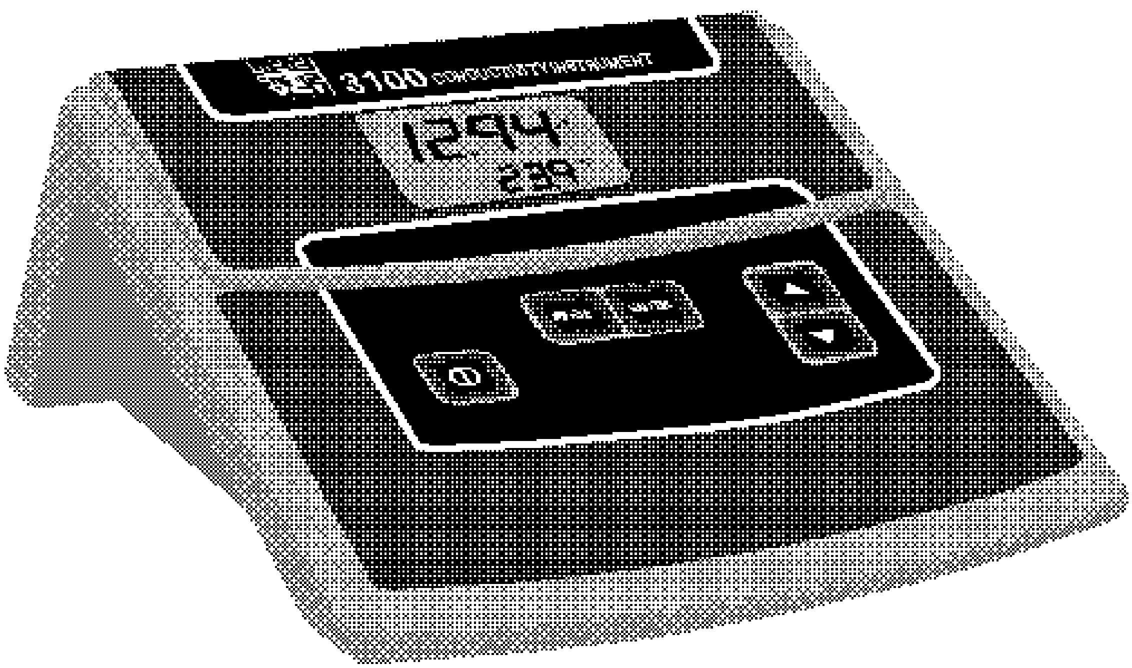
Service Manual

YSI Model 3100 Instrument

Conductivity
Salinity
Temperature



YSI INCORPORATED
1725 Brannum Lane
Yellow Springs, Ohio 45387 USA
Phone 937 767-7241 • 800 765-4974 • Fax 937 767-9353 • Inet info@ysi.com

Table of Contents

1. Introduction

The YSI Model 3100 is a microprocessor based instrument designed to perform laboratory measurement of conductivity, salinity and temperature. The instrument's push button operation makes it simple to use.

The Model 3100's microprocessor allows the system to be easily calibrated with the press of a few keys. Additionally, the microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the cell constant, function of the instrument circuitry, and the quality of the readings you obtain.

The system simultaneously displays temperature (in ^{o}C), along with one of the following parameters: conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand [ppt]). You can switch back and forth from salinity, conductivity, and temperature compensated conductivity with a single push of the [**MODE]** key.

Capabilities

- Adjustable reference temperature 15 to 25 °C
- Automatic temperature compensation
- Adjustable temperature compensation factor 0 to 4%/°C
- Adjustable Cell constant, ranges:
- 0.01, 0.08-0.12, 0.8-1.2, 8-12
- Auto or manual ranging
- Conductivity or Salinity readings
- 7-pin mini DIN connector with thermistor connections
- AC line power

Service Philosophy

The YSI Model 3100 is designed so that service can be performed easily by replacement of components or entire sub-assemblies. A snap together case reduces disassembly time and eliminates the need for elaborate tools.

Most service issues that occur in conductivity systems are caused by improper maintenance of the cell. For this reason, troubleshooting efforts should be initially directed at determining the condition and functionality of the cell and/or cable.

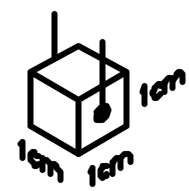
In the event that a problem is isolated to the instrument itself, YSI recommends replacement of the entire defective sub-assembly rather than the individual components. To lessen down time, YSI maintains an adequate stock of replacement sub-assemblies.

After servicing, the *Verification Test* should be performed to insure that the Model 3100 is working properly. If components on the printed circuit board have been replaced as part of the repair, and this test fails, the 3100 will need to be returned to YSI for factory software calibration or the printed circuit board will have to be replaced.

2. Principles of Operation

Conductivity Fundamentals

Electrical **conductance (k)** is defined as the ratio of the current (I) in a conductor to the difference in the electrical potential (V) between its ends (k=I/V), measured in mhos or siemens (S). Conductance, therefore, is not a specific measurement. Its value is dependent upon the length of the conductor. **Conductivity (À)**, or specific conductance, is the conductance per unit of conductor length. For our purposes, conductivity is defined as the conductance in mhos or siemens measured across the sides of a one centimeter cube of liquid at a specified temperature.

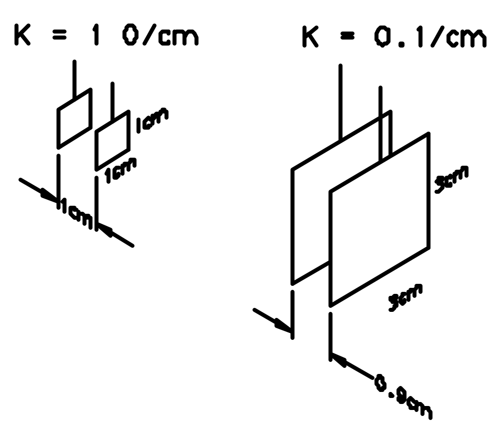


Looking at our electrodes as sides of a cube, it becomes apparent that the conductance changes as the geometry of the cube changes. If the cube lengthens with respect to the area of the sides, then the conductance will decrease. If the area of the sides increases with respect to the distance between them, then the conductance will increase. The conductivity, however, will remain the same, regardless of the geometry, provided that the temperature and composition of the measured solution remain constant. A factor called the **cell constant (K)** relates conductivity to conductance. The cell constant is defined as the ratio of the **distance between the electrodes (d)** to the **area normal to the current flow (A):**

$$\textbf{Cell Constant} = \qquad K = \frac{d}{A}$$

$$\text{À} = k \times K$$

Therefore, conductivity equals conductance multiplied by the cell constant.



