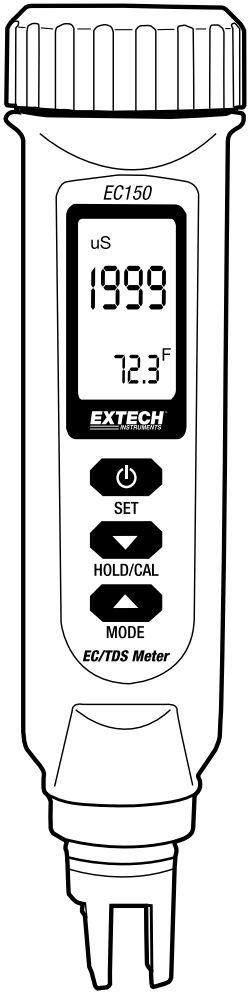
EXTECH INSTRUMENTS

User's Guide

Conductivity and TDS Meter

Pen Style Water Quality Meter

Model EC150



Introduction

Congratulations on your purchase of the Extech Pen Style Water Quality instrument; the Model EC150 measures Conductivity and TDS (Total Dissolved Solids) plus Temperature. The instrument is housed in an IP65 Water-proof enclosure for safety. This instrument is shipped fully tested and calibrated and, with proper use, will provide years of reliable service.

Features

- Automatic Ranging and Manual Ranging capability
- Dual Display with ATC (automatic temperature control)
- Data hold for freezing displayed readings
- Low battery indicator
- Automatic power-off for maximum battery efficiency
- Switchable temperature units of measure (C/F)
- Multi-point and one-touch calibration features
- Powered by four (4) LR44 batteries

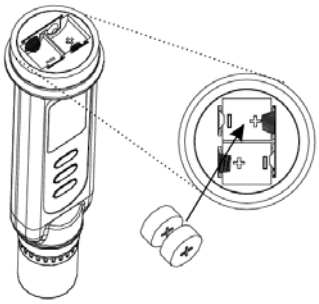
Supplied Materials

- EC150 meter
- Four (4) LR44 button batteries
- Operation manual (hard copy, mini-disk, and on-line availability at www.extech.com)

Battery Installation

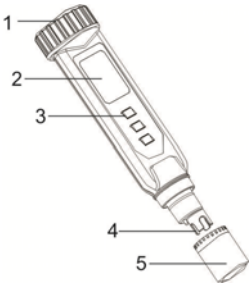
The meter is shipped with the four (4) LR44 button batteries removed. The user must install the batteries before the meter can be used. Refer to accompanying diagram.

1. Unscrew the battery compartment cover (top of meter) in a counter-clockwise direction. Please do not discard the black washer.
2. Install the four (4) LR44 button batteries, carefully orienting the batteries and observing polarity.
3. Replace the battery compartment cover.
4. Please remove the batteries while the meter is not in use for long periods.



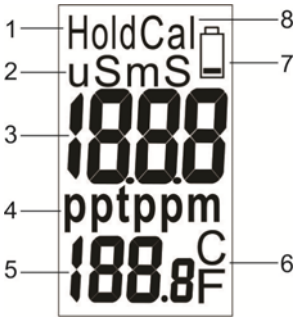
Meter Description

1. Battery Compartment
2. Display
3. Keypad
4. Electrode
5. Electrode protective cap



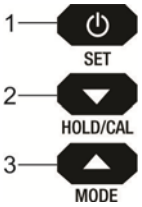
Display Description

1. Data Hold icon
2. Micro- and milli-Siemens units
3. Primary measurement reading
4. Parts per thousand and parts per million units
5. Temperature reading
6. Temperature units of measure
7. Battery strength indicator
8. Calibration icon



Keypad Description

1. Power ON-OFF and SET button
2. Down Arrow, Data Hold, and Calibration button
3. Up arrow and MODE Button



Operation

Getting Started

1. Remove the probe's protective cap (bottom of meter) by pulling the cap firmly downward, away from meter, until it snaps off (see diagram).
2. Press the power button ⏻ to power ON the meter. The meter display will cycle through several icons (representing the current configuration of the meter) before settling on the main display as shown in the display description above.
3. Press and hold the power button to power OFF the meter.
4. This meter is powered by four (4) LR44 buttons batteries. If the meter will not switch ON please check that fresh batteries are installed.

