cm factor 0.50
1413 µS/cm factor 0.53
12.88 mS/cm factor 0.58
80 mS/cm factor 0.50
Clean the sensor, or replace.

Data Entry Errors

Entered solids factor value changes to 0.40 or 1.00 - the 441 will not accept solids factors outside this range.

Entered temperature coefficient value changes to 0.00 or 10.0 - the 441 will not accept temperature coefficients outside this range.

4.5 Meter Specifications

Operating Ranges

Cond	0.01 to 1999µS/cm
	2.00 to 199.9mS/cm
TDS	0.1 to 1999mg/L
	2.00 to 199.9g/L
Temp.	–5 to 105°C

Resolution

Cond	variable
TDS	variable
Temp.	0.1

Relative Accuracy*

Cond	±0.5%
TDS	±0.5%
Temp.	±0.5°C

* ±1 least significant digit

Auto Calibration Points
Zero (air) and
84µS/cm or 1413µS/cm or
12.88mS/cm or 80mS/cm

Solids Factor
0.40 to 1.00, selectable

Reference Temperature
20/25°C, selectable

Temperature Coefficient
0.0 to 10.0%/°C, selectable

Temperature Compensation
0.0 to 40.0°C (ATC)

Display
LCD display

Outputs
RS232

Input Conditions
Impedance greater than 10^{12} ohms

Operating Conditions
Operating temperature: 5 to 40°C
Operating humidity: max 80% at 35°C (non condensing)
Installation category 2
Pollution category degree 2

Size
10 x 8 x 4 inches
(255 x 200 x 95 mm)

Weight
2.4 lb (1.1 kg)

Power Requirements
The 441 is supplied with an appropriate power supply unit, e.g.

USA/Japan	100-120V 50/60Hz, 9VA
Europe	230V 50Hz, 9.7VA

Output from PSU 9V DC

NOTE The 441 should only be used with the power supply unit provided.

441 Power Rating 4.5VA

Regulatory Compliance

The 441 is manufactured in a FDA (Food & Drug Administration) and ISO 9001 approved plant (for Corning) and complies with the following regulatory standards: UL1262, CSA151, IEC1010. The 441 also complies with the European EMC Directives and therefore carries the CE mark.

Environmental Compliance

The casework components of the 441 are marked with the appropriate recycling identification symbol. The packaging is manufactured using recycled cardboard, and printed with water based ink. The packaging is recyclable. The manual is printed on environmentally friendly paper.

Consumables and Accessories

Catalog #	Description	Quantity
476501	Conductivity Sensor	1
477389	Disposable Meter Cover	5
478109	Sensor Arm Assembly	1
470439	Guide to Conductivity/Dissolved Oxygen	1
473623	Conductivity Standard 1413µS/cm (500 mL)	1 bottle
473624	Conductivity Standard 12.88mS/cm (500 mL)	1 bottle
473732	Conductivity Standard 84µS/cm (460 mL)	1 bottle
473733	Conductivity Standard 80mS/cm (460 mL)	1 bottle
473737	Conductivity Standard 12.88mS/cm Sachets	30 packs
473738	Conductivity Standard 1413µS/cm Sachets	30 packs
473740	Conductivity Standard 84µS/cm Sachets	30 packs
473741	Conductivity Standard 80mS/cm Sachets	30 packs
471226	Power Supply, 110/120V - 50/60Hz	1
471228	Power Supply, 230V - 50Hz	1
477758	RS232C Cable	1
470493	Dot Matrix Printer with Cables	1

Warranty:

Corning warrants this product to be free from defects in materials and workmanship. The warranty period for the meter is two (2) years from the date of purchase and the probe is six (6) months from the date of purchase.

THIS WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. CORNING SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGES ARISING FROM THE USE OF THESE PRODUCTS NOR FOR CONSEQUENTIAL DAMAGES OF ANY KIND.

In the event that a meter or probe fails under normal laboratory conditions within the specified period because of a defect in material or workmanship, Corning will, at its option, repair or replace the product. Contact Corning Customer Service for return authorization and shipping instructions at:

1-866-664-NOVA (6682).

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