Example: For an observed conductance of 100 micro mhos (100 microsiemens) and a cell constant of 0.1/cm

$$\begin{aligned} \aleph &= k \times K \\ &= 100\, m\,\text{mho} \times 0.1/\text{cm} \\ &= 10\, m\,\text{mho}/\text{cm} \end{aligned}$$

In SI units, the cell constant K=0.1/cm would become K=10/m, and the same conductivity would be expressed:

$$\begin{aligned} \aleph &= k \times K \\ &= 100\, m\,\mathrm{S} \times 10\,/\,\mathrm{m} \\ &= 1\, m\,\mathrm{S}\,/\,\mathrm{m} \end{aligned}$$

Cell Constant

The **cell constant (K)** is used to determine the resistivity or conductivity of a solution. It is defined as the ratio of the **distance between electrodes (d)** to the **area normal to the current flow (A).** Cells with constants of 1.0/cm or greater normally have small, widely-spaced electrodes, while cells with constants or 0.1/cm or less have larger electrodes that are closely-spaced.

Cell Constant Calculation

Anytime the condition of the conductivity cell changes, it is possible that the cell constant has also changed. Therefore, you should calibrate your system regularly. If you want to manually calculate your cell constant, measure the conductance of a standard solution and compare with the theoretical conductivity of the solution. The formula for determining the cell constant is:

$$K = \frac{\aleph}{k}$$

where **K** **= cell constant in cgs metric units (cm^{-1})**
k **= measured conductance in m mho**
À **= theoretical conductivity in m mho/cm**

The measured conductance (k) and conductivity (ℵ) must either be determined at the same temperature or corrected to the same temperature for the equation to be valid. One main reason for cell constant calibration is to increase overall system accuracy.

Conductivity Law

Solution Conductivity		Instrument Conductance		Cell Constant
S/cm or mho/cm	=	S or mho	×	1/cm
mS/cm or mmho/cm	=	mS or mmho	×	1/cm
µS/cm or µmho/cm	=	µS or µmho	×	1/cm

$$\text{Cell Constant} = \frac{\text{Solution Conductivity}}{\text{Meter Conductance}}$$

$$\text{Meter Conductance} = \frac{\text{Solution Conductivity}}{\text{Cell Constant}}$$

Platinization

The electrodes of YSI 3200 and 3400 Series conductivity cells are coated with platinum black during manufacturing. This coating is extremely important to cell operation, especially in solutions of high conductivity.

The cell should be inspected periodically. If the coating appears to be thin or if it is flaking off, the electrodes should be cleaned and replatinized. Properly maintained conductivity cells will perform for years without replatinizing.

Salinity

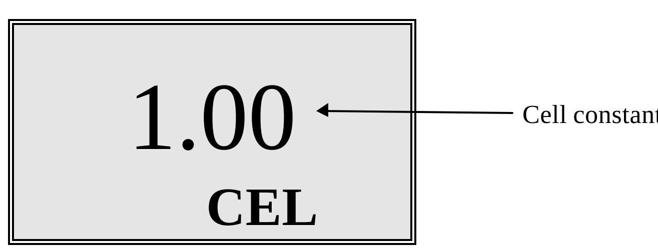
Salinity is determined automatically from the Model 3100 conductivity and temperature readings according to algorithms found in *Standard Methods for the Examination of Water and Wastewater (ed. 1995).* The use of the "Practical Salinity Scale" results in values which are unitless, since the measurements are carried out in reference to the conductivity of standard sea water at 15°C. However, the unitless salinity values are very close to those determined by the previously-used method where the mass of dissolved salts in a given mass of water (parts per thousand) was reported. Hence, the designation "ppt" is reported by the instrument to provide a more conventional output.

Temperature

The Model 3100 system utilizes a thermistor of sintered metallic oxide which changes predictably in resistance with temperature variation. The algorithm for conversion of resistance to temperature is built-in to the Model 3100 software, and accurate temperature readings in degrees Celsius or Fahrenheit are provided automatically. No calibration or maintenance of the temperature sensor is required.

3. System Configuration and Operation

Plug the power supply (300 ma minimum @ 12 VDC) into its mating connector on the back of the instrument. Depress the ⏻ (on/off) key to turn the instrument on. The instrument will activate all segments of the display for a few seconds, which will be followed by a self test procedure which will last for several more seconds. During this power on self test sequence, the instrument’s microprocessor is verifying that the instrument is working properly. The Model 3100 will display the current cell constant when the self test is complete.



If the instrument were to detect a problem, the display would show a continuous error message. For a list of these error messages, see the *Troubleshooting* chapter. After the instrument completes this diagnostic routine, the following screen should be displayed (with no cell connected).

0.00 µS
udr °C

3.1 Configure the 3100

Before operating the 3100, or whenever you change cells, you **must** configure the 3100 to match the cell used. You must enter the manufacturer's stated (or your manually calculated) cell constant (K) as shown below (*Cell Constant*).
The default configuration is as follows:

- Cell constant of K = 1
- Temperature compensation corrected to 25°C using a coefficient of 1.91%/°C.

3.2 Cell Constant

Follow these steps to change the cell constant:

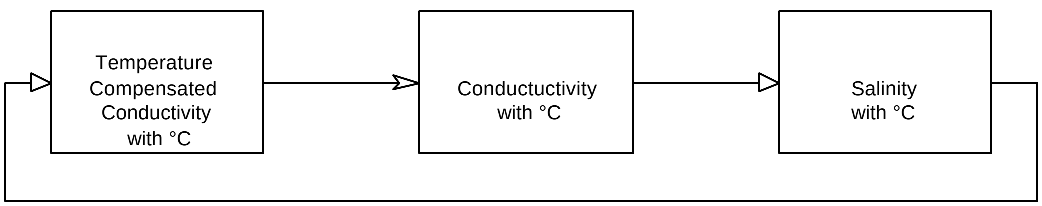
1. With the instrument on, press and release the **[DOWN ARROW]** and **[MODE]** keys at the same time. The **CAL** symbol will appear at the bottom left of the display and the large portion of the display will show 1.91% (or a value set previously using Setup).
2. Press and release the **[MODE]** key. The large portion of the display will show **25.0C** (or a value set previously using Setup).
3. Press and release the [**MODE**] key again. The large portion of the display will show **1.00** (or a value set previously using Setup).
4. Use the [**UP ARROW**] or [**DOWN ARROW**] key to change the value to the desired new cell constant.
5. Press the [**ENTER]** key. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted. The 3100 will return to normal operation mode.

3.3 Measurement Modes

The Model 3100 is designed to provide four distinct measurements:

- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Temperature Compensated Conductivity** -- Automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25^{o} C (or some other reference temperature which you choose). See *Advanced Setup*. **NOTE: Requires YSI 3200 series cell.**
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings. **NOTE: Requires YSI 3200 series cell.**
- **Temperature** -- Always displayed.

To choose one of the measurement modes (temperature is always displayed), simply press and release the [**MODE**] key. Carefully observe the small legends at the far right side of the LCD.



If the instrument is reading **Temperature compensated conductivity,** the large numbers on the display will be followed by either a µS or mS **and** the small portion of the display will show the **^{o}C** flashing on and off.

