xylem

USER MANUAL
527626

YSI 2900 Series Biochemistry Analyzers

OPERATIONS AND MAINTENANCE MANUAL

YSI
a xylem brand

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1. Introduction

1.1 Description

The 2900 Series Biochemistry Analyzer is a laboratory instrument intended for use in research, food-processing and bioprocessing applications. **THE 2900 Series IS NOT FOR HUMAN MEDICAL DIAGNOSTIC USE OR FOR HUMAN PERFORMANCE EVALUATION.**

The 2900 Series can be set up to measure up to 6 different analytes in a sample. The total number of analytes depends on the number of sample modules installed (up to two analytes per module) and the number of different buffers required (up to three buffers). Available analytes are listed below.

- Ammonium
- D-Glucose (Dextrose)
- L-Lactate
- L-Glutamate
- L-Glutamine
- Glycerol
- Xylose
- Choline
- Potassium
- Hydrogen Peroxide[1]
- Sucrose
- Ethanol
- Methanol
- Galactose[1]
- Lactose

Additional analytes are currently under development. For a current listing, please contact YSI Life Sciences Technical Support (937 767-2769 or 800 659-8895 extension 2) or visit the YSI Life Sciences web site at www.ysi.com/lifesciences.

1.2 User Features

Slim modular design	Easily expand analytes or chemistries Multiple units use much less bench space
Proprietary enzyme electrode	Fast, accurate, and analyte-specific results
Uses biological separation technology	No hazardous chromatography solvents to dispose of
Icon-driven user interface with touchscreen	Easy to learn
Data download options	Save data on a USB drive, send it over the network, or access it in a searchable database anytime
Onboard training videos	Minimizes operator learning curve
21 CFR Part 11	Regulatory compliance

1.3 Models

- 2900D 2900 Biochemistry Analyzer with 1 biosensor module
- 2900M 2900 Online Monitor & Control System
- 2950D-0 2950 Biochemistry Analyzer with 1 biosensor module
- 2950D-1 2950 Biochemistry Analyzer with 2 biosensor modules
- 2950D-2 2950 Biochemistry Analyzer with 3 biosensor modules
- 2950D-3 2950 Biochemistry Analyzer with 2 biosensor modules and 1 ISE module
- 2950D-4 2950 Biochemistry Analyzer with 1 biosensor module and 1 ISE module
- 2940 4-Channel Online Monitor System
- 2960 1-Channel Online Monitor and Control Accessory
- 2980 8-Channel Online Monitor System

[1] YSI does not currently offer calibration standards for this analyte.

1.4 2900 Series General Specifications

Sample size ..... Adjustable from 10 to 50 microliters (aspirated volume), per module

Response time ..... Enzyme Sensors

- Sample results in 60 seconds (average) for one module
- 100 seconds for 2 modules
- 135 seconds for 3 modules
- Complete sample-to-sample cycle in less than 3 minutes (May vary with analyte and sample matrix.)

Ion Selective Electrodes (ISE)

- Sample results in 150 seconds (average) for 2 modules
- 195 seconds for 3 modules
- Complete sample-to-sample cycle in less than 5 minutes (May vary with analyte and sample matrix)

Output signals:

Serial ..... USB and RS232


Power requirement — 100–240 VAC ±10%
50–60 Hz ±5%
42 Watts nominal

Working environment:

Ambient temperature ..... 15–35°C

Relative humidity ..... 10–75% (non-condensing)

Regulatory compliance ..... ETL, CE, RoHS
61010-1 compliance:

- Pollution degree 2
- Installation category 2
- Altitude 2000m
- Atmosphere 75 KPa to 106 KPa
- Indoor use only

Instrument dimensions ..... 2950: 25.5" wide x 20.5" deep x 15.75" high (65 cm x 52.1 cm x 40 cm)
2900: 12" wide x 20.5" deep x 15.75" high (30.5 cm x 52.1 cm x 40 cm)

Instrument weight ..... 2950: 46 pounds (20.9 kilograms)
2900: 30.5 pounds (13.9 kilograms)

1.5 2960 Online Monitor Specifications

1.5.1 Monitor

Size:

Monitor Cup ..... 0.75 x 0.75 x 0.88 inches

Pump Head ..... 2.0 x 2.2 x 0.85 inches

Sample Inlet Tubing ..... Silicone, 0.08 OD x 0.02 ID (inches)

Volume ..... 5.1 microliters/inch

Inlet Channel Pump Tubing ..... PharMed®, 0.13 OD x 0.035 ID (inches)

Valve Tubing ..... 0.03 ID (inches)

Wasteline Tubing ..... Silicone, 0.16 OD x 0.10 ID (inches)

Nominal Flow Rate (inlet line) ..... 100–2500 microliters/minute (± 8% @ ± 6 PSI)

1.5.2 Analog/Control

Full Scale Voltage ..... Selectable: +10.00 VDC or +5.00 VDC

Full Scale Concentration ..... User selectable

Resolution ..... 1:65,536 or 0.0015% FS,
0.153 mv on +10.00 VFS,
0.076 mv on +5.00 VFS

Maximum Gain Error ..... ±12 LSB

Linearity ..... ±1 LSB

Minimum analog output Load Impedance ..... 2K Ohms

Logic output drive ..... 0 and 5 VDC nominal at 10 milliamps

Logic Input levels ..... < 0.8 VDC = logic 0,
> 2.0 VDC = logic 1

2. Safety

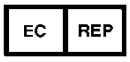
2.1 Important Safety Instructions

DO NOT PLUG THE INSTRUMENT IN AT THIS TIME. You should apply power only when directed to do so in the setup instructions.

1. Use ONLY the line power cord supplied with the instrument. When directed to, connect the plug to a matching three-pronged wall receptacle.
2. Use ONLY fuses of the type supplied. Replacement power cords and fuses can be obtained from YSI, or your Dealer Representative.
3. Do NOT use an extension cord without protective grounding.
4. Do NOT remove rear cover. There are no user serviceable parts inside.
5. Repairs are to be performed only by trained and approved personnel.
6. This instrument must be connected to a protectively grounded (earthed) outlet.
7. The following notice is provided in compliance with IEC1010 Part 1 1990.
   See Appendix for mains plug wiring and fusing instructions.
8. If the equipment is used in a manner not specified by YSI, the protection provided by the equipment may be impaired.

   WARNING: For RS232 or USB connection, equipment should be EN/CSA/UL 61010 or EN/CSA/UL 60950 approved only.
9. The mains (power) switch is for functional purposes ONLY. To disconnect the instrument from the mains supply, unplug the mains power cord from the back of the instrument.
10. Personal protective equipment (PPE) recommended—protective gloves and safety goggles or glasses.

2.2 Explanation of Symbols

	WARNING AVERTISSEMENT	Warning indicates that misuse of the instrument could result in death or serious injury to a person. Un avertissement indique qu'une mauvaise utilisation de l'instrument peut entraîner la mort ou une blessure grave chez une personne.
	CAUTION ATTENTION	Caution, consult accompanying documents. Caution indicates that misuse of the instrument could result in mild or serious injury to a person and/or damage to equipment. Attention, consulter la documentation jointe. Cette mise en garde indique qu'une mauvaise utilisation de l'instrument peut entraîner une blessure légère ou grave chez une personne et/ou un endommagement du matériel.
		Biological Risks Risques biologiques
		Chemical Irritant Irritant chimique
		Manufacturer Fabricant
		Authorized Representative in the European Union Représentant agréé dans l'Union européenne
	2776	Catalog number Numéro de référence
	20A100549	Lot number Numéro de lot
	YEAR-MO	Date of manufacture Date de fabrication
	YEAR-MO-DY	Use by Date Date limite d'utilisation
		Temperature Limitation Limite de température

3. Getting Started

3.1 Unpacking

When you unpack your new 2900 Series for the first time, check the packing list to make sure you have received everything listed. Note that reagents for the 2900 Series are not packaged in the same carton as the instrument. If there is anything missing or damaged, call the dealer from whom you purchased the 2900 Series. If you do not know which of our authorized dealers sold the system to you, call YSI Life Sciences Customer Service at 800 659-8895 or 937 767-7241, and we'll be happy to help you.

1. After removing the instrument from the shipping box, tilt the display to the full upright position.

Figure 3-1

2. Grasp the hand hold in the right side cover of the instrument and pull up and out to remove the cover.
   NOTE: Leave the cover off the instrument until you have aligned the sipper and installed the membranes as described in the following sections.
3. Carefully cut the tie strap holding the sipper.

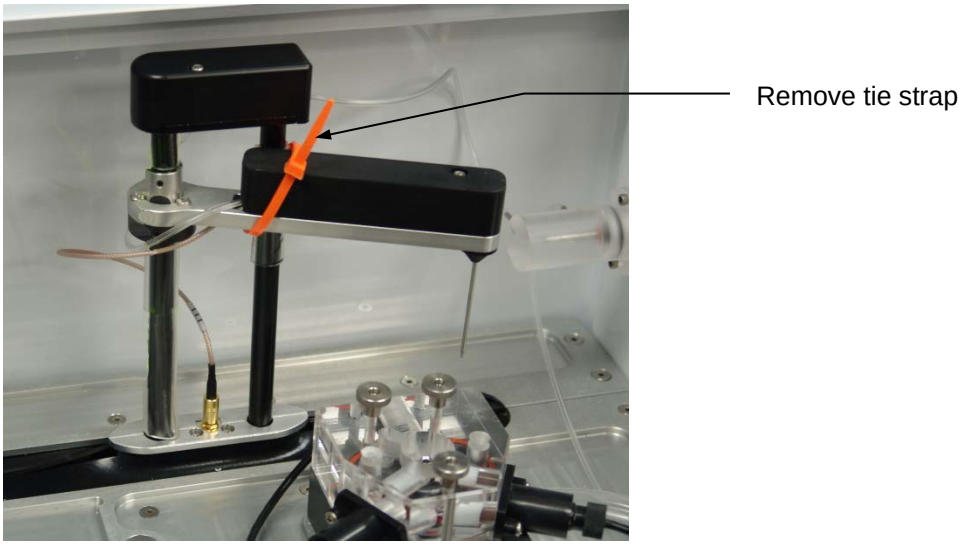


Figure 3-2

3.2 Warranty Card

Please complete the Warranty Card or register your purchase online at www.ysi.com/customer-support/warranty-card. This will record your purchase of this instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your 2900 Series should ever need repair.

3.3 What You Need

Several things are needed in order to analyze samples using the 2900 Series. The following list shows the basic items required.

- 2900 Series Instrument (with AC Power Cord)
- Bottle Racks with Reagent Level Sensing (YSI 2936, 2938
- YSI Buffer(s)
- YSI Calibrator Standard(s)
- YSI Linearity Standard(s)
- YSI Membrane(s)
- YSI ISE probes (2950D-3 and 2950D-4 models only)
- YSI 2960 Online Monitor (optional)
- YSI 2901 Printer (optional)

3.4 Major Components

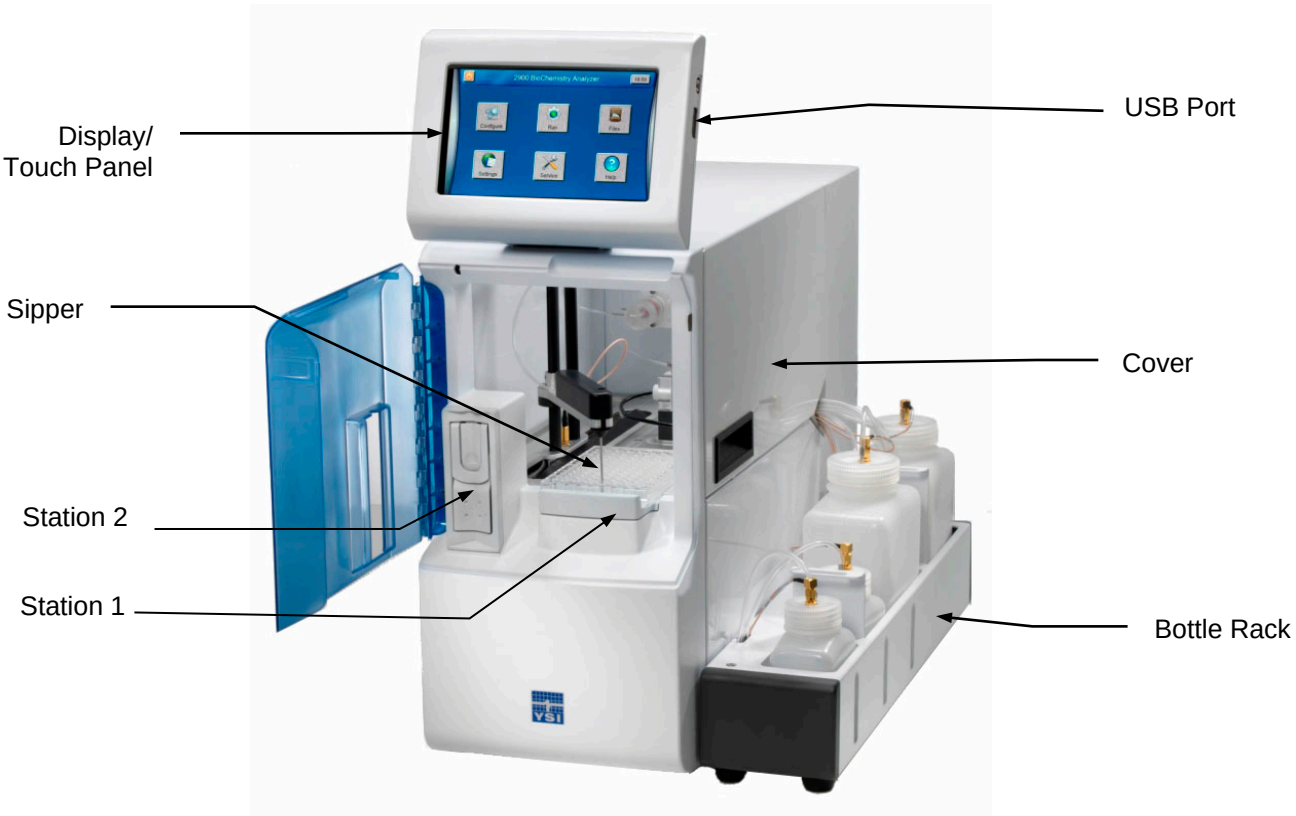


Figure 3-3

Display	Graphical color LCD covered by a touch screen
USB ports	The USB ports allow a flash drive to be connected to the 2900 Series to download sample results or upgrade the instrument's software. A USB port is located on the right side of the display. An additional USB port is located on the rear of the instrument. The rear port is used to connect the 2960 Online Monitor to the 2900 Series.
Sipper	Can be raised, lowered, rotated, and moved horizontally to its various positions. The positions are: Calibrator Wells, Sample Module, Stations 1 and 2, and Monitor Sample Cup. The Sipper senses fluid level to control immersion depth and detect errors.
Station 1	Plate and rack holder accepts most standard plates/racks for batch sampling of up to 96 samples.
Station 2	Test tube holder for manual sampling.
Buffer Pumps *(not shown)*	Draw buffer from the buffer bottles, pump it through the Valves, Sipper Pump and the Sipper, and flush the Sample Module.
Calibrator Pumps *(not shown)*	Draw the appropriate standard solution from the Calibrator Bottles and fill the Calibrator Wells.

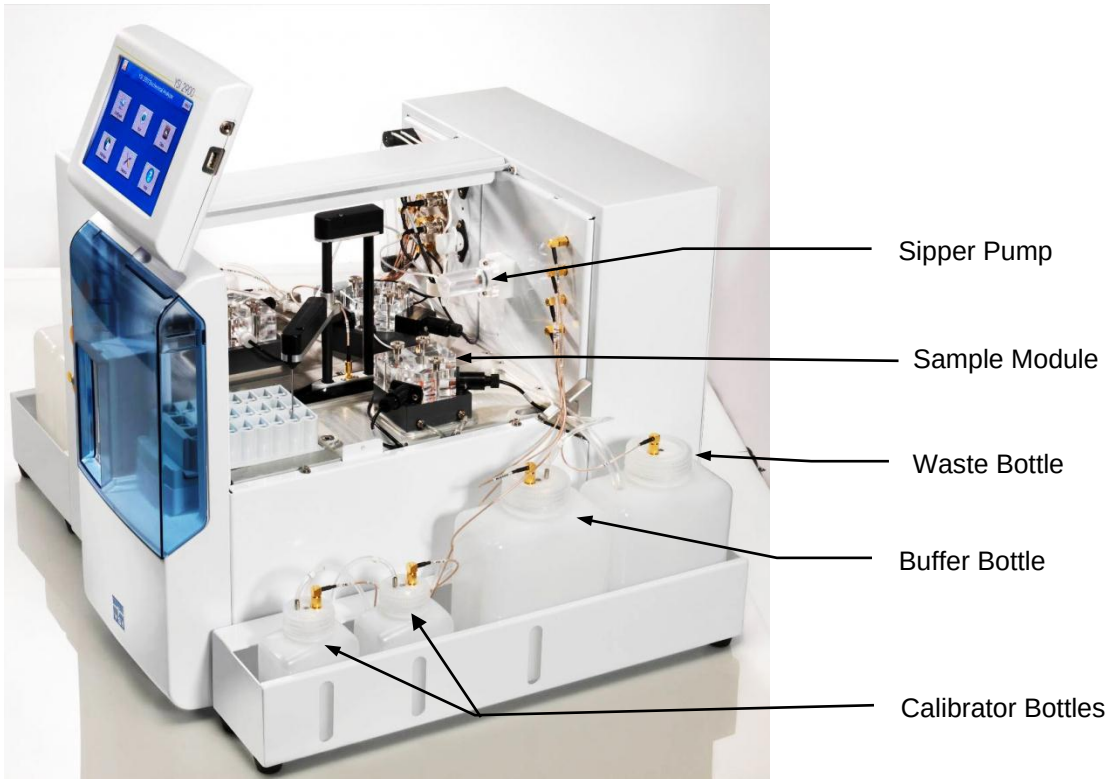
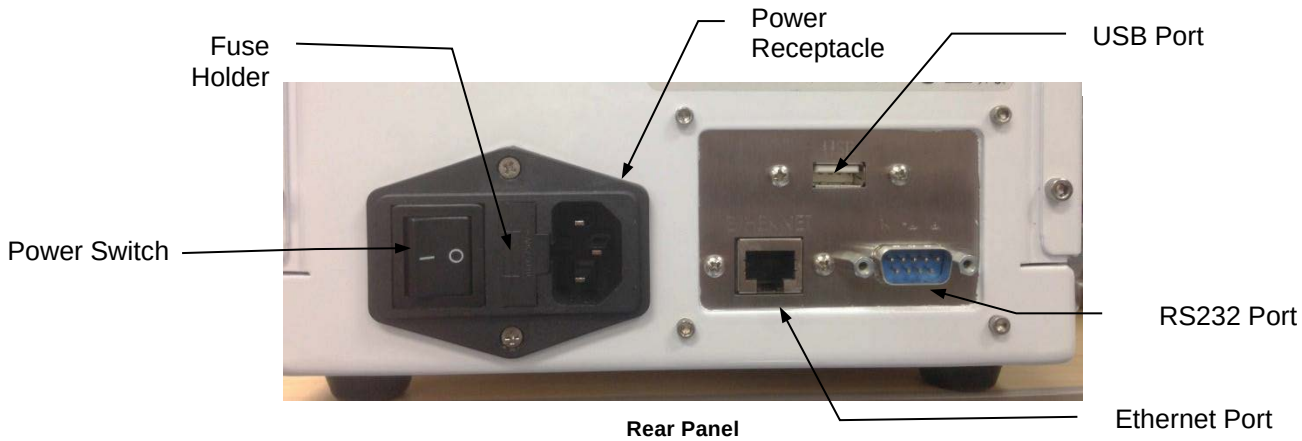


Figure 3-4

Sipper pump	It retracts its piston to draw standard from the Calibrator Wells or sample from the sample stations. It extends its piston to dispense standard or sample into the sample module.

Sample modules	They are made of clear acrylic plastic. Sensor probes are screwed into either side of the module. In biosensor modules, the immobilized enzyme membranes are mounted on O-rings which act as fluid seals. In ISE modules, an O-ring is positioned inside a sleeve on the end of the electrode. A reference or auxiliary electrode is housed in the temperature probe and positioned at the back of the Sample module.
Stir Bars *(not shown)*	They are plastic encapsulated magnets. They are activated by motors housed below the sample modules. They provide thorough mixing inside the sample modules.
Buffer, Waste and Calibrator Bottles	Are conveniently located for maintenance. Fluid levels are monitored by sensors. Operation is automatically halted when the Buffer or Calibrator Bottles are empty, or when the Waste bottles are full.



Rear Panel
Figure 3-5

Power Switch	The main power switch is an on/off rocker switch (0-off and I-on) located on the back of the instrument
Fuse Holder	The fuse holder houses the power line fuse and opens up for fuse replacement.
Power Receptacle	One end of the power cord (supplied) plugs into this receptacle, while the other end plugs into a properly grounded electrical outlet. The instrument will automatically adjust the voltage as needed.
Ethernet Port	It allows connection to a network or router via an RJ45 Ethernet port.
RS232 Serial Port	The RS232 connection is a standard DB9F connector. It is used to interface with the YSI 2901 Printer, YSI 2940 or 2980 Multi-Channel Online Monitor, YSI 2920 OPC Data Manager, or a remote host.

4. Basic Setup

The following list describes the basic steps necessary for sampling with the 2900 Series.

1. Install Bottle Racks
2. Connect Printer (optional)
3. Connect AC Power
4. Connect 2960 Online Monitor, 2940 4-Channel Online Monitor, or 2980 8-Channel Online Monitor (optional)
5. Align Sipper
6. Prepare and Install Buffer solution(s)
7. Install Calibrator Solution(s)
8. Prime the Fluid System
9. Install Membrane(s) and ISEs
10. Configure Instrument Chemistries
11. Check Probe Currents

4.1 Install Bottle Racks

4.1.1 Right Side

1. Install the YSI 2938 Bottle Rack with Reagent Level Sensing onto the right side of the instrument by sliding the slots in the tray over the pins on the side of the instrument.
2. Then remove the packing material holding the tubing to the right side of the instrument.
3. Next, connect bottle tubing and cables
    a. Insert the large diameter waste tube into the hole in waste bottle 1.
    b. Connect one end of a short cable to the threaded fitting on the waste bottle 1 cap and connect the other end to the Waste 1 (top) fitting on the instrument.
    c. Connect the tubing marked “B1” and one end of a short cable to the fittings on the buffer bottle 1 cap and connect the other end of the cable to the Buffer 1 (2nd) fitting on the instrument.
    d. Connect the tubing marked “C1B” and one end of a long cable to the fittings on the second calibrator bottle cap and connect the other end of the cable to the CAL 1B (3rd) fitting on the instrument.
    e. Connect the tubing marked “C1A” and one end of a long cable to the fittings on the first calibrator bottle cap and connect the other end of the cable to the CAL 1A (bottom) fitting on the instrument.

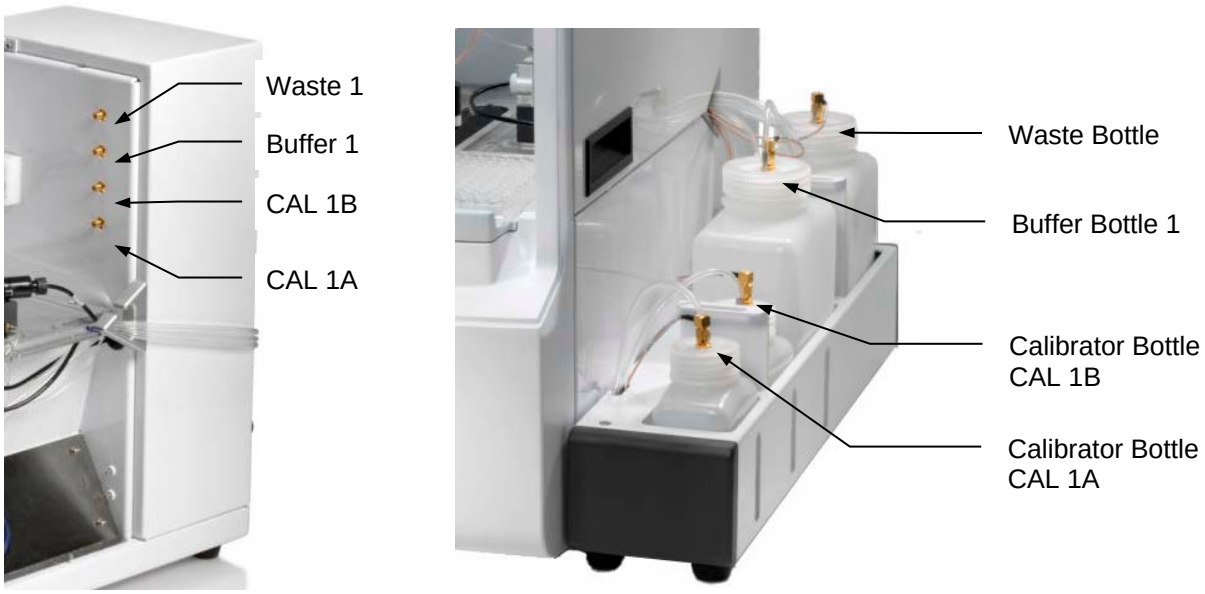


Figure 4-1

4.1.2 Left Side (2950 models only)

2. Install the YSI 2936 Bottle Rack with Reagent Level Sensing onto the left side of the instrument by sliding the slots in the tray over the pins on the side of the instrument.
3. Then remove the packing material holding the tubing to the left side of the instrument.
4. Next, connect bottle tubing and cables
    a. Insert the large diameter waste tubing into the holes in waste bottles 2 and 3.
    b. Connect one end of a long cable to the threaded fitting on the waste bottle 2 cap and connect the other end to the W2 (top left) fitting on the instrument.
    c. Connect one end of a long cable to the threaded fitting on the waste bottle 3 cap and connect the other end to the W3 (top right) fitting on the instrument.
    d. Connect the tubing marked “B2” and one end of a long cable to the fittings on the buffer 2 bottle cap and connect the other end of the cable to the B2 (2nd from top on left) fitting on the instrument.
    e. Connect the tubing marked “B3” and one end of a long cable to the fittings on the buffer 3 bottle cap and connect the other end of the cable to the B3 (2nd from top on right) fitting on the instrument.
    f. Connect the tubing marked “C2A” and one end of a short cable to the fittings on the calibrator 2A bottle cap and connect the other end of the cable to the 2A (bottom left) fitting on the instrument.
    g. Connect the tubing marked “C2B” and one end of a short cable to the fittings on the calibrator 2B bottle cap and connect the other end of the cable to the 2B (3rd from top on left) fitting on the instrument.
    h. Connect the tubing marked “C3A” and one end of a short cable to the fittings on the calibrator 3A bottle cap and connect the other end of the cable to the 3A (bottom right) fitting on the instrument.
    i. Connect the tubing marked “C3B” and one end of a short cable to the fittings on the calibrator 3B bottle cap and connect the other end of the cable to the 3B (3rd from top on right) fitting on the instrument.

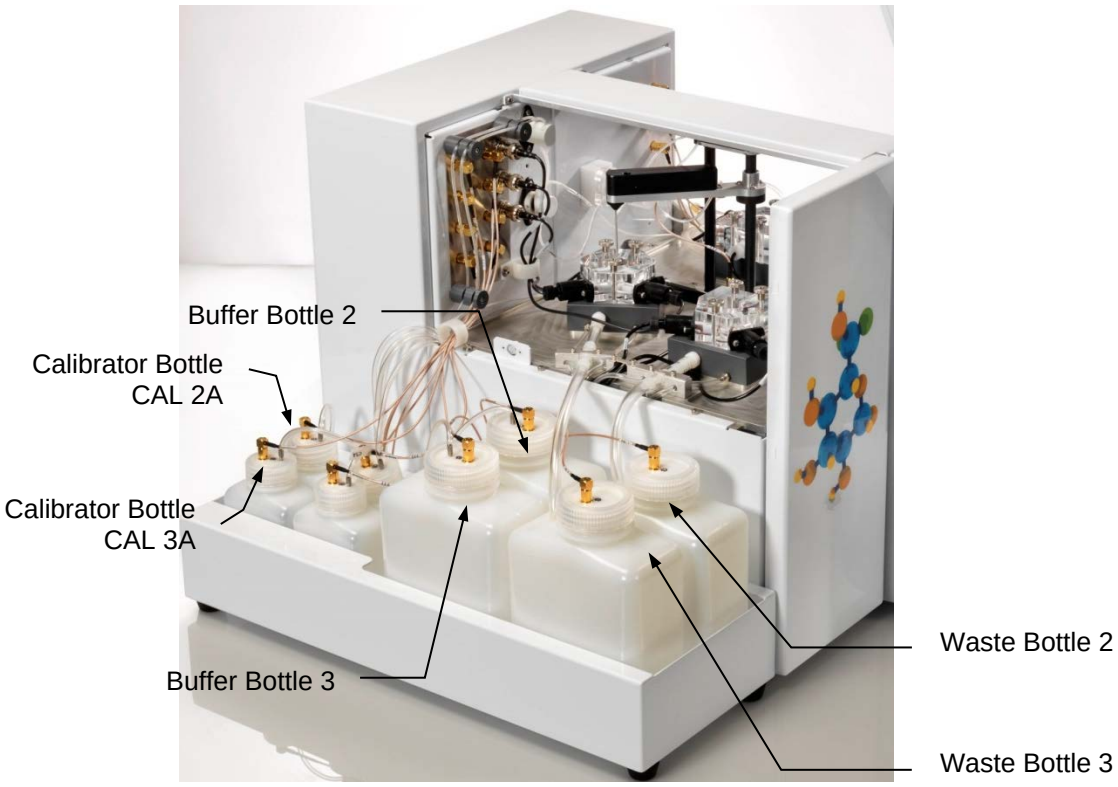


Figure 4-2

4.2 Connect Printer

Connect the optional YSI 2901 Printer to the 2900 Series Biochemistry Analyzer using the data cable provided. The small RJ12 connector plugs into the bottom of the printer and the large DB9 connector plugs into the RS232 port on the back of the analyzer. Refer to the instruction sheet included with the printer for details of printer operation.

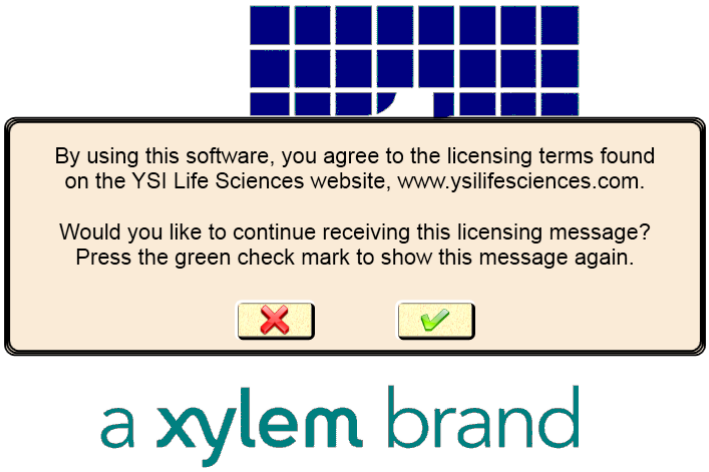
4.3 Connect AC Power

1. Plug the power cord (included with the 2900 Series Analyzer) into the power receptacle on the back of the instrument, then into a properly grounded electrical outlet provided with a 15 or 20 Amp circuit breaker. The instrument will automatically adjust the voltage as needed.
   If you are located outside the United States, see Appendix for Line Power Cord and Plug Wiring.

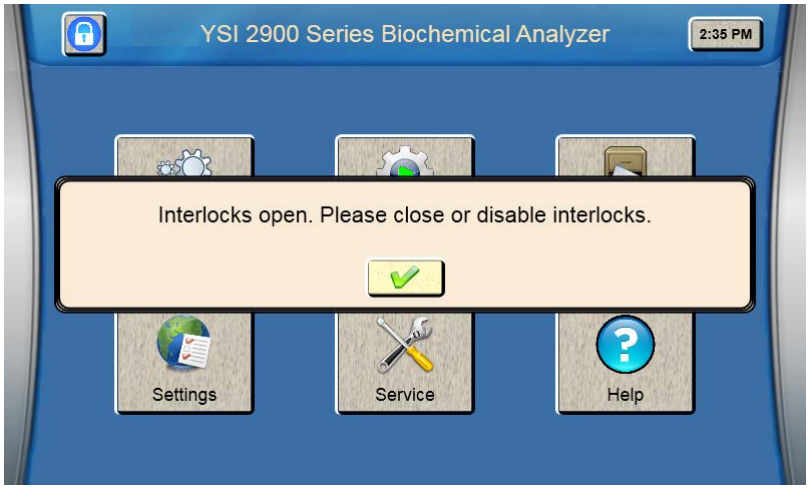
WARNING: Keep your hands clear of the sipper while the instrument is in operation.

2. Turn the instrument on with the main power switch on the rear panel. After about 30 seconds, the Initializing window should appear.

3. The first time the instrument is powered up, the software license window will appear. Touch [X] to prevent the license screen from appearing each time the instrument is turned on.



4. Since the top cover of the instrument is removed, the message below will appear.



5. Touch ☑ to confirm, then touch the Service icon.

6. Touch the Interlocks [On] button and change it to [Off] to disable the safety interlock, and then press ☑ to confirm.

4.4 Connect Online Monitor

If you will be using the 2960 Online Monitor, see Section 6.1 for instructions on how to connect it.

If you will be using the 2940 or 2980 Multi-Channel Online Monitor, refer to the *YSI Multi-Channel Online Monitor Operations and Maintenance Manual* for instructions on how to connect it.

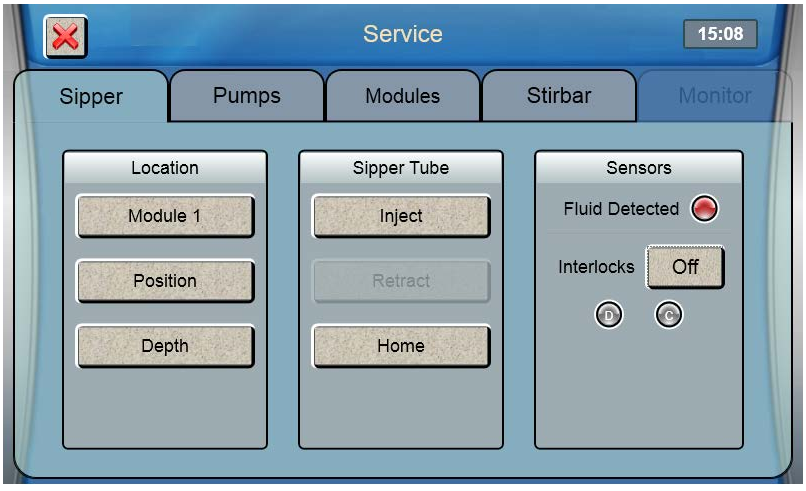
4.5 Align Sipper

It is very important that the sipper be accurately adjusted.

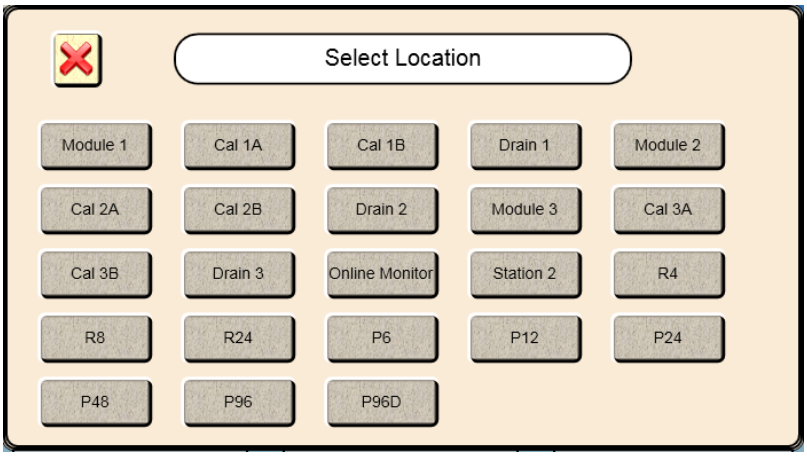
WARNING: Keep your hands clear of the sipper while the instrument is in operation.

1. From the Sipper tab of the Service screen, touch [Home].

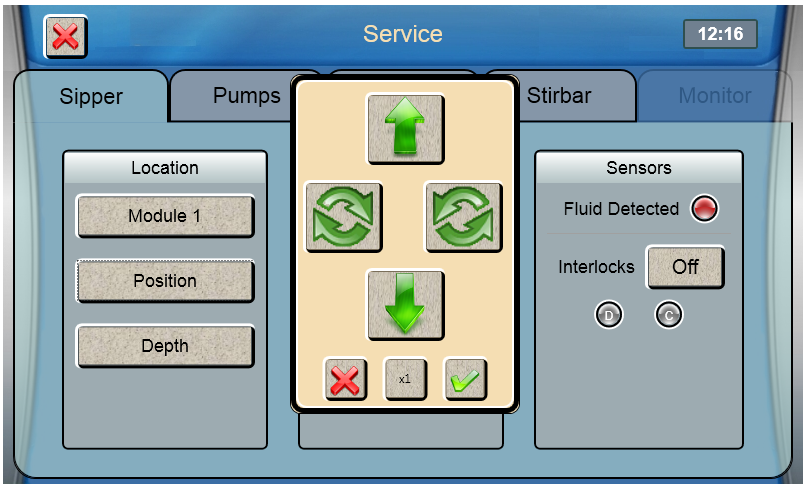
2. Once the sipper has moved to the home position, touch [Module 1].



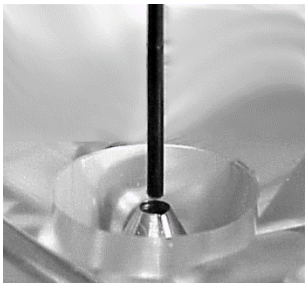
3. The Select Location screen will appear. Select [Module 1]. The sipper will move to sample module 1 and should be centered above the cone shaped opening in the top of the module.
If the sipper does not move, make sure the packing material was removed.



