YSI MODEL 3560
WATER QUALITY MONITORING SYSTEM
INSTRUCTIONS

YSI Incorporated
Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387 USA • Phone 513 767-7241 • 800 343-HELP • Fax 513 767-9353 • Telex 205437

Price $10.00

TABLE OF CONTENTS

GENERAL DESCRIPTION

The YSI 3560 Water Quality Monitoring System

The rugged YSI 3560 Water Quality Monitoring System is primarily designed to be used in the field with a well or surface water pump, but use with a bailer, in the laboratory, or the like, is also possible. The 3560 system consists of a YSI 3500 Water Quality Monitor, a YSI 3510 Temperature Probe, a YSI 3520 Flow-Through Conductivity Cell, a YSI 3530 pH Electrode, a YSI 3550 Sample Chamber Assembly, a YSI 3565 Sample Cup Pack and assorted fittings. Other components, described below, are available as optional accessories.

As water is pumped through the system, temperature, conductivity, temperature compensated conductivity, pH, temperature compensated pH, and millivolts can all be measured. It is possible to make stable readings of the fluids running through the sample chamber in as little as two minutes. The constant monitoring of these values will help determine when a representative sample of the aquifer has been obtained. The system is designed for simple assembly and disassembly to facilitate frequent sensor calibration and easy cleaning.

The YSI Model 3500 Water Quality Monitor

The YSI 3500 Water Quality Monitor is an integral part of the 3560 system. This instrument allows the user to visually monitor three parameters simultaneously by means of three 1/2" LCD displays. The recorder output allows simultaneous recording of four parameters. The monitor is housed in a yellow molded ABS plastic case which has been tested to military specifications for shock and vibration. The 3500 uses 6 alkaline D cells which will power it for a minimum of 1400 hours. When **BAT** is shown on any of the displays, it is time for battery replacement.

An on/off switch controls power to the instrument. A second function switch controls each of the three ranges of conductivity and automatically temperature compensated conductivity as indicated on the middle display. The displayed values are read out in millimho/cm (m℧/cm). When a temperature probe is attached, temperature is read out constantly in °C on the top display and temperature compensated conductivity can be measured, automatically corrected to 25°C. This correction uses a temperature coefficient recommended in "Official Methods of Analysis of the Association of Official Analytical Chemists", Ed. Sidney Williams, 14th edition, 1984, Arlington, Va. This temperature coefficient of 2%/°C is calculated by the formula:

$$\text{Compensated Conductivity} = \frac{\text{Uncompensated Conductivity}}{[(P/4\%)(0.04T-1)]+1}$$

T = temperature in °C
P = temperature coefficient in %

A third function switch controls the bottom display which shows manually temperature compensated pH, or automatically temperature compensated pH, in either pH units or in millivolts (mV). Both of the temperature compensated pH functions use a temperature coefficient of .335%/°C. The mV function is designed to work with optional electrodes such as the YSI 3540 ORP Electrode. It may be used with most ion specific electrodes that meet the 3500 input specifications.

The YSI Model 3510 Temperature Probe

The YSI 3510 Temperature Probe can be used as either a Temperature/ATC Conductivity Probe or as a pH ATC Probe when attached appropriately to the YSI 3500 Water Quality Monitor. It is usable over a temperature range of -5 to 50°C with an accuracy of ±.2°C. The polyurethane cable is three feet long and is terminated at one end with a watertight MS connector. A YSI Thermilinear® thermistor is mounted in a stainless steel sheath.

The YSI Model 3520 Flow-Through Conductivity Cell

The YSI 3520 Flow-Through Conductivity Cell is an integral conductivity cell of rigid and durable chlorinated polyvinyl chloride (CPVC). A three foot polyurethane jacketed cable is attached to the cell body with a bend relief. A watertight MS type connector terminates the cable.

Two electrodes measure conductivity. The cell response time is 10 seconds for 95% reading of conductivity changes. Accurate measurements can be made with a flow rate up to 1.5 gallons per minute. The conductivity cell constant is K = 5.0/cm.

The YSI Model 3530 pH Electrode Assembly

The YSI 3530 pH Electrode Assembly has been designed for YSI for use with the YSI 3560 Water Quality Monitoring System, but it may be used equally well with other pH measuring systems that have similar specification requirements. The 3530 has a rugged 5.5 inch long polymer body designed to withstand demanding field and laboratory use. The silver/silver chloride reference electrode and silver working electrode are sealed in a 4 molar potassium chloride gel to eliminate the need to add filling solution; a porous Teflon® junction is used to maximize electrode life. The 3530 comes with a 36 inch long cable, a black BNC cover and a black end cap for easy visual distinction. The unit is shipped in a soaker bottle containing pH 4.0 buffer. It is important that the electrode be immersed in the buffer solution to prevent the electrode from drying out in storage or transport.

The YSI Model 3540 ORP Electrode Assembly

The YSI 3540 ORP Electrode Assembly has been designed for YSI for use with the YSI 3560 Water Quality Monitoring System, but it may be used equally as well with other ORP measuring systems that have similar specification requirements. The 3540 has a rugged 5.5 inch long polymer body designed to withstand demanding field and laboratory use. The silver/silver chloride reference electrode and platinum working electrode are sealed in a 4 molar potassium chloride gel to eliminate the need to add filling solution; a porous Teflon Circle R junction is used to maximize electrode life. The 3540 comes with a 36 inch long black cable, a yellow BNC cover and a yellow end cap for easy visual distinction.

The electrode assembly is shipped in a soaker bottle containing pH 4.0 buffer. It is important that the electrode be immersed in the buffer solution to prevent the electrode from drying out in storage or transport.

The YSI Model 3682 Zobell Solution

This is a reference solution used to verify the performance characteristics of redox potential cells such as the YSI 3540 ORP Electrode Assembly.

The YSI Model 3550 Sample Chamber Assembly

The YSI 3550 Sample Chamber Assembly is an integral part of the YSI 3560 Water Quality Monitoring System. It is designed to be attached to a pump outlet but can be used equally well as a non-flowing sample chamber. It is designed to hold up to five sensors and to provide inlet and outlet ports for fluid movement through the chamber. It provides good mixing of fluids so residual sample will not be a problem. The clear acrylic sides of the chamber permits observation of fluid flow.

Two gaskets keep fluids from leaking around the sensor mounting plate and base assemblies, while two o-rings in each of the sensor ports provide excellent seals. The sensor mounting plate is permanently marked to indicate the location of each sensor. This sample chamber holds approximately one liter. See Figure 1.

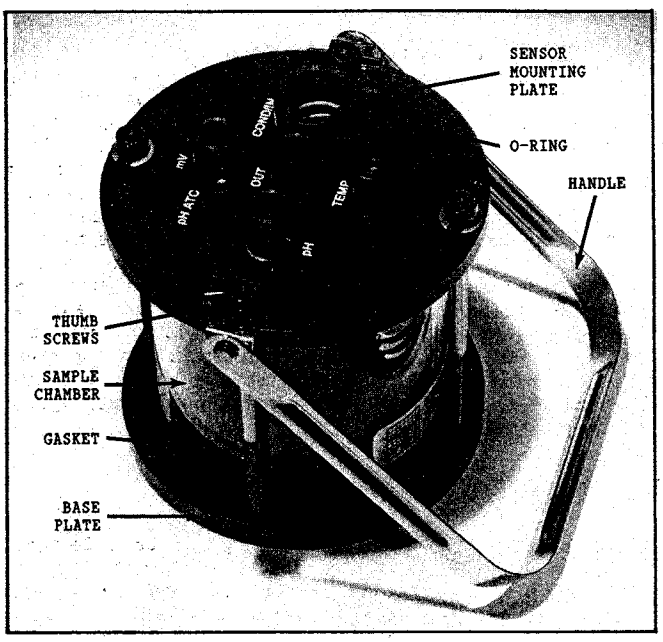


Figure 1. The YSI Model 3550 Sample Chamber Assembly

The YSI Model 3555 Sample Chamber Maintenance Kit

The YSI Model 3555 Sample Chamber Maintenance Kit is designed to provide all the o-rings, gaskets and tools necessary to perform the prescribed annual maintenance on the 3550 Sample Chamber Assembly.

The YSI Model 3565 Sample Cup Pack

The YSI Model 3565 Sample Cup Pack consists of five boxes of 100 each 50 ml polypropylene sample cups. Each box comes with velcro strips for easy installation to most surfaces. The 50 ml size is ideal for use with the 3560 system to minimize the consumption of buffers and standards used in routine calibration procedures.