If the instrument is reading **Conductivity,** the large numbers on the display will be followed by either a **mS** or **mS,** but the small portion of the display will show the **^{o}C** **<u>NOT</u>** flashing.

If the instrument is reading **Salinity,** the large numbers on the display will be followed by a **ppt.**

NOTE: Temperature compensated conductivity and salinity modes cannot be used unless a YSI 3200 series cell is connected. When using a YSI 3400 series cell (or equivalent) with the 3232 cell adapter, these modes will display an error message (“LErr”) since 3400 series cells do not contain a temperature sensor.

3.4 Making Measurements

After setting up the 3100 instrument and cell as described earlier, the following basic steps should be used to make measurements.

1. Verify that the 3100 is properly setup to use the current cell by measuring, or calibrating with, a standard conductivity solution.
2. Immerse the cell in the solution to be measured.
3. Gently tap the cell to remove any air bubbles and dip the cell in the solution 2 or 3 times to ensure proper wetting. The cell electrodes must be submerged and the electrode chamber must not contain any trapped air. If using a flow through or fill cell, be certain it is completely full.
4. Allow time for the temperature to stabilize.
5. Press the [**MODE**] key to select the units required, then read the display.
6. Rinse the cell with distilled or deionized water.

3.5 Autoranging & Range Searching

The YSI Model 3100 is an autoranging instrument. This means that, regardless of the conductivity or salinity of the solution (within the specifications of the instrument), all you need to do to get the most accurate reading is to put the cell in the sample.

When you first place the cell into a sample or calibration solution, and again when you first remove the cell, the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches, the instrument display will flash **rANG** to indicate its movement from one range to another.

The length of the range search depends on the number of ranges which must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

During normal operation the [**ENTER**] key enables and disables the autoranging feature of the instrument.

4. Advanced Setup

For highest accuracy, the 3100 and cell may be calibrated as a system using standard conductivity calibration solution and the temperature coefficient can be adjusted.

4.1 Cell Calibration

Prior to calibration of the YSI Model 3100, it is important to remember the following:

- The cell constant must be set correctly before calibrating. See, *Configure the 3100, Cell Constant*.
- **Always use clean, properly stored, NIST traceable calibration solutions.** When filling a calibration container prior to performing the calibration procedures, make certain that

the level of calibrant buffers is high enough in the container to cover the electrodes. Gently agitate the cell to remove any bubbles in the conductivity cell.

- Rinse the cell with distilled water (and wipe dry) between changes of calibration solutions.
- During calibration, allow the cell time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. The readings after calibration are only as good as the calibration itself.
- Perform calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

Follow these steps to perform an accurate calibration of the YSI Model 3100 system (with cell):

1. Select a calibration solution which is most similar to the sample you will be measuring.
    - For sea water choose a 50mS/cm conductivity standard (YSI 3165 or 3169)
    - For fresh water choose a 1mS/cm conductivity standard (YSI 3161 or 3167)
    - For brackish water choose a 10mS/cm conductivity standard (YSI 3163 or 3168)
2. Place at least 3 inches of solution in a clean glass beaker.
3. Insert the cell into the beaker deep enough to completely cover the electrodes. Do not rest the cell on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
4. Gently tap the cell to remove any air bubbles and dip the cell in the solution 2 or 3 times to ensure proper wetting.
5. Allow at least 60 seconds for the temperature reading to become stable.
6. Press the [**MODE**] key until the instrument is in the mode that you want to calibrate in as follows:
    - Temperature compensated conductivity (°C symbol flashing): This mode will automatically compensate the calibration value to 25°C using a coefficient of 1.91%/°C.
    - Conductivity (°C symbol NOT flashing): This mode does NOT use temperature compensation.
7. Press and release both the [**UP ARROW**] and [**DOWN ARROW**] keys at the same time.

The CAL symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.

8. Use the [**UP ARROW**] or [**DOWN ARROW**] key to adjust the reading on the display until it matches the value of the calibration solution you are using. If you are calibrating in temperature compensated conductivity mode, enter the value at 25°C. If you are calibrating in conductivity mode (not temperature compensated), enter the value the calibration solution should read at the current temperature.

9. Once the display reads the exact value of the calibration solution being used, press the [**ENTER**] key. The word "**SAVE"** will flash across the display for a second indicating that the calibration has been accepted.

The YSI Model 3100 is designed to retain its last calibration permanently. Therefore, there is no need to calibrate the instrument after power down.

4.2 Setting the Temperature Coefficient

Follow these steps to modify the temperature coefficient of the Model 3100.

1. Press and release the [**DOWN ARROW**] and [**MODE**] keys at the same time. The **CAL** symbol will appear at the bottom left of the display and the large portion of the display will show **1.91**% (or a value set previously using Advanced Setup).
2. Use the [**UP ARROW**] or [**DOWN ARROW**] key to change the value to the desired new temperature coefficient.
3. Press the [**ENTER**] key. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
4. Press the [**MODE**] key two times to return to normal operation; the **CAL** symbol will disappear from the display.

4.3 Reference Temperature

Follow these steps to modify the reference temperature of the Model 3100.

1. Press and release the [**DOWN ARROW]** and [**MODE]** keys at the same time.

   The **CAL** symbol will appear at the bottom left of the display and the large portion of the display will show **1.91**% (or a value set previously using Advanced Setup).
2. Press and release the [**MODE]** key. The large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).
3. Use the [**UP ARROW**] or [**DOWN ARROW**] key to change the value to the desired new reference temperature (the allowable range is 15°C to 25°C).
4. Press the [**ENTER**] key. The word "**SAVE**" will flash on the display for a second to indicate that your change has been accepted.
5. Press the [**MODE**] key to return to normal operation.

4.4 Manual Ranging

If your application is easier to perform using a manual range that you select, the YSI Model 3100 allows you to turn off the default autoranging feature. While you are making conductivity or temperature compensated conductivity measurements, simply press and release the [**ENTER**] key. Each additional press of the [**ENTER**] key will cycle the Model 3100 to a different manual range until you return again to autoranging. Five pushes of the [**ENTER**] key will cycle the Model 3100 through the four available manual ranges and return the instrument to autoranging.

NOTE: You may see an error message in some manual ranges if the range selected is not adequate for the sample you are measuring.

If this happens, simply press and release the [**ENTER]** key again until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. The instrument will default to autoranging when first turned on.

The YSI Model 3100 has five possible ranges. The number of ranges available for use depends on the current cell constant.

Cell Constant	Range 1 0 - 49.99 µS/cm	Range 2 0 - 499.9 µS/cm	Range 3 0 - 4999 µS/cm	Range 4 0 - 49.99 mS/cm	Range 5 0 - 499.9 mS/cm
K=0.01	√	√			
K=0.1	√	√	√		
K=1	√	√	√	√	
K=10		√	√	√	√

NOTE: Cells may be used beyond their normal range, but with instability and/or reduced accuracy.

5. Cell Maintenance

5.1 Cleaning and Storage

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it.