Automatic and Manual Ranging

There are two ranges available in each measurement mode (see Range table below). The meter defaults to the AUTO RANGE mode where the range is selected automatically to provide the best resolution and accuracy for each given measurement. However, MANUAL RANGE can be selected by pressing and holding the up arrow button ▲ for at least 2 seconds. The display will briefly display the 'man' icon indicating that the meter is changing to the Manual Range mode and the next available range will be selected as indicated by the change in the units of measure icon.

	Conductivity	**TDS (Total Dissolved Solids)**
Range 1	0 to 1999 µS	0 to 1999 ppm
Range 2	0 to 19.99 mS	0 to 19.99 ppt

Measurement Preparations, Notes, and Considerations

- Accuracy is given in percent FULL SCALE, therefore using the lowest range will yield the best accuracy.
- The meter's display will indicate E02 or E03 if the measured value is below (E02) or above (E03) specified limits of the meter. If this occurs, please select another range as described in the Manual Range discussion in previous paragraph.
- Set the temperature coefficient. The factory default setting is 2.1% per °C (this nominal value is correct for most applications). Refer to the Setup section of this User Guide for details on changing this setting. Also refer to Appendix D (Temperature effects) for more information.
- Set the normalization (reference) temperature. The factory default setting is 25°C (this nominal value is correct for most applications). Refer to the Setup section and the Appendices of this User Guide for programming details and instructions on changing this setting.
- Rinse the probe with deionized or distilled water before use to remove impurities that may adhere to the electrode. When the meter has been idle for a long period, soak the electrode for at least 30 minutes before use.
- When dipping the probe into a sample solution, be sure to eliminate air bubbles trapped in the probe's slot. To remove air bubbles, give the probe a gentle stir while submerged in the solution.
- When taking a measurement, stir the probe gently in the sample to create a homogenous sample. Allow a few seconds to elapse for the probe and the sample to reach temperature equilibrium. Ideally, wait 15 minutes to achieve maximum accuracy and best temperature compensation.
- The unit of measure icon will flash on the meter's display while stabilization is taking place in measurement mode. When stabilization is achieved, the meter's icon will stop flashing.
- Press the HLD (HOLD) button to freeze a displayed reading. Press again to release the display.

TDS (Total Dissolved Solids) and Conductivity Measurements

1. Read the Measurement Preparation section above before continuing.
2. Use the MODE button to switch between the TDS and the Conductivity measurement modes. In TDS mode the unit of measure is ppt (parts per thousand) or ppm (parts per million). In Conductivity mode the units of measure are µS or mS (micro- or milli-Siemens).
3. The TDS conversion factor is set to 0.50 at the factory. To change the setting, refer to the Setup section. Also refer to Appendix B (Conductivity-to-TDS Conversion Factors) and Appendix C (Calculating TDS Conversion Factors) for more information.
4. To switch from Auto Range mode (default) to Manual Range mode press and hold the up arrow button for at least two seconds as described previously.

Finishing a Measurement Session

After a measurement session:

- Rinse the electrode in de-ionized water and store dry.
- Affix the protective cap over the electrode when storing.
- If the unit is to be left un-unused for a month or more, remove and store the batteries separately.

Automatic Power OFF (Sleep mode)

The meter will automatically switch OFF after 20 minutes of inactivity. To disable the Sleep Mode:

With the instrument switched off, press and hold the SET and HLD/CAL buttons simultaneously until the 'n' icon appears on the display. Release the buttons and the meter will power up. The meter will now stay switched ON until the user manually switches it OFF. The meter reverts to the Sleep Mode Active state each time it is powered down.

