THORNTON
Leading Pure Water Analytics

Part No. 84401

2000 Two-Channel Instrument

for pH, ORP, Conductivity, Resistivity, Dissolved Oxygen, Dissolved Ozone

Instruction Manual

METTLER TOLEDO

IMPORTANT SAFETY INFORMATION

- Follow all warnings, cautions, and instructions indicated on and supplied with this product.
- Install equipment as specified in this instruction manual. Follow appropriate local and national codes.
- Use only factory documented components for repair. Tampering or unauthorized substitution of parts and procedures can affect the performance and cause unsafe operation of your process.
- Protective covers must be in place unless qualified personnel are performing maintenance.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

WARNINGS:

- Installation of cable connections and servicing of this product require access to shock hazard voltage levels.
- Main power and relay contacts wired to separate power source must be disconnected before servicing.
- Main power must employ a switch or circuit breaker as the disconnecting device for the equipment.
- Electrical installation must be in accordance with the National Electrical Code and/or any other applicable national or local codes.
- Safety and performance require that this instrument be connected and properly grounded through a three-wire power source.
- RELAY CONTROL ACTION: the 2000 instrument relays will always de-energize on loss of power, equivalent to normal state, regardless of relay state setting for powered operation. Configure any control system using these relays with fail-safe logic accordingly.
- PROCESS UPSETS: Because process and safety conditions may depend on consistent operation of this instrument, provide appropriate means to maintain operation during sensor cleaning, replacement or sensor or instrument calibration.

This manual includes specific safety information with the following designations and formats:

WARNING: OF POTENTIAL FOR PERSONAL INJURY.

CAUTION: of possible instrument damage or malfunction.

NOTE: important operating information.

On the instrument indicates: Caution, risk of electric shock

On the instrument indicates: Caution (refer to accompanying documents)

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CHAPTER 1: GETTING STARTED

INTRODUCTION

The 2000 is an analytical and process control instrument for measuring solution properties. It can process two sensor inputs for pH, ORP (redox potential), conductivity or resistivity, or one sensor input for dissolved oxygen or dissolved ozone, in all combinations except for ozone and four-electrode conductivity. A liquid crystal display conveys measuring data and setup information. The display is backlit for viewing in all lighting conditions. The menu structure allows the operator to modify all operational parameters by using keys on the front panel. A menu-lockout feature, with password protection, is available to prevent the unauthorized use of the meter. The 2000 can have up to four relays for process control.

The 2000 instrument is equipped with a communication interface that can be configured as either an RS422 or an RS232. This interface provides real-time data output and complete instrument configuration capabilities for central monitoring via personal computer or Programmable Logic Controller (PLC). An external isolator for the digital communications signal is required if measurements other than conductivity with 0.1/cm cell constants are being made. For coverage of communications, see Manual 84423.

FEATURES

Display: 16 character backlit LCD.

Measurements: pH, ORP (redox potential), resistivity, conductivity, dissolved oxygen, dissolved ozone, °C, °F, total dissolved solids, %rejection, difference, ratio, %HCl, %NaOH, %H_2SO_4.

Measurement Channels: 2.

Signal Inputs per channel: 2 (total of 4 signals for measurement).

Measurement Cycle Time: 1 second (4 measurements processed per second).

Programmable: all setup information is stored in non-volatile memory.

Setpoints (alarms): 4 independent alarms programmable as high, low, USP, or EP limits.

Relays: up to 4 with programmable delay time and hysteresis.

Outputs: 2 analog outputs (0/4-20mA).

Communications: RS232/RS422 interface, bi-directional; external isolator recommended with measurements other than conductivity with 0.1/cm cell constants.

Security: keypad lockout with password.

Calibration: complete instrument, output, and sensor calibration; can be NIST traceable.

Built-In Diagnostics: several self tests can be initiated at any time.

OVERVIEW OF OPERATION

When power is applied to the 2000, the initialization process begins. The instrument will perform a number of self tests. Any problems detected during these tests will be reported by a displayed message.

Next, all setup parameters (setpoints, states, relay conditions, etc.) are restored from a non-volatile memory.

The meter will then begin the measurement process. A complete measurement cycle is performed once per second and consists of the following:

1. Measure four signals and compute four measurements.
2. Check setpoints against the measurements.
3. Control the relays.
4. Update analog output signals.
5. Transmit measurement data over the communication port.
6. Display data (if not displaying a menu).

At any time during this process the menus can be accessed by pressing one of the menu keys. The display of a menu will not affect the measurement process.

INSTALLATION & SET UP PROCEDURE

The following guideline shows the steps necessary to install a 2000 meter and begin operation.

1. Follow the meter installation procedure for physically mounting the meter, as outlined in Chapter 2. The meter may be mounted in a panel, on a pipe, or on a wall.

   Optional: the rear cover is required for wall and pipe mounting. Drill holes as needed for conduit or cable grips, install the cover and wire the meter before wall or pipe mounting.

2. Make all necessary electrical connections to the meter after panel mounting. The wiring procedure is outlined in Chapter 2.

3. Required wiring: input power and sensor cables.

CAUTION: Be certain that patch cord is wired specifically for the type of sensor to be connected or damage could result.

4. Optional wiring: relays, analog outputs, and serial port.

5. Set appropriate input line frequency to reduce measurement noise. See AC POWER FREQUENCY in Chapter 4.

6. Instrument calibration is performed at the factory to specifications. Re-calibration is not necessary. If QA/QC practice requires it, meter calibration may be verified as outlined in Chapter 8.

7. Connect sensors to the patch cords.

8. Select the desired measurements for each sensor as shown in SELECTING A MEASUREMENT TYPE in Chapter 4.

9. Enter sensor constants from the label of each cell as outlined in ENTERING/EDITING CELL CONSTANTS in Chapter 9. DO NOT PERFORM A SENSOR CALIBRATION except for pH, dissolved oxygen or ozone.

10. Optional: program the analog outputs as shown in Chapter 7. DO NOT PERFORM AN OUTPUT CALIBRATION.

11. Optional: program the setpoints as shown in Chapter 5.

12. Optional: program the relays as shown in Chapter 6.

13. Optional: program other features such as averaging method, special temperature compensation, security/password, etc, as needed.

CHAPTER 2: INSTALLING THE 2000

UNPACKING

Each 2000 is packed in an individual biodegradable carton. Retain the packaging in the event that the instrument must be returned to Thornton for service or calibration.

This carton should contain:

1 - 2000 Instrument

1 - Set of panel mounting hardware with gasket

1 - 02192 kit of 2 ferrite bead noise suppression modules

1 - 84401 Instruction Manual

1 - 84402 Startup Instruction Sheet

1 - Certificate of Calibration

INSTALLATION

The 2000 can be mounted in a panel, on a pipe or attached to a wall.

Panel Mounting Cutout and Installation

The panel cutout should measure 7.56 inches wide by 3.780 inches high (192 mm X 96 mm). Drill four holes for the #10 mounting screws. See Figure 14.3 for panel cutout size and mounting screw hole spacing. When mounting multiple instruments on the same panel, note the front flange dimensions in Figure 14.2 in order to allow enough space between instruments.

Panel cutouts should be clean and free of burrs and sharp edges. The proper dimensions allow an instrument to slide freely into the cutout.

Install the panel gasket (supplied with instrument) on the instrument mounting flange. Slide the instrument into the cutout and secure it with the mounting screws.

CAUTION: Do not over tighten the screws as this may crack the case.

If the rear cover is used in a panel mounted installation, the 2000 unit must be installed in the panel opening before the rear cover is installed.

Wall Mounting

The 2000 can be easily mounted to a wall when the rear cover is installed. The flanges on the ends of the cover contain holes for screws to fasten the assembly to the wall. A layout for drilling mounting holes is included in the wall mount kit.

Pipe Mounting

The 2000 can be mounted to a pipe with the pipe mounting accessory kit. The assembly is shown in Figure 14.5.

ELECTRICAL CONNECTIONS

All electrical connections are made at plug-in terminal blocks at the rear of the 2000 case.

WARNING: MAKE SURE POWER TO ALL WIRES IS TURNED OFF BEFORE PROCEEDING WITH THE INSTALLATION. HIGH VOLTAGE MAY BE PRESENT ON THE INPUT POWER WIRES AND RELAY WIRES.

CAUTION: A good power earth ground connection is required for safety and for proper operation of the instrument. To prevent electrostatic discharge (ESD) from damaging the instrument during installation, the installer must also be electrically grounded i.e., wear a conductive wrist strap connected to earth ground.

Do not run power and relay wiring in the same conduit or parallel with sensor and output signal wiring to prevent interference.

Input Power and Relay Connections

Terminal block TB1 contains connections for the input line power and relay contacts. Depending upon the model number, the 2000 will have either 2 or 4 relays. Table 2.1 shows the wiring sequence.

All relays have “dry contacts”; they are potential-free and require external power to be wired in series with the load and instrument terminals. Relays 3 and 4, if specified, are solid state AC-only relays (triacs) and require a minimum current of 10 mA to switch reliably. With very small loads such as a neon bulb, test meter or PLC, a load resistor is required in parallel with the load, e.g. a 10K ohm, 2 watt resistor, for operation with 115 VAC.

TB1 Label	Input Power & Relay Function
L	115V/230 VAC Line
N	115V/230 VAC Neutral
⏚	Earth Ground
NC1	Relay1: Normally Closed
C1	Relay1: Common
NO1	Relay1: Normally Open
NC2	Relay 2: Normally Closed
C2	Relay 2: Common
NO2	Relay 2: Normally Open
C3	Relay 3: Common
NO3	Relay 3: Normally Open
C4	Relay 4: Common
NO4	Relay 4: Normally Open

Table 2.1: Input Power & Relay Connections

WARNING: MISWIRING THE AC POWER MAY DAMAGE THE INSTRUMENT AND WILL VOID ALL WARRANTIES.

Setting Input Voltage for 115 VAC or 230 VAC

The input voltage for a 2000 can be set for either 90-130 VAC or 180-250 VAC operation. The input voltage is preset at the factory and is indicated on the serial number label on the side of the unit. Jumpers on the printed circuit board can be changed to change the input voltage. See Figure 14.7. W4 jumper pins are located between the power transformer and the fuse. For 90-130 VAC operation jumper pins 1-2 and 3-4 must be used. For 180-250 VAC operation only a jumper on pins 2-3 must be installed. The jumpers can be accessed by removing two screws from the back panel and carefully lifting the panel off.

WARNING: IF THE INPUT VOLTAGE JUMPERS ARE CHANGED YOU MUST LABEL THE UNIT WITH THE NEW VOLTAGE REQUIREMENT. ALSO, THE FUSE MUST BE CHANGED TO THE PROPER RATING TO AVOID RISK OF FIRE HAZARD

Fuse requirements:

For 90-130 VAC: 1/8 Amp, SB, 250 VAC

For 180-250 VAC: 1/16 Amp, SB, 250 VAC

NOTE: If the line power frequency is changed, select the correct setting (see AC POWER FREQUENCY in Chapter 4).

Setting Input Voltage for 24 VDC

The 2000 can be operated from a +24 VDC power supply instead of the typical 90-130 VAC or 180-250 VAC source.

NOTE: 24 VDC power supply must be isolated from earth ground and between instruments. Use a DC/DC power isolator if necessary.

Remove any AC power connections from terminal block TB1.

1. Move circuit board jumper W6 to the 24V position (left two pins) as shown in Figure 14.7.
2. Connect + 24V DC power to the connection labeled PS+ on terminal block TB3. Connect the power supply ground to the connection labeled PS- on TB3.

WARNING: AC POWER CONNECTIONS MUST BE REMOVED WHEN USING THE +24V POWER INPUT.

NOTE: The +24 VDC input is not fused within the meter. Use an external fuse.

AC Power Wiring

In order to maintain safety for the electrical installation, no more than 6 mm of insulation is to be removed from each conductor before fully inserting into the electrical terminal.

The plug-in terminal blocks for all connections will accept wire sizes from 26 AWG (0.126 mm^2) to 14 AWG (2.08 mm^2), solid or stranded and up to 12 AWG (3.31 mm^2) stranded only.

Output Connections

Connections for all outputs are made to terminal block TB4. The serial port can be configured as an RS232 port (shown in Table 2.2.) or an RS422 port (shown in Table 2.3). An external isolator for digital communications is strongly recommended to prevent ground loop problems.

TB2 Label	RS232 Function
DGND	Ground
TXD+	Not Used
TXD-	Transmit Data
RXD+	Not Used
RXD-	Receive Data

Table 2.2: RS232 Connections

TB2 Label	RS422 Function
DGND	Ground
TXD+	Transmit Data Positive
TXD-	Transmit Data Negative
RXD+	Receive Data Positive
RXD-	Receive Data Negative

Table 2.3: RS422 Connections

Each analog output has + and – connections. Analog outputs are self-powered with a maximum load resistance of 500 ohms.

CAUTION: Do not connect analog outputs to circuits supplying power.

CAUTION: Do not connect analog output cable shield(s) to the adjacent DGND terminals. Connect shield(s) only to one of the earth ground terminals next to AC line power.

TB2 Label	Analog Output Function
AO2-	Output 2 (-)
AO2+	Output 2 (+)
AO1-	Output 1 (-)
AO1+	Output 1 (+)

Table 2.4: Analog Output Connections

Sensor Patch Cord Connections

The sensors are connected to plug-in terminal blocks TB2 and TB3. Each channel has nine terminals for the sensors plus earth ground. Patch cords, 1XXX-67 or 58 080 20X series, for the 2000 have a connector on one end and tinned leads on the other end. Table 2.5. shows the wiring pattern for each type of sensor.

CAUTION: Wiring for each type of sensor is different. Miswiring patch cords may damage sensors and will void all warranties. Verify wire colors in table 2.5. Disconnect power before wiring sensors to prevent damage to the input circuit.

If sensors other than conductivity must be wired with the instrument powered, make the PS- connection first to prevent damage to the input circuit.

To meet CE electromagnetic compatibility requirements for emissions Class B, install a ferrite suppression module from kit 02192 on each sensor patch cord as close to the instrument as possible.

NOTE: For ultrapure water conductivity measurements with all-plastic piping, especially semiconductor wet benches, it is recommended to connect a jumper from one of the three earth ground terminals to sensor ground terminal SIG6(6) on TB3 for Channel A. This will prevent possible instrument damage due to electrostatic charges that build up in plastic piping systems. Do not use a ground jumper with higher conductivity water, with metal piping or with pH or ORP measurements.

Terminal	Cond/ Resistivity	pH/ORP	Dissolved Oxygen	Ozone
EARTH GND*	SHIELD	SHIELD	-	SHIELD
PS-	-	BLACK	BLACK	BLACK
+5V (9)	-	BLUE	BLUE	BLUE
I/O (8) **Ch A****	-	-	WHT/BLU	WHT/BLU
I/O (8) **Ch B****	-	-	RED	RED
SIG7(7)	BLUE	WHT/BLU	SHIELD	JUMP-5***
SIG6(6)	BLACK	-	-	-
SIG5(5)	RED	RED	CLEAR	CLEAR
SIG4(4)	GREEN	GREEN	GREEN	GREEN
SIG3(3)	WHITE	WHITE	WHITE	WHITE
SIG2(2)	CLEAR	CLEAR	-	-
SIG1(1)	WHT/BLUE	-	-	-

*   Connect to any of three earth ground terminals.

** Connections for dissolved oxygen and ozone use both channel A and B I/O terminals regardless of which channel is assigned for that measurement.

*** Install a wire jumper between terminals 5 and 7.

For instruments with firmware version 2.0 and earlier (before April 2004), pH, ORP and dissolved oxygen connections must connect the black wire to SIG6(6) instead of PS-. Ozone measurement requires firmware version 4.0 or higher.

Table 2.5: Sensor Patch Cord Connections

Voltage and current measuring terminals are rated for overvoltage category II.

Sensor Models/Types

240-, 243-	2-Electrode Conductivity
244-	4-Electrode Conductivity
363- & 1200-	pH or ORP
367-	dissolved oxygen
368-	dissolved ozone

Alternative 3-Lead Conductivity Sensor Connections

Tinned-lead cells with 1000 Pt or 500 Ni-Fe RTDs may be used with the 2000. These sensors, with integral leadwire and no connector, enable the lead to pass through small openings. The sensor/instrument separation is limited to less than 50 feet (20 feet recommended).

Somewhat lower accuracy may result. Connections are given in Table 2.6. Jumpers should be 22 gauge to match the conductor size in the cable, for secure terminal connections.

Terminals	Three-lead Conductivity Sensor Wiring
+5V (9)	-
I/O (8)	-
SIG7(7)	Jumper to SIG(6)
SIG6(6)	Jumper to SIG(5)
SIG5(5)	CLEAR (shield)
SIG4(4)	WHITE
SIG3(3)	Jumper to SIG(1)
SIG2(2)	-
SIG1(1)	RED

Table 2.6: Alternative Sensor Connections

With these 2_8 Series Dot Two sensors there is no label with factory-supplied precision calibration constants. Only the nominal value 0.1/cm for cell constant and 1.0 for temperature constant are entered into the 2000.

With all tinned-lead sensors, when meter calibration is desired, the cell must be disconnected and a patch cord installed in its place to accept a calibrator.

CHAPTER 3: USING THE 2000

APPLYING POWER TO THE 2000

After applying power to the meter, the display will show an introduction message for three seconds and then begin making measurements. This message shows the model number and the software version number as follows:

68XX Ver X.X

While the message is being displayed the instrument is performing self diagnostics. Various circuits are tested during this process and any failure will be noted with a message. The diagnostics can be repeated at any time via the menus.

The default measurement display is the primary readings from the sensors on channel A and B as shown below:

A1.76μS B2.11μS

All 2000 meters are calibrated from the factory and normally require no further calibration. If QA/QC practice requires it, the instrument be calibrated after installation. See Chapter 8 for more information on meter calibration.

THE DISPLAY

The 2000 uses a 1 line by 16 character alphanumeric display to convey all measurement and setup information. This instrument will display one or two measurements, each with channel indication and unit of measure. A typical display of measurement data is:

A7.76pH B2.10μS

This display indicates that channel A is measuring 7.76pH and channel B is measuring 2.10μS/cm. The display of the other measurements can be achieved by pressing the UP or DOWN keys.

In the menus, an underline cursor and flashing (bold) characters will indicate a field that can be changed. A typical menu appears as follows:

SP1=1**7**.00 M High

This menu indicates that setpoint #1 is programmed at a value of 17.00 M (million) and is set as a high limit. The cursor is under the digit "7" indicating that the UP and DOWN keys can be used to change it. The RIGHT and LEFT keys will move the cursor to the next or previous field.

Display Contrast Adjustment

The contrast quality of the display can change with ambient temperature. The display contrast is adjusted from the factory for operation at standard room temperature (25°C). If the meter is operated at an ambient temperature that is much different then it may be necessary to make an adjustment. A potentiometer is accessible from the back side of the instrument to change the contrast. Use a small slotted screwdriver to gently turn the potentiometer. A counter-clockwise turn will increase the contrast and a clock-wise turn will decrease the contrast. The rear panel is shown in Figure 3.1.

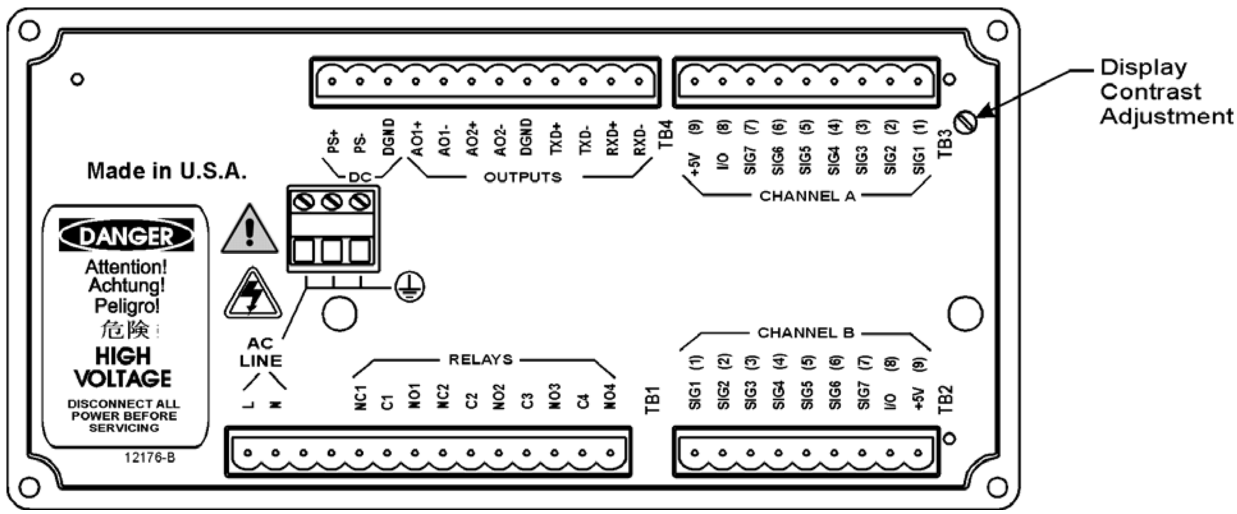


Figure 3.1: 2000 Rear Panel

THE KEYPAD

The 2000 is equipped with an 11-key keypad as shown in Figure 3.2.