The YSI Model 3570 Recorder Interface Cable

The YSI 3570 Recorder Interface Cable Assembly has four leads and a common conductor, terminated with a PVC molded connector. The 1/4 inch diameter, 10 foot long polyurethane jacketed cable provides the interface between the YSI Model 3500 Water Quality Monitor and whatever data logging or data recording device is in use. The watertight MS connector is pinned out as follows:

Pin A - Green Conductor - mV
Pin B - White Conductor - pH
Pin C - Gray Conductor - Common
Pin D - Red Conductor - mΩ/cm
Pin E - Black Conductor - °C

The YSI Model 3580 Carrying Case

The YSI Model 3580 Carrying Case is constructed of yellow polyethylene outer shells and has a yellow ABS insert which holds the 3560 system in place for carrying and provides a convenient working platform for the system in use. All metal parts are either plated or anodized to resist corrosion in the harshest environments. Two stays and a continuous hinge give the case rugged strength and durability. Two locks assure that it will stay closed in transit; tie-down straps keep the components secure from movement or damage. Up to four bottles of calibrator solutions can be put into the cavity in the lid for easy access and safe storage away from the instrument. A recess in the lid of the case is provided for convenient mounting of a 3565 Sample Cup Pack box.

SYSTEM SPECIFICATIONS

The time needed for the system to come to equilibrium with the sample under test will very with sample flow characteristics. It could be two minutes or longer.

Temperature Measurement (using YSI 3500 and 3510)
Measurement range: -5.0 to 50.0°C.
Accuracy of temperature measurements: ±0.4°C
Resolution: 0.1°C
Response Time: 95% of reading in 10 seconds

Conductivity Measurement (using YSI 3500, 3510 and 3520)
Ranges: 0.0 to 2.000 mŪ/cm conductivity
0.0 to 20.00 mŪ/cm conductivity
0.0 to 100.0 mŪ/cm conductivity
0.0 to 2.000 mŪ/cm conductivity ATC to 25°C
0.0 to 20.00 mŪ/cm conductivity ATC to 25°C
0.0 to 100.0 mŪ/cm conductivity ATC to 25°C

Accuracy of conductivity and ATC conductivity measurements:
at 25°C: ±3% of full scale from 0 to 20.00 mŪ/cm, and ±6% of full scale from 20.00 to 50.0 mŪ/cm, with cell electrodes not platinized

When the cell is platinized using YSI 3140 Platinizing Solution and YSI 3045 Platinizing Instrument an accuracy of ±6% of full scale from 50.0 to 100.0 mŪ/cm, can be achieved.

Temperature compensated conductivity is automatically corrected to 25°C with a temperature coefficient of 2%/°C

Resolution: 0.001 mŪ/cm for 0.0 to 2.000 mŪ/cm range
0.01 mŪ/cm for 0.0 to 20.00 mŪ/cm range
0.1 mŪ/cm for 0.0 to 100.0 mŪ/cm range

Response Time: 95% of reading in 10 seconds

pH Measurement (using YSI 3500, 3510 and 3530):
Range: 0 - 14.00 pH units
Accuracy: Subject to calibration using available pH buffer solutions in measurement range
Resolution: 0.01 pH
Response Time: 95% of reading in 10 seconds
Temperature Compensation: Automatic: -5 to 50°C
Manual: ±1°C from 0 to 50°C
Sample Temperature: -5 to 50°C

mV Measurement (using YSI 3500)
Range: -1500 mV to +1500 mV
Accuracy: ±1% of reading, plus 1 count
Resolution: 1 mV

Instrument (YSI 3500)
Monitor Size: 8.3 x 11.8 x 4.1 inches
(21.1 x 30.0 x 10.4 centimeters)
Weight: 5.5 pounds (2.5 kilograms)
Ambient Operating Temperature Range: -20 to 50°C
Humidity: operates in 10 to 90% RH, non-condensing at 25°C
Shock and Vibration: conforms to MIL-T-28800-C, Class 3, Style A
EMI: conforms to FCC (47CFT, Part 15, Subpart J), Class A & B
Recorder Output: 4 channels simultaneous (°C, mŪ/cm, pH, mV)
Sensitivity: 1 mV = 1 count on display
Accuracy: ±10 counts of display
50 K ohm minimum load impedance
Conductivity ATC output = uncompensated conductivity output
Calibrated with 50 K ohm load resistor

Power Supply: Batteries: 6 alkaline D cells
Life: At 1 micromho/cm, 25°C, 8 hr. per day, 700 hours minimum, 1,000 hours typical

Carrying Case (YSI 3580) (not included with system)
Size: 8.5 x 24.0 x 14.9 inches
(21.6 x 61.7 x 37.8 centimeters)
Weight: 11.0 pounds (5.0 kilograms)

ACCESSORIES

3500	Water Quality Monitor
3510	Temperature Probe (also used for Conductivity ATC, and pH ATC)
3520	Flow-Through Conductivity Cell
3530	pH Electrode Assembly
3540	ORP Electrode Assembly (Redox Potential)
3550	Sample Chamber Assembly
3555	Sample Chamber Maintenance Kit
3565	Sample Cup Pack (500 each)
3570	Recorder Interface Cable Assembly
3580	Carrying Case
3682	Zobell Solution (ORP Calibrator Solution)
3167	Conductivity Solution, nom. 1.0 mŪ/cm, field use
3168	Conductivity Solution, nom. 10.0 mŪ/cm, field use
3169	Conductivity Solution, nom. 50.0 mŪ/cm, field use
3045	Platinizing Instrument
3140	Platinizing Solution

Accessories may be purchased through your YSI dealer.

OPERATION

Pump Hook-Up

The YSI 3560 Water Quality Monitoring System is shipped unassembled and must be assembled before use. The system may be connected to the pump outlet at any time during the purging-pumping process as long as the flow rate does not exceed 1.5 gallons per minute. The system is normally connected prior to starting the pump so that constant parameter monitoring may be achieved and the point for logging the representative sample values can be determined. Because of sample chamber construction, **it is very important that a 1.5 gallons per minute sample flow not be exceeded; otherwise, leakage may occur.**

The outlet from the pump must first be prepared for the sample chamber input. Inlet and outlet lines for the 3550 are cut to the length desired from the ten foot long plastic tubing supplied. Insert a tube-hose stem adapter into each end of the inlet tubing. This section connects the pump outlet to the sample chamber inlet. Insert a third tube-hose stem adapter into one end of the outlet tubing. This goes from the sample chamber to a waste container.

Next, the 3550 is connected to a 1/2" or 3/8" OD pump outlet by using the appropriate straight union connector supplied. For a 1/2" OD pump outlet, use the straight-union connector with two 1/2" ID ports. For a 3/8" OD pump outlet, use the straight-union connector which has one 3/8" ID port and one 1/2" ID port. Hand-tighten the appropriate port of the straight union connector at the pump outlet. Insert one end of the previously constructed sample chamber inlet tubing into the opposite port of the straight union connector and hand tighten it (see Figure 2).

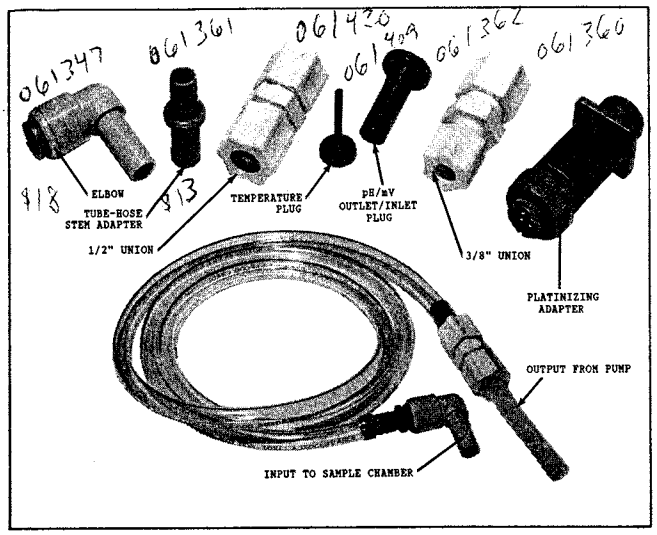


Figure 2. Plumbing Components and Platinizing Adapter

Insert the other end of the constructed inlet tubing into an elbow until it stops. Then insert the elbow into the top of the YSI 3520 Flow-Through Conductivity Cell and push down until it stops. Two internal o-rings in the cell serve as water seals.