Setup Mode

Parameter P1: Temperature Units, Ambient Temperature, and Temperature Coefficient settings

1. From the normal operating mode, press and hold the SET button for at least 2 seconds until the '**P1.0**' icon appears on the meter display.
2. Press the SET button momentarily, the '**C'** or '**F'** icon should now be flashing and the '**t.ut**' icon (abbreviation for temperature units) will be visible above the flashing unit.
3. Use the arrow keys to select the desired unit of measure.
4. Press the MODE button momentarily to confirm the selection.
5. A temperature value will be flashing at the bottom of the display and the '**t.nr**' icon (normalization temperature i.e., reference temperature) will be visible above the flashing temperature. See Appendix D (Temperature Effects) for more information on reference temperature.
6. Use the MODE button to toggle between 20°C(68°F) and 25°C(77°F) (default is 25°C/77°F).
7. Press the SET button to confirm the setting.
8. The temperature coefficient value should now be flashing on the bottom of the display with the '**t.Co**' icon visible above it.
9. Use the arrow buttons to select the coefficient temperature (default is 2.1°C).
10. Press the SET button momentarily to confirm the selection.
11. The meter display should be back to the P1 level starting point.
12. Press and hold the SET button for at least 2 seconds to return to the normal operation mode or press the SET button momentarily to move to Parameter P2 (see below).

Parameter P2: TDS Conversion Factor

1. If continuing from Parameter P1 skip directly to step 2 below. If starting from the normal operating mode, press and hold the SET button for at least 2 seconds until the '**Px**' icon appears on the meter display (x = setup parameter number).
2. Use the MODE button to scroll to the P2 icon. The '**tdS**' display will be visible above the P2.0 icon.
3. Press the SET button momentarily and the current TDS factor setting should start flashing (0.50 is the factory default setting).
4. Use the arrow buttons to change the factor; the available range is 0.40 to 1.00.
5. Press the SET button momentarily to confirm the change.
6. Press and hold the SET button for at least 2 seconds to return to the normal operation mode or press the MODE button momentarily to move to Parameter P3 (see below).

Parameter P3: Meter Reset

This parameter can be used to restore all settings to their factory default state.

1. If continuing from Parameter P2 skip directly to step 2 below. If starting from the normal operating mode, press and hold the SET button for at least 2 seconds until the '**Px**' icon appears on the meter display (x = setup parameter number).
2. Use the arrow buttons to scroll to the P3 icon if necessary. The '**rSt**' display icon will be visible above the P3 icon.
3. Press the SET button momentarily; a '**y**' or an '**n**' will be flashing.
4. Use the arrow buttons to select '**y**' for YES RESET or '**n**' for NO RESET.
5. Press the SET button momentarily to confirm the setting.
6. Press and hold the SET button for at least 2 seconds to return to the normal operation mode or press the MODE button momentarily to move to Parameter P4 (see below).

Parameter P4: Calibration Review for Range 1 and Range 2 Concentrations

1. If continuing from Parameter P3 skip directly to step 2 below. If starting from the normal operating mode, press and hold the SET button for at least 2 seconds until the '**Px**' icon appears on the meter display (x = setup parameter number).
2. Use the MODE button to scroll to the P4.0 icon if necessary. The '**CAL**' display icon will be visible above the P4.0 icon.
3. Press the SET button momentarily to view the current Range 1 Calibration Concentration. The P4.0 icon will change to P4.1. If dashes (- - -) appear on the display this indicates that the meter has not been calibrated thus far.
4. Press the up arrow button to move to the P4.2 display. The displayed value now represents the Range 2 Calibration Concentration. Again, if dashed lines appear, then the meter has not been calibrated up to this point.
5. Press and hold the SET button for at least 2 seconds to return to P4.0. Press the MODE button momentarily to move back to parameter P1.
6. Press and SET for at least 2 seconds to return to normal operation mode.

Calibration

Calibration Preparation and Considerations

The user must first determine:

1. The best calibration schedule for the application at hand.
2. What calibration standard to use.

Calibration Schedule

- Calibration is necessary and should be performed regularly.
- If measuring in the mid-ranges calibrate the meter at least once per month and soak the probe for 15 minutes before each use.
- If measuring in extreme temperature environments, or at the low end of the measurement range, calibrate the meter at least once per week.

Selecting a Calibration Standard

For best results select a calibration standard closest to the expected sample value. Alternatively, use a calibration solution value that is approximately 2/3 of the expected full scale measurement range. For example, in the 1999µS range, use the 1413µS solution standard. Remember not to re-use calibration solutions; contaminants in the solution will affect the calibration and the accuracy.

