

English

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Thermo Scientific Orion Star and Star Plus meters are designed for every application, from basic portable measurements to advanced laboratory analysis.

This user guide contains information on the preparation, operation and maintenance for the Orion Star and Star Plus meters.

Español

Page ES-1

Esta guía del usuario se presenta resumida para incluir los datos más importantes en inglés, español, francés, alemán e italiano.

*Para descargar la versión completa en el idioma de su elección, visite nuestro sitio web en [**www.thermo.com/water**](http://www.thermo.com/water).*

Français

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Ce guide d'utilisation a été abrégé de façon à inclure les informations les plus pertinentes en anglais, espagnol, français, allemand et italien.

*Pour télécharger une version complète dans votre langue, connectez-vous à notre site [**www.thermo.com/water**](http://www.thermo.com/water).*

Die vorliegende Kurzfassung der Bedienungsanleitung enthält die wichtigsten Anweisungen auf Englisch, Spanisch, Französisch, Deutsch und Italienisch.

Die ausführliche Bedienungsanleitung ist in jeder dieser Sprachen zum Download verfügbar. Besuchen Sie hierzu die Website www.thermo.com/water.

La presente guida per l'utente è stata ridotta per includere i dettagli più importanti in Inglese, Spagnolo, Francese, Tedesco e Italiano.

Per scaricare la versione completa nella Vostra lingua, visitate il nostro sito web all'indirizzo www.thermo.com/water.

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Chapter 1 Introduction

Congratulations! You have selected an industry-leading Thermo Scientific Orion Star or Star Plus series meter that is designed for electrochemistry measurements in the field or in the laboratory.

- 2-Star meters provide the single parameter measurement of pH.
- 3-Star Plus meters provide the single parameter measurement of pH, dissolved oxygen, RDO® optical dissolved oxygen or conductivity.
- 4-Star Plus meters provide the dual parameter measurements of pH/dissolved oxygen, pH/conductivity, pH/ISE (ion selective electrode) or RDO optical dissolved oxygen/conductivity.
- 5-Star Plus meters provide the multi-parameter measurements of pH/ISE/dissolved oxygen/conductivity, pH/dissolved oxygen/conductivity or pH/RDO optical dissolved oxygen/conductivity.

All meters include a temperature measurement function. All meters with pH measurement capability include a mV/relative mV/ORP function.


Built to meet the demands of busy, multiple user laboratory or plant environments, all Orion Star and Star Plus series meters are microprocessor controlled, which aids in the delivery of accurate and precise measurements. The waterproof portable meters can even withstand submersion for short periods of time.

The 3-Star, 4-Star and 5-Star Plus meters have been enhanced to include an increased number of datalog points, improved temperature displays and a new temperature calibration mode for each measurement parameter. Benchtop 3-Star, 4-Star and 5-Star Plus meters include autosampler capability and are compatible with the AutoTration-500 autosampler. Refer to the AutoTration-500 user guide for information on interfacing and operating the Star Plus meters with the autosampler.

Note: *Please read this user guide thoroughly before using your benchtop or portable meter. Any use outside of these instructions may invalidate your warranty and cause permanent damage to the meter.*

Meter Features




To better meet the needs of users in environmental protection and control, food and beverage, pharmaceutical and consumer product laboratories, the Orion Star and Star Plus series meters include these key features:

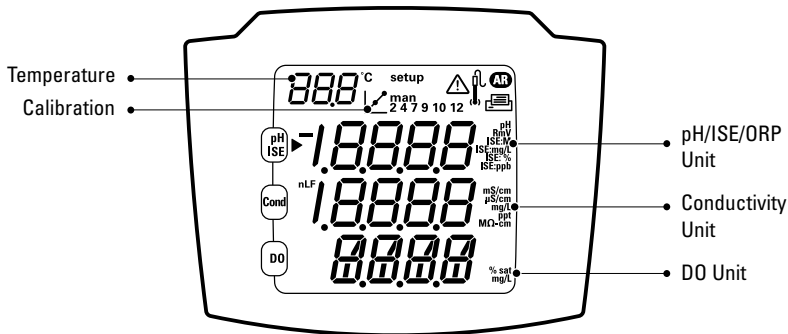
- **Password Protected Methods** – The meter will save up to ten custom measurements and calibrations for future reference. Password protection of each method eliminates any tampering with methods as multiple users access only the procedure most appropriate to their work.
- **AUTO-READ™** – The meter takes a measurement and automatically prints or logs data when the reading becomes stable. The measurement is frozen on the display until the user prompts the meter to take a new measurement.
- **Stirrer Control** – Benchtop meters (3-Star and higher) have a stirrer control for the stirrer probe, Cat. No. 096019, and the AUTO-STIR™ BOD probe, which eliminates the need for additional stir plates and stir bars.
- **SMART STABILITY™ and SMART AVERAGING™** – Remove the guesswork by automatically compensating for measurement conditions and optimizing the meter response time.
- **Display Backlight** – All 3-Star, 4-Star and 5-Star meters include a display backlight feature. When the meter is on, a quick press of  will turn the backlight on and off. When the meter is operating on battery power, the backlight will automatically turn off after two minutes to conserve power. When batteries are low, the backlight will no longer turn on.
- **Automatic Shutoff** – The meters will shut down after 20 minutes without a keypress. This maximizes battery power on portable meters and benchtop meters that are being run on battery power.
- **Audible Signals** – The meter will beep whenever a key is pressed, providing immediate verification that the user's input was received.

An easy-to-use reference guide, attached to each meter, supports daily meter use.

Chapter II Display

General Description

Throughout a given process, the display on an Orion Star or Star Plus series meter provides temperature and calibration data. The temperature appears in the left, top corner of the display. The  icon indicates that a calibration mode or calibration setup menu is active. The **man**, **2**, **4**, **7**, **9**, **10**, and **12** icons indicate which pH buffers were saved after a pH calibration is performed. The **setup** icon only appears when the meter is in setup mode. The  icon indicates an error condition and when it is displayed with the  icon, a calibration alarm or sensor quality issue exists. The **AR** icon indicates that the AUTO-READ measurement mode is active and is discussed in greater detail in the **Meter Setup** section.






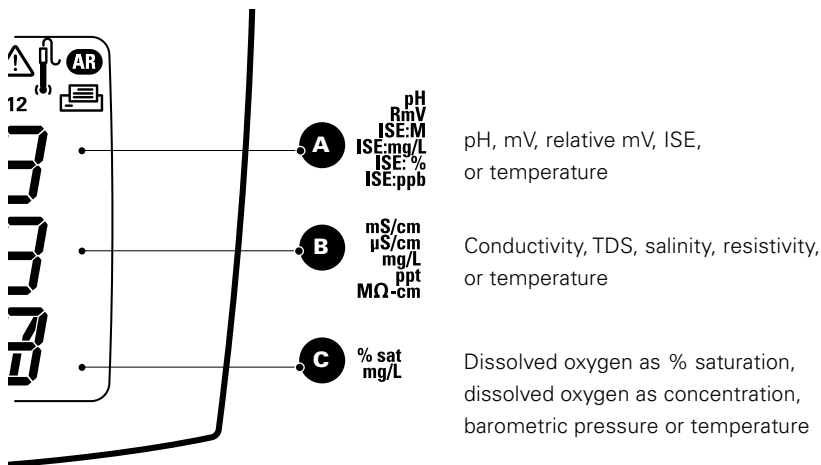
5 Star Meter

This is the display of the 5-Star meter capable of multi-parameter measurements. The single and dual parameter meters will have fewer measurement lines, depending on the meter capabilities.




Note: In the measurement mode, the three main lines of data on the meter display correspond to what is being measured.

Measurement Unit Icons

In the measurement mode, the arrow icon on the left side of the display screen indicates the active line. Press  to move the arrow icon to the desired line and press  /  to scroll through the measurement unit icons associated with the selected line. The measurement unit icons for the 5-Star multi-parameter meter are shown below. The single and dual parameter meters will have fewer measurement lines and icons, depending on the meter capabilities.




The units of measurement, which are displayed on the right side of the screen, will flash until the reading is stable.

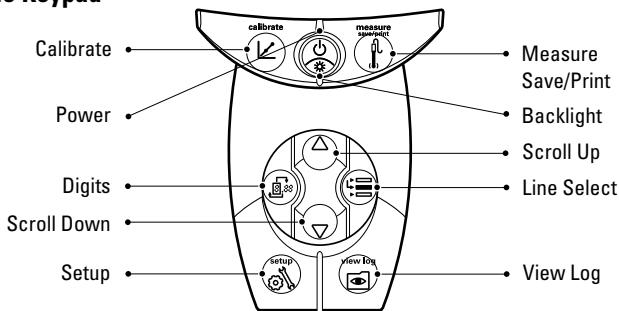
Note: If a measurement line is not needed, press  to move the arrow icon to the measurement line that is not needed and press  /  until the measurement line is completely blank.

Chapter III Keypad

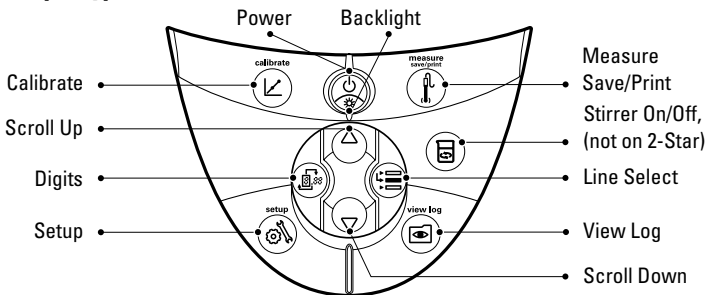
General Description

The keypad layout is the same for all Orion Star and Star Plus series meters. The portable and 2-Star benchtop meters have nine keys. The 3-Star, 4-Star and 5-Star benchtop meters have 10 keys due to the addition of the stir key – .











Portable Keypad



Benchtop Keypad



Key Definitions

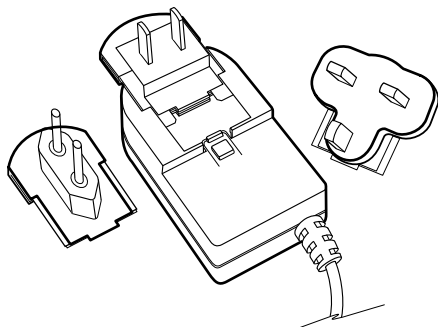
Key	Description	Key	Description
	<p>Turns the meter on, if the meter is off.</p> <p>Toggles the backlight on and off, if the meter is on (3-Star, 4-Star and 5-Star meters only).</p> <p>If the meter is on, hold down the key for about three seconds to turn off the meter.</p>		Changes the measurement units of the selected line in the measurement mode.
			<p>Changes the value on the selected line in the setup, methods and log view modes.</p> <p>Edits the value of the flashing digit for setup, password entry and calibration modes.</p>
	Scrolls the arrow icon on left of screen among the three display lines, so the selected line can be edited or calibrated.		Selects the next digit to edit and moves the decimal point for setup, password entry and calibration modes.
	<p>Starts the calibration for the selected line in the measurement mode.</p> <p>If the arrow icon points to the top line and the displayed units are pH, pressing the key will start a pH calibration.</p> <p>Each time the key is pressed in the calibration mode, the meter will accept the calibration point and move to the next point until the maximum number of calibration points are reached.</p>		<p>Prints and logs a measurement in the continuous or timed measurement modes.</p> <p>Prints, logs and freezes the display when the reading becomes stable in the AUTO-READ measurement mode.</p> <p>Exits the setup menu and returns to measurement mode.</p> <p>Accepts the calibration and returns to measurement mode.</p>
	<p>Enters the setup menu, starting with selected line in the measurement mode.</p> <p>If the arrow icon points to the top line and the displayed units are ISE, pressing the key will enter the ISE setup screen.</p>		Enters the log view and download menu.
			Turns the stirrer on and off.