The constructed end of the outlet tubing with the inserted tube-hose stem adapter is then pushed into another elbow until it stops. Then the elbow is inserted into the outlet port of the sensor mounting plate and pushed down until it stops. There is a double o-ring seal here too.

Install the sensors that will be used into the sensor mounting plate in their respective ports. The sensor ports not in use must have plugs installed to close off the system. Attach each of the sensors to the 3500. The input jacks are marked for proper placement of each connector. The temperature, conductivity, pH ATC probe inputs, and the recorder output have MS connectors. The pH and ORP electrodes come with BNC connectors which have very low water integrity and so should have their "boots" installed over their connectors. The color coding on the boots also helps identify them when they are in the cable harness. With the sensors attached to the 3500, place all the cables from the sample chamber into the black cable harness provided with the 3560 system. The harness is slotted for easy cable installation. The system is now ready for operation. (See Figure 3.)

With the system connected to the pump, begin pumping according to the pump manufacturer's instructions. Turn on the 3500. Before recording any values, make sure the sample chamber is full, that all air is voided, and that all of the displayed values are stable.

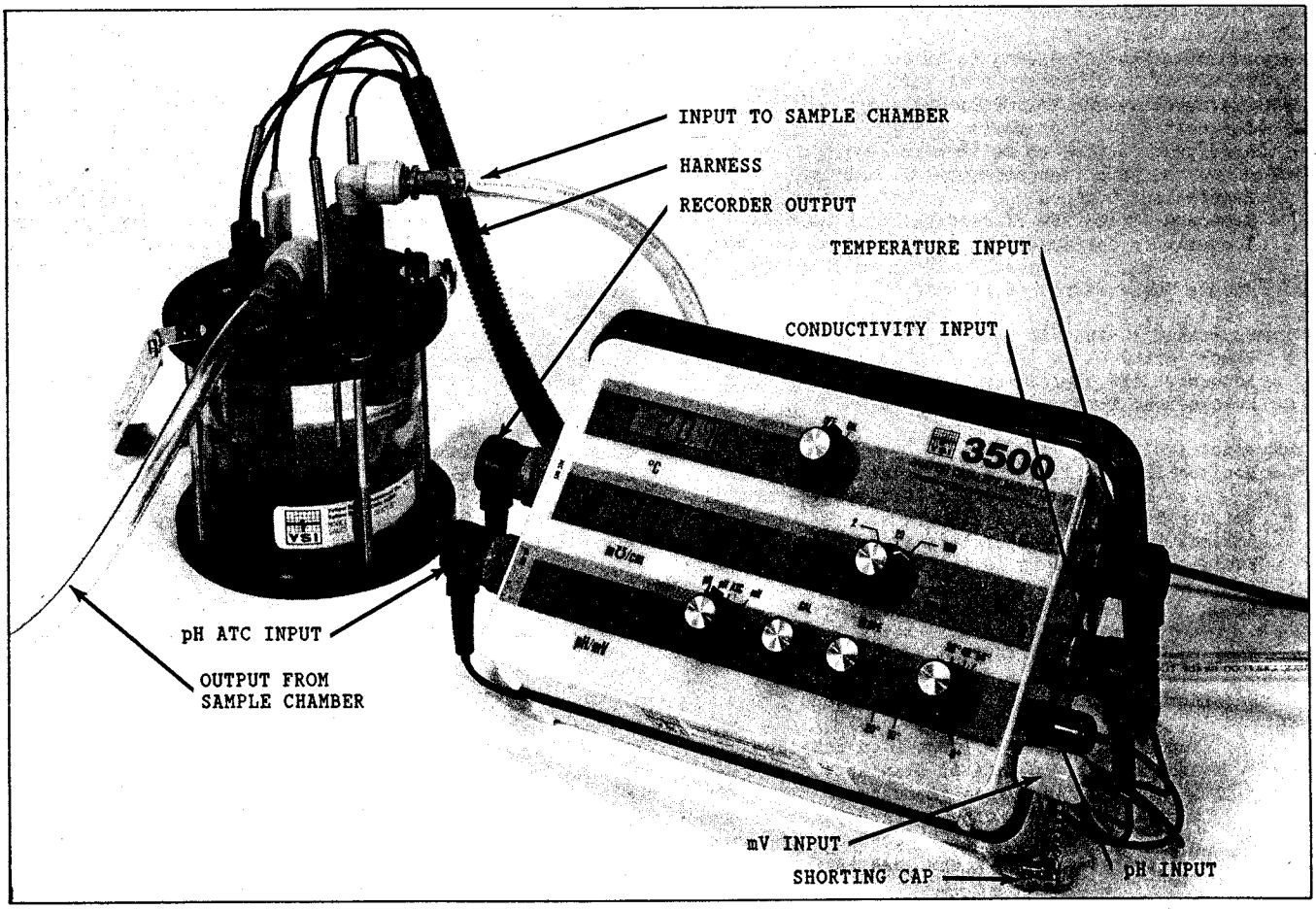
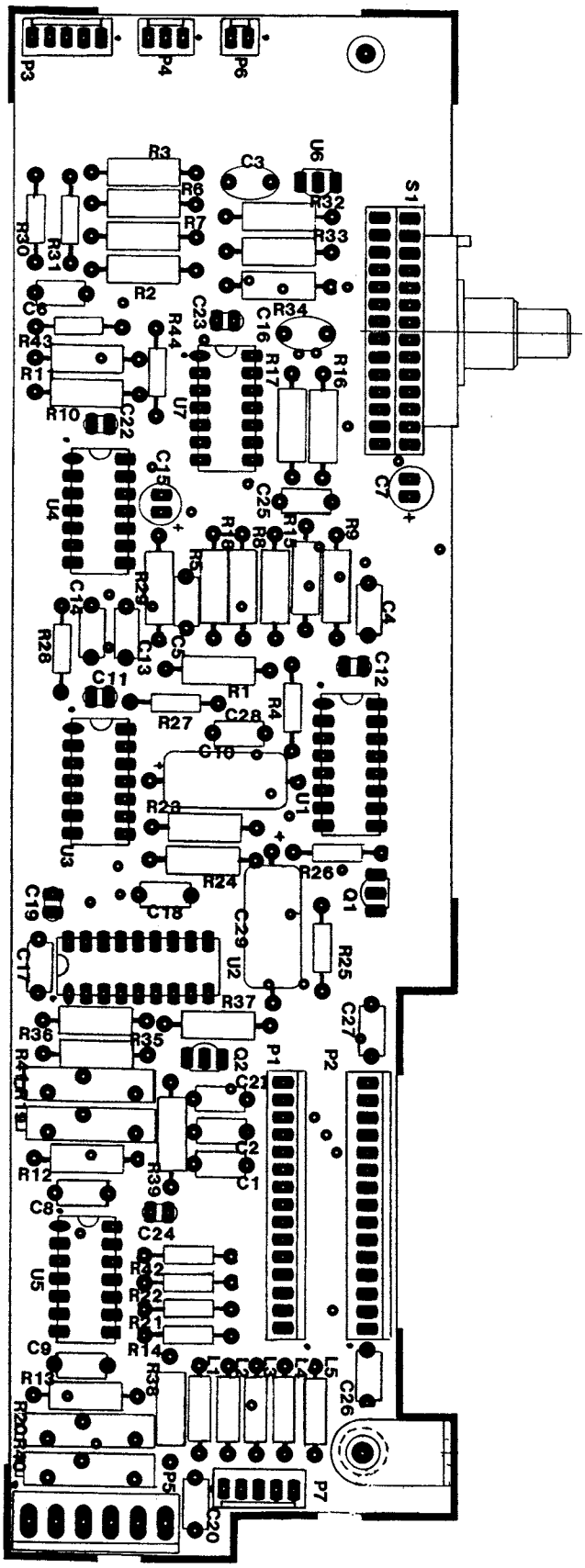