4. If the sipper is not centered, touch [Position] and use the arrow buttons to center the sipper.



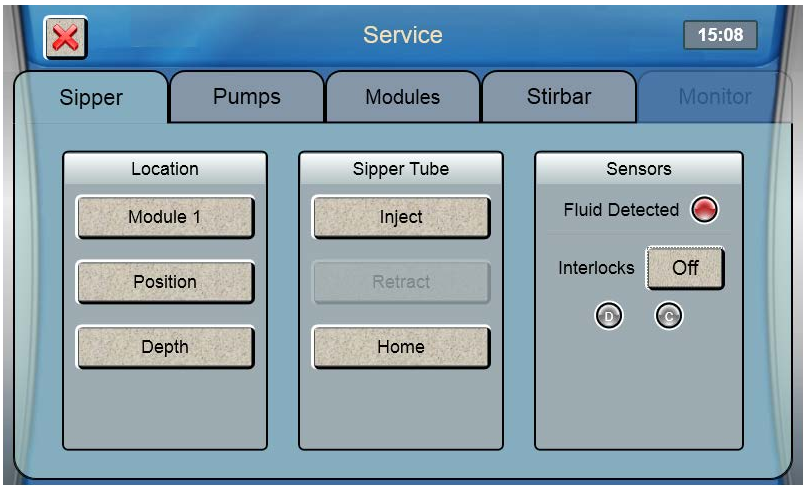
5. Make certain the Sipper is centered, then touch ☑ at the bottom right of the adjustment window.



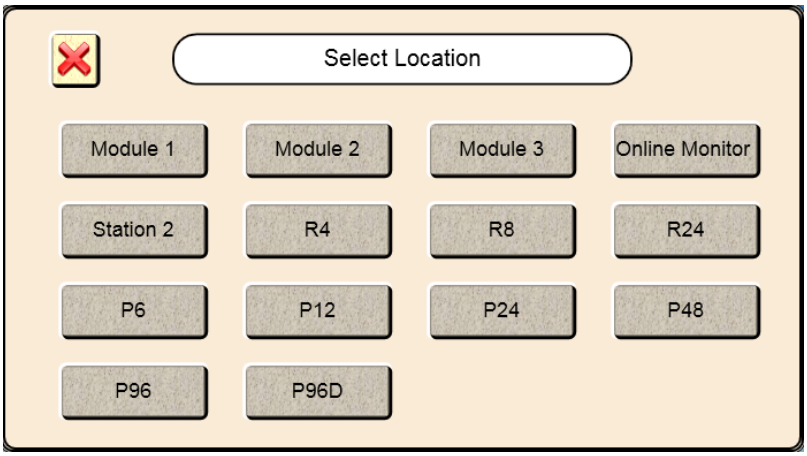
Sipper Adjustment Position
Figure 4-3

6. Touch ☑ to save the position and close the confirmation window.

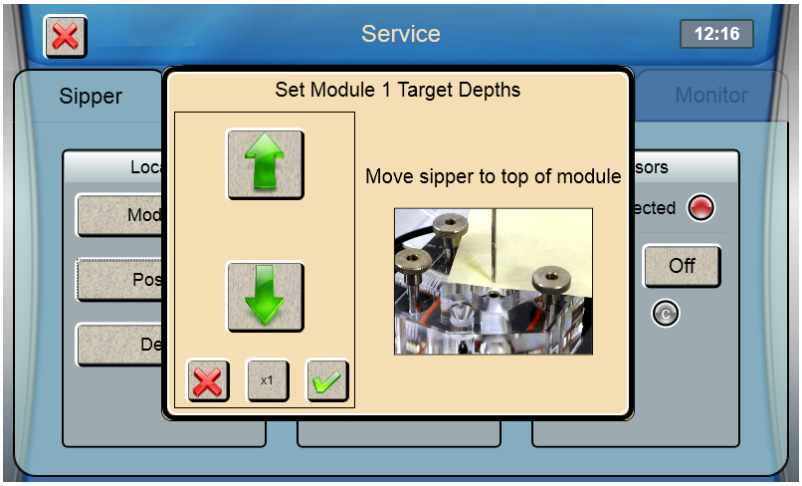
7. To test the alignment of the sipper, Touch [Inject] to lower the sipper, then touch [Retract] to raise the sipper back up. If necessary, touch [Position] and repeat the adjustment.



8. Once the sipper enters the sample module without hitting the cone, touch [Depth] to set the sipper depth. The Select Location screen will appear.



9. Select [Module 1]. The tip of the sipper should be right at the top of the module. Use the arrow buttons to lower or raise the sipper until the tip of the sipper is even with the top of the module.
10. Then touch ☑ at the bottom right of the adjustment window.



11. Touch ☑ to save the depth and close the confirmation window.
12. Check the sipper alignment at the Cal 1A, Cal 1B and Drain 1 locations and adjust the position if necessary.

13. Once you have aligned the sipper and properly set the depth, sipper alignment for Module 1 is complete. Touch [X] at the top left of the screen to return to the main display.

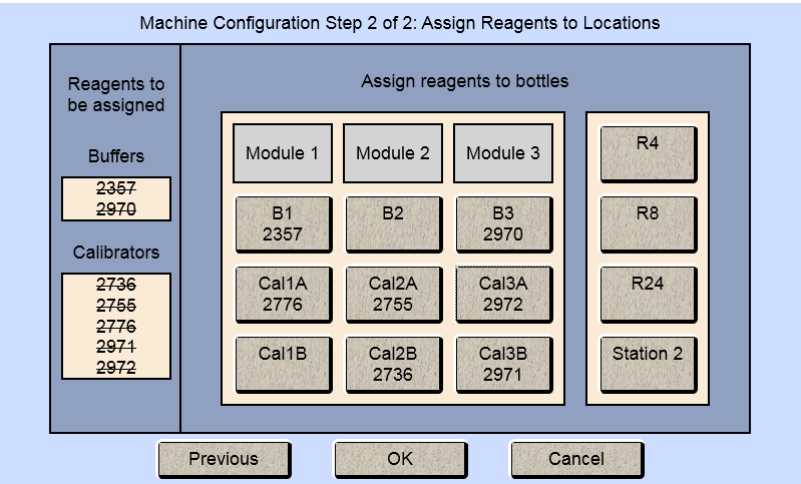
Repeat this procedure for any additional modules installed on your 2950 analyzer.

After you have aligned the sipper with all installed modules, touch the Interlock button and change it back to [On] to enable the safety interlocks.

4.6 Prepare and Install Buffer Solutions

> ⚠ **Caution: To prevent possible damage due to an electrostatic discharge, do NOT touch the metal tips of the connectors located at the ends of the bottle leads. Handle only the insulated section of the connectors.**

Prepare the system buffers and fill the buffer bottles as indicated on the display.



4.6.1 Prepare Buffer

4.6.1.1 From powder concentrate:

1. Place about 500 mL of reagent water (distilled or deionized) into a 1000 mL flask or other clean container.
2. Add two packages of powder buffer concentrate and stir.
3. Add more reagent water until the total volume of solution is between 900 and 1000 mL.
4. Stir as necessary until the buffer chemicals have completely dissolved.

4.6.1.2 From liquid concentrate:

Mix the content of the bottle of liquid buffer concentrate with enough reagent water (distilled or deionized) to make 1000 mL.

4.6.2 Install Buffer Solution(s)

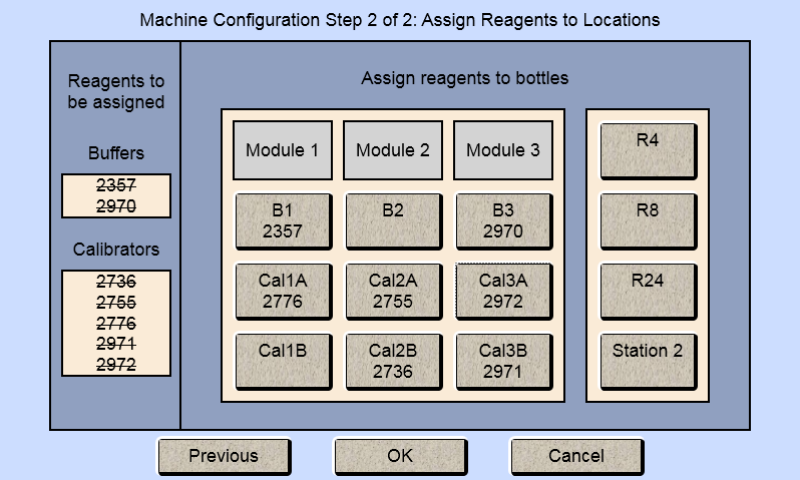
1. Unscrew and remove the lid from one of the buffer bottles.

IMPORTANT: When adding fresh buffer to the Buffer Supply Bottles, make every effort to avoid contamination of the lid and level sensor assemblies.

2. Pour the prepared buffer into the buffer bottle.
3. Install the bottle in the rack as indicated on the display.
4. Replace the bottle lid.

4.7 Install Calibrator Solution(s)

Caution: To prevent possible damage due to an electrostatic discharge, do NOT touch the metal tips of the connectors located at the ends of the bottle leads. Handle only the insulated section of the connectors.



1. Unscrew and remove the lid from the empty calibrator bottle (Cal1A–Cal3B as indicated).

IMPORTANT: make every effort to avoid contamination of the lid and level sensor assemblies.

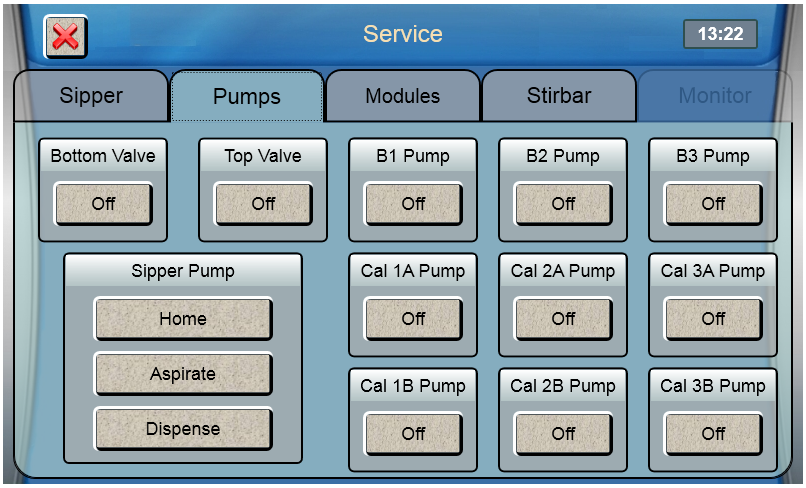
2. Mark the date of installation on the label of the new bottle of YSI calibrator solution.
3. Place the new bottle of calibrator in the bottle rack as indicated on the display.
4. Screw the lid and level sensor assembly onto it.
5. Repeat this process for any additional calibrator bottles (Cal1A–Cal3B as indicated).

4.8 Prime the Fluid System

Please note that it may take from several minutes to more than an hour to initially stabilize the probes when setting up for the **first time**.

To prime the fluid system:

1. From the Service screen, touch the [Pumps] tab.



2. Touch the button under B1 Pump to turn it on.
3. The instrument will prime the B1 buffer solution.
4. Once buffer flows from the end of the sipper, touch the button under B1 Pump to stop the pump.
5. Repeat this procedure to prime all other buffer bottles and calibrator bottles you have installed.

Prime all installed calibrator bottles daily to remove air bubbles from the tubing.

4.9 Install Membranes and ISEs

4.9.1 Enzyme Membranes

Each biosensor probe installed in your instrument is fitted with a protective "shipping membrane" which must be removed and replaced with a new membrane. **Make sure you install the correct membrane for each chemistry you are measuring.**

Enzyme membranes are color-coded for each type of chemistry. It is important that you install the specific membrane as indicated on each probe (A or B).

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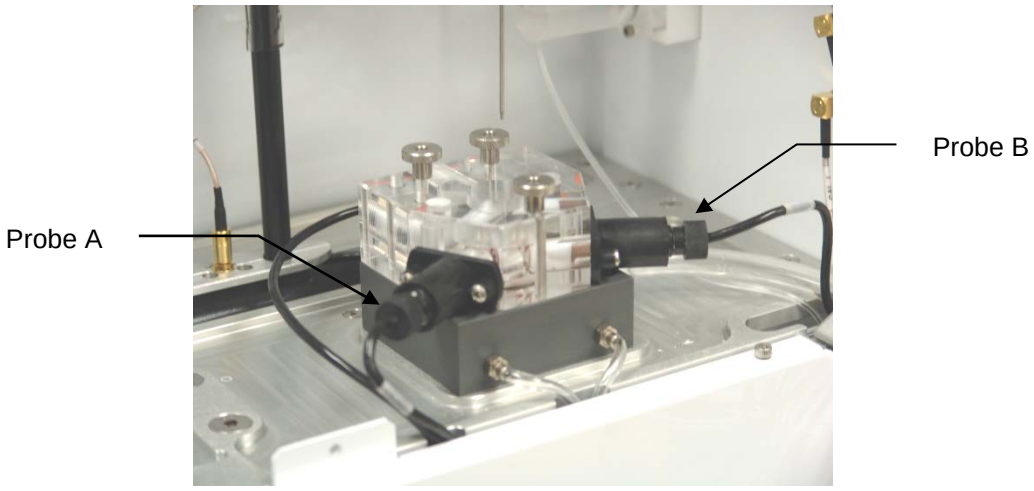

Probe A is always on the left when looking in from the side of the instrument
Figure 4-4

To install a membrane:

1. Make sure the top cover(s) are removed from the instrument.
2. Next, unscrew the appropriate enzyme probe retainer and gently pull the probe out of the module.
3. Remove the existing O-ring membrane assembly from the end of the enzyme probe. A lint free tissue or toothpick or pipet tip may be needed to unseat the old membrane. Be careful not to scratch the enzyme probe face.
4. Examine the enzyme probe surface and remove any pieces of membrane that remained.
5. Open a cavity of the plastic membrane holder.
6. Rinse the membrane inside with a few drops of salt solution (YSI 2392).
7. Place one drop of salt solution on the enzyme probe face.
8. Using the plastic membrane holder, press the O-ring membrane assembly gently onto the probe face.

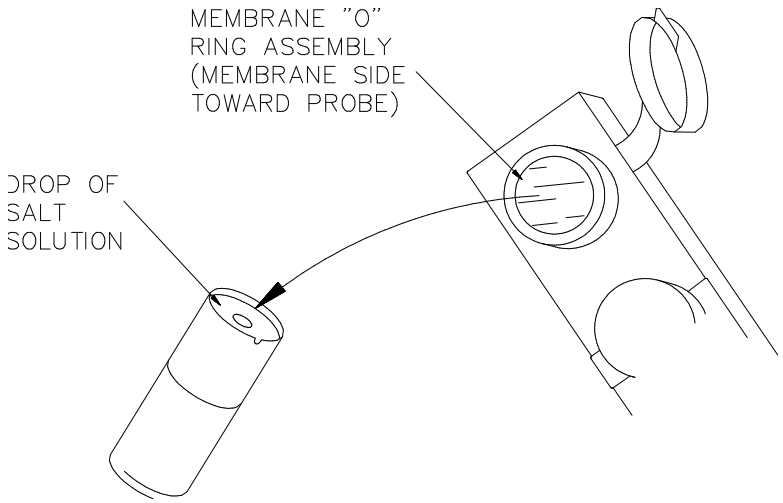

Figure 4-5

9. Wipe excess salt solution from the probe body.
10. Install a stir bar in the module.
11. Then return the enzyme probe to the module.
12. Finger tighten the probe retainer so that the O-ring seals the probe in place. Do not overtighten.
13. Return the membrane holder to the foil pouch and refrigerate it.
14. Note the expiration date on the membrane package
15. Repeat this procedure for the remaining enzyme probes.

You may want to maintain an instrument log book in which dates and lot numbers of reagents are recorded, along with information from daily operational checks and other relevant information.

4.9.2 Ion Selective Electrodes

The 2900 Series is shipped without the Ion Selective Electrodes installed in module 3. To install an ISE:

1. First remove the packaging material and the cap from the ISE (save the cap for later use).
2. Slide a black probe retainer over each ISE cable (threaded end first).
3. Slide a white probe sleeve (notched end out) over the end of each ISE. Note that the sleeve may already be installed.

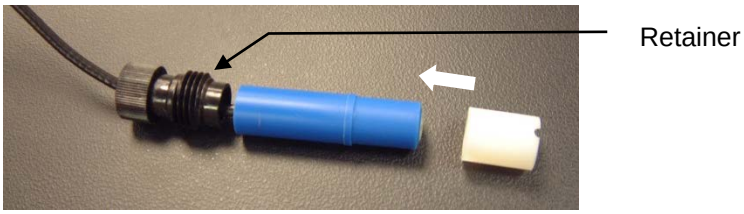

Figure 4-6

Figure 4-7

4. Place an O-ring into the end of each sleeve, pushing the O-ring gently so that it is secured by the sleeve.

Figure 4-8

5. Install the reference electrode by screwing the probe retainer into the module (finger tighten only; do not overtighten).

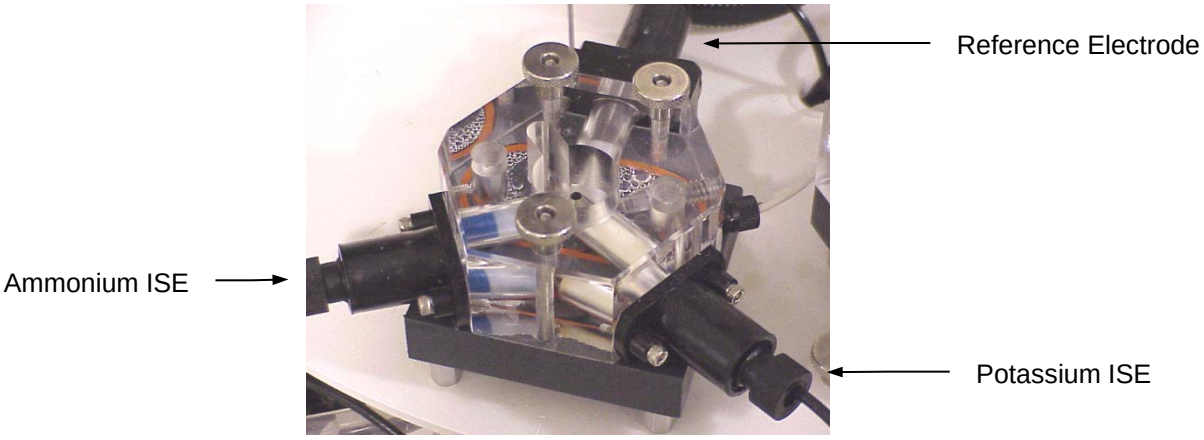

Figure 4-9

6. Install a stir bar in the module.
7. Secure the ammonium and potassium ISEs in place by screwing the probe retainers into the module (finger tighten only; do not overtighten).
8. Connect the ISE cables to the matching connectors located at the rear of the instrument.

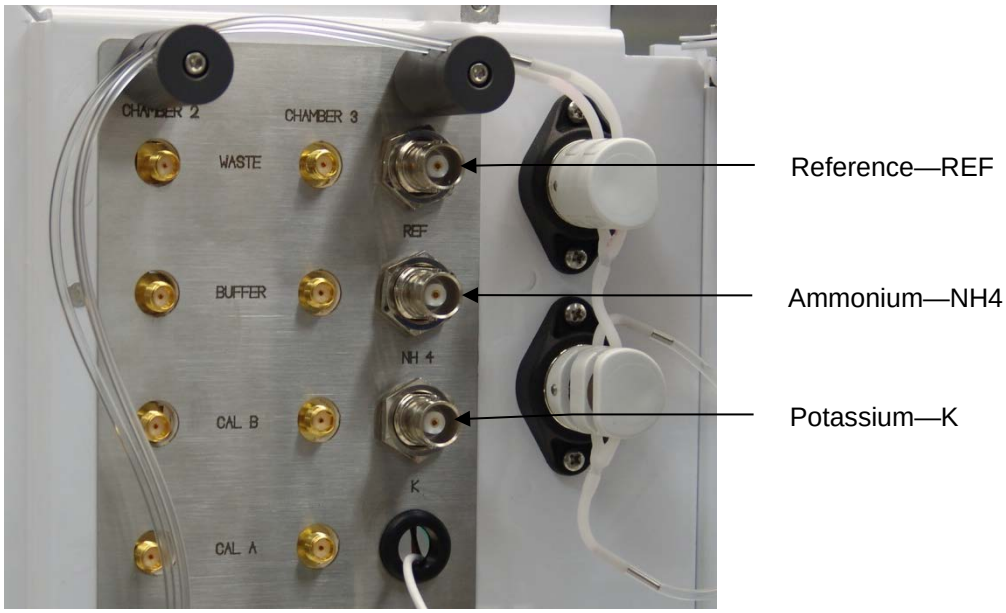

Figure 4-10

9. Install the top covers on the instrument.

4.10 Configure Instrument Chemistries

Before operating the 2900 Series, you must set the instrument parameters.

4.10.1 Assign Chemistries to Probes

1. From the main display, touch 

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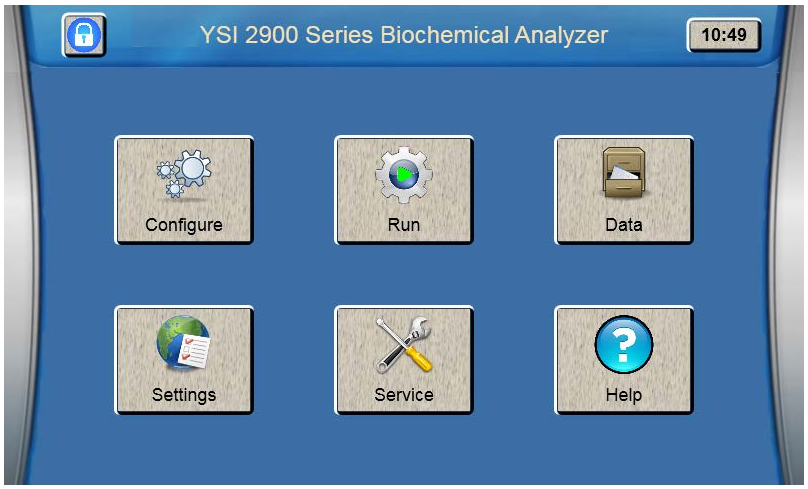
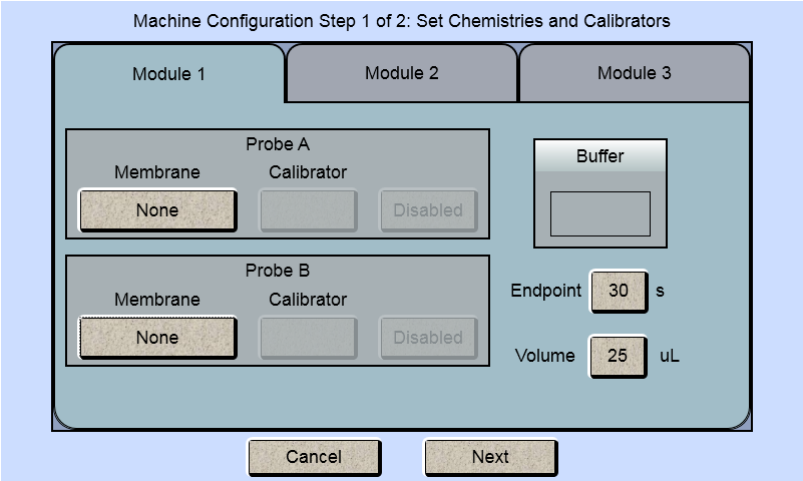
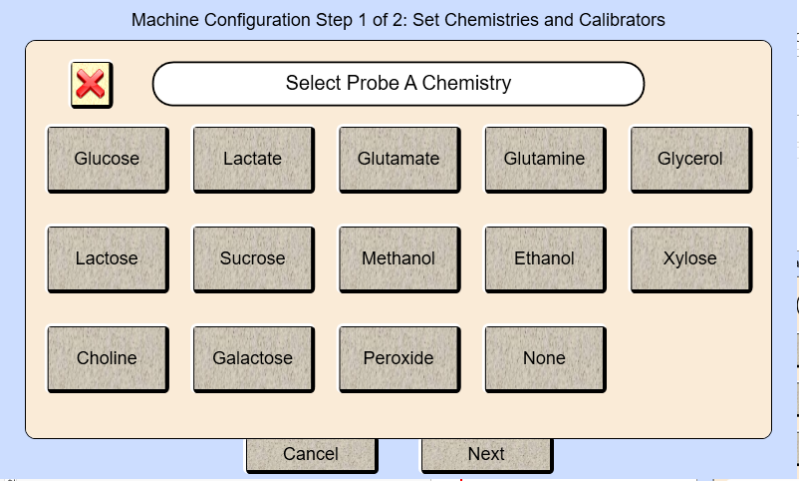


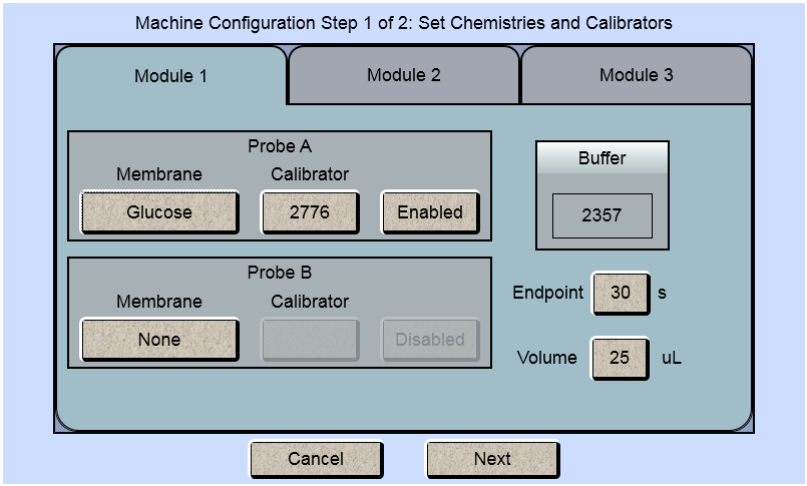
2. From the [Module 1] tab, touch the Probe A membrane button.



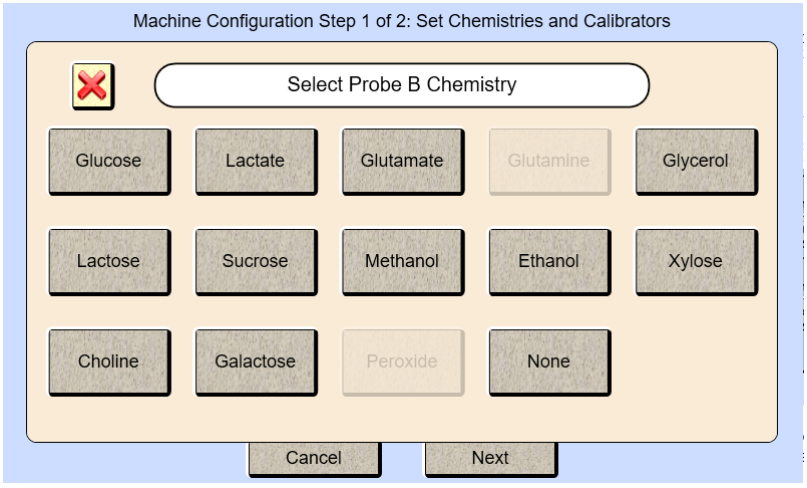
3. Select the chemistry you want to measure.



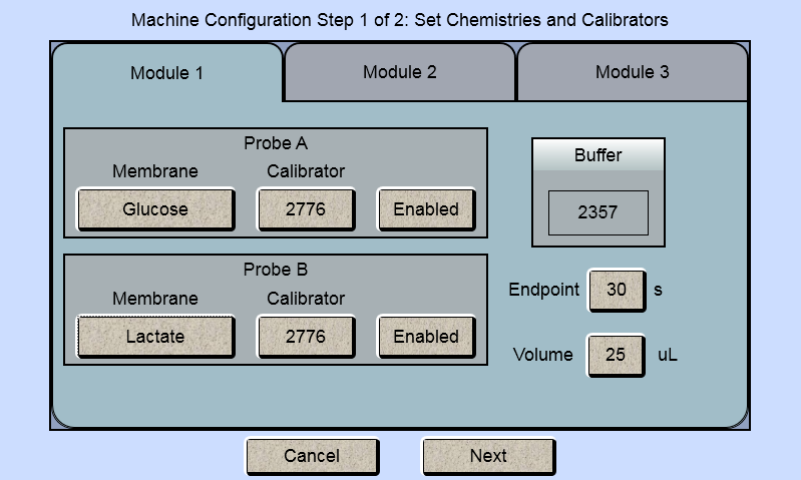
4. The Probe A Membrane button will now show the chemistry you have selected. The screen also indicates which reagents should be installed.



5. To run a second chemistry in module 1, touch the Probe B membrane button. Only chemistries that can be run simultaneously with your selected chemistry will be displayed.



6. Select the chemistry you want to measure. The Probe B Membrane button will now show the chemistry you have selected.



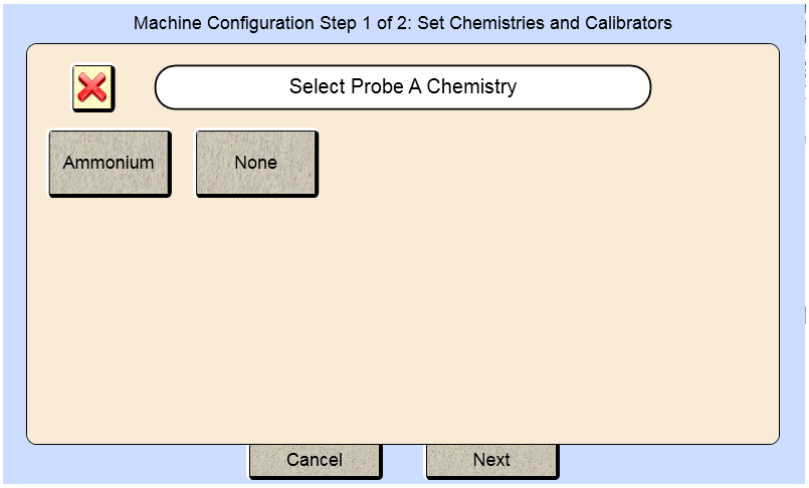
NOTE: The default Sample Volume and Endpoint for the chemistries are also displayed. **Use the default settings unless a particular application instruction specifies another value** (see Section *8 Chemistry Setup* for details).

7. Once you have selected one or two chemistries for the first module, proceed to the next installed module on your instrument, and repeat the procedure.

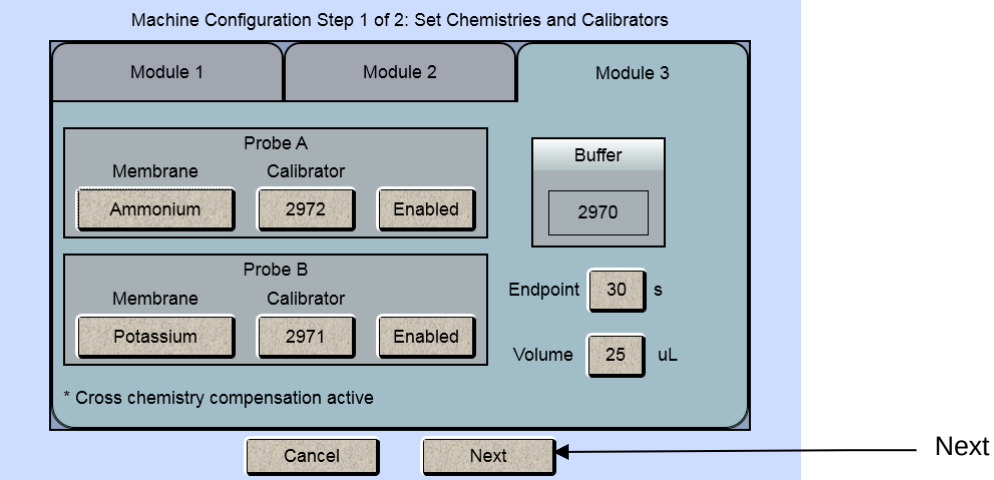
NOTE: Changing chemistry assignments will change the calibrator values back to the default settings.

If your instrument has an ISE module:

1. From the [Module 3] tab, touch the Probe A membrane button and select Ammonium.



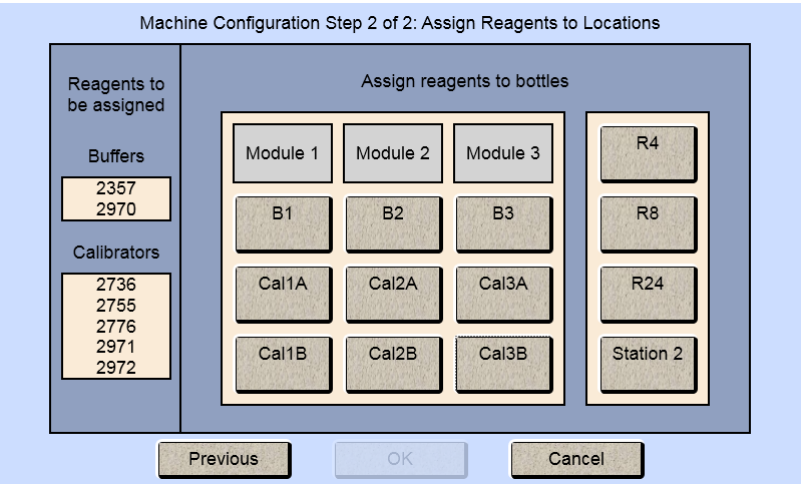
2. The Probe A Membrane button will now show the chemistry you have selected. Potassium will automatically be selected for Probe B.



4.10.2 Assign Reagents

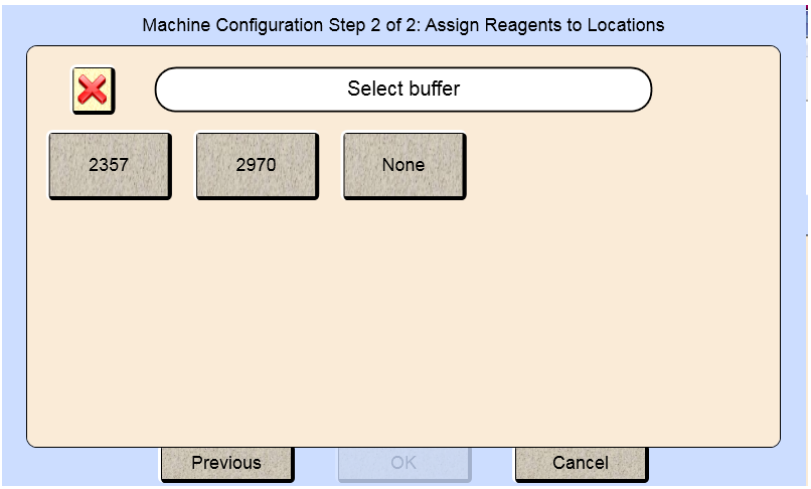
Once you have selected all the chemistries you want to measure, touch the [Next] button. The Assign Reagents screen will be displayed.

Reagents needed are listed on the left of the screen. Bottle positions are listed on the right. Each reagent must be assigned to a bottle position.

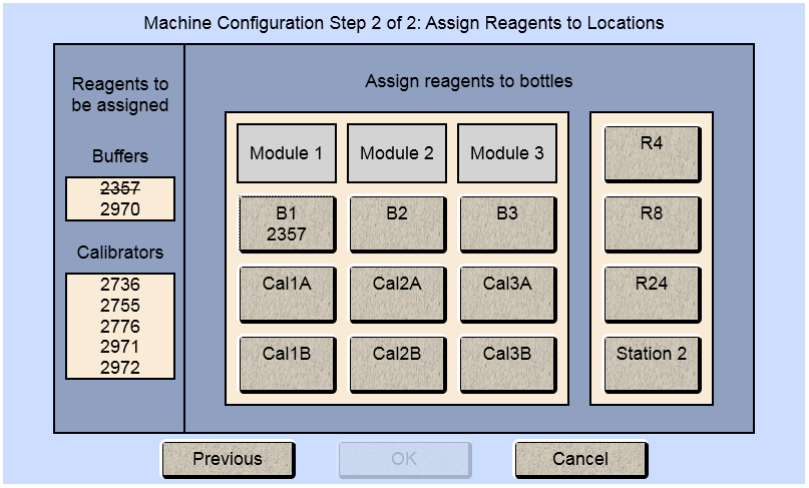


4.10.2.1 Buffers

1. Touch the [B1] button to display the Select Buffer screen.



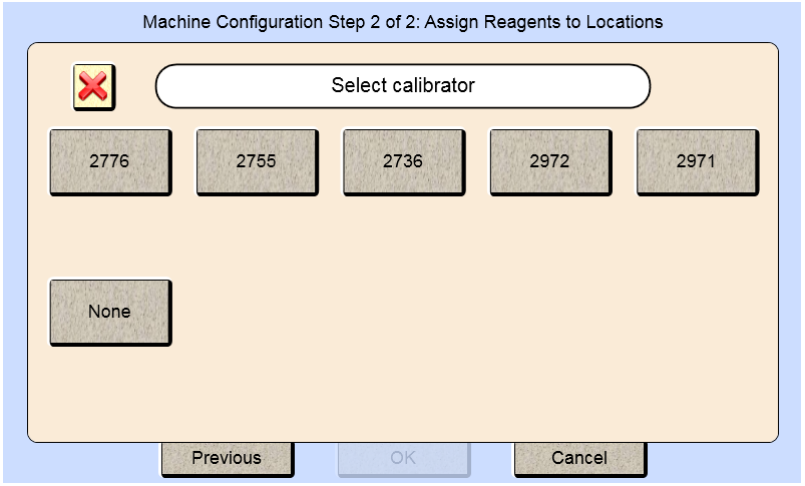
2. Pick your appropriate buffer and it will be assigned to the B1 button.
   Note that the selected buffer is now marked out in the list of reagents needed.



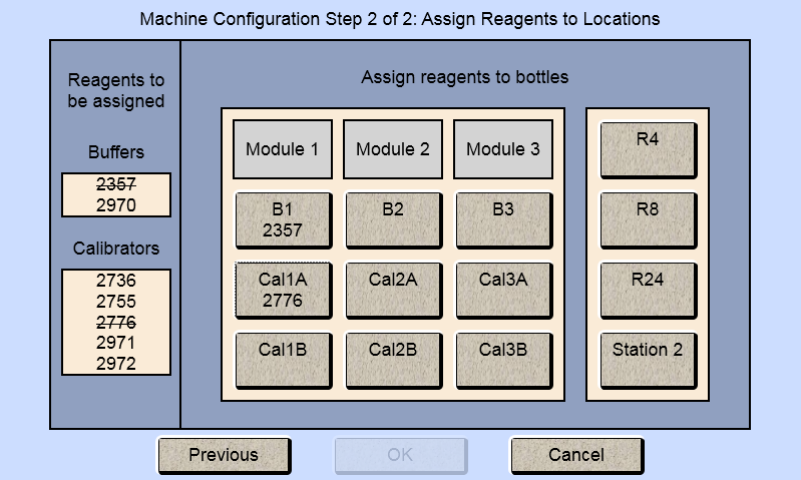
3. For additional buffer assignment, please repeat process.