CONDUCTIVITY Calibration Procedure

1. Allow the probe to soak in de-ionized or distilled water for 30 minutes.
2. Select an appropriate conductivity calibration standard as discussed in previous section.
3. Pour the calibration solution into two separate, clean containers to a height of 3cm.
4. Power the meter and select the Conductivity mode using the MODE button if necessary.
5. Rinse the probe in one of the calibration solution containers; gently stirring the probe.
6. Dip the probe into the second calibration solution container. Tap the probe on the bottom of the container to remove air bubbles. Allow the probe to stabilize to the solution temperature (15 minutes is typical).
7. Press and hold the HLD/CAL button for at least 2 seconds. The conductivity value and the 'CAL' icon on the display will flash.
8. Press the MODE or HLD/CAL buttons to adjust the displayed conductivity value so that it matches the standard solution value (normalized for the measured temperature). The conductivity reading can only be adjusted to ±30% of the detected value. If detected value (displayed value) differs from the calibration standard by more than ±30%, the probe may need cleaning or the meter may require replacing.

   For example: The calibration standard is 10µS and the detected value is 19µS. The adjustable range is ±5.7µS (19*30%). In this example the values differ over the 30% limit.
9. When the CAL icon stops flashing, press the SET button momentarily to confirm the value. The meter will then return to the Conductivity measurement mode. If the CAL icon continues flashing, verify that the calibration solutions are fresh and stable. Also re-check that the value selected in step 8 is correct.
10. Repeat the procedure above for other ranges as required.

Note: When switching from measurement mode to calibration mode, the meter will display the factory default calibration value. This is normal and does not affect the user calibration.

Note: To exit the calibration mode without confirming the calibration, press and hold the SET button in Step 9 for at least 2 seconds. This will abort the calibration and revert to the previous calibration values.

TDS (Total Dissolved Solids) Calibration Procedure

TDS CALIBRATION OPTION 1

1. Allow the probe to soak in de-ionized or distilled water for 30 minutes.
2. Select an appropriate TDS calibration standard. The factory default TDS conversion factor setting is 0.50. To change this value to better match the TDS factor of a particular calibration solution, refer to the Setup section. Also, refer to Appendix B (Conductivity-to-TDS Conversion Factors) and Appendix C (Calculating TDS Conversion Factors) for more information.
3. Pour the calibration solution into two separate, clean containers to a height of 3cm.
4. Power the meter and select the TDS mode using the MODE button if necessary.
5. Rinse the probe in one of the calibration solution containers; gently stirring the probe.
6. Dip the probe into the second calibration solution container. Tap the probe on the bottom of the container to remove air bubbles. Allow the probe to stabilize to the solution temperature (15 minutes is typical).
7. Press and hold the HLD/CAL button for at least 2 seconds. The TDS value and the '**CAL**' icon on the display will flash.
8. Press the MODE or HLD/CAL button to adjust the displayed TDS value so that it matches the standard solution value (normalized to the measured temperature). The TDS reading can only be adjusted to ±30% of the detected value. If detected value (displayed value) differs from the calibration standard by more than ±30%, the probe may need cleaning or the meter may require replacing.

   For example: The calibration standard is 10ppm and the detected value is 19ppm. The adjustable range is ±5.7ppm (19*30%). In this example the values differ over the 30% limit.
9. When the CAL icon stops flashing, press the SET button momentarily to confirm the value. The meter will then return to the TDS measurement mode.

TDS CALIBRATION OPTION 2

TDS values are related to Conductivity; therefore the meter can be calibrated using Conductivity standards (as described in the Conductivity Calibration section above) and then the meter can be programmed with a given conversion factor.

1. Perform the Conductivity Calibration as described previously.
2. Select the Conductivity-to-TDS conversion factor in Setup mode (refer to the Setup section in this User Guide. Also, refer to Appendix B (Conductivity-to-TDS Conversion Factors) and Appendix C (Calculating TDS Conversion Factors) for more information.)
3. Refer to the Setup section for instructions on programming the conversion factor.

Maintenance

- **Keep the meter's measurement electrode clean**. Between measurements, rinse the electrode with de-ionized water. If the electrode has been exposed to a solvent immiscible in water, clean it with a solvent miscible in water, e.g. Ethanol, and then rinse carefully with water.
- **Store the electrode carefully.** Before storing, rinse carefully in de-ionized water and store dry.