Figure 3. The 3560 System, Assembled

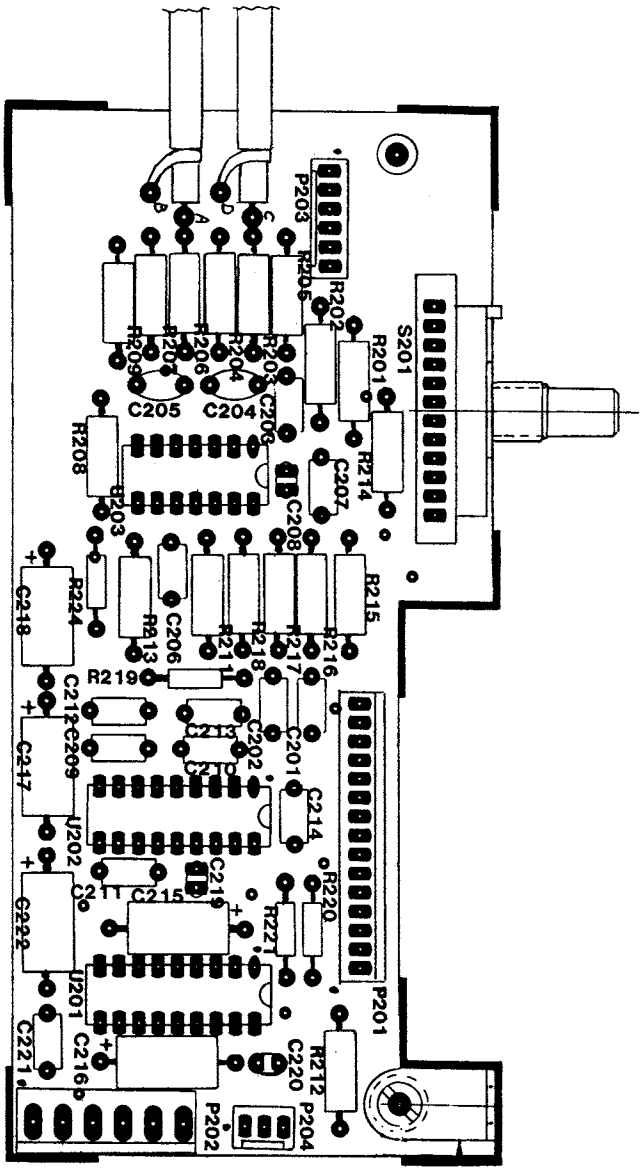
NOTES

(Schematics and board layouts on following pages)