Cleaning the Cell

1. Dip or fill the cell with cleaning solution and agitate for two to three minutes. Any one 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 1:1 isopropyl alcohol and 10N HCl or Sulfuric Acid or Ethanol or Methanol.

   CAUTION: ***Cells should not be cleaned in aqua regia or in any solution known to etch platinum or gold.***

2. Remove the cell from the solution and rinse in several changes of distilled or deionized water. Inspect the platinum black to see if replatinizing is required.

Storage

Short term: Store conductivity cells in deionized or distilled water. Change the water frequently to prevent any growth that may cause electrode fouling.

Long term: Rinse thoroughly with deionized or distilled water and store dry. Any cell that has been stored dry should be soaked in distilled water until the electrodes appear black before use.

5.2 Platinization

The electrodes of YSI 3200 and 3400 Series conductivity cells are coated with platinum black during manufacturing. This coating is extremely important to cell operation, especially in solutions of high conductivity.

The cell should be inspected periodically. If the coating appears to be thin or if it is flaking off, the electrodes should be cleaned and replatinized. Properly maintained conductivity cells will perform for years without replatinizing.

The 3100 can be used to replatinize the electrodes of the cell. In addition, you will need a 2-oz bottle of platinizing solution (YSI 3140).

WARNING: Before replatinizing the electrodes of a cell, make sure that the cell is designed to have a platinum coating on the electrodes.

1. Immerse the cell in the platinizing solution (YSI 3140). Make sure that both electrodes are submerged.
2. Press both the **[UP ARROW]** and **[MODE]** keys at the same time. The large portion of the display will show “**PLA**” flashing, indicating that platinization is in process.
3. After the platinization process is complete (about 30 minutes), the 3100 will return to normal mode. Remove the cell from the platinizing solution. If you want to stop the platinization before 30 minutes have passed, press both the [**UP ARROW**] and [**MODE**] keys at the same time to abort.
4. Thoroughly rinse the cell with distilled or deionized water.
5. Promptly return the platinizing solution to its container.

6. Test and Verification Procedure

Connect the YSI Model 3100 as shown in Figure #1 (next page) and follow the charts below to verify it's electronic accuracy. Test the system accuracy (instrument and cell) using conductivty standards. See *Cell Calibration.*

Equipment Required:

If using the YSI 3166 Precision Calibrator Set to simulate conductance a YSI 3232 adapter is required for proper connection to the cell connector. Temperature can only be accessed using the YSI #003229 cable assembly. See figure #1.

If a decade resistance box is used to simulate conductance and temperature a YSI #003229 cable is required for connection to the cell connector.

Important Notes:

1. Place the Model 3100 in conductivity mode with temperature compensation turned off (°C not flashing).
2. Model 3100 cell constant set to 1.00. See *Configure, Cell Constant*.
3. The 3100 has no internal calibration. Opening the case should only be attempted by a qualified service technician or permanent damage may result.

Conductance Verification

Resistance Input @ Cell Connector	3100 Range	Displayed Conductance
10.00 Ω ± 0.2%	499.9 mS	100.0 ± 2.6 mS
100.00 Ω ± 0.1%	49.99 mS	10.00 ± .26 mS
1000.0 Ω ± 0.1%	4999 µS	1000 ± 26 µS
10.0 KΩ ± 0.1%	499.9 µS	100.0 ± 2.6 µS
100.0 KΩ ± 0.1%	49.99 µS	10.00 ± .26 µS
1.000 MΩ ± 0.1%	49.99 µS	1.00 ± .25 µS

Temperature Verification

Temperature	Resistance Input @ Cell Connector, Pin 1 & 2	Displayed Temperature
0 °C	32660 Ω ± .25%	0.0 ± .2 °C
25 °C	10000 Ω ± .25%	25.0 ± .2 °C
40 °C	5329 Ω ± .25%	40.0 ± .2 °C