4.10.2.2 Calibrators

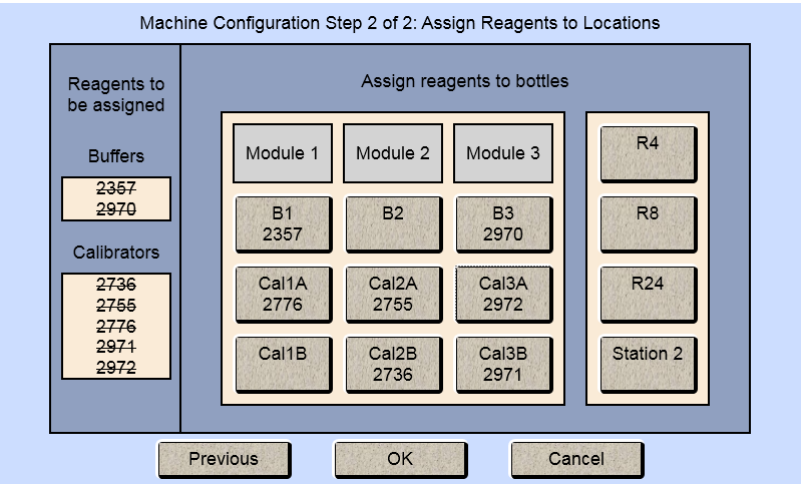
1. Touch the [Cal 1A] button. The Select Calibrator screen appears.



2. Pick the appropriate calibrator.



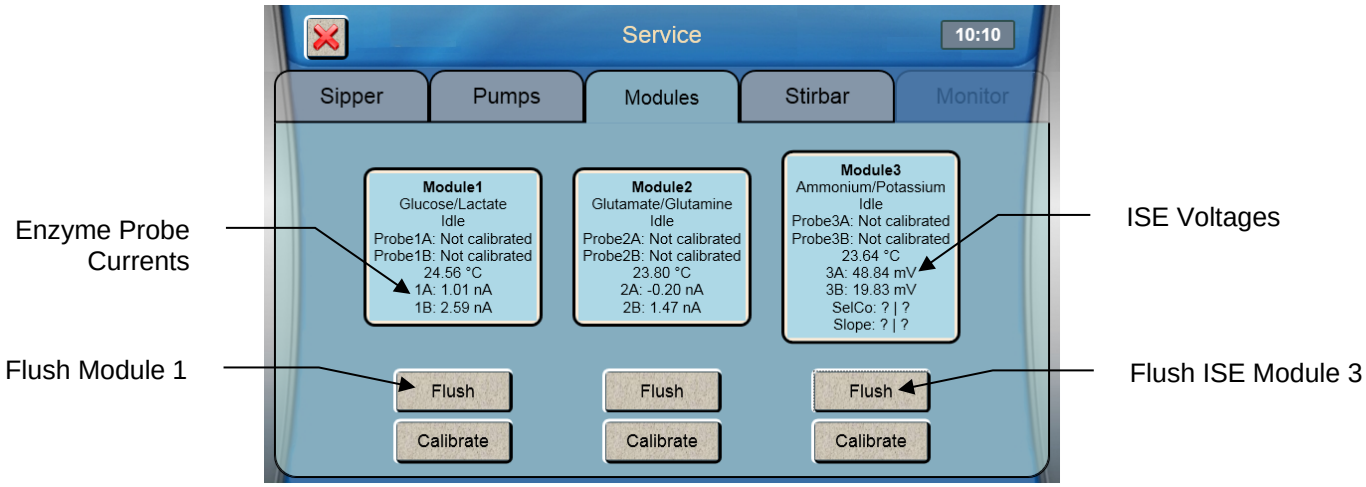
3. Select additional bottles until all reagents on the left side of the screen have been assigned and marked out, then press [OK].



4.11 Check Probe Currents

4.11.1 Biosensor Probes

1. From the [Modules] tab of the Service screen, touch the [Flush] button under Module 1 to flush the selected sample module with buffer.



2. Observe the probe current values (baseline). They must be below 6 nA and stable.
3. Check to see if they are decreasing in value.
4. Check the sample module; it should be full of buffer.
5. If necessary, touch the [Flush] Button to flush the sample module again.
6. Flush any additional modules by touching the [Flush] button under the Module.

Please note that when the instrument is first powered up, it may take several hours for the baseline currents to drop below 6 nA.

4.11.2 ISE Probes

1. Touch the [Flush] button under Module 3 to flush the selected sample module with ISE buffer. Note that the instrument will purge buffer to waste if the incorrect buffer is in the line.
2. Observe the ISE voltage values. They should be between -40 and 60mV and stable.
3. Check the module; it should be full of buffer.
4. If necessary, touch the [Flush] button to flush the sample module again.

Please note that when the instrument is first powered up, it may take an hour for the voltages to stabilize.

Once biosensor probe currents and ISE voltages are acceptable, touch the [X] button at the top left of the screen to exit to the main display.

4.12 Enable 21 CFR Part 11 Mode

If you will be using the optional 21CFR Part 11 compliance features, enable 21 CFR Part 11 Mode (see *Section 7.1.5 21 CFR Part 11* for details).

5. Running the Instrument

5.1 Perform Daily Operational Checks

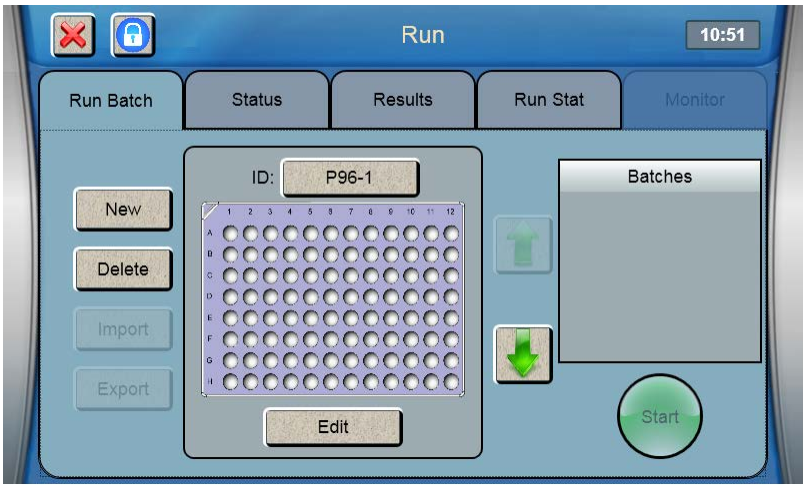
To ensure that your 2900 Series is operating properly, perform the Membrane Integrity and Linearity checks on a daily basis **before running samples**.

5.1.1 Enzyme Membrane Integrity Test

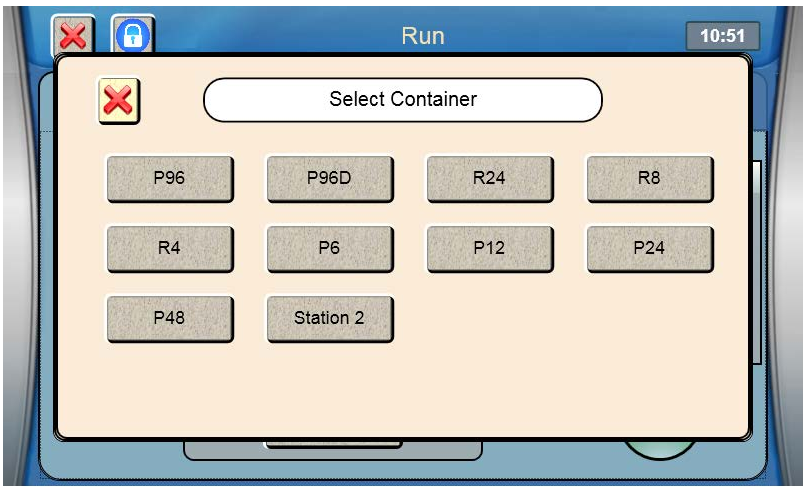
Use YSI 2363 Potassium Ferrocyanide (FCN) Standard to determine if your enzyme membranes are structurally intact.

1. Pour small amount of FCN standard (1000 mg/dL) in a test tube or multi-well plate
2. Press the Run icon 

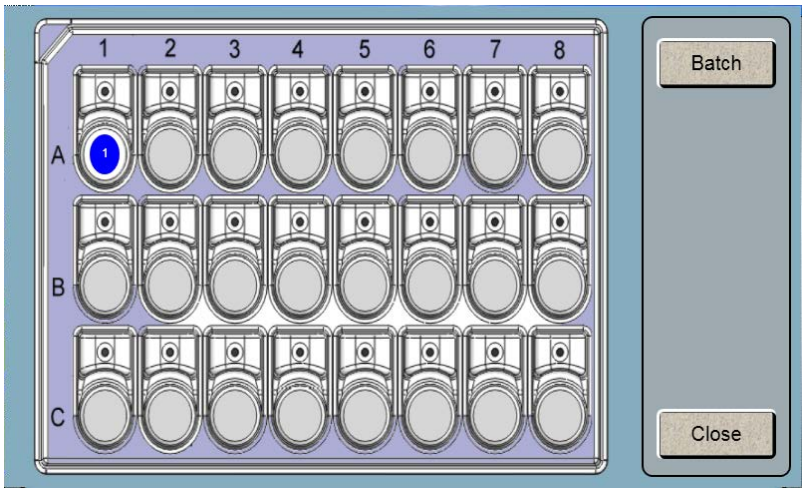
to process it as a sample.
3. From the Run Batch tab, touch [New]



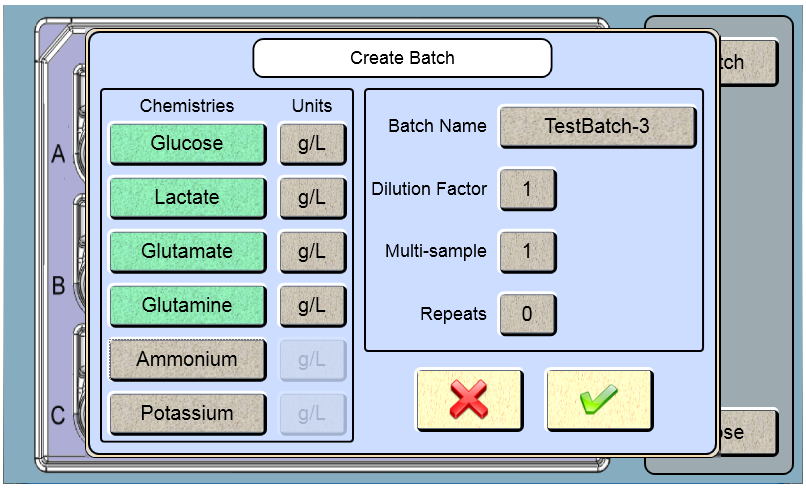
4. Choose from the selection of supported racks and plates.



5. We highly recommend renaming the rack/plate “Daily Checks” by touching its ID to indicate that it contains your daily check batches.
6. After selecting your plate/rack, touch the [Edit] button
7. Touch the location of each sample for the first batch. Selected locations will be blue.



8. Touch the [Batch] button.
9. Select only the chemistries that require the FCN test.



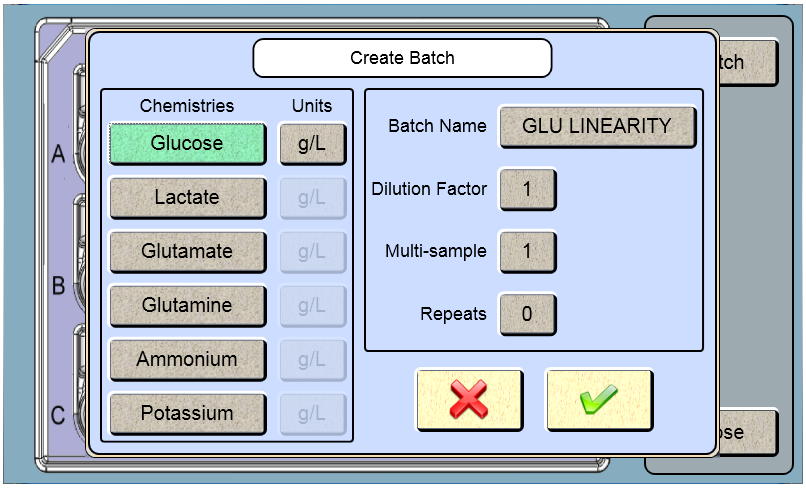
10. To change the Batch Name from the default value of TestBatch- #, touch the [TestBatch- #] button. The keypad window will appear.

11. Type your new batch name and touch [DONE].

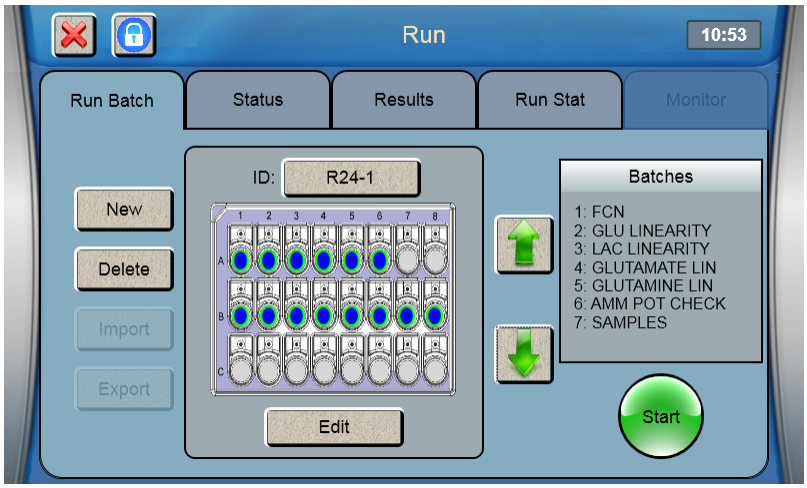
12. Touch ☑ to save the batch.

5.1.2 Linearity Test

13. Pour small amount of linearity standard in a test tube or multi-well plate.
14. Touch additional sample locations to create new batch for the linearity tests.
15. For the daily linearity checks, select only the chemistry that corresponds to the linearity standard in that sample location.

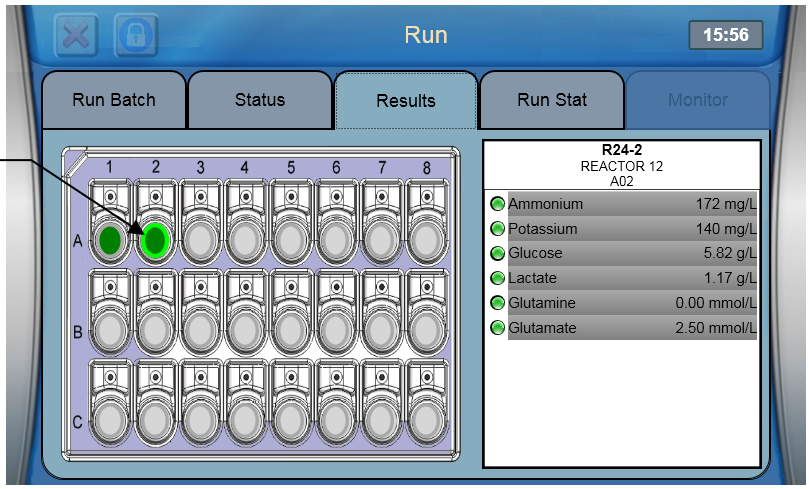


16. Touch ☑ to save the batch.
17. Create additional batches for each linearity solution.
18. Touch [Close] when all batches are created.
19. Load the plate/rack in the sampling station 1.
20. Touch [Start] to run the FCN and the linearity standards as samples.
    The analyzer will calibrate as required and run the batches.

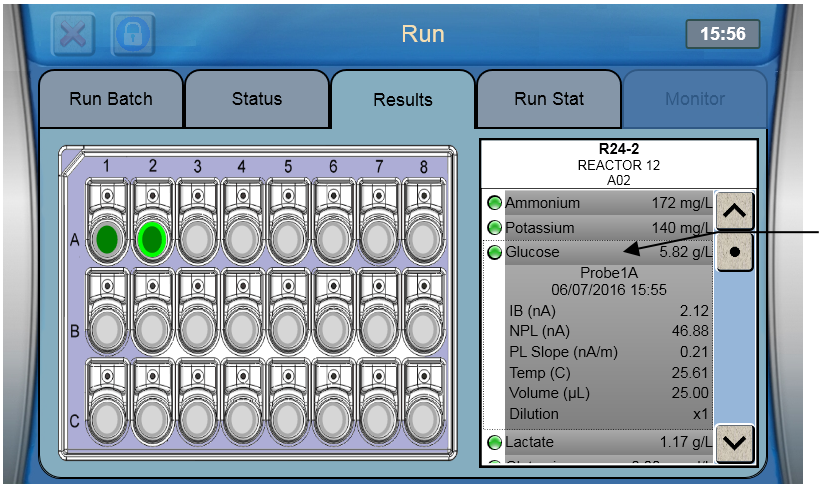


5.1.3 Results

21. Touch the Results tab
22. Select a sample location.



23. Touch a chemistry to show details



24. Listed in table 6-1 below are the recommended FCN limits.
    a. Values less or equal to FCN limits indicate integral membranes
    b. Values greater than FCN limits indicate membrane structural failure
    c. If readings are high, recalibrate and repeat all the steps above to confirm.
    d. If the reading is still out of tolerance, refer to the Troubleshooting Section.

Chemistry	Membrane	Calibration Standard	FCN Limit[2]
Choline	2771	2772	0.02 g/L
Ethanol	2786	2790 (2.00 g/L)	0.05 g/L
Glucose	2365	2776 or 2747	0.05 g/L
L-Glutamate	2754	2755	0.06 g/L
L-Glutamine	2735	2736	0.06 g/L
L-Lactate	2329	2776	0.03 g/L
Methanol	2725	2726 (1.00 g/L)	0.05 g/L
Sucrose	2703	2780	0.10 g/L
Xylose	2761	2767	0.05 g/L

Table 6-1

[2] If you are using units other than g/L for the FCN test, refer to *161 Appendix B – Concentration Unit* Conversion for conversion values.

25. See the list of acceptable values in table 6-2 below to interpret linearity readings.
    a. Values that are ± 5% of specified tolerance limits indicate good membranes.
    b. Values that are out of tolerance indicate an aging enzyme membrane.
    c. If readings are out of tolerance limits, recalibrate and repeat all the steps above to confirm.
    d. If the reading is still out of tolerance, refer to the Troubleshooting Section.

Chemistry	Calibration Std	Linearity Std	Acceptable Range (g/L)
Ammonium[3]	2972 (0.50 g/L)	7179 (0.10 g/L)	0.095 to 0.105
Choline	2772 (0.175 g/L)	2773 (0.450 g/L)	0.43 to 0.47
Ethanol	2790 (2.00 g/L)	2790 (3.20 g/L)	3.04 to 3.36
Glucose	2776 (2.50 g/L)	1531 (9.00 g/L)	8.55 to 9.45
L-Glutamate	2755 (0.73 g/L)	2756 (1.46 g/L)	1.39 to 1.53
L-Glutamine	2736 (0.73 g/L)	2737 (1.17 g/L)	1.11 to 1.23
Glycerol	7141 (25.00 g/L)	7142 (40.00 g/L)	38.0 to 42.0
L-Lactate	2776 (0.50 g/L)	1530 (2.67 g/L)	2.54 to 2.80
Lactose	2783 (5.00 g/L)	2784 (25.00 g/L)	23.75 to 26.25
Methanol	2726 (1.00 g/L)	2726 (2.50 g/L)	2.38 to 2.63
Potassium[3]	2971 (1.00 g/L)	7179 (0.20 g/L)	0.190 to 0.210
Sucrose	2780 (5.00 g/L)	2778 (25.00 g/L)	23.75 to 26.25
Xylose	2767 (20 g/L)	2768 (30 g/L)	25.5 to 34.5

Table 6-2

Sample Preparation

A variety of sample types can be analyzed with the 2900 Series. Generally, the only sample preparation that **may** be required is dilution of the sample to bring the substrate concentration within the linear range of the instrument. (see Section *8 Chemistry Setup* for the working range of each chemistry).

Neither color nor turbidity interferes with measurements.

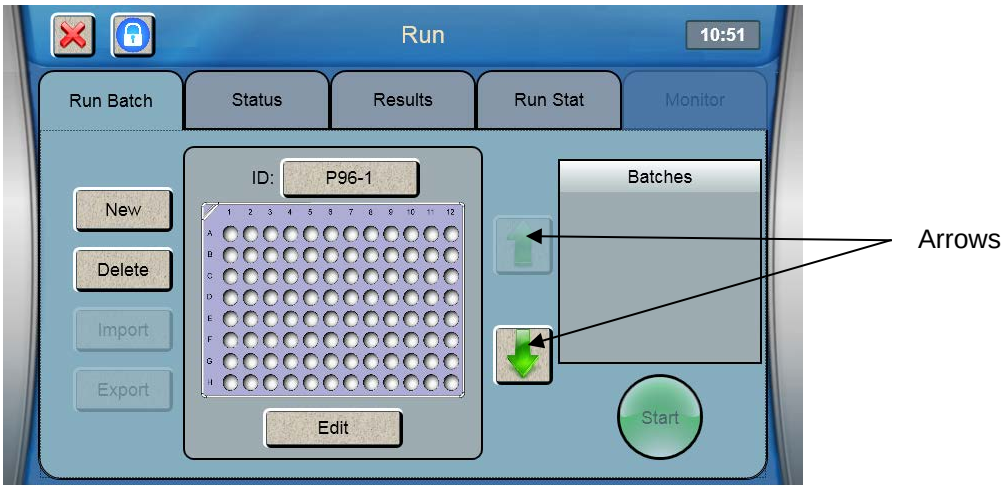
Small particles do not affect the reaction in the sample module that houses the probes, but samples with particles large enough to clog the sipper should be avoided.

5.3 Run Batch

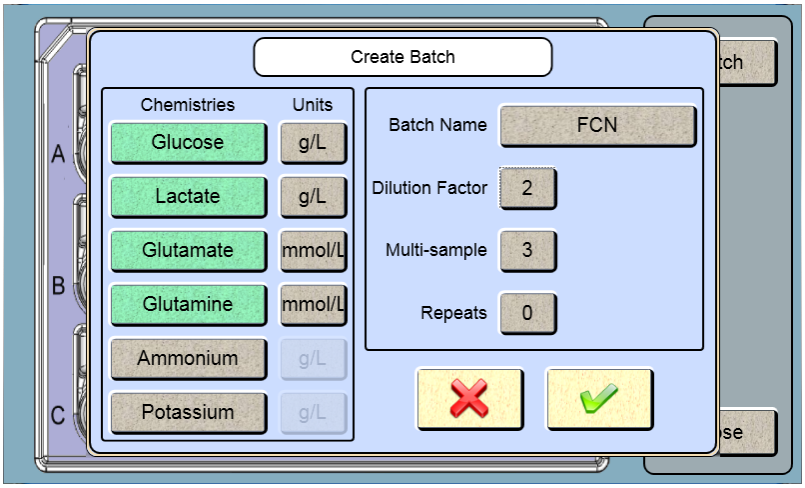
5.3.1 Create Batches

1. From the Run Batch tab of the Run screen, select a sample rack/plate and create batches for your samples.

[3] Range for single linearity check. Refer to *8.2.15 Simultaneous Ammonium and Potassium* for sample to sample precision.

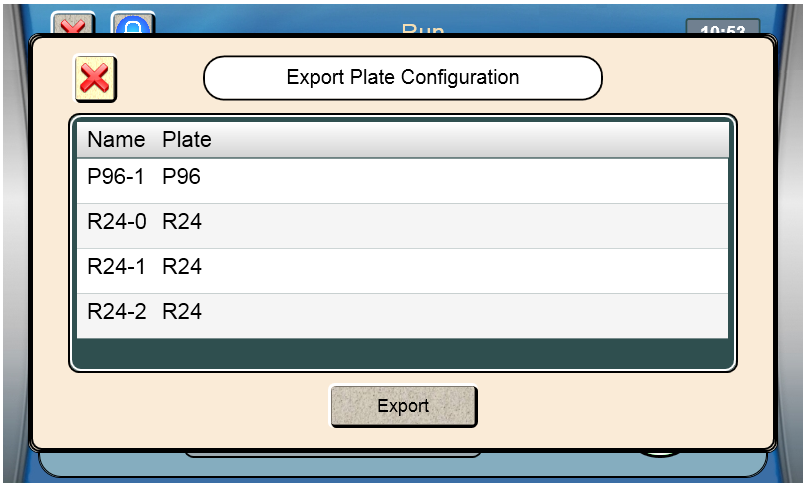


2. Touch [New] and choose from the selection of supported racks and plates. Alternatively, use the arrows to scroll through the saved racks and plates until you find the type that you are using.
3. You may rename the rack/plate by touching its ID.
4. After selecting your plate or rack, touch the [Edit] button.
5. Touch the location of each sample for the first batch (selected locations are blue).
6. Touch [Batch].
7. Select the chemistries to run in this batch.
8. Enter any optional parameters, such as Batch Name (separate name for this batch), Dilution Factor, Units, Multi-Sample (multiples of each sample location in this batch), or Repeats (multiples of the entire batch).
   Please note that the instrument does not automatically dilute samples.



9. If you diluted your samples:
   a. Touch the Dilution Factor [1] button.
   b. Enter your dilution factor then touch [OK].
10. To change the number of sample replicates:
   a. Touch the Multi-Sample [1] button.
   b. Enter the number of times each sample in the batch should be run, then touch [OK].
11. To repeat the entire batch:
   a. Touch the Repeats [0] button
   b. Enter the number of times the entire batch should be repeated.
12. Touch ☑ to save the batch.

13. You may also create one or more batches for samples. Alternatively, you may create a separate rack for sample batches.
14. Touch [Close] when all batches are created.
15. To save your plate configurations to a flash drive, touch [Export].



16. Select the plates you want to export, and then touch [Export].
17. Previously exported plates can be imported later using the [Import] button.

5.3.2 Load Samples

5.3.2.1 R24 and P6-P96 Racks/Plates

1. Open the front door of the instrument

2. Insert the plate/rack (end marked A1 first) into the instrument. Slide the front edge of the plate/rack in until it stops.

Figure 5-1

3. Gently lower the rear of the plate/rack and push it down into position.

Figure 5-2

5.3.2.2 R4 or R8 Tube Racks

1. Open the front door of the instrument.
2. Insert the R4 or R8 tube rack into the cavity just inside the front door.

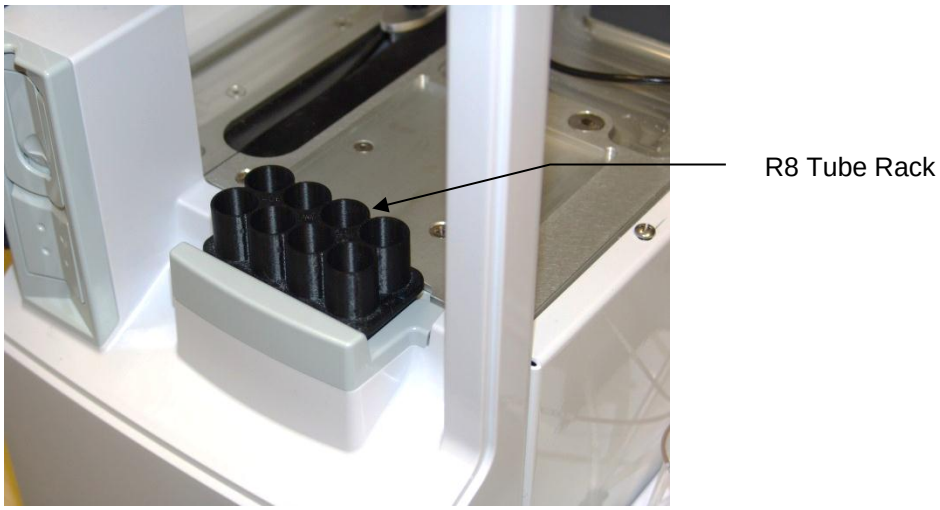


Figure 5-3

3. Insert your sample tubes into the tube rack you installed.

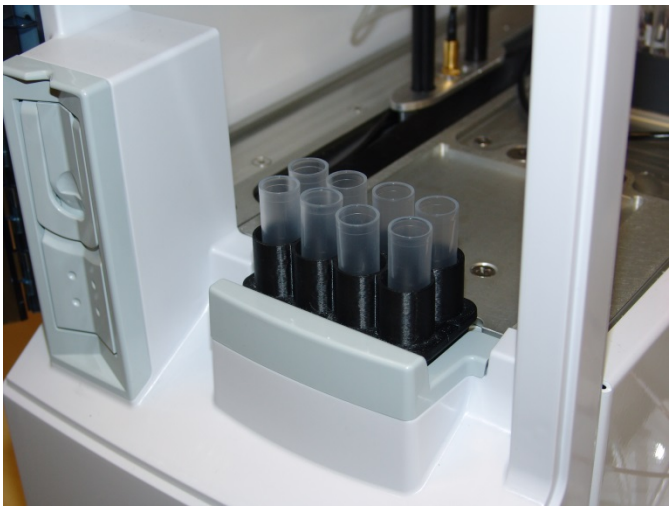


Figure 5-4

5.3.3 Start

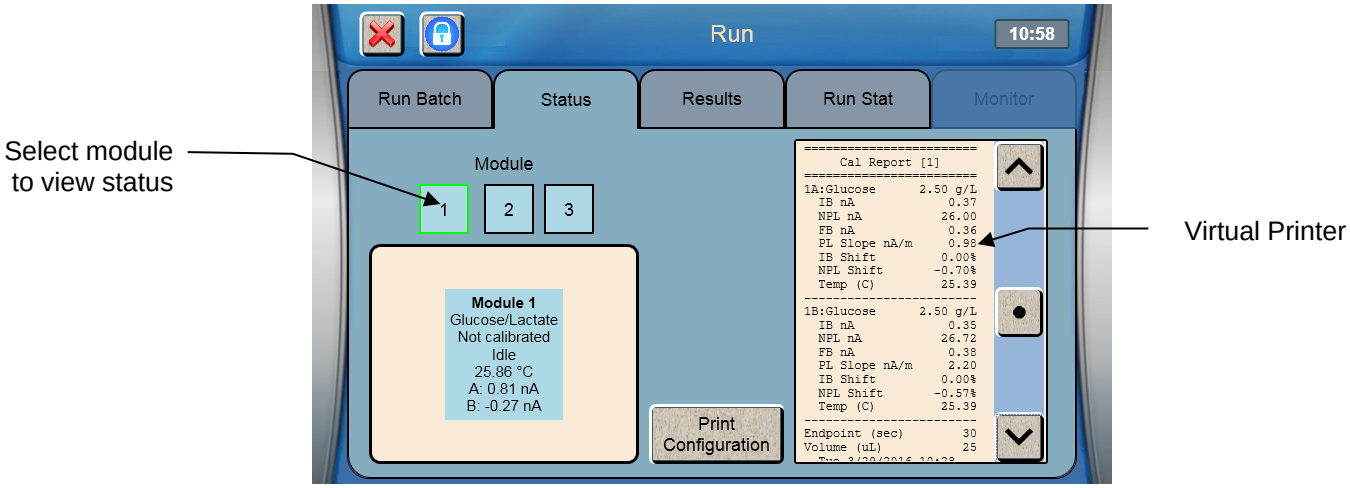
Touch 

to run the current batches.

The 2900 Series will calibrate as required and run the batches.

5.3.4 Status

1. Touch the Status tab.
2. Then select a module to view its status.



3. The virtual printer window displays details of previous samples and calibrations.
4. Use the arrow buttons to scroll the printer window.

5.4 Run Stat

A Stat sample at Station 2 runs without stopping a plate analysis or monitor session that is in progress.
NOTE: The Sipper is not designed to pierce septa.

1. Touch the Run Stat tab
2. Place the Stat sample in Station 2:
    a. Insert your sample tube into the tube holder (Station 2) from below the spring clip
    b. Slide it up all the way until it rests below the notch at the top.

    The test tube holder accepts tubes sizes up to 16x100mm.
    Any container other than this should be sampled manually by holding the sample at Station 2.
    For a Syringe sample, wait until you are prompted to present the sample.

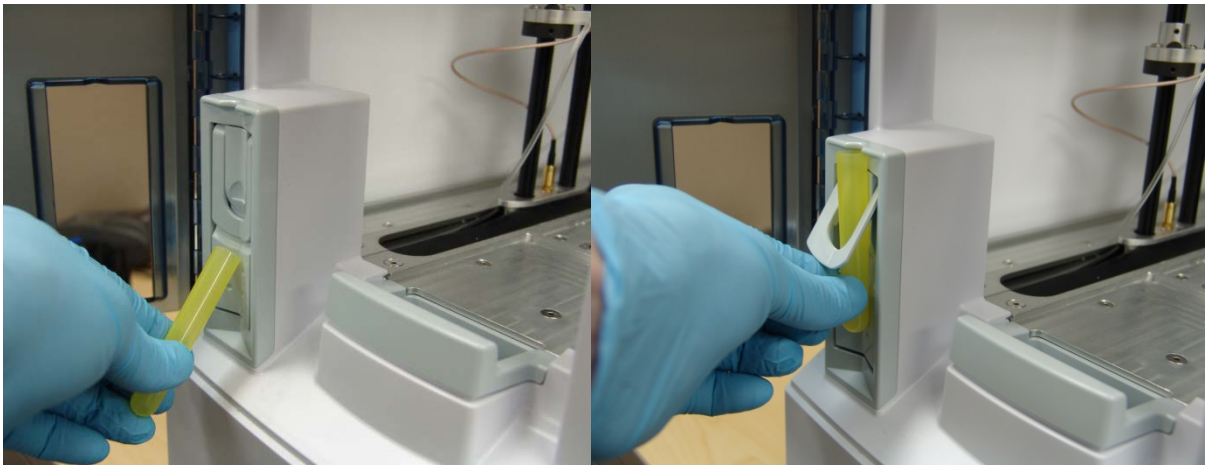
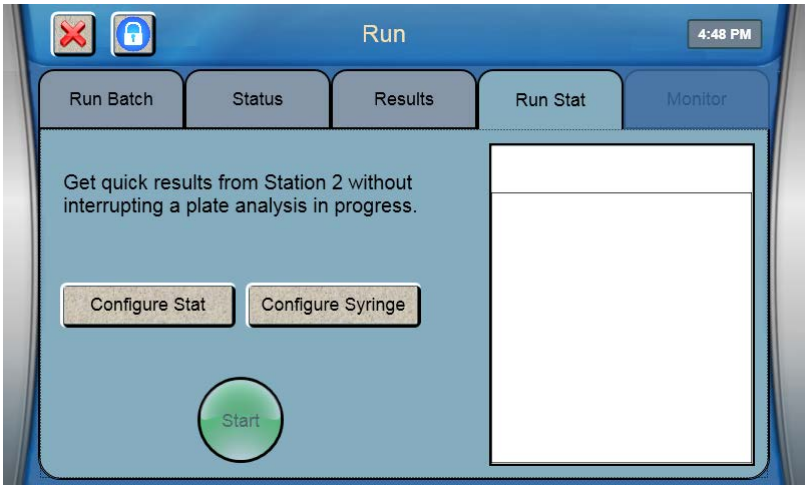
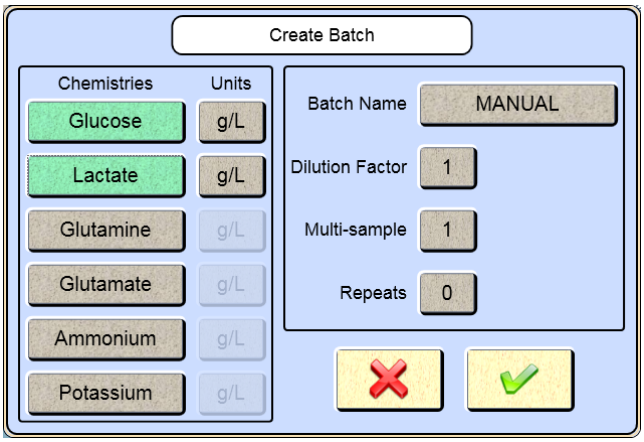


Figure 5-5

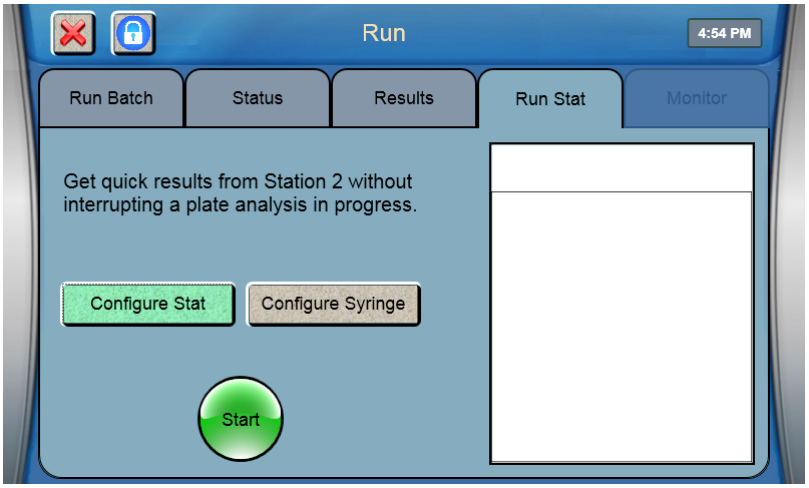
3. Touch [Configure Stat] to setup a Stat sample or [Configure Syringe] to setup a Syringe sample. For a Syringe sample, the analyzer will wait and allow time for the user to carefully immerse the tip of the sipper into the sample.