BOARD LAYOUT

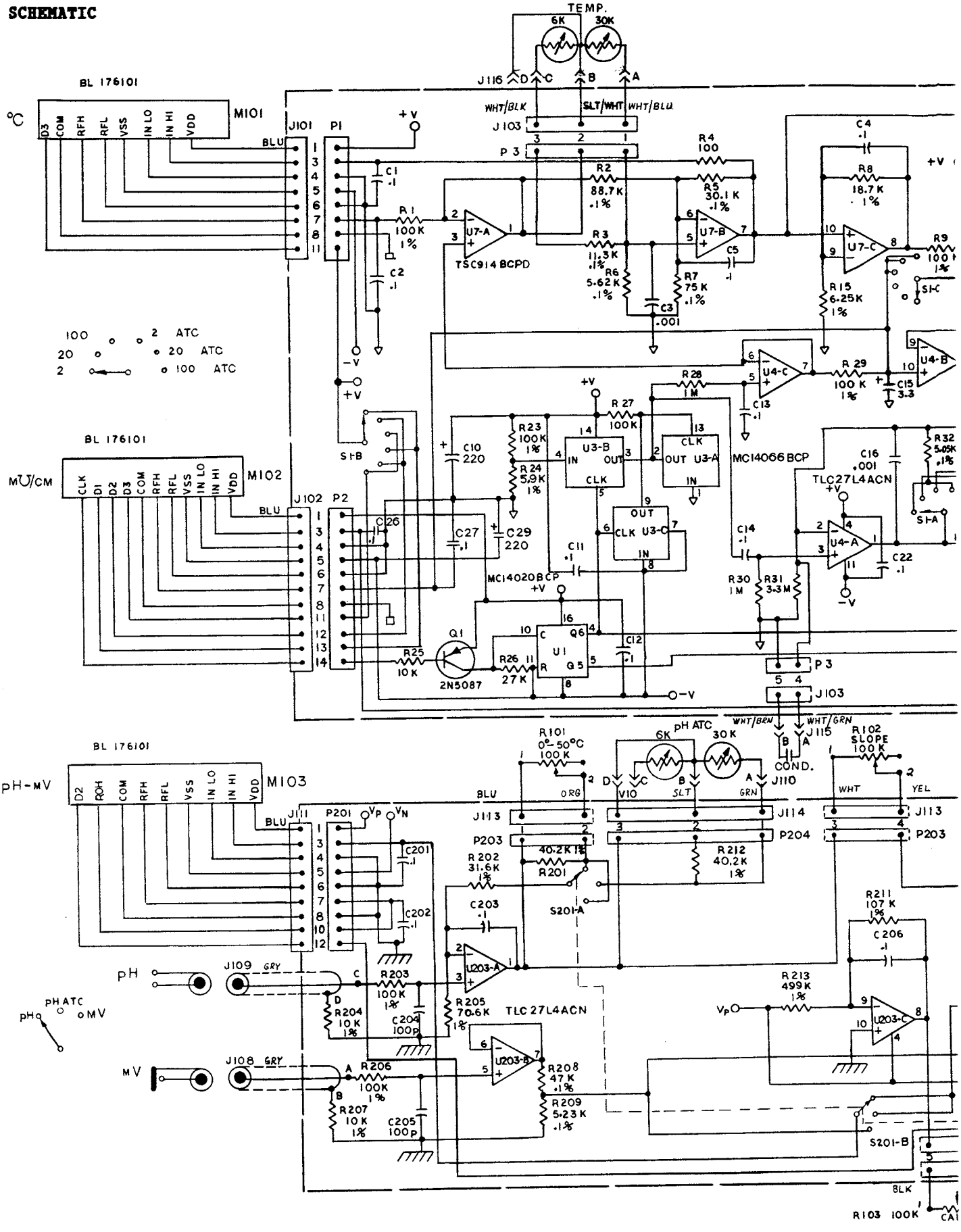


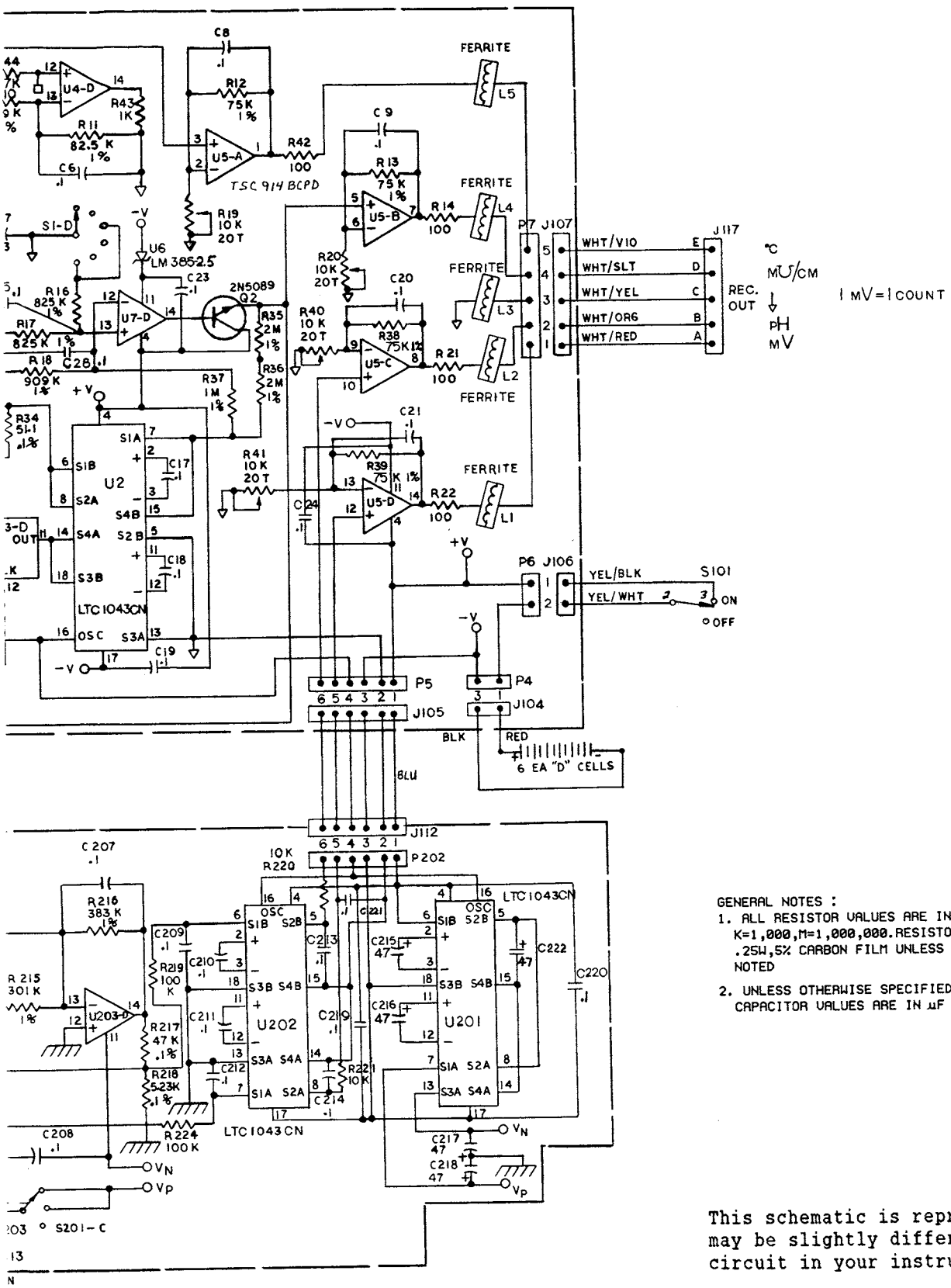
CONDUCTIVITY/TEMPERATURE BOARD



pH/mV BOARD

SCHEMATIC


TEMP.
6K
30K
J116
WHT/BLK
SLT/WHT
WHT/BLU
J103
P3
BL 176101
°C
M101
D3
COM
RFH
RFL
VSS
IN LO
IN HI
VDD
J101
P1
BLU
+V
-V
C1
C2
R1
100K 1%
U7-A
TSC914 BCPD
R2
88.7K .1%
R3
11.3K .1%
R4
100
R5
30.1K .1%
R6
5.62K .1%
R7
75K .1%
C3
.001
U7-B
C5
U7-C
C4
R8
18.7K .1%
R9
R15
6.25K 1%
S1-C
100 ATC
20 ATC
100 ATC
U4-B
U4-C
R28
1M
R29
100K 1%
C15
3.3
C13
BL 176101
MV/CM
M102
J102
P2
R23
100K 1%
R24
5.9K 1%
C10
220
C26
C27
C29
220
R27
100K
U3-B
U3-A
U3-C
MC14066 BCP
C11
MC14020 BCP
C16
.001
TLC27L4ACN
R32
5.05K .1%
S1-A
C14
C22
U4-A
R30
1M
R31
3.3M
Q1
2N5087
R25
10K
R26
27K
U1
C12
P3
J103
BL 176101
pH-MV
M103
D2
ROH
COM
RFH
RFL
VSS
IN LO
IN HI
VDD
J111
P201
VP
VN
C201
C202
R101
0°-50°C
100K
pH ATC
6K
30K
J115
COND.
J110
R102
SLOPE
100K
WHT/BRN
WHT/GRN
J114
P204
J113
P203
R202
31.6K 1%
R201
40.2K 1%
R212
40.2K 1%
S201-A
C203
R211
107K 1%
C206
R213
499K 1%
pH
J109
GRY
R203
100K 1%
C204
100p
R204
10K 1%
R205
70.6K 1%
TLC27L4ACN
U203-A
U203-B
U203-C
R208
47K .1%
R209
5.23K .1%
pH ATC
MV
J108
GRY
R206
100K 1%
R207
10K 1%
C205
100p
S201-B
BLK
R103 100K



GENERAL NOTES :

1. ALL RESISTOR VALUES ARE IN OHMS, K=1,000,M=1,000,000. RESISTORS ARE .25W,5% CARBON FILM UNLESS OTHERWISE NOTED
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN μF

This schematic is representative and may be slightly different from the circuit in your instrument.

Temperature Measurement

To measure temperature, connect a 3510 Temperature Probe to the 3500. Temperature is measured in °C and is shown continuously on the top display. With no probe attached, the 3500 display will read -34.0 ±.2°C.

Conductivity Measurements

Before any conductivity cell is used, it should be soaked in distilled or deionized water for at least one hour. To make conductivity measurements, connect a YSI 3520 Flow-Through Conductivity Cell to the 3500. Set the conductivity function switch to 2 and observe the displayed value after the reading is stable. The display reads out in millimhos/centimeter (m℧/cm). If micromhos/centimeter (μ℧/cm) is desired, multiply the displayed value by 1000.

If the overrange signal (1.___) is displayed, the conductivity of the water being assayed is greater than 1.999 m℧/cm. Reset the function switch to 20. If the overrange signal is still displayed, reset to 100. If the overrange signal is still displayed, either the conductivity is greater than 100.0 m℧/cm and the YSI 3500 Water Quality Monitor can not be used for conductivity determinations, or else there is a system error.

If no cell or a dry cell is attached to the 3500, the display will read 000 (±002) with the appropriate decimal point.

Automatically Temperature Compensated Conductivity

To measure automatically temperature compensated conductivity, connect a YSI 3510 Temperature Probe and a YSI 3520 Flow-Through Conductivity Cell to the 3500, and set the conductivity function switch to the correct ATC conductivity range. Readings are automatically compensated by 2%/°C to 25°C. The 3510 must be located in the sample under test for the automatic compensation to work correctly. If no temperature probe is connected to the monitor, the display will show the overrange signal (1.___). See Tables I and II for the correction values.

pH Measurements

To measure pH, connect a YSI 3530 pH Electrode or equivalent to the 3500, and set the pH function switch to pH. Typically, a two point calibration is necessary before actual measurements can be made. See pH Calibration procedure. Once the 3530 is calibrated, install the electrode into its port in the 3550. Though the instrument and electrode have been calibrated at one temperature, they can be used at other temperatures as long as the manual temperature knob is reset to the new sample temperature before final values are determined. Be sure to reset the dial to the temperature indicated by the top display. Though pH is temperature dependent, it is not customarily corrected to 25°C, as conductivity often is. pH changes with temperature at the rate of .335%/°C from the calibration point.

When measuring pH with no electrode connected to the mV input, the shorting cap attached to the 3500 should be on the mV input jack.

Automatically Temperature Compensated pH

To measure automatically temperature compensated pH, a YSI 3510 Temperature Probe and a YSI 3530 pH Electrode must be connected to the 3500. As long as the pH ATC mode is being used, the 3510 must remain connected to the pH ATC input jack or else the pH display will show an underrange negative value, or an overrange condition greater than 14.00--which are outside of the pH range of 0.00 to 14.00 and can not be adjusted into the measurable pH range.

Typically, a two point calibration is necessary before actual measurements can be made. See pH Calibration procedure. Once the 3530 is calibrated, install the electrode into the 3550 in its appropriate port, and the 3510 into the pH ATC port. Though the instrument and sensors have been calibrated at one temperature, they can be used at other temperatures, since temperature changes from the calibration point will be automatically corrected to the new value. Though pH is temperature dependent, it is not customarily corrected to 25°C, as conductivity often is. pH changes with temperature at the rate of .335%/°C from the calibration point.

When measuring pH with no electrode connected to the mV input, the shorting cap attached to the 3500 should be on the mV input jack.

mV Measurement

The millivolt (mV) function is intended for use with the YSI 3540 ORP Electrode, though other sensors may also be used. Set the pH function switch to the mV mode and read the bottom display. There are no adjustments in this mode, so any sensor that is attached to this input jack should be tested against some known standard as defined by its manufacturer. See Calibration for ORP Electrode. When no electrode is attached to the mV input, the shorting cap attached to the 3500 should be installed on this jack. If the pH input is not in use when an ORP electrode is on the mV input, the shorting cap should be connected to the pH input jack. With the shorting cap installed, the display will read 000 ±001.

Bailers

To use the 3560 system with a bailer instead of a pump, use the funnel provided to fill the sample chamber with the solution to be tested. The sample chamber and the conductivity cell must be filled to the very top and all air must be removed to ensure accurate readings.

