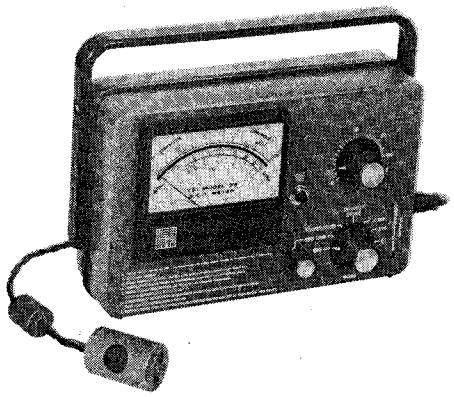
YSI MODEL 33 S-C-T METER INSTRUCTIONS



GENERAL DESCRIPTION

The YSI Model 33 S-C-T Meter is a battery powered, transistorized instrument designed to accurately measure salinity, conductivity and temperature. It uses a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single unit.

Conductivity is expressed in micromhos/centimeter. This is a measurement of the electrical conductance the sample would show if measured between opposite faces of a 1 cm cube. Salinity is expressed in the number of grams of salt/kilogram of sample (ppt = parts per thousand). The "metric," or Systeme International unit is milliSiemens/meter. (Conversion information: 1 micromho/cm = 0.1 mS/m. "Metric" values are shown in parenthesis in these instructions.) This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated; however, a temperature function is provided on the instrument to aid with calculation of corrections. When temperature and conductivity are known, it is possible to calculate salinity; and when only temperature and salinity are known, it is possible to calculate conductivity. This is discussed in the section on Recalibration.

SPECIFICATIONS

Model 33 Conductivity

Ranges: 0 to 500 (x1), 0 to 5,000 (x10), and 0 to 50,000 micromhos/cm (x100) with YSI 3300 Series Probes. (Note: The "micromho" designations on the meter are a shorthand form for "micromho/cm".)

Accuracy: (See Error Section)
±2.5% max. error at 500, 5,000 and 50,000 plus probe.
±3.0% max. error at 250, 2,500 and 25,000 plus probe.

Readability:
2.5 micromhos/cm on 500 micromho/cm range.
25 micromhos/cm on 5,000 micromho/cm range.
250 micromhos/cm on 50,000 micromho/cm range.

Temperature Compensation: None.

Salinity

Range: 0-40 ppt in temperature range of -2 to +45°C, within specified conductivity range of 0 to 50,000 micromho/cm (0 to 5.000 mS/m). See chart in section on Recalibration.

Accuracy (See Error Section)
Above 4°C: ±0.9 ppt at 40 ppt and ±0.7 ppt at 20 ppt plus conductivity probe.

Below 4°C: ±1.1 ppt at 40 ppt and ±0.9 ppt at 20 ppt plus conductivity probe.

Readability: 0.2 ppt on 0-40 ppt range.

Temperature Compensation: Manual by direct dial from -2 to +45°C.

Temperature Range: -2 to +50°C.

Accuracy: ±0.1°C at -2°C, ±0.6°C at 45°C plus probe (See Error Section)

Readability: ±0.15°C at -2°C to ±0.37°C at 45°C.

Power Supply: Two D-size alkaline batteries, Eveready E95 or equivalent, provide approximately 200 hours of operation.

Instrument Ambient Range: -5 to +45°C. A maximum error of ±0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is readjusted to redline for each reading.

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YSI 3300 Series Conductivity/Temperature Probe

Nominal Probe Constant: K = 5/cm (K = 500/m)

Accuracy: ±2% of reading for conductivity and salinity.

Error of ±0.1°C at 0°C and ±0.3°C at 40°C.

OPERATION

Setup

1. Adjust meter zero (if necessary) by turning the bakelite screw on the meter face so that the meter needle coincides with the zero on the conductivity scale.

2. Calibrate the meter by turning the MODE control to REDLINE and adjusting the REDLINE control so the meter needle lines up with the redline on the meter face. If this cannot be accomplished, replace the batteries.

3. Plug the probe into the probe jack on the side of the instrument.

4. Put the probe in the solution to be measured. (See Probe Use.)

Temperature

Set the MODE control to TEMPERATURE. Allow time for the probe temperature to come to equilibrium with that of the water before reading. Read the temperature on the bottom scale of the meter in degrees Celsius.