4. Select the chemistries and units for the sample.



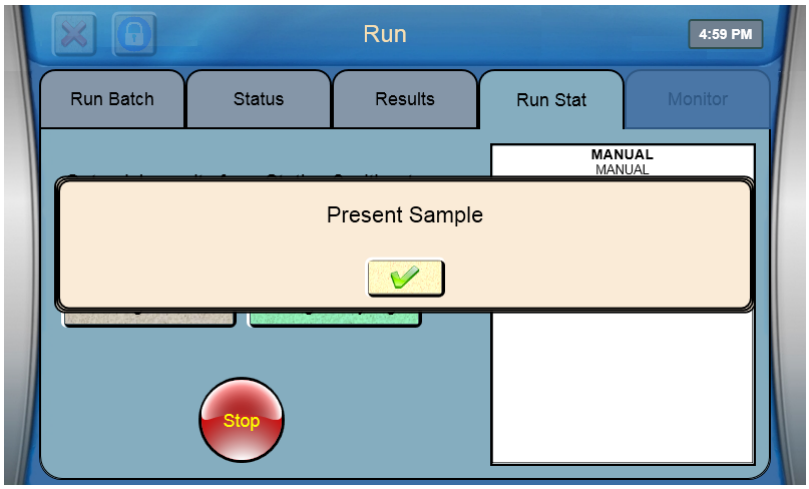
5. Touch ☑ to return to the Run Stat screen. The type of sample you configured will be highlighted.



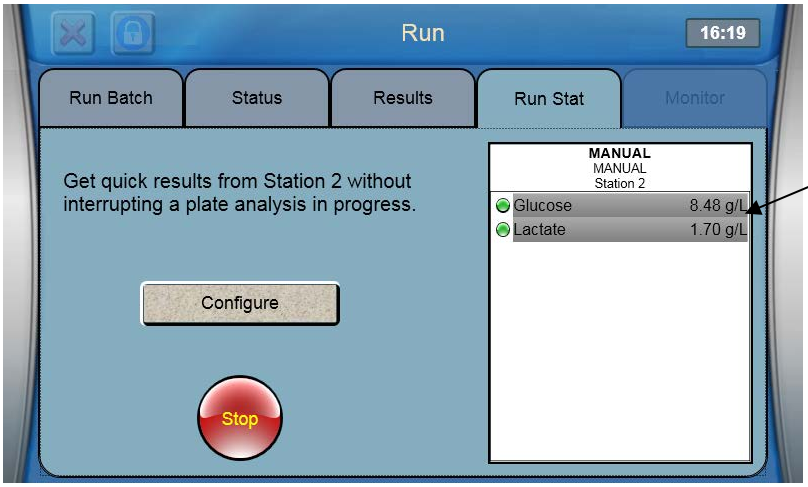
6. Touch 

to run the highlighted (Stat or Syringe) sample at Station 2.
If a Station 1 batch or monitor sample is in progress, the Stat sample will run as soon as the required module(s) is available.

7. If you configured a Syringe sample, present the sample to the sipper then touch ☑ to run the sample.

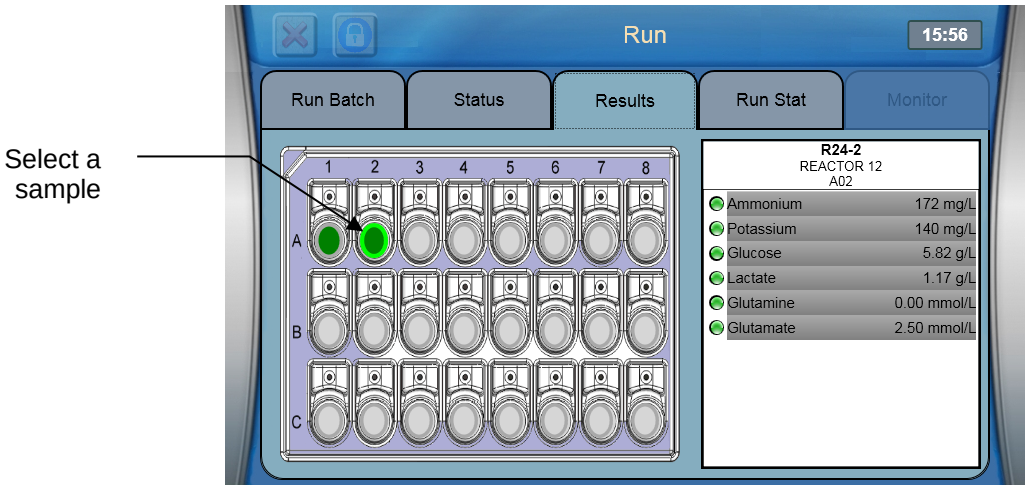


8. The Stat sample results are displayed on the Run Stat tab.

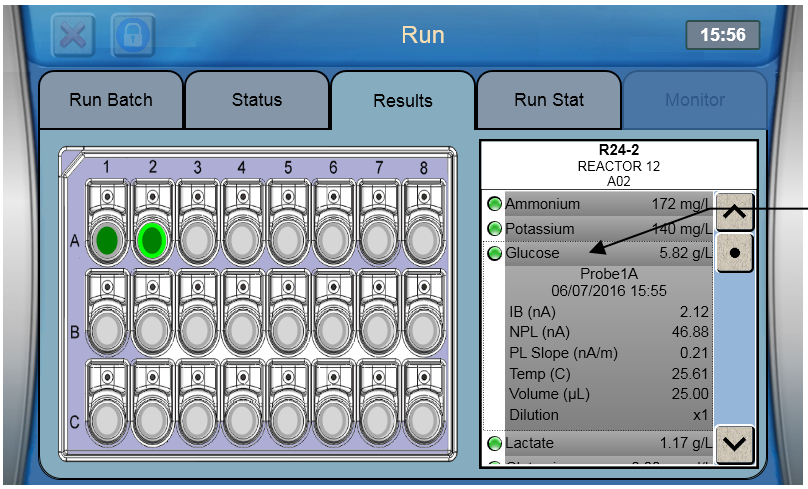


5.5 Results

1. Touch the Results tab.
2. Then select a sample position to display the results.



3. Select a chemistry to display details.



Select to show details

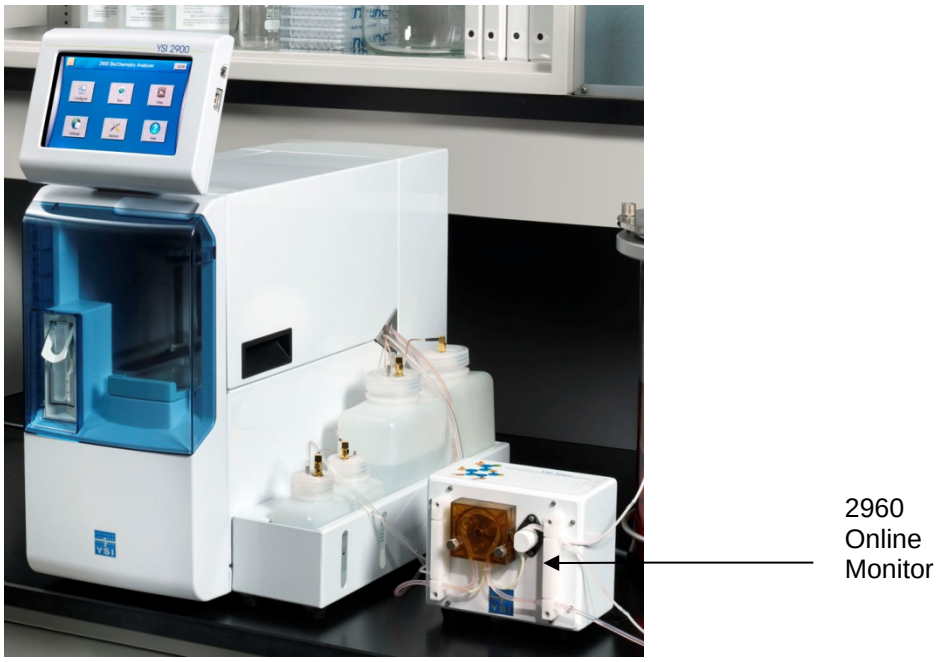
6. Online Monitor and Control

The YSI 2960 Online Monitor and Control System allows “on-line” monitoring and control of sterile systems over long periods of time without contamination. It also provides an alternative means of interfacing the 2900 Series with external measurement/control systems.

The 2960 may draw sample from a process stream, bioreactor or other suitable source and deliver sample to the analyzer. The system can operate unattended for days or weeks, provided sufficient reagent supply is considered.

The sample volume required for each analysis varies somewhat depending on the distance, flow rate and fluid interface used, however, typically 1.5 milliliters is sufficient to purge the 2960 sample cup and deliver fresh sample.

The 2960 preserves sterility by filling the end of the sampling line with an antiseptic after every sample.



YSI 2900M Online Monitoring and Control System
Figure 6-1

The analog output of the 2960 provides a voltage signal which is proportional to the concentration of the analyte. The 2960 provides this voltage output for up to two chemistries, two "handshake" signals, and a system status signal. In addition, the user has the ability to adjust full scale analog output for each chemistry.

The 2960 also provides three discrete signal outputs (TTL logic level) to control external pumps which can be used to replenish nutrients or optimize byproduct concentrations.

6.1 2960 Installation

1. Connect the small end of the supplied USB cable to the mini USB socket on the back of the 2960.
2. Connect the large end of the USB cable to the USB socket on the back of the 2900 Series.

Rear panel of 2960 Online Monitor
Figure 6-2

3. Install the correct AC plug for your location onto the 2960 power supply, then plug the power supply into an AC power outlet.
4. Connect the cable from the power supply to the power socket on the back of the 2960.
5. Using a 3/32” Allen hex wrench, remove the screw from the right rear of the 2900 Series deck as shown below. Discard the screw.

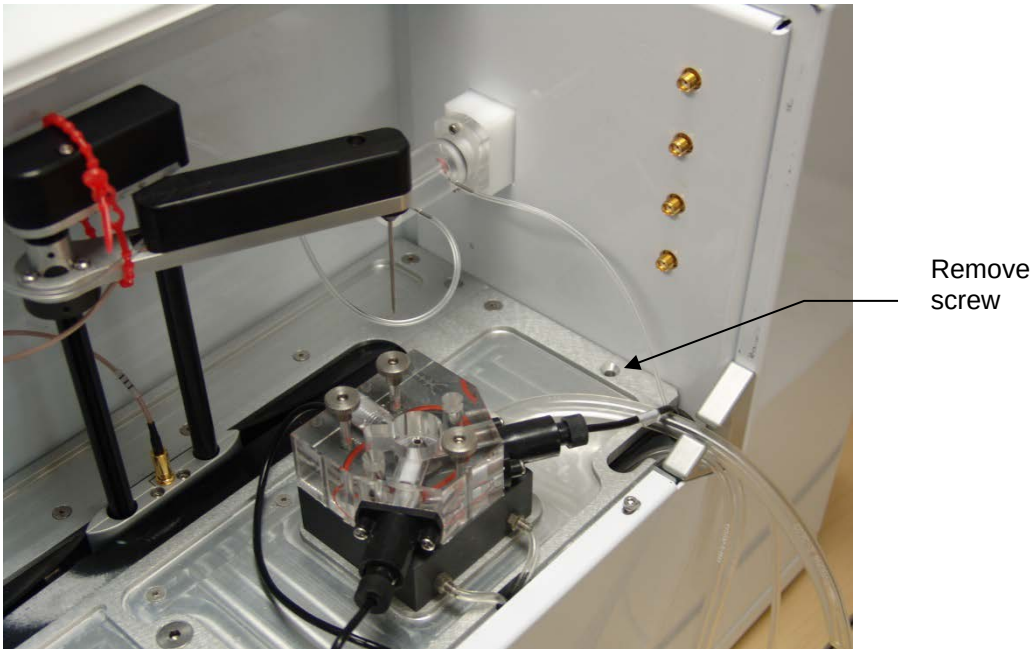


Figure 6-3

6. Using a 9/64” Allen hex wrench and the long hex screw provided with the 2960, install the Monitor Sample Cup on the 2900 Series deck (see Figure 6-4 below).

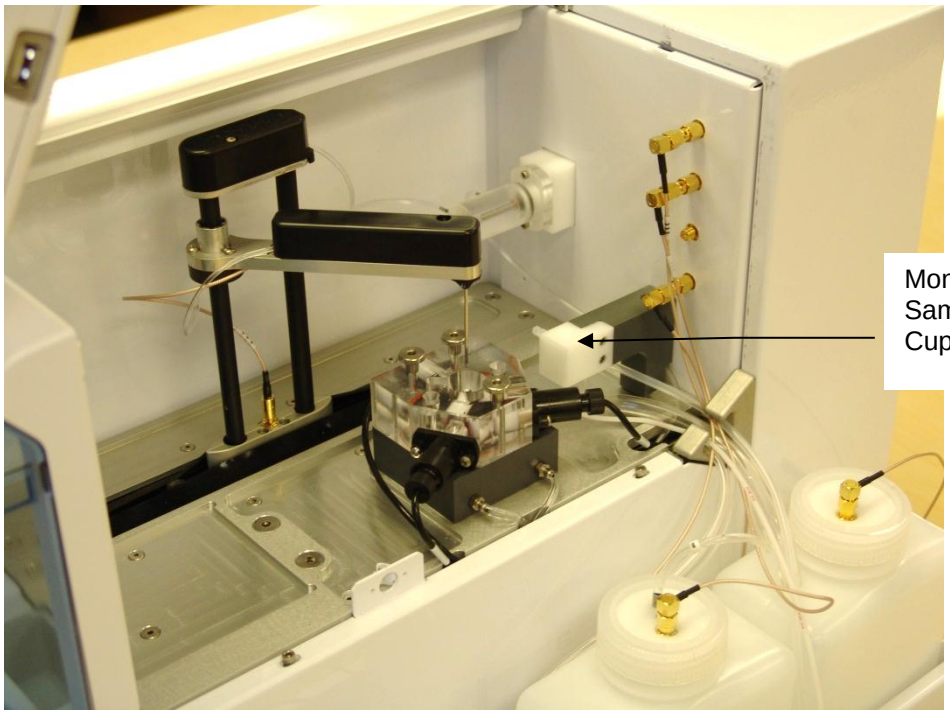


Figure 6-4

7. Connect the small sample tubing from the left side of the 2960 Online Monitor to the bottom of the Monitor Cup you just installed inside the 2900 Series.

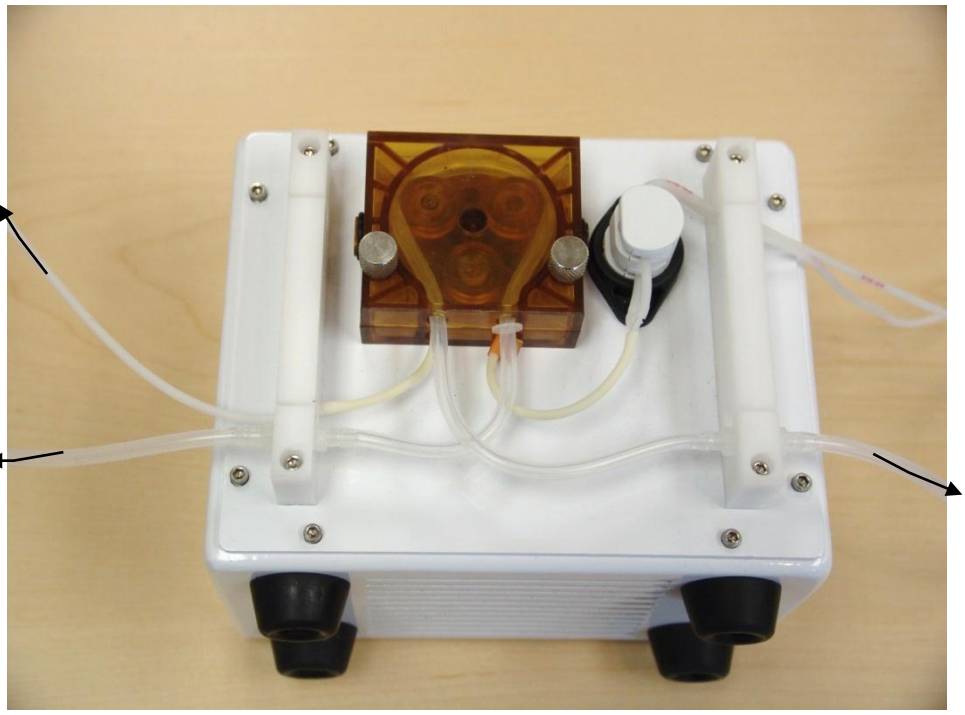


Figure 6-5

8. Connect the larger diameter waste tubing from the fitting on the left side of the 2960 Online Monitor to the waste fitting on the side of the Monitor Sample Cup inside the 2900 Series.

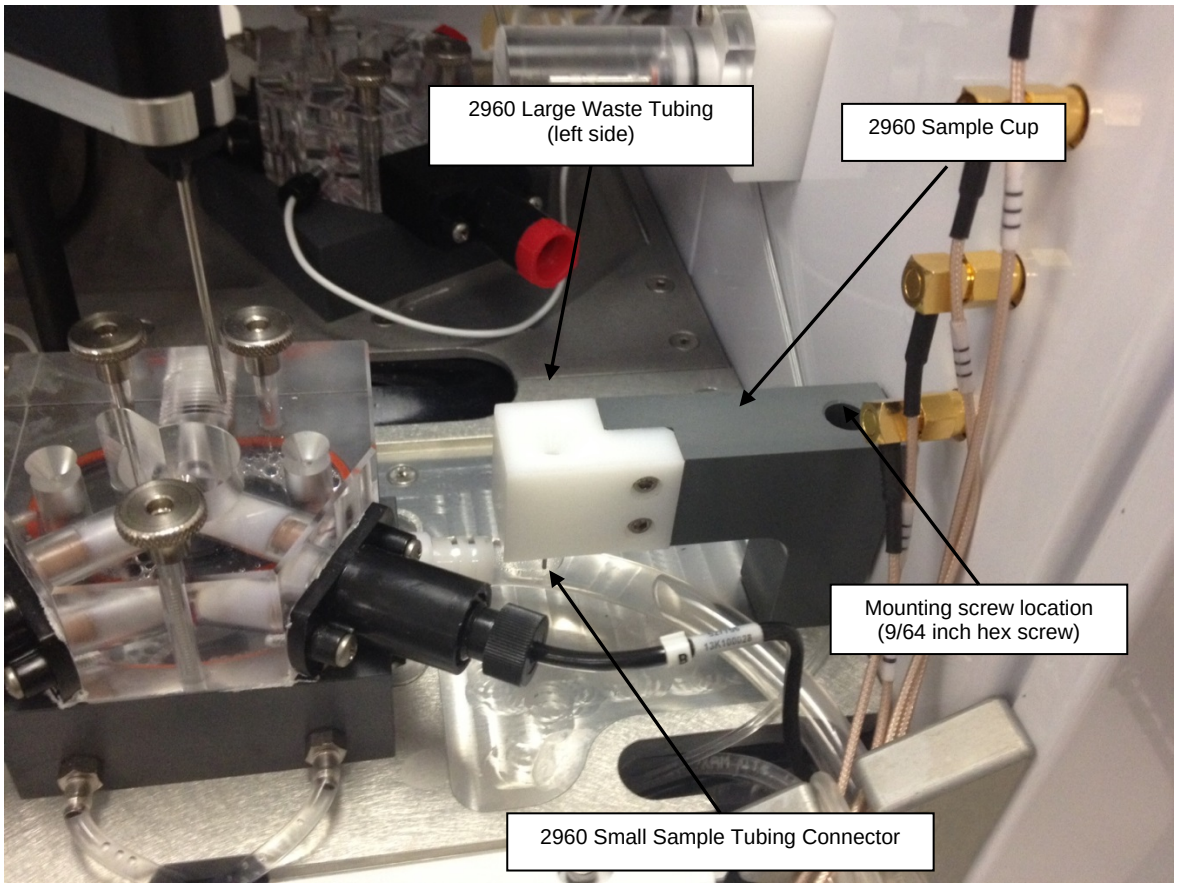
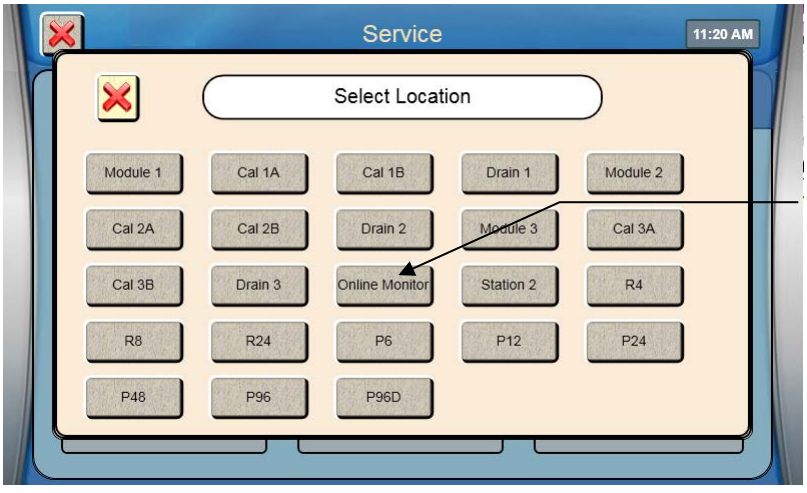


Figure 6-6

9. Run the larger diameter waste tubing from the fitting on the right side of the 2960 Online Monitor to an appropriate waste container.

6.2 Align Sipper

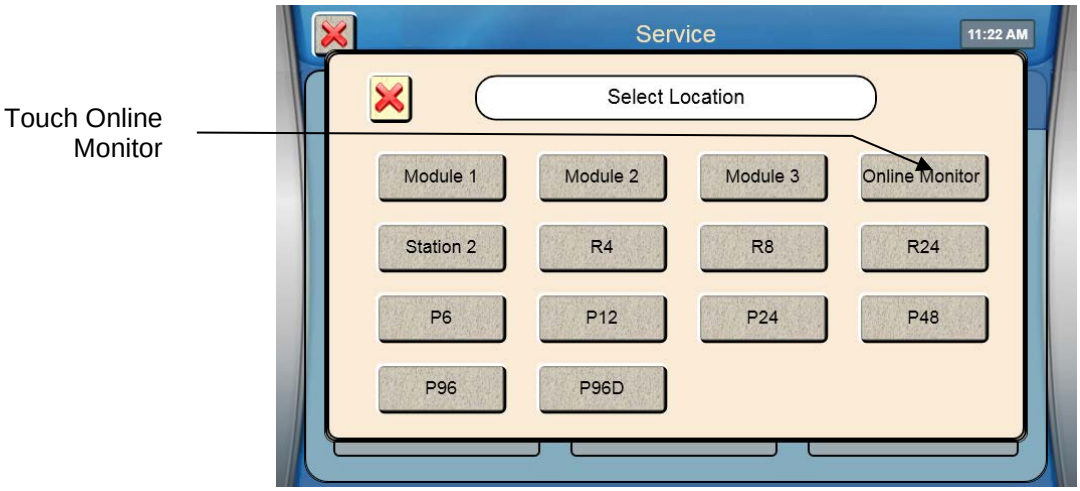
1. From the Service menu, touch the Location button. The Select Location screen will appear.



Touch Online Monitor

2. Select [Online Monitor]. The sipper will move to the Monitor Sample Cup and should be centered above the funnel shaped opening in the top of the cup.
3. If the sipper is not centered, touch [Position] and use the arrow buttons to center the sipper.
4. Make certain the Sipper is centered, then touch ☑ at the bottom right of the adjustment window.

5. Touch [Depth] and select [Online Monitor] to set the sipper depth.



6. Use the Up and Down Arrow buttons to adjust the sipper so the tip is flush with the top of the Monitor Sample Cup.
7. Touch ☑ at the bottom right of the adjustment window to save the depth setting.

6.3 Sample Interface

When configured appropriately the 2960 automatically samples a bioreactor, process stream, or other suitable sample source. Since color, turbidity, optical density and many other physical factors do not affect the YSI enzyme biosensor, filtration and/or dilution may not be necessary and the 2960 may draw the sample directly. If cell loss is a concern, or if high cell density is expected, a filtration device (e.g., tangential flow filter) which separates broth and cells may be installed between the sample source and the 2960.

Using the additional tubing included with the 2960, connect the tubing from the outer slot of the 2960 valve to your sample source—bioreactor, process stream, etc. Keep the tubing as short as possible to minimize purge time.

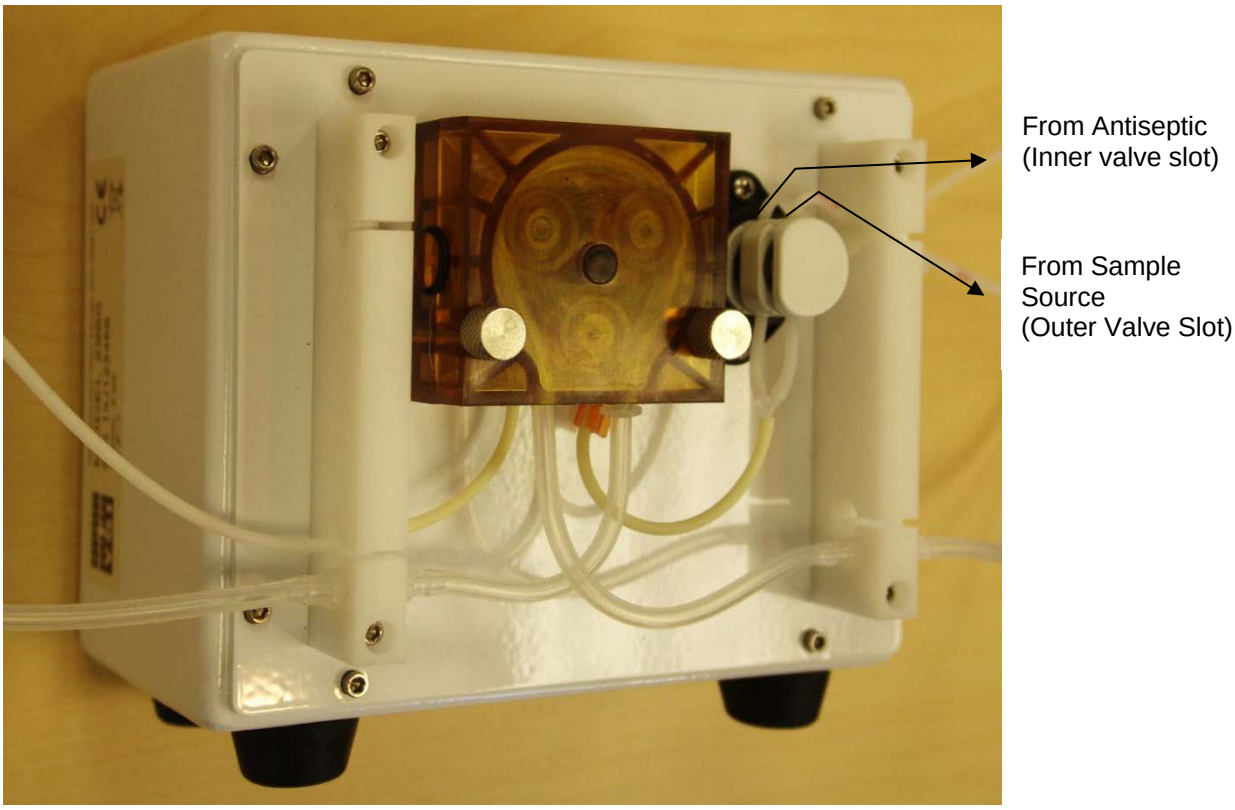


Figure 6-7

If you are using an antiseptic, connect the tubing from the inner slot of the 2960 valve to your antiseptic container. Typical solutions might include 1% sodium hydroxide,70% ethanol, 70% IPA or 0.25% hypochlorite in reagent water. Even if you are not using an antiseptic solution, the solenoid valve still switches to the antiseptic position and air or fluid is pumped through the antiseptic line during sample aspiration. The antiseptic line must be kept free from obstructions. A dry 0.2 micron filter may be connected to the antiseptic line to prevent contamination in the air from entering the line.

6.3.1 Sterilization

If your application requires aseptic monitoring, all tubing and connectors should be sterilized (autoclaved) prior to use. The tubing, connectors and pump head should be assembled, the open ends of the tubing should be clamped off (two clamps are provided) and the entire assembly (tubing with pump head) should be sterilized along with the bioreactor.

If the tubing is connected to the bioreactor after sterilization, a sterile connection must be made.

After sterilization the pump should be remounted onto the 2960 (see Section 9.6 2960 Maintenance for details). The antiseptic cycle must be enabled and the antiseptic solution must be primed immediately after the tubing is reconnected.

6.4 Electrical Interface

6.4.1 Analog Outputs

The 2960 interface provides additional signals to aid in synchronizing the reading of the analog outputs. In addition to the two analog outputs, three logical signals are provided. These "handshake signals" are nominally +5 volts for a logic 1 and ground (0 volts) for a logic 0. The "READY" signals are output from the 2960 and are set to a logic 1 when the analog output signal for that channel has been updated. This signal indicates to the host system that the analog voltage is "new" and that it represents the most recent reading of the analyte concentration. The host system (the external system to which the 2960 is connected) then can send a logic 0 to the "ACK" input of the 2960. This "ACK" (acknowledge) signal response from the host resets the READY line of the 2960 to its low state before the next sample is ready.

Figure 6-8 below shows the typical signal pattern that would occur during two sample update cycles. The READY signals will reset themselves immediately prior to updating the analog output if not reset externally via the ACK\ signal input.

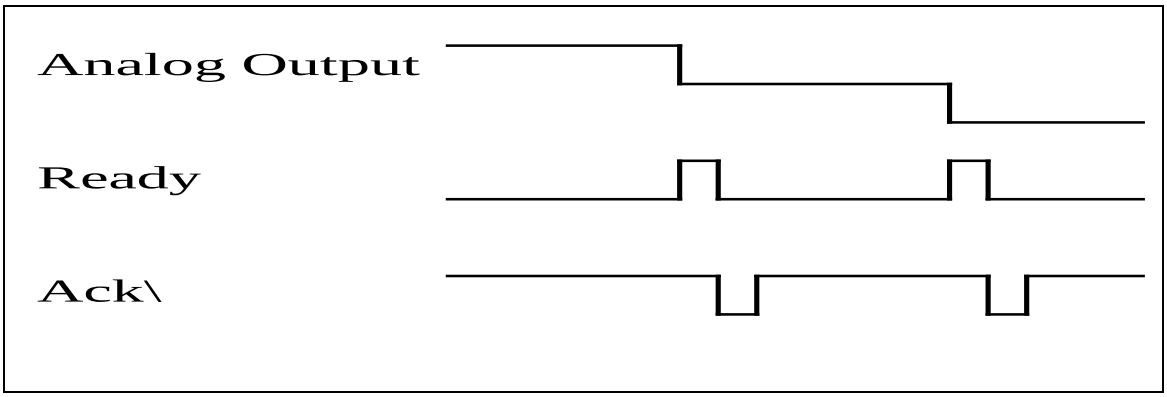


Figure 6-8

6.4.2 Pump Control Outputs

Three discrete outputs are provided on the 2960 which are intended to control external pumps. The means of control is on or off only, no intermediate states are supported. The three outputs are labeled Feed Pump A, Feed Pump B, and Filtrate Pump. All of these outputs are electrically identical and are designed as control signals only, i.e. they are incapable of driving any pumps directly. These signals must be buffered externally in a manner appropriate to the nature of the pumps being used. These output signals transition between +5 volts and 0 volts nominally. The logic of each, i.e. whether 5 volts turns on or off the external device, is selectable (See *6.5 Monitor Setup*).

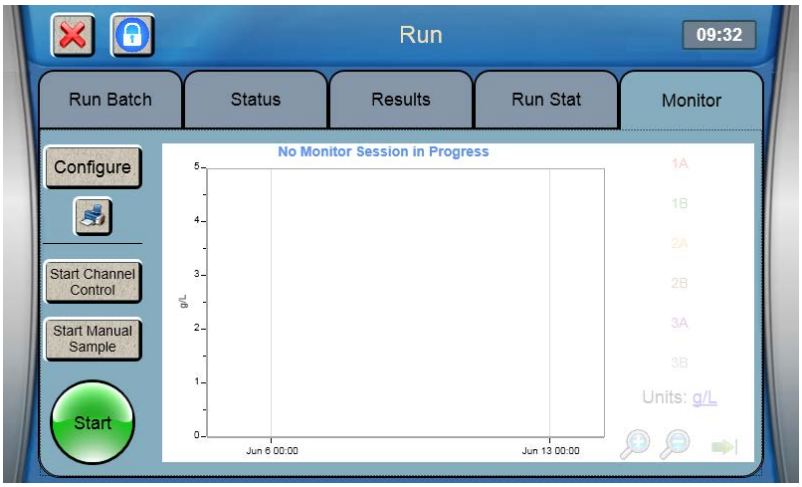
6.4.3 Auxiliary Connector / Signal List

On the back of the 2960 is the 15 pin "D" type connector where the signals emanate. The following table relates the signals with the connector pin positions and cable wire colors.

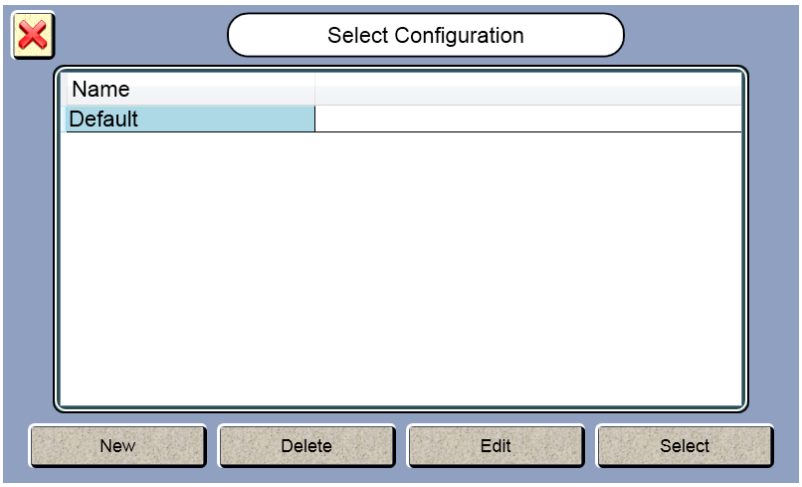
2960 Signal	Pin#	Wire color
Ground	1	Black/White
Ground	2	Orange/Black
Ground	3	Blue/Black
Ground	4	Red/White
Ground	5	Black
Channel B Ready	6	White
Channel A Pump Control	7	Green/White
SysErr	8	Blue/White
Channel A Analog Output	9	Green/Black
Channel B Analog Output	10	Green
Channel B Pump Control	11	Red/Black
Filtrate Pump Control	12	Red
+12V Power Out	13	Blue
Ack\	14	White/Black
Channel A Ready	15	Orange
Chassis Ground	None	Shield

6.5 Monitor Setup

1. From the Run menu, touch the [Monitor] tab.
2. Touch the [Configure] button

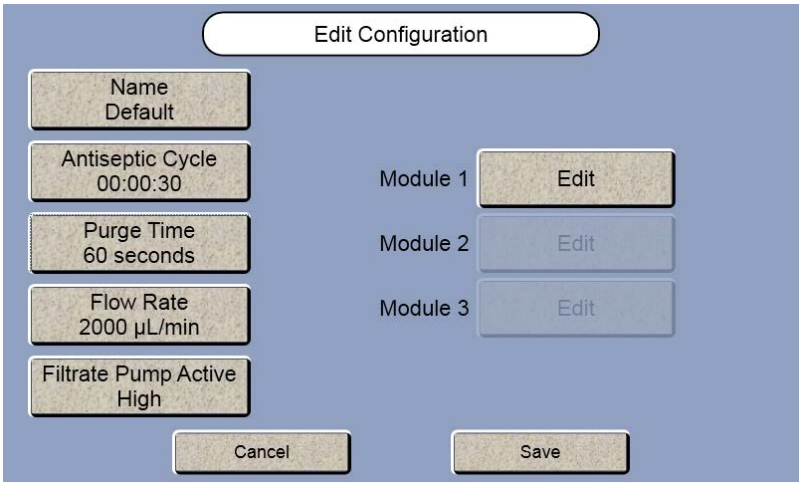


3. When configuring the monitor for the first time, touch the [Edit] button to edit the default monitor configuration. To add additional configurations in the future, touch [New] to create a new configuration.



6.5.1 Name

4. Touch the [Name] button and enter a name for this configuration.



6.5.2 Flow Rate and Purge Time

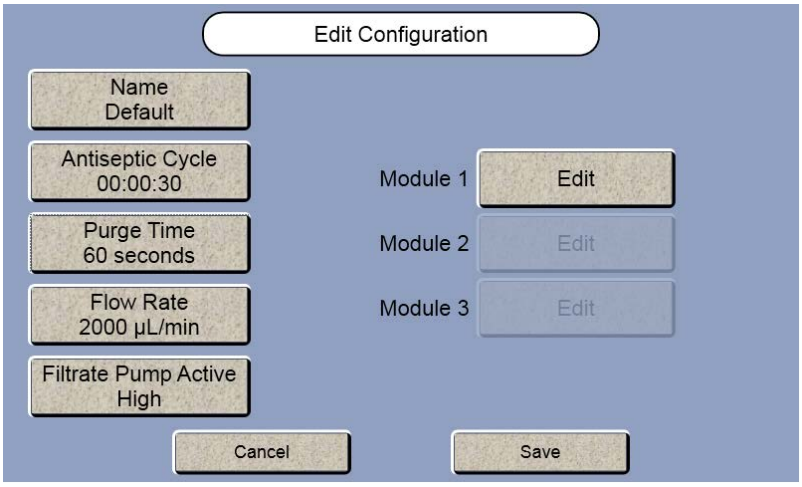
The flow rate and purge time settings must be such that a sufficient volume of sample is pumped during each cycle to completely purge the Monitor sample cup and system tubing. This is especially important when an antiseptic is used since the antiseptic may damage the enzyme membrane if aspirated by the sipper.

The table below shows the flow rates and minimum time needed to purge the tubing lines from the solenoid valve to the Monitor sample cup. These values are based upon a 6-fold volume turnover. Additional time may be necessary to purge the line from the sample source to the solenoid valve. The volume of the supplied sample tubing is 5.1uL per inch.