Chapter IV Preparation

Installing the Power Adapter

The universal power adapter that is included with your benchtop meter is the only power adapter recommended for use with this unit. The use of any other power adapter will void your meter warranty. The external electrical power adapter is rated to be operated at 100 to 240 VAC, 0.5 A, 50/60 Hz.

Based on your wall outlet, select one of the four plug plates provided (110 V, 220 V, 240V) and slide it into the grooves on the adapter. A click will be heard when the plug is properly in place.



Connect the output plug of the power adapter to the power input on the benchtop meter. Refer to the diagram in the **Connecting the Electrodes** section.

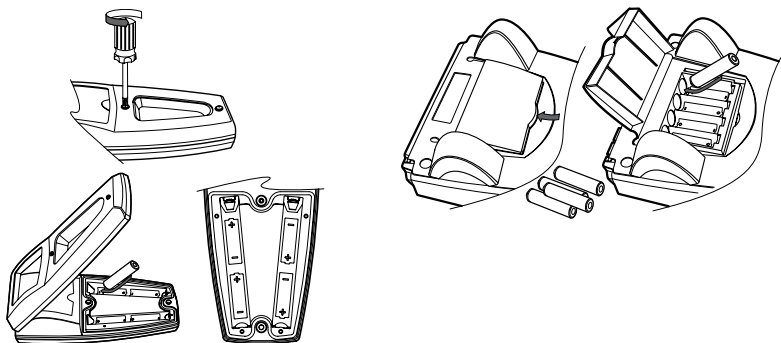
Batteries can be installed in the benchtop Orion Star or Star Plus series meters, so the meter setup settings are protected if the meter is disconnected from the wall outlet or a brief power outage occurs.

Installing the Batteries

Orion Star and Star Plus series meters use four AA alkaline batteries. Do not use lithium or rechargeable batteries. Improper installation of non-alkaline batteries could create a hazard.

Note: For benchtop meters, the installation of batteries is not required if the unit will always be connected to a power source via the universal power supply. For portable meters, the batteries are supplied from the factory. To access the battery compartment in portable meters, loosen the two screws in the back of the meter.

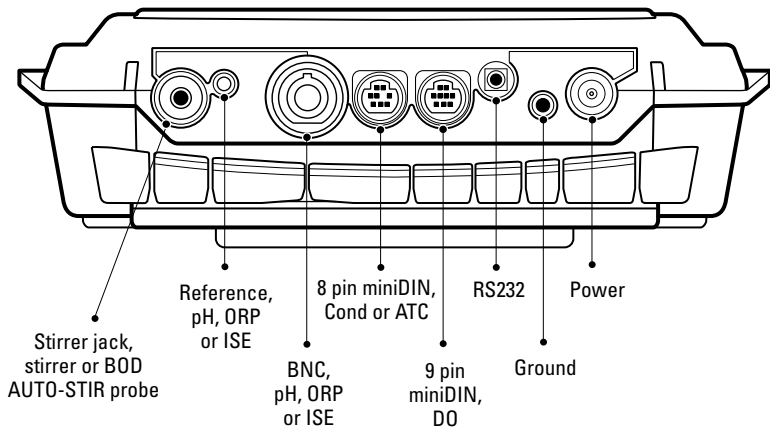
1. Confirm that the meter is off and gently place the meter upside down on a clean, lint-free cloth to prevent scratching the LCD.
2. Remove the battery case cover.
3. Insert new batteries with the + side orientation as depicted in the battery compartment housing.
4. Replace the battery case cover.
5. Stored data, calibrations and methods will remain in the meter's nonvolatile memory when the batteries are being replaced. However, the date and time may need to be reset when the batteries are changed.



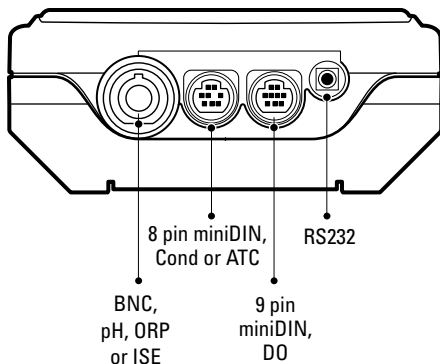
Connecting the Electrodes

Follow the diagrams below to correctly connect electrodes and probes to the meter. The multi-parameter meter is depicted; single parameter and dual parameter meters will have fewer connections, depending on the meter measurement capabilities.

Benchtop Meter Electrode Connections



Portable Meter Electrode Connections






Preparation

Meter Connections with Multiple Functions

- Use the BNC input to connect pH, ISE and ORP electrodes with a BNC or waterproof BNC connector.
- Benchtop meters have a reference input that is used to connect a separate reference electrode. Reference electrodes require an separate, appropriate sensing electrode for measurements.
- The 970899WP dissolved oxygen probe can be used on the BNC input.
- Use the 8 pin miniDIN input for conductivity probes or for automatic temperature compensation (ATC) probes.
- The DO AUTO-STIR probe uses the 9 pin miniDIN input and the stirrer jack.
- Connect a printer or computer to the RS232 input using the appropriate cable.

Turning on the Instrument

With the batteries installed in the portable meters and the power adapter attached or the batteries installed in the benchtop meter, press  to turn on the meter.

If using a 3-Star, 4-Star or 5-Star meter, press  when the meter is powered on to toggle the backlight on and off. When the benchtop meter is drawing line power, the backlight will stay on until  is pressed.

To turn off the meter, press and hold  for about three seconds.

Meter Maintenance














For routine meter maintenance, dust and wipe the meter with a damp cloth. If necessary, a warm water or a mild water-based detergent can be used. Perform meter maintenance on a daily, weekly or monthly basis, as required by the environment in which the meter is operated.

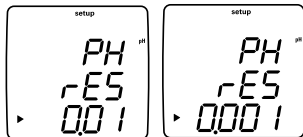
Immediately remove any spilled substance from the meter using the proper cleaning procedure for the type of spill.



Chapter v Meter Setup

Setup Menu

To navigate the setup menu:

1. Press  to enter the setup menu.
2. Press  /  until the desired setup option is displayed on the top line.
3. Press  to move the arrow icon to the middle line.
4. Press  /  until the desired setup option is displayed on the middle line.
5. Press  to move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit. For example, to change the pH measurement resolution press  to scroll from 0.01 to 0.001 on the bottom display line.



7. Press  to move the arrow icon to the top line.
8. Repeat steps 2 through 7 to program a new setup option or press  to exit the setup menu and return to the measurement mode.

Note: Refer to Appendix A for a description of the special setup menu features.

Meter Setup

Setup Menu Table – The following table is for the complete line of Orion Star and Star Plus meters. Meters may not include all of the options listed in this table.















Top Line	Middle Line	Bottom Line	Setup Menu Description (default setting, method specific)
PH	rES	0.1, 0.01, 0.001	pH measurement resolution (0.01, yes)
PH	bUF	USA, EUR0	pH buffer set for automatic buffer recognition during calibration, USA buffers are 1.68, 4.01, 7.00, 10.01, 12.46 and EUR0 buffers are 1.68, 4.01, 6.86, 9.18 (USA, yes)
ISE	rES	1, 2, 3	ISE measurement resolution in significant figures (1, yes)
ISE	Unit	m, mg/L, PEr, PPb, n0nE	ISE measurement units (PPb, yes)
ISE	rAng	LOw, HIgH	ISE concentration range for calibration stability criteria (HIgH, yes)
ISE	nLIIn	AU0, OFF	ISE automatic blank correction for low-level calibration (AU0, yes)
C0nd	tC	OFF, LIIn, nLF	Conductivity temperature compensation type, LIIn is for linear, nLF is for non-linear pure water samples (LIIn, yes)
C0nd	COEF	0.0 to 10.0	Conductivity temperature compensation coefficient in % change in conductivity per °C, appears if LIIn was selected for tC (2.1, yes)
C0nd	tdSF	0.00 to 10.0	Conductivity TDS factor value (0.49, yes)
C0nd	CELL	0.001 to 199.0	Conductivity default cell constant value for automatic conductivity calibration mode (0.475, yes)
C0nd	trEF	5, 10, 15, 20, 25	Conductivity reference temperature (25, yes)
C0nd	tyPE	Std, 1, 2, 3, 4, 5, 6, 7, USP	Conductivity cell type and selectable range (Std, yes)
See the Setup Menu for RDO Optical Dissolved Oxygen Sensor section for details on the RDO sensor information menus.			
d0	rES	0.1, 1 % sat	DO % saturation measurement resolution (0.1, yes)
d0	rES	0.01, 0.1 mg/L	DO mg/L measurement resolution (0.01, yes)
d0	bAr	AU0, mAn	DO barometric pressure compensation type (AU0, yes)
d0	PrES	450.0 to 850.0	DO manual barometric pressure compensation value, appears if mAn was selected for bAr (760.0, yes)
d0	SAL	AU0, mAn	DO salinity correction type (AU0, yes)
d0	SALF	0 to 45	DO manual salinity correction value, appears if mAn was selected for SAL or a DO meter without a conductivity mode is used (0, yes)
d0	CALt	AIr, H2O, mAn, SEt0	DO calibration type (AIr, yes)
d0	LIFE	365 to 0	RDO cap replacement countdown in days – 3, 4 and 5 Star Plus RDO meters only (Set by RDO sensor, no)
dUE	PH	0 to 9999	pH calibration alarm value in hours, 0 is off (0, yes)
dUE	OrP	0 to 9999	ORP calibration alarm value in hours, 0 is off (0, yes)
dUE	ISE	0 to 9999	ISE calibration alarm value in hours, 0 is off (0, yes)
dUE	C0nd	0 to 9999	Conductivity calibration alarm value in hours, 0 is off (0, yes)
dUE	d0	0 to 9999	DO calibration alarm value in hours, 0 is off (0, yes)