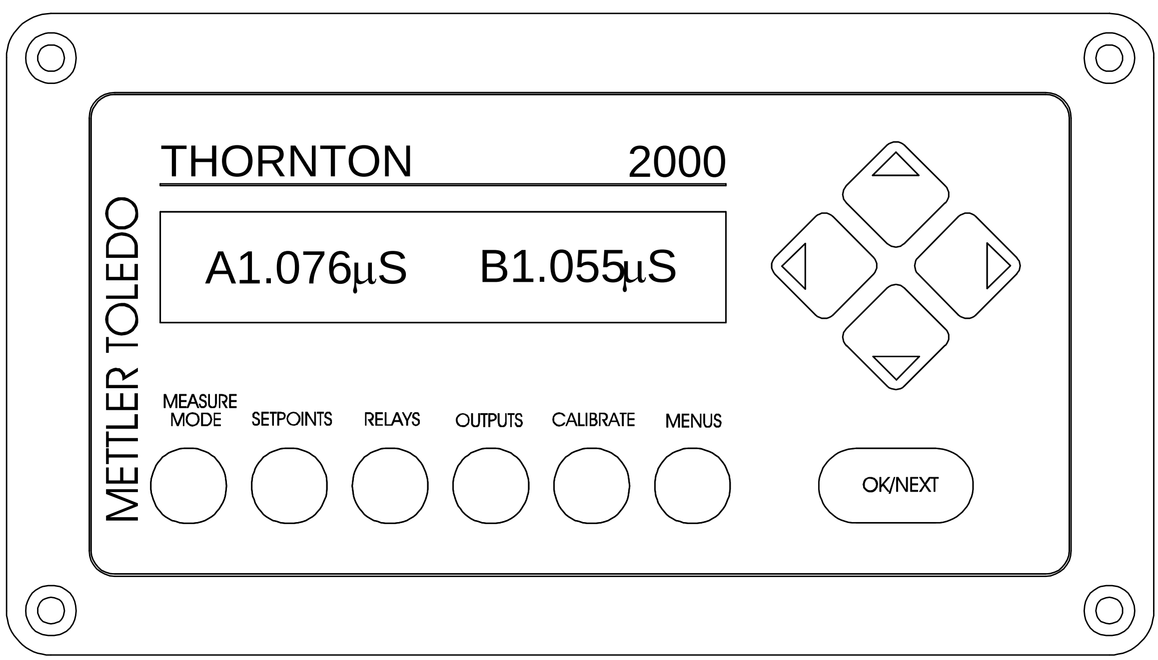


Figure 3.2: 2000 Front Panel

The keypad has 6 keys that provide direct access to specific menus as follows:

1. **MEASURE MODE -** menus to change measurement modes.
2. **SETPOINTS -** menus for programming setpoints.
3. **RELAYS -** menus for programming relays.
4. **OUTPUTS -** menus for programming outputs.
5. **CALIBRATE -** menus to perform calibration.
6. **MENUS -** all other menus (cell constants, security, compensation, averaging, etc.).

The other keys are referred to as control keys and are used to make changes within a menu.

1. **OK/NEXT** Key - used to accept a selection and proceed to the next menu level.
2. **UP** Key - up arrow is used to scroll up through a list of options.
3. **DOWN** Key - down arrow is used to scroll down through a list of options.
4. **LEFT** Key - left arrow is used to move the cursor to the left within a menu.
5. **RIGHT** Key - right arrow is used to move the cursor to the right within a menu.

USING THE MENUS

There are six menu keys across the bottom of the 2000 front panel. The first five of these keys (MEASURE MODE, SETPOINTS, RELAYS, OUTPUTS, AND CALIBRATION) are used to enter specific menus. These menus allow the modification of parameters most frequently used by the operator. The sixth key labeled MENUS allows access to all other menus for various functions such as setting compensation methods, security levels, etc.

The UP and DOWN arrow keys scroll vertically through the menus. Part or all of the display changes to the next option whenever an UP or DOWN arrow key is pressed. A field is defined as a section of the display that can be changed. The characters of the field will also blink. The LEFT and RIGHT arrow keys move the underline cursor across the display from one field to the next. Pressing the OK/NEXT arrow key causes the instrument to accept the options that are displayed and move to the next menu.

Numbers are set one digit at a time using the arrow keys. The LEFT and RIGHT arrow keys are used to position the underline cursor below the digit to be changed. The UP and DOWN arrow keys are then used to change the value of the digit. Each digit can be scrolled through the values: .(decimal point), 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 The first digit of any number can also be set to a negative sign (-).

To exit the menus either scroll completely through a set of menus with the OK/NEXT key or press any of the six menu keys at any time. The meter will display a prompt asking if the recent changes should be saved.

Save Changes **Yes**

To save the changes press the OK/NEXT key with “Yes” on the display. To discard the changes use the UP or DOWN arrow keys to change “Yes” to “No”, then press the OK/NEXT arrow key.

If the instrument is displaying a menu and a key is not pressed for two minutes, *the instrument will automatically exit the menus without saving any changes*. When performing a calibration the operator may need to wait for a measurement to stabilize so the menu time-out feature is automatically disabled.

Menu Example

Press the MEASURE MODE key and the display will show:

A=**S/cm** (AUTO)

This menu indicates that the Channel A primary measurement is set for conductivity (S/cm) with auto ranging. The section **“S/cm”** is the field to be changed and will be flashed as long as the cursor is under it. Pressing the UP arrow key will change the **“S/cm”** to **“Ω-cm”**. The RIGHT arrow key will move the cursor to the **“(AUTO)”** field.

A=**Ω/cm** (AUTO)

The OK/NEXT key is used to accept the entry and move to the next menu. When the last menu level is reached the following message is displayed:

Save Changes **Y**es

Pressing the OK/NEXT key will save the changes and exit the menus. The UP and DOWN arrow keys can be used to change the “Yes” to “No”. Pressing the OK/NEXT key with “No” will discard the changes and exit the menus.

INSTALLING A SENSOR

Each sensor is equipped with a cell and temperature sensor (except ORP). Conductivity sensors have calibration constants for these elements that must be programmed into the meter for proper operation. These factors are printed on the sensor (as well as a Certificate of Calibration supplied with each conductivity sensor). The label may look like this:

RES M=1.0034 TEMP M=1.0015

RES M is the conductivity cell constant, and TEMP M is the temperature sensor constant. pH preamps will have a pH A (adder) constant. Long life 367-110 dissolved oxygen sensors have Cell M (multiplier), Cell A (adder) and TEMP M (multiplier) constants. See ENTERING/ EDITING CELL CONSTANTS in Chapter 9 for information on entering cell constants.

MEASUREMENT DESIGNATIONS

The 2000 instrument will measure four fundamental signals during each measurement cycle. These measurements are the conductivity, pH or dissolved oxygen and temperature of the probe on channel A and the conductivity or pH and temperature of the probe on channel B.

The 2000 can process and display four calculated measurements. They are referred to as A primary, A secondary, B primary and B secondary. These measurements are designated by a single letter as follows:

A = channel A primary measurement

a = channel A secondary measurement

B = channel B primary measurement

b = channel B secondary measurement

Upper case letters are used to indicate the primary measurements and lower case letters are used to indicate the secondary measurements.

Each of the four calculated measurements can be one of the following:

1. pH
2. ORP (redox potential)
3. Resistivity
4. Conductivity
5. Total Dissolved Solids (TDS)
6. Degrees C
7. Degrees F
8. % Rejection
9. Difference (A-B or B-A)
10. Ratio (A/B or B/A)
11. %HCl
12. %NaOH
13. %H_2S0_4
14. Dissolved Oxygen
15. Dissolved Ozone
16. Power plant calculations of pH, CO_2, chlorides or sulfates from conductivity

DISPLAYING MEASUREMENTS

Changing the Display of Measurements

The 2000 display can show either one or two measurements at a time. The display of measurements can be changed by using the UP or DOWN arrow keys. Pressing one of these keys will cause the meter to change the display mode (show an alternative set of data).

The display modes for two measurements per line are:

Mode #1: A primary and B primary (three significant digits displayed for each parameter):

A1.76µS   B2.11µS

Mode #2: A secondary and B secondary (three significant digits displayed for each parameter).

a25.2°C b25.1°C

Mode # 3: A Primary and A Secondary (four significant digits displayed for each parameter):

A1.764µS 25.10°C

Mode #4: B primary and B Secondary (four significant digits displayed for each parameter):

B2.109µS 25.12°C

Note that when two measurements from the same channel are displayed, the secondary measurement indicator (a or b) is not displayed. This allows for greater precision in the display of the primary measurement.

The default display setting (after a system reset) is mode #1 (A Primary & B Primary).

The display modes for one measurement per line are:

Mode #1: A Primary:

A 1.765µS/cm

Mode #2: A Secondary:

a 25.25 deg C

Mode #3: B Primary:

B 2.109µS/cm

Mode # 4: B Secondary:

b 25.12 deg C

Setting the Number of Measurements per Display Line

The 2000 can be set to display either one or two measurements per line.

To change this feature:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until "Display Menus" is displayed.

Display Menus

Press the OK/NEXT key to access this menu. Use the Up or DOWN keys to toggle the field until "Disp Format" appears. Press OK/NEXT to access this menu.

Set: **Disp Format**

Use the UP and DOWN keys to toggle the field between "1" and "2".

Measure per Line: **1**

Press OK/NEXT when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press OK/NEXT key to save the changes and return to the display of measurement data.

Measurement Display Scrolling

The 2000 has an automatic display scrolling feature for measurement data. With this feature enabled, the display will show channel A data for 5 seconds and then show channel B data for 5 seconds. Secondary measurements are not shown if a single measurement is selected per display line. The process is repeated indefinitely.

To enable or disable this feature:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until "Display Menus" is displayed.

Display Menus

Press the OK/NEXT key to access this menu

Set: **A**uto Scroll

Use the Up or Down arrow keys to toggle the field until "Auto Scroll" appears. Press OK/NEXT to access this menu.

Auto Scroll=**off**

Use the UP or DOWN arrow keys to toggle the field from "Off" to "On". Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

ALARM INDICATIONS

A setpoint can be programmed as a high limit, a low limit, USP or EP (temperature-dependent pharmaceutical water conductivity) limits. When a measurement is higher than a high, USP or EP point or lower than a low point then the setpoint is in alarm state. This condition is indicated by flashing the corresponding measurement value in the normal operating display. See Chapter 5: Using Setpoints.

CHAPTER 4: MAKING MEASUREMENTS

MEASUREMENT PROCESS

The 2000 will process two measurements from each of the two channels. The measurements of each channel are referred to as the primary and the secondary measurement. The instrument will process a total of four different measurements per cycle.

Measurements are designated as follows:
A = channel A primary measurement
a = channel A secondary measurement
B = channel B primary measurement
b = channel B secondary measurement

Upper case letters indicate primary measurements and lower case letters indicate secondary measurements.

MEASUREMENT TYPES

Each of the four measurements (channel A primary, etc.) is programmed as one of the following with corresponding 1 or 2-character display:

Measurement	**Display**
pH	pH
ORP (redox potential)	V
Resistivity	Ω
Conductivity – siemens/cm, siemens/m	S, Σ
Total Dissolved Solids (TDS), ppm, ppb	PM, PB
Dissolved Oxygen – g/L, ppm, ppb, % saturation	g, pm, pb, %
Dissolved Ozone – ppm (mg/L), ppb (µg/L)	Z, z
Temperature – Deg C, Deg F	°C, °F
% Rejection	%R
Difference (A-B or B-A)	d
Ratio (A/B or B/A)	r
%HCl - Hydrochloric Acid	%H
%NaOH - Sodium Hydroxide	%N
$\%H_2S0_4$ - Sulfuric Acid	%S
Power cycle chemistry calculations of pH, CO_2, Chloride, Sulfate	PH, CD, Cl, Sf

pH and ORP (Redox potential)

pH is displayed with fixed range. ORP is displayed in fixed range millivolts (mV).

Resistivity

Resistivity is expressed in ohms-centimeter (Ω-cm). This measurement can be displayed with a prefix in front of the units. The prefixes are k (kilo or 1,000) and M (Mega or 1,000,000).

The display can be set for a fixed range such as Ω-cm, KΩ-cm (1,000Ω-cm), or MΩ-cm (Mega or 1,000,000Ω-cm). The 2000 can also be set for auto ranging where the range will be automatically adjusted for the most appropriate display. The range is set via the measure mode menus.

1,000,000 Ω-cm = 1,000 KΩ-cm = 1 MΩ-cm

Conductivity

Conductivity is expressed in siemens per centimeter (S/cm) and is the reciprocal of resistivity. This measurement can be displayed with a prefix in front of the units. The prefixes are m (milli or 1/1,000) and µ (micro or 1/1,000,000). The 2000 can also be set for auto ranging where the range will be automatically adjusted for the most appropriate display. The range is set via the measure mode menus.

1 S/cm = 1,000 mS/cm = 1,000,000 µS/cm

Conductivity may also be expressed in siemens per meter (S/m) with a multiplier in front of the units as described above. To clearly distinguish these units in the 2000 display, the symbol "Σ" is used in place of "S". In operation, microsiemens per meter is displayed as µΣ.

Total Dissolved Solids

Total Dissolved Solids (TDS) is another way to measure and display conductivity/resistivity data. TDS is the equivalent of Sodium Chloride (NaCl) required to produce the measured conductivity--approximately 0.46 ppm TDS per µS/cm. If some other conversion is desired, it is necessary to adjust the cell constant to give direct readout. For example, if a conversion of 0.6 ppm TDS per µS/cm is desired, the cell multiplier to be entered into the 2000 is 0.6/0.46 x Multiplier on sensor label. See Chapter 9, Entering/Editing Sensor Constants.

TDS is measured in parts per billion (ppb), parts per million (ppm), or parts per thousand (ppk). A TDS reading of 10 ppm is equivalent to 10 milligrams per liter. Because of space limitations, the following abbreviations are used to display TDS units:

PB = parts per billion

PM = parts per million

PK = parts per thousand

Dissolved Oxygen

Dissolved oxygen can be measured in units of parts per billion (ppb), parts per million (ppm), and grams per liter (g/L), with or without auto-ranging between micro and milli (grams per liter). Abbreviations used in the display mode are pb, pm, µg and mg, respectively. Note that dissolved oxygen uses lower case pb and pm to distinguish it from TDS which uses upper case PB and PM.

NOTE: Select dissolved oxygen as a measurement *after* connecting the probe. This initiates an automatic internal preamp calibration for highest accuracy at startup and will display "Saving Changes" for an extended period. Otherwise, the system will initiate calibration by itself 1 hour later.

Dissolved Ozone

Dissolved ozone can be measured in units of parts per billion (ppb) with resolution of 1 ppb or in units of parts per million (ppm) with resolution of 0.01 ppm. Abbreviations for units in the normal display mode are z and Z respectively.

NOTE: Select dissolved ozone as a measurement *after* connecting the preamp. This initiates an automatic internal preamp calibration for highest accuracy at startup and will display "Saving Changes" for an extended period. Otherwise, the system will initiate calibration by itself 1 hour later.

Temperature

Temperature can be measured in degrees Celsius (°C) or degrees Fahrenheit (°F). The 2000 normally works with a 1000 ohm DIN platinum RTD sensor which is built into Thornton most conductivity, dissolved oxygen, dissolved ozone and most pH sensors. Alternatively, the 2000 can automatically recognize and measure with a 500 ohm Ni-Fe RTD temperature sensor. When configured for a 50/cm constant cell only, the 2000 automatically changes its characteristic to measure from the 262 ohm @ 25°C thermistor supplied in those sensors.

% Rejection

For reverse osmosis (RO) applications, percent rejection is measured in conductivity to determine the ratio of impurities removed from product water to the total impurities in the incoming feed water. The formula for obtaining Percent Rejection is:

[1 - (Product/Feed)] X 100 = % Rejection

Where Product is the conductivity measurement of the first sensor and Feed is the conductivity of the second sensor. Figure 4.1 shows a diagram of an RO installation with sensors installed for Percent Rejection.

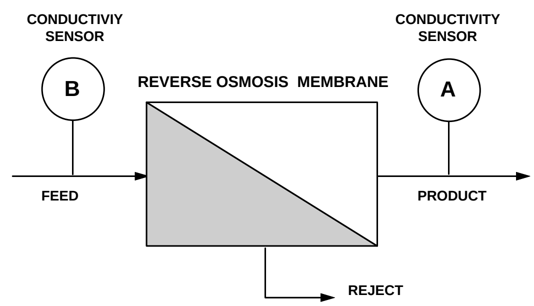


Figure 4.1: % Rejection

IMPORTANT: When preparing the system to perform a percent rejection measurement, the product monitoring sensor must be installed in the channel that will measure percent rejection. If the product conductivity sensor is installed in channel A, then percent rejection must be measured in channel A. Likewise if the product sensor is installed in channel B, then the percent rejection measurement must also be programmed in channel B.

Difference (A-B or B-A)

The difference measurement is computed as:

Difference on channel A = A-B.

or

Difference on channel B = B-A.

When the difference is assigned to one channel, the meter will measure the same type of measurement mode of the other channel as a basis. For example, if channel A is set to measure the difference and channel B is measuring conductivity, then the 2000 will measure conductivity on both channels before computing the difference. The displayed unit for difference is ‘d’.

Ratio (A/B or B/A)

This measurement is similar to the difference measurement.

Ratio on channel A = A/B.

Ratio on channel B = B/A.

The displayed unit for ratio is ‘r’.

Concentrations (%HCl, %NaOH, %H_2SO_4)

All concentrations are displayed as percent by weight. Setting a measurement for concentration automatically activates specialized temperature compensation for that particular material. The compensation setting is ignored for that channel.

Power Plant Calculated Parameters

The following derived parameters are valid only for power plant cycle chemistry samples conditioned by a cation exchanger (and sometimes a degasifier) as illustrated in Figure 4.2. They are not applicable to other samples and would give very erroneous results elsewhere. Because the 2000 can provide two measurements from a single sensor channel, it can be configured to display two conductivity measurements, sample temperature and calculated pH or CO_2 measurements.

Calculated pH may be obtained very accurately from specific and cation conductivity values when the pH is between 7.5 and 10.5 due to ammonia or amines and when the specific conductivity is significantly greater than the cation conductivity. The 2000 uses this algorithm when CALCPH is selected using the Measure Mode key for the channel measuring cation conductivity.

For example, set up measurement ‘A’ to be specific conductivity, measurement ‘a’ to be temperature, measurement ‘B’ to be cation conductivity and measurement ‘b’ to be calculated pH. Set the temperature compensation mode to “Ammonia” for measurement ‘A’ and to “Cation” for measurement ‘B.’

Note that if operation goes outside the recommended conditions, a glass electrode pH measurement is needed to obtain an accurate value. On the other hand, the calculated pH provides an accurate standard for one-point trim calibration of the electrode pH measurement when sample conditions are within the ranges noted above.

Carbon dioxide may be calculated from cation conductivity and degassed cation conductivity using tables from ASTM Standard D4519. The 2000 has these tables stored in memory which it uses when units of CO2ppb are selected under the Measure Mode key.

For example, set up measurement ‘A’ to be cation conductivity, measurement ‘a’ to be CO2ppb, measurement ‘B’ to be degassed cation conductivity and measurement ‘b’ to be temperature. Set the temperature compensation mode to “Cation” for both conductivity measurements.

Total anions as chlorides or sulfates may be readout on a degassed cation conductivity sample using tables from ASTM Standard D4519. The 2000 has these tables stored in memory which it uses when selected under the Measure Mode key by choosing units of “Clppb” or “SO4ppb” for parts per billion chlorides or sulfates. Conductivity is non-specific and cannot determine the actual anions present—it merely converts the conductivity value as if they were all chlorides or all sulfates. Set the temperature compensation mode to “Cation”.

The display units for these derived parameters are given below.

Measurements Menu	Normal Display
PHCALC ( )	PH
CO2ppb ( )	CD
Clppb ( )	Cl
SO4ppb ( )	Sf

pH calculated from conductivity is designated by all upper case 'PH'. pH measured by electrode is designated by the conventional lower/upper case 'pH'.