Conductivity

1. Switch to X100. If the reading is below 50 on the 0-500 range (5.0 on the 0-50 mS/m range), switch to X10. If the reading is still below 50 (5.0 mS/m), switch to the X1 scale. Read the meter scale and multiply the reading appropriately. The answer is expressed in micromhos/cm (mS/m). Measurements are not temperature compensated.

Example
Meter Reading: 247 (24.7 mS/m)
Scale: X10
Answer: 2470 micromhos/cm (247.0 mS/m)

2. When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

NOTE: The CELL TEST does not function on the X1 scale.

Salinity

1. Determine the sample temperature and adjust the temperature dial to that value.

2. Switch to x100. If the reading is above 500 micromho/cm (50 mS/m), the salinity value is beyond the measurement range.

3. If the reading is in range, switch to SALINITY and read salinity on the red 0-40 ppt meter scale.

4. Depress the CELL TEST button. The fall in meter reading should be less than 2%; if it is greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

Temperature Error

The temperature scale is designed to give the minimum salinity error when temperature readings are used to compensate salinity measurements.

Figure 1 shows total error for probe and instrument versus °C meter reading.

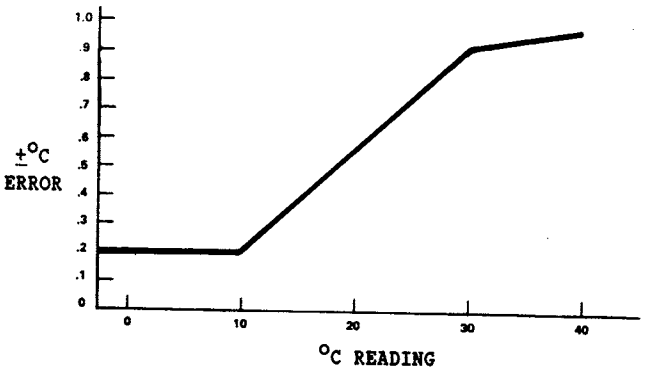


FIGURE 1

Example:
Meter Reading: 15°C
Total Error: 0.4°C
Accuracy: 15°C ±0.4°C for probe and instrument combined.

Conductivity Error

Figure 2 shows the worst-case conductivity error as a function of the conductivity reading for the probe and instrument combined.

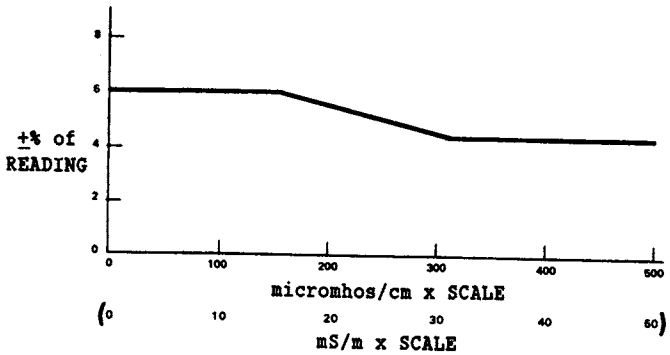


FIGURE 2

Example
Meter Reading: 360 micromhos/cm (36 mS/m)
Scale: X10
% Reading Error: ±4.5%
Accuracy: 3600 ±162 micromhos/cm (360 ±16.2 mS/m) for probe and instrument

Salinity Error

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both.

The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale error.

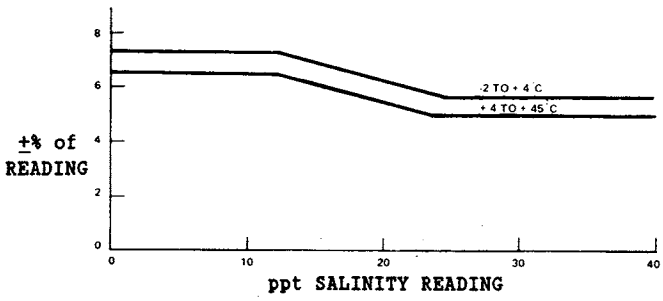


FIGURE 3

Example
Meter Reading: 10 ppt, @ 10°C
% of Reading Error: 6.5%
Accuracy: 10 ppt ±0.65 ppt for all errors, combined worst case.