Recorder Output

The Model 3500 recorder output is capable of driving a data logging device or strip chart recorder. Four outputs are located on the connector designated REC OUT and are defined as Temperature (pin E), Conductivity (pin D), pH (pin B), and mV (pin A); the common for each output is pin C. Each output circuit has a minimum load impedance of 50 K ohms. Each produces 1 mV for every count on the respective displays, and is accurate to ±10 counts of the display. The outputs have been calibrated with a 50 K ohm load. It should be noted that the conductivity output in the ATC mode is not temperature compensated. Conductivity output is always uncompensated conductivity. Compensated conductivity can be calculated as described elsewhere.

Shut Down

To shut down the system, simply turn the power switch to OFF. Turn the pump off before disconnecting the plumbing. Remove the straight union connector from the pump outlet, then remove the hose and fittings from the sample chamber ports and drain them. Plug the ports with the plastic plugs provided.

To keep the sensors in a suitable environment, the sample chamber can be moved from one site to another with its contained fluid. When the day's measurements are finished, drain the chamber by removing one of the plugs from its port and pouring out the sample. The pH and ORP electrodes should be stored in their soaker bottles to prevent them from drying out. The conductivity cell should be stored moist to minimize its equilibration period.

MAINTENANCE

Instrument

The YSI 3500 Water Quality Monitor requires occasional battery replacement and cleaning. Six alkaline "D" cells in the 3500 provide a minimum of 1400 hours of operation. When BAT appears on any of the three displays, it is time to replace the batteries. It is important to replace all the alkaline batteries at the same time for long life between battery changes. Remove the four rubber feet located on the back of the instrument and take off the back. Replace the batteries in the battery holder tubes, making sure the polarity is correct (red is positive). Reassemble the case, being careful to align the gasket correctly to prevent water infiltration. The rubber feet should be reinstalled finger tight. Do not use a screw driver.

Use a mild soap and water solution to clean the instrument. Wipe the solution on and wipe it off right away; follow this with a clean water wipe. Either a probe or connector cap should be in place over every jack to keep water out. If water gets into the instrument, disassemble it and wipe it dry. Do not dry it with hot air; this could damage the electronic components.

For stubborn stains and other marks, a solution of 50% water and 50% isopropyl alcohol may be used. Do not allow the solution to stand on the instrument case. Rinse by wiping with water, as above.

When storing the 3500 for long periods, remove the batteries to lessen the possibility of leakage.

Sample Chamber

The YSI 3550 Sample Chamber Assembly comes apart easily. The o-ring seals in the ports and the chamber gaskets should be replaced annually. Use the tweezers provided in the YSI 3555 Sample Champer Maintenance Kit to remove old o-rings and install new ones. Be sure the o-rings are properly seated in their grooves; they fit back in the sides of the ports. When you replace the gaskets located in recesses at the top and bottom of the clear acrylic tube, re-apply the thumbscrews finger-tight only; do not use any tool to tighten them. The gaskets could be cut, which would cause them to leak.

You may clean the parts of the disassembled chamber, as well as the plumbing fittings, with a mild soap solution or with isopropyl alcohol for tough stains. Rinse the cleaned components with water to remove any residual soap or alcohol; residues might cause interference with measurements.

Whenever storing the 3550, remove all the sensors to minimize the possibility of damaging, and store each one as recommended below. The sample chamber should be disassembled and dried before storage to prevent microbial growth.

The tubing and fittings used with the Sample Chamber may be cleaned with a general laboratory detergent. The tubing may be autoclaved. To remove the hose-stem adapter from the elbow, push in the collar on the elbow while pulling out the hose-stem adapter.

Temperature Probe

The 3510 requires very little maintenance in normal use. The durable stainless steel sheath and polyurethane cable may be cleaned with a mild soap and water solution. A solution of 50% isopropyl alcohol and 50% water may be used to remove stains and mineral deposits.

The 3510 should be stored dry in its own shipping box, and kept in a dry location.

Flow-Through Conductivity Cell

The stainless steel electrodes of the 3520 do not require platinization when used between 0.0 and 50.0 mÖ/cm. When conductivity values from 50.0 to 100.0 mÖ/cm are to be measured, the electrodes do require platinization for system accuracy. A platinization adapter has been provided with the system for use in conjunction with the YSI 3045 Platinizing Instrument and YSI 3140 Platinizing Solution. See the 3045 instructions for further information. The cell must always be kept clean to assure proper operation and reproducible accuracy. A dirty cell will contaminate the sample under test and change the conductivity reading. Any of the foaming acid tile cleaners such as Dow Chemical "Bathroom Cleaner" will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 10 parts distilled water, 10 parts isopropyl alcohol, and one part 10 normal hydrochloric acid.

Dip the cell into the cleaning solution and agitate for two or three minutes. A small test tube brush may be used to gently clean the electrodes and the flow-through port. Be careful to not scratch the electrodes. Rinse the cell in several changes of distilled or deionized water. The cell constant should be checked after each cleaning (see Calibration).

Store the 3520 in deionized water. For short term storage, the cell can be wrapped in a moist towel and placed in a plastic bag. After the 3520 cell has been stored dry, the cell constant will be in error until it has been soaked in deionized water for at least an hour.

Change the two silicone o-rings annually to maintain their sealing integrity. Use the tweezers provided in the 3555 Sample Chamber Maintenance Kit to remove old o-rings and install new ones. Be sure the o-rings are properly seated in their grooves, and be careful not to damage the o-rings or the cell with the tweezers.

pH Electrode

All sealed pH electrodes, including the YSI 3530, will deteriorate with time. The typical electrode will deteriorate after 3 to 6 months of normal use. Age deterioration is characterized by a shortened slope adjustment and slower speed of response. Aging can best be detected by calibrating the electrode. As a rule, if the span for slope adjustment can not be brought into range (that is, a reading of 4.00 can not be set), the electrode should be cleaned and retested or reconditioned (see below). When storing the electrode, keep it in the soaker bottle provided. The solution in the bottle may be replenished with 5 to 10 mL of pH 4 buffer with 1/2 teaspoon of sodium chloride (NaCl). If performance is not restored the electrode should be replaced. The slope control on the YSI 3500 Water Quality Monitor will allow a pH electrode with an 80% to 100% efficiency to be calibrated to the slope adjustment value. If this cannot be set, the electrode is probably below an 80% efficiency value. To clean or recondition a 3530, proceed as follows:

pH Electrode Cleaning: Coating of the bulb can lead to erroneous readings including shortened slope adjustment. Cleaning technique is determined by the type of coating. Soft coatings can be removed by vigorous stirring or by use of a squirt bottle of water. Organic chemicals or hard coatings should be chemically removed. A half-hour soaking in an industrial strength

detergent is recommended. Only in extreme cases should the bulb be mechanically cleaned as abrasion can lead to permanent damage. If cleaning does not restore performance, reconditioning may be attempted.

pH Electrode Reconditioning: When reconditioning is required due to electrode aging or severe fouling, the following chemical treatments can be tried. They are presented in the order of the severity of their attack on the pH electrode glass and may not improve electrode performance, and in some cases they might actually reduce it.

NOTE: USE PROPER PRECAUTIONS WHEN HANDLING THESE HAZARDOUS CHEMICALS.

1. Immerse the electrode tip in 0.1 normal hydrochloric acid for 15 seconds, rinse it in tap water,then immerse the tip in 0.1 normal sodium hydroxide for 15 seconds, and rinse in tap water again. Repeat this sequence three times and then recheck electrode performance. If it has not been restored, try the next step.

2. Immerse the electrode tip in a solution of 20% ammonium bifluoride and 80% water for two to three minutes, rinse in tap water and recheck performance. If performance has not been restored, try the next step.

3. Immerse the electrode tip in a solution of 5% hydrofluoric acid and 95% water for 10 to 15 seconds, rinse well in tap water, quickly rinse in 5 Normal hydrochloric acid, then rinse well in tap water again and recheck performance. If performance has not been restored, replace the electrode.

ORP Electrode

The 3540 should be periodically inspected for coating of the platinum surface, which can cause erroneous readings. The bulb guard of the electrode can be removed to expose the platinum for cleaning. When storing the electrode, keep it in the soaker bottle provided. The solution in the bottle may be replenished with 5 to 10 mL of pH 4 buffer with 1/2 teaspoon of sodium chloride (NaCl) .By testing the 3540 with YSI 3682 Zobell Solution, the need for cleaning can be determined (see Calibration). To clean the 3540, proceed as follows:

1. Soft coatings should be removed by use of a squirt bottle of water or by gently wiping with a soft cloth. Remove the bulb guard if necessary. Be careful not to scratch the platinum.