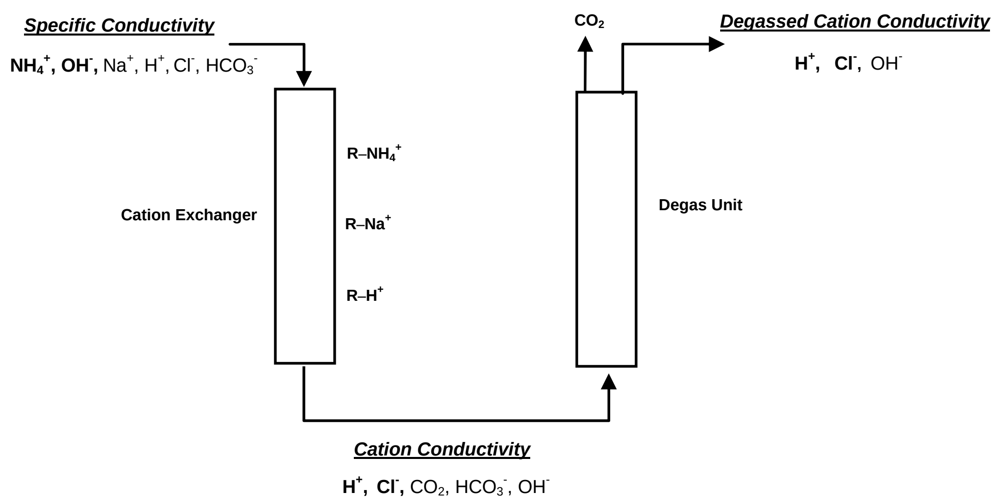


Fig. 4.2: Sample conditioning for specific, cation and degassed cation conductivity measurements used to calculate pH, CO_2 and anion concentration on power plant cycle chemistry samples

SELECTING A MEASUREMENT TYPE

To set or change a measurement type for each of the four measurements:

Press the MEASURE MODE key and the display will show the measurement type assigned to channel A primary. The display may appear as:

A = **Ω-cm** (AUTO)

This menu indicates that channel A primary measurement is set for resistivity (Ω-cm) with auto ranging. The section **"Ω-cm"** is the first field to be changed and will be flashed as long as the cursor is under it. Pressing the UP arrow key will change the **"Ω-cm"** to **"S/cm"**.

A = **S/cm** (AUTO)

Use the UP and DOWN arrow keys to select the desired measurement type.

For dissolved oxygen, the sensor should be connected to the 2000 before selecting this parameter because the 2000 performs a DO preamplifier calibration when it is saved (and at hourly intervals thereafter). Also for this reason there is a long delay in the saving process.

For conductivity, both temperature compensated and uncompensated measurement are available. Uncompensated readings are needed to meet pharmaceutical water requirements. Select units of "S/cm" for compensated measurement or "s/cm U" for uncompensated measurement. Using both primary and secondary parameters, both compensated and uncompensated measurements are available simultaneously. In normal operation, uncompensated measurements are identified by a flashing cursor under the units, for example, "μs". Normal compensated readings are identified by "μS".

Another option for conductivity is to display in units of siemens per meter in accordance with the SI metric system. The Menu setting is

A = **S/m** (AUTO)

The measurement mode will display it as "μΣ" or "mΣ".

The field on the right half side of the display is the range field. Some measurements can be set for a fixed range, others can be set only for auto ranging. For example, conductivity can be set for micro, milli, units, or auto ranging. To change the field, use the RIGHT arrow key to move the cursor under "(Auto)". Use the UP and DOWN arrow keys to select the desired range.

The OK/NEXT key is used to accept the entry for channel A primary and move to the next menu for setting channel "a" secondary. Press the OK/NEXT key a third and fourth time to set the measurement types for channel B primary and channel "b" secondary, respectively.

When the last menu level is reached (after setting channel "b" secondary), the following message is displayed:

Save Changes **Yes**

Pressing the OK/NEXT key will save the changes and exit the menus. The UP and DOWN arrow keys can be used to change the "Yes" to "No". Pressing the OK/NEXT key with "No" will discard the changes and exit the menus.

CELL CONSTANTS

The calibration of each measurement is defined by a set of constants known as cell constants. There are two cell constants for each measurement: a **Multiplier Factor** and an **Adder Factor**. They are used to derive an accurate measurement from the sensor's output signal. As an example, the output of a conductivity sensor can be represented by the following equation:

$$R = x / M + A$$

Where:

R = resistivity value

x = output from cell

M = multiplier factor

A = adder factor

Example: for a typical two-electrode conductivity sensor the multiplier (M) is 0.1 and the adder (A) is 0. If the sensor output is 120,000 ohms, then the actual resistivity of the solution measured is 1.2 Mohm-cm and is calculated as follows:

$\mathbf{R} = x / M + A$

$\mathbf{R} = 120,000/0.1 + 0$

$\mathbf{R} = 1,200,000$

R = 1.2 Mohm-cm

NOTE: The adder is zero only for two-electrode conductivity, resistivity and ORP sensors.

The cell constants can be modified via the menus. For more information see ENTERING/EDITING CELL CONSTANTS in Chapter 9.

CONDUCTIVITY TEMPERATURE COMPENSATION

Conductivity, resistivity and TDS measurements can be compensated for temperature. Compensation will adjust the measurement to give an equivalent reading of the solution at 25°C. For example, the resistivity of ultrapure water at 25°C is18.18 MΩ-cm. The resistivity of ultrapure water at 30°C is 14.08 MΩ-cm. By compensating the resistivity reading, the value of pure water will continue to read 18.18 MΩ-cm.

The 2000 can use one of nine different compensation methods: standard, linear, cation, ammonia, alcohol, Light 84, 50% glycol, 100% glycol or none. Channels A and B can be programmed with different compensation methods.

For pharmaceutical USP <645> and EP conductivity measurements where uncompensated measurement is required, select None for compensation. For simultaneous uncompensated and compensated measurements, see SELECTING A MEASUREMENT TYPE earlier in this chapter.

Standard Compensation

The standard compensation method includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.

Linear Compensation

The raw resistance measurement is compensated by multiplication with a factor expressed as a “% per °C” (deviation from 25°C). The range is 0 - 99%/°C with a default value of 2%/°C.

Cation Compensation

Power industry applications for cation conductivity measurements with acidic samples are accurately compensated with this setting. It takes into account the effects of temperature on the dissociation of pure water with the presence of very dilute acids. See ASTM Standard D6504 for recommendations on this measurement.

Semiconductor acid etch rinse operations are also more accurately monitored using this setting.

Ammonia Compensation

Power industry applications for specific or direct conductivity on samples with ammonia or ETA (ethanolamine) are accurately compensated with this setting. It takes into account the effects of temperature on the dissociation of pure water with these very dilute bases.

Alcohol Compensation

This compensation provides for the temperature characteristic of a 75% solution of isopropyl alcohol in pure water used for some rinsing operations in semiconductor manufacture. Compensated measurements using this solution may go well above 18 Mohm-cm.

Light 84 Compensation

This compensation matches the earlier high purity water research results of Dr. T.S. Light published in 1984. It is provided only for use by institutions that have standardized on that work. For all other pure water and general purpose applications, Standard Compensation (1994 high purity water research of Thornton & Light) is recommended.

Glycol Compensation

This compensation matches the characteristics of 50% and 100% ethylene glycol in deionized water cooling/antifreeze solutions.

Setting conductivity compensation

Enabling the compensating feature is done via the menus as follows:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until “Compensation” menu is displayed.

Compensation

Press the OK/NEXT key to access this menu.

A: Comp = Standard

The cursor will be initially placed under channel. Use the UP and Down arrow keys to change the channel if desired. Use the RIGHT arrow key to move the cursor to the method field. Use the UP and DOWN arrow keys to scroll through the list of available methods: “Standard”, “Linear”, “Cation”, “Alcohol”, "Light84", “Glycol 100%”, “Glycol 50%”, “Ammonia”, or “None”. Selecting “None” disables the compensation feature. Press the OK/NEXT key to accept the selection. If “Linear” is selected then another menu will be displayed where the linear value can be entered. This menu will appear as (the actual value may be different):

A: Comp = **2**.000%/°C

Adjust the numerical field as desired using the arrow keys and press OK/NEXT when done. After setting the compensation state for channel A, repeat for channel B. Press OK/NEXT when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press OK/NEXT key to save changes and return to the display of measurement data.

Compensation Indication

When displaying measurements, the 2000 will indicate that a measurement is NOT compensated by displaying a flashing underline cursor at the units character. The following display shows that channel A is compensated and channel B is not compensated (the character “µ” has a blinking underline cursor).

A1.76µS B2.11µS

PH TEMPERATURE COMPENSATION

The 2000 Instrument provides two types of pH temperature compensation, described in following sections. If a temperature sensor is not included in a particular pH probe, a manual temperature setting or the temperature from the other channel sensor may be used instead. See Chapter 11.

With ORP measurement, temperature is not measured or compensated.

Conventional pH Electrode Temperature Compensation

Electrode Temperature Compensation (Nernst Response) is provided in most pH instruments. All pH electrodes produce a millivolt signal with gain proportional to the absolute temperature. Electrode temperature compensation normalizes that variable millivolt output to give pH values. The default and normal operating setting of the instrument has this compensation active. Some specialized measurements may need to disable it by accessing the "Compensation" setting via the MENUS key. Compensation for each channel may be individually turned on or off.

pH Solution Temperature Compensation

Solution Temperature Compensation allows settings for compensation of the variable ionization of pure waters. The change is so small in more conductive waters that it is usually ignored, but for high purity water, it is significant. It is used in addition to the conventional (Nernst) compensation, described above, which is normally active. Solution temperature compensation is used primarily with power plant and other pure water samples less than 30 µS/cm conductivity. It references the pH of pure water to 25°C. All other applications should leave the solution temperature coefficient (STC) set to its default value of zero.

For pure makeup water or boiling water reactor samples, the STC should be set to 0.016 pH/°C. For ammonia, phosphate and/or amine-treated samples the STC should be set to 0.033 pH/°C. The appropriate setting for other pure water compositions may be determined by developing temperature vs. pH data for the particular sample with the STC set to zero. The negative slope of this data becomes the STC value.

Because Solution Temperature Compensation is unique to the process sample and is different for buffer solutions, it is not active during calibration. The 2000 ignores the STC during calibration. For this reason, the reading in a buffer solution after calibration may not be the exact value entered. To read and verify the exact buffer value, temporarily set the STC to zero.

The Solution Temperature Coefficient setting is accessed via the MENUS key / Spec pH Function / STC=0.000 pH/C for each channel.

pH Isopotential Point

The isopotential Point, IP, is left at the default setting of 7.0 for all Thornton and other conventional pH sensors. Special purpose pH electrodes with zero potential at values other than 7 pH will have this identified in their instruction manuals. A different IP setting will allow proper temperature compensation of these special electrodes. The IP setting is accessed via MENUS key / Spec pH Function / IP = 7.000 pH for each channel.

DISSOLVED OXYGEN TEMP. & PRESSURE COMPENSATION

For dissolved oxygen and ozone, temperature compensation is automatically provided for both the changing permeation rate of gas through the membrane and for its changing solubility in water.

For dissolved oxygen, during air calibration, the effective oxygen concentration is affected slightly by the barometric pressure. Therefore the barometric pressure should be entered before calibration.

AC POWER FREQUENCY

The 2000 meter was designed to reduce fluctuations in measurements by eliminating noise pickup from the AC power line. The meter can be set to filter either 50Hz or 60Hz power. Factory settings are 60 Hz for 90-130 VAC models and 50 Hz for 180-250 VAC models.

Setting 50/60 Hz Operation

To set the appropriate filter, press the MENUS key and the following menu will appear:

Menus use arrows

Press the DOWN arrow key until the “Set Frequency” menu is displayed.

Set Frequency

Press the OK/NEXT key to access this menu.

Frequency = **6**0

Use UP or DOWN arrow keys to set the desired frequency. Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press OK/NEXT to save changes and return to the measurement mode.

CHAPTER 5: USING SETPOINTS

OVERVIEW

A setpoint is a limit or alarm point applied to a measurement. A setpoint can be programmed as a high limit, a low limit, a USP limit or an EP limit. (A USP or EP setpoint is a high alarm used for pharmaceutical water monitoring, described later in this chapter.) When the measurement value is higher than a high setpoint, or lower than a low setpoint, a setpoint error condition exists. The meter will indicate this condition by blinking the measurement on the display. The 2000 can also be programmed to control a relay upon this error condition. Refer to Chapter 6 for more information on relays.

Four setpoints are available and can be assigned to any of the four measurements (A, a, B and b). More than one setpoint can be assigned to the same measurement and more than one setpoint can activate the same relay.

The following parameters can be programmed for setpoint operation:

1. The assigned signal: which signal (A, a, B, or b) is monitored by the setpoint.
2. The setpoint value: the measurement value that triggers the setpoint error condition, with prefix.
3. The setpoint type: High, Low, Off, USP, EP WFI or EP PW.
4. The assigned relay: which relay will be controlled when a setpoint error occurs (this is optional).
5. Operation on overrange: Whether or not the setpoint will be active when the measurement is outside its range — yes or no.

SETPOINT SIGNAL

The setpoint signal is the measurement that will be monitored by the setpoint. The signal can be any of the measurements:

1. A - Channel A primary
2. a - Channel a secondary
3. B - Channel B primary
4. b - Channel b secondary

SETPOINT VALUE

The setpoint value is the limit that will trigger a setpoint error condition. This number is entered as a four digit number with a suffix.

NOTE: The correct units multiplier suffix must be entered or the setpoint will not function properly.

The suffixes are:

"μ" (micro) = multiply value by 0.000001 (10^{-6}).

"m" (milli) = multiply value by 0.001 (10^{-3}).

"-" (blank) = multiply value by 1

"K" (kilo) = multiply value by 1,000 (10^{3}).

"M" (Mega) = multiply value by 1,000,000 (10^{6}).

For example, a setpoint value of 18.18M is equivalent to 18,180,000.

When programming the setpoint values with TDS units, the following prefixes should be used (parts per million is the basis):

m = parts per billion

_ = parts per million

K = parts per thousand

For ppm or ppb dissolved oxygen or ozone, the ppm or ppb units are the basis and "_" should be set as the units multiplier suffix.

For g/L dissolved oxygen, g/L is the basis and a unit multiplier suffix of m - milli or μ - micro should be used.

SETPOINT TYPE

The setpoint type can be "High", "Low", "USP" or "Off". A setpoint error condition occurs when the measurement is above the high or USP limit or below the low limit.

ASSIGNED RELAY

The assigned relay will change state according to the setpoint condition. When a setpoint error condition exists, the assigned relay will change state. If the relay is normally closed, then it will be opened.

Default settings after a system reset: Setpoints are disabled, no signals assigned, no relays assigned and values are zero.

PROGRAMMING A SETPOINT

Press the SETPOINTS key to access the first setpoint menu. This menu is used to assign a measurement to each of the four setpoints.

SP**1** on signal: A

The cursor is under the setpoint number field. Use the UP and DOWN arrow keys to select the desired setpoint number (1 to 4). Use the RIGHT arrow key to move the cursor to the signal field. Then use the UP and DOWN arrow keys to select the desired signal. The signal can be set to "-" which indicates that the setpoint is not assigned (disabled).

To change the assigned signal of another setpoint, move the cursor back to the setpoint number. Change the setpoint number, then move the cursor back to the assigned signal field.

SP1=**.0**000 _ off

Press the OK/NEXT key when done to proceed to the next menu.

The cursor is initially under the setpoint number field. Select the desired number then move the cursor to the numerical field. Set the desired value and prefix.

Examples of numerical entries:

Desired Value	**Menu Entry**
10.34	10.34_
1,456	1.456K
18,180,000	18.18M
567,456	567.5K
0.003	.0030_ or 3.000m
.000000055	.0550µ

Move the cursor over to the setpoint type field. To turn the setpoint on, select High, Low or USP. Press the OK/NEXT key when done to proceed to the next menu.

The next menu is used to assign a relay to the setpoint. This is optional. The menu will appear as:

SP1 use Relay#_

After selecting the desired setpoint number, move the cursor to the relay field. The choices are: 1 - 4 and "_". The "_" indicates that there are not any relays assigned to the setpoint.

NOTE: Some models of the 2000 are equipped with only 2 relays and will allow settings of only #1 or #2.

Press the OK/NEXT key when done to proceed to the next menu.

SP1 over-range **Yes**

This menu selects whether the setpoints will be active when the measurement is out of range, which could be due to process upset, loss of fluid at the sensor, disconnected sensor leads, etc. Use the arrow keys to select Yes or No for each setpoint.

Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

Example: Set Up a Setpoint

Program setpoint #2 with the following conditions:

1. Assigned to channel A secondary signal ("a").
2. A value of 18,200,000 (18.2 M Ω-cm)
3. Set as a high limit
4. Use relay #2
5. Disabled when out of range

Press the SETPOINTS key

Use the arrow keys to select setpoint #2 and signal "a". The display will appear as follows:

SP2 on signal: **a**

Press the OK/NEXT key:

Use the arrow keys to set the value at 18.20M and the state to high. The display will appear as follows:

SP2=18.20 M High

Press the OK/NEXT key:

Use the arrow keys to set the relay number to 2. The display will appear as follows:

SP**2** use Relay **#2**

Press the OK/NEXT key:

Use the arrow keys to set the over-range to No, resulting in the following display:

SP**2** over-range **No**

Press the OK/NEXT key. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

USP & EP SETPOINTS

USP & EP type setpoints provide a high alarm used for pharmaceutical water monitoring with non-temperature compensated conductivity measurements. USP (United States Pharmacopoeia) section <645> and European Pharmacopoeia require that non-temperature compensated conductivity of pharmaceutical waters must be below a limit from tables based on the temperature of the sample. In other words, pharmaceutical requirements temperature compensate the limit rather than the measurement.

The 2000 instrument has these pharmaceutical limit tables in memory and automatically determines the conductivity limit based on the measured temperature. USP and EP WFI (Water for Injection) setpoints use Table 5.1. The limit is the conductivity value corresponding to the 5° temperature step immediately below or equal to the measured temperature. EP *Highly* Purified Water limits are identical to EP WFI limits.

EP PW (Purified Water) setpoints use Table 5.2. The limit in this case is the conductivity value interpolated for the measured temperature. The 2000 takes care of this automatically.

The pharmaceutical setpoint *value* entered into the 2000 is the percentage safety margin *below* the limits to activate the setpoint. For example, the USP table conductivity limit at 15°C is 1.0 µS/cm. If the setpoint value is set at 40% then the setpoint will activate whenever the conductivity goes above 0.6 µS/cm at 15°C.

Temperature (°C)	**Conductivity Limit (µS/cm)**
0	0.6
5	0.8
10	0.9
15	1.0
20	1.1
25	1.3
30	1.4
35	1.5
40	1.7
45	1.8
50	1.9
55	2.1
60	2.2
65	2.4
70	2.5
75	2.7
80	2.7
85	2.7
90	2.7
95	2.9
100	3.1

Table 5.1: USP Section <645> Stage 1, EP WFI (Water for Injection), and EP Highly Purified Water Conductivity Limits as a Function of Temperature

Temperature (°C)	Conductivity Limit (μS/cm)
0	2.4
10	3.6
20	4.3
25	5.1
30	5.4
40	6.5
50	7.1
60	8.1
70	9.1
75	9.7
80	9.7
90	9.7
100	10.2

Table 5.2: EP PW (Purified Water) Conductivity Limits as a Function of Temperature

To configure a pharmaceutical setpoint, use the previous procedure but select USP, EP WFI or EP PW instead of High or Low. When selected, the display appears as:

SP1=**0**.000 % USP

Using the arrow keys, enter the percent safety margin below the USP conductivity limit desired.

CHAPTER 6: USING RELAYS

DESCRIPTION

The 2000 is equipped with up to four relays. Each relay can be programmed to activate when a setpoint is exceeded (defined as a setpoint error condition). The programmable parameters for a relay are:

1. Delay Time: up to 999 seconds
2. Hysteresis Value: up to 99%
3. State: normal or inverted

ELECTRICAL CONNECTIONS

For units equipped with two relays, each one has a common connection, a normally open connection and a normally closed connection. Units with 3rd and 4th solid state relays have only a common connection and a normally open connection as shown in Table 2.1.

DELAY TIME

Delay time is the length of time that the setpoint must be exceeded continuously (in a setpoint error condition) before activating the relay. When the setpoint error condition occurs, the delay timer is started. If during the delay time the setpoint error condition no longer exists, the delay timer is reset and the relay will not be activated. The maximum delay time is 999 seconds (16 minutes and 39 seconds).

HYSTERESIS

The hysteresis value is entered as a percentage of the setpoint value. For a high setpoint, the measurement must fall more than this percentage point below the setpoint value before the relay is deactivated. With a low setpoint, the measurement must rise at least this percentage above the setpoint value before the relay is deactivated.

For example: a high setpoint is set at 100 and the measurement is currently above this value so the setpoint error condition exists. If the hysteresis value is 10% then the measurement must fall below 90 before the relay is deactivated.

NOTE: Hysteresis does not function (has no effect) with USP setpoints.

RELAY STATE

The relay can be programmed for normal or inverted operation. When the relay is in the inverted state, the relay operation is reversed. When there is no setpoint error condition the relay is activated. The normally open contacts are closed.

WARNING: RELAYS WILL ALWAYS DE-ENERGIZE ON LOSS OF POWER, EQUIVALENT TO NORMAL STATE, REGARDLESS OF RELAY STATE SETTING. HOWEVER, THE SETTING IS RETAINED ON RESTORATION OF POWER.

Default settings after the system reset:

1. Relay is disabled.
2. Delay is 0 seconds.
3. Hysteresis is 0%.
4. Relay state is normal.

PROGRAMMING A RELAY

To enable or modify a relay:

Press the RELAYS key. The first relay menu is used to set the delay time.

R**1** Delay= 000 sec

In this menu, the cursor is initially under the relay number. Use the UP and DOWN arrow keys to select the desired relay number (1 to 4). Use the RIGHT arrow key to move the cursor to the delay time field. Then use the UP and DOWN arrow keys to set the delay time (000 to 999 seconds).

To change the delay time of another relay, move the cursor back to the relay number. Change the relay number, then move the cursor back to the relay time field.