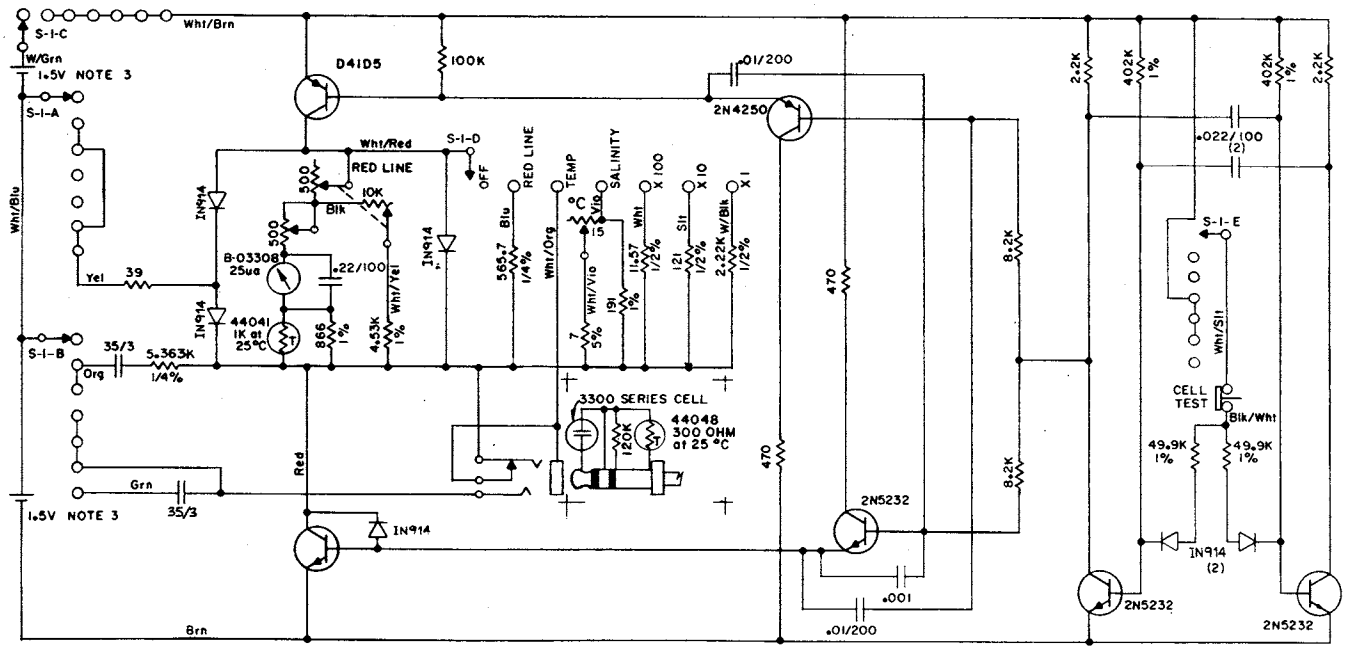
CIRCUIT DESCRIPTION

The circuit is composed of two parts; a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus providing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a user-adjusted temperature compensator. In the temperature, redline and X1 positions, the multivibrator operates at 100Hz. In the salinity, X100 and X10 positions the multivibrator operates at 600Hz; in these ranges, pushing the CELL TEST button drops the frequency to 100Hz, allowing the operator to test for probe polarization.

INSTRUMENT MAINTENANCE

The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent, will provide 200 hrs. of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.

Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the screws from the rear cover. The battery holders are color coded. The positive end must go on red.



NOTES:
Resistance values in ohms. K = 1,000. Resistors are 1/2 W, 10%, unless otherwise specified.

Battery is D size, alkaline only. Eveready E-95 or equivalent.

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

YSI MODEL 33 AND 33M SCHEMATIC

RECALIBRATION

Recalibration should be done at the factory. If emergency recalibration is necessary, however, one of the procedures described below may be attempted.