Flow Rate uL/min	Purge Time Seconds	Flow Rate uL/min	Purge Time Seconds
100	900	1400	65
200	450	1500	60
300	300	1600	57
400	225	1700	53
500	180	1800	50
600	150	1900	48
700	129	2000	45
800	113	2100	43
900	101	2200	41
1000	90	2300	39
1100	82	2400	38
1200	75	2500	36
1300	69		

Table 7-1

5. Touch the [Purge Time] button and enter the required purge time.

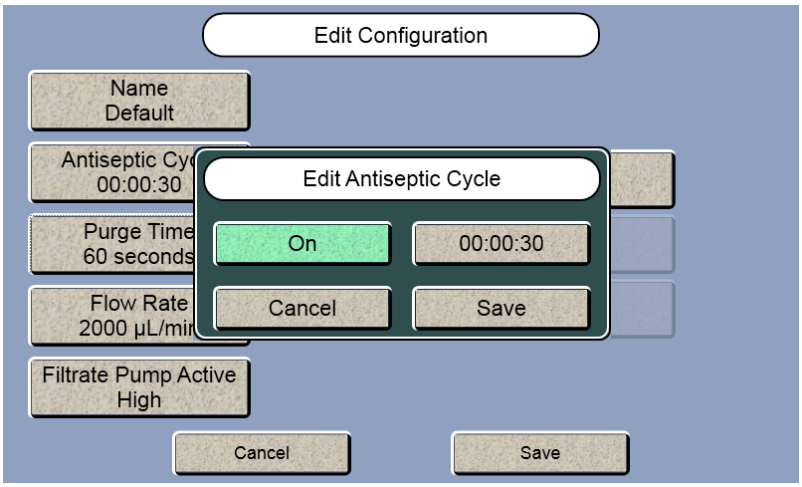


If you are using a filter on your sample line, make sure your Flow Rate does not exceed the maximum rated flow rate of your filter. If necessary, touch the [Flow Rate] button and enter the correct flow rate.

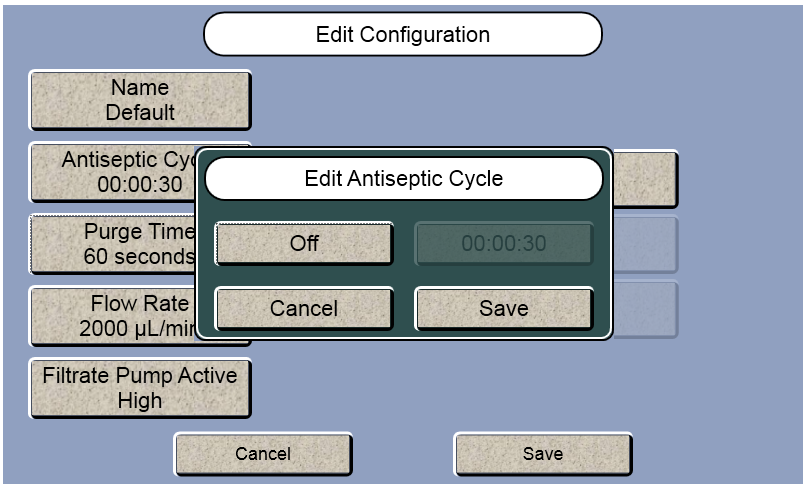
6.5.3 Antiseptic

If you are **not** using an antiseptic solution:

6. Touch the [Antiseptic Cycle] button.



7. Touch the [On] button and change it to [Off] if you are not using and antiseptic solution.



8. Touch [Save] to save your change and return to the Edit Configuration screen.

6.5.4 Filtrate Pump

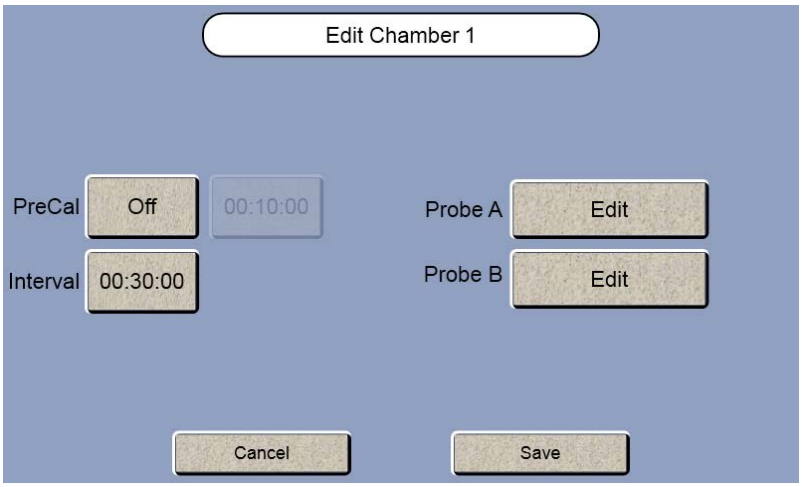
The filtrate pump control output from the 2960 is provided to control a user-supplied external pump for pumping the sample from its point of origin to the 2960. The timing of this signal is the same as the purge pump of the 2960. **This option is normally not used** since the 2960 pump can transport most samples to the Monitor sample cup. If an external filtrate pump is used, the flow rate must be maintained at or above 580uL/minute in order to guarantee that the sipper does not aspirate air during the sampling process.

The default filtrate pump output is Active High (+5V). Touch the [Filtrate Pump Active High] button to change it to Active Low if your pump requires an Active Low signal (0V) to turn on.

6.5.5 Module

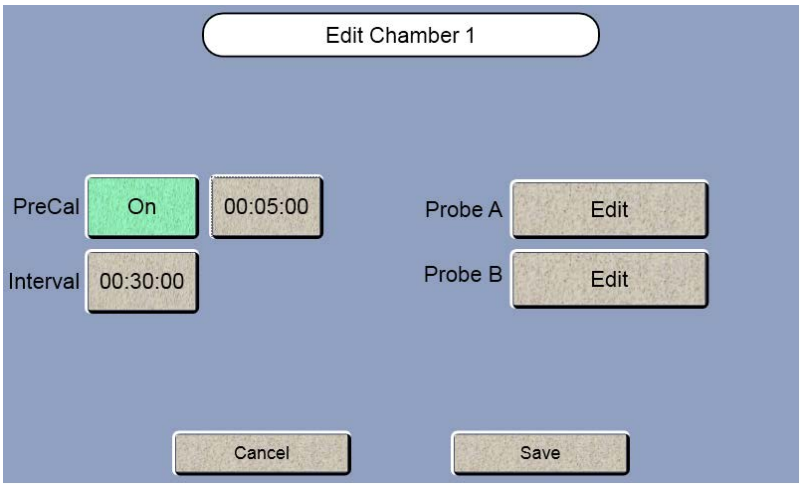
Set up a Module for the chemistries you want to monitor/control.

9. Touch the Module 1 [Edit] button.



6.5.5.1 PreCal

10. Touch the PreCal [Off] button and change it to [On] to initiate an autocalibration at a predetermined interval before each monitor sample.
11. Touch the PreCal time interval button [00:10:00] and enter the time in minutes before the monitor sample when an autocalibration will be initiated.



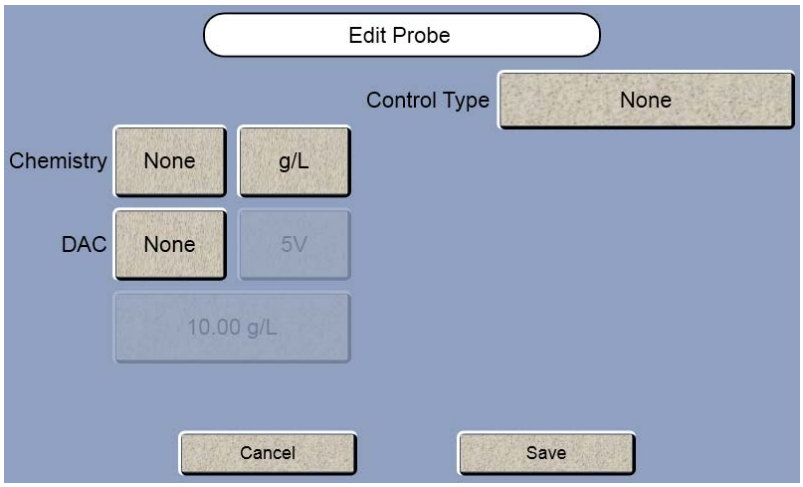
When in the monitoring mode and when the 2900 Series is stabilized in terms of calibration drift, you may elect to disable autocalibrations related to time and number of samples and use the PreCal option only.

6.5.5.2 Interval

12. Touch the Interval [00:30:00] button and enter the time interval between your monitor samples for Module 1.

6.5.5.3 Chemistry and Units

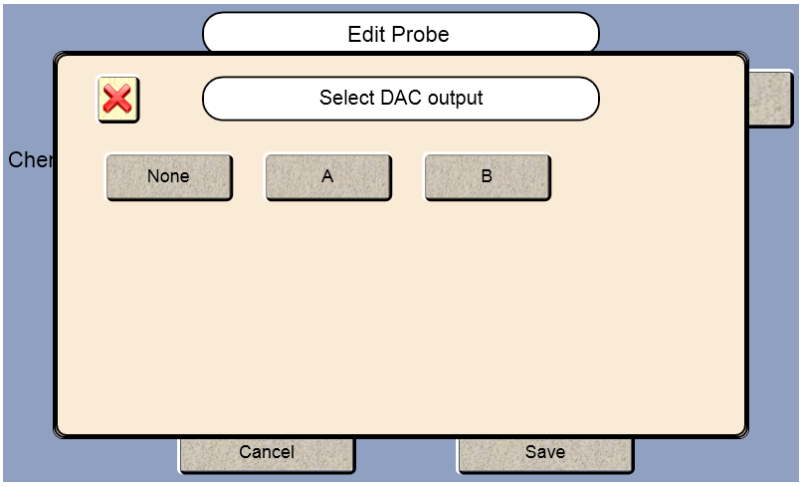
13. Touch the Probe A [Edit] button.



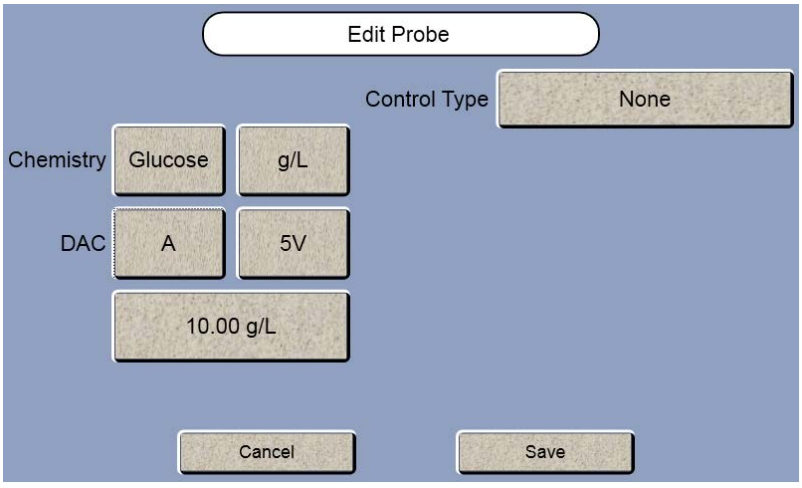
14. Touch the Chemistry [None] button and select the chemistry you are monitoring.
15. Touch the Units [g/L] button and select the units for this chemistry.

6.5.5.4 Analog Output

16. Touch the DAC [None] button to enable the analog output for this probe.



17. Select the Analog output for this probe.

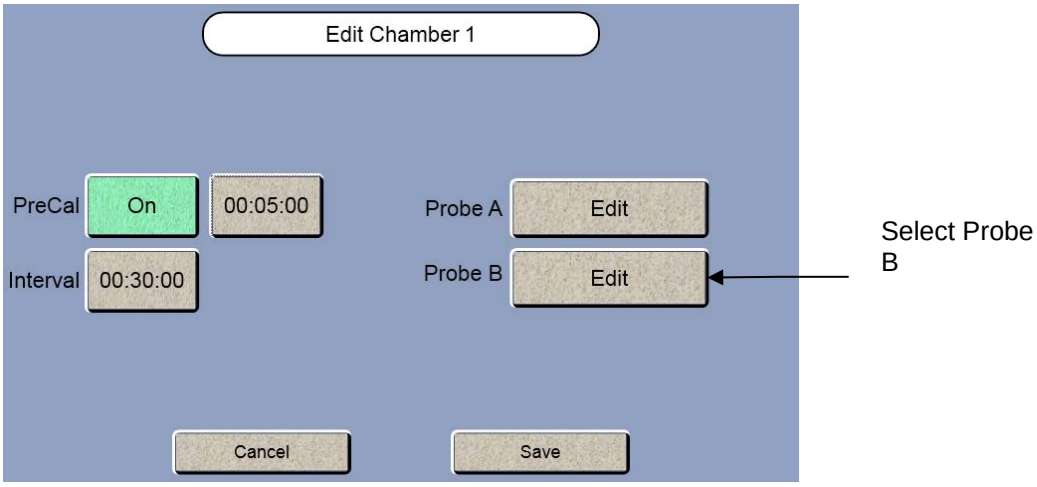


18. The Analog output can be set to 5 Volts or 10 Volts full scale. Touch the DAC [5V] button to change the Voltage to [10V].

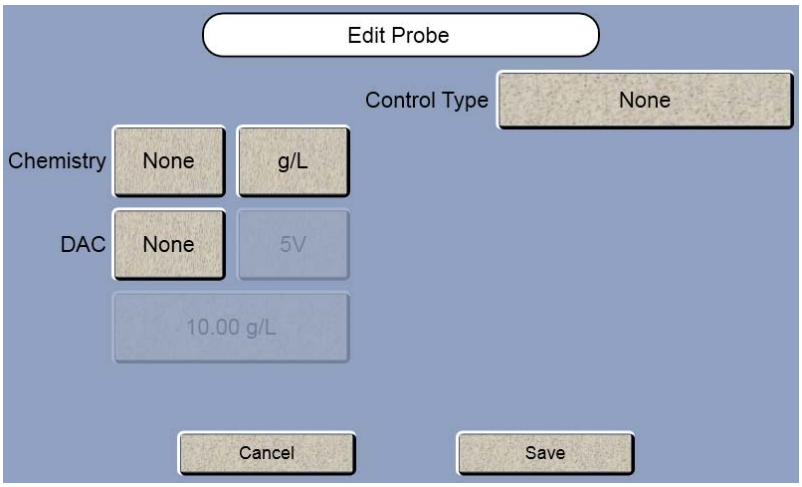
19. Touch the [10.00g/L] button to set the sample value that corresponds to the full scale Voltage.

6.5.5.5 Control Type

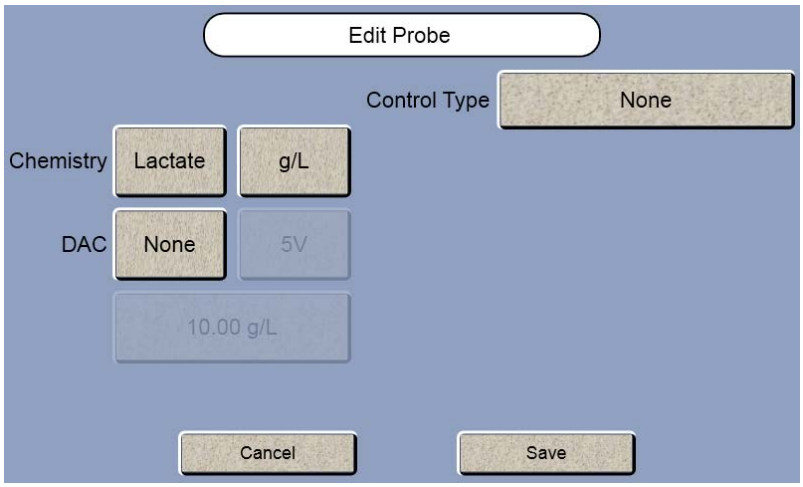
20. See Section *6.8 Control Setup* for setting up the control function.
21. Touch [Save] to save your Probe A changes and return to the Edit Chamber 1 screen.



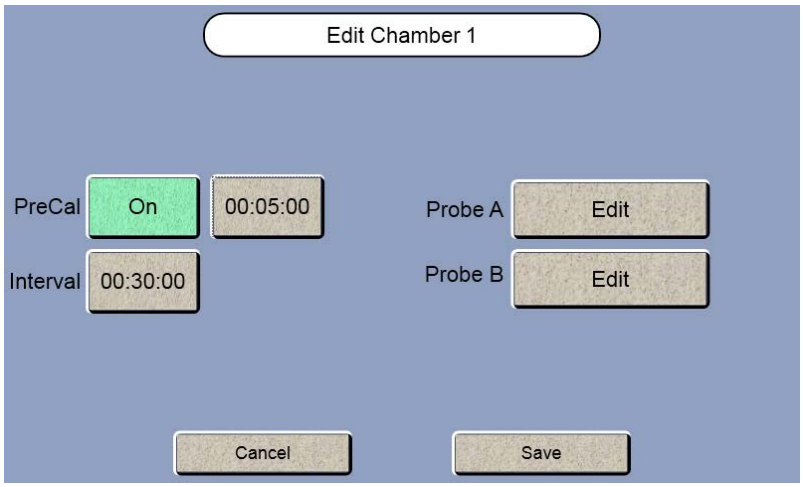
22. To monitor an additional chemistry, touch the Probe B [Edit] button.



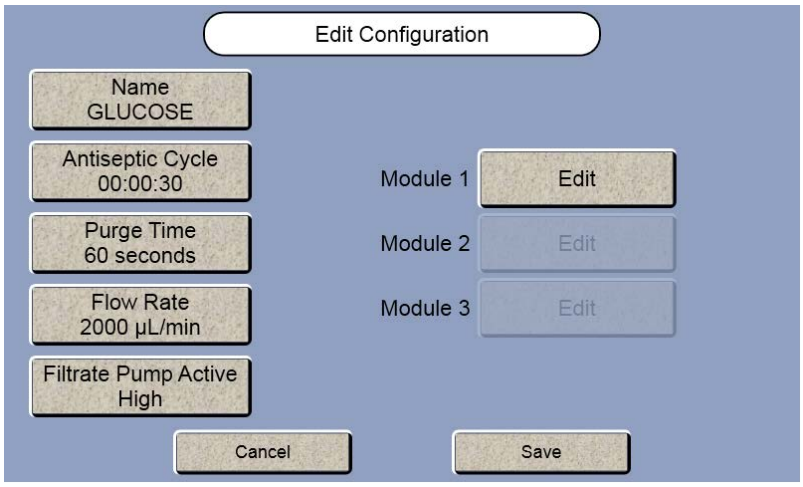
23. Enter the Chemistry and Units for Probe B. Analog output and Control can also be set for Probe B.



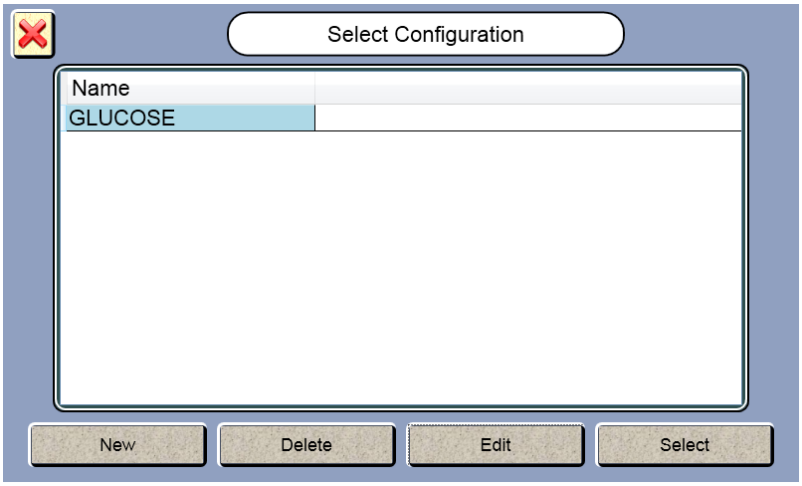
24. Touch [Save] to save your Probe B changes and return to the Edit Chamber 1 screen.



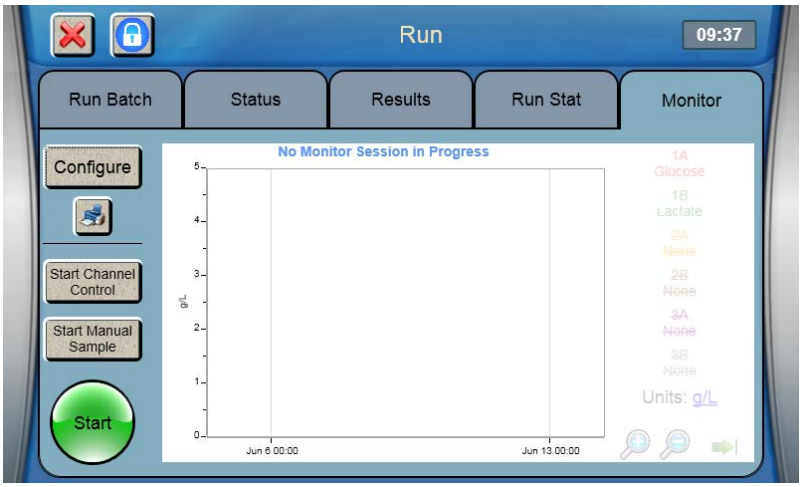
25. Touch [Save] to save your Chamber 1 changes and return to the Edit Configuration screen.



26. Touch [Save] to save your Configuration and return to the Select Configuration screen.



27. Touch [Select] to choose the selected configuration and return to the Monitor screen.



6.6 Start Monitor

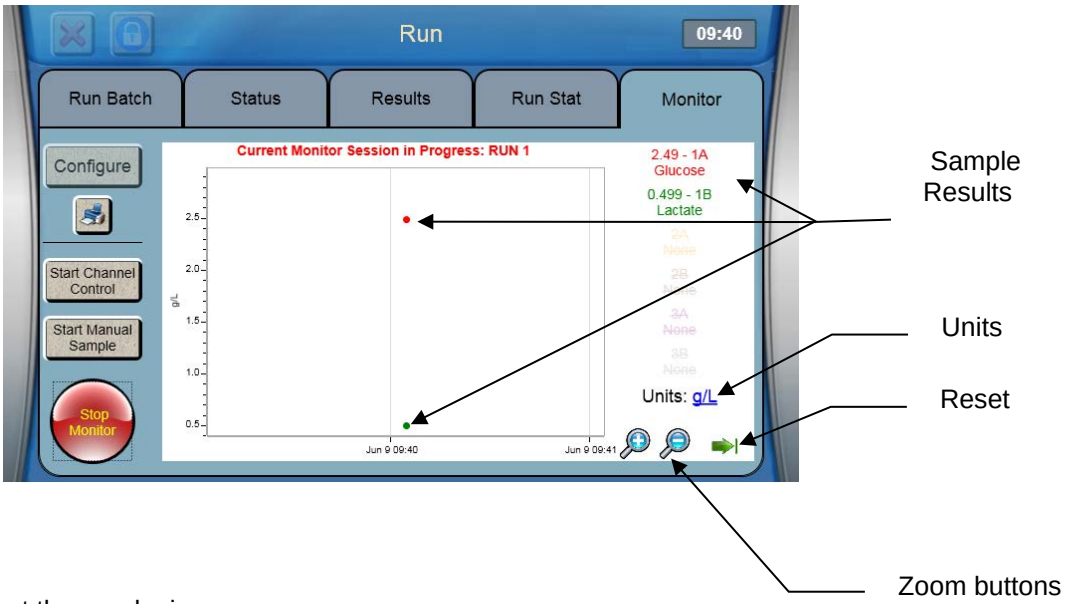
1. Once you have setup and selected your monitor session, touch 

.
2. Enter a name for this specific run, then touch [DONE].

3. The monitor session will start.

The instrument will calibrate the required probe(s) if necessary, or if Precal is enabled, then run the first monitor sample.

Once the sample has run, it will be displayed on the graph:



Use zoom and reset to adjust the graph size.

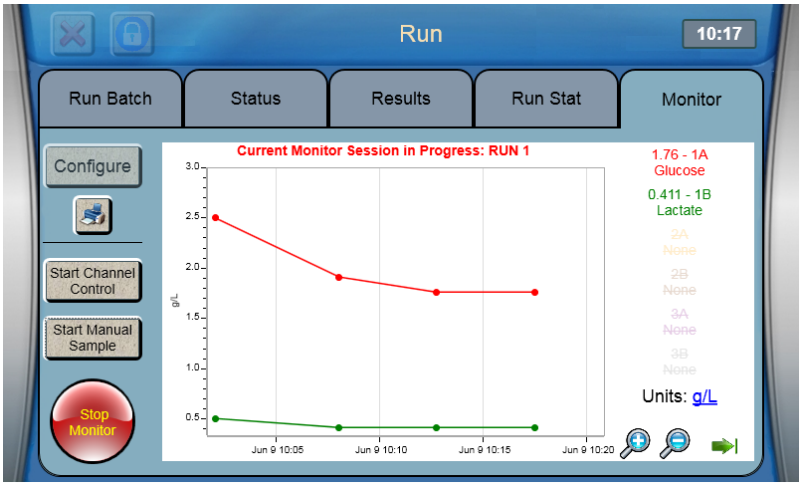
Touch the Units “g/L” to change the displayed monitor units.

6.6.1 Manual Sample during Monitor Session

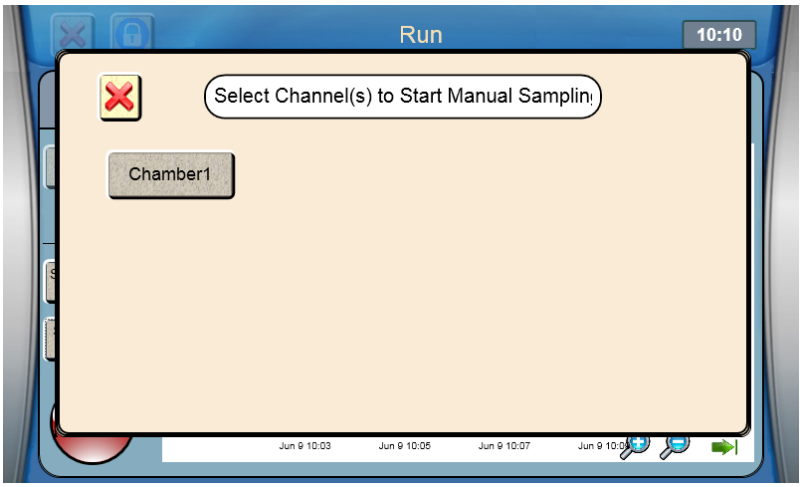
A plate/rack or Stat sample may be run during a monitor session provided there is sufficient time between monitor samples.

If you want to manually initiate a monitor sample (without waiting for the Next Sample Time to arrive)

1. Touch the [Start Manual Sample] button.



2. Select the Chamber that you want to start.



This will initiate a monitor sample and reset the time until the next sample.

6.7 Stop Monitor

To stop the current monitor session, touch 

.

6.8 Control Setup

The 2960 offer two types of control, Proportional-Integral-Derivative (PID) control or Threshold. PID control attempts to maintain the sample source at a user defined set point by adding an amount of feed stock proportional to the error. Threshold simply triggers an alarm or feed pump when the measured sample value passes a user defined value.

The control algorithm incorporated into the 2960 is a variant of the PID algorithm used in many process controllers. Because of the many factors which can affect control it is difficult, if not impossible, to accommodate all circumstances in a single form of the PID control algorithm. Certain assumptions apply to the application of this control scheme of which the user should be aware. Deviations from these assumed conditions will result in degraded regulation.

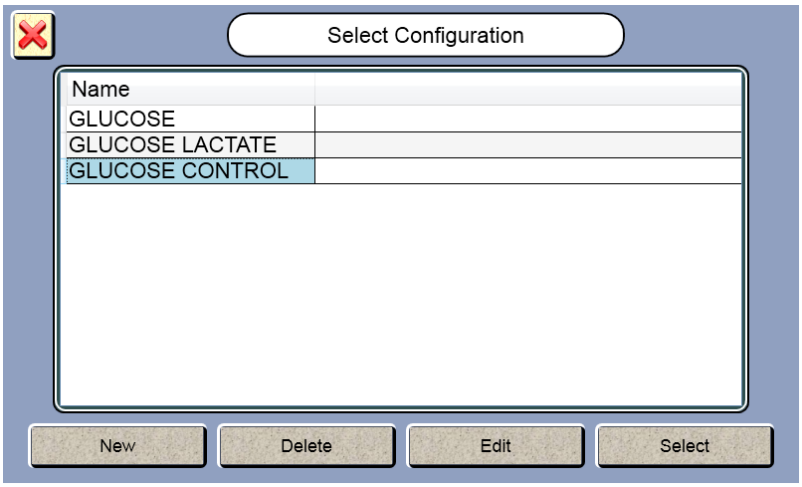
Assumptions:

1. Regulation is begun (enabled) when the analyte concentration is within ±10% of the set point.
2. The sampling interval is regular. That is, the period between samples (corrections) is constant. Random calibration timing will degrade regulation performance if it affects sample timing.
3. Higher rates-of-change of the analyte are coupled with shorter sampling intervals to the maximum extent possible.
4. Maximum control pump on-time is kept less than the sampling interval.

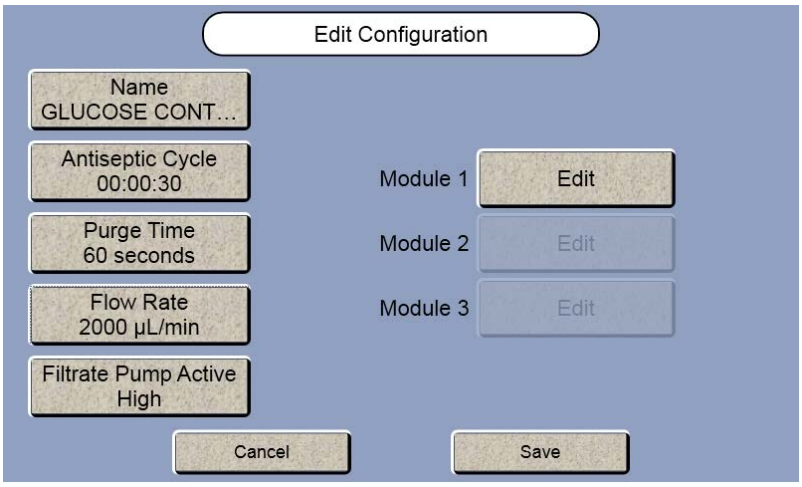
NOTE: A sample performed at station 1 or 2 will not initiate regulation or affect analog output.

6.8.1 Control Type

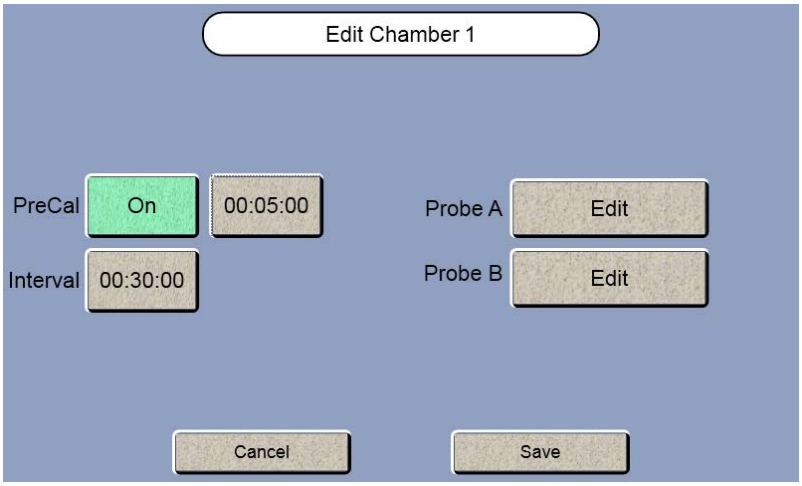
1. From the Run menu [Monitor] tab, touch the [Configure] button.



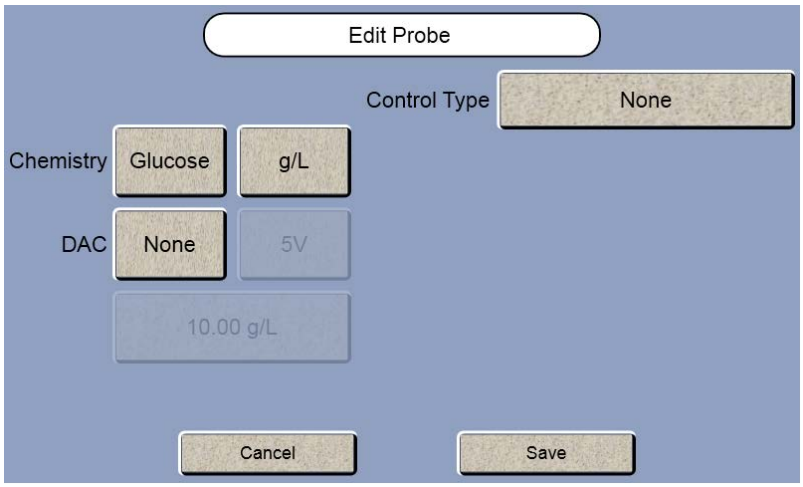
2. Touch [New] to create a new monitor configuration, or select an existing configuration and touch [Edit].



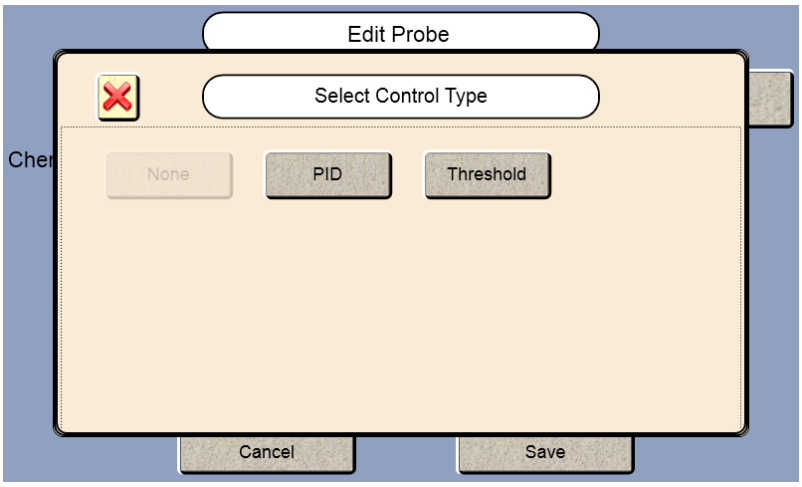
3. Touch the Module 1 [Edit] button.



4. Touch the [Edit] button for the probe you want to control.



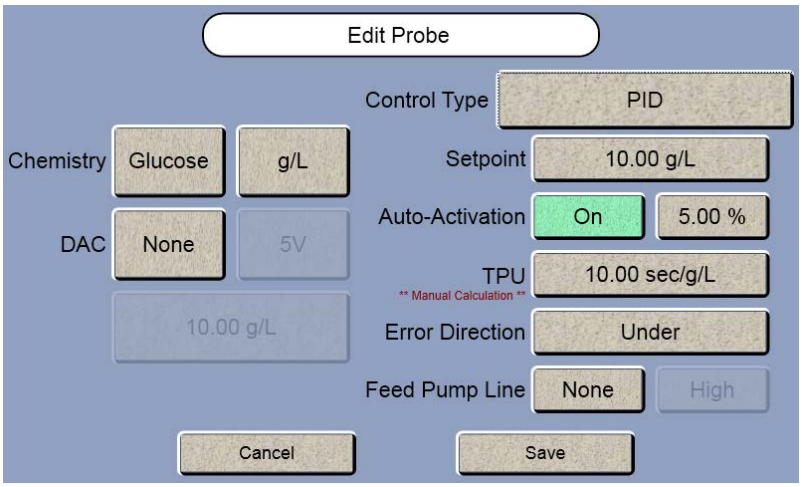
5. Touch the Control Type [None] button.



6. Select the type of control for this channel, [PID] or [Threshold], and follow the corresponding instructions in the section below.

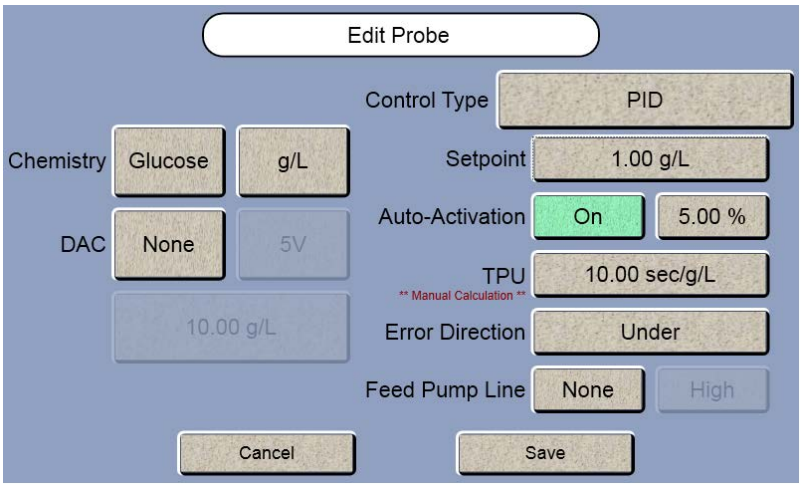
6.8.1.1 PID

For proportional control, select [PID] as the Control Type.



Setpoint

Touch the Setpoint [10.00g/L] button and enter the concentration at which the analyte will be regulated.



Error Direction

[Under] means that the user wishes to regulate to the set point in an environment where the analyte is being consumed and as such tends to fall **under** the set point. In this circumstance the control algorithm will attempt to regulate by making additions of correction feed stock (which contains the analyte) to the controlled volume.

[Over] error direction assumes that the correction applied by the controller will have the effect of diluting or removing analyte to perform regulation. When [Over] is selected, enter the TPU manually.

Example: In the case of a fermentation where glucose is the controlled analyte the user should select [Under] error direction since the organisms in the fermentation will consume glucose, thereby forcing the controller to add glucose via feed stock additions.

Auto-Activation

Auto-Activation automatically starts control once the sample value is within a certain percentage of the setpoint to minimize over/under correction. Using the default value, control will not start until the monitored sample value is within 5% of the setpoint. To change this value, touch the Auto-Activation [5.00%] button and enter the new value.

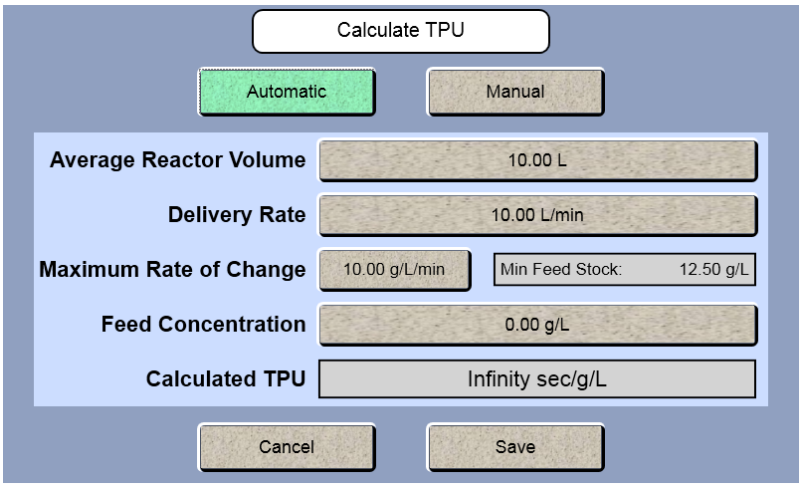
When using Auto-Activation, make sure the monitored sample value is moving towards the setpoint value. If the monitored sample value is moving further away from the setpoint value, control will need to be started manually.