Top Line	Middle Line	Bottom Line	Setup Menu Description (default setting, method specific)
rAd	tyPE	AUt0, tInE, C0nt,	Measurement read type as AUTO-READ, timed or continuous (AUt0, yes)
rEAd	tInE	00:05 to 99:59	Timed measurement value in minutes and seconds (01:00, yes)
L0g	dEL	n0, YES	Delete datalog after download option (n0, yes)
L0g	AUt0	OFF, 0n	Automatic datalog point saving option (OFF, yes)
gEn	dEgC	-5.0 to 105	Manual temperature value (25.0, yes)
gEn	Stlr	OFF, 1, 2, 3, 4, 5, 6, 7	Stirrer speed – 3, 4 and 5 Star benchtop meters only (4, yes)
gEn	PASS	0000 to 9999	Meter password entry (0000, yes)
gEn	AUt0	0n, OFF	Automatic meter shutoff option (0n, no)
gLp	SEt	OFF, 0n	GLP option, GLP feature enables or disables methods (OFF, no)
dAtE	H0Ur	HH00 to HH23	Hour setting (HH12, no)
dAtE	tInE	mm00 to mm59	Minute setting (mm00, no)
dAtE	tYPE	mdY, dmY	Date format as month, day, year or day, month, year (mdY, no)
dAtE	YEAr	2000 to 2099	Year setting (2004, no)
dAtE	dAtE	mm01 to mm12	Month setting (mm01, no)
dAtE	dAY	dd01 to dd31	Day of the month setting (dd01, no)
r232	bAUd	1200, 2400, 4800, 9600	Baud rate setting (9600, no)
r232	OUtF	Prnt, C0mP	Output format for printer or computer, C0mP format is comma delimited (Prnt, no)
AUt0	SAPL	OFF, 0n	Autosampler – 3, 4 and 5 Star Plus benchtop meters only (OFF, no)
AUt0	trAY	28, 48	Beaker tray setting (28, no)
AUt0	rInb	1, 2, 3, 4, 5	Number of rinse beakers (3, no)
AUt0	rSEC	5 to 60	Rinse time in each rinse beaker, seconds (10, no)
AUt0	PH	0, 1, 2, 3	pH calibration points (3, no)
AUt0	OrP	n0, YES	ORP calibration option, appears if 0 was selected for PH (n0, no)
AUt0	ISE	0, 2, 3	ISE calibration points, appears if 0 was selected for PH (2, no)
1	AUt0	ISE1	Concentration value of ISE standard 1, appears if 2 or 3 was selected for the ISE calibration points (1, no)
10	AUt0	ISE2	Concentration value of ISE standard 1, appears if 2 or 3 was selected for the ISE calibration points (10, no)
100	AUt0	ISE3	Concentration value of ISE standard 1, appears if 3 was selected for the ISE calibration points (100, no)
AUt0	C0nd	0, 1, 2, 3	Conductivity calibration points (3, no)
AUt0	n0SA	0 to 47	Number of sample beakers (1, no)

General Menu Settings

















- **Manual Temperature** controls temperature compensation when no temperature sensor is attached to the meter.
- **Stirrer Speed** sets the stirrer speed from 1 (slowest) through 7 (fastest) and off (3-Star, 4-Star and 5-Star benchtop meters only).
- **Password Protection** protects setup menu options and methods from being accidentally erased or tampered with (3-Star, 4-Star and 5-Star meters only).
- **Automatic Shutoff** controls whether the instrument will automatically turn off after 20 minutes without a keypress.

1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until *9En* is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through *dEGC* for the manual temperature setting, *St Ir* for the stirrer speed setting, *PASS* for password entry and *AUTO* for the automatic shutoff setting.
5. Press  to accept the selection and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another general setting or press  to return to the measurement mode.

Time and Date Settings




















- The date and time settings are saved with the data and calibration log points and are included with the data that is sent to a computer or printer.
- The date format can be set to read month, day, year or day, month, year according to the user's preference.




1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until *DATE* is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through *HOUR* for the current hour setting, *MIN* for the current minute setting, *TYPE* for the date format setting, *DATE* for the current month setting, *DAY* for the current day setting and *YEAR* for the current year setting.
5. Press  to accept the selection and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another time and date setting or press  to return to the measurement mode.

AUTO-READ™, Continuous or Timed Measurement Settings



- In the AUTO-READ mode, the meter starts taking a measurement when  is pressed. Once the measurement is stable, the display freezes and the data is logged and printed. The AUTO-READ mode also controls the stirrer. The stirrer starts when  is pressed and stops when the measurement becomes stable.
 - In the continuous mode, the meter is constantly taking measurements and updating the display. Press  to log and print a measurement in this mode.
 - In the timed mode, the meter is constantly taking measurements and updating the display. The meter logs and prints the measurement at the selected time interval. Timed dissolved oxygen measurements with the RDO sensor are taken only at the selected time interval, which conserves the meter battery power.
1. In the measurement mode, press .
 2. Press  /  to scroll through the setup menu until *rEAd* is displayed on the top line.
 3. Press  to accept the selection and move the arrow icon to the middle line.
 4. Press  /  to scroll through *tYPE* for the measurement read type and *t InE* for the timed reading interval.
 5. Press  to accept the selection and move the arrow icon to the bottom line.
 6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
 7. Press  to accept the selection and move the arrow icon to the top line.
 8. Repeat steps 3 through 7 to change another measurement setting or press  to return to the measurement mode.

Selecting the Measurement Parameter

In the measurement mode, the arrow icon on the left side of the display indicates the active line. Press  to move the arrow icon to the desired measurement line and press  /  to scroll through the measurement parameters associated with the selected line.

The measurement lines and icons for the 5-Star multi-parameter meter are shown below. The single and dual parameter meters will have fewer measurement lines and icons, depending on the meter capabilities.



pH
mV
RmV
ISE

No icon for temperature

No icon and no measurement – the measurement line is turned off



$\mu\text{S/cm}$ or mS/cm for conductivity
mg/L for TDS
ppt for salinity
 $\text{M}\Omega\text{-cm}$ for resistivity

No icon for temperature

No icon and no measurement – the measurement line is turned off






% sat for dissolved oxygen percent saturation
mg/L for dissolved oxygen concentration

No icon for barometric pressure

No icon for sample temperature

No icon for membrane temperature (polarographic DO readings only)












No icon and no measurement – the measurement line is turned off

Note: If a measurement line is not needed, press  to move the arrow icon to the measurement line that is not needed and press  /  until the measurement line is completely blank.






Method Setup

The Orion 3-Star, 4-Star and 5-Star meters can save up to 10 methods when the GLP function is enabled. When a method is selected, the meter will use the last calibration performed in that method, so electrodes that share a common meter connection can be more easily interchanged. When using multiple methods, a calibration must be performed for each method that will be used.

1. To enable the GLP function:

- a. In the measurement mode, press .
- b. Press  /  until **GLP** is displayed on top line.
- c. Press  to move the arrow icon to the middle line and press  /  until **SET** is displayed.
- d. Press  to move the arrow icon to the bottom line and press  /  until **On** is displayed.
- e. Press  to move the arrow icon to the top line.
- f. Press  to exit the setup menu and return to the measurement mode.












2. To display and change the current method number:

- a. In the measurement mode, press . The current method number will be displayed.
- b. Press  /  to select a new method number.
- c. Press  to save the method number and press  to return to the measurement mode.














Chapter VI pH Technique

pH Setup Menu

Note: Refer to the Setup Menu section for the Setup Menu Table, which contains a complete list of meter setup options and descriptions. Refer to Appendix A for a description of the special setup menu features.








1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until **PH** is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through **rES** for pH measurement resolution and **bUF** for the automatic buffer recognition setting.
5. Press  to accept the selection and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another pH setting or press  to return to the measurement mode.

pH Calibration

1. Prepare the electrode according to the electrode user guide.
2. In the setup mode, select the buffer set (*USA* or *EU-D*) that will be used for the automatic buffer recognition feature.
3. In the measurement mode, press  until the arrow icon points to the top line, press  until the **pH** icon is shown and press  to begin the calibration.
4. Rinse the electrode, and ATC probe if being used, with distilled water and place into the buffer.
5. Wait for the **pH** icon to stop flashing.
 - a. Automatic buffer recognition – When the **pH** icon stops flashing the meter will display the temperature-corrected pH value for the buffer.
 - b. Manual calibration – When the **pH** icon stops flashing the meter will display the actual pH value read by the electrode. Press  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the meter displays the temperature-corrected pH value of the buffer. Once the pH buffer value is set, press  until the decimal point is in the correct location.
6. Press  to proceed to the next calibration point and repeat steps 4 and 5 or press  to save and end the calibration.
7. The actual electrode slope, in percent, will be displayed in the main field and *SLP* will be displayed in the lower field.
 - a. For a one point calibration, press  and  /  to edit the slope and press  to return to the measurement mode.
 - b. For a two or more point calibration, the meter will automatically proceed to the measurement mode after the slope is displayed.

pH Measurement

Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.




1. Rinse the electrode with distilled or deionized water. Shake off any excess water and blot the electrode dry with lint-free tissue.
2. Place the electrode into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **pH** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the measurement and freeze the display. If a benchtop meter is used and the stirrer is enabled, the stirrer will turn on when  is pressed and turn off when the reading is stable.
 - c. If the meter is in the timed measurement mode, it will start reading immediately and continuously update the display. The meter will log and print the measurement at the frequency specified in the setup menu. If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
3. Remove the electrode from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
4. Once all of the samples have been measured, rinse the electrode with distilled or deionized water and blot it dry. Consult the electrode user guide for proper storage techniques.

pH Temperature Display and Calibration

pH Temperature Display

Star Plus meters allow the temperature to be viewed on individual measurement lines in addition to the temperature display on the top, left of the screen.









To view the temperature for the pH measurement line:

1. In the measurement mode, press  to select the top display line. The arrow icon will point to the selected line.
2. Press  /  to change the value on the selected line. The top line can be changed to display pH (pH), millivolts (mV), relative millivolts (RmV), concentration (ISE), temperature (no icon) or a blank line.

pH Temperature Calibration

The temperature calibration mode of the Star Plus meter allows the temperature on each measurement line to be manually adjusted.

To calibrate the temperature for the pH measurement line:










1. In the measurement mode, press  to choose the top measurement line and press  /  until the temperature is shown for the selected line.
2. Press  to begin the calibration.
3. When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
4. Press  to save and end the calibration.

Chapter VII mV, Relative mV and ORP Technique

All meters with pH measurement capability include a mV, relative mV and ORP function. Measure the raw millivolt (mV) values of an electrode in the mV mode. Calibrate the relative millivolt (RmV) values of a redox electrode for oxidation-reduction potential (ORP) measurements in the relative mV and ORP mode. Refer to the **pH Technique** section for information on the temperature display and temperature calibration of the pH/mV/RmV/ISE measurement line.








Note: *The mV measurements are raw readings and cannot be calibrated. Use the relative mV mode to calibrate mV measurements.*

Relative mV and ORP Calibration

1. Prepare the electrode according to the electrode user guide.
2. In the measurement mode, press  until the arrow icon points to the top line, press  until the **RmV** icon is shown and press  to begin the calibration.
3. Rinse the electrode with distilled water and place it into the standard.
4. Wait for the **RmV** icon to stop flashing. When the **RmV** icon stops flashing, the meter will display 000.0 RmV. Press  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the meter displays the millivolt value of the standard. To change the value to negative or positive number, press  until none of the digits are blinking and the arrow icon is blinking and then press  to change the sign of the millivolt value.
5. Press  to save and end the calibration.
6. The millivolt offset will be displayed and the meter will automatically proceed to the measurement mode.

mV, Relative mV and ORP Measurement















Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.

1. Rinse the electrode with distilled or deionized water. Shake off any excess water and blot the electrode dry with lint-free tissue.
2. Place the electrode into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **mV** or **RmV** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the measurement and freeze the display. If a benchtop meter is used and the stirrer is enabled, the stirrer will turn on when  is pressed and turn off when the reading is stable.
 - c. If the meter is in the timed measurement mode, it will start reading immediately and continuously update the display. The meter will log and print the measurement at the frequency specified in the setup menu. If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
3. Remove the electrode from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
4. Once all of the samples have been measured, rinse the electrode with distilled or deionized water and blot it dry. Consult the electrode user guide for proper storage techniques.