Press the OK/NEXT key when done to proceed to the next menu.

R1 Hyster = **0**0%

Select the desired relay number and enter the hysteresis value (00 to 99%).

Press the OK/NEXT key when done to proceed to the next menu.

R1 State = **<u>N</u>ormal**

Select the desired relay number, then use the DOWN arrow key to select either Normal or Invert. Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **<u>Y</u>es**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

Example: Setup a Relay

Program relay #2 with the following conditions:

1. Delay of 60 seconds.
2. A hysteresis of 10%.
3. Inverted state.

Press the RELAYS key.

Use the arrow keys to select relay #2 and set a delay time of "060". The display will appear as follows:

R2 Delay = **0<u>6</u>0** sec

Press the OK/NEXT key.

Use the arrow keys to set the hysteresis value to "10%". The display will appear as follows:

Press the OK/NEXT key.

R2 Hyster = **<u>1</u>**0%

Use the arrow keys to set the state to inverted. The display will appear as follows:

R**2** State = **<u>I</u>nvert**

Press the OK/NEXT key. The meter will now ask if changes should be saved.

Save Changes **<u>Y</u>es**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

CHAPTER 7: USING ANALOG OUTPUTS

DESCRIPTION

An analog output is an isolated current signal that is proportional to any measurement. The two 2000 analog outputs have a minimum value of 4mA and a maximum value of 20mA (the signal can be re-calibrated to 0-20mA when needed, see ANALOG OUTPUT CALIBRATION later in this chapter). Each output can be scaled to a range of a measurement signal with either linear or bi-linear scaling. See Chapter 2 for electrical connections.

To use analog outputs, the following parameters must be configured:

1. Assigned Signal - The analog output will be proportional to the value of the assigned signal. Any of the four measurements (A, a B, b) can be assigned to the output.
2. Minimum Value - This is the measurement reading that will correspond to an output of 4mA.
3. Maximum Value - This is the measurement reading that will correspond to an output of 20mA.
4. Mid Value - For normal linear scaling leave this setting at zero. To use bi-linear scaling, set this to the measurement reading corresponding to an output value of 12 mA. See later section on bi-linear scaling.

This configuration is independent from any measurement. See PROGRAMMING THE ANALOG OUTPUTS later in the chapter for details.

PROGRAMMING THE ANALOG OUTPUTS

To set up an analog output channel, press the OUTPUTS key:

Output: **Analog**

Press the OK/NEXT key to access this menu. The next menu is used to assign a measurement signal to the output. The choices are: A, a, B, b, and _. The selection of "_" is used to disable the output by not assigning a signal to the output. The output will remain at 4mA when it is disabled. The menu may appear as:

Aout**1** signal = A

In this menu the cursor is initially under the output number. Use the UP or DOWN keys to select the desired output number (1 or 2). Press the RIGHT arrow key to move the cursor under the assigned field.

Aout1 signal = **A**

Use the UP or DOWN arrow keys to change the assigned measurement. Press the OK/NEXT key to accept it and proceed to the next menu.

Aout1 Min=**0**.000_

This menu is used to set the measurement value that will correspond to a 4mA output. Set the desired value. The last position in this menu is the suffix which can be one of the following:

"µ" (micro) = multiply value by 0.000001 (10^{-6}).

"m" (milli) = multiply value by 0.001 (10^{-3}).

"_" (blank) = multiply value by 1.

"K" (kilo) = multiply value by 1,000 (10^{3})

"M" (Mega = multiply value by 1,000,000 (10^{6})

When programming the analog output scaling limits with TDS units, the following suffixes should be used (parts per million is the basis):

m parts per billion

_ parts per million

K parts per thousand

For ppm or ppb dissolved oxygen or ozone, the ppm or ppb units are the basis and "_" should be set as the units multiplier suffix.

For g/L dissolved oxygen, g/L is the basis and a unit multiplier suffix of m - milli or µ - micro should be used.

After setting the desired value, press the OK/NEXT key to accept minimum value and proceed to the next menu.

Aout1 Max=**1**.000_

This menu is used to set the measurement value that will correspond to an output of 20mA. Repeat the process as described above. Press the OK/NEXT key to accept the maximum value and proceed to the next menu.

Aout1 Mid=0.**1**00_

If using bi-linear scaling, this menu is used to set the measurement value that will correspond to an output of 12mA. If using linear scaling leave it at zero. Press the OK/NEXT key to accept the mid range value and proceed to the next menu.

1:If err set **Max**

Using an arrow key, select max or min as the fail safe mode for the output signal on overange or failure conditions. The output will go to 20mA if set for max; to 4mA (or 0mA if re-calibrated) if set for min. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

Example: Setup an Analog Output

Set analog output #2 with the following parameters:

1. Assigned to channel B primary measurement
2. Minimum value of 1.000 M ohms
3. Maximum value of 20.00 M ohms
4. Fail to low end of scale.

Press the OUTPUTS key. The display will show:

Output: **Analog**

Press the OK/NEXT key.

Use the arrow keys to select analog output #2 and assign measurement B to this output. The display will appear as follows:

Aout2 signal = **B**

Press the OK/NEXT key.

Use the arrow keys to set the minimum value to 1.000 M ohms. The display will appear as follows:

Aout2 Min=1.000**M**

Press the OK/NEXT key.

Use the arrow keys to set the maximum value to 20.00 M ohms. The display will appear as follows:

Aout2 Max=20.00**M**

Press the OK/NEXT key.

Aout2 Mid=**0**.000_

Since bi-linear scaling is not used in this example, press the OK/NEXT key.

2:If err set **Max**

Select Min.

2:If err set **Min**

Press OK/NEXT.

Save Changes **Yes**

Press the OK/NEXT key to save changes and return the display of measurement data.

Bi-Linear Scaling

Bi-linear scaling of an analog output signal enables high resolution data acquisition at the low end of a range yet includes on-scale records of higher measurements from the same 4-20 mA signal. For example, with a dissolved oxygen measurement normally in the 0 to 200 ppb range, this range can be set as the scaling for the lower half of the analog output signal (4-12 mA) as shown below. The upper half of the signal (12-20 mA) can be scaled for 200 to 10,000 ppb to allow tracking the progress of de-oxygenation during a startup. In this example, 200 ppb would be the mid-range setting.

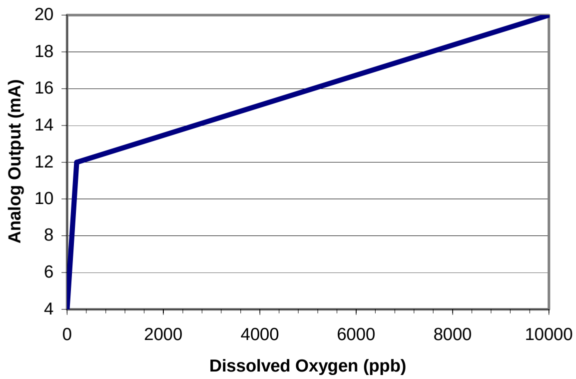


Figure 7.1: Bi-Linear Output Scaling

ANALOG OUTPUT CALIBRATION

The analog output signals have been factory calibrated to specifications and normally do not require any further adjustment. To match other equipment, they may be re-calibrated in a two step process where 4mA and 20mA levels are adjusted. A current meter is connected in series with the output. The arrow keys are then used to adjust the current output for the appropriate level (4mA, then 20mA).

The 4mA end of the signal can be calibrated down to zero mA, where needed. With a 500 ohm resistor across the output terminals, a 0-10 VDC signal may also be obtained.

For NIST traceability, the outputs can be calibrated with any NIST-calibrated current meter.

Procedure: Connect the meter in series with the output signal.

Press the CAL key and the display will show:

Calibrate **Sensor**

Use the UP and DOWN keys to change the display until the “Analog” option is displayed:

Calibrate **Analog**

Press OK/NEXT to proceed to the next menu.

Cal Analog Ch **1**

Use the UP and DOWN keys to select the desired output channel number (1 or 2). Press the OK/NEXT key to proceed to the next menu.

1:Adj 4mA=1064**1**

Use the UP and DOWN keys to adjust the output current for a 4mA level (as measured by the current meter). The number displayed is an arbitrary value proportional to the analog output signal, near 10,000 for 4 mA, near 0.000 for 0 mA and near 55,000 for 20 mA. Adjusting a more significant digit of this number will change the output signal level faster. Adjust a less significant digit for closer resolution.

Press the OK/NEXT key when done adjusting the 4mA or 0mA output. The next menu is for adjusting the 20mA output.

1:Adj 20mA=5409**1**

Adjust the 20mA level in a similar manner. Press the OK/NEXT key when done adjusting the 20mA. The meter will ask if changes should be saved.

Save Changes **Yes**

Press OK/NEXT to save the changes and return to display measurement data.

CHAPTER 8: METER CALIBRATION

OVERVIEW

The 2000 meter is factory calibrated within specifications. It is not necessary to perform meter re-calibration unless extreme conditions cause out of specification operation shown by Verification (see CALIBRATION VERIFICATION section). Periodic verification/re-calibration may also be necessary to meet Q.A. requirements. ALWAYS perform a verification before considering a meter calibration. If within specification do not perform a meter calibration.

CAUTION: Do not perform a meter calibration unless a Thornton calibrator or precision decade box is connected. Factory calibration cannot be restored in the field.

The 2000 meter is re-calibrated for conductivity/resistivity by installing a known resistance value in place of the cell and using the calibration menus to complete the process. The meter is designed for calibration at six points for conductivity/resistivity and two points of temperature (on each channel) as shown in Table 8.1. The second column of the table indicates the calibrators that are applicable for a region of measurement. Note that a single conductivity/resistivity calibration covers both Channels A and B at one time but separate temperature calibrations are required on each channel.

Calibration Point (ohms)	Calibrator Part No.	Approx. Meas. Range
Short	1864-09	0-2K ohms
Open	1864-12	>200K ohms
500K	1864-05	>200K ohms
50K	1864-06	20K-200K ohms
5K	1864-07	2K-20K ohms
500	1864-08	0-2K ohms
A Temp 1K	1864-06,-08	0 °C
A Temp 1.4K	1864-05,-07	104 °C
B Temp 1K	1864-06,-08	0 °C
B Temp 1.4K	1864-05,-07	104 °C

Table 8.1 Calibration Points

Standards for verification or calibration of conductivity and temperature are available as six Thornton NIST-Traceable calibrators (second column) which include one resistance and one temperature value in each unit. They plug directly into patch cables in place of the sensor. Full Range Calibration Kit 1865-07 includes all six calibrators in Table 8.1. High Resistivity Kit 1865-05 includes 1864-05,-06,-12. Low Resistivity Kit 1865-06 includes 1865-07,-08,-09.

If measurements will always be within a certain range, only that range requires calibration. For example, if measurement will always be >200K ohms, as with ultrapure water, only the >200K ohm range requires calibration.

CAUTION: Calibrators are for calibrating conductivity/resistivity measurements only. Do not connect a calibrator to a patch cord wired for pH, ORP, dissolved oxygen or ozone sensors.

If decade boxes are used, connect per Figure 14.10, shown for channel A, and similarly for channel B (temperature only).

NOTE: To display the actual value of a calibration device, use the Calibration Verification menu described in the next section.

WARNING: INSTALLING A CALIBRATION DEVICE ON A CHANNEL MAY TRIGGER ALARM STATES, RELAY ACTION AND PROCESS UPSET. USE THE HOLD FUNCTION.

CALIBRATION VERIFICATION

The calibration verification menu can be used to quickly confirm the meter's performance. A calibration/verification device is installed on a channel and this menu is used to display the actual resistance value. The verification feature can be accessed from either the CALIBRATE or MENUS keys to allow the calibration menu to be locked yet still allow operators to verify calibration.

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the DOWN arrow key until the "Verify Calibrate" menu is displayed.

Calibrate **V**erify

Press the OK/NEXT key to access this menu.

Verify Cal: Ch **A**

Use the UP arrow key to select the desired channel. Press the OK/NEXT key when set. The meter will now display the actual values of the calibrator. A typical display may appear as:

A10.04MΩ 1.003KΩ

The first number is the measured value of the conductivity/resistivity input and the second number is the measured value of the temperature input. Compare these numbers with the values printed on the label of the verifier/calibrator as well as on the Certificate of Accuracy supplied with it. Values should be within ±0.5%. Press any key to end this menu. Other calibration/verification values may be checked in the same manner. If within specification, do not perform a calibration.

CALIBRATION PROCEDURE

The resistance calibration sequence should use the "short" and/or "open" calibrators first, whenever they are used. Other calibrators may be used in any order.

Step 1: Select the Meter Calibration

Press the CALIBRATE key and the display will show:

Calibrate **Sensor**

Use the UP and DOWN keys to change the display until it reads:

Calibrate **Meter**

Press the OK/NEXT key to proceed to the next menu.

Step 2: Select the channel

Cal Meter Ch **A**

Use the UP and DOWN keys to select channel B if desired (for temperature). Press the OK/NEXT key to proceed to the next menu.

Step 3: Select the signal to calibrate:

Cal A #1: **R 500K**

Use the UP and DOWN keys to select the point to be calibrated. The choices are: "R500K", "R50K", "R5K", "R500", "Temp", "Volts", "Short", or "Open". Press the OK/NEXT key when ready to proceed to the next menu.

For the following example "Temp" is selected for calibration.

Cal A #1: **Temp**

Step 4: Enter the calibrator value:

A Temp =**1**.0000K

This menu is used to enter the value of the calibrator (printed on the label as well as the Certificate of Accuracy supplied with the calibrator). The display will show a nominal value but the actual value of the calibrator must be entered. Use the UP and DOWN keys to change the digit. Use the RIGHT and LEFT arrow keys to move the cursor to the next digit. The last character on the display is the units prefix, which appears after the value on the calibrator.

For Reference:

The available prefixes are "µ" = micro, "m" = milli, "k" = kilo, "M" = mega and "_" = one. The numerical entry is multiplied by the value of the prefix as follows:

"µ" (micro) = multiply value by 0.000001 (10^{-6}).

"m" (milli) = multiply value by 0.001 (10^{-3}).

"_" (blank) = multiply value by 1.

"K" (kilo) = multiply value by 1,000 (10^{3})

"M" (Mega = multiply value by 1,000,000 (10^{6})

When the value of the calibrator is entered, press the OK/NEXT key when ready to proceed to the next menu.

Step 5: Install the calibrator on the selected channel:

A= 1.0003KT Ω   OK?

The instrument will display the value of the calibrator as measured by the meter. it is important to wait for this displayed measurement to stabilize. The reading may fluctuate slightly but the changes should be no more than ±1 digit (least significant). For example, in the display above the reading may fluctuate from 1.0002K to 1.0004KΩ. It is recommended that you wait at least 30 seconds to be certain that the measurement has settled.

To discontinue the calibration, press any of the menu keys. To proceed with the calibration process (after the readings have stabilized), press the OK/NEXT key.

Step 6: Perform the calibration:

The calibration process may take a few seconds to complete. When the instrument is done, the following message will be displayed.

Done,   press **OK**

Step 7: Proceed to the 2nd calibration point:

Press the OK/NEXT key to complete the calibration of the first point. The meter will display the following menu:

Do point #2   **No**

Press the OK/NEXT key to save the new calibration factor and return to the measurement mode. Otherwise, use the UP and DOWN arrow keys to change the "No" to "Yes" and press the OK/NEXT key to perform calibration for a 2nd point. The meter will display the following menu, requesting the value of the 2nd calibration point:

Step 8: Enter the calibrator value (point #2)

A   Temp = **1**.4000K

Enter the exact value of the 2nd calibrator and press the OK/NEXT key when ready to proceed.

Step 9: Install the second calibrator:

As with the 1st calibration point, the meter will now display the measured value of the calibrator as follows:

A=1.4011KTΩ   **OK**?

When the reading has stabilized, press the OK/NEXT key.

Step 10: Perform the calibration (point #2):

The calibration process may take a few seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

Press the OK/NEXT key. The meter will ask if the changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

The calibration process is complete for the temperature circuit of one channel. Repeat this process for the other channel temperature, if used, and for the conductivity/resistivity points.

Reminder: due to entered cell constants and temperature compensation, the meter will only read the exact connected calibrator value in the "Verify" mode.

Special Temperature Calibration

NOTE: If using 2_8 series Dot Two cells with Ni-Fe 500 ohm RTD, substitute a decade box with 500 ohms for 0°C and 735 ohms for 100°C in place of the calibrators in the previous procedure.

Voltage Calibration for pH, dissolved oxygen, dissolved ozone and ORP

It is generally not necessary to calibrate the voltage range which is used for these measurements. Sensor calibration is performed frequently in NIST traceable pH buffer solutions, air or other standard and will override any voltage calibration. (The pH scale is defined by response in NIST standard reference materials and air provides a very reliable oxygen standard.)

The voltage input is also used with ORP sensors. To calibrate the voltage range, use a stable voltage source and precision voltmeter and connect as given in Figure 14.10. Follow the procedure above, selecting "Volts" as the signal to be calibrated. A two-point calibration should be done near -400 and +400 mV. A 2000 meter voltage calibration cannot be done at zero millivolts.

CHAPTER 9: SENSOR CALIBRATION

CONDUCTIVITY/RESISTIVITY CELL CONSTANTS

Best performance is normally obtained by entering the factory-documented cell constants in the Entering/Editing Cell Constants sections below. Cell constants are provided on the label of the sensor cable and on their certificates of calibration.

However, if the sensor's performance is not acceptable then it can be calibrated. It is important to ensure that the meter is properly calibrated and that a very accurate standard solution is available before performing a sensor calibration described in this chapter.

Entering/Editing Conductivity/ Resistivity Cell Constants

Upon the installation of a conductivity cell, the cell constants must be entered into the meter. Channel A has two cell constant types: one for the resistivity/conductivity sensor and one for the temperature sensor. These constants are referred to as "A Cell" and "A Temp", respectively. Each of these types has a Multiplier and an Adder cell constant. Channel B has similar constants ("B Cell" and "B Temp"). The Adder factors are left at zero for 2-electrode conductivity/resistivity sensors.

The procedure to enter and edit constants is as follows:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until "Edit Sensor Cal" menu is displayed.

Edit Sensor Cal

Press the OK/NEXT key to access this menu

A Cell M=.10000_

The cursor is initially under the channel/type field. Use the UP arrow key to select the desired channel/type ("A Cell", "A Temp", "B Cell", "B Temp").

The next field selects either the Multiplier, M, or the Adder, A, factor.

A Cell **M**=.10000_

Use the RIGHT arrow key to move the cursor to the number field. Use the arrow keys to enter the cell constants from the sensor label. The last position in the menu is a unit prefix which should be left at "_" (blank or units); although μ (micro), m (milli), K (Kilo) and M (mega) are also available.

After setting the desired value, the RIGHT arrow key can be used to move the cursor back to the channel/type field (1st field) so that the other constants can be entered and edited. The changes are recorded when you proceed to a different constant.

Pressing the OK/NEXT key will accept all set values. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return the display to measurement mode.

CONDUCTIVITY/RESISTIVITY SENSOR CALIBRATION

Conductivity sensors can be calibrated with either a one-point or two-point calibration process. For conventional 2-electrode conductivity sensors (240- and 243-series), a 1-point calibration is recommended. For 4-electrode sensors (244-series), a 2-point calibration requiring two standard solutions is recommended for highest accuracy.

The solution(s) must be known with very high accuracy (either resistivity, conductivity, °C or °F) before the sensor can be calibrated. Calibration is accomplished by entering the known solution value into the meter and instructing the meter to perform a calibration.

When a one-point conductivity calibration is performed, the meter will compute a new Multiplier factor. With a two-point calibration, the meter will compute new Multiplier and Adder factors.

Conductivity/resistivity sensor calibration cannot be done if the *MEASUREMENT* menu is set for non-temperature compensated conductivity (see SELECTING A MEASUREMENT TYPE in Chapter 4). If necessary, temporarily set the instrument for compensated measurement for the calibration. (Calibration can be done, if desired, with Compensation set to "None", accessed by the *MENUS* key)

NOTE: The 240-501 cell with 50/cm cell constant uses a 262.4 ohm @ 25°C thermistor. With this sensor, use the factory temperature multiplier constant provided on the cell leadwire label. No further temperature calibration is possible. (Conductivity calibration may be performed in the normal manner.)

Conductivity/ Resistivity Calibration Procedure

If a process upset may occur during calibration, activate the HOLD function as described in the pH sensor calibration section following.

Press the CALIBRATE key and the display will show:

Calibrate **Sensor**

Press the OK/NEXT key to proceed to the next menu.

Cal Sensor Ch **A**

Use the UP arrow key to select the desired channel. Press the OK/NEXT key when set.

Cal Ch A #1: **Res**

Use the UP arrow key to select the measurement to be calibrated. The choices are: Res, Con, pH, Volts, g/L O2, ppm/ppb O2, °C and °F. Press the OK/NEXT key when set.

The next menu will allow the known value of the signal (or solution) to be entered.

A Res = **1**8.180 M

Enter the known value. Be certain to set the proper units prefix. In this example, the prefix is "M" for Megohms. Press the OK/NEXT key when done.

The meter will now display the *uncalibrated* reading for checking stability only. For example, a typical display for calibrating resistivity may appear as:

A= 18.15MΩ OK?