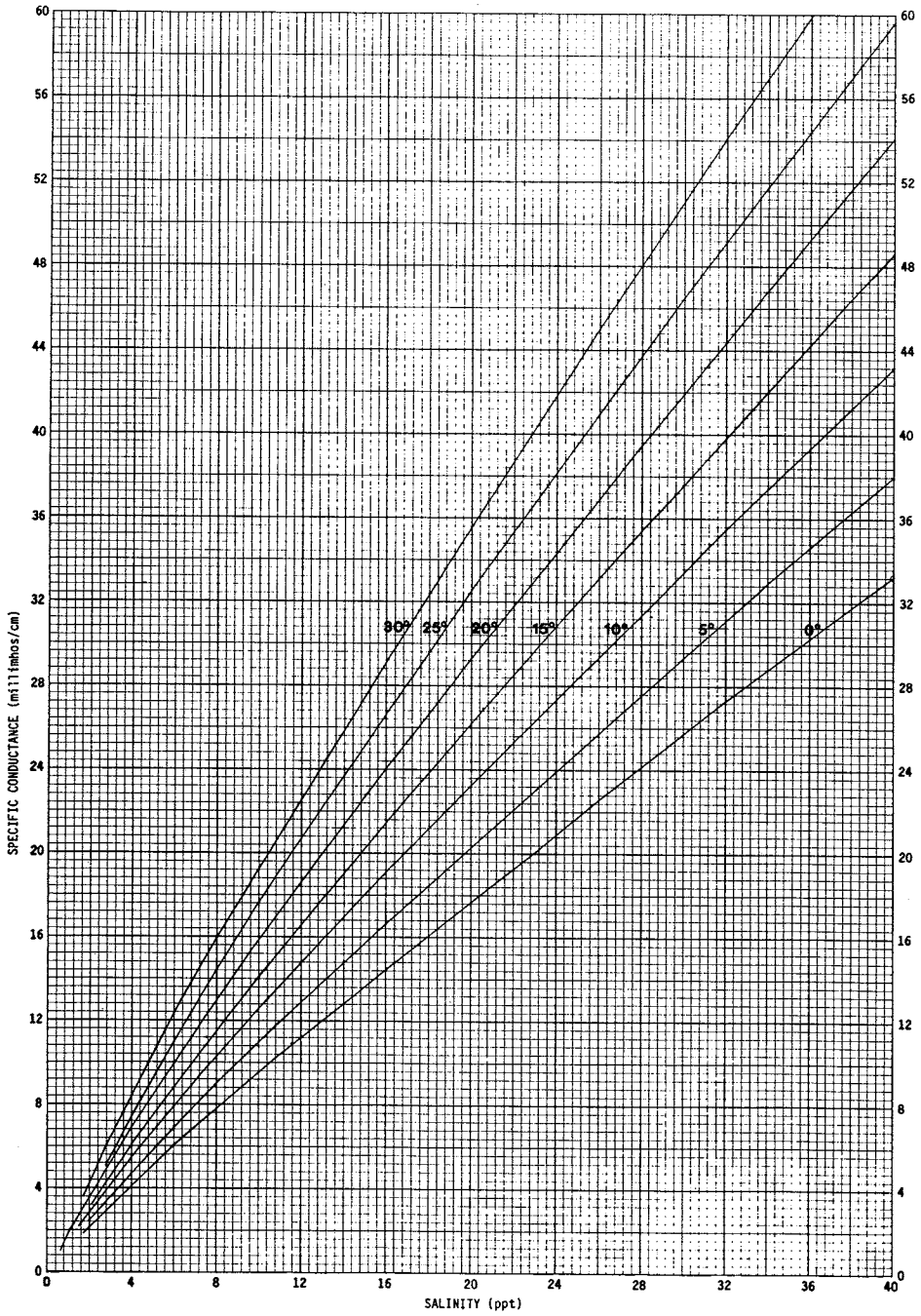
1. Use this method if the temperature knob has become loose or slipped from its normal position.

a. Read the temperature and conductivity of a sample. Determine the salinity of the solution by running a line vertically on the Calibration Graph from this conductance value until it intersects the appropriate ^{o}C line (interpolate as required for temperature between the given ^{o}C lines). From this intersection extend a line horizontally to the edge of the graph to read the salinity for this sample.