Chapter VIII Dissolved Oxygen Technique








Dissolved Oxygen Setup Menu

Note: Refer to the Setup Menu section for the Setup Menu Table, which contains a complete list of meter setup options and descriptions. Refer to Appendix A for a description of the special setup menu features.

1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until *dO* is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through *rES* for the % saturation resolution, *rES* for the mg/L concentration resolution, *bAr* for the barometer type (automatic or manual), *PRES* for the manual barometric pressure compensation value, *SAL* for the salinity compensation type (automatic or manual), *SALF* for the manual salinity correction value and *CALC* for the dissolved oxygen calibration type.
5. Press  to select the option and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another dissolved oxygen setting or press  to return to the measurement mode.






Dissolved Oxygen Calibration

- Prior to calibration, the dissolved oxygen probe must be prepared and polarized. The probe is continuously polarized when it is connected to the meter. When the probe is first connected or if the probe is disconnected for more than 60 minutes, connect the probe to the meter, connect the meter to a power source and wait 30 to 60 minutes for the probe to polarize. Disconnecting the probe for less than one hour will require 5 to 25 minutes for polarization.
 - The meters will supply a polarization current to the dissolved oxygen probe even when the meter power is off. To maximize the meter battery life, unplug the probe if it will not be used for an extended period.
1. Select one of the following calibration modes in the setup menu.
 - a. **Air** – An air calibration is performed in water saturated air using the calibration sleeve. This is the simplest and most accurate calibration. Due to the inherent differences between water saturated air and air saturated water, 102.3% saturation will be displayed when the calibration reading is stable.
 - i. The highest possible accuracy is reached when calibration temperature is the same as the measuring temperature.
 - ii. Moisten the sponge or absorbent cloth in the calibration sleeve with distilled water and insert the probe into the sleeve without touching the water saturated material. For BOD measurements, this calibration can be performed in a BOD bottle.
 - b. **H₂O** – A water calibration is performed using water that is 100% saturated with air. Bubble air into a water sample and gently stir the sample to prevent the buildup of air bubbles on the dissolved oxygen probe membrane.
 - c. **mAn** – A manual calibration is performed using a water sample with a known concentration of dissolved oxygen. This method can be used to calibrate the dissolved oxygen probe to the value achieved by a Winkler titration.



- i. A manual calibration involves performing a Winkler titration and using that sample as a calibration standard. The oxygen level result from the titration is entered in a manual calibration as the dissolved oxygen value. This correlates the meter input to the Winkler titration. This method is inherently less accurate, due to the possibility of titration errors.
- d. **SETO** – A zero point calibration is performed in an oxygen-free solution. A zero point calibration is not generally required unless measurements will be taken below 10% saturation or 1 mg/L. Zero the probe when using a new membrane, using fresh filling solution or when measuring dissolved oxygen levels below 1 mg/L. An air calibration should be performed prior to the zero point calibration.
2. Allow the probe and calibration standard (water saturated air, air saturated water, Winkler standard or oxygen-free solution) to reach equilibrium.
 3. In the measurement mode, press  until the arrow icon points to the bottom line, press  until the **% sat** or **mg/L** icon is shown and press  to begin the calibration.
 4. Wait for the dissolved oxygen reading to stabilize.
 - a. If an air calibration is performed, the meter will display 102.3% and automatically return to the measurement mode.
 - b. If a water calibration is performed, the meter will display 100.0% and automatically return to the measurement mode.
 - c. If a manual calibration is performed, wait for the **mg/L** icon to stop flashing and enter the dissolved oxygen value by pressing  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the meter displays the correct dissolved oxygen value. Once the dissolved oxygen value is set, press  until the decimal point is in the correct location.
 - d. If a zero point calibration is performed, the meter will display 0.00 and automatically return to the measurement mode.

Dissolved Oxygen Measurement

Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.

1. Rinse the dissolved oxygen probe with distilled or deionized water. Shake off any excess water and blot the probe dry with lint-free tissue.
2. Place the dissolved oxygen probe into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **mg/L** or **% sat** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the probe and stirrer from the sample.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the reading and freeze the display. If a benchtop meter is used and the stirrer is enabled, the stirrer will turn on when  is pressed and turn off when the reading is stable. If the BOD AUTO-STIR probe is used, press the button on the probe to start the AUTO-READ measurement.

Note: Benchtop Star Plus dissolved oxygen meters allow the measurement and stirring functions to be controlled by the AUTO-STIR probe when the meter is in the AUTO-READ measurement mode. Press the button on the AUTO-STIR probe to start and stop measurement and stirring functions.

- c. If the meter is in the timed measurement mode, it will start reading immediately and continuously update the display. The meter will log and print the measurement at the frequency specified in the setup menu. If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the probe and stirrer from the sample.




3. Remove the dissolved oxygen probe from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
4. Once all of the samples have been measured, rinse the dissolved oxygen probe with distilled or deionized water and blot it dry. Consult the dissolved oxygen probe user guide for proper storage techniques.

Dissolved Oxygen Temperature Display and Calibration

Dissolved Oxygen Temperature Display

Star Plus meters allow the temperature to be viewed on individual measurement lines in addition to the temperature display on the top, left of the screen.









To view the temperature for the dissolved oxygen measurement line:

1. In the measurement mode, press  to choose the bottom display line. The arrow icon will point to the selected line.
2. Press  /  to change the value on the selected line. The bottom line can be changed to display dissolved oxygen (% saturation), dissolved oxygen (mg/L), barometric pressure (no icon), sample temperature (no icon), electrolyte solution/membrane temperature (no icon, *m* after number) or a blank line.









Dissolved Oxygen Temperature Calibration

The temperature calibration mode of the Star Plus meter allows the temperature on each measurement line to be manually adjusted. The dissolved oxygen measurement line displays the sample temperature and the electrolyte solution/membrane temperature.

To calibrate the sample temperature for the dissolved oxygen measurement line:

1. In the measurement mode, press  to choose the bottom measurement line and press  /  until the sample temperature is displayed (i.e. *25.0*).
2. Press  to begin the calibration.
3. When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
4. Press  to save and end the calibration.

To calibrate the electrolyte solution/membrane temperature for the dissolved oxygen measurement line:

1. In the measurement mode, press  to choose the bottom measurement line and press  /  until the membrane temperature is displayed (i.e. *25.0m*).
2. Press  to begin the calibration.
3. When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
4. Press  to save and end the calibration.

Chapter IX RDO® Optical Dissolved Oxygen Technique









Note: The RDO optical dissolved oxygen meters have serial numbers that begin with R (i.e. R12345). Only the RDO meters are compatible with the RDO optical dissolved oxygen sensors.

RDO Cap Overview

The RDO sensor has an internal clock that counts down the 365 day lifespan of a new RDO cap. The countdown begins when the RDO cap is installed on the RDO sensor, the sensor is connected to the meter and the first measurement is taken. The 365 day countdown cannot be reset or changed once the first measurement is taken. Each RDO cap has a unique serial number that is recognized by the RDO sensor, so reinstalling the cap will not reset the countdown.















Note: The power to the meter must be turned off when a new RDO cap is installed on the RDO sensor. Once the RDO cap is installed, turn the power to the meter on and the new cap information will be sent to the meter.

To print the RDO cap information:

1. Connect the meter to a printer or computer and verify the meter baud rate and output settings in the setup menu.
2. From the measurement mode, press .
3. Press  /  to scroll through the setup menu until *PrOb* is displayed on the top line and *dO* is displayed on the middle line.
4. Press  two times to move the arrow icon to the bottom line.
5. Press  /  until *Info* is displayed on the bottom line.
6. Press  to print the RDO cap information. Press  to return to the measurement mode.

RDO Optical Dissolved Oxygen Setup Menu







Note: Refer to the Setup Menu section for the Setup Menu Table, which contains a complete list of meter setup options and descriptions.

1. From the measurement mode, press .
2. Press  /  to scroll through the setup menu until **dO** is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through **rES** for the % saturation resolution, **rES** for the mg/L concentration resolution, **bAR** for the barometer type (automatic or manual), **PRES** for the manual barometric pressure compensation value, **SAL** for the salinity compensation type (automatic or manual), **SALF** for the manual salinity correction value, **CALt** for the dissolved oxygen calibration type and **LIFE** for the RDO cap replacement countdown in days.
5. Press  to select the option and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another dissolved oxygen setting or press  to return to the measurement mode.






Setup Menu for RDO Optical Dissolved Oxygen Sensor

The RDO optical dissolved oxygen meters have a special setup menu feature that allows the user to print information about the RDO sensor.

Top Line	Middle Line	Bottom Line	Setup Menu Description
PrOb	dO	tESt	The tESt option initiates a 30 second test of the communication link between the RDO sensor and meter. The temperature display will show a 30 second countdown as the test progresses. The meter will send a report to the printer or computer when the test is done.
PrOb	dO	CAL	The CAL option prints the meter serial number, date, time and slope for the last five dissolved oxygen calibrations that were performed with the RDO sensor that is currently connected to the meter.
PrOb	dO	dFLt	The dFLt option prints the factory calibration information for the RDO sensor that is currently connected to the meter.
PrOb	dO	SLP	The SLP option prints a drift per minute value of the slope for the last five dissolved oxygen calibrations that were performed with the RDO sensor that is currently connected to the meter.
PrOb	dO	mEtH	The mEtH option prints the RDO specific method information of the last method used for the RDO sensor that is currently connected to the meter.
PrOb	dO	InFO	The InFO option prints the RDO sensor information, including the sensor serial number and revision, sensor and RDO cap date of manufacturing, cap start date, cap life and internal real time clock for the sensor that is currently connected to the meter.

1. Connect the meter to a printer or computer and verify the meter baud rate and output settings in the setup menu.
2. From the measurement mode, press .
3. Press  /  to scroll through the setup menu until *PrOb* is displayed on the top line and *dO* is displayed on the middle line.
4. Press  two times to move the arrow icon to the bottom line.
5. Press  /  to scroll through *tESt* for the communication link test, *CAL* for the RDO sensor calibration information, *dFLt* for the RDO sensor factory calibration information, *SLP* for the RDO sensor slope information, *mEtH* for the RDO method information and *InFO* for the general RDO sensor information.

RDO® Optical Dissolved Oxygen Technique

- Press  to print the selected option.
- Press  /  to select another option from the bottom line and press  to print the selected option or press  to return to the measurement mode.