70 ^{o}C	1752 Ω ± .25%	70.0 ± .2 ^{o}C

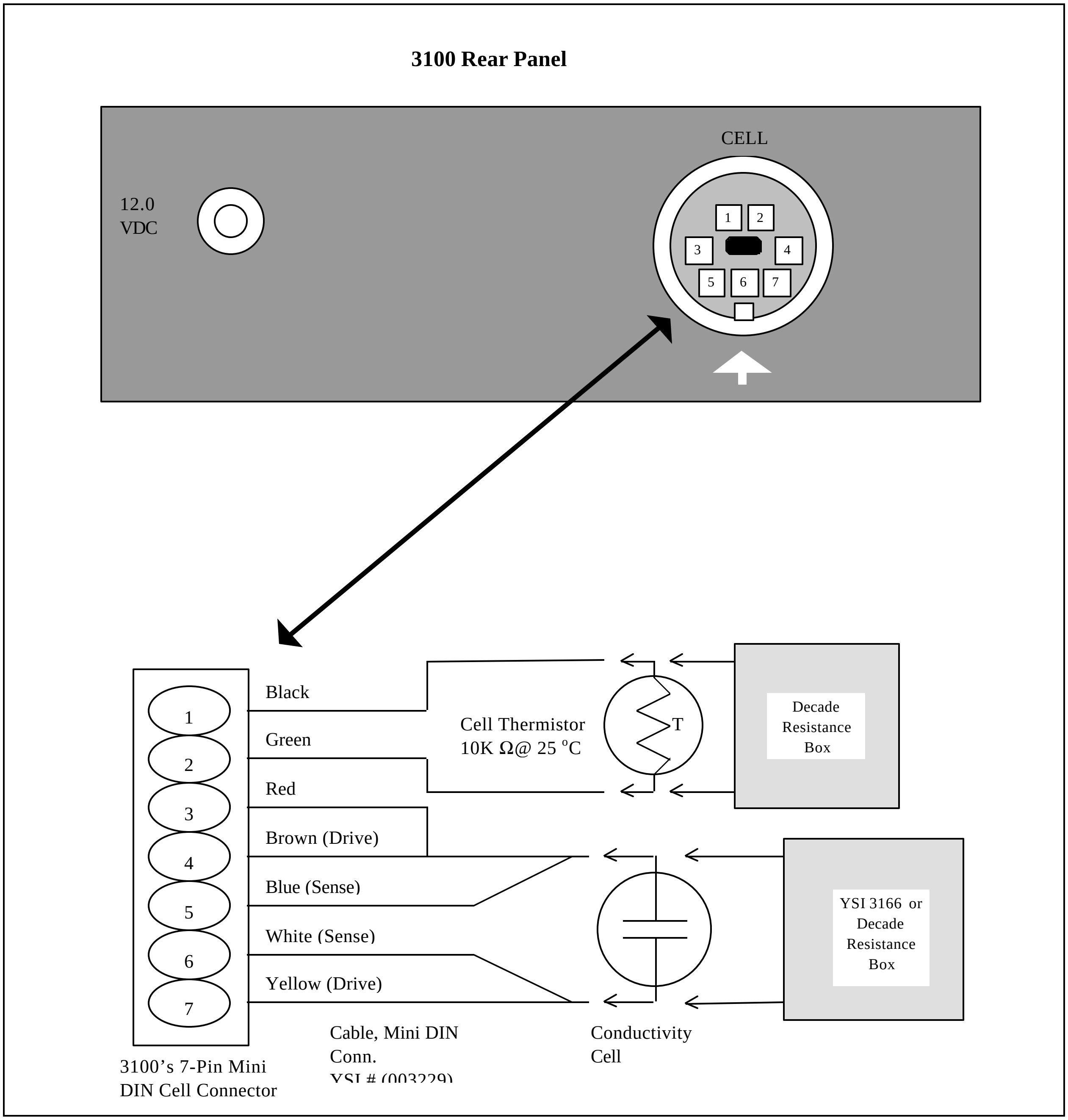


Figure #1

7. Troubleshooting

SYMPTOM	POSSIBLE CAUSE	ACTION
1. Instrument will not turn on	• Power supply failure • Instrument failure	• Check power supply and AC outlet • Repair or replace board assy
2. Instrument fails verification test	• Incorrect calibration procedure • Board requires service	• See *Cell Calibration* • Repair or replace board assy • Board needs factory calibration
3. System readings are inaccurate (Instrument and cell combination)	• Calibration is required • Cell is contaminated • Temperature coefficient has been set incorrectly • Reference temperature incorrect • Readings are or are not temperature compensated.	• See *Cell Calibration* • See *Maintenance* • See *Temperature Coefficient* • See *Reference Temperature* • See *Measurement Modes*
4. Main Display reads “OVEr”	• Conductivity Reading is over range: >112 uS with K=0.01 cell >11.2 mS with K=0.1 cell >112 mS with K=1 cell >499.9 mS with K=10 cell • Salinity reading is > 80ppt • User cell constant cal is over the limit of the current range	• In all cases, check calibration values and procedure; check Advanced Setup settings. • Set cell constant to correct range. • If each of these is set correctly, repair or replace board assy.
5. Main Display reads “Undr”	• User cell constant cal is under the limit of the current range	• Set cell constant to correct range. • Recalibrate using known good conductivity standard. • Follow cell cleaning procedure.
6. Main Display reads “rErr”	• User has selected manual ranging & sample exceeds selected range • Conductivity reading is over the range of the instrument: >499.9 mS	• Use the ENTER key to select a higher or lower manual range, or to set system to Autoranging.
7. Main Display reads “PErr”	• Incorrect sequence of key strokes	• Refer to manual section which provides step by step procedures for the function you are attempting.
8. Secondary Display reads “Err ra”	• System has failed its RAM test check procedure	• Turn instrument OFF and back ON. • Repair or replace board assy
9. Secondary Display reads “Err ro”	• System has failed its ROM test check procedure	• Turn instrument OFF and back ON. • Repair or replace board assy.
10. Secondary Display reads “udr”	• Current cell does not contain a temperature sensor (such as YSI 3400 series). • Temperature is < -5^{o}C	• Use a YSI 3200 series cell if temperature readings or compensation are required • Read solution of higher

SYMPTOM	POSSIBLE CAUSE	ACTION
		temperature • Replace Cell/Cable assy • Repair or replace board assy

SYMPTOM	POSSIBLE CAUSE	ACTION
11. Secondary Display reads “ovr”	• Temperature is > 95^o C	• Read solution of lower temperature • Replace Cell/Cable assy. • Repair or replace board assy
12. Main Display reads “LErr”	• In temperature compensated conductivity mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature. • In cell constant cal mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature. • The user has selected Temperature Compensated Conductivity or Salinity and the current cell does not contain a temperature sensor.	• Adjust user defined temperature coefficient (see *Temperature Coefficient*) or reference temperature (see *Reference Temperature*) • Use a YSI 3200 series cell or turn off temperature compensation.
13. Secondary Display reads “rEr”	• Temperature jumper is set to ^{o}F and reading is >199.9 ^{o}F but < 203 ^{o}F	• Set jumper to read ^{o}C. • Repair or replace board assy

8. Circuit Description

Power Supply

Power is input at JP2 (12V nominal). U8 regulates this input voltage to approximately 5v and supplies it to U9, which is always powered, even when the instrument is off. R26 pulls the power switch line up to 5v, U9 pin 13 is pulled back low when the power button is depressed. The micro (U15) holds the power on through U9 (U9 pin 8 > 4v and U9 pin 11 < 1v).

Regulator U10 has a 6 volt output which is set by divider R28 & R29. U10 shuts down when pin 5 is low. C18 & 19 are output caps. U11 is a -5 to -6v charge pump, it should output negative 5 to negative 6 volts on pin 5. C22 is its output capacitor.

Digital Section

U15, system microprocessor, runs when pin 17 is high and the crystal is oscillating. U14 will pull the reset line low under low input power conditions. R33, R34 and R43 are not required, so may not be installed on all boards. Serial port JP4 is used for factory calibration only.

Data is output to the display driver chip in four bit nibbles on port B. U16 drives the LCD. The LCD holder and conductive strips (zebra strips) must be mounted flush to the PCB board and the connections kept clean for the LCD to properly operate.

Analog Section

The Model 3100 uses the "Forced Current" measurement technique. This technique uses a voltage-mode feedback loop around a square-wave current source so that the output of the current source generates a fixed AC voltage across the conductivity cell. Since the current required to produce a fixed voltage across the cell is proportional to the conductance of the cell, the DC programming voltage to the square-wave current source is proportional to the conductance of the cell.