Troubleshooting

Power ON is attempted but there is no display

- Be sure to press the ON-OFF but for at least 100mS to switch the meter ON.
- Check that batteries are positioned correctly, making good contact, and follow correct polarity.
- Replace the batteries if necessary.
- Remove and replace the existing batteries.

Display switches OFF

- This is normal when Auto Power OFF is activated.
- Replace the batteries if necessary.

Air Bubbles adhered to Electrode

- Stir the electrode completely and be sure to dip the electrode into a solution at an oblique angle. Vertical dipping can cause many air bubbles to adhere.
- Gently tap the bottom of the solution container while stirring the electrode in the solution.
- Air can be blown across the electrode before dipping it into the solution.

Error Codes

- Refer to the Table below for details on Error Codes displayed by the meter.

Code	Description	Suggestions
CONDUCTIVITY ERRORS		
-----	Measurement outside of range	In Manual Range mode, press and hold the up arrow for 2 seconds to change range or use the Auto Range mode.
E03	Conductivity is over-range	Check with a standard buffer solution. If problem persists, repair meter.
E04	Temperature error	
TDS ERRORS		
-----	Measurement outside of range	In Manual Range mode, press and hold the up arrow for 2 seconds to change range or use the Auto Range mode.
E04	Temperature error	
TEMPERATURE ERRORS		
E01	Temperature circuit damaged	Repair meter.
E02	Temperature value is below allowable range or Temperature circuit damage	Check again at room temperature. If error persists, repair meter.
E03	Temperature value is above allowable range or Temperature circuit damage	Check again at room temperature. If error persists, repair meter.

Battery Replacement and Disposal

When the low battery icon appears on the LCD, the batteries must be replaced. Several hours of accurate readings are still possible in this condition; however batteries should be replaced as soon as possible:

1. Remove the two (2) Phillips screws from the rear of the meter (directly above the top of the tilt stand).
2. Remove and safely place the battery compartment and screws where they will not be damaged or lost.
3. Replace the six (6) 1.5V 'AA' batteries, observing polarity.
4. Replace the battery compartment cover with the two (2) Phillips screws.

All EU users are legally bound by the battery ordinance to return all used batteries to collection points in your community or wherever batteries / accumulators are sold! Disposal in the household garbage is prohibited!

Appendix A: Factory Default Settings

Type	Parameter	Default	Notes
P1.1	Select °C/°F	°C	Temperature units
P1.2	Normalized Temperature (reference temperature)	25°C	Select 20°C or 25°C
P1.3	Temperature Coefficient	2.1% / °C	Adjust from 0.4 to 10%
P2.1	TDS Factor	0.50	Adjust from 0.40 to 1.00
P3.1	Revert to Factory Default settings	NO	Select YES to revert to default settings
P4.1	Review previous Calibration data	-----	Calibration Data for Range 1
P4.2		-----	Calibration Data for Range 2

Appendix B: Conductivity to TDS Conversion Factors

Conductivity at 25°C	TDS KCl		TDS NaCl		TDS 442*	
	ppm	Factor	ppm	Factor	ppm	Factor
23 µS	11.6	0.5043	10.7	0.4652	14.74	0.6409
84 µS	40.38	0.4807	38.04	0.4529	50.5	0.6012
447 µS	225.6	0.5047	215.5	0.4822	300	0.6712
1413 µS	744.7	0.527	702.1	0.4969	1000	0.7078
1500 µS	757.1	0.5047	737.1	0.4914	1050	0.7
2070 µS	1045	0.5048	1041	0.5029	1500	0.7246
2764 µS	1382	0.5	1414.8	0.5119	2062.7	0.7463
8974 µS	5101	0.5685	4487	0.5	7608	0.8478
12,880 µS	7447	0.5782	7230	0.5613	11,367	0.8825
15,000 µS	8759	0.5839	8532	0.5688	13,455	0.897
80mS	52,168	0.6521	48,384	0.6048	79,688	0.9961

*442: 40% sodium sulfate, 40% sodium bicarbonate, and 20% chloride

Appendix C: Calculating TDS Conversion Factors

This meter can be calibrated using TDS calibration standard solutions. The calibration requires the TDS value at a standard temperature such as 25°C. Note that the TDS calibration can be performed using the *conductivity* calibration (detailed earlier in this user guide) and thereafter using a conductivity-to-TDS conversion factor. To determine the Conductivity-to-TDS conversion factor, use the following formula: *Factor = Actual TDS / Actual Conductivity at 25°C*

Where the Actual TDS is the value from the solution bottle label or from a standard buffer made using high purity water and precisely weighed salts. Actual Conductivity is the measured value using a calibrated Conductivity/TDS/Temperature meter.