Example RDO Sensor General Information Printout

```
smartprobe info
type                1
run_status          255
format_version      1
probe_SN            6
app_version         9
HW_version          1

cap_SN              129614
rtc                 1210257372 (05-08-2008 14:36:12)
mfg_time            1208371349 (04-16-2008 18:42:29)
start_time          1210178953 (05-07-2008 16:49:13)
expiration          1241736553 (05-07-2009 22:49:13)
probe_mfg_time      1208440800 (04-17-2008 14:00:00)
write_count         14

pass_count          12
expire              0x01
days_left          364.3








probe_reading       149.529243
temp_reading        24.942651

state               21
general_event        0x00
internal_event       0x00
internal_state       3
internal_retry       0x00
```

RDO Optical Dissolved Oxygen Calibration




1. Select one of the following calibration modes in the setup menu.
 - a. **Air** – An air calibration is performed in water saturated air using the calibration sleeve. This is the simplest and most accurate calibration method.
 - i. The highest possible accuracy is reached when calibration temperature is the same as the measuring temperature.
 - ii. Moisten the sponge in the calibration sleeve with distilled water. Insert the RDO sensor into the sleeve without touching the water saturated sponge.
 - b. **H₂O** – A water calibration is performed using water that is 100% saturated with air. Bubble air into a water sample and gently stir the sample to prevent the buildup of air bubbles on the RDO cap.
 - c. **mAn** – A manual calibration is performed using a water sample with a known concentration of dissolved oxygen. This method can be used to calibrate the RDO sensor to the value achieved by a Winkler titration.
 - i. A manual calibration involves performing a Winkler titration and using that sample as a calibration standard. The oxygen level result from the titration is entered in a manual calibration as the dissolved oxygen value. This correlates the meter input to the Winkler titration. This method is inherently less accurate, due to the possibility of titration errors.
 - d. **SEtO** – A zero point calibration is performed in an oxygen-free solution. A zero point calibration is not generally required unless measurements will be taken below 10% saturation or 1 mg/L.
2. Allow the RDO sensor and calibration standard (water saturated air, air saturated water, Winkler standard or oxygen-free solution) to reach equilibrium.

RDO® Optical Dissolved Oxygen Technique

3. In the measurement mode, press  until the arrow icon points to the bottom line, press  until the **% sat** or **mg/L** icon is shown and press  to begin the calibration.
4. Wait for the dissolved oxygen reading to stabilize.
 - a. If an air calibration is performed, the meter will display 100.0% and automatically return to the measurement mode.
 - b. If a water calibration is performed, the meter will display 100.0% and automatically return to the measurement mode.
 - c. If a manual calibration is performed, wait for the **mg/L** icon to stop flashing and enter the dissolved oxygen value by pressing  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the meter displays the correct dissolved oxygen value. Once the dissolved oxygen value is set, press  until the decimal point is in the correct location.
 - d. If a zero point calibration is performed, the meter will display 0.00 and automatically return to the measurement mode.

RDO Optical Dissolved Oxygen Measurement

Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.




1. Rinse the RDO sensor with distilled or deionized water. Shake off any excess water and blot the sensor dry with lint-free tissue.
2. Place the RDO sensor into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **mg/L** or **% sat** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . This mode will use a large amount of meter battery power.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the measurement and freeze the display. This mode uses various amounts of meter battery power, depending on how often  is pressed.
 - c. If the meter is in the timed measurement mode, it will take a dissolved oxygen reading at the frequency specified in the setup menu. If parameters other than dissolved oxygen are measured, the meter will continuously take the other readings and update the display. The meter will log and print the measurement at the predetermined time interval. This mode can be used to extend the meter battery life, since the power consumption of the RDO sensor is reduced, depending on the set time interval.
3. Remove the RDO sensor from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
4. Once all of the samples have been measured, rinse the RDO sensor with distilled or deionized water and blot it dry. Consult the RDO sensor user guide for proper storage techniques.

RDO Optical Dissolved Oxygen Temperature Display and Calibration

RDO Optical Dissolved Oxygen Temperature Display

Star Plus meters allow the temperature to be viewed on individual measurement lines in addition to the temperature display on the top, left of the screen.









To view the temperature for the RDO dissolved oxygen measurement line:

1. In the measurement mode, press  to choose the bottom display line. The arrow icon will point to the selected line.
2. Press  /  to change the value on the selected line. The bottom line can be changed to display dissolved oxygen (% saturation), dissolved oxygen (mg/L), barometric pressure (no icon), temperature (no icon) or a blank line.

RDO Optical Dissolved Oxygen Temperature Calibration

The temperature calibration mode of the Star Plus meter allows the temperature on each measurement line to be manually adjusted.















To calibrate the temperature for the RDO dissolved oxygen measurement line:

1. In the measurement mode, press  to choose the bottom measurement line and press  /  until the temperature is displayed.
2. Press  to begin the calibration.
3. When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
4. Press  to save and end the calibration.

Chapter X Conductivity Technique









Conductivity Setup Menu


Note: Refer to the Setup Menu section for the Setup Menu Table, which contains a complete list of meter setup options and descriptions. Refer to Appendix A for a description of the special setup menu features.





1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until **Cond** is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through **TC** for the temperature compensation type, **COEF** for the temperature coefficient value used for **L In** temperature compensation, **TDSF** for the TDS factor value used for total dissolved solids measurement, **CELL** for the nominal cell constant value of the conductivity probe, **TEMP** for the reference temperature used for temperature compensation and **TYPE** for the conductivity cell type.
5. Press  to accept the selection and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another conductivity setting or press  to return to the measurement mode.



Conductivity Calibration

Note: For an automatic calibration, the nominal cell constant of the conductivity probe must be entered in the setup menu before the calibration is performed.

1. In the measurement mode, press  until the arrow icon points to the middle line, press  until the **µS/cm** or **mS/cm** icon is shown and press  to begin the calibration.
2. Rinse the probe with deionized water and place it into the conductivity standard.
3. To perform a manual calibration – The manual calibration screen will display the cell constant on the top line, the conductivity value of the calibration standard on the middle line and **CELL** on the bottom line. To change the cell constant, press  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the displayed conductivity value matches the value of the standard at the measured temperature. Once the value is set, press  until the decimal point is in the correct location. Press  to save and end the calibration.








Note: In the manual calibration screen, start changing the cell constant within five seconds or the meter will proceed to the automatic/direct calibration. If this occurs, press and hold  to abort the calibration and repeat the calibration.

4. To perform an automatic or direct calibration – Wait for the meter to go from the manual calibration screen to the automatic/direct calibration screen. The automatic/direct calibration screen will display the conductivity value of the calibration standard on the middle line and **CAL. I** on the bottom line.
 - a. Automatic calibration – When the **µS/cm** or **mS/cm** icon stops flashing, the meter will display the temperature-corrected conductivity of the standard.
 - b. Direct calibration – When the **µS/cm** or **mS/cm** icon stops flashing, the meter will display the actual conductivity value read by the probe. To change the conductivity value, press  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the correct conductivity value of the standard at the measured temperature is displayed. Once the value is set, press  until the decimal point is in the correct location.

5. Press  to proceed to the next calibration point, rinse the conductivity probe with distilled or deionized water, place it into the next conductivity standard and repeat step 4a / 4b or press  to save and end the calibration.
6. The cell constant will be displayed in the main field and the meter will automatically advance to the measurement mode.

Conductivity Measurement

Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.

1. Rinse the conductivity probe with distilled or deionized water. Shake off any excess water and blot the probe dry with lint-free tissue.
2. Place the conductivity probe into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **µS/cm** or **mS/cm** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the probe and stirrer from the sample.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the measurement and freeze the display. If a benchtop meter is used and the stirrer is enabled, the stirrer will turn on when  is pressed and turn off when the reading is stable.
 - c. If the meter is in the timed measurement mode, it will start reading immediately and continuously update the display. The meter will log and print the measurement at the frequency specified in the setup menu. If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the probe and stirrer from the sample.




Conductivity Technique

- Remove the conductivity probe from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
- Once all of the samples have been measured, rinse the conductivity probe with distilled or deionized water and blot it dry. Consult the conductivity probe user guide for proper storage techniques.

Conductivity Temperature Display and Calibration









Conductivity Temperature Display

Star Plus meters allow the temperature to be viewed on individual measurement lines in addition to the temperature display on the top, left of the screen.

- In the measurement mode, press  to choose the middle display line. The arrow icon will point to the selected line.
- Press  /  to change the value on the selected line. The middle line can be changed to display conductivity ($\mu\text{S}/\text{cm}$ or mS/cm), total dissolved solids (mg/L), salinity (ppt), resistivity ($\text{M}\Omega\text{-cm}$), temperature (no icon) or a blank line.

Conductivity Temperature Calibration















The temperature calibration mode of the Star Plus meter allows the temperature on each measurement line to be manually adjusted.

- In the measurement mode, press  to choose the middle measurement line and press  /  until the temperature is shown for the selected line.
- Press  to begin the calibration.
- When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
- Press  to save and end the calibration.

Chapter XI ISE Technique
















ISE Setup Menu

Note: Refer to the Setup Menu section for the Setup Menu Table, which contains a complete list of meter setup options and descriptions. Refer to Appendix A for a description of the special setup menu features.

1. In the measurement mode, press .
2. Press  /  to scroll through the setup menu until *ISE* is displayed on the top line.
3. Press  to accept the selection and move the arrow icon to the middle line.
4. Press  /  to scroll through *RES* for the ISE measurement resolution, *Un It* for the ISE measurement units, *rAng* for the ISE calibration range and *nL In* for the non-linear blank correction feature.
5. Press  to accept the selection and move the arrow icon to the bottom line.
6. To scroll through a list of options on the bottom line, press  /  until the desired option is displayed. To enter a numeric value for an option on the bottom line, press  /  to adjust each digit and  to move to the next digit.
7. Press  to accept the selection and move the arrow icon to the top line.
8. Repeat steps 3 through 7 to change another ISE setting or press  to return to the measurement mode.








ISE Calibration

The calibration standards should be prepared in the same ISE units as the desired sample results. Start the calibration with the lowest concentration calibration standard and work up to the highest concentration calibration standard. Any reagents, such as ionic strength adjustors, should be added to samples and standards as specified in the electrode user guide.

1. Prepare the electrode, standards and any other required solutions for use according to the electrode user guide.
2. In the measurement mode, press  until the arrow icon points to the top line, press  until the **ISE** icon is shown and press  to begin the calibration.
3. Rinse the electrode with distilled or deionized water, shake any excess water off, blot it dry and place the electrode into the least concentrated standard.
4. Wait for **ISE** icon to stop flashing. Press  until the first digit to be changed is flashing, press  /  to change the value of the flashing digit and continue to change the digits until the meter displays the concentration value of the standard. Once the standard value is set, press  until the decimal point is in the correct location.
5. Press  to proceed to the next lowest calibration standard and repeat steps 3 and 4, working from the lowest concentration standard to the highest concentration standard, or press  to save and end the calibration.
6. The actual electrode slope, in mV per decade concentration, will be displayed in the main field and **SLP** will be displayed in the lower field.
 - a. For a one point calibration, press  and  /  to edit the slope. To change the sign of the slope to negative or positive, press  until none of the digits are blinking and the arrow icon is blinking and press  to change the sign of the slope. Press  to return to the measurement mode.
 - b. For a two or more point calibration, the meter will automatically proceed to the measurement mode after the slope is displayed.

ISE Measurement

Note: Turn on the automatic datalog feature to send measurements to the meter datalog at the frequency specified in each measurement mode. Refer to the Data Archiving and Retrieval section for details. If the automatic datalog feature is off, connect the meter to a printer or computer to record the measurements.





1. Rinse the electrode with distilled or deionized water. Shake off any excess water and blot the electrode dry with lint-free tissue.
2. Place the electrode into the sample.
 - a. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The **ISE** icon will flash until the reading is stable. Once the reading is stable, log and print the measurement by pressing . If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
 - b. If the meter is in the AUTO-READ measurement mode, press  to start the reading. The **AR** icon will flash until the reading is stable. Once the reading is stable, the meter will log and print the measurement and freeze the display. If a benchtop meter is used and the stirrer is enabled, the stirrer will turn on when  is pressed and turn off when the reading is stable.
 - c. If the meter is in the timed measurement mode, it will start reading immediately and continuously update the display. The meter will log and print the measurement at the frequency specified in the setup menu. If a benchtop meter is used and the stirrer is enabled, press  to start the stirrer. Press  again to turn off the stirrer before removing the electrode and stirrer from the sample.
3. Remove the electrode from the sample, rinse it with distilled or deionized water, blot it dry, place it in the next sample and repeat step 2.
4. Once all of the samples have been measured, rinse the electrode with distilled or deionized water and blot it dry. Consult the electrode user guide for proper storage techniques.