2. Hard coatings or organic chemicals should be removed by an appropriate chemical solvent, by gently scrubbing with a very fine cleansing powder such as "Softscrub," or by gently polishing with 600 grade wet silicon carbide paper. Wet a piece of the paper with water and gently polish the electrode with a circular twisting motion.

NOTE: After cleaning the platinum surface, soak the electrode for 8 to 24 hours in 4.0 pH buffer, then recheck it with YSI 3682 Zobell Solution before further use.

CALIBRATION

Instrument

The Model 3500 has no user serviceable adjustments. If you suspect that the instrument is out of calibration, it may be tested for accuracy using the YSI 3590 pH Sensor Simulator and the 3595 Test Probe Kit. Install the 3595 Test Probe Assembly by connecting the temperature unit (4 pins) to the **TEMP** input jack on the 3500, and the conductivity unit (2 pins) to the **COND** input jack. The readings you should see to ascertain correct operation of the temperature, conductivity and ATC conductivity functions of the 3500 are as follows:

°C = 15.5 ±0.3

2 mŌ/cm = 1.563 ±0.020
20 mŌ/cm = 1.56 ±0.10
100 mŌ/cm = 1.6 ±0.2

2 mŌ/cm ATC = 1.928 ±0.020
20 mŌ/cm ATC = 1.93 ±0.10
100 mŌ/cm ATC = 1.9 ±0.2

Connect the 3590 pH Sensor Simulator to the 3500 as described on the instruction label on the back of the 3590, then follow the steps listed in these instructions. If the displayed values are out of specification, the 3500 should be returned for service. See Warranty and Shipping Information.

Temperature

The 3510 Temperature Probe is assembled with a YSI Thermilinear thermistor and may be tested by customers using an ohmmeter. With the sheath of the probe submerged in a 0.0 ±.1°C ice bath, thermistor resistance can be compared to the following values:

Across Pins A & B = 94.98 K ±482 Ohms
Across Pins B & C = 19.59 K ±103 Ohms
Across Pins A & C = 114.6 K ±585 Ohms
Across Pins B & D = 0 ±1 Ohm

If any measurement is out of tolerance, see Warranty and Shipping Information for repair or replacement information.

Conductivity

The designed cell constant of the YSI 3520 Flow-Through Conductivity Cell is K = 5 /cm. Different accuracies in different ranges is a characteristic of the stainless steel electrodes. Though in normal use, re-determination of the cell constant may not be required, the constant can be affected by electrode fouling or mechanical shock. Therefore, it is wise to re-determine the cell constant routinely. When testing the calibration of the system, be sure check the accuracy of the test against System Specifications.

The total accuracy of the system is the sum of all the inaccuracy of its parts. As an example, at 10.00 mŌ/cm the 3500 and 3520 have an accuracy of ±3% of full scale (20.00), and the 3168 Conductivity Solution has an accuracy of ±1% of solution value. So when the solution is tested in the ATC mode, the displayed value should be 10.00 ±.70 mŌ/cm.

To check the cell constant, YSI 3167, 3168 or 3169 Conductivity Calibrator Solutions may be used. These solutions are packaged eight to a box in unbreakable plastic one pint bottles designed for field use. The solutions are manufactured to nominal values of 1, 10, or 50mŌ/cm at 25°C, with a ±1% accuracy of the stated

value on the label. A chart for uncompensated values at temperatures other than 25°C is included with each box.

In the following example, cell/instrument calibration is confirmed by use of YSI 3167 solution, but these procedures may be followed using any of the YSI solutions with only slight procedural changes.

Connect the 3520 cell and a 3510 Temperature Probe to the 3500, and remove them from the sample chamber. Set the conductivity function switch to 2 ATC. Rinse the inside and outside of the cell and the probe with about 1/3 of the contents of the 3167 bottle. Place both of the sensors into the remainder of the solution in the bottle, and allow them to come to temperature equilibrium. Make sure that the 3520 body is immersed so that the water level is half way up the knurled portion of the cell. See Figure 4. Read the displayed value and determine if the cell/instrument is within specified accuracy. The displayed value is corrected to 25°C automatically and should be 1.000 ±.070 mŏ/cm. If the value is within specification, the measured error can be used to further improve the accuracy of the system by providing a correction factor for further readings. This is done as follows:

$$\text{Corrected Sample Value} = \frac{\text{Calibrator Value}}{\text{Displayed Value}} \times \text{Sample Value}$$

Calibrator Value = 1.000 mŏ/cm
Displayed Value = .978 mŏ/cm
Sample Value = .634 mŏ/cm

0.648 mŏ/cm = (1.000 mŏ/cm)/(.978 mŏ/cm X (.634 mŏ/cm)

Discard the calibrator solution once the accuracy of the system has been determined. It has been contaminated and should not be reused. If system accuracy is out of specification, see Warranty and Shipping Information for repair instructions.

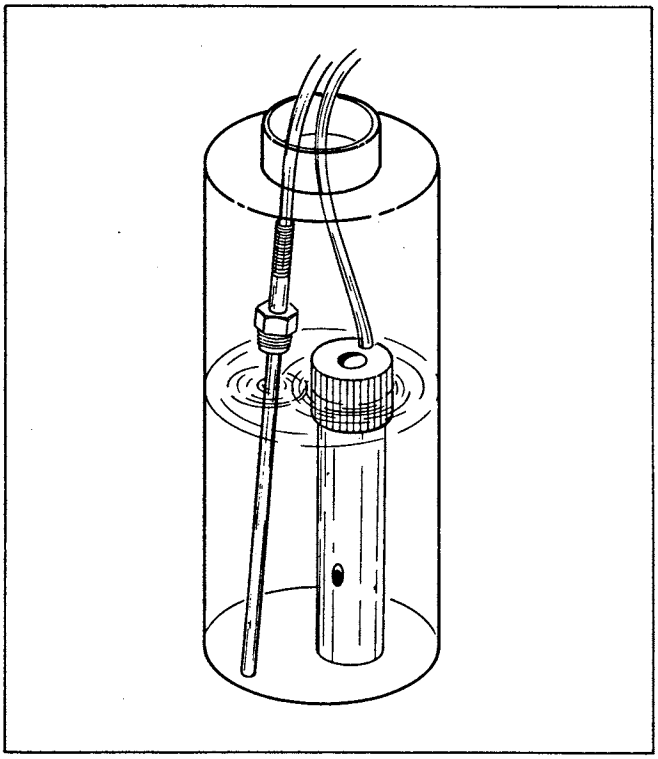


Figure 4. Sensor Level in Conductivity Calibrator Solution

pH

The frequency at which calibration is needed depends on the electrode, the pH monitor and the characteristics of the water to which the electrode is exposed. Since normal life of a pH electrode is only three to six months, it is advisable to calibrate the pH system before sampling at each site. The pH electrode should be tested for background noise and appropriately offset on a weekly basis.

Before connecting the pH electrode, zero the electronics with the shorting cap attached to the 3500. Turn on the 3500 and set the pH function switch to pH. Next, connect the shorting cap to the pH input jack and set the manual temperature compensation knob to 25°C. Then, adjust the CAL control to indicate 7.00 ±0.01 on the pH-mV display. Disconnect the shorting cap from the pH input and connect it to the mV input jack. The monitor is now zeroed.

Test the 3530 pH Electrode for noise and offset as follows. Rinse the 3530 and a YSI 3510 Temperature Probe with pH 7.00 buffer to remove any contaminants. Connect the 3530 to the pH input jack and the 3510 to the TEMP input jack. Pour pH 7.00 buffer into a 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, then immerse both of the sensors into the buffer at 25.0 ±0.1°C (use the °C display to confirm the temperature). Allow the sensors to equilibrate. A display value other than 7.00 shows electrode background noise and offset. The 3530 background noise and offset at pH 7.00 should not exceed ±0.2 pH units at 25°C.

Once it has been established that the electrode offset is functioning properly, a two point calibration should be performed. pH buffers of 7.00 and 4.00 or of 7.00 and 10.00, whichever two are closer to the expected sample value, should be used. Proceed as follows to make a two point calibration.