When the reading has stabilized, press the OK/NEXT key to perform the calibration. The calibration process may take a few seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

Press the OK/NEXT key. The meter will display the menu for performing the second calibration point.

Do point #2 **No**

If doing a two-point calibration, then use the UP key to change the "No" to "Yes". Press the OK/NEXT key to perform the 2nd calibration point or to exit the menus.

NOTE: Performing a sensor calibration will modify the cell constants shown in the "Edit Sensor Cal" menu such that they will not match the constants written on the cell label.

PH/ORP (REDOX) SENSOR CALIBRATION

Overview

Periodic sensor calibration is necessary because pH sensors have some variation in output which can change over time, especially under harsh or contaminating process conditions. The frequency of calibration must be determined by experience with a particular application. For example, begin with daily calibration, then extend to weekly, then to monthly, bi-monthly, etc. as allowed by the drift experienced and process accuracy requirements. Such a sequence is also appropriate since new sensors will show some initial drift as they acclimate to the process. The accuracy of calibration is determined by the accuracy and traceability of the standard buffer solutions used.

Calibration is accomplished by entering the known value into the instrument and instructing it to perform the calibration. When a one-point calibration is performed, the instrument computes a new Adder (standardize offset or zero) constant. With a two-point calibration, the instrument computes new Adder and Multiplier (slope or span) constants. It should be noted that a non-functional sensor can always be calibrated at one point. Response to a changing process or to a second calibration point is needed to ensure the sensor is functioning.

For ORP measurement, no sensor calibration is recommended although it is possible. It is recommended that the instrument read in absolute millivolts established by factory meter calibration. The Adder constant is set to the value provided on the label on the preamp and the Multiplier is left at 1.0. Standard ORP solutions are available for checking operation of sensors, however, their tolerance under process conditions is generally too wide to be useful for calibration.

Two methods are used for pH sensor calibration: buffer and grab sample. In some situations, it is most convenient to do a grab sample calibration on a routine basis. A two-point buffer calibration may be performed at less frequent intervals to provide full adjustment to sensor response.

Buffer calibration requires removal of the sensor from the process and immersing it in standard buffer solution. It may be done at one or two points and gives the most direct traceability to the standard(s). The sensor should be rinsed well with deionized or distilled water before immersing in each standard.

Before removing the sensor from the process for buffer calibration, activating the 2000 HOLD function will maintain analog outputs and alarm relays in their existing condition. This should be done to prevent disruption of the process.

Grab sample calibration allows the sensor to remain in the process but is limited to a one-point procedure. A sample is removed and measured by a portable pH system that has been previously calibrated in standard buffer solutions. The process pH must be stable enough that there is high confidence that a sample will be representative of the on-line value. For pure water samples (< 20 µS/cm conductivity), the "grab sample" should be a flowing side stream not exposed to air before measurement, to minimize carbon dioxide contamination.

For stable processes, simply perform a one-point calibration making the on-line measurement agree with the grab sample. For a process that can change pH significantly between the time the grab sample is taken and measured and the time the 2000 can be calibrated, the following steps are recommended:

1. Record the displayed pH at the time the grab sample is taken.
2. Measure the grab sample pH.
3. Calculate the difference of the grab sample pH minus the recorded process pH, retaining the sign (positive or negative).
4. Add the difference value to the current displayed process pH and immediately enter the result as the calibration standard value in the procedure.

Example:

1. The 2000 instrument reads 6.50 pH when the grab sample is taken.
2. The grab sample measures 6.20 pH on the portable system.
3. The difference is - 0.30 pH.
4. The current 2000 instrument reading is 7.00 pH so 6.70 pH is the value entered for one-point calibration.

pH Calibration Procedure

Use the first 4 steps if desired to activate the Hold function which maintains the relays and analog outputs at their current levels to prevent process upset:

1. Press the CALIBRATE key and the display will show:

Calibrate **S**ensor

2. Press the DOWN Arrow key and the display will show:

Hold output **t**ime

3. Press OK/NEXT key and using the arrow keys, enter the length of time in minutes needed to complete the calibration, for example:

Hold time = 0**6** min

4. Press the OK/NEXT key twice.

Press the CALIBRATE key and the display will show:

Calibrate **S**ensor

5. Press the OK/NEXT key to proceed to the next menu.

Cal Sensor Ch **A**

6. Use the UP arrow key to select the desired channel. Press the OK/NEXT key when set.

Cal Ch A #1: **p**H

7. Use the UP arrow key to select the measurement to be calibrated. The choices are: pH, Volts, Res, Con, °C and °F. Press the OK/NEXT key when set.

The next menu will allow the known value of the standard solution to be entered.

A pH = **4**.000 _

8. Using the arrow keys, change the display to the solution value. For buffer solutions, enter the exact pH value corresponding to its temperature. Press the OK/NEXT key. The meter will now display the *uncalibrated* reading to check for stability only. The actual value of the calibration will appear only after completion of the procedure. For example, a typical display may appear as:

A= 3.925 OK?

9. When the reading has stabilized, press the OK/NEXT key to perform the calibration. The calibration process may take a number of seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **O**K

10. Press the OK/NEXT key. The meter will display the menu for performing the second calibration point.

Do point #2 **N**o

11. If doing a two-point calibration, use the UP key to change the “No” to “Yes”. Press the OK/NEXT key to perform the 2nd point of calibration similar to the first but with the sensor in a different buffer solution. For a single point calibration, press OK/NEXT with “No” in the display above to exit the menus.
12. If the Hold function is still active after completing calibration and the sensor is back in the process, deactivate Hold by pressing CALIBRATE, DOWN Arrow and OK/NEXT. Set the time to 00 and press OK/NEXT. Otherwise, the Hold condition will continue until it times out.

NOTE: Performing a sensor calibration will modify the cell constants shown in the "Edit Sensor Cal" menu such that they will not match the constants written on the sensor label. This is normal.

Entering/Editing pH and ORP Calibration Constant

Upon the installation of a pH or ORP preamp, its Adder (zero or offset) calibration constant is entered into the 2000 as follows:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until "Edit Sensor Cal " menu is displayed.

Edit Sensor Cal

Press the OK/NEXT key to access this menu

A Cell M=1.0000_

The cursor is initially under the channel/type field. Use the UP arrow key to select the desired channel/type (either "A Cell", "A Temp", "B Cell", "B Temp").

In the next field, select the adder, A, factor.

A Cell **A**=.00300_

Use the RIGHT arrow key to move the cursor to the number field. Use the arrow keys to modify the number desired. The last position in the menu is a unit prefix which should be left at "_" (blank); although μ (micro), m (milli), K (Kilo) and M (mega) are also available.

After setting the desired value, the RIGHT arrow key can be used to move the cursor back to the channel field (1st field) to enter the Adder for the other channel, if used. The changes are recorded when you proceed to a different constant.

Pressing the OK/NEXT key will accept all set values. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return the display of measurement data.

PH SENSOR DIAGNOSTICS

The Adder and Multiplier constants described above can provide valuable preventive maintenance information about the sensors.

The **Adder** factor (zero, asymmetry or standardize offset) is an indication of how far the sensor has drifted from the nominal zero starting point, in pH units. It is recalculated after ever calibration. Drift in this value is usually due to aging or contamination of the reference electrode portion of the sensor.

An offset of more than ±1 pH unit or a more rapid change in this value is an indication that the sensor should be replaced soon. The Adder factor "A" can be viewed at any time in the Edit Sensor Cal menu. However, the value must not be changed in this menu or the sensor will have to be recalibrated.

Because the 2000 meter is auto-ranging, when the Adder Factor is very small, it may be displayed in milli-pH units with an "m" prefix following the numeric value. In this case the value is very near the nominal zero offset.

The **Multiplier** (slope or span) is an indication of the sensitivity of the sensor to changes in pH. It has a nominal value near 1 and is recalculated after every 2-point calibration. Reduction in this value is usually due to aging, coating or hot caustic attack of the glass measuring membrane of the sensor.

A sensor with Multiplier value less than 0.90 should be replaced soon. The Multiplier "M" can be viewed at any time in the Edit Sensor Cal menu. The value must not be changed on this menu (except at startup) or the sensor will have to be re-calibrated.

DISSOLVED OXYGEN SENSOR CALIBRATION

Entering/Editing Long Life Dissolved Oxygen Calibration Constants

Upon the installation of a 367-110 Long Life dissolved oxygen sensor, its calibration constants should be entered into the meter. (This is not done for the 367-210 High Performance sensor.) Channel A has two cell constant types: one for the dissolved oxygen signal and one for the temperature signal. These constants are referred to as “A Cell” and “A Temp”, respectively. Each of these types has a Multiplier and an Adder cell constant. Channel B has similar constants (“B Cell” and “B Temp”) though only one channel can be used for dissolved oxygen measurement. These constants provide pre-calibration of temperature and dissolved oxygen for the specific probe and amplifier.

The procedure to enter and edit constants is as follows:

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until “Edit Sensor Cal” menu is displayed.

Edit Sensor Cal

Press the OK/NEXT key to access this menu

A Cell M=.10000_

The cursor is initially under the channel/type field. Use the UP arrow key to select the desired channel/type (either “A Cell”, “A Temp”, “B Cell”, “B Temp”).

The next field selects either the Multiplier, M, or the Adder, A, factor.

A Cell **M**=.10000_

Use the RIGHT arrow key to move the cursor to the number field. Use the arrow keys to enter the cell constants from the sensor label. The last position in the menu is a unit suffix which should be left at “_” (blank or units) for the Multiplier. It is normally set to m (milli) for the Adder.

After setting the desired value, the RIGHT arrow key can be used to move the cursor back to the channel/type field (1st field) so that the other constants can be entered and edited. The changes are recorded when you proceed to a different constant.

Pressing the OK/NEXT key will accept all set values. The meter will ask if changes should be saved.

Press the OK/NEXT key to save the changes and return the display to measurement mode.

Air Calibration

Dissolved oxygen sensor output will vary slightly over time as the membrane and electrodes age. Periodic calibration in air is needed at installation and at intervals based on experience in the particular application. The following procedure should be performed quickly to minimize the length of air exposure time. Short exposure promotes fast recovery to low levels.

Sensor air calibration will change the Multiplier value from the original factory value on the sensor cable. This is normal and the factory Multiplier value should not be used again.

For highest accuracy air calibration, determine the absolute barometric pressure at the instrument location from a calibrated barometer in mm of mercury (1 bar = 750 mmHg).

To prevent relay or analog output upset, activate the HOLD function in the next 4 steps, otherwise begin with step 5.

1. Press the CALIBRATE key and the display will show:

Calibrate **Sensor**

2. Press the DOWN Arrow key and the display will show:

Hold output **time**

3. Press OK/NEXT key and using the arrow keys, enter the length of time in minutes needed to complete the calibration, for example:

Hold time = 0**6** min

4. Press the OK/NEXT key twice.
5. Stop sample flow to the DO sensor.
6. Loosen the probe retainer ring and gently pull the probe out of the flow chamber, rotating it slightly clock-wise, hang it in the open air and gently blot the membrane dry.

7. When a stable reading is obtained in 1-2 minutes, press the CALIBRATE key and the display will show:

Calibrate **<u>S</u>ensor**

8. Press the OK/NEXT key to proceed to the next menu.

Cal Sensor Ch **<u>A</u>**

9. Use the UP arrow key to select the channel measuring dissolved oxygen. Press the OK/NEXT key when set and select O2 Air Calibration displayed as:

Cal ChA #1: **<u>O</u>2 A**

10. Press OK/NEXT to display:

Atm Press= <u>7</u>60.0

11. Change the display as necessary to match the actual atmospheric pressure.
12. Press OK/NEXT.
13. Use the UP arrow key to set the measurement to be calibrated-“O2 A” (dissolved oxygen air). Press the OK/NEXT key when set.
14. The next menu displays the air saturation value in mg/L (ppm) automatically calculated for the existing temperature and atmospheric pressure entered previously. Units of mg/L are indicated for calibration regardless of normal display units.

A O2 A = **<u>8</u>**.2133m

This value should not be changed for air calibration. For calibration to a known standard, see next procedure.

15. Press the OK/NEXT key. The meter will now display the *uncalibrated* reading to check for stability only. The actual value of the calibration will appear only after completion of the procedure. For example, a typical display may appear as:

A = **<u>8</u>**.1496mg OK?

16. When the reading has stabilized, press the OK/NEXT key to perform the calibration. The calibration process may take a number of seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **<u>O</u>K**

17. Press the OK/NEXT key twice.

Dissolved Oxygen Zero Calibration

It is not normally necessary to perform a zero calibration unless operation is very close to zero DO and it is suspected the calibration has shifted. The need for zero calibration may also be indicated by frequent readings of zero DO with a flashing display.

A zero calibration changes the Adder calibration constant from the factory value.

Follow the sensor instructions to make up and administer a zero solution to the probe, allowing several hours if necessary to achieve zero.

1. When stable, press the CALIBRATE key and the display will show:

Calibrate **<u>S</u>ensor**

2. Press the OK/NEXT key to proceed to the next menu and use the Up Arrow key to select the channel measuring dissolved oxygen.

Cal Sensor Ch **<u>A</u>**

3. Press the OK/NEXT key when set. Then use the UP arrow key to select the measurement to be calibrated—“O2 Z” (dissolved oxygen zero).

Cal Ch A #1: **<u>O</u>2 Z**

4. Press the OK/NEXT key to display 0 µg/L (ppb) which cannot be changed:

A= 0**.**000µg OK?

5. Press the OK/NEXT key.
6. Press the OK/NEXT key to perform the calibration. The calibration process may take a number of seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

7. Press the OK/NEXT key twice to save and exit.

Dissolved Oxygen Electrical Zero Calibration

For model 367-210 High Performance DO Sensors only, it is possible to calibrate out the electrical zero offset in the preamplifier. This is recommended when operation is near zero and it is suspected the calibration has shifted. It can give a more reliable and faster zero calibration than that provided by a solution.

1. If desired, activate the Hold function to hold relays and output signals constant during calibration by pressing CALIBRATE and DOWN arrow to display:

Hold output **time**

2. Press OK/NEXT and set the time needed for calibration:

Hold time=1**0** min

3. Press OK/NEXT twice to save it.
4. Disconnect the probe from the DO preamp.
5. Press MENUS and UP arrow 5 times to display:

Temp Source

6. Press OK/NEXT and select the channel on which DO is measured (B in this example) to display:

B: Use this chan

7. Press DOWN arrow to display:

B: **Fixed**= 25.00°C

8. Press OK/NEXT to save changes. The above steps restore a temperature value to allow zero calibration with the preamp disconnected.
9. Press CALIBRATE to display:

Calibrate **Sensor**

10. Press OK/NEXT to proceed to the next menu and use the Up Arrow key to select the channel measuring dissolved oxygen:

Cal Sensor Ch **B**

11. Press the OK/NEXT key. Then use the UP arrow key to select the measurement to be calibrated—“O2 Z” (dissolved oxygen zero):

Cal Ch B #1: **O2 Z**

12. Press the OK/NEXT key to display 0 μg/L (ppb) which cannot be changed:

B= 0.000μg OK?.

13. Press OK/NEXT to perform the calibration. The calibration process may take an extended period to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

14. Press the OK/NEXT key twice to save and exit.
15. Reconnect the patch cord to the DO preamp and allow several minutes to pass to begin repolarizing the DO sensor.
16. Restore the measured temperature by repeating Steps 5-8 but selecting “Use this chan”.
17. Deactivate the HOLD function by repeating Steps 1-3 and setting the time to 00 minutes.

DO readings will continue to move toward accurate values as the sensor re-polarizes over the next minutes or hours. The time to reach final stability depends on how long it was disconnected.

DISSOLVED OZONE SENSOR CALIBRATION

Comparison Span Calibration

Dissolved ozone sensor output will vary slightly over time as the electrolyte, membrane and electrodes age. Periodic calibration to a standard test measurement is needed at installation and at intervals based on experience in the particular application.

A span calibration is performed by comparison while measuring a stable ozonated sample. Use the value of another calibrated ozone instrument or the value of a colorimeter reading on the same sample. A colorimeter sample must be taken from the same point and read very quickly to limit errors due to the rapid decay of ozone. Span calibration will change the Multiplier value from its previous value.

To prevent relay or analog output upset, activate the HOLD function in the next 4 steps, otherwise begin with step 5.

1. Press the CALIBRATE key and the display will show:

Calibrate **Sensor**

2. Press the DOWN Arrow key and the display will show:

Hold output **time**

3. Press OK/NEXT key and using the arrow keys, enter the length of time in minutes needed to complete the calibration, for example:

Hold time = 0**6** min

4. Press the OK/NEXT key twice.
5. When ozonation is at steady state and a stable reading is being observed on the 2000, obtain the reference value of dissolved ozone from another calibrated instrument or a colorimeter measuring the same sample.
6. Press the CALIBRATE key and the display will show:

Calibrate **Sensor**

7. Press the OK/NEXT key to proceed to the next menu.

Cal Sensor Ch **A**

8. Use the UP arrow key, if necessary, to select the channel measuring dissolved ozone. Press the OK/NEXT key when set and select O3 Comparison Calibration displayed as:

Cal ChA #1: **O3 C**

9. Press the OK/NEXT key. The display gives a zero reading. Units of µg/L (ppb) are indicated for calibration regardless of normal display units. Using the arrow keys, enter the standard value from the calibrated instrument or the colorimeter **in units of µg/L (ppb)**. (1 ppm = 1000 µg/L or ppb)

A O3 C = **248.0**µ

10. Press the OK/NEXT key. The meter will now display the *uncalibrated* reading to check for stability only. The actual value of the calibration will appear only after completion of the procedure. For example, a typical display may appear as:

A = 249.0 z OK?

11. When the reading has stabilized, press the OK/NEXT key to perform the calibration. The calibration process may take a number of seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

12. Press the OK/NEXT key twice.

Dissolved Ozone Zero Calibration

Zero calibration should be performed at startup and at infrequent intervals thereafter since it does not normally change significantly. A zero calibration changes the Adder calibration constant from the factory value. To prevent relay or analog output upset, activate the HOLD function as described in the first 4 steps of the previous comparison calibration procedure; otherwise begin with step 1 below.

1. Expose the probe to ozone-free water or to air. When readings are stable, press the CALIBRATE key and the display will show:

Calibrate **Sensor**

2. Press the OK/NEXT key to proceed to the next menu and use the Up Arrow key, if needed, to select the channel measuring dissolved ozone.

Cal Sensor Ch **A**

3. Press the OK/NEXT key when set. Then use the UP arrow key to select the measurement to be calibrated—"O3 Z" (dissolved ozone zero).

Cal Ch A #1: **O3 Z**

4. Press the OK/NEXT key to display 0 ppb which cannot be changed:

A= 0.000 z OK?

5. Press the OK/NEXT key to perform the calibration. The calibration process may take a number of seconds to complete. When the instrument is done, the following message will be displayed:

Done, press **OK**

6. Press the OK/NEXT key twice to save and exit.

7. Deactivate the HOLD function by repeating Steps 1-3 and setting the time to 00 minutes.

CHAPTER 10: SECURITY/LOCKOUT

SECURITY FEATURES

All menus, or only specific ones, can be protected from unauthorized use by using the lockout feature. When enabled, the menu(s) will be inaccessible unless the proper five digit password is entered. Each menu key on the front panel can be locked out individually. The functions that can be locked are:

1. MEASURE MODE: locks the measure mode key
2. SETPOINTS: locks the setpoint key.
3. RELAYS: locks the relays key.
4. OUTPUTS: locks the output key.
5. CALIBRATE: locks the calibrate key.
6. MENUS: locks the menu key.
7. DISPLAY: locks the arrow keys such that the display mode for measurements cannot be changed.

The password can be changed at any time, although the current password must be entered before the change is allowed. The password and lockout state is retained through a power-down sequence and a system reset.

All units shipped from the factory are set with the password of “00000”. It is suggested that this password be changed to another five digit sequence before using the lockout feature.

CAUTION: Retain the password for future access.

CHANGING THE PASSWORD

To change the password, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the “Change Password” menu is displayed.

Change Password

Press the OK/NEXT key to access this menu. The next menu will request the current password.

Old Pass = **<u>0</u>0000**

After setting the current password, press the OK/NEXT key. If the current password is not properly set, then the following message will be displayed before exiting the menus:

Invalid Password

If the password was properly entered, then the meter will request the new password:

New Pass = **<u>0</u>0000**

After setting the new password, press the OK/NEXT key. The meter will ask if changes should be saved.

Save Changes **<u>Y</u>es**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

ENABLING THE LOCKOUT

To enable the lockout, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP key until the “Set/Clr Lockout” menu is displayed.

Set/Clr Lockout

Press the OK/NEXT key to access this menu. The next menu will request the current password.

Password = **<u>0</u>**0000

After setting the password, press the OK/NEXT key. If the correct password has been entered, then the following menu will allow the enabling or disabling of the lockout feature.

Enable Lockout **N**

If "N" is selected then the lockout is disabled and the meter will exit the menus. If "Y" is selected the next menu will allow each menu to be individually locked out.