ISE Temperature Display and Calibration

ISE Temperature Display

Star Plus meters allow the temperature to be viewed on individual measurement lines in addition to the temperature display on the top, left of the screen.









To view the temperature for the ISE measurement line:

1. Press and hold  until the meter displays the measurement mode.
2. Press  to choose the top display line. The arrow icon will point to the selected line.
3. Press  /  to change the value on the selected line. The top line can be changed to display pH (pH), millivolts (mV), relative millivolts (RmV), concentration (ISE), temperature (no icon) or a blank line.

ISE Temperature Calibration

The temperature calibration mode of the Star Plus meter allows the temperature on each measurement line to be manually adjusted.

To calibrate the temperature for the ISE measurement line:

1. In the measurement mode, press  to choose the top measurement line and press  /  until the temperature is shown for the selected line.
2. Press  to begin the calibration.
3. When the reading stabilizes, the arrow icon and the first digit will flash. Enter the temperature by pressing  /  to adjust each digit and  to move to the next digit.
4. Press  to save and end the calibration.

Chapter XII Data Archiving and Retrieval












Datalog and Calibration Log

All 3-Star Plus and the 4-Star Plus pH/ISE meters have a 1000 point datalog. The 4-Star Plus pH/conductivity and pH/dissolved oxygen meters have a 750 point datalog. The 5-Star Plus meters have a 500 point datalog. The 2-Star meter has a 50 point datalog and all Orion Star meters have a 200 point datalog.

The Star Plus meter printouts have been enhanced to include additional information. The pH and ISE calibration printouts now include the average slope, the slope between points and the E_o per point. The polarographic dissolved oxygen printouts now include slope, membrane temperature and solution temperature.












Automatic Datalog Feature

The 3-Star, 4-Star and 5-Star Plus meters have been enhanced to include an automatic datalog feature that can be turned on or off. To enable the automatic recording of data into the datalog:

1. In the measurement mode, press .
2. Press  /  until *LOG* is displayed on top line.
3. Press  to accept the selection and move the arrow icon to the middle line and press  /  until *AUTO* is displayed.
4. Press  to accept the selection and move the arrow icon to the bottom line and press  /  until *On* is displayed.
5. Press  to accept the selection and move the arrow icon to the top line.
6. Press  to save the setup option and return to measurement mode.

Datalog Deletion Setting

The datalog deletion setting determines if the meter will automatically delete the datalog after it is downloaded to a printer or computer and if the meter will overwrite the datalog points when the datalog is full. If the datalog deletion setting is set to **YES**, the meter will automatically delete the datalog after the datalog is downloaded to a printer or computer. The meter will also display the **Err 038** error message when all 200 datalog points are filled and the datalog must be downloaded to a printer or computer to clear the error message. If the datalog deletion setting is set to **n0**, the meter will overwrite the oldest datalog point when all 200 datalog points are filled and will not delete the datalog after the datalog is downloaded to a printer or computer.














1. In the measurement mode, press .
2. Press  /  until **LOG** is displayed on top line.
3. Press  to accept the selection and move the arrow icon to the middle line and press  /  until **dEL** is displayed.
4. Press  to accept the selection and move the arrow icon to the bottom line and press  /  until **YES** or **n0** is displayed.
5. Press  to accept the selection and move the arrow icon to the top line.
6. Press  to save the setup option and return to measurement mode.

Note: If the datalog is not required, set the datalog deletion setting to **n0** to prevent the error 038 (datalog full) message.


Viewing and Printing the Datalog and Calibration Log




The 3-Star, 4-Star and 5-Star Plus meters have been enhanced to include a calibration log view feature in addition to the datalog view, datalog print and calibration log print features. The Orion Star meters include the datalog view, datalog print and calibration log print features.

To view the datalog or calibration log:

1. In the measurement mode, press .
2. Press  /  to scroll through μIEW to view the datalog or $CALU$ to view the calibration log (Star Plus meters only).
3. Press . The meter will display the date/time screen. The log number will be on the top of the screen and the time, date and year the log was recorded will be on the top, middle and bottom display lines respectively. Press  /  to scroll through the log.
4. Press . The meter will display the data or calibration point associated with the selected date/time screen.
 - a. Press  to print the individual data point.
 - b. Press  /  to scroll through the log.
 - c. Press  to return to the date/time screen.
5. To exit the log view mode, press  until the meter displays the date/time screen and press .

To send the datalog or calibration log to a printer or computer:

1. Connect the meter to a printer or computer and verify the meter baud rate and output settings in the setup menu.
2. In the measurement mode, press .

3. Press  /  to scroll through *SEnd* to print the datalog or *CALS* to print the calibration log. The Orion Star meters will display *CALD* instead of *CALS*.
4. Press  to send the selected data to the printer or computer.

To interfacing the meter with a computer:

The Orion Star and Star Plus meters can send measurement and calibration data to a computer in a comma delimited format that is easy to parse in computer programs like Excel. Select the *r232, OUTF, COMp* output setting in the setup menu.

To send data from the meter to a computer using HyperTerminal:

1. Connect the meter to a computer port using the computer interface cable, Cat. No. 1010053.
2. Click on the start button on the lower left side of the computer screen. Select All Programs, Accessories, Communications and HyperTerminal.
3. When the HyperTerminal window opens, enter a file name, select an icon for the connection and click on the OK button.
4. When a new window opens, go to the Connect Using drop-down menu, select the COM port that the meter is connected to and click on the OK button.
5. A window will open with the COM port properties listed. Select the following settings from the drop-down menus and then click on the OK button.

Bits per second: 9600

Data bits: 8

Parity: None

Stop bits: 1

Flow control: Hardware

6. Send data from the meter to HyperTerminal.

Chapter XIII Declaration of Conformity

Manufacturer: Thermo Fisher Scientific Inc.

Address: 166 Cummings Center
Beverly, MA 01915
USA

We declare that the following products described below conform to the Directive and Standard listed below:

Product(s): Meters for measuring pH, conductivity, dissolved oxygen, and/or ISE
Benchtop models are rated 100 to 240 VAC, 50/60 Hz, 0.5 A
Handheld models use four non-rechargeable AA batteries

Benchtop Meters

5-Star Plus pH/ISE/Conductivity/DO Meter
4-Star Plus pH/Conductivity Meter
4-Star Plus pH/DO
4-Star Plus pH/ISE Meter
3-Star Plus Conductivity Meter
3-Star Plus DO Meter
3-Star Plus pH Meter
2-Star pH Meter

Portable Meters

5-Star Plus pH/ISE/Conductivity/DO Meter
5-Star Plus pH/Conductivity/DO Meter
4-Star Plus pH/Conductivity Meter
4-Star Plus pH/DO Meter
4-Star Plus pH/ISE Meter
3-Star Plus Conductivity Meter
3-Star Plus pH Meter
3-Star Plus DO Meter
5-Star Plus RDO® Optical DO/pH/Conductivity Meter
4-Star Plus RDO Optical DO/Conductivity Meter
3-Star Plus RDO Optical DO Meter

Equipment Class: Measurement, control and laboratory
Benchtop models are EMC Class A
Portable models are EMC Class D

Declaration of Conformity

Directive(s) and Standard(s):

- 89/336/EEC – Electromagnetic Compatibility (EMC Directive)
 - EN 61326:1997 + A1:1998 + A2:2001 – Electrical equipment for measurement, control, and laboratory use – EMC requirements
- 73/23/EEC – Low Voltage Directive (LVD)
 - EN 61010-1:2001 – Safety requirements for electrical equipment for measurement, control, and laboratory use – general requirements

Manufacturer's Authorized Representative:

Date:



Patrick Chiu
Senior Quality Assurance Engineering,
Regulatory Compliance

June 6, 2006

WEEE Compliance







This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

We have contracted with one or more recycling/disposal companies in each EU Member State and this product should be disposed of or recycled through them. Further information on compliance with these Directives, the recyclers in your country, and information on Thermo Scientific Orion products which may assist the detection of substances subject to the RoHS Directive are available at www.thermo.com/WEEERoHS.



Chapter XIV Troubleshooting



Meter Self Test

1. Disconnect all of the electrodes and probes from the meter and cover all of the meter inputs with the black caps.
2. Power on the meter, wait until the software revision is displayed and press .
3. All the segments on the display will turn on. Visually inspect the display segments to verify that all of the segments are lit and press .
4. All the segments on the display will turn off. Visually inspect the display segments to verify that all of the segments are not lit and press .
5. The display will read *KEY*. Press every key on the keypad one at a time in any order. If the keys are not pressed within five seconds of one another, the display will read *Err 033*, which indicates a key failure. Press  to clear the error 033 message and complete the self test. If all the keys are pressed and functioning, the meter will restart and proceed to the measurement mode.

Note: If the meter reads *Err 034* during the self test, ensure that all of the electrodes are disconnected from the meter, all of the meter inputs are covered with the black caps and the BNC shorting cap is firmly attached to the BNC meter input. This error code usually occurs if the BNC shorting cap is missing or not fully connected to the BNC meter input during the meter self test.






Meter Error Codes

- If the reading on the screen is flashing **9999**, the value is out of range. Perform the meter self test, clean the electrode according to the electrode user guide and re-calibrate the electrode with new standards.
- If the  icon is lit and the reading is flashing, the sensor needs to be calibrated according to the user's set calibration interval or the pH slope is outside the range of 85 % to 115%.
- Press  to clear an error code. Error codes show **Err** on the middle line and a set of three alphanumeric characters on the bottom line. Some of these codes are errors, some are warnings and some are purely informational.

Error Code	Description	Troubleshooting
002, 026, E##, F##	Hardware or Memory Error	Press  to clear the error. If the error occurs again, contact Technical Support.
005	Value Outside Allowable Range	Press  and re-enter the value. Check meter specifications for the allowable range of values.
033	Keypad Failure	Repeat the self test. When the meter reads KEY , press all the keys, including the power key, within five seconds of one another.
034	BNC Input Failure	Disconnect all the electrodes from the meter, connect the BNC shorting cap to the meter and repeat the self test.
038	Datalog Full	Download the datalog to a printer or computer, turn the automatic datalog feature off in the setup menu (Star Plus meters only) or change the datalog setting to LOG, dEL, nD in the setup menu so the meter deletes the datalog points when the datalog is full.
D##	Remote Control Error	Check the programming instructions to verify the correct commands, names and values.
107	pH Calibration Standard Error	The millivolts measured during calibration are the same for two buffers. Review the calibration procedure and verify that the electrode was placed in the buffers at the appropriate time. Clean the electrode according to the electrode user guide. Re-calibrate the electrode with fresh buffers.
109	Bad pH Slope or Calibration Offset	Clean the electrode according to the electrode user guide. Re-calibrate the electrode with new buffers.
200	Autosampler Interface Error	The meter is unable to send a signal to the autosampler. Make sure that the autosampler is properly connected to the meter.
201	Autosampler Signal Error	The autosampler is unable to receive a signal from the meter. Review the meter setup parameters and make sure that the baud rate of the meter is set to 1200.