TPU

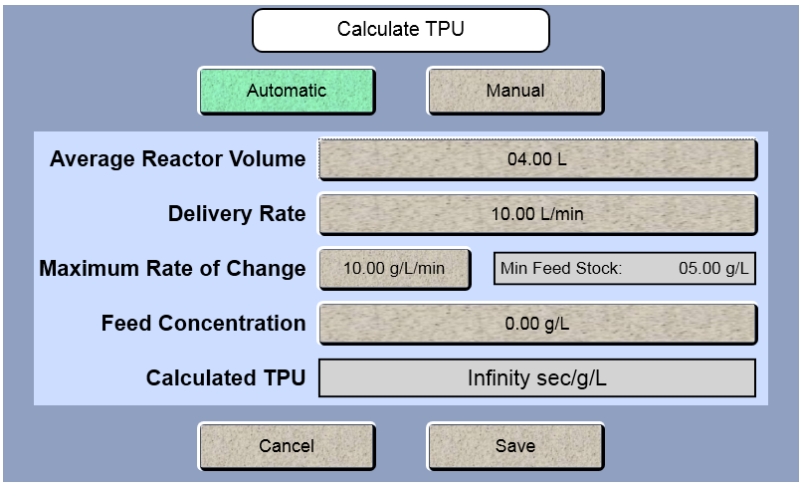
Time-Per-Unit error reflects the amount of time that the correction pump must run to correct for an error in concentration equal to the unit of measure (e.g. g/L, mg/L, etc.).

Touch the [TPU] button. Select [Automatic] to allow the 2960 to calculate the TPU or [Manual] to enter the TPU manually. If your Error Direction is [Under], calculate the TPU manually.

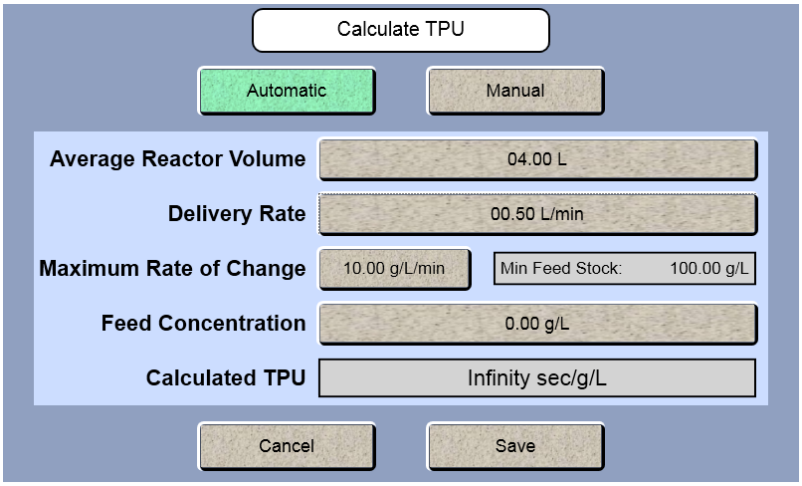
Automatic TPU Calculation



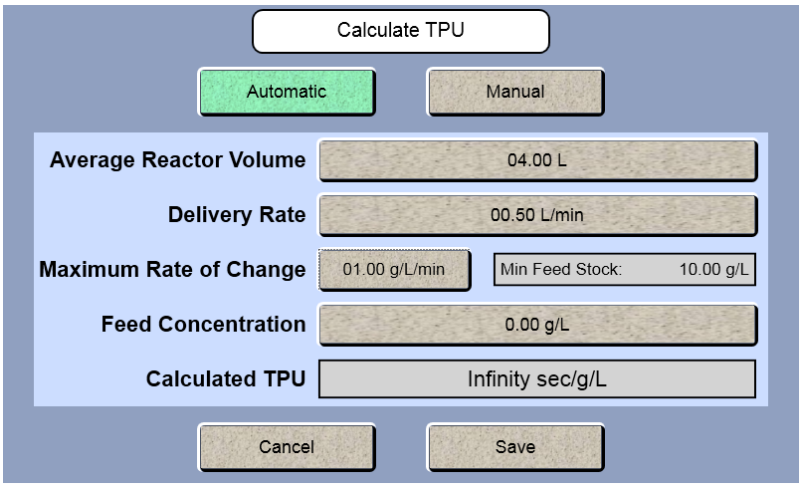
Touch the Average Reactor Volume [10.00] button and enter the average volume of your reactor.



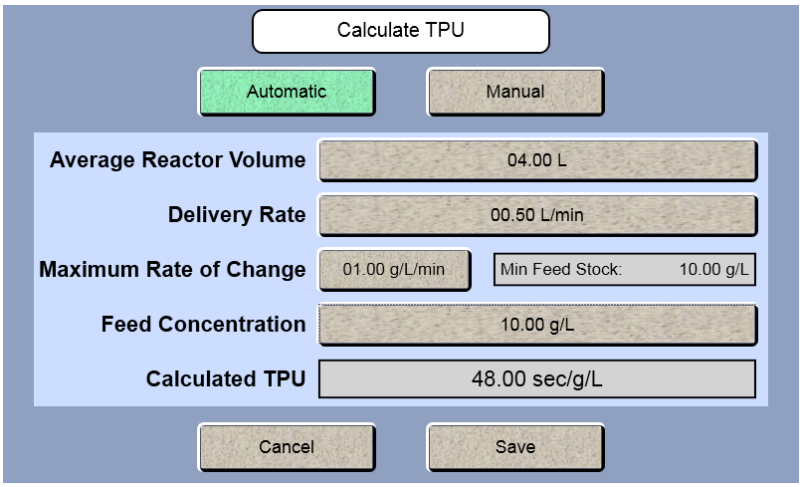
Touch the Delivery Rate [10.00L/min] button and enter the flow rate of your feed pump.



Touch the Maximum Rate of Change [10.00g/L/min] button and enter the maximum rate of change expected during the monitor session (maximum rate of consumption of the measured analyte during the run).

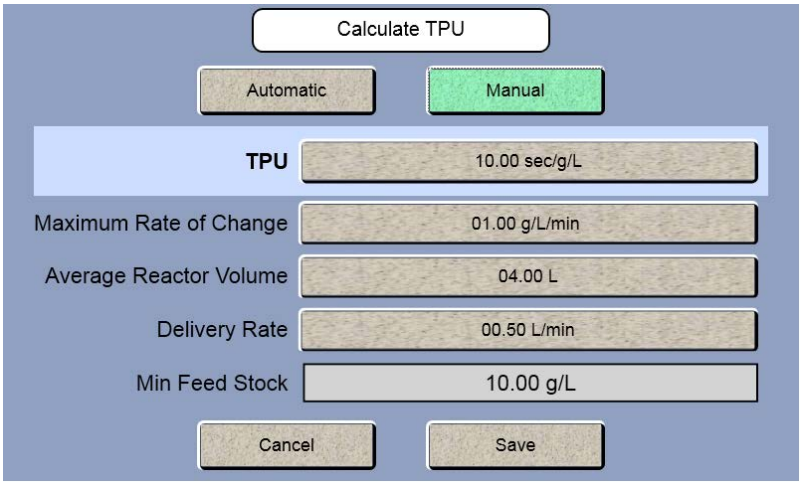


Touch the Feed Concentration [0.00g/L] button and enter the concentration of your feedstock solution. The minimum value required is displayed in the [Min Feed Stock:] box.

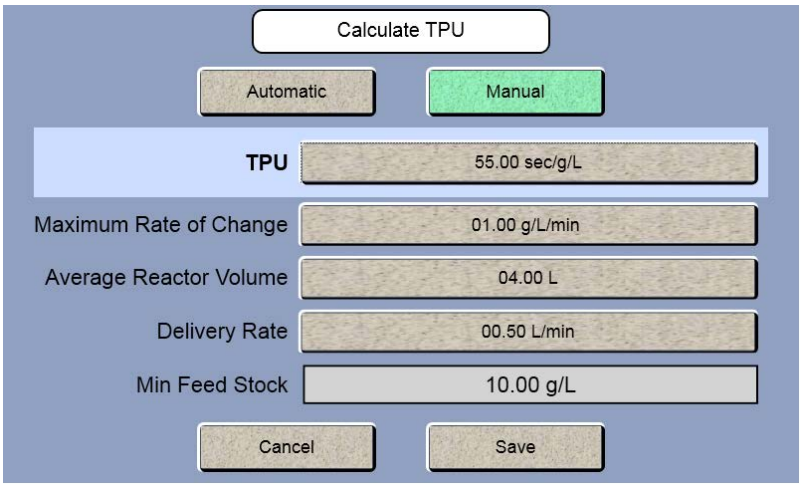


Manual TPU Calculation

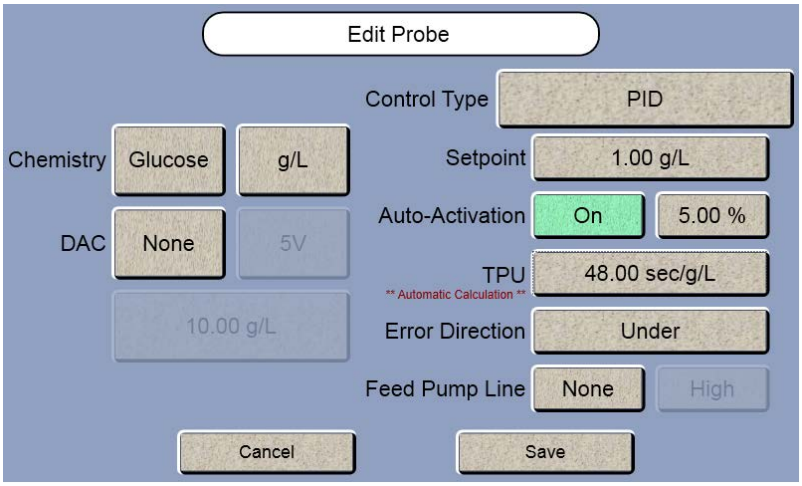
Touch [Manual] to enter the TPU manually. Manual allows you to enter the TPU value that you calculated yourself.



Touch the TPU [10.00 sec/g/L] button and enter your manually calculated TPU value.

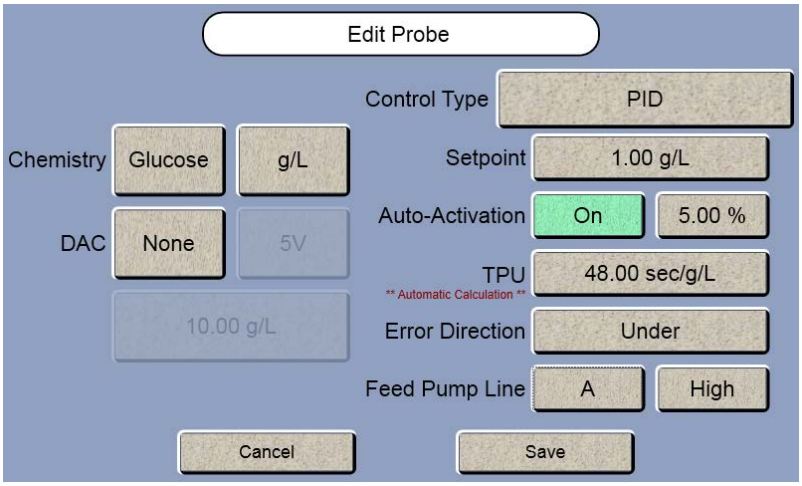


Touch [Save] to save changes and return to the Edit Probe screen.

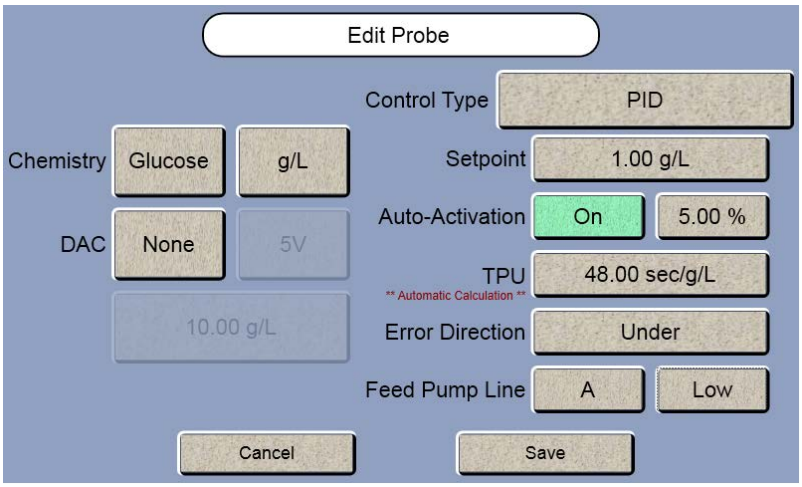


Feed Pump line

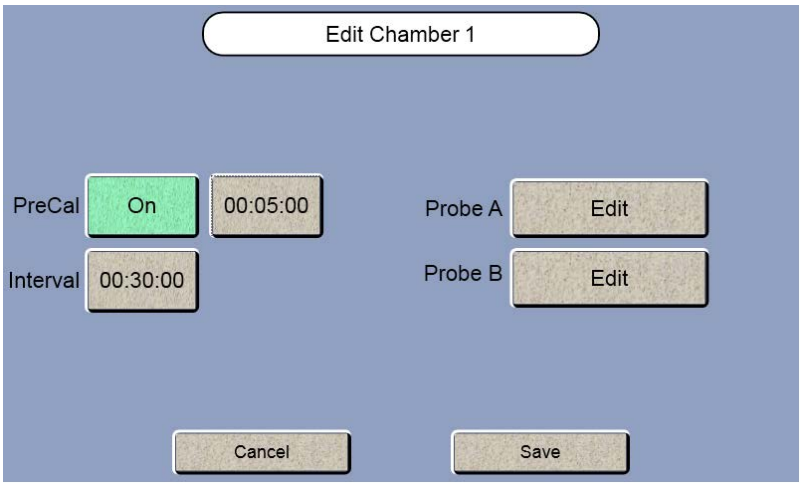
Touch the Feed Pump Line [None] button and select the 2960 feed pump output line that your external feed pump is connected to.



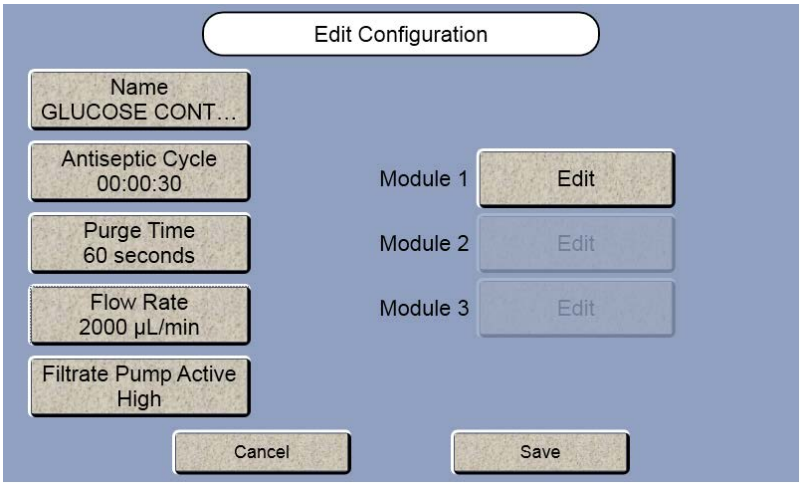
The default feed pump output is Active High (+5V). Touch the Feed Pump Line [High] button to change it to [Low] if your feed pump requires an Active Low signal (0V) to turn on.



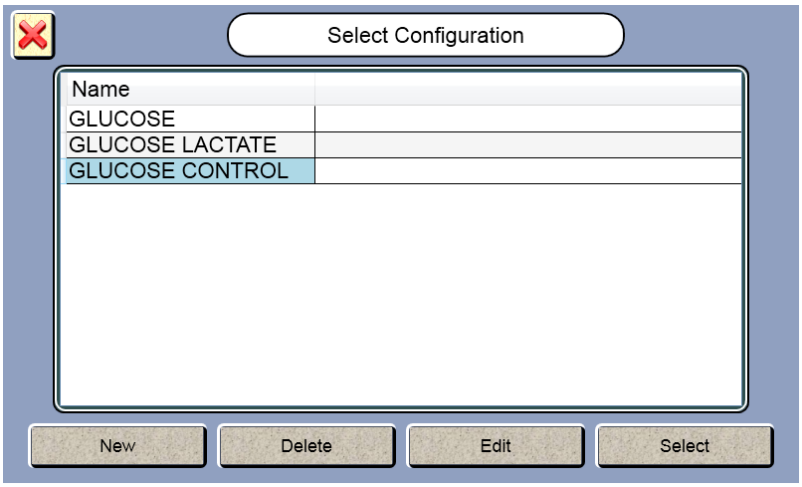
Touch [Save] to save changes and return to the Edit Chamber 1 screen.



Touch [Save] to save changes and return to the Edit Configuration screen.



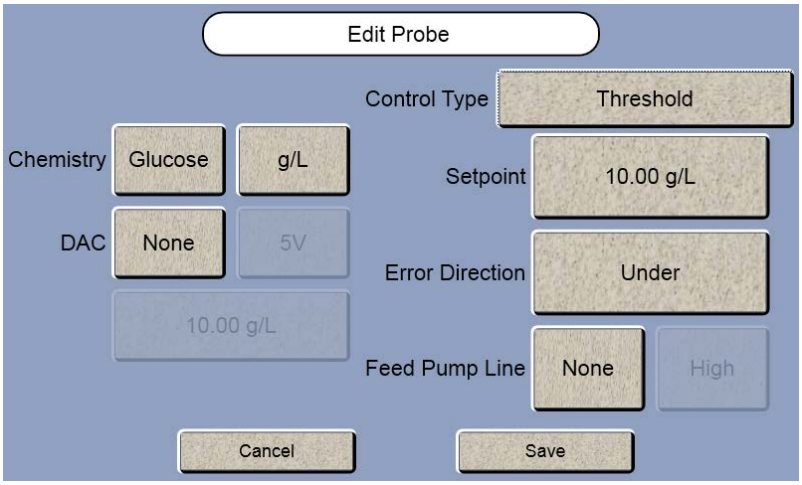
Touch [Save] to save changes and return to the Select Configuration screen.



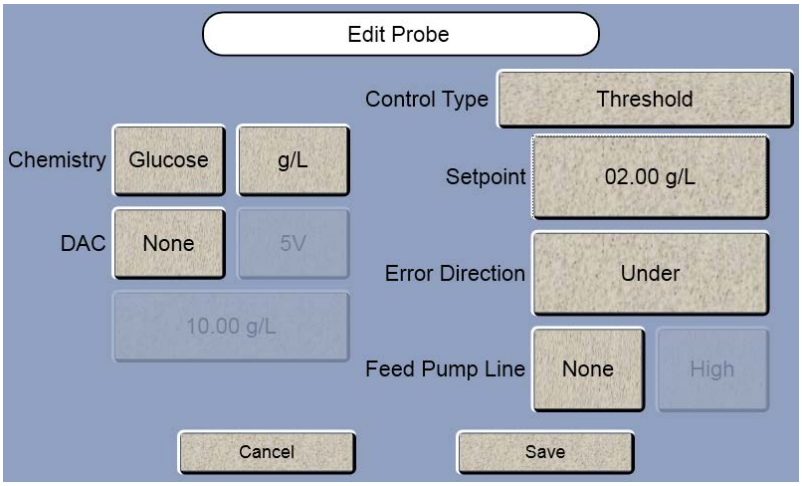
Touch [Select] to choose the selected Configuration and return to the Monitor screen.

6.8.1.2 Threshold

For simple threshold alarm, select [Threshold] as the Control Type.

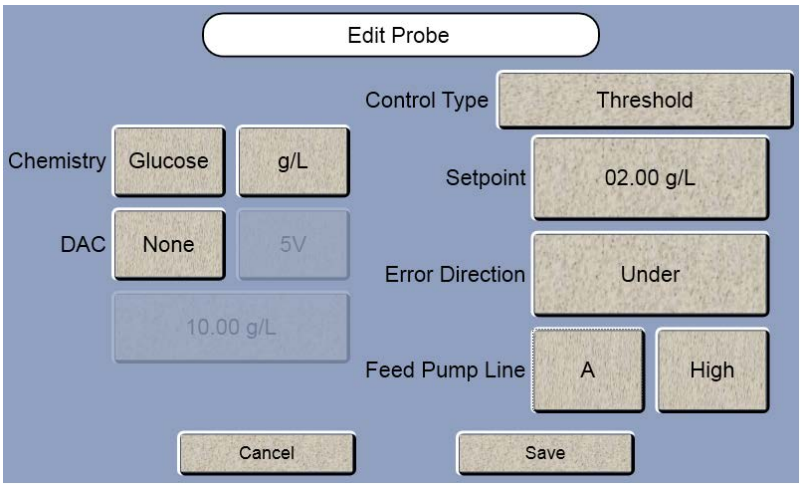


Touch the Setpoint [10.00g/L] button and enter the threshold value.



Set the Error Direction to trigger when the measured analyte value goes [Under] the threshold or [Over] the threshold.

Touch the Feed Pump Line [None] button and select the 2960 output line that your external alarm/pump is connected to.



The default output is Active High (+5V). Touch the Feed Pump Line [High] button to change it to [Low] if your alarm/pump requires an Active Low signal (0V) to turn on.

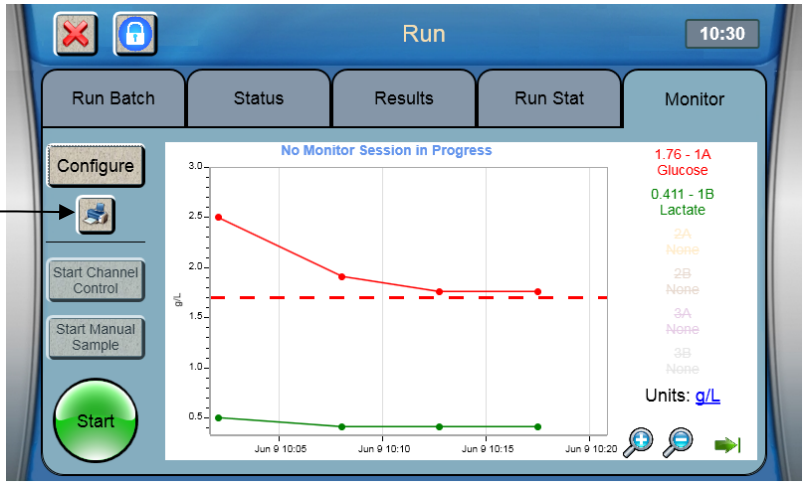
Touch [Save] to save changes and return to the Edit Chamber 1 screen.

Touch [Save] to save changes and return to the Edit Configuration screen.

Touch [Save] to save changes and return to the Select Configuration screen.

Touch [Select] to choose the selected Configuration and return to the Monitor screen.

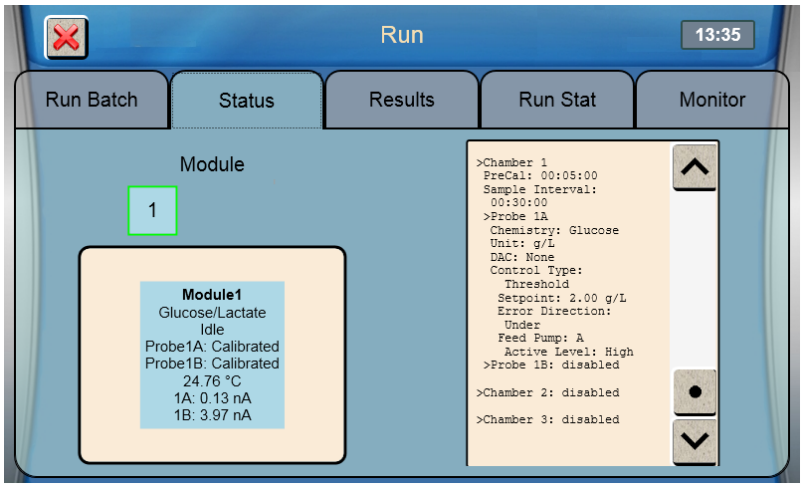
6.9 Print Monitor Configuration



Print Monitor Configuration

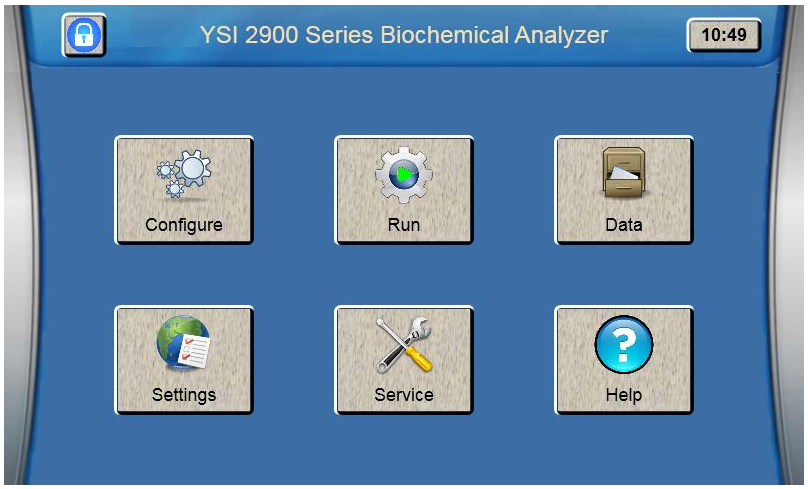
Touch the Print Monitor Configuration button to print the current monitor configuration. The configuration can then be reviewed on the YSI 2901 Printer or from the Status tab:

```
>    ONLINE MONITOR    <
> CONFIGURATION REPORT <

Config Name: GLUCOSE CON
TROL
 Antiseptic Cycle:
  00:00:30
 Purge Time: 00:01:00
 Flow Rate: 2000 uL/min
 Filtrate Pump Active
  Level: High

>Chamber 1
 PreCal: 00:05:00
 Sample Interval:
  00:30:00
 >Probe 1A
  Chemistry: Glucose
  Unit: g/L
  DAC: None
  Control Type: PID
   Setpoint: 1.00 g/L
   Auto Activation: 5%
   TPU: 48.00
   Error Direction:
    Under
   Feed Pump: None
 >Probe 1B: disabled

>Chamber 2: disabled

>Chamber 3: disabled
```



7. Advanced Functions

7.1 Settings



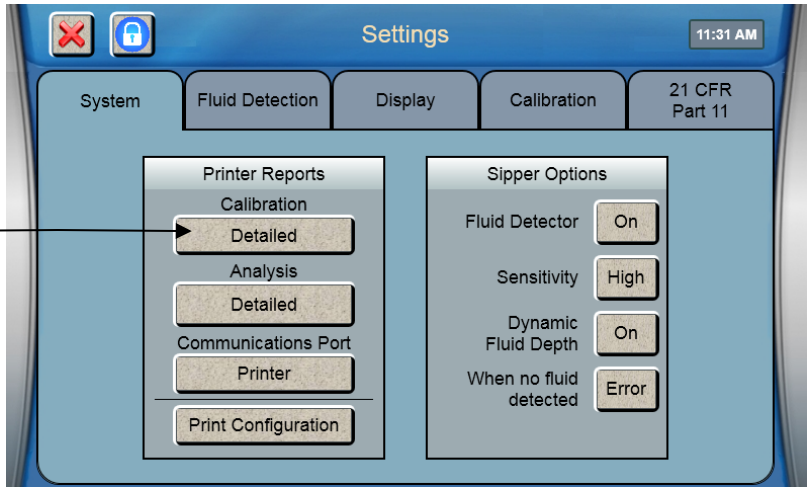
Touch [Settings] to display the global settings screen as shown below. Settings include System, Display, and Scheduler.

NOTE: If 21 CFR Part 11 mode is enabled, only an Administrator can access Settings.

7.1.1 System

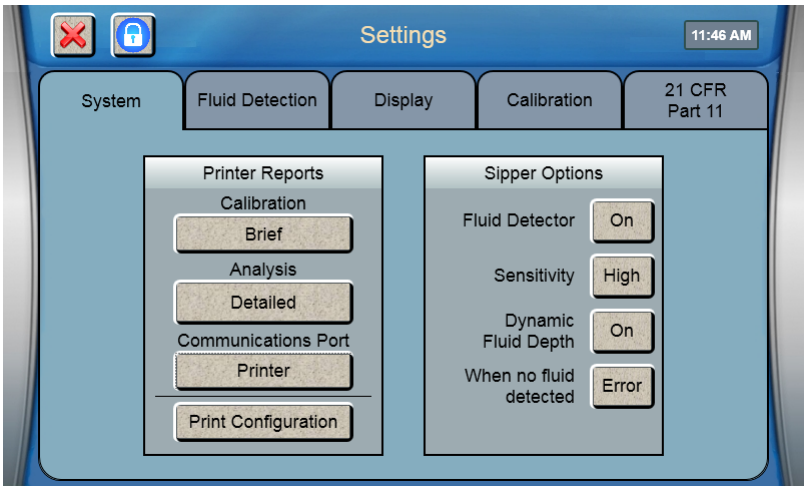
Touch the [System] tab (if not already selected). The System tab is used to select the type of sample and calibration reports, enable sipper fluid detection, configure the RS232 port, and print the configuration.

Touch Detailed



7.1.1.1 Report Details

To change the Sample or Calibration Reports, touch the button below it to cycle through the selections—Detailed, Brief, or None.



7.1.1.2 Communication Port

Set the Communications Port to [Printer] when using the optional YSI 2901 Printer.

Set the Communications Port to [Remote Commands] when using the optional 2940 or 2980 Multi-Channel Online Monitor or the 2920 OPC Data Manager.

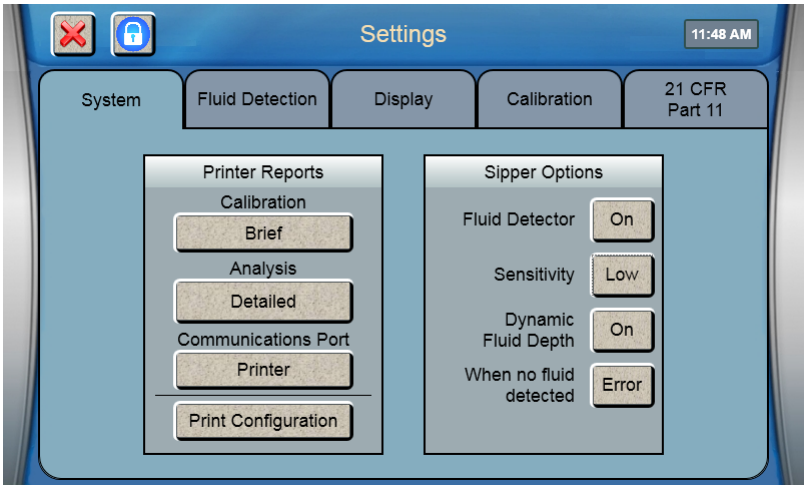
The RS232 Communications Port can also be used to connect the 2900 Series to a remote host. Set the Communications Port to [Remote Commands] to enable the remote host to send commands to the 2900 Series.

7.1.1.3 Print Configuration

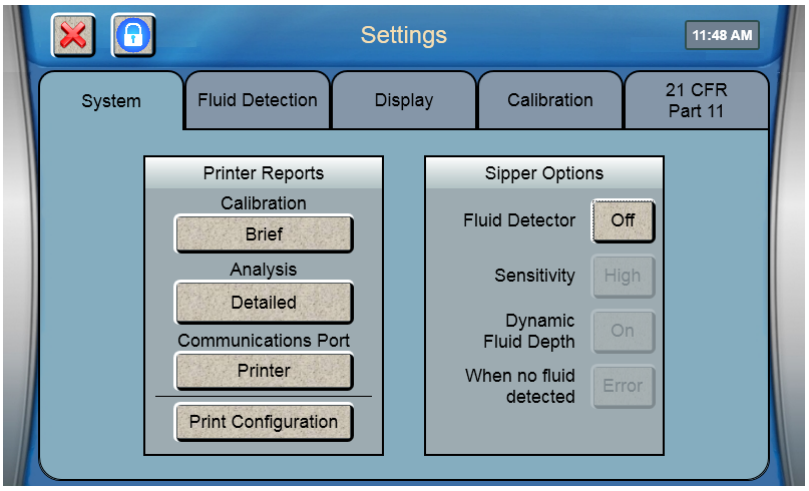
Touch the [Print Configuration] button to send the current instrument configuration to the printer.

7.1.1.4 Sipper options

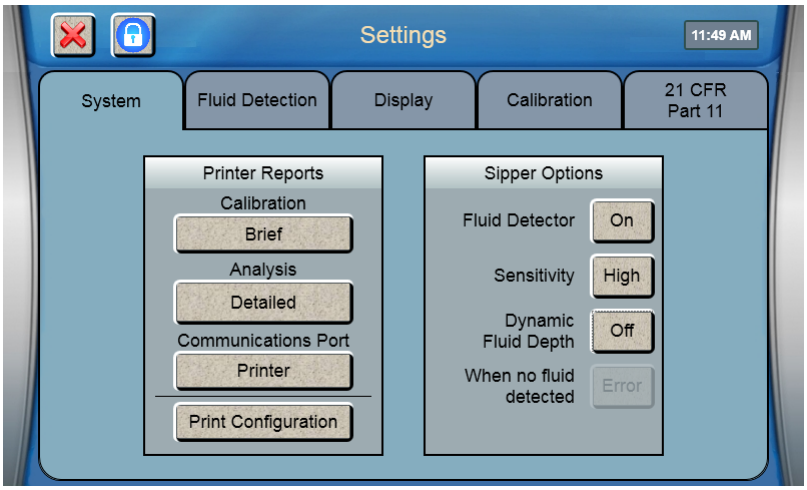
Touch the Sensitivity [High] button and change it to [Low] for samples with high conductivity.



Touch the Fluid Detector [On] button and change it to [Off] to completely disable sipper fluid detection at all locations, including the calibrator wells.



Touch the Dynamic Fluid Depth [On] button and change it to [Off] to disable sipper fluid detection and use fixed depth at sample stations.



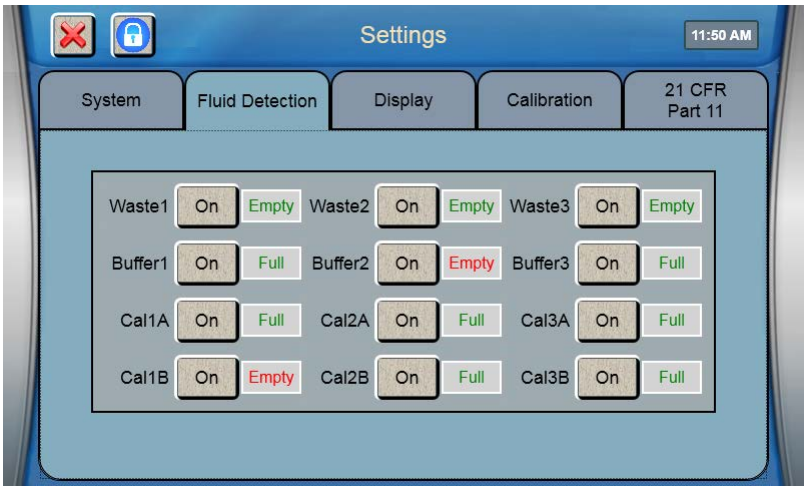
Touch the “When no fluid detected” button and select the sample fluid detection mode you prefer:

[Error] Produce an error when no sample is detected (no sample result).

[Warn] Use fixed depth when no sample is detected (report a sample result).

7.1.2 Fluid Detection (Bottles)

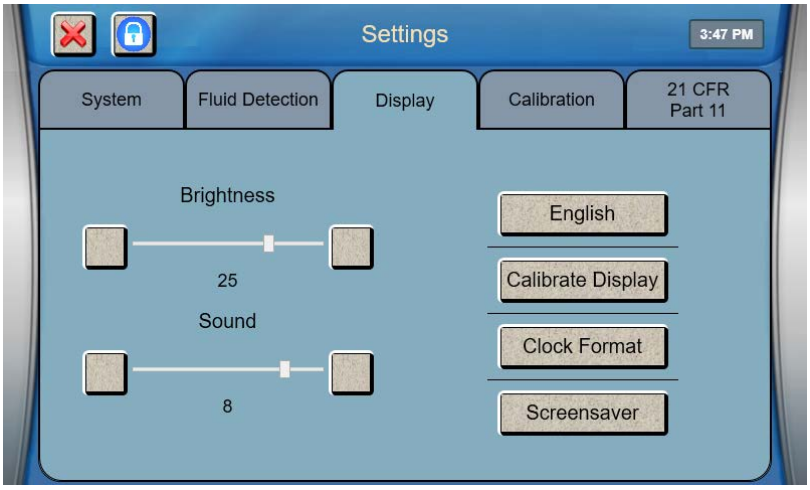
From the Settings screen, touch the [Fluid Detection] tab.



To change bottle Fluid Detection, touch the button for the bottle you wish to change. If the 2938 or 2936 Bottle Trays with Reagent Level Sensing are not installed, turn off the bottle sensors. **NOTE: When bottle sensors are off, check bottle fluid levels regularly to prevent waste fluid from backing up into sample modules.**

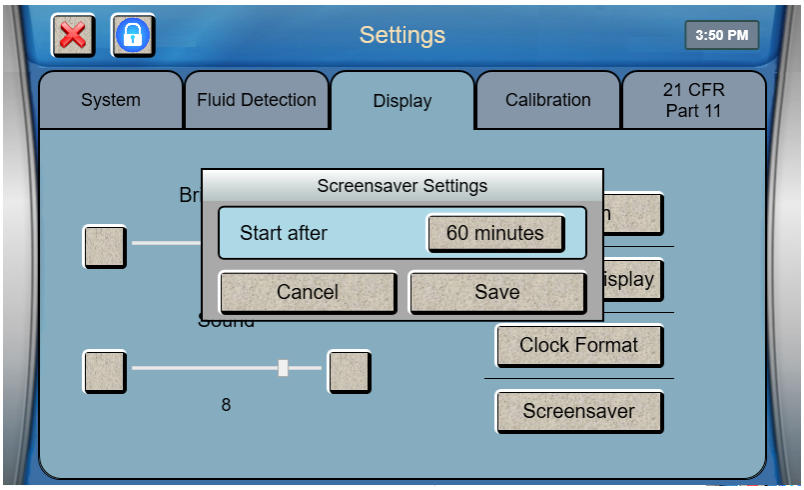
7.1.3 Display

From the Settings screen, touch the [Display] tab.