Example: 25,000 micromhos/cm (2,500 mS/m) and 20^{o}C gives a salinity of 17 ppt.

b. Remove the temperature knob, switch to SALINITY, and turn the conrol shaft until the meter needle indicates the salinity value determined in Step a. In the example given, the value is 17.

c. Switch to TEMPERATURE and note the reading. This reading must be the same as Step in a; if it is not, begin again. Replace the knob (without turning the control shaft) with the pointer at the same temperature as the meter reading and tighten both set screws securely.

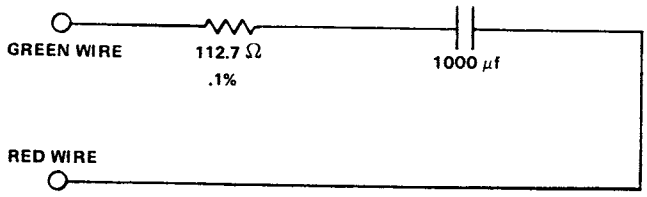


2. You may use the resistor and capacitor hookup shown in the sketch to substitute for the probe in the following recalibration procedure.

a. Set the instrument for a salinity measurement as normal.

b. Substitute a 1000 microfarad capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



c. Turn the temperature dial until the meter reads redline.

d. Reinstall the temperature knob with the arrow at 25°C.

This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

YSI 3300 SERIES CONDUCTIVITY/TEMPERATURE PROBES

Description

These probes are designed and constructed for rugged, accurate service in field use. The conductivity cell constant is 5.0/cm (500.0/m) ±2%. Each probe contains a precision YSI thermistor temperature sensor of ±0.1°C accuracy at 0°C and ±0.3°C at 40°C. The low capacitance cable assembly terminates in a three terminal 0.25" dia. phone plug.

The 3310 has a 10 foot cable and the 3311 a 50 foot cable. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinized pure nickel electrodes, and a rugged cable.

Cleaning and Storage

Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as Dow Chemical "Bathroom and Chrome Cleaner," Johnson Wax "Envy, Instant Cleaner," or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alchol and 1 part HCl can be used.

Always rinse the probe thoroughly in tap water, then in distilled or deionized water after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, replatinizing is required.

Storage

It is best to store conductivity cells in deionized water. Cells stored in water require less frequent platinization. Any cell that has been stored dry should be soaked in deionized water for 24 hours before use.

Replatinization

1. Clean the probe.

2. Place the cell in a 50 ml (approximate) jar or beaker and add enough YSI 3140 Platinizing Solution to cover the electrodes. Do not cover the top of the probe.

3. Plug the probe into the Model 33 or 33M, switch to the X100 scale to platinize the electrodes. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below:

Meter Reading micromhos/cm	mS/m	Time in minutes
30,000	3,000	5
25,000	2,500	6
20,000	2,000	8
15,000	1,500	11
10,000	1,000	16

4. After the elapsed time, remove the probe and rinse in tap water, then in distilled or deionized water.

5. Return the solution to its container. 2 oz. of solution should be sufficient for 50 treatments.

Probe Use and Precautions

1. Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.

2. Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.

3. Gentle agitation by raising and lowering the probe several times during a measurement insures flow of specimen solution through the probe and improves the time response of the temperature sensor.

Conductivity and Salinity Corrections for Long Cables

The additional length of wire in long cables adds capacitance and resistance which will effect readings. The recommended way to correct for these influences is by use of YSI Conductivity Calibrator Solutions (see below), which will permit an estimate of correction factors. If these solutions are not available, the following tables can be used for the correction of errors caused by cable resistance and capacitance on special length versions of the 3310, 3311, S-17933 and S-16120 probes.

TABLE I: CONDUCTIVITY CORRECTIONS (IN % OF READING)

Indicated Conductivity Range	umho/cm	Cable Length in Feet 10	50	100	200	300	500	1000
x1	100	-1.0	-5.0	NR	NR	NR	NR	NR
x1	500	-0.2	-1.0	-2.0	-4.0	-6.0	NR	NR
x10*	500	-1.2	-6.0	NR	NR	NR	NR	NR
x10	1000	-0.6	-3.0	-6.0	NR	NR	NR	NR
x10	5000	-0.1	-0.5	-1.0	-2.0	-3.0	-5.0	NR
x100	10000	-0.06	-0.3	-0.6	-1.2	-1.8	-3.0	-6.0
x100	50000	-0.01	-0.05	-0.1	-0.2	-0.3	-0.5	-1.0

* This row indicates the effect of the change from 100 Hz to 600 Hz when the instrument is switched to the x10 range.