Error Code	Description	Troubleshooting
202	Autosampler is Jammed	Turn the autosampler off and wait 45 seconds before turning it back on. The autosampler should return to the home position.
203	Unstable Reading from Autosampler	The measurements taken using the autosampler are unstable. Check the electrodes for proper function. Make sure that the electrode cables are properly connected.
306	ISE Automatic Blank Error	Disable the automatic blank feature in the setup menu and re-calibrate the meter without using a zero concentration standard.
307	ISE Calibration Standard Error	The millivolts measured during calibration are the same for two standards. Review the calibration procedure and verify that the electrode was placed in the standards at the appropriate times. Clean the electrode according to the electrode user guide. Re-calibrate the electrode with fresh standards.
309	Bad ISE Slope	Clean the electrode according to the electrode user guide. Re-calibrate the electrode with freshly prepared standards.
707	Conductivity Calibration Standard Error	The conductivity value measured during calibration is the same for two standards. Review the calibration procedure and verify that the conductivity probe was placed in the standards at the appropriate times. Clean the conductivity probe according to the probe user guide. Re-calibrate the probe with new standards.
709	Conductivity Cell Constant Error	The cell constant is not in the range of 0.001 to 199.0 cm ⁻¹ . Clean the conductivity probe according to the probe user guide. Re-calibrate the probe with new standards.
808	Bad Zero Point DO Slope	An air calibration should be performed before the zero point calibration. Verify that a solution with zero oxygen is being used for the zero point calibration. A solution with 15 grams of Na ₂ SO ₃ dissolved in 250 mL of distilled water is recommended.
809	Bad DO Slope	For polarographic DO probes, connect the probe to the meter, power on the meter and let the probe to polarize for at least 30 minutes. For an air calibration, check that the sponge in the calibration sleeve is damp and there is no water on the probe membrane. For a water calibration, bubble air into the sample and stir to keep bubbles off the membrane. Clean the DO probe according to the probe user guide. Re-calibrate the DO probe.
880	RDO® Optical DO Sensor Not Attached	Verify that the RDO sensor is properly connected to the meter. Connect another, known working RDO sensor to the meter.
881	RDO Optical DO Sensor Expired	The RDO cap attached to the RDO sensor has expired. Install a new RDO cap according to the RDO sensor user guide.
882	RDO Optical DO Sensor Failure	Verify that the RDO cap on the RDO sensor was properly installed, not expired and not tampered with. Connect another, known working RDO sensor to the meter.

General Troubleshooting

Problem:	The display freezes and the measurement values will not change.
Solution:	The meter is in the AUTO-READ measurement mode (the AR icon will appear in the top, right corner of the display). Press  to start a new reading or select another measurement mode in the setup menu.
Problem:	When I press  the meter displays <i>wA It</i> .
Solution:	The meter is printing and cannot enter the calibration mode until the printing is done. This should rarely occur if the meter is set to a 9600 baud rate. If the meter is at a lower baud rate, the delay will be longer.
Problem:	The meter did not accept the change I made in the setup menu.
Solution:	After making a change in the setup menu, press  until the arrow icon points to the top line (confirms the change) and then press  to save the change and return to the measurement mode.
Problem:	How do I abort a calibration?
Solution:	Press and hold  to abort any meter operation and return to the measurement mode.
Problem:	The printout is a string of numbers and units with commas.
Solution:	The output format in the setup menu is set to the computer output or the printer baud rate is set incorrectly in the setup menu. Change the output format to the printer output in the setup menu. Change the baud rate to the correct value for the printer that is being used.
Problem:	When I press the stirrer button, the stirrer doesn't work.
Solution:	The current stirrer setting is off. Set the speed to 1 through 7 in the setup menu.
Problem:	The timed measurement time entry screen does not appear in the setup menu.
Solution:	The meter is in the AUTO-READ or continuous mode. When the meter is set to the timed mode, the next setup screen will be for time entry.
Problem:	I cannot tell if I have the Star Plus meter or the Orion Star meter.
Solution:	When the meter is powered on, the Star Plus meters with enhanced features will display <i>STAR PLUS</i> with the meter revision number (<i>r229</i> or similar) and proceed to the measurement mode.

pH Troubleshooting

- Problem:** The meter does not recognize the pH buffer value during calibration.
- Solution:** Verify that the correct buffer set was selected in the setup menu. The meter uses the raw mV reading of the electrode to recognize a buffer during calibration. As the electrode ages or becomes dirty, its mV readings will drift and you will need to manually enter the pH buffer value when calibrating.

ISE Troubleshooting

- Problem:** It takes several minutes for the readings to stabilize during a calibration.
- Solution:** The concentration range in the setup menu is set to low. Change the concentration range to high.
The ISE resolution is set to 3 digits in the setup menu. Change the ISE resolution to 2 digits for faster stabilization of the readings.
- Problem:** When I use the automatic blank correction setting and calibrate an ISE, the meter gives a slope that is too low or cannot be manually checked.
- Solution:** Turn the automatic blank correction setting off in the setup menu.

Conductivity Troubleshooting

- Problem:** The meter does not recognize the conductivity standard during calibration.
- Solution:** Verify that the default cell constant was entered in the setup menu. The cell constant is usually printed on the conductivity probe cable. Verify that the conductivity standard is one that is programmed into the meter. Re-calibrate with a fresh standard.
- Problem:** The temperature coefficient value does not appear in the setup menu.
- Solution:** The current temperature compensation setting is nonlinear or off. Change the temperature compensation to linear and the next screen will be the temperature coefficient value entry screen.
- Problem:** The measurement is out of range when it should be in range.
- Solution:** Check that the conductivity probe is fully immersed in the solution. Verify that the cell constant is correct for the conductivity probe that is connected to the meter. Verify that the cell type selected in the setup menu is set to Std.

Dissolved Oxygen Troubleshooting

Problem: The manual barometric pressure entry screen does not appear in the setup menu.

Solution: The barometric pressure compensation is set to automatic in the setup menu. Change the barometric pressure compensation to manual and the next screen will be the manual pressure entry screen.

Problem: The manual salinity factor entry screen does not appear in the setup menu.

Solution: The salinity correction is set to automatic in the setup menu. Change the salinity correction to manual and the next screen will be the salinity factor entry screen.

Problem: The AUTO-STIR BOD probe does not turn on when the button on the probe is pressed.

Solution: The read type must be set to AUTO-READ in the setup menu and the stirrer speed must be set from 1 to 7 to initiate a measurement and start stirring by pressing the button on the AUTO-STIR BOD probe.

RDO® Optical Dissolved Oxygen Troubleshooting

Problem: The meter displays an error 881 message and will not take a dissolved oxygen measurement.

Solution: Turn the meter off, replace the old RDO cap with a new cap and turn the meter on. This should clear the error message.

Assistance

After troubleshooting all components of your measurement system, contact Technical Support. Within the United States call 1.800.225.1480 and outside the United States call 978.232.6000 or fax 978.232.6031. In Europe, the Middle East and Africa, contact your local authorized dealer. For the most current contact information, visit www.thermo.com/contactwater.

For the latest application and technical resources for Thermo Scientific Orion products, visit www.thermo.com/waterapps.

Warranty

For the most current warranty information, visit www.thermo.com/water.

Chapter xv Meter Specifications

Meter Specifications

Environmental Operating Conditions

Portable and Benchtop Meter Environmental Operating Conditions	
Operating Ambient Temperature	5 to 45 °C
Operating Relative Humidity	5 to 85 %, non-condensing
Storage Temperature	-20 to +60 °C
Storage Relative Humidity	5 to 85 %, non-condensing
Pollution	Degree 2
Overvoltage	Category II
Altitude	Up to 2000 meters
Weight	Portable: 0.45 kg Benchtop: 0.91 kg
Size	Portable: 4.8 cm (H) x 9.7 cm (W) x 21.3 cm (D) Benchtop: 9.4 cm (H) x 17.0 cm (W) x 22.4 cm (D)
AC Powered Meters	Indoor use only
Battery Operated Meters	Indoor or outdoor use
Regulatory and Safety	CE, CSA, TÜV, UL, FCC Class limits*
Case Material	ABS
Shock and Vibration	Vibration, shipping/handling per ISTA #1A Shock, drop test in packaging per ISTA #1A
Enclosure (designed to meet)	IP67 (portable meter) IP54 (benchtop meter)

* TÜV and UL certifications are pending for all Star Plus RDO® optical dissolved oxygen meters.

Meter Specifications

Universal Power Adapter Environmental Operating Conditions	
Operating Ambient Temperature	0 to 50 °C
Operating Relative Humidity	0 to 90 %, non-condensing
Storage Temperature	-20 to +75 °C
Storage Relative Humidity	0 to 90 %, non-condensing
Pollution	Degree 2
Overvoltage	Category II
Operating Altitude	Up to 2000 meters
Benchtop Meters	Indoor use only

Meter Parameter Specifications

The following meter parameter specifications are for the complete line of Orion Star and Star Plus series meters. Single parameter, dual parameter and some multi-parameter meters will not include all of the parameters listed in this section.

pH	
Range	-2.000 to 19.999
Resolution	0.1, 0.01, 0.001
Relative Accuracy	± 0.002
Calibration Points	1 to 5
pH (2-Star pH Meter Only)	
Range	0.000 to 14.999
Resolution	0.1, 0.01, 0.001
Relative Accuracy	± 0.002
Calibration Points	1 to 3
Millivolts, Relative Millivolts, ORP	
Range	± 1999.9 mV
Resolution	0.1 mV
Relative Accuracy	± 0.2 mV or 0.05 % of reading, whichever is greater

ISE	
Range	0 to 19999
Resolution	1 to 3 significant figures
Relative Accuracy	± 0.2 mV or 0.05 %, whichever is greater
Displayed Units	M, mg/L, %, ppb or no units
Calibration Features	Linear point to point, selectable non-linear automatic blank correction and low concentration range stability
Dissolved Oxygen (Polarographic)	
Range	0.00 to 90.0 mg/L 0.0 to 600 %
Resolution	0.1, 0.01 mg/L 0.1, 1 %
Relative Accuracy	± 0.2 mg/L ± 2 %
Salinity Factor	0 to 45 ppt
Barometric Pressure	450 to 850 mm Hg
Calibration Types	Water saturated air, air saturated water, manual (Winkler), zero point
Probe Type	Polarographic
RDO® Optical Dissolved Oxygen	
Range	0.00 to 20.0 mg/L 0.0 to 200 %
Resolution	0.1, 0.01 mg/L 0.1, 1 %
Relative Accuracy	± 0.1 mg/L up to 8 mg/L; ± 0.2 mg/L from 8 mg/L to 20 mg/L ± 2 %
Salinity Factor	0 to 45 ppt
Barometric Pressure	450 to 850 mm Hg
Calibration Types	Water saturated air, air saturated water, manual (Winkler), zero point
Probe Type	RDO optical

Meter Specifications

Conductivity	
Range	0.000 to 3000 mS/cm, auto-resolution with cell constant dependence
Resolution	4 significant figures down to 0.001 μ S/cm, cell constant dependant
Relative Accuracy	0.5 % \pm 1 digit or 0.01 μ S/cm, whichever is greater
Cell Constant	0.001 to 199.9 cm^{-1}
Reference Temperature	5 $^{\circ}$ C, 10 $^{\circ}$ C, 15 $^{\circ}$ C, 20 $^{\circ}$ C or 25 $^{\circ}$ C
Resistivity Range	0.0001 to 100 Megohm
Resistivity Resolution	Automatic
Resistivity Relative Accuracy	0.5 % \pm 1 digit
Salinity Range	0.1 to 80.0 ppt NaCl equivalent, 0.1 to 42 ppt practical salinity
Salinity Resolution	0.1 ppt
Salinity Relative Accuracy	0.1 \pm 1 digit
TDS Range	0 to 19999 mg/L
TDS Resolution	1 mg/L
TDS Relative Accuracy	0.5 % \pm 1 digit
Temperature	
Range	-5 to 105 $^{\circ}$ C
Resolution	0.1 up to 99.9 $^{\circ}$ C, 1.0 over 99.9 $^{\circ}$ C
Relative Accuracy	\pm 0.1 $^{\circ}$ C
Temperature* (RDO [®] Optical Dissolved Oxygen Meter Only)	
Range	0 to 50 $^{\circ}$ C
Resolution	0.1 $^{\circ}$ C
Relative Accuracy	\pm 0.3 $^{\circ}$ C

* This temperature specification is only for the Star Plus RDO optical dissolved oxygen meter when it is used with the RDO optical dissolved oxygen sensor. The 4-Star and 5-Star RDO meters will have the standard temperature specifications when used with an electrode other than the RDO sensor.