Lock **Measure** N

The first field lists the functions to be locked. Use the UP and DOWN arrow keys to access the list. The choices are: MEASURE, SETPOINT, RELAYS, OUTPUTS, CALIBRATE, MENUS, DISPLAY. When the desired function is selected, move the cursor to the next field to change the state. A "Y" indicates that this function is locked and an "N" indicates that the function is not locked. use the LEFT arrow key to move the cursor back to the function field to select another key for lockout. When done setting all the functions, press the OK/NEXT key. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

NOTE: If the lockout feature is used, it is recommended that the MENUS key also be locked to prevent any indirect changes to the meter's setup.

ACCESSING A LOCKED MENU

If the lockout feature is enabled and a key is pressed that is also locked, the following message will be displayed:

Password = **00000**

If the proper password is entered, then access to that menu will be allowed. This menu key will operate as normal. When the menu is exited, the lockout will be re-enabled.

CHAPTER 11: OTHER FUNCTIONS

AVERAGING

The 2000 has various levels of measurement averaging or damping, each for specific applications. The options are: low, medium, high and special. Each channel can be assigned an averaging level. The assigned averaging will apply to both the primary and secondary measurements of that channel. The averaging setting is not functional for dissolved oxygen or ozone measurements.

Low averaging is useful in applications that require a fast response to changes in the system. Medium and high averaging help to reduce display fluctuations. The special averaging setting is recommended for most conductivity/resistivity applications. This method provides the most reduction in display fluctuations, while retaining fast response.

Special (Spec) averaging is self-adjusting. If a large change in the measurement is detected, then the meter will respond immediately to the change (does not use any averaging). Small changes to the measurement (i.e., system noise less than 1%) will be highly averaged. If measurement noise can exceed 1%, 0.15 pH or 15 mV, then special averaging should not be used.

To set the averaging, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the “Set Averaging” menu is displayed.

Set Averaging

Press the OK/NEXT key to access this menu.

A: Average = High

The cursor is initially under the channel field. Use the UP and DOWN keys to change the channel if desired. Use the RIGHT arrow key to move the cursor to the level field. The display will appear as:

A: Average = **High**

Use the UP and DOWN arrow keys to change the averaging level. Press the OK/NEXT key when done. The next menu will show the averaging level for channel B. Press the OK/NEXT key after setting channel B. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

SYSTEM RESET

CAUTION: A system reset will set all operational parameters to their default conditions and may require extensive reprogramming.

1. A Primary Measurement Mode:
   Conductivity (fixed at μS/cm)
2. A Secondary Measurement Mode:
   Temperature (DegC)
3. B Primary Measurement Mode:
   Conductivity (fixed at μS/cm)
4. B Secondary Measurement:
   Temperature (DegC)
5. Display Mode:
   Mode #1 (A primary and B primary)
6. Setpoints (all):
   Off, value = 0, no relay assigned, active on over-range
7. Relays (all):
   Delay = 0, hysteresis = 0, state = normal
8. Serial Port:
   Data output off.
9. Analog Outputs:
   no signal assigned, min = 0, max = 0
10. Temperature Source:
    Use this Chan.
11. Compensation Method:
    Standard.

12. Cell Constants:
resistivity multiplier = 0.1, temperature multiplier = 1.0, all adders = 0.

13. Atmospheric Pressure:
760.

14. Auto Display Scroll: Off.

A system reset will not change the password, lockout state, meter calibration, analog output calibration, or line power frequency.

To reset the meter, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until "System Reset" is displayed.

System Reset

Press the OK/NEXT key to access this menu.

Reset Unit? **Yes**

Press the OK/NEXT key to perform the reset. The meter will display a confirmation message for three seconds then exit the menus.

Unit is Reset

SETTING THE TEMPERATURE SOURCE

The temperature used for display and compensation may come directly from the sensor, may come from the other channel sensor or may be set to a fixed manual value. These features are useful when a cell does not have a temperature sensor built-in, is slow responding, or if it is desirable to compensate a measurement based on a fixed temperature.

NOTE: When "Use other chan" is selected, it is also necessary to enter the temperature Multiplier calibration factor for the sensor into both channels, as described in Chapter 9.

To set the temperature source, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the "Temp Source" menu is displayed.

Temp Source

Press the OK/NEXT key to access this menu.

A: Use this chan

The cursor is initially under the channel field. Use the UP or DOWN arrow keys to change the channel if desired. Use the RIGHT arrow key to move the cursor to the source selection field. The display will appear as follows:

A: **Use this chan**

Selections in this menu include "Use this chan", "Use other chan" and "Fixed= XX.XX°C". If the last is chosen, using the down arrow key, the display appears as:

A: **Fixed** =25.00°C

Set the desired temperature value. Press the OK/NEXT key when done. The meter will ask if changes should be changed.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data

SENDING DATA TO A PRINTER OR COMPUTER

With measurements other than conductivity with 0.1/cm cell constants, an external isolator for the digital communications signal is strongly recommended to prevent ground loop problems.

The 2000 can be set to output measurement data automatically to a printer or computer at a fixed time interval. The time interval can be set from 1 second up to 255 seconds. The data is transmitted as a string of ASCII characters, terminated with a carriage return character. All four measurements are contained in the string. To use this feature, the baud rate, parity, and output timer must be set as follows:

Setting the Baud Rate and Parity

Press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the “Set Serial Port” menu is displayed.

Set Serial Port

Press the OK/NEXT key to access this menu. A typical menu may appear as:

Baud=9600 P=Even

The cursor is initially under the baud rate setting. Press the UP or DOWN arrow keys to change the baud rate. Use the RIGHT arrow key to move the cursor to the parity field. The parity setting can be switched between even parity and no parity.

Press the OK/NEXT key when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

Setting the Data Output Timer

Press the OUTPUTS key.

Output: **Analog**

Press the UP-arrow key until “Serial” is displayed. Press the OK/NEXT key to access this menu.

Output **off** >001s

Press the UP arrow key to toggle the serial output from “Off” to “On”. Setting the serial out feature to “On” enables the automatic data output. Use the RIGHT arrow key to move the cursor to the time field.

Output On >**0**01s

Use the arrow keys to set the desired time interval in seconds.

NOTE: Entering a value greater than 255 seconds will automatically set the timer interval to 255 seconds.

Press OK/NEXT when done. The meter will ask if changes should be saved.

Save Changes **Yes**

Press the OK/NEXT key to save the changes and return to the display of measurement data.

For details on communications output, refer to Manual 84364.

CHAPTER 12: TROUBLESHOOTING

OFF-LINE SELF-DIAGNOSTICS

A number of diagnostic and self test functions are available via the menus. The following functions can be tested:

1. ROM: this test is non-functional in software versions up to 3.3 and failure indications should be ignored.
2. RAM: the data memory is tested for reading and writing.
3. AOUT1: analog output channel #1 is tested by setting the output current from 0mA to 20mA in 1mA steps.
4. AOUT2: analog output channel #2 is tested by setting the output current from 0mA to 20mA in 1mAn steps.
5. A/D: the analog to digital converter circuit (used for making measurements) is tested for functionality.
6. COMM: the communication port is tested for its ability to receive and transmit data. A jumper wire is connected from the transmit line to the receive line before conducting the test.
7. NVRAM: the non-volatile memory is tested for functionality. This memory is used to hold setup information in case of a power down condition (or low line voltage).
8. DISPLAY: the display is tested by writing various patterns. This is a visual test conducted by the operator.

To perform any of these tests, press the MENUS key and the following menu will appear:

Menus use arrows

Press the UP arrow key until the “Diagnostic” menu is displayed.

Diagnostic Menu

Press the OK/NEXT key to access this menu.

Test? **ROM**

The cursor is under the first field which indicates the test to be conducted. The choices are: ROM, RAM, AOUT1, AOUT2, A/D, COMM, NVRAM, DISPLAY, KEYPAD or exit. Use the RIGHT arrow key to select the desired test. Press the OK/NEXT key to perform the test. Select “Exit” to exit this menu.

The test results are displayed with the following messages (for example, the ROM test):

ROM: Passed **Ok**

or

ROM: Failed **Ok**

ON-LINE DIAGNOSTICS

Error, Over-range & Sensor Error Indications

A measurement that cannot be properly measured or computed or is over-range is considered to be in an error state. The display will show asterisk characters (“*”) in place of the allocated digits.

An example:

A *****µS *****°C

In this display, measurements could not be measured or computed properly. This condition could be caused by a disconnected or mis-wired sensor, no sample at the sensor, too high or too low sample conductivity or resistivity for the sensor/instrument to measure, sensor failure, etc. If the temperature display gives asterisks indicating a problem with that measurement then any temperature compensated measurement will also display asterisks, even if it is otherwise OK.

"Check Setup" Message

The 2000 constantly checks the condition of the setup data (setpoints, compensation methods, etc.). If the meter detects an unauthorized change in this data (i.e., corrupted data) then a message will be displayed every few seconds as follows:

Check Setup

This message can be cleared by entering and exiting any menu.

TROUBLESHOOTING

Problem	Possible Cause
1. Display is blank	• no power to unit • blown fuse • loose display cable • display contrast potentiometer needs adjustment • display cable improperly connected • circuit board failure
2. Wrong readings	• sensor improperly installed • incorrect measurement prefix entered • incorrect cell constant entered • meter improperly calibrated • temperature compensation is incorrectly set or disabled • sensor patch cord is defective • defective sensor • circuit board failure
3. Keypad not functioning	• keypad cable connector loose or broken • defective keypad
4. Negative readings in %rejection	•% rejection is calculated on the wrong channel
5. Readings fluctuate too much	• wrong line power frequency selected • cells and/or cables installed too close to equipment that generates high levels of electrical noise
6. Data not sent out to serial port	• serial port wiring is wrong • wrong baud rate and/or parity • automatic data output not enabled • data output timer set too high

RECOVERY PROCEDURE

If the meter is unable to make valid measurements, then the following procedure may help to resolve the problem.

1. Check sensor patch cord wiring. Look for loose wires at the terminal block or incorrect wiring.
2. Perform a system reset as outlined in SYSTEM RESET in Chapter 11.
3. Re-enter the cell constants as shown in ENTER/EDITING CELL CONSTANTS in Chapter 9. Set the desired measurement mode and prefix as shown in SELECTING A MEASUREMENT TYPE in Chapter 4.
4. Re-calibrate the meter as outlined in Chapter 8.
5. Check that the proper compensation method is selected.

CHAPTER 13: SERVICE

FUSE REPLACEMENT

The 2000 is protected from accidental voltage overloading, short circuits, and related damage by a 1/4 amp time-delayed fuse (for 90-130 VAC units only). The 180-250 VAC unit uses a 1/8 amp time-delayed fuse. The fuse is located on the printed circuit board (PCB) inside of the case.

WARNING: FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH FUSE OF THE SPECIFIED TYPE AND CURRENT RATING.

To replace the fuse:

1. Disconnect all power to the 2000 unit before proceeding.
2. Remove the two screws from the center of the rear panel.
3. Slowly pull the rear panel assembly out of the unit, no more than 1”.
4. Disconnect the two ribbon cables connecting the case to the PCB.
5. The fuse is located near the transformer. Remove the old fuse and replace it with one with the same rating as indicated above.
6. Position the PCB near the case and connect the two cables to the PCB. Make sure each cable is properly seated and oriented.
7. Gently push the rear panel assembly back into the case. Make sure the four mounted posts align with the holes in the assembly.
8. When the assembly is properly seated, re-install the two mounting screws.
9. Reconnect power to the meter.

FRONT PANEL CLEANING

Clean the front panel with a soft damp cloth (water only, no solvents). Gently wipe the surface and dry with a soft cloth.

REDUCING 2000 PATCH CORD LENGTH

2000 patch cords are available in a variety of standard lengths. Occasionally it is necessary to reduce standard cord lengths to accommodate system design. The following procedure outlines how to terminate the end of the cable to assure accurate system operation. The 2000 patch cords include two (2) drain (bare) wires. It is essential that these wires not make contact with each other. Place insulating tubing over these wires.

CAUTION: If the wires are touching, it will cause the readings to be inaccurate. Be sure that the wires never make contact with each other.

Tools required:

Cable cutters, wire strippers, insulating tubing, soldering iron & solder, wire markers (optional).

Procedure:

1. Measure the cable from the end connector to the desired length and cut.
2. Strip outer jacket and shield 4 inches from the end.
3. Cut at the jacket the orange, yellow and all white wires that are outside the inner shield. DO NOT CUT the drain (bare) or the wires enclosed inside the inner shield.
4. Strip the inner shield all the way to the jacket.
5. Strip all leads 1/4 inch and tin the inner shield.
6. Slide clear insulating tubing over the inner drain (bare) wire. Tuck the insulating tubing under the jacket. THIS WIRE MUST NEVER TOUCH THE OUTER SHIELD OR OUTER DRAIN WIRE.
7. Place wire markers on leads if desired.
8. Wire the cable to the 2000 as indicated. See Figure 14.8 and Table 2.5.

SPARE PARTS LIST

Description	Recommended QTY	Part No.
1. Fuse:		
For 90-130VAC (Type 2AG, 1/4 Amp SB, Littlefuse® #218.250)	1	35087
For 180-250VAC (Type 2AG, 1/8 Amp SB, Littlefuse® #218.125)	1	35088
2. Display Assembly	1	06235
3. Power Selection Jumper—(1) for 230 VAC; (2) for 230 VAC		25242
4. Panel Mounting Kit (gasket, screws, nuts)	-	02181
5. 9-Pin Plug in Terminal Strip	2	22617
6. 12-Pin Plug in Terminal Strip	1	22619
7. 14-Pin Plug in Terminal Strip	1	22613
8. Ferrite Bead noise suppression kit consisting of two modules (one for each sensor cable to meet CE class B requirements)	1	02192
9. Replacement circuit board assembly for 6822-1	-	58091005

ACCESSORIES

Description	Part #	
Complete Conductivity Calibrator Kit (includes 1864-05, -06, -07, -08, -09, -12)	1865-07	
High Resistivity/Low Conductivity Calibrator Kit (includes 1864-05, -06, -12)	1865-05	
Low Resistivity/High Conductivity Calibrator Kit (includes 1864-07, -08, -09)	1865-06	
Calibrator 500k ohms & 1400 ohms (104°C)	1864-05	
Calibrator 50K ohms & 1000 ohms (0°C)	1864-06	
Calibrator 5K ohms & 1400 ohms (104°C)	1864-07	
Calibrator 500 ohms & 1000 ohms (0°C)	1864-08	
Calibrator, 0 ohms (short) & 1097 ohms (25°C)	1864-09	
Calibrator, infinite ohms (open) & 1097 ohms (25°C)	1864-12	
Back Cover for wall mounting and IP65 Rating	1000-62	
Pipe Mounting Kit for 1-1/2 to 4” pipe (requires back cover, above)	1000-63	
Manual, Communications (RS232, RS422)	84423	
	Standard*	VP**
Patch Cord, 1 ft (0.3 m)	1001-67	-
Patch Cord, 5 ft (1.5 m)	1005-67	58 080 201
Patch Cord, 10 ft (3 m)	1010-67	58 080 202
Patch Cord, 15 ft (4.5 m)	1015-67	58 080 203
Patch Cord, 25 ft (7.6 m)	1025-67	58 080 204
Patch Cord, 50 ft (15.2 m)	1050-67	58 080 205
Patch Cord, 75 ft (23 m)	-	58 080 206
Patch Cord, 100 ft (30.5 m)	1110-67	58 080 207
Patch Cord, 150 ft (45.7 m)	1115-67	58 080 208
Patch Cord, 200 ft (61 m)	1120-67	58 080 209
pH VP Preamp, 1 m	1200-01	
pH VP Preamp, 3 m	1200-02	
pH VP Preamp, 5 m	1200-03	
pH VP Preamp, 10 m	1200-04	
ORP AS9 Preamp, 1 m	1200-05	
ORP AS9 Preamp, 3 m	1200-06	
ORP AS9 Preamp, 5 m	1200-07	
ORP AS9 Preamp, 10 m	1200-08	

* Standard patch cords for pH, ORP, dissolved oxygen, dissolved ozone and most 2-E conductivity sensors

** VP patch cords for VP conductivity sensors only

CHAPTER 14: TECHNICAL ILLUSTRATIONS

MENU TREES

OVERALL DIMENSIONS

PANEL CUTOUT

EXPLODED ASSEMBLY

PIPE MOUNTING

SEALED IP65 REAR COVER ASSEMBLY

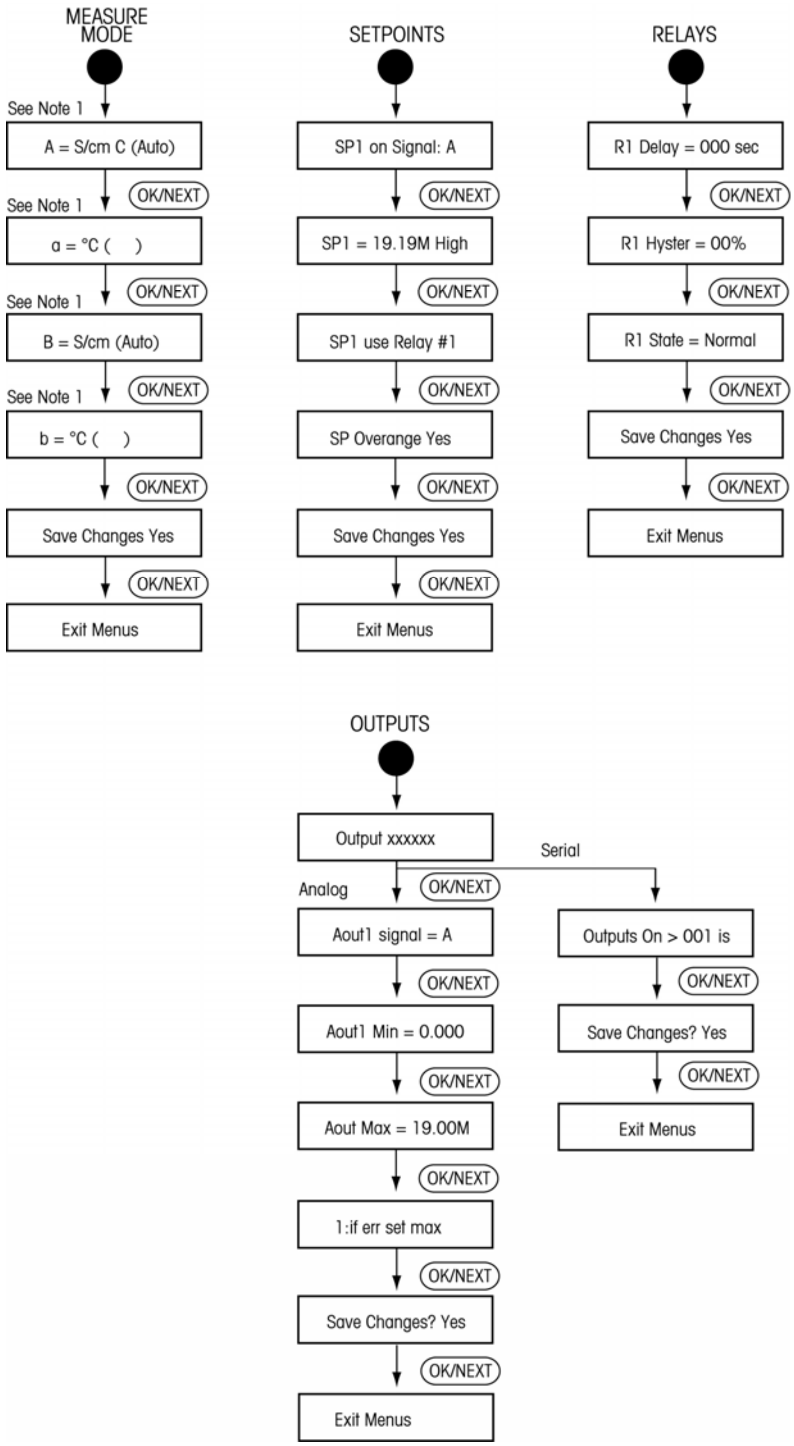
PRINTED CIRCUIT BOARD LAYOUT

REAR PANEL WIRING & PATCH CORDS

CONDUCTIVITY CALIBRATORS

METER CALIBRATION USING DECADE BOX AND VOLTAGE SOURCE

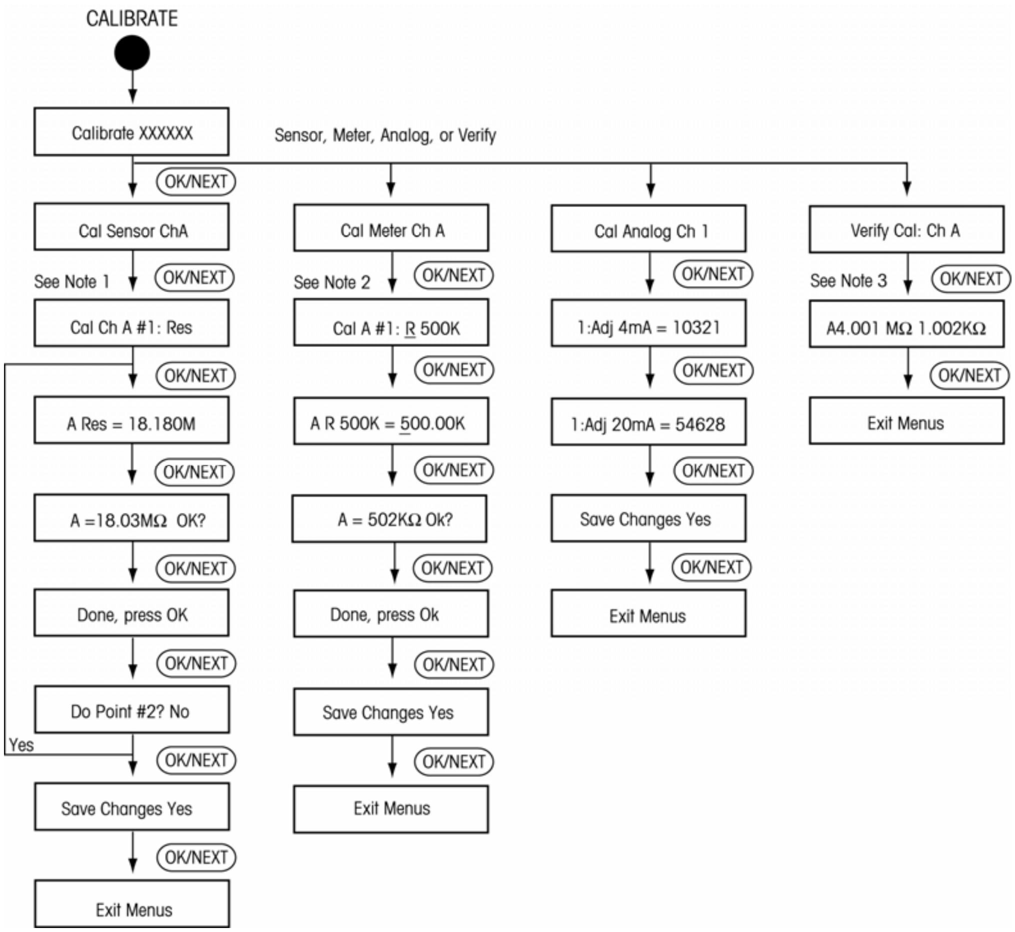
MENU TREES



Notes

1. Choices for this menu are: Ohm-cm, S/cm, DegC, DegF, TDS, % Rejection, S/m, A/B, A-B, pH, Volts, %HCl, %NaOH, %H2SO4, s/cmU, g/L O2, O2ppm, O2ppb, %sat, O3ppm, O3ppb, nAmps, PHCALC, CO2 ppb Cl ppb SO4 ppb, None.