Screensaver

Touch the [Screensaver] button.



Touch the number of Minutes button next to “Start after.” Enter the number of minutes that the instrument should remain idle before enabling the screensaver, then touch [OK].

If 21 CFR Part 11 Mode is enabled, the screensaver locks the screen and a User name and Pin are required to unlock the screen (see *7.1.5 21 CFR Part 11*). The maximum setting for number of minutes with 21 CFR Part 11 Mode enabled is 60.

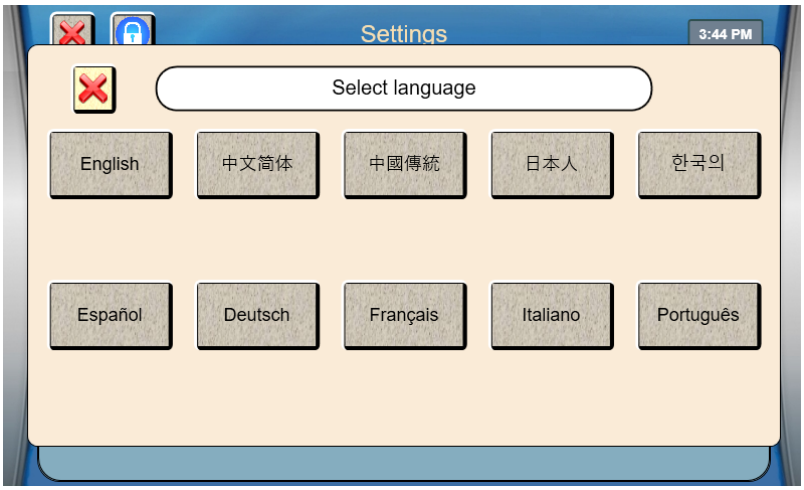
Note that once the Screensaver is active and analyzer has been idle for 4 hours, the analyzer will dispense calibrator into each module, then flush with buffer, once every 4 hours to exercise the membranes.

Brightness

Adjust the display brightness or sound volume by touching [+] or [–].

Language

To change the displayed language, touch the current language button.



Select your language from the available choices.

7.1.3.1 Touch Screen Calibration

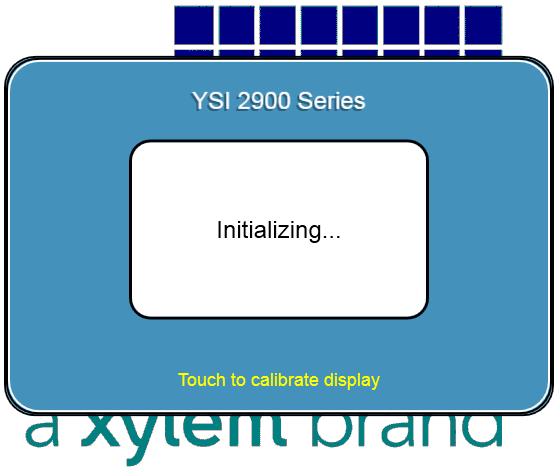
The touch screen is calibrated at the factory and should not require user calibration.

Touch the [Calibrate Display] button to enter touch screen calibration.

Using a stylus, touch and hold the **center** of the red flashing that appears at each corner of the display until appears.

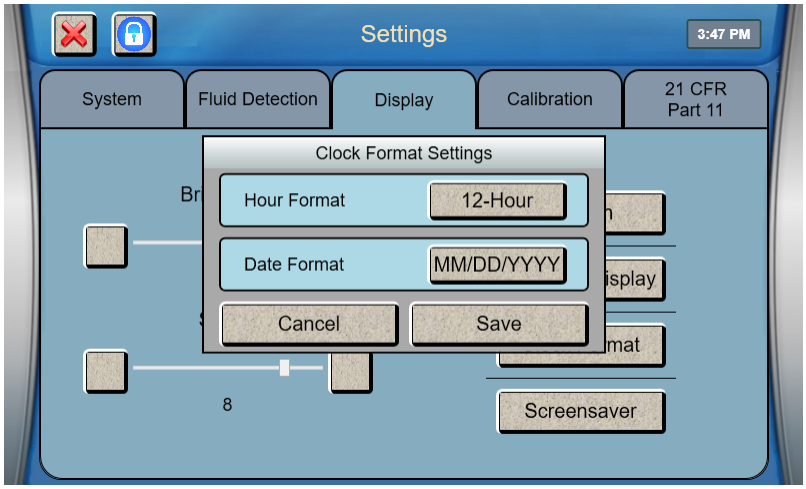
After you have held the in all four corners, the touch panel is calibrated.

Touch screen calibration can also be initiated by touching anywhere on the Initialization screen while the instrument is powering up.



7.1.3.2 Clock Format

Touch the Clock Format button.



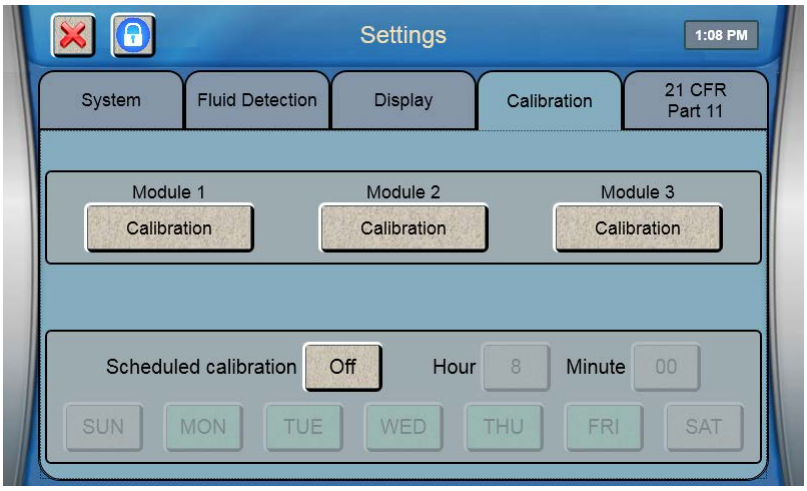
Touch the Hour Format button and select [12-hour] or [24-hour] clock format.

Touch the Date Format button and select [DD/MM/YYYY] or [MM/DD/YYYY] date format.

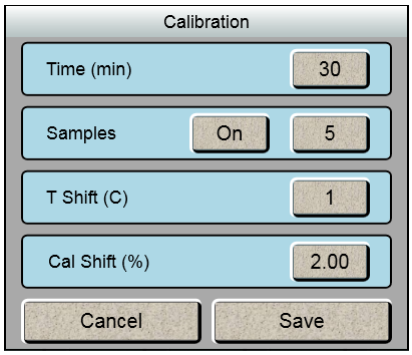
Touch the [Save] button to save your changes.

7.1.4 Calibration Settings

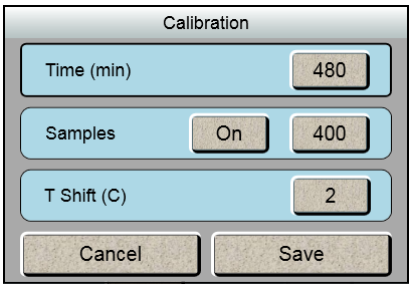
From the Settings screen, touch the [Calibration] tab.



Touch the [Calibration] button for a module to display the Calibration settings for that module.



Enzyme Probe Calibration



ISE Calibration

The default Auto-calibration settings are shown above. You may alter any of these parameters to suit your application, however, **you may compromise precision and/or accuracy** when doing so. YSI's stated specifications are based on the default settings. These selections are provided as part of the overall concept of the 2900 Series flexibility.

To change the value of a Calibration parameter, simply touch the value to open the numeric keypad. Enter the new value, then touch [OK].

To disable the number of Samples parameter, touch the [ON] button and change it to [OFF].

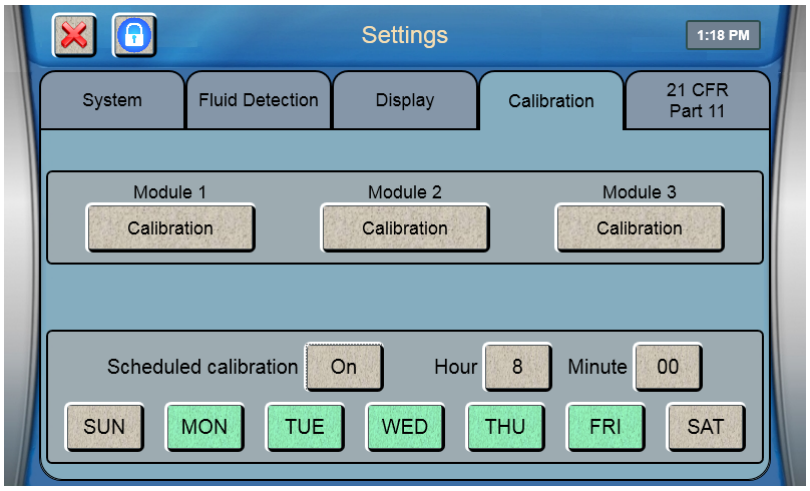
NOTE: When the analyzer is NOT in the Configure or Service screen, it will continue to calibrate at the time interval entered until the Screensaver is active AND it has been idle for 4 hours. The analyzer will then stop calibrating and simply dispense calibrator into each module, then flush with buffer, once every 4 hours to exercise the membranes.

Touch [Save] to save your changes.

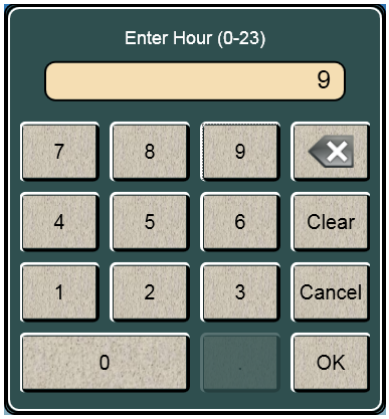
Scheduler

The 2900 Series can be set to automatically calibrate at a specific time of day, such as the start of each workday.

Touch the Scheduled calibration [OFF] button and change it to [ON]. Touch any days to select them. Days of the week that the scheduler is enabled are green.



Touch the Hour button:



Enter the Hour each day that the instrument should calibrate in 24 hour format (0–23), then touch [OK].

Touch the Minute button [00] and enter the Minutes. Touch [OK].

After you have finished making your changes, touch the [X] button to return to the main display.

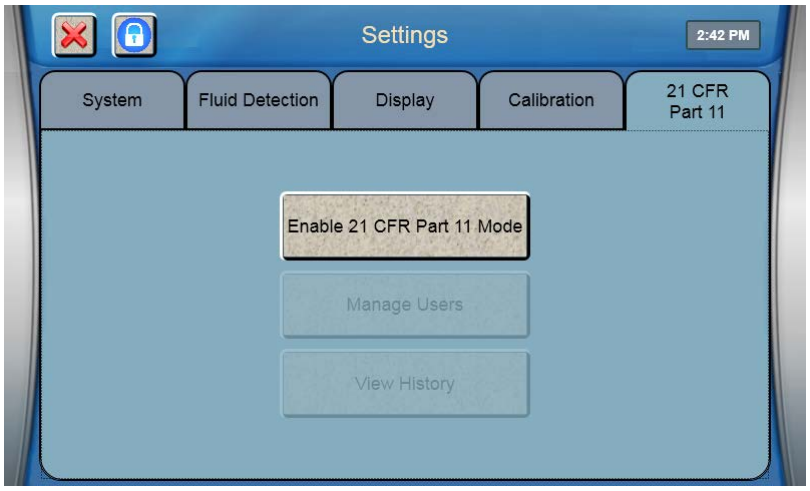
7.1.5 21 CFR Part 11

FDA 21 CFR Part 11, Electronic Records; Electronic Signatures, was established by the FDA to define the requirements for submitting documentation in electronic form and the criteria for approved electronic signatures. Since YSI 2900 Series analyzers generate electronic records, these systems must facilitate compliance with 21 CFR Part 11.

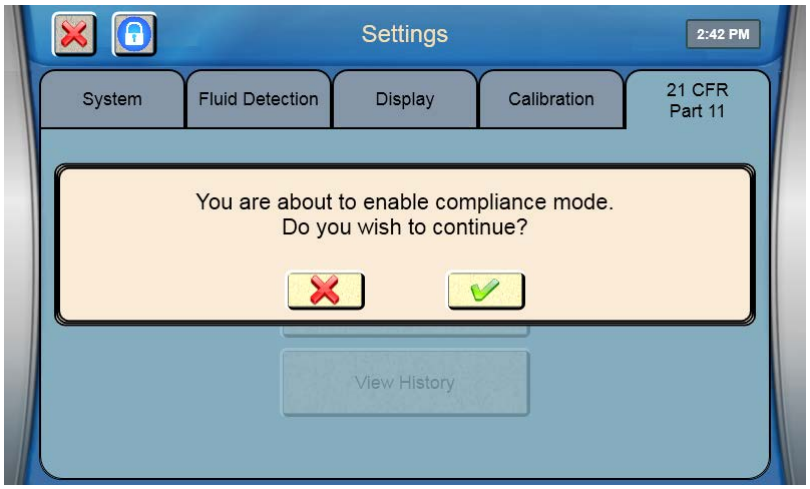
YSI 2900 Series analyzers feature the following functions to provide 21 CFR 11 compliance:

- Audit & event trails
- Secure user sign-on
- User level permissions
- Administrative configuration tools

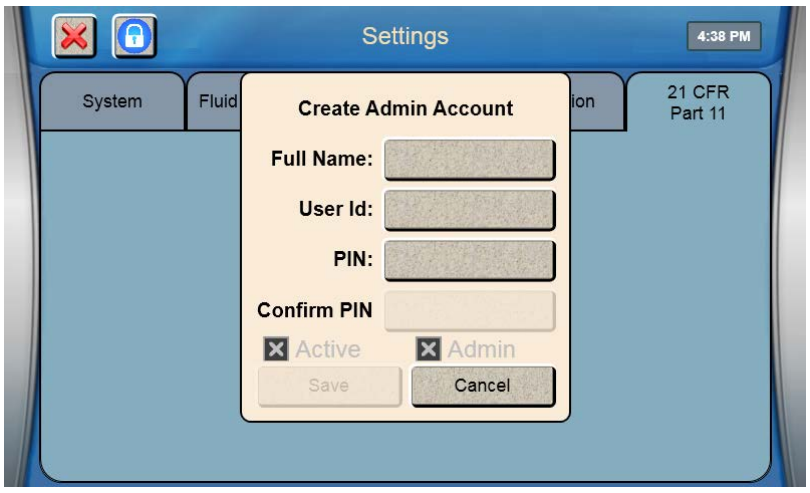
From the Settings screen, touch the [21 CFR Part 11] tab.



To enable 21 CFR Part 11 mode, touch the [Enable 21 CFR Part 11 Mode] button.

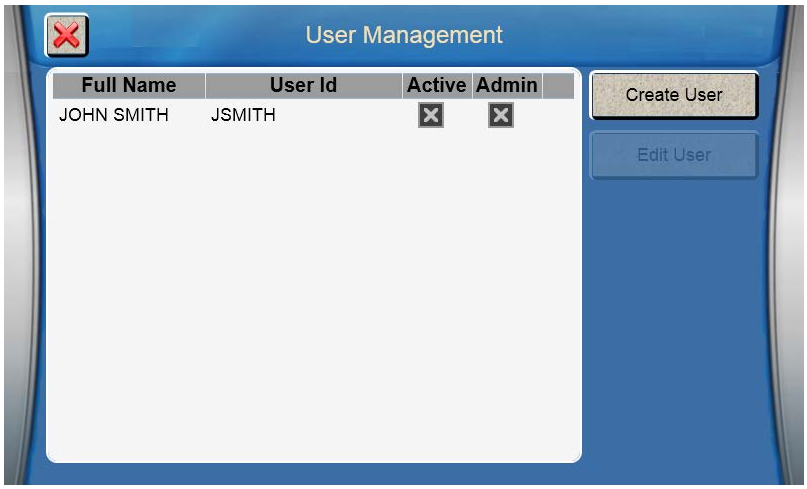


Touch the ☑ to enable 21 CFR Part 11 mode.



Enter a Name, User ID, and PIN to create at least one Admin account. Note that the PIN must be at least 8 characters.

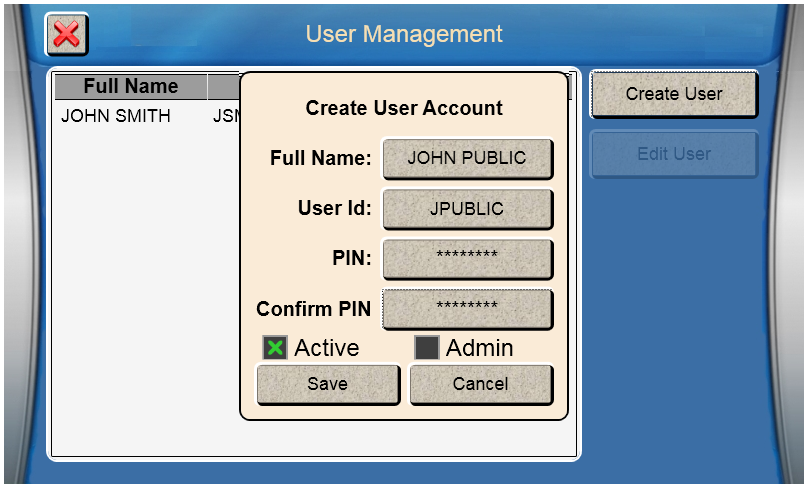
Touch [Save].



7.1.5.1 Manage Users

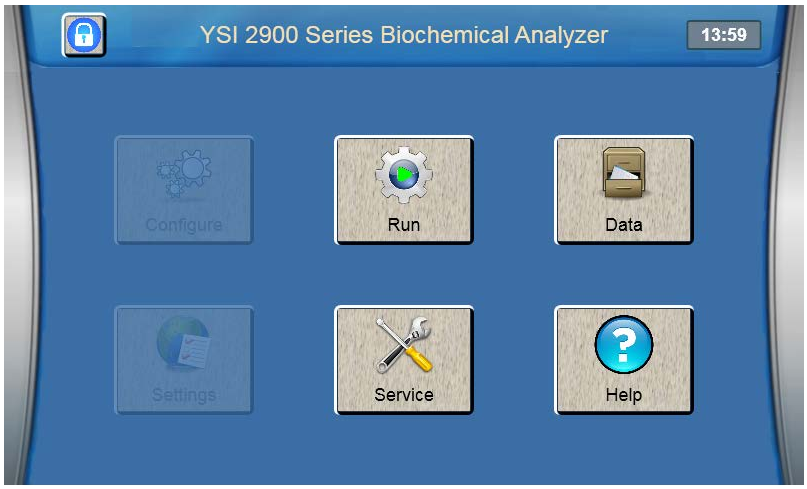
Create User

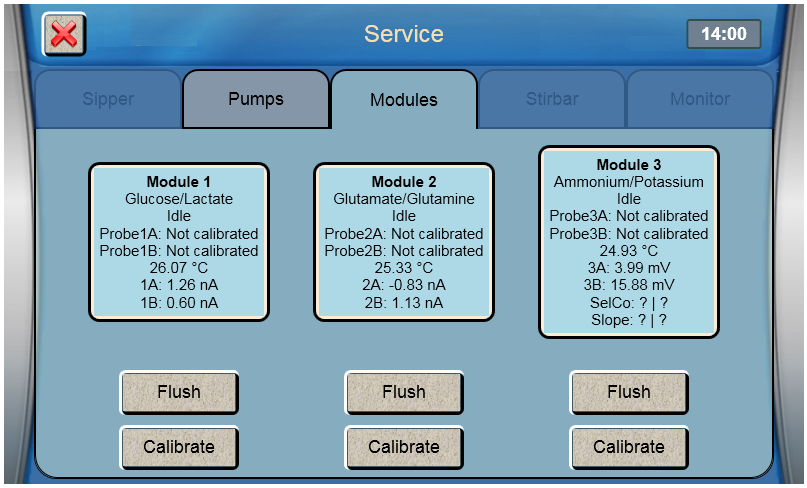
Touch the [Create User] button to create additional accounts as required.



Leave the Admin box blank if you are creating a standard user. Touch the Admin box to mark it ☒ ONLY if you are creating a new Administrator.

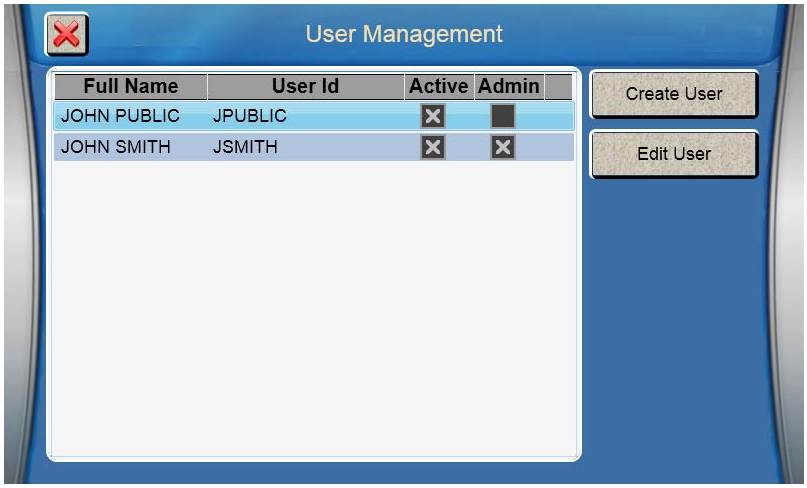
Note that standard users cannot access the Settings menu, Configure menu, the Sipper or Stirbar tabs under the Service menu, or the Software tab under the Help menu (as shown below).



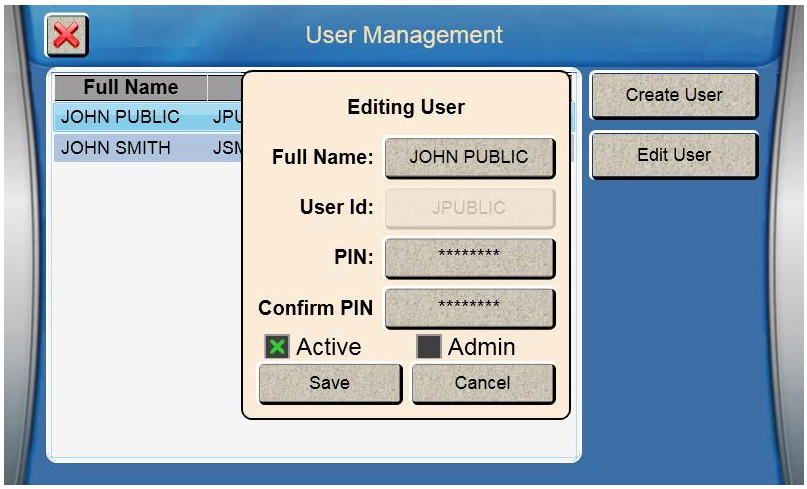


Edit User

To edit an existing user, select the user.



Touch the [Edit User] button.



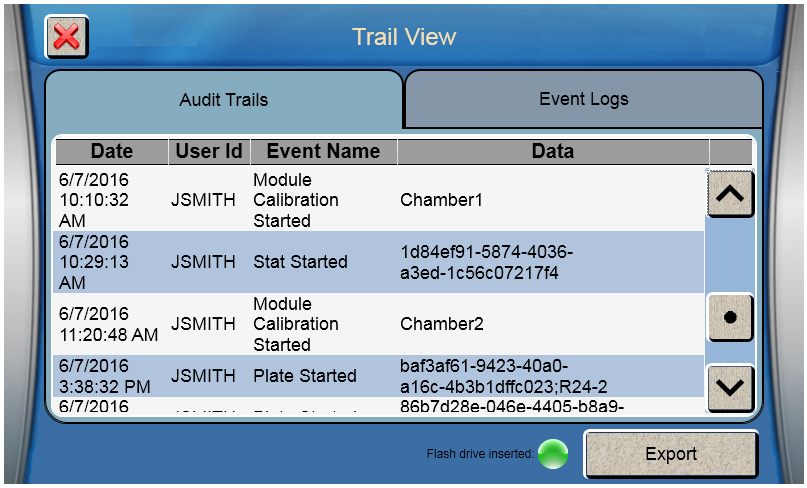
Change the Name, PIN, Active, or Admin fields as required. To disable a user, remove the X from the Active box.

After you have finished making your changes, touch [Save]. Touch the [X] button to return to the 21 CFR Part 11 screen.

7.1.5.2 View Audit Trail and Event Log

Audit Trail

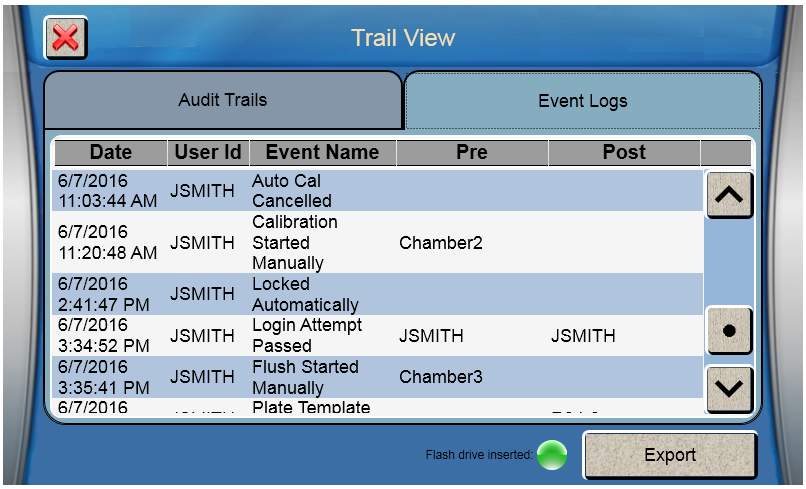
Touch the [View History] button to display the audit trail.



Use the scroll buttons to view events in the audit trail.

Event Log

Touch the [Event Log] tab to display the event log.



Use the scroll buttons to view events in the log.

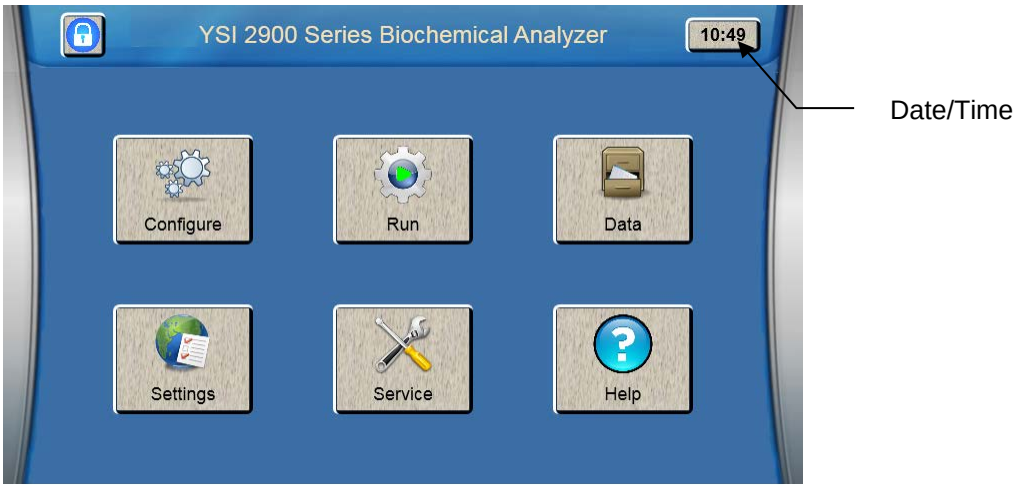
Export

Plug a flash drive into the 2900 Series' USB port, then touch the [Export] button to send the Audit Trail and Event Log to the flash drive.

A folder named YSI\BiochemistryAnalyzer\21 CFR Part 11\ (followed by the Machine ID) will be created on the flash drive.

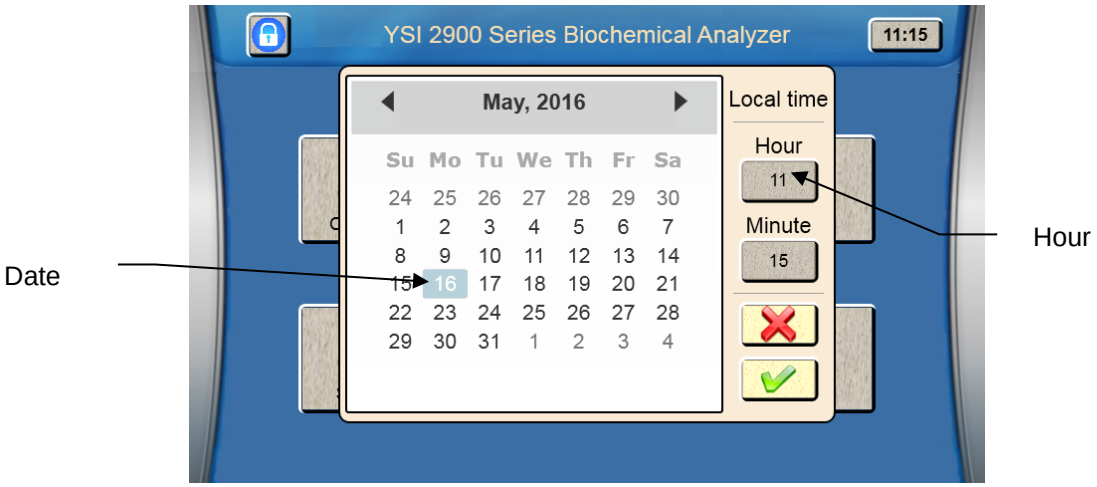
When you have finished exporting, touch the [X] button to return to the 21 CFR Part 11 screen.

7.1.6 Date/Time



To set the date/time, touch the time button on the main screen.

NOTE: If 21 CFR Part 11 mode is enabled, only an Administrator can change the date/time.



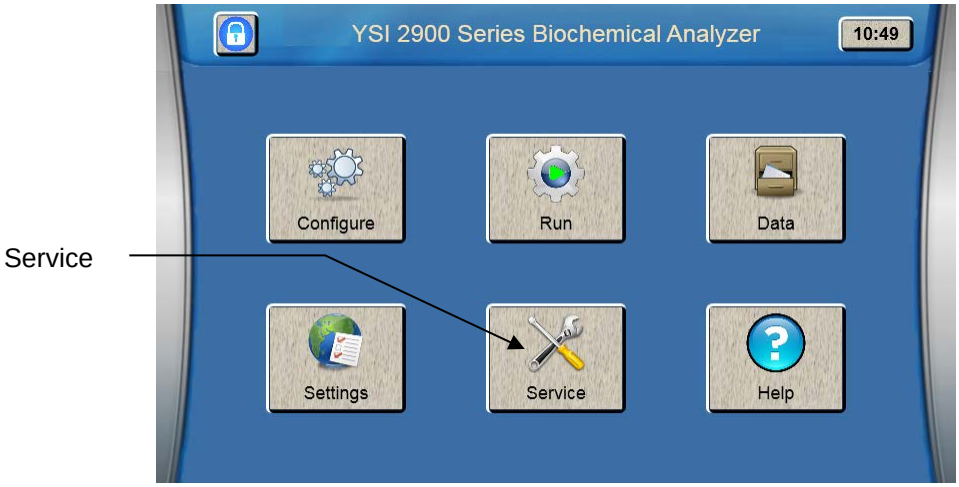
Touch the current date on the calendar to select it.

Touch the Hour button and enter the current hour in 24 hour format (0–23), then touch [OK].

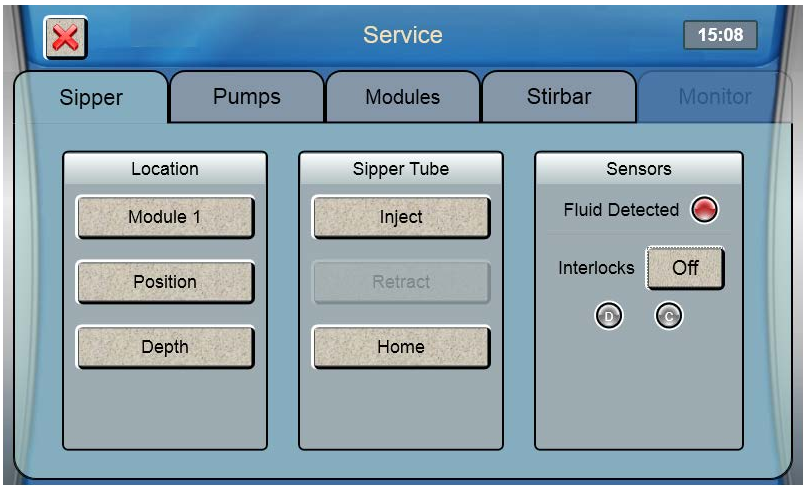
Touch the Minute button and enter the current minute, then touch [OK].

When you have finished entering the date and time, touch [OK] to return to the main display.

7.2 Service



Touch [Service] to display the Service menu.



7.2.1 Sipper

See Section 4.5 Align Sipper for details on aligning the sipper with each sample module.

Always [Home] the sipper before performing alignment.

If necessary, the sipper can also be aligned with Station 2, the different types of racks/plates used at Station 1, and the calibrator wells.

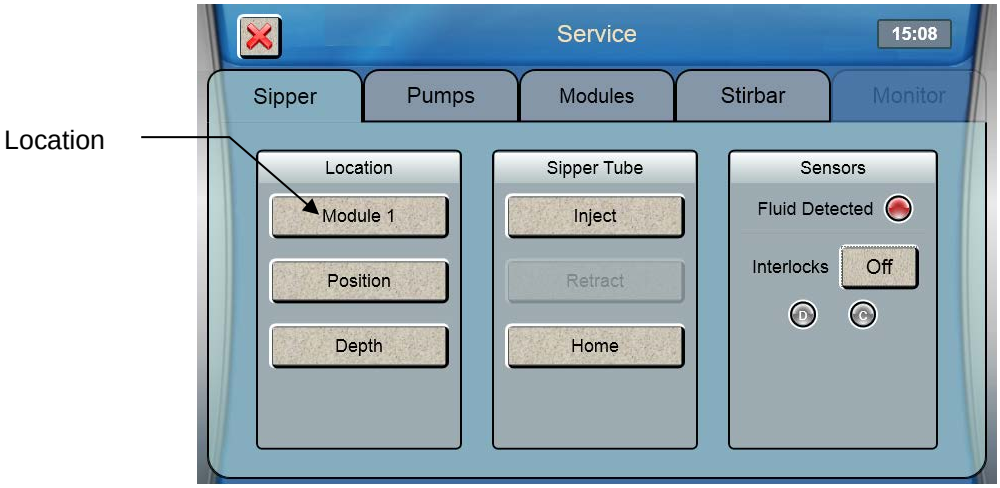
NOTE: If 21 CFR Part 11 mode is enabled, only an Administrator can access the Sipper tab.

7.2.1.1 Interlock

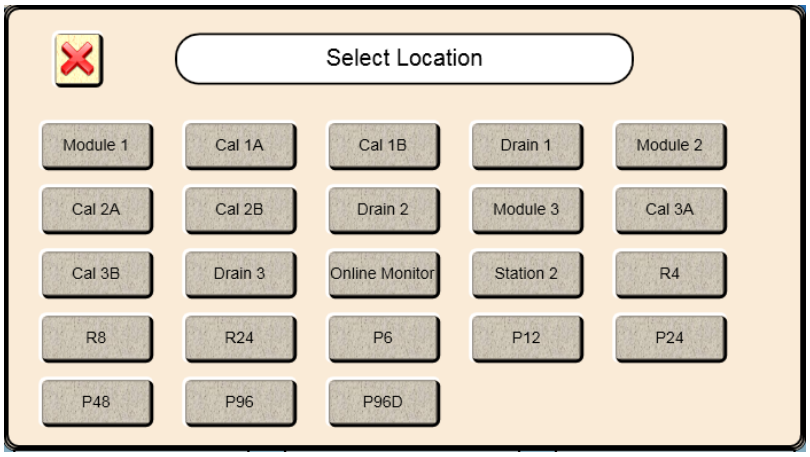
Touch the Interlock button and change the status to [Off] to disable the interlock switches on the front door and side panel when aligning the sipper.

WARNING: Keep your hands clear of the sipper while the instrument is in operation.

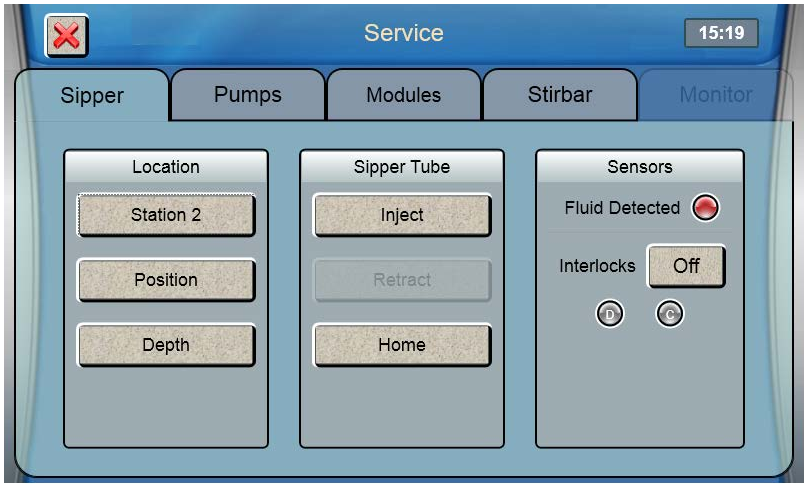
Always turn the Interlock back [On] before operating the instrument!