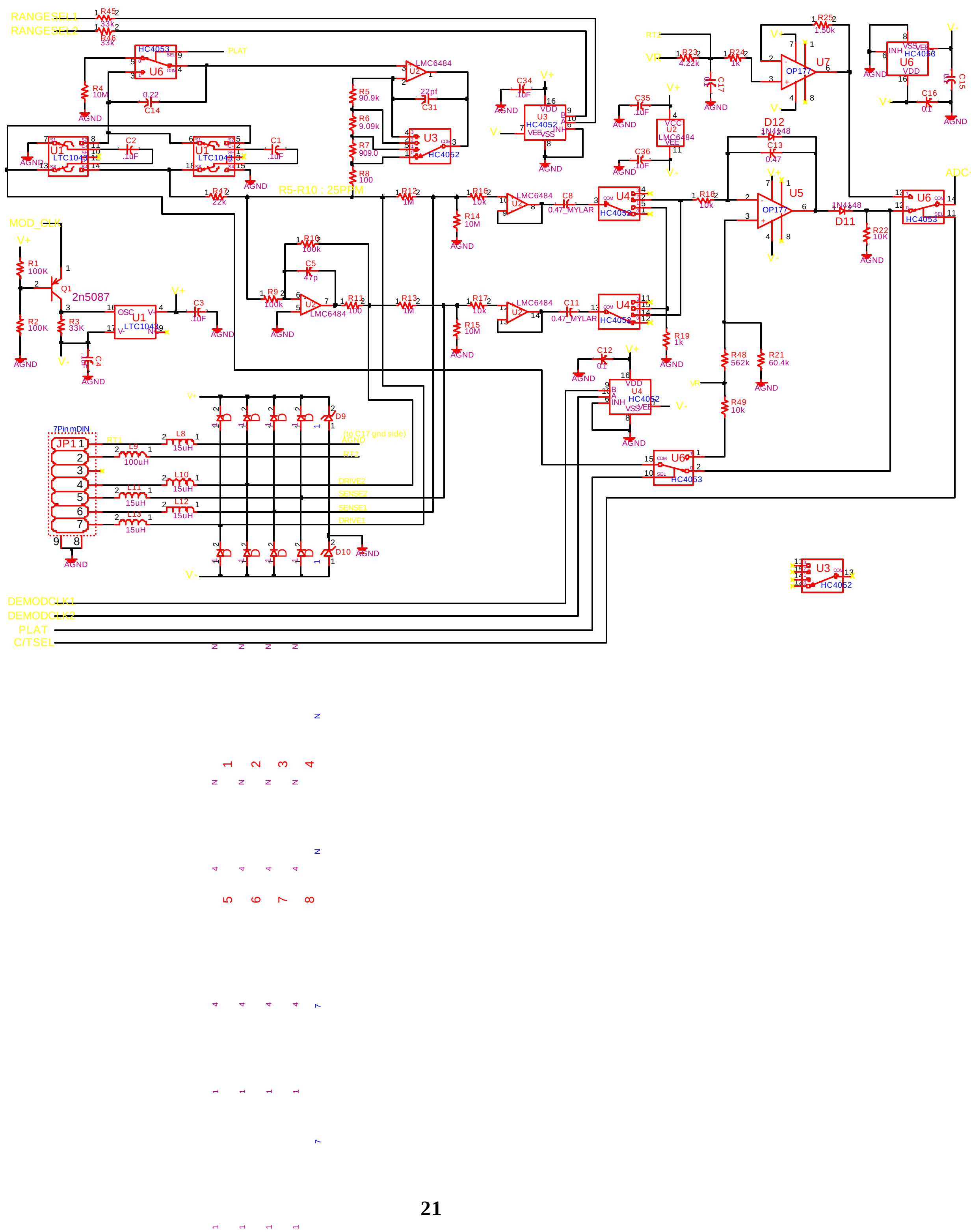
U1 is a switched-capacitor device that converts the DC programming voltage to a symmetrical square-wave which provides the floating reference voltage for current source U2a. U1 gets its clock from the system controller via level-shifter Q1. Current source U2a uses reference resistors R5 - R8 as selected by analog switch U3, which provides four decade ranges of cell current. The cell drive current is supplied by U2a, and returned through inverting current-sink U2b, which provides a cell drive that is symmetrical with respect to circuit common. The potential across the cell is buffered by U2c and U2d, and sampled by U4 acting as a synchronous demodulator to convert the cell potential into a DC voltage. The demodulator uses a center-sampling technique to minimize both series and parallel capacitance errors. The demodulator output is compared to a reference voltage of 120mV by integrating comparitor U5, which provides the reference voltage for the square-wave current source, and the input voltage for the conductivity channel of the A/D converter MUX U6c.

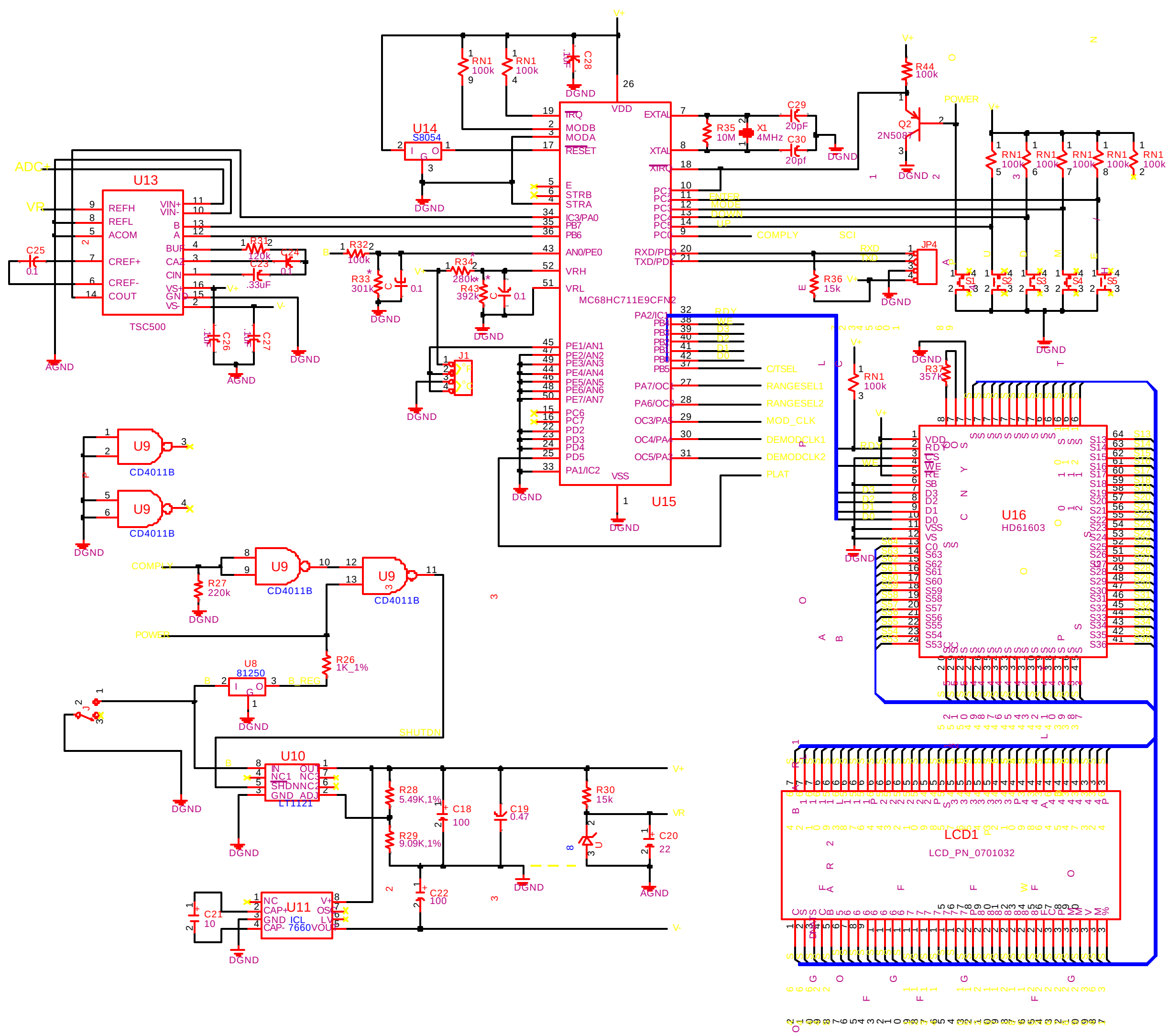
Conductivity cell platinization is provided by U6a and U6b, which open the main feedback loop, and use the system reference voltage as the programming voltage for the current source. The current source is clocked at 0.05Hz to provide platinizing current which switches polarity every 10 seconds.