Figure 14.1a: Menu Trees

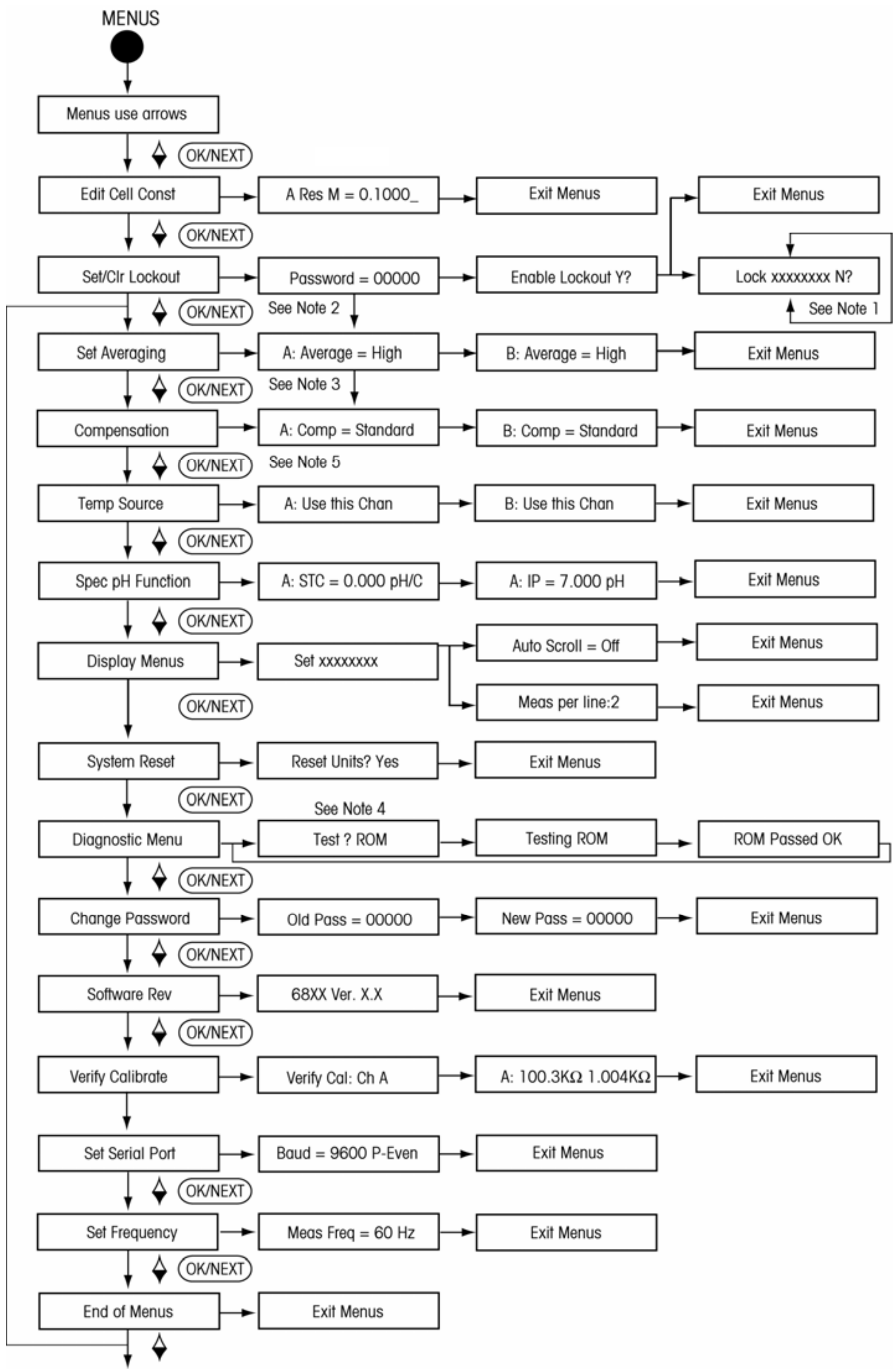


Notes

1. Choices for this menu are Res, Con, °C, °F, pH, Vlt, O2 A, O2 Z, O3 C, O3 Z.
2. Choices for this menu are R 500K, R 50K, R 5K, R 500, Temp, Volts, short, open.
3. Will display volts for pH, ORP, dissolved oxygen or dissolved ozone measurements.

Figure 14.1b: Calibrate Menu Tree

MENU TREES (CONTINUED)



Notes

1. Choices for this menu are: Measure, Display, Menus, Calibrate, Relays, Outputs, Setpoint.
2. Choices for this menu are: High, Medium, Low, Spec.
3. Choices for this menu are: Standard, Linear, Cation, Alcohol, Light 84, Gly 100%, Gly 50%, Ammonia, None.
4. Choices for this menu are: ROM, RAM, Aout#1, Aout#2, A/D, Comm, NVRAM, Display, Keypad.
5. Choices for this menu are: Use this chan, Use other chan, Fixed = XX.XX°C.

Figure 14.1c: Menus Menu Tree

OVERALL DIMENSIONS

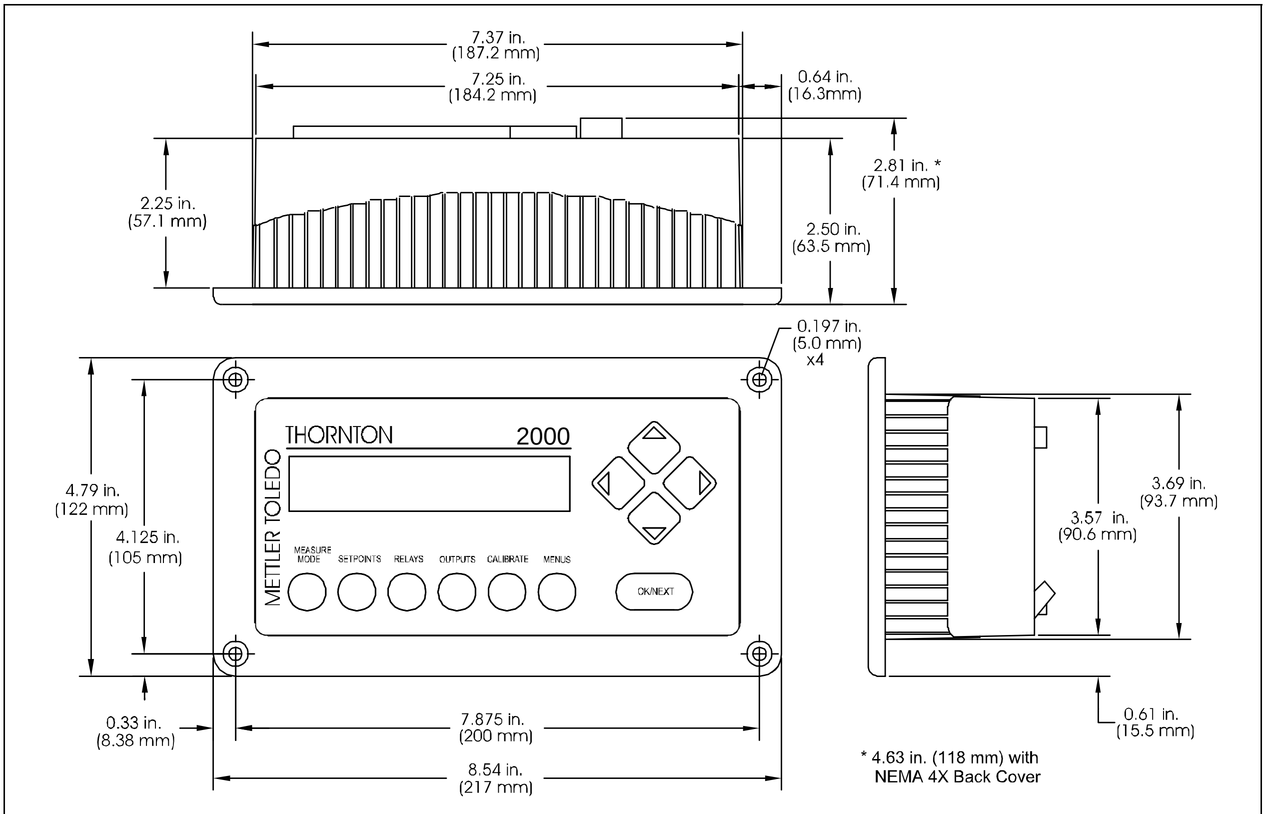


Figure 14.2a: Panel Mounting Dimensions

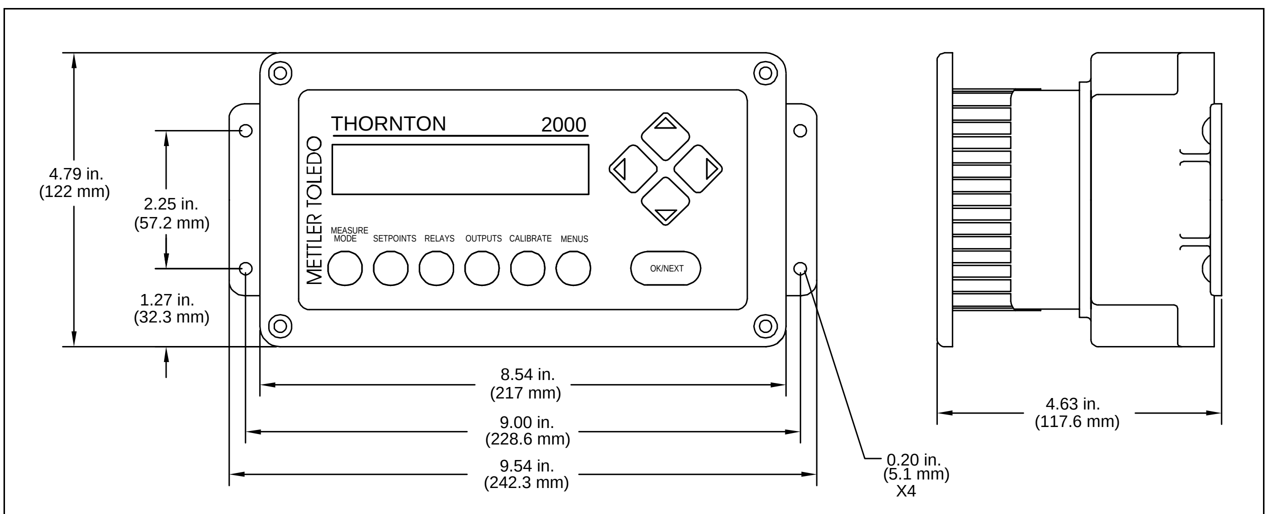


Figure 14.2b: Wall Mounting Dimensions (with accessory back cover installed)