NR represents conductivity levels which we do not recommend for probes with the indicated cable lengths.

TABLE II: TEMPERATURE CORRECTIONS IN ^{o}C

Indicated Temperature ^{o}C	Cable Length in Feet 10	50	100	200	300	500	1000
0	NONE	NONE	NONE	NONE	+0.1	+0.2	+0.4
10	NONE	NONE	NONE	+0.1	+0.2	+0.3	+0.6
20	NONE	NONE	+0.1	+0.2	+0.3	+0.5	+1.0
30	NONE	NONE	+0.1	+0.3	+0.4	+0.7	+1.4
40	NONE	+0.1	+0.2	+0.4	+0.7	+1.1	+2.2
50	NONE	+0.2	+0.3	+0.6	+1.0	+1.5	+3.1

NONE indicates that the corrections are less than $0.1^{o}C$.

TABLE III: SALINITY CORRECTIONS IN PARTS PER THOUSAND

Temperature Setting ^{o}C	% Conductivity Corrections from Table I -1	-5	-10
0	-0.1	-0.5	-1.0
10	NONE	-0.4	-0.8
20	NONE	-0.3	-0.6
30	NONE	-0.25	-0.5
40	NONE	-0.2	-0.4
50	NONE	-0.12	-0.25

NOTES:

1. Conductivity corrections should be made from Table I, or by interpolation of the table.

2. Salinity corrections require determination of conductivity, hence conductivity correction, and the setting of corrected temperature readings prior to salinity measurements.

3. Use of these corrections should increase the error band for measurements by less than 10%.

4. If your measurement conditions are such that a 2% or greater conductivity correction is required, the cell test feature will not properly indicate a defective probe.

Cell Calibration and Standard Solutions

The cell constant of a conductivity cell may vary slightly with the conductivity of the solution being measured. Cell Calibration may also be affected by electrode fouling, replatinization, or by mechanical shock. A cell and meter can be calibrated together, as a system, with YSI Conductivity Calibrator Solutions.

YSI Conductivity Calibrator Solutions are supplied with a full technical discussion and detailed instructions for use.

Part Number	Size	Conductivity at 25.00 degrees C
YSI 3161	Quart	1000 micromho/cm ±0.50%
YSI 3163	Quart	10,000 micromho/cm ±0.25%
YSI 3165	Quart	100,000 micromho/cm ±0.25%
YSI 3167	8 Pints	1000 micromho/cm ±1%
YSI 3168	8 Pints	10,000 micromho/cm ±1%
YSI 3169	8 Pints	50,000 micromho/cm ±1%

Directions for calibration at temperatures other than $25^{o}C$ are included with the Conductivity Calibrator Solutions.

In calculating the cell constant in absolute terms, the uncertainty of the meter calibration must be added to the tolerance of the conductivity Calibrator Solution.

YSI Model 33 Used with YSI 51A, 54, 57 and 58 Oxygen Meters

If the salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorosity. The formula is:

PPM Chlorosity = $[(\text{Salinity ppt} - 0.03) / (1.8)] \times 10^3$

For these instruments the 0.03 can be neglected so the equation simplifies to:

PPM/Cl = $(\text{salinity in ppt} \times 10^3) / 1.8$

For salinity correction when using the Model 57 or 58, use the Model 33 salinity reading directly. No conversion is necessary.

Model 33 salinity readings taken in conjunction with Model 54 dissolved oxygen readings can be used to correct the Model 54 for salinity and to make post-measurement salinity corrections to dissolved oxygen data. Correction tables are available from the factory.

WARRANTY

All YSI products carry a one-year warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge.

If you are experiencing difficulty with any YSI product, it may be returned to an authorized YSI dealer for repair, even if the warranty has expired. If you need factory assistance for any reason, contact:

Product Service Department
YSI Incorporated
1725 Brannum Lane
P.O. Box 279
Yellow Springs, Ohio 45387, U.S.A.
Phone: (513) 767-7241, (800) 343-HELP

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