Note: Specifications are subject to change without notice.

Ordering Information

Cat. No.	Description
1111000	2-Star pH benchtop meter with universal power adapter and user guide
1112000	3-Star Plus pH benchtop meter with universal power adapter and user guide
1212000	3-Star Plus pH portable meter with batteries and user guide
1113000	3-Star Plus DO benchtop meter with universal power adapter and user guide
1213000	3-Star Plus DO portable meter with batteries and user guide
1114000	3-Star Plus conductivity benchtop meter with universal power adapter and user guide
1214000	3-Star Plus conductivity portable meter with batteries and user guide
1115000	4-Star Plus pH/ISE benchtop meter with universal power adapter and user guide
1215000	4-Star Plus pH/ISE portable meter with batteries and user guide
1116000	4-Star Plus pH/DO benchtop meter with universal power adapter and user guide
1216000	4-Star Plus pH/DO portable meter with batteries and user guide
1117000	4-Star Plus pH/conductivity benchtop meter with universal power adapter and user guide
1217000	4-Star Plus pH/conductivity portable meter with batteries and user guide
1218000	5-Star Plus pH/DO/conductivity portable meter with batteries and user guide
1119000	5-Star Plus pH/ISE/DO/conductivity benchtop meter with universal power adapter and user guide
1219000	5-Star Plus pH/ISE/DO/conductivity portable meter with batteries and user guide
1213300	3-Star Plus RDO [®] optical DO portable meter with batteries and user guide
1213310	4-Star Plus RDO optical DO/conductivity portable meter with batteries and user guide
1213320	5-Star Plus RDO optical DO/pH/conductivity portable meter with batteries and user guide

Cat. No.	Description
090043	Swing arm electrode stand
1010003	Universal power adapter
1010006	Star series printer with RS232 printer interface cable (Cat. No. 250302-001)
1010053	RS232 computer interface cable
096019	Stirrer probe with paddle, for 3-Star, 4-Star and 5-Star benchtop meters
8102BNUWP	ROSS Ultra combination pH electrode with glass body
8165BNWP	ROSS Sure-Flow combination pH electrode with epoxy body
8172BNWP	ROSS Sure-Flow combination pH electrode with glass body
9107BNMD	Gel-filled pH/ATC Triode with epoxy body
9157BNMD	Refillable pH/ATC Triode with epoxy body
9165BNWP	Sure-Flow combination pH electrode with epoxy body
9172BNWP	Sure-Flow combination pH electrode with glass body
927005MD	ATC probe with epoxy body
927007MD	ATC probe with stainless steel body
9512HPBNWP	High performance ammonia combination ion selective electrode
9609BNWP	Fluoride combination ion selective electrode
9707BNWP	Nitrate combination ion selective electrode
8611BNWP	ROSS sodium combination ion selective electrode
083005MD	Polarographic DO probe with calibration sleeve and 1.5 meter cable
083010MD	Polarographic DO probe with calibration sleeve and 3 meter cable
086030MD	Polarographic BOD AUTO-STIR DO probe with calibration sleeve
087010MD	RDO® optical DO sensor with stainless steel guard, RDO cap and 3 meter cable
087020MD	RDO optical DO sensor with stainless steel guard, RDO cap and 6 meter cable
011050MD	Conductivity probe with 1 µS/cm to 20 mS/cm range and 1.5 meter cable
013005MD	DuraProbe conductivity probe with 1 µS/cm to 200 mS/cm range and 1.5 meter cable
013010MD	DuraProbe conductivity probe with 1 µS/cm to 200 mS/cm range and 3 meter cable
013016MD	Conductivity probe with 0.01 µS/cm to 300 µS/cm range and 1.5 meter cable

Visit www.thermo.com/water for additional meter kits, accessories, electrodes and solutions.

Appendix A Meter Setup Menu Features

pH Setup Menu Features

Automatic buffer recognition

The Orion Star and Star Plus pH meters are capable of automatically recognizing pH 1.68, 4.01, 6.86, 7.00, 9.18, 10.01 and 12.46 buffers during a pH calibration. During a calibration, the meter uses the selected buffer set and the raw mV reading of the pH electrode in the buffer to recognize and display the buffer value at the measured temperature. The raw mV value must be about ± 30 mV from the theoretical mV reading of the buffer in order for the meter to automatically recognize the buffer.

Buffer	mV Range	Buffer	mV Range	Buffer	mV Range
1.68	+285 to +345	7.00	- 30 to + 30	10.01	-207 to -147
4.01	+207 to +147	9.18	-99 to -159	12.46	-293 to -353
6.86	+38 to -22				

Dissolved Oxygen Setup Menu Features

Barometric Pressure Compensation

The Orion Star and Star Plus dissolved oxygen meters have an internal barometer that is used for pressure compensated dissolved oxygen readings. The meter can also use manual barometric pressure compensation if dissolved oxygen is measured with a submerged probe or in a pressurized vessel. The pressure must be entered as mm Hg. 1 mm Hg = 0.03937 inch Hg = 1.3332 hPa (mBar) = 0.01934 PSI.

Salinity Correction

Automatic salinity correction for dissolved oxygen readings is available on Orion Star and Star Plus dissolved oxygen meters that have a conductivity measurement mode. The meter uses the conductivity value read by the conductivity probe to calculate the salinity correction factor and applies the factor to dissolved oxygen readings reported as mg/L.

Meter Setup Menu Features

The meter can also use manual salinity correction for dissolved oxygen readings reported as mg/L. The manual salinity correction factor must be entered as ppt (parts per thousand).

Conductivity at 20 °C (mS/cm)	Salinity Correction Value (ppt)	Conductivity at 20 °C (mS/cm)	Salinity Correction Value (ppt)	Conductivity at 20 °C (mS/cm)	Salinity Correction Value (ppt)
5	3	20	13	35	25
6	4	21	14	36	25
7	4	22	15	37	26
8	5	23	15	38	27
9	6	24	16	39	28
10	6	25	17	40	29
11	7	26	18	42	30
12	8	27	18	44	32
13	8	28	19	46	33
14	9	29	20	48	35
15	10	30	21	50	37
16	10	31	22	52	38
17	11	32	22	54	40
18	12	33	23	56	42
19	13	34	24		

This table was calculated from the International Oceanographic Tables, Vol. 1, National Institute of Oceanography of Great Britain, Womley, Godaming, Surrey, England and Unesco, Paris 1971.

Conductivity Setup Menu Features

Temperature Compensation and Reference Temperature

The Orion Star and Star Plus conductivity meters have the ability to use a temperature compensation feature that calculates and displays the conductivity measurements at a reference temperature of 5 °C, 10 °C, 15 °C, 20 °C or 25 °C (Orion Star meters have a reference temperature of 15 °C, 20 °C or 25 °C only). The temperature compensation can be set as linear for most aqueous samples, non-linear for ultra pure and low ionic strength samples or off for non-temperature compensated conductivity measurements.

The closer the sample temperature is to the selected reference temperature, the more accurate the conductivity measurement will be, especially if the temperature compensation coefficient is estimated or inaccurate.

The conductivity of a solution with a specific electrolyte concentration changes with temperature and this relationship is described by the temperature coefficient of the solution. The meter has a default temperature coefficient of 2.1 percent change in conductivity per °C, which is representative of many aqueous samples.

Solution (25 °C to 50 °C)	Temperature Coefficient (% / °C)
Ultra Pure Water	4.55
Salt (NaCl)	2.12
5% NaOH	1.72
Dilute Ammonia	1.88
10% HCl	1.32
5% Sulfuric Acid	0.96
98% Sulfuric Acid	2.84
Sugar Syrup	5.64

Total Dissolved Solids (TDS)

The Orion Star and Star Plus conductivity meters measure TDS as the total amount of dissolved inorganics in a solution. The dissolved inorganics carry a current that is measured by the conductivity probe. Since there is a direct relationship between conductivity and TDS, conductivity readings are used to estimate the presence of inorganics. The user must enter a TDS factor between 0.01 and 10 mg/L in the setup menu.

The standard method of determining TDS involves evaporating a sample to dryness at 180 °C and weighing the residue. The TDS factor is calculated by taking the residue weight and dividing it by the sample conductivity. Subsequent conductivity readings are multiplied by the TDS factor to determine the TDS value of the sample.

Automatic Calibration

The Orion Star and Star Plus conductivity meters are capable of automatically recognizing 100 $\mu\text{S}/\text{cm}$, 1413 $\mu\text{S}/\text{cm}$ and 12.9 mS/cm conductivity standards when the nominal cell constant of the conductivity probe is entered in the setup menu. For the meter to recognize the conductivity standard, the entered cell constant must be accurate within a factor of 3. For example, if the actual cell constant is 1.0 cm^{-1} , entering a nominal cell constant in the range of 0.3 cm^{-1} to 3.0 cm^{-1} would allow the meter to identify the conductivity standard and perform the automatic calibration.

ISE Setup Menu Features

Concentration Range

The Orion Star and Star Plus ISE meters can be set for a high or low ISE concentration range that is used to determine the calibration stability criteria. If a high ISE concentration range is selected, the meter will perform a normal calibration with no delay in displaying the calibration standard value. If a low ISE concentration range is selected, the meter will wait about three to five minutes before displaying a stable reading for the calibration standard values. The delay will depend on the species being measured and the concentration of the calibration standards. The low ISE concentration range is designed to improve the accuracy of low concentration measurements by allowing the electrode to have a longer amount of time to stabilize in the calibration standards.

Automatic Blank Correction

The Orion Star and Star Plus ISE meters have an ISE automatic blank correction feature that uses an algorithm to compensate for the non-linearity of the ion selective electrode in low-level standards and samples. Since the automatic blank correction feature requires the use of a set of non-linear equations that can only be calculated numerically, the user cannot analytically verify the calibration and the average slope value that is displayed on the meter may be outside of the slope range that is specified in the electrode user guide. In applications where analytical verification is required, the automatic blank correction feature should be turned off.