Rinse the 3530 and a YSI 3510 Temperature Probe with pH 7.00 buffer to remove any contaminants. Connect the 3530 to the pH input jack and the 3510 to the TEMP input jack. Pour pH 7.00 buffer into a 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, then immerse both of the sensors into the buffer. Allow the sensors to equilibrate in the buffer until a stable reading is obtained. Read the temperature and adjust the pH manual temperature compensation knob to the same value. Adjust the CAL control knob for 7.00 ±0.01 pH units on the display and discard the buffer. Rinse the sensors with deionized or distilled water, followed by a rinse of the next desired buffer (typically pH 4.00 or 10.00). Half fill another disposable 50 ml sample cup with the next buffer for calibration and immerse the sensors. Allow the sensors to equilibrate until a stable reading is obtained. The temperature of the two buffers should not differ by more than ±0.1°C. Adjust the SLOPE control until the display is within 0.01 pH units of the buffer's stated value. Discard the buffers. The pH system is now calibrated and ready for use.

Temperature Compensated pH

Follow the pH instructions above, with the following modifications:

Set the pH function switch to pH ATC. Connect the 3510 to the pH ATC input jack. While the 3510 can be used in either location, the pH ATC function will not work unless the 3510 is connected to the pH ATC input. It is recommended that a second YSI 3510 Temperature Probe be used for this operation. Manual temperature compensation is not necessary since temperature compensation is performed automatically in this mode.

mV

The frequency with which the mV function needs to be evaluated depends on the electrode, the monitor and characteristics of the ground water to which the electrode is exposed. It is wise to test the ORP system against a standard on a weekly basis. The YSI 3540 ORP Electrode comes with a bottle of YSI 3682 Zobell Solution which is used as a reference solution. To test the system with this standard, proceed as follows:

First, turn on the YSI 3500 Water Quality Monitor and set the pH function switch to mV. Next, connect the shorting cap attached to the 3500 to the mV input jack. The display should read 000 ±2 mV. This indicates that the 3500 electronics are zeroed. Detach the shorting cap and connect the 3540 to the mV input jack. If a pH electrode is not attached to the pH input jack, connect the shorting cap to it. Attach the 3510 to the TEMP input jack. Rinse the 3540 and 3510 with distilled or deionized water, followed by a rinse with a small amount of reconstituted YSI 3682 ZoBell Solution. Half fill a disposable 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, with ZoBell Solution and fully immerse the bulb of the 3540 and the end of the sheath of the 3510. Allow the sensors to equilibrate, and note the reading. The displayed mV value is not temperature compensated and should be corrected to 25°C at 1.3 mV/°C. The temperature coefficient is in reverse proportion to the temperature. The calculated value for the ZoBell Solution should be 231 ±10 mV at 25°C.

Example: Displayed Temperature = 22.1°C
Displayed Value of ZoBell Solution = 236 mV

231 mV = Display Value + [(Display Temp. - 25°C) x (1.3 mV)]
231 mV = 236 mV + [(22.1°C - 25°C) x (1.3 mV)]
231 mV = 236 mV + [-3.8 mV]
231 mV = 232.2 mV, corrected to 25°C

The calculated value of the Zobell solution in this example is within its specified range of 231 ±10 mV. This confirms that the ORP system is functioning properly. Rinse the sensors with deionized or distilled water and discard the used Zobell solution.

NOTE: If a pH sensor such as the 3530 and another potentiometic sensor such as the 3540 are to be installed at the same time into the 3550 Sample Chamber, and if both have their own reference electrodes, **both** reference electrodes must be immersed in the calibration solution during calibration.

WARRANTY AND SHIPPING INFORMATION

The YSI 3560 is warranted for one year against defects in workmanship and materials exclusive of batteries when used for its intended purposes and maintained according to manufacturer's instructions. The YSI 3530 and 3540 are warranted for three months. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered. The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. This warranty is limited to repair or replacement at YSI's option.

IF SERVICE IS REQUIRED
Contact the YSI dealer from whom you bought the instrument, or the YSI Product Service Department. Report the date purchased, model, serial number, and the nature of the failure.

When shipping any instrument, be sure that it is properly packaged and insured for complete protection. When returning for repair, please note the requirements of the Cleaning Certificate. In communications regarding this instrument or accessories please mention the model and serial number.

Yellow Springs Instrument Co., Inc.
Product Service
1725 Brannum Lane
Yellow Springs, Ohio 45387

YSI Toll Free Number: 1-800-343-HELP

REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A or Class B computing device in accordance with the specification in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

a) reorient the receiving antenna
b) relocate the computer with respect to the receiver
c) move the computer away from the receiver
d) plug the computer into a different outlet so that the computer and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 0004-000-00345-4.

TROUBLESHOOTING INFORMATION

Five basic assemblies make up the 3500: the conductivity-temperature board assembly, the pH-mV board assembly, the battery assembly, the meter assembly and a front panel assembly. The conductivity-temperature board provides references for the conductivity and temperature circuits as well as signal conditioning, timing, upper display drives and recorder output for all four monitor parameters.

Power is provided by the Battery Assembly and conditioned by the Cond-Temp board. +V is a constant 3.5 V to common and -V varies with the battery level. Power and timing are provided to the pH-mV board via a cable. The pH-mV board in turn provides signal conditioning, lower display drive and circuit isolation for the pH and mV circuits.

The Front Panel Assembly provides interfacing for the sensor inputs, front panel controls and Meter Assemblies.

With no sensors connected, the °C display will indicate -34.0 ±.2°C. The m℧/cm display will indicate 000 ±002 m℧/cm plus the appropriate decimal point in the 2, 20, and 100 ranges and an overrange condition (1___) in the 2 ATC, 20 ATC, and 100 ATC ranges with appropriate decimal point. With a temperature probe connected to the TEMP input, the overrange condition will turn off and the same display will appear as for the 2, 20, and 100 ranges.

With the function switch set to **pH**, and with the shorting cap on the pH input, the CAL knob can be adjusted so that the display shows from approximately 6.00 to 8.00 pH units, and the SLOPE and manual temperature compensation knobs will not affect the display value. With the shorting cap on the mV input, the display will indicate 000 ±002 mV in the mV function.

The pH electrode can be tested at the mV input. See Table IV for the electrode output in millivolts at different temperatures when the electrode is immersed in 4.00 and 10.00 pH buffers. The table shows the ideal mV outputs when the electrode is 100% efficient. Since the instrument SLOPE knob permits for adjustment from 100% down to 80%, the table value minus 20% is acceptable as an electrode output at any of the listed parameters. Before the electrode is tested for output, it should be evaluated for background noise and offset. At 25°C in pH 7.00 buffer, the electrode should indicate 0 ±11 mV.

TABLES

I. Temperature Correction Values Used for Automatic Temperature Compensation by the Model 3500 at 2%/°C

Temperature °C	Conductivity Ratios in m℧/cm ATC to 25°C
-5	2.500
0	2.000
5	1.667
10	1.429
15	1.250
20	1.111
25	1.000
30	.909
35	.833
40	.769
45	.714
50	.667

II. Temperature Correction Values of Two Typical Solutions (0.007 Normal and 0.089 Normal Potassium Chloride)

Temperature °C	0.007 Normal KCl m℧/cm at T°C	0.089 Normal KCl m℧/cm at T°C
-5	.455	5.54
0	.541	5.54
5	.628	6.39
10	.718	7.26
15	.810	8.15
20	.904	9.07
25	1.000	10.00
30	1.098	10.96
35	1.199	11.93
40	1.302	12.93
45	1.406	13.95
50	1.513	14.99

III. Temperature Values for Zobell Solution used with Silver/Silver Chloride and Calomel Electrodes

Temperature °C	Ag/AgCl (4M KCl) Millivolts	Calomel Millivolts
-5	270.0	234.2
0	263.5	226.0
5	257.0	217.8
10	250.5	209.6
15	244.0	201.4
20	237.5	193.2
25	231.0	185.0
30	224.5	176.8
35	218.0	168.6
40	211.5	160.4
45	205.0	152.2
50	198.5	144.0

IV. Ideal pH Electrode Output in pH 4.00 and 10.00 Buffers

Temperature °C	pH 4.00 Millivolts	pH 10.00 Millivolts
-5	159.6	-159.6
0	162.6	-162.6
5	165.6	-165.6
10	168.6	-168.6
15	171.5	-171.5
20	174.5	-174.5
25	177.5	-177.5
30	180.4	-180.4
35	183.4	-183.4
40	186.4	-186.4
45	189.4	-189.4
50	192.4	-192.4

YSI Incorporated
Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387 USA • Phone 513 767-7241 • 800 343-HELP • Fax 513 767-9353 • Telex 205437

Item 061381 PN A35178 C SEPT 1988 EP