Temperature is measured by a thermistor connected to the input of buffer-amp U7. Current through the thermistor is supplied from the system reference through precision resistor R23. The output of U7c is connected to the temperature channel of A/D MUX U6c.

Analog-to-digital conversion is done by dual-slope integrator U13. U13 (TSC500A) is the analog half of an A/D, which provides all of the signal switching and buffering functions, but leaves the timing and control to the system controller.

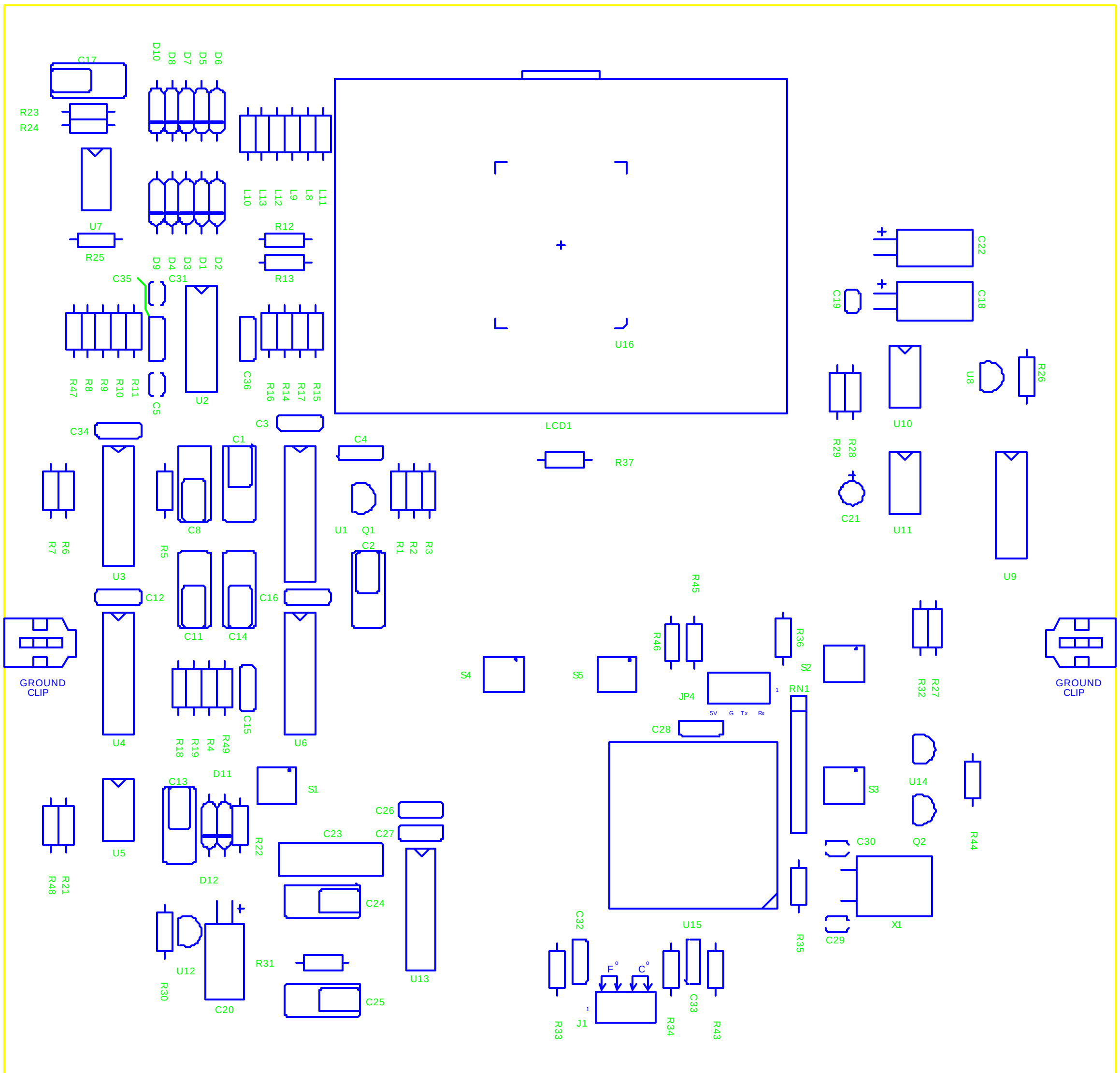
9. Schematic Diagrams





Important: U15, Microcontroller, is not field replaceable because it programed for a specific board during factory calibration.