Both the Actual TDS and the Actual Conductivity values must be in the same magnitude of units. For example, if the TDS value is ppm, the Conductivity value must be in µS; if the TDS value is n ppt, the Conductivity value must be in mS.

Check this by multiplying the conductivity reading by the factor in the above formula; the result is the TDS in ppm.

Refer to the Setup section of this User Guide for instructions on programming the TDS factor.

Appendix D: Temperature Effects

Conductivity measurements are temperature dependent; if the temperature increases, conductivity also increases. For example, the conductivity measured in a 0.01 M KCL solution at 20°C is 1.273mS/cm, whereas, at 25°C, it is 1.409 mS/cm.

The concept of reference temperature (normalization temperature) was introduced to allow the comparison of conductivity results obtained at different temperatures. The reference temperature is usually 20°C or 25°C. This conductivity meter measures the actual conductivity and temperature and then converts it to the reference temperature using a temperature correction function and then displays the conductivity at the reference temperature. This meter uses linear temperature correction.

Linear temperature correction

In moderately and highly conductive solutions, temperature correction can be based on a linear equation involving a temperature coefficient. The coefficient is usually expressed as a conductivity variation in %/°C. Refer to the following formula:

$$K_{T_{ref}} = \frac{100}{100 + \theta * (T - T_{ref})} * K_T$$

Where:

K_{Tref} = Conductivity at Tref

K_T = Conductivity at T

T_{ref} = Reference temperature

T = Sample temperature

θ = Temperature coefficient

Note: The correction is accurate only within a limited temperature range near T1 and T2; the greater the difference between T and Tref, the higher the risk of error.

Calculating Temperature Coefficient (θ)

Measuring the conductivity of a sample at temperature T1 close to Tref and another temperature T2, the temperature coefficient can be calculated using the following equation:

$$\theta = \frac{(KT2 - KT1) * 100}{(T2 - T1) * KT1}$$

T2 should be selected as a typical sample temperature and should be approximately 10°C different from T1. The temperature coefficients of the following electrolytes generally fall into the ranges shown below:

Acids: 1.0 – 1.6%/°C

Bases: 1.8 – 2.2%/°C

Salts: 2.2 – 3.0%/°C

Drinking water: 2.0%/°C

Ultrapure water: 5.2%/°C

Average temperature coefficients of standard electrolyte solutions expressed as %/C of the conductivity value at 25C.

Temperature Range (°C)	**KCl 1 M**	**KCl 0.1 M**	**KCl 0.01 M**	**Saturated NaCl**
15 – 25	1.725	1.863	1.882	1.981
15 – 25 – 35	1.730 (15 – 27°C)	1.906	1.937 (15 – 34°C)	2.041
25 - 35	1.762 (25 – 27°C)	1.978	1.997 (25 - 34°C)	2.101

Specifications

General Specifications

Measurement ranges	Conductivity: 0 to 1999µS and 0 to 19.99mS
	TDS: 0 to 1999ppm and 0 to 19.99ppt
Accuracy	Conductivity and TDS: 1% Full Scale ±1digit
Resolution	Conductivity: 1µS and 0.01mS
	TDS: 1ppm and 0.01ppt
Temperature Accuracy	±0.5°C
Temperature Resolution	0.1°C/°F
Calibration	One point calibration per range
Auto Power OFF	After 20 minutes of inactivity
Data Hold	Freezes displayed reading
Automatic Temperature Compensation (ATC): 0 to 50°C	
Waterproof	IP65 rated
TDS Factor	Selectable from 0.40 to 1.00
Temperature Coefficient	Selectable from 0 to 4.0%/°C
Normalization Temperature	(Reference Temperature) Selectable: 20°C or 25°C
Basic status indicators	Out-of-range (----) and low battery
Power Supply	Four (4) LR44 'button' batteries
Dimensions	165 x 35 x 32mm (6.5 x 1.4 x 1.3")