PANEL CUTOUT

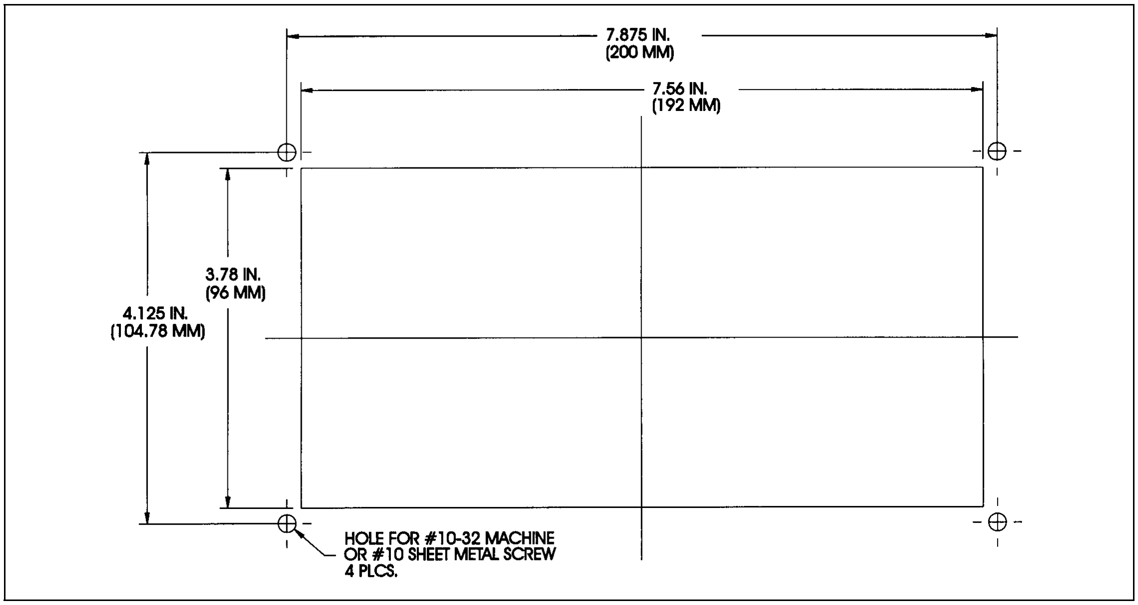


Figure 14.3: Panel Cutout

EXPLODED ASSEMBLY

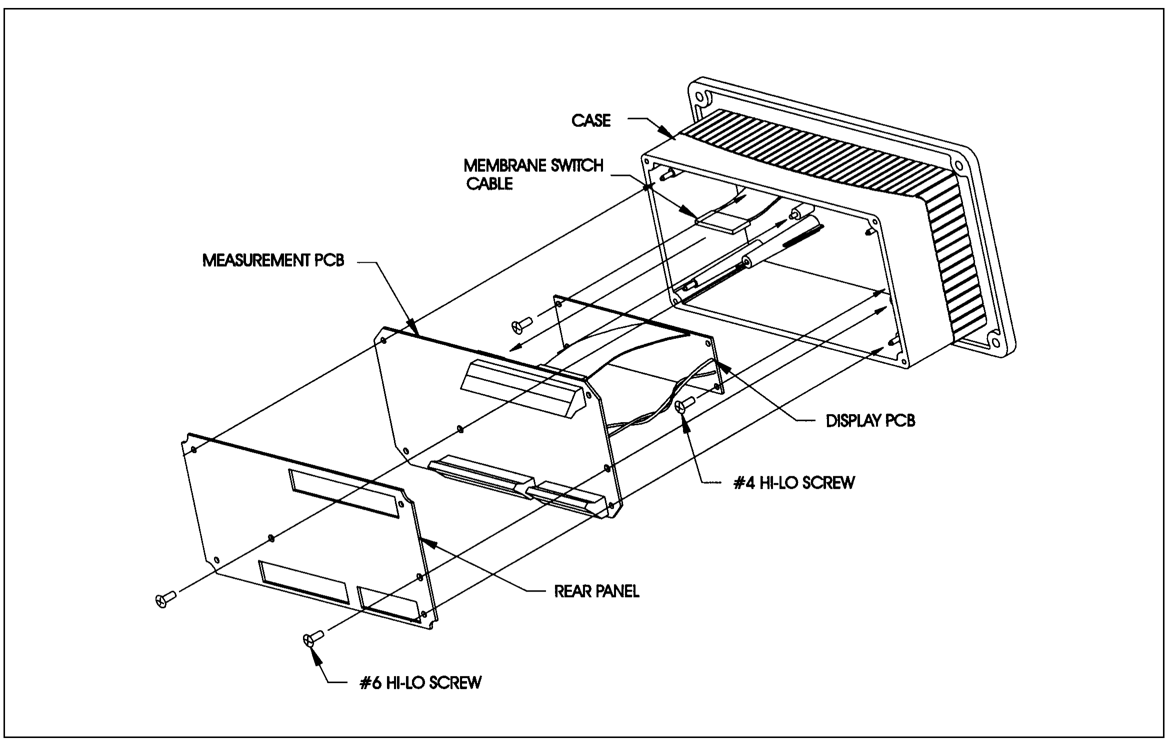


Figure 14.4: Exploded Assembly

PIPE MOUNTING

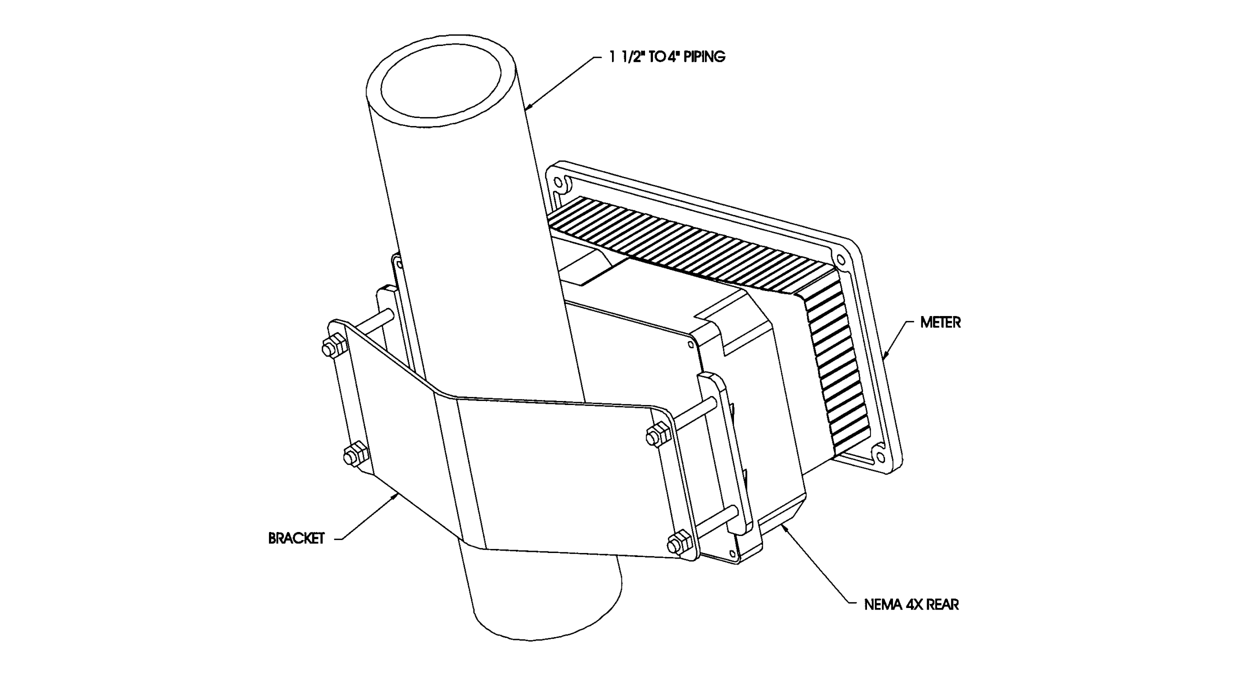


Figure 14.5: Pipe Mounting

SEALED BACK COVER ASSEMBLY

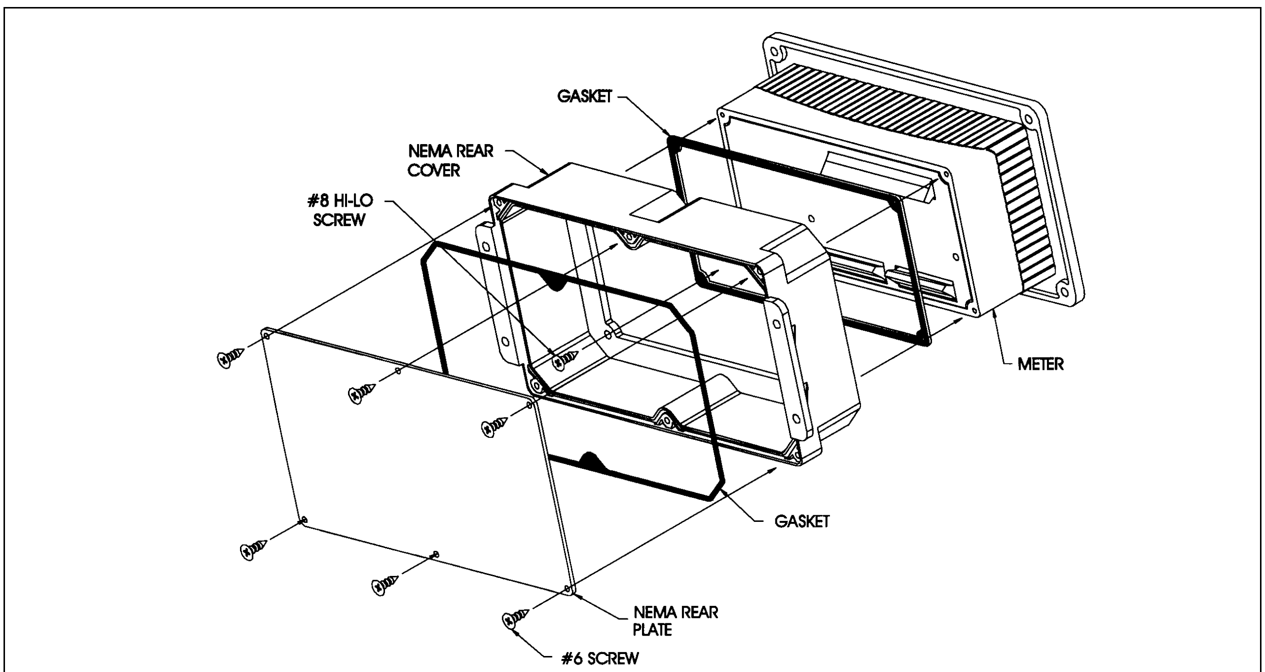


Figure 14.6: Sealed Back Cover Assembly

PRINTED CIRCUIT BOARD LAYOUT

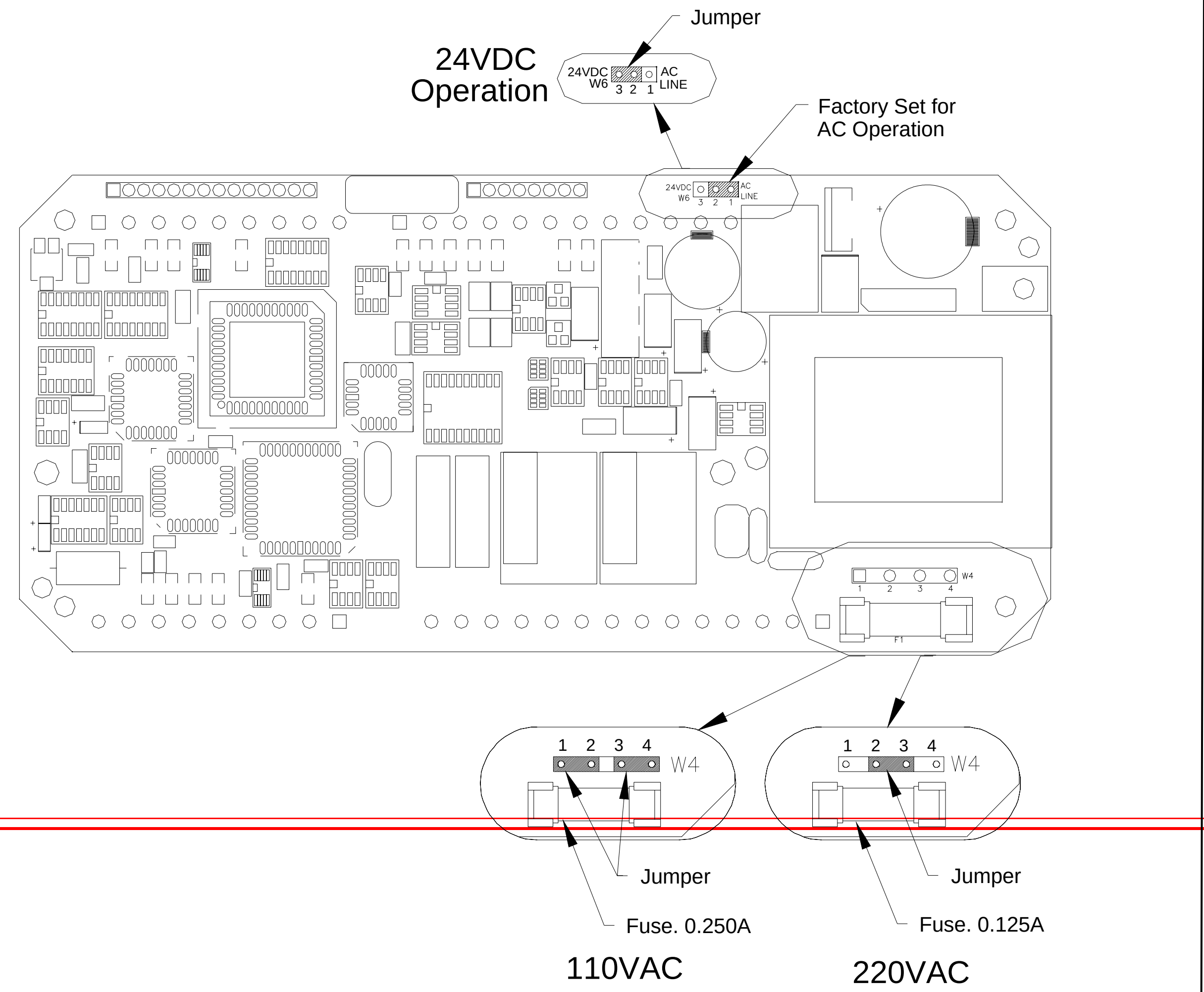


Figure 14.7: Printed Circuit Board Layout

REAR PANEL WIRING & PATCH CORDS

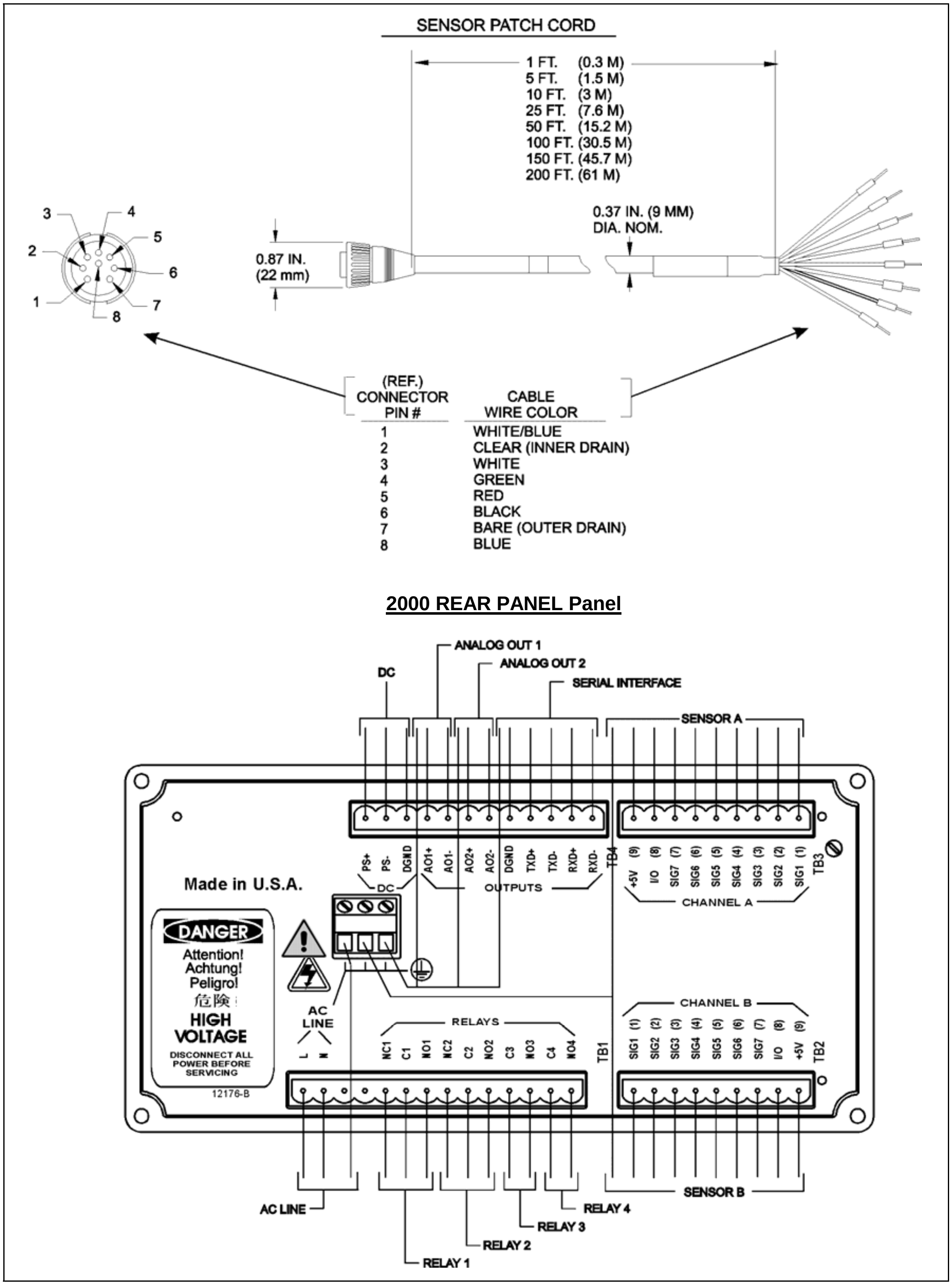


Figure 14.8: 2000 Rear Panel Wiring & Patch Cords—see Sensor Wiring Table 2.5, Chapter 2

CONDUCTIVITY CALIBRATORS

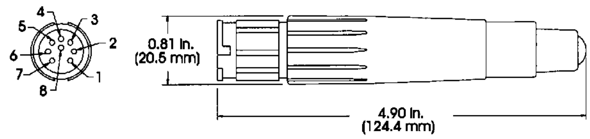


Figure 14.9: Calibrators for conductivity/resistivity only

Be sure the patch cord is wired for conductivity/resistivity measurement before connecting a calibrator.

METER CALIBRATION CONNECTIONS USING DECADE BOX AND VOLTAGE SOURCE

Terminal	Conductivity	pH/ORP, Dissolved Oxygen & Ozone
1	Resistance	-
2	-	-
3	Jumper to 1	pH/ORP/DO voltage
4	Temperature resistance	Temperature resistance
5	Temperature common	Temperature common
6	Resistance common & jumper to 5	-
7	Jumper to 6	Jumper to 5
PS-	-	Voltage common & jumper to 7

Figure 14.10: Meter Conductivity, DO, ozone and pH/ORP Calibration Using Decade Box or Voltage

(A channel measuring DO or ozone must be calibrated in the voltage mode)

2000 SPECIFICATIONS

Functional

Cond./Resist. Ranges:	0.01 Constant Sensor: 0.002 to 200 µS/cm; 5000 Ω-cm to 500 MΩ-cm 0.1 Constant Sensor: 0.02 to 2000 µS/cm; 500 Ω-cm to 50 MΩ-cm 50 Constant Sensor: 100 µS/cm to 1.0 S/cm; 1.0 Ω-cm to 0.01 MΩ-cm 4-electrode Sensor: 10 to 650,000 µS/cm; 1.5 Ω-cm to 0.1 MΩ-cm (244-63X) TDS: 0-100,000 ppm with appropriate sensors Concentrations: HCl: 0-20%, NaOH: 0-15%, H_2SO_4: 0-20%,
pH & ORP (redox) Ranges:	-1 to 15 pH, -1250 to +1250 mV
Dissolved Oxygen Ranges:	0-10,000 µg/L or ppb
Dissolved Ozone Ranges:	0-5,000 ppb, 0-5.00 ppm or equivalent g/L ranges
Temperature Range:	-40° to 200°C, -40 to 392°F
Derived Measurements:	% rejection, difference, ratio; power plant calculations of pH, CO_2, chlorides and sulfates from specific, cation and degassed cation conductivity.
Resolution:	0.001 µS/cm, 0.01 MΩ-cm, 0.01°, 0.01 pH, 1 mV, 0.1 ppb, 0.1 µg/L DO; 1 ppb, 0.01 ppm ozone
Inputs:	From Thornton conductivity/resistivity, pH, ORP, dissolved oxygen, dissolved ozone sensors with patch cord.
Sensor compatibility:	Ozone and 4-electrode conductivity sensors connected to the same 2000 must be in separate processes that are isolated from each other. Only a single dissolved oxygen <u>or</u> ozone sensor may be used.
Cond./Resist. Temp. Comp:	Automatic, referenced to 25°C for Resistivity, Conductivity, Percent Rejection and TDS. Field selectable for standard high purity (Thornton/Light), cation, ammonia/ETA (power industry), 100% glycol, 50% glycol, isopropyl alcohol, or Light 84 (special microelectronics applications). Non-temperature compensated measurement standard to meet USP <645> requirements. Concentration measurements also include specialized compensation for the specific material.
pH Temp. Comp.	pH temperature compensation for Nernst electrode output effects plus adjustable solution temperature compensation for high purity water ionization effects, referenced to 25°C.
DO & Ozone Temp Comp:	Compensation for membrane permeability and gas solubility.

Outputs

Setpoints/Alarms:	Four, may be set as high, low, USP or EP limits. Any relay can be programmed to operate from multiple setpoints
Relays:	2 SPDT relays, rated 5 amp max. resistive load up to 30 VDC or 250 VAC, standard; optional additional: 2 AC-only Solid State, rated 1.5 amp max, 250 VAC resistive load, 10 mA minimum current
Analog Output Signals:	Two optional powered 4-20 mA outputs (may be recalibrated to 0-20 mA), 500 ohm load maximum, freely scalable to any parameter, isolated from input and from ground; accuracy ±0.05 mA
Serial Output:	RS232 maximum distance 50 feet. RS422 maximum distance 4,000 feet. Field selectable up to 19.2 k baud. Requires external isolation if using sensors other than 0.1/cm conductivity.

Performance

Cond./Resist. Accuracy:	±0.5% of reading or ± 0.5 Ω, whichever is greater; ±0.25°C
pH/ORP Accuracy:	±0.03 pH, ±2 mV, ±0.3°C
Dissolved Oxygen Accuracy:	System, ± 2% of reading or 1 ppb, whichever is greater, 367-110 sensor; ±1% of reading or 1 ppb, whichever is greater, 367-210 sensor
Dissolved Ozone Accuracy:	System, ± 2% of reading or 3 ppb, whichever is greater
Repeatability:	±0.5% of reading for cond./resist, ±0.075°C, ±0.02 pH, ±1 mV
Update Rate:	2 seconds, typical
Ratings/Approvals:	Meets CE requirements; UL & cUL listed

Environmental

General:	If the equipment is used in a manner not specified by Thornton Inc., the protection provided by the equipment may be impaired. For indoor use, Pollution Degree 1
Storage Temperature:	-40° to 70°C (-40° to °158F)
Operating Temperature:	-10° to 55°C (14 to 131°F)
Humidity:	0 to 95% RH (non-condensing)
UL Electrical Environment:	Installation (overvoltage) Category II

Enclosure

Display/keypad:	16 character, backlit LCD (4.8 mm x 9.6 mm);11 tactile feedback keys
Material:	ABS-PC alloy
Rating:	NEMA 4X, IP65 front panel mount and accessory back cover.
Panel Cutout:	3.78" x 7.56" (96 x 192 mm) DIN
Weight:	1.9 lbs. (0.9kg)
Sensor Patch Cord Length:	200 ft (61 m) maximum, 2-electrode conductivity, pH, ORP, DO and ozone sensors; 50 ft (15 m) maximum, 4-electrode conductivity sensors

Power: 90-130 VAC or 180-250 VAC 12 Watts maximum, 50-60Hz or 12-30 VDC, 300 mA steady state, 600 mA inrush at 24 VDC. DC power supply must be fused and isolated from earth ground and between instruments—use a DC/DC power isolator if necessary. On power loss all stored values are retained in non-volatile memory without batteries.

2000 Models

Part Number	Relays	Analog Outputs	Line Power
6820-1	2 SPDT	None	90-130 VAC (24 VDC)
6820-2	2 SPDT	None	180-250 VAC (24 VDC)
6822-1	2 SPDT	2	90-130 VAC (24 VDC)
6822-2	2 SPDT	2	180-250 VAC (24 VDC)
6842-1	2 SPDT and 2 Solid State, AC only	2	90-130 VAC (24 VDC)
6842-2	2 SPDT and 2 Solid State , AC only	2	180-250 VAC (24 VDC)

2000 instruments operate as 4-wire transmitters with either AC or DC power.

RATINGS

CE

Declaration of Conformity

We,

Mettler-Toledo Thornton Inc.
36 Middlesex Turnpike
Bedford, MA 01730 USA

Declare Under our sole responsibility that the product:

2000 Two-Channel Instrument for pH, ORP Conductivity/Resistivity and Dissolved Oxygen, Models 6820-1, 6820-2, 6822-1, 6822-2, 6842-1, 6842-2 to which this declaration relates, in conformity with the following European, harmonized and published standards at the date of this declaration:

EMC Emissions:		
	EN 55011	Class A (with accessory ferrite suppressor modules installed)
EMC Emissions & Immunity:		
	EN 61326	Measurement Control and Laboratory Equipment EMC requirements.
Safety:		
	IEC 61010-1	“Safety requirements for electrical equipment for measurement, control and laboratory use” incorporating Amendments Nos. 1 & 2.

Testing for compliance was done to the following specifications:

Following the provisions of the directives 89/336/EEC Electromagnetic Compatibility

Amendment to the above directive: 93/68/EEC

Low Voltage. Directive 73/23/EEC

Amendment to the above directive: 93/68/EEC

Anthony Bevilacqua, Compliance Signatory for Mettler-Toledo Thornton, Inc.

UL Listing

Mettler-Toledo Thornton Inc., 36 Middlesex Turnpike, Bedford, MA 01730 USA has obtained Underwriters Laboratories’ Listing for 2000 pH, ORP Conductivity/Resistivity and Dissolved Oxygen Instruments. They bear the UL and cUL Listed mark signifying that the products have been evaluated to the applicable UL and CSA standards for electrical process control equipment, UL3121-1.

WARRANTY

Mettler-Toledo Thornton, Inc. warrants products it manufactures against defects in materials and workmanship for 18 months from the date of shipment from Thornton. Some non-Thornton manufactured resale items may have shorter warranties. Thornton honors only the warranty period of the original manufacturer. Consumable items such as pH and ORP sensors and TOC UV lamps are warranted for a period of 6 months from shipment in normal use and service.

Catalog descriptions, although accurate, should not be taken as a guarantee or warranty. Thornton's obligation under the warranty shall be to repair at its facility or replace any products which Thornton finds to be defective. Items returned for warranty must be properly packaged, shipped prepaid and insured, and must be accompanied by a Return Materials number assigned by Thornton Customer Service. Proper return packaging for pH, ORP and dissolved oxygen sensors includes their original storage boot, chamber or alternative packaging containing a small amount of water to keep the sensor tip from drying out.

Note: Substitution, modification or mis-wiring of cables voids all warranties.

THE ABOVE WARRANTY IS THE ONLY WARRANTY MADE BY METTLER TOLEDO THORNTON, INC. AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THORNTON SHALL NOT BE LIABLE FOR ANY LOSS, CLAIM, EXPENSE OR DAMAGE CAUSED BY, CONTRIBUTED TO OR ARISING OUT OF THE ACTS OR OMISSIONS OF THE BUYER OR THIRD PARTIES, WHETHER NEGLIGENT OR OTHERWISE. IN NO EVENT SHALL THORNTON'S LIABILITY FOR ANY CAUSE OF ACTION WHATSOEVER EXCEED THE COST OF THE ITEM GIVING RISE TO THE CLAIM, WHETHER BASED IN CONTRACT, WARRANTY, IDEMNITY, OR TORT (INCLUDING NEGLIGENCE).

Returned Goods:

Contact Mettler-Toledo Thornton, Inc. Customer Service for a Return Materials Authorization (RMA) number before any item is returned. Items returned for credit or exchange must be in new, salable condition and in original packaging. For items being returned up to 90 days there is a 15% restocking charge; from 91 days to one year, 25% restocking charge. No returns on custom and/or special orders.

Mettler-Toledo Thornton, Inc.
36 Middlesex Turnpike
Bedford, MA 01730 -USA
781-301-8600
www.thorntoninc.com

Toll-Free: 800-510-PURE
Fax: 781-271-0214
info@thorntoninc.com
Part # 84401
Rev. G 02/06