10. Board Layout

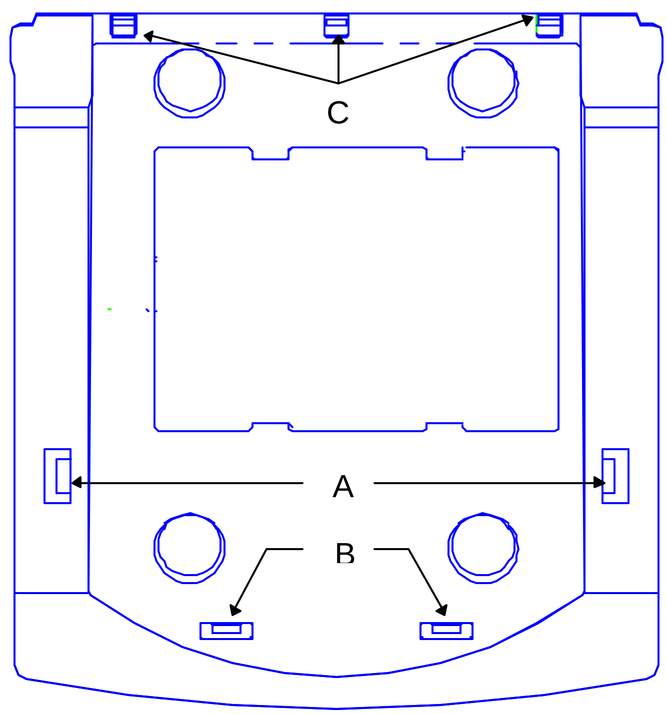


11. PC Board Parts List

Reference Designator(s)	Description	YSI Part #
R1, R2, R9, R10, R32, R44	Res, 100K, 1%, 1/4W	3161001
R3, R45, R46	Res, 33K, 5%, 1/4W	031204
R12, R13	Res, 1.0M, 5%, 1/4W	041032
R5	Res, 90.9K, 1%, 1/4W	031249
R6, R29	Res, 9.09K, 1%, 1/4W	031205
R7	Res, 909K, 1%, 1/4W	031206
R8	Res, 100, 1%, 1/4W	031207
R48	Res, 562K, 1%, 1/4W	031208
R11	Res, 100, 5%, 1/4W	031248
R4, R14, R15, R35	Res, 10.0M, 5%, 1/4W	031210
R19, R24, R26	Res, 1.0K, 1%, 1/4W	031247
R21	Res, 60.4K, 1%, 1/4W	031212
R16~18, R22, R49, R50	Res, 10K, 5%, 1/4W	040838
R23	Res, 4.22K, 1%, 1/4W	092806
R25	Res, 1.50K, 1%, 1/4W	031246
R27	Res, 220K, 5%, 1/4W	031213
R28	Res, 5.49K, 1%, 1/4W	040813
R30, R36	Res, 15.0K, 5%, 1/4W	031215
R31	Res, 120K, 1%, 1/4W	031216
R37	Res, 357K, 5%, 1/4W	031220
R51	Res, 22.1K, 5%, 1/4W	031221
RN1	Res Network, 100K, SIP	031145
C1, C2, C17, C24, C25	Capr, MPE, 0.1µF, 63V	031223
C3, C4, C12, C15, C16, C26~28, C32~36	Capr, Multi, 0.1µF, 50V	031224
C5	Capr, Cer, 47pF	031225
C29~31	Capr, Ce, 22pF	031226
C14	Capr, MPE, 0.22µF, 63V	031227
C8, C11, C13	Capr, MPE, 0.47µF	031228
C18, C22	Capr, Ele, 100µF, 16V	031229
C19	Capr, Multi, 0.47µF, 50V	031230
C20	Capr, Ele, 22µF, 16V	069864
C21	Capr, Ele, 10µF, 16V	031231
C23	Capr, MPE, 0.33µF, 63V	031232
D1~8, D11	Diode, 1N4148	031201
D9, D10	Diode, Zener, 7.5V	031202
U1	IC, LTC1043CN	060873
U2	IC, LMC6468, OP Amp	031234
U3, U4	IC, 74HC4052BCN, Multiplexer	031250
U5, U7	IC, OP177GP, OP Amp	031236
U6	IC, CD4053BCN, Multiplexer	031237
U8	Regulator, S8125OHG	031238
U9	IC, CD4011BCN, NAND	078595
U10	IC, LT1121CN8, Regulator	031239
U11	IC, TC7660CPA, DC-DC Con.	031240
U12	Low Volt Ref, ICL8069DCZR	031241
U13	IC, TC500CPE, Analog Process	031242
U14	Detector, S8054ALR	031243
U16	IC, HD61603, LCD Driver	031245
Q1, Q2	Transistor, 2N5087, PNP	031203
X1	Crystal, 4.0 MHZ	031146
JP1	Conn, Mini-DIN, 7-Pin	031149
JP2	Battery Conn, Switch	031148
JP4, JP1	Conn., 4 pin wafer	031144
S1~S5	Switch, SMT, Single Pole	031251
L8, L10~L13	Inductor, 15µH ±10%	031253
L9	Inductor, 100µH ±10%	031254
	Bracket, LCD	031154

12. Disassembly/Assembly Procedures

NOTE: The following procedure should only be performed by a qualified service technician.



Case Disassembly

- While applying slight separation force to the front, curved edge of the case near one corner, use a small straight-blade screwdriver to release the snap (A) on the same side.
- When that snap releases, keep applying the separation force, and use the screwdriver to release the front snap (B) nearest the same corner.
- Repeat the procedure on the other corner to release both front and both side snaps.
- Swing the case open slowly, pivoting on the three rear snaps (C) until they release.
- Lay the lower case assembly to the side.

12.2 PC Board Removal

- Gently release the two snaps nearest the front, curved edge of the unit.
- With the snaps released, lift the front of the board slightly and slide the board out of the rear connector openings.

PC Board Re-installation

- Remove the protective covering from the display. DO NOT TOUCH THE FACE OF THE DISPLAY, FINGERPRINTS AND DUST CANNOT BE EASILY REMOVED.
- Slip the connector end of the board into place against the gaskets at the rear of the case, then rotate the board down into position, engaging each snap as you go. Be sure that the switch extenders line up with the switches.
- Inspect the assembly to insure that all board snaps are fully engaged and the board is in the proper position in the case. Turn the assembly over and activate each switch. Be sure you can hear and feel each switch click as it is pressed.

Case Re-assembly

- Hook the three snaps at the rear of the case into place and rotate the lower case assembly into place on the upper case. Make sure all four snaps are fully engaged. Press firmly down on the three rear snaps to make sure they are completely engaged.

13. Replacement Parts and Accessories

YSI Item #	Description	Comments
003208	3208 Power Supply, 115 VAC	
003209	3209 Power Supply, 240 VAC	
031008	Overlay, Window	
031009	Overlay, Keypad	
051009	Window	
113117	Board Assy, PC, Main	
113138	Case Assy, Upper	
111027	Case Assy, Lower	Includes 003226 weight
003226	Weight, SS	
051043	Foot, Rubber, Self-Stick	
032061	Gasket, Connector, Cell	
032063	Gasket, Connector, Power	
051025	Standoff, .25, Snap-In	Retain display
031155	Display, Liquid Crystal	LCD1
003228	Extension, Switch	
031041	Operations Manual	
031043	Service Manual	
003229	Cable Assy, Cell	7-pin mini DIN to pigtail
3232	Cell adapter	For YSI 3400 Series cells
3166	Calibrator resistor set	Requires 3232 cell adapter

14. Instrument Specifications

Modes:
Conductivity
Temperature compensated conductivity
Salinity
Temperature

Conductivity:

Range	Accuracy	Resolution	Frequency
0 - 49.99 µS*	± 0.5% full scale	0.01 µS	70 Hz
0 - 499.9 µS	± 0.5% full scale	0.1 µS	70 Hz
0 - 4999 µS**	± 0.5% full scale	1 µS	240 Hz
0 - 49.99 mS***	± 0.5% full scale	0.01 mS	1562 Hz
0 - 499.9 mS****	± 0.5% full scale	0.1 mS	1562 Hz

Salinity:

Range	Accuracy	Resolution
0-80 ppt (NaCl)	±2% or ±0.1 ppt	0.1 ppt

Temperature:

Range	Accuracy	Resolution
-5 - 95°C	±0.1°C +1LSD	0.1°C

Temperature Compensation:
Method: Linear
Ref. temp., °C: 15 - 25
Temp. Coefficient: 0 - 4%/°C

Cell constant, cm^{-1} :
0.01
0.08 - 0.12
0.8 - 1.2
8 - 12

Power Adaptor: AC, 115V, 220V

Instrument Power: 12 VDC, 300mA max

Approvals: UL, CSA, CE

Environmental requirements: 95% RH non-cond

Size: 9 x 9.5 x 4.4 inches 22.9 x 24.1 x 11.2 cm

Weight: 2.6 pounds 1.1 kg

* Requires a cell constant of K=0.01, K=0.1 or K=1.
** Requires a cell constant of K=0.1, K=1 or K=10.
*** Requires a cell constant of K=1 or K=10.
**** Requires a cell constant of K=10.