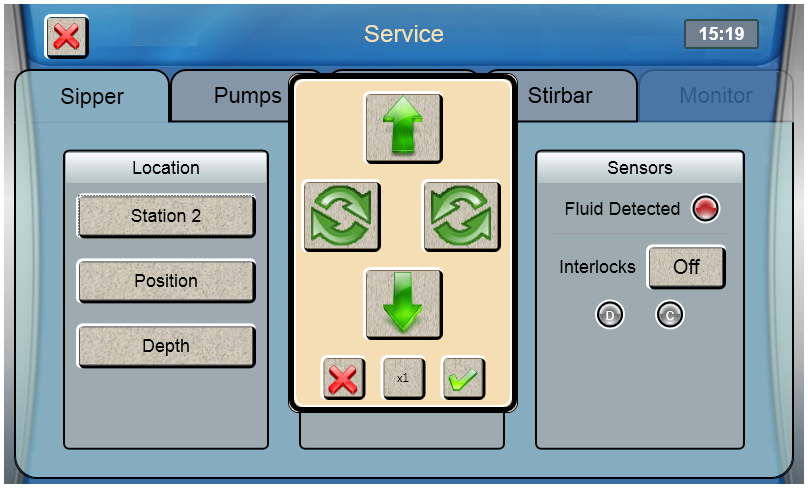
To align the sipper at other locations, touch the button under Location.



Touch the button for your location, [Station 2] for example.



Touch the [Position] button and use the arrow buttons to align the sipper with the selected location.

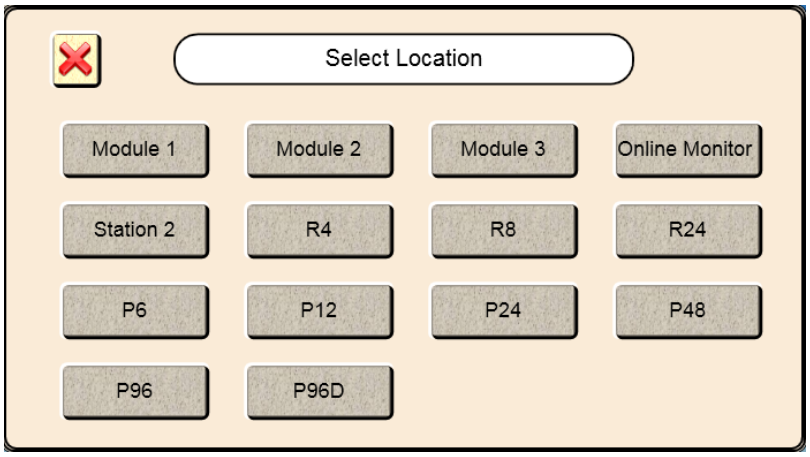


Touch ☑ at the bottom right of the adjustment window, then touch [YES] to save the position.

Touch [Inject] to lower the sipper and test the alignment, then touch [Retract] to raise the sipper back up. If necessary, touch [Position] and repeat the adjustment.

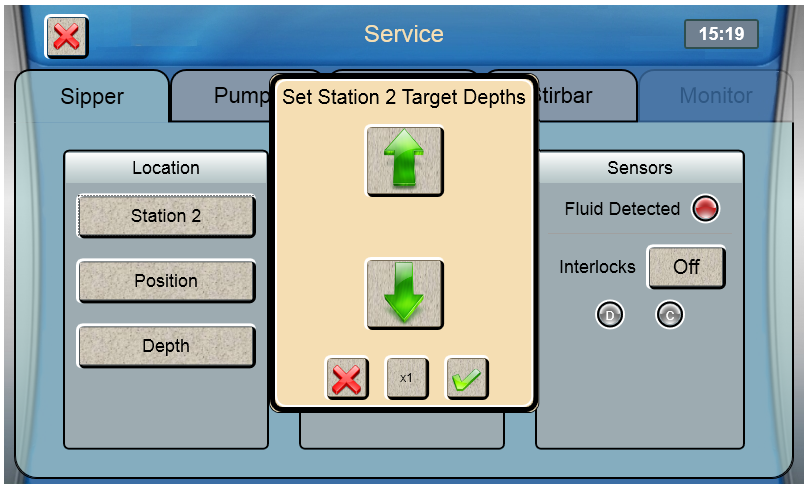
7.2.1.2 Depth

Touch [Depth] and select the location. The sipper will move to the selected location.



Sample Modules: use the up and down arrows to set the tip of the sipper even with the top of the Module. Refer to Section *4.5 Align Sipper* for details.

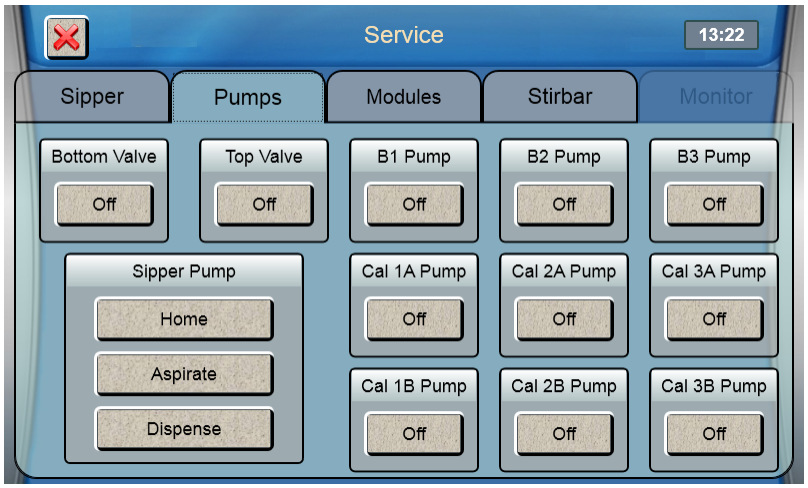
Sample Locations: use the up and down arrows to set the maximum depth the sipper will travel at that sample location. Note that your sample fluid level must be above the maximum depth setting.



Touch ☑ at the bottom right of the adjustment window, then touch ☑ to confirm saving the position.

7.2.2 Pumps

From the Service menu, touch the [Pumps] tab.



7.2.2.1 Sipper Pump

Home

Touch the [Home] button to Home the sipper pump plunger. The pump plunger will extend fully, then retract slightly.

Aspirate

Touch the [Aspirate] button. The pump plunger will retract about half way as it does when it aspirates a sample. Note that the actual distance depends on the sample size setting.

Dispense

Touch the [Dispense] button. The pump plunger will extend about half way as it does when it dispenses a sample into the sample module.

When you have finished testing the sipper pump, touch the [X] button to return to the main display.

7.2.2.2 Buffer Pumps

Touch the [ON] button under a buffer pump. The selected buffer pump will run. Touch the [OFF] button to stop the pump.

When you have finished testing the buffer pumps, touch the [X] button to return to the main display.

7.2.2.3 Calibrator Pumps

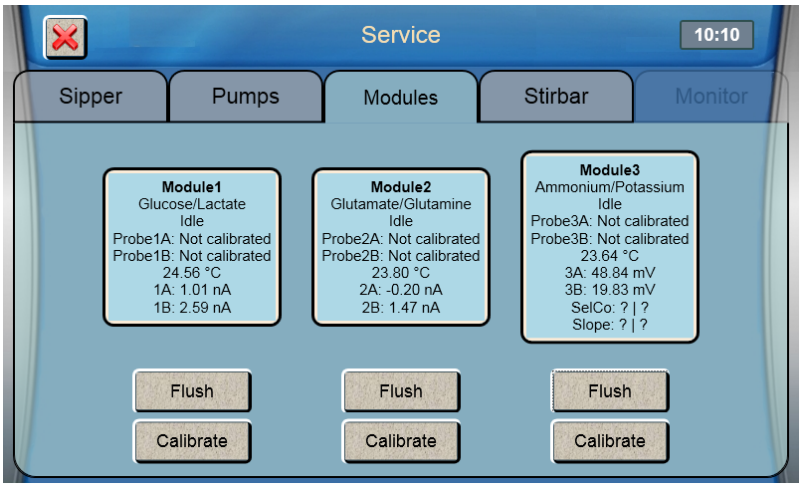
Touch the [ON] button under a Cal Pump. The selected calibrator pump will run. Touch the [OFF] button under the same pump to stop it.

NOTE: Prime all installed calibrator bottles daily to remove air bubbles from the tubing and deliver fresh calibrator to the cal wells!

When you have finished priming the fluid pumps, touch the [X] button to return to the Main display.

7.2.3 Modules

From the Service menu, touch the [Modules] tab.



The Modules tab displays the status of the probes, probe current for each enzyme probe, voltage for each ISE, and the temperature. The probe current is expressed in nA (nanoamperes, 10^{-9} amperes), a very low level of electrical current.

7.2.3.1 Flush

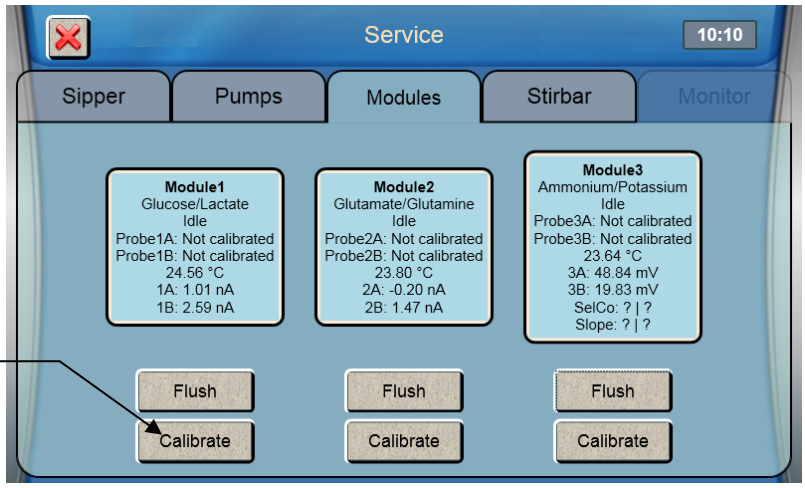
Touch the [Flush] button under Module 1 to flush the sample module with buffer. Observe the probe current values (baseline). If they are above 6 nA, check to see if they are decreasing in value. Check the sample module; it should be full of buffer. If necessary, touch the [Flush] key to flush the sample module again. Note that when the instrument is first powered up, it may take several hours for the baseline currents to drop below 6 nA.

Touch the [Flush] button under Module 3 to flush the sample module with ISE buffer. Note that the instrument will purge buffer to waste if the incorrect buffer is in the line.

Observe the ISE voltage values. They should be between -40 and 60mV and stable. When the instrument is first powered up, it may take an hour for the voltages to stabilize.

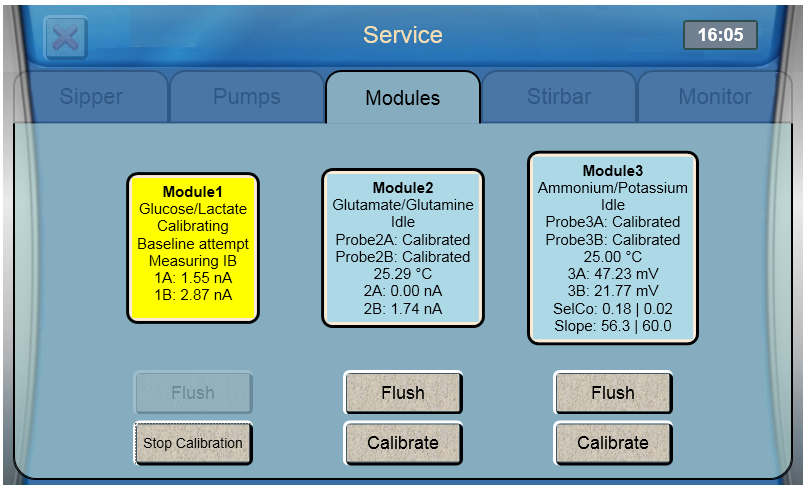
7.2.3.2 Calibrate

The 2900 Series will automatically calibrate before running a sample batch. You may initiate manual calibration from the [Modules] tab of the Service screen by touching the [Calibrate] button under each Module.

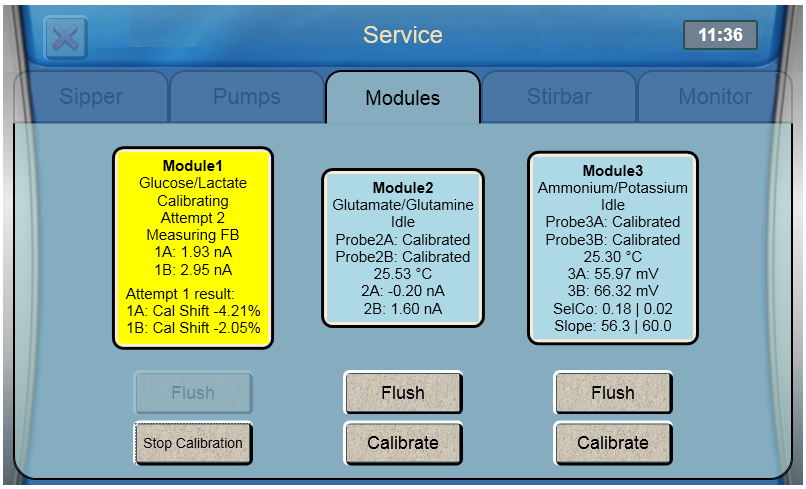


Calibrate Module 1

Calibration status is displayed on the screen.



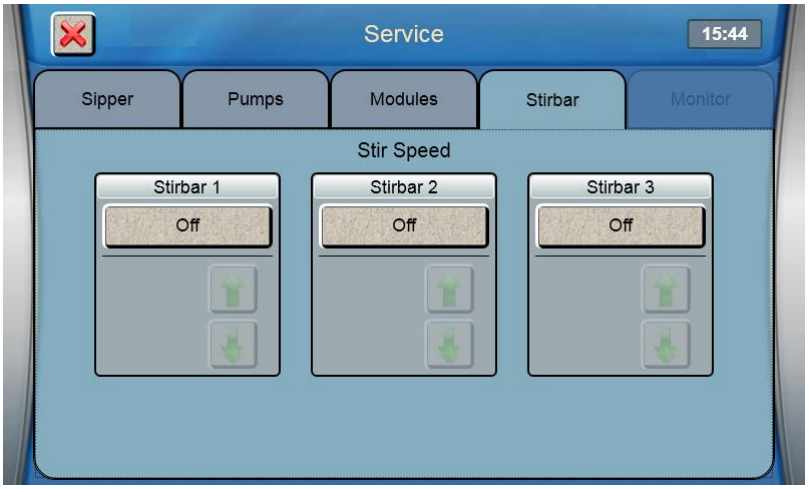
The instrument attempts to calibrate each active probe up to 5 times before aborting calibration. If calibration fails, see *11 Troubleshooting*.



7.2.4 Stirbar

From the Service menu, touch the [Stirbar] tab.

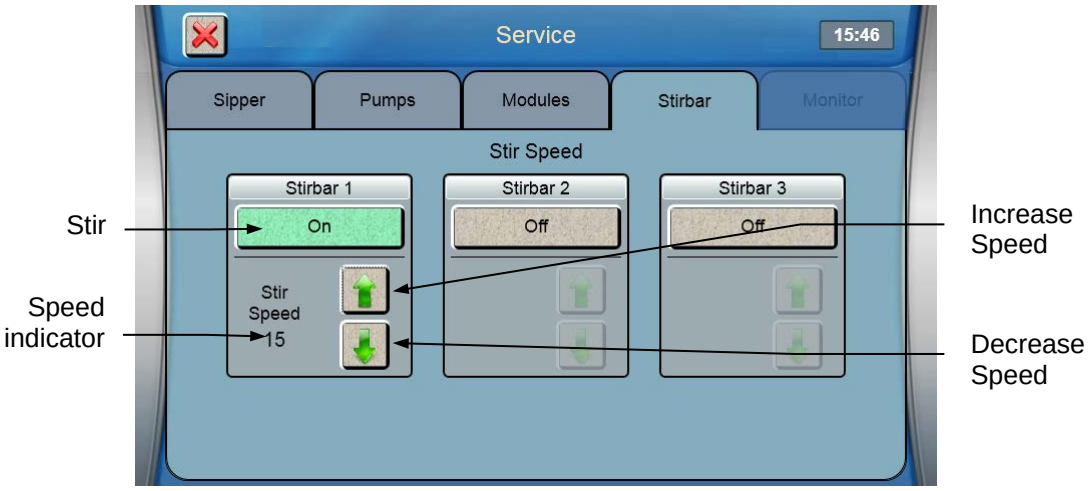
NOTE: If 21 CFR Part 11 mode is enabled, only an Administrator can access the Stirbar tab.



The StirbBar screen is used to adjust the speed of the stir bar.

Note: The sample module must be full of buffer when adjusting stir speed. To fill the module with buffer, see *7.2.3 Modules*.

Touch the [Off] button under Stirbar1 to change it to [On]. Verify the stir bar is rotating smoothly, but not jumping.



If the stir bar is jumping, use the Down Arrow Button to decrease the stir speed until the stir bar is spinning smoothly.

NOTE: Set the stir speed as high as possible without causing the stir bar to jump!

Touch the [On] button under the same stir bar to change it to [off]. The stir bar will stop.

Touch the [Off] button again. Verify the stir bar is spinning smoothly and not jumping. If necessary, reduce the stir speed until the stir bar is not jumping.

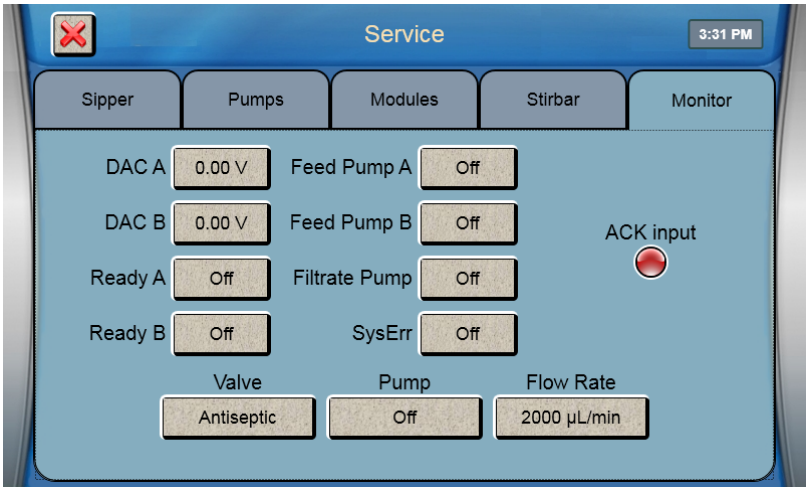
Touch the [On] button under the same stir bar to stop the stir bar.

For the 2950, repeat this process for the remaining modules (Stirbar2 and Stirbar3).

After you have adjusted the stir speed for all modules, touch the [X] button to return to the Main display.

7.2.5 Monitor

From the Service menu, touch the [Monitor] tab.



Test Outputs

Touch the DAC A or DAC B [0.00V] button to test the analog output by setting the output to 0, 5 or 10VDC.

Touch the Ready, Feed Pump, Filtrate Pump, or SysErr [Off] button and change it to [On] to test the corresponding output.

Flow Rate

Touch the Flow Rate [2000 µL/min] button to enter a different flow rate for Service mode only.

Prime Monitor Pump

If you are using an antiseptic solution, touch the Pump [Off] button and change it to [On] to prime the antiseptic solution. The pump will turn off automatically.

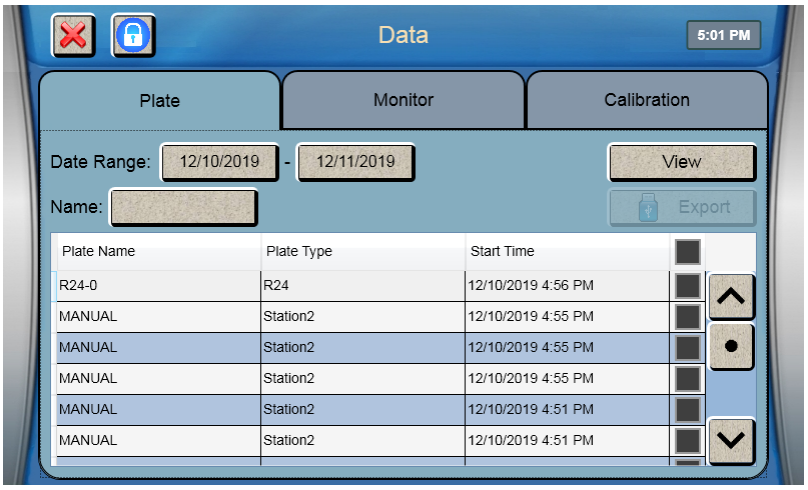
Touch the Valve [Antiseptic] button to change the state of the valve and change it to [Sample].

Touch the Pump [Off] button and change it to [On] to prime the monitor sample line. The pump will turn off automatically.

NOTE: After sterilization, the antiseptic solution must be primed immediately after the tubing is reconnected.

7.3 Data

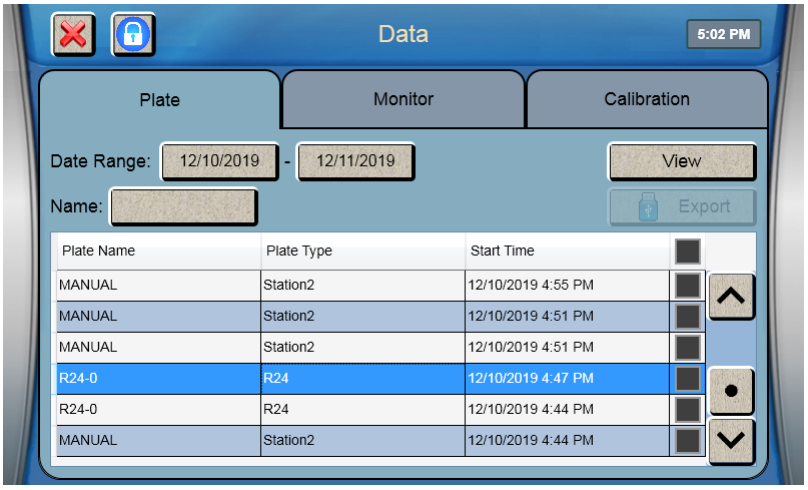
From the Main display, touch [Data].



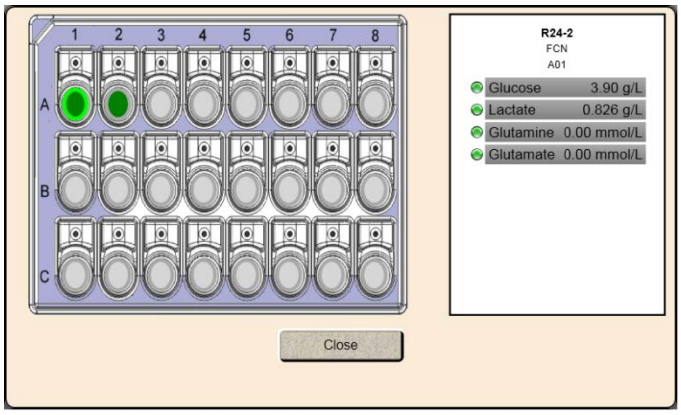
7.3.1 Plate

Historical plates of sample data are displayed under the Plate tab. Touch the scroll buttons to page through plates.

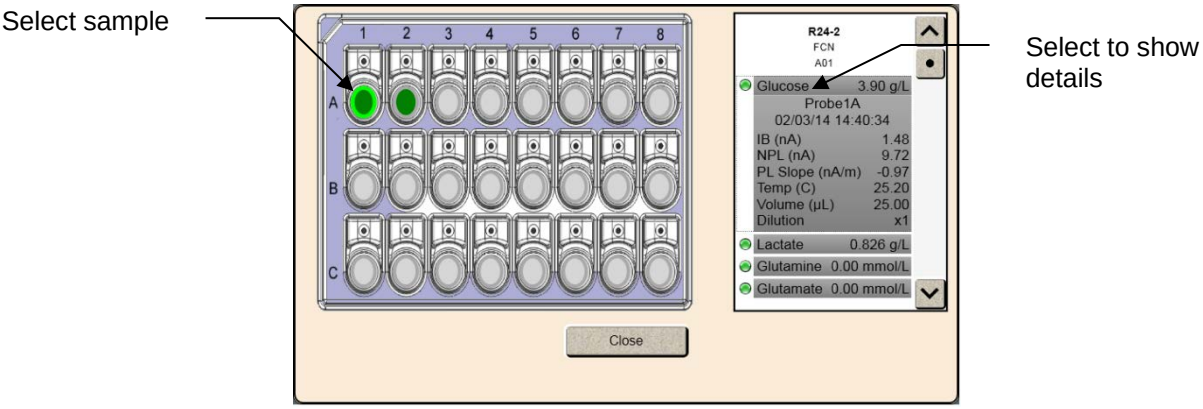
Touch a specific plate to highlight it, then touch [View] to display the sample data for the selected plate.



Sample data for the first sample in the batch (A1) is displayed.



Touch any other sample location to display the sample data. Touch the sample result to show details.



Touch [Close] to return to the Data screen.

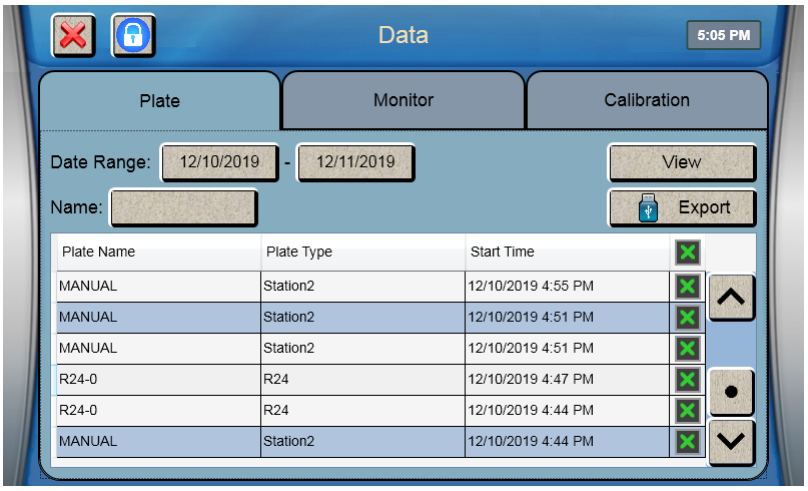
Plate Name Filter

Touch the Name button and enter a plate name to filter the data.

Only plates that contain that name will be displayed.

Export

Check the box for each plate that you would like to export to a flash drive. To select all plates within the selected date range, check the box at the top.



.

Plug a flash drive into the 2900 Series' USB port, then touch the [Export] button to send the selected sample results from memory to the flash drive.

When you have finished exporting data, touch the [X] button to return to the Main screen.

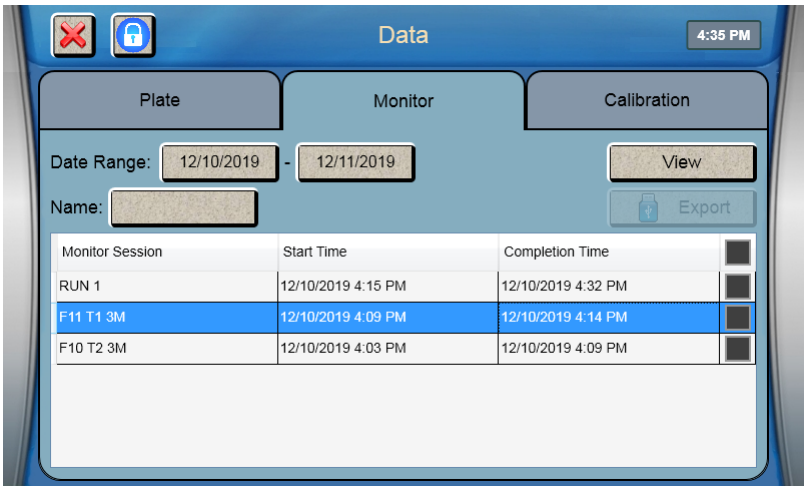
A folder named YSI\BiochemistryAnalyzer will be created on the flash drive. Sample data files are copied to the Data subfolder. The data file name will contain the instrument's Machine ID along with the date and time.

Example Sample Data File:

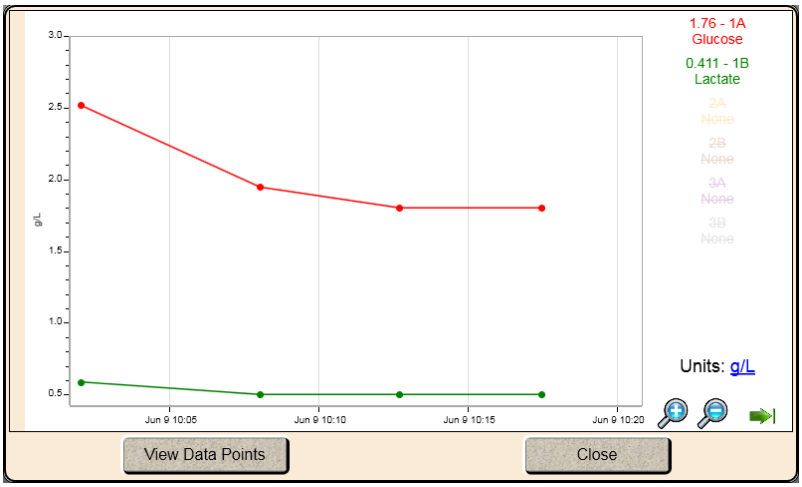
Local Completion Time	Plate Name	Batch Name	Well Id	Chemistry	Probe Id	Concentration	Units	Endpoint (s)	Sample Size (µl)	Initial Baseline (nA)	Plateau (nA)	Final Baseline (nA)	Net Plateau (nA)	Net Plateau Temp Adj (nA)	Cross Net Plateau (nA)	Cross Net Plateau Temp Adj (nA)	Plateau Slope (nA/min)	Temperature (C)	Errors
9/10/2019 9:25	R8-0	TestBatch-2	R8_A02	Fructose	1A	24.3426	g/L	45	25	0.0179	111.713	1.7462	111.6951	111.8945	0.0166	0.0167	32.9441	27.16	
9/10/2019 9:29	R8-0	TestBatch-1	R8_B01	Fructose	1A	66.503	g/L	45	25	1.4373	306.4251	5.9046	304.9878	305.7901	0.4009	0.404	84.2369	27.13	
6/13/2019 9:16	Station2	MANUAL	Station2	Glucose	2A	2.7406	g/L	30	25	2.6168	19.4779	2.7886	16.8611	16.9442			2.0996	24.85	
6/13/2019 9:16	Station2	MANUAL	Station2	Lactate	2B	2015.662	mg/L	30	25	0.2625	89.8054	1.8639	89.5428	89.5555			9.2697	24.79	
6/12/2019 9:12	P96-1	REACTOR 12	P96_A01	Glutamate	3A	1.4392	g/L	30	20	0.5216	31.3612	0.8917	30.8396	31.1207			0.2681	24.55	
6/12/2019 9:12	P96-1	REACTOR 12	P96_A01	Glutamaine	3B	0.1087	g/L	30	20	2.2705	32.3041	2.2708	30.0336	30.3804	30.83.4	31.121	-0.0221	24.55	

7.3.2 Monitor

Touch the Monitor tab to display the list of monitor sessions.



Select a monitor session, then touch [View] to display the graph for the selected monitor session.

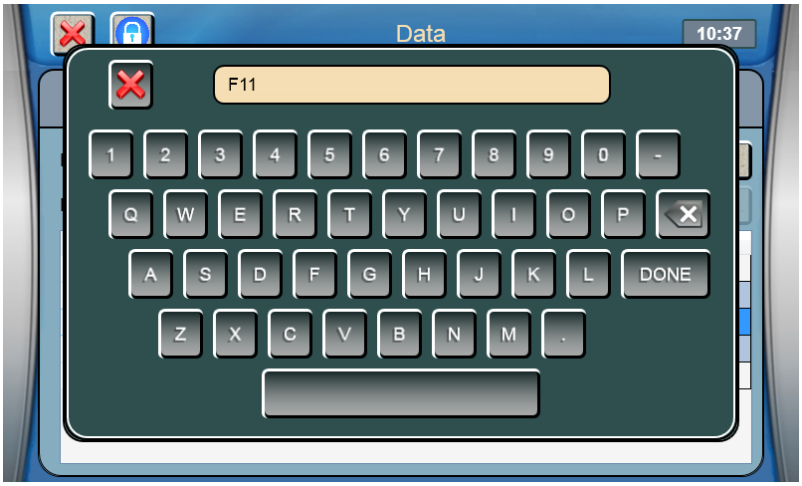


Touch [View Data Points] to view the actual data.

Touch [Close] to return to the Data screen.

Name Filter

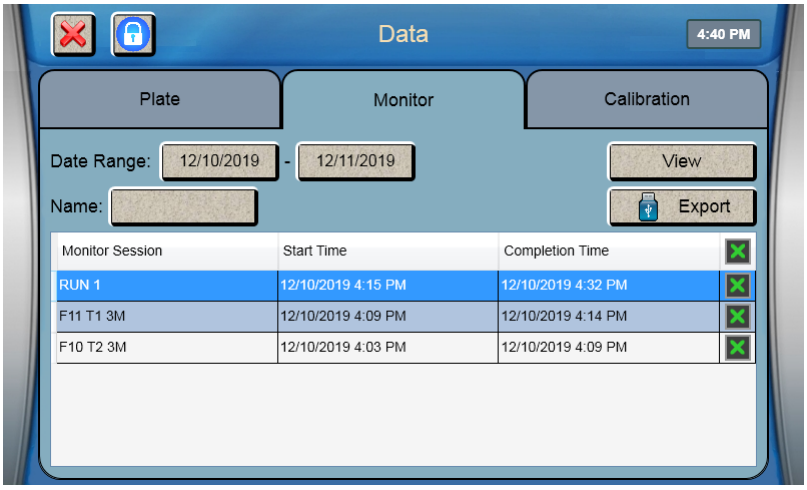
Touch the Name button and enter a monitor session name to filter the data.



Only sessions that contain that name will be displayed.

Export

Check the box for each session that you would like to export to a flash drive. To select all sessions within the selected date range, check the box at the top.



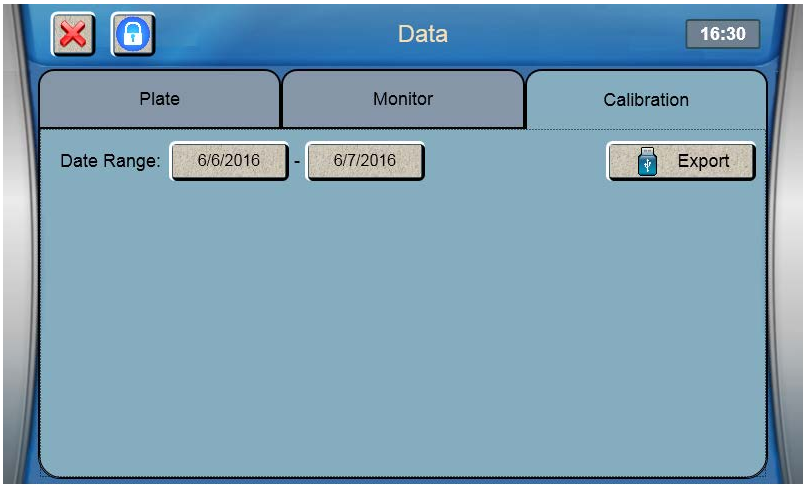
Plug a flash drive into the 2900 Series' USB port, then touch the [Export] button to send the selected sessions from memory to the flash drive.

When you have finished exporting data, touch the [X] button to return to the Main screen.

A folder named YSI\BiochemistryAnalyzer will be created on the flash drive. Sample data files are copied to the Data subfolder. The data file name will contain the instrument's Machine ID along with the date and time.

7.3.3 Calibration

Touch the Calibration tab.



Plug a flash drive into the 2900 Series' USB port. Select a date range, then press the [Export] button to send calibration data to the flash drive.

When you have finished exporting data, touch the [X] button to return to the Main screen.

A folder named YSI\BiochemistryAnalyzer will be created on the flash drive. Calibration data files are copied to the Data subfolder. The data file name will contain the instrument's Machine ID along with the date and time.

Example Calibration File:

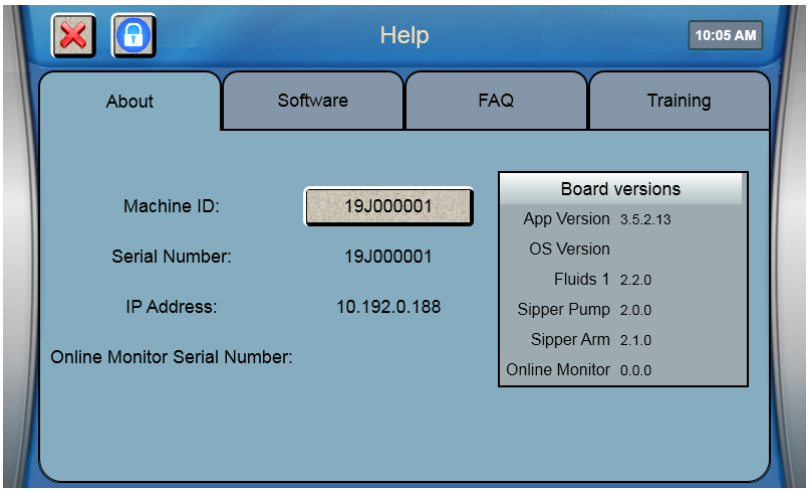
Local Completion Time				Chemistry	Probe Id	Concentration	Units	Endpoint (s)	Sample Size (µl)	Initial Baseline (nA)	Plateau (nA)	Final Baseline (nA)	Net Plateau (nA)		Cross Net Plateau (nA)		Plateau Slope (nA/min)	Temperature (C)	Errors
12/12/2019 13:11				Glucose	1A	2.5	g/L	30	25	2.9905	14.9612	3.0258	11.9707		NaN		0.1442	21.92	(No previous calibration-Probe1A)
12/12/2019 13:11				Lactate	1B	0.5	g/L	30	25	3.2762	29.3721	3.3032	26.0959		NaN		-0.1724	21.92	(No previous calibration-Probe1B)
12/12/2019 13:13				Glucose	1A	2.5	g/L	30	25	0.9606	15.992	1.1777	15.0314		NaN		0.3379	27.01	(Cal Shift-Probe1A)
12/12/2019 13:13				Lactate	1B	0.5	g/L	30	25	2.2744	30.9102	2.5932	28.6358		NaN		0.1664	27.01	(Cal Shift-Probe1B)
12/12/2019 13:15				Glucose	1A	2.5	g/L	30	25	0.9971	15.6327	1.175	14.6356		NaN		0.6005	26.84	
12/12/2019 13:15				Lactate	1B	0.5	g/L	30	25	2.241	30.2067	2.5655	27.9657		NaN		1.0046	26.84	
12/12/2019 13:08				Glutamate	2A	5	mmol/L	30	20	4.2451	20.1511	4.2504	15.906		14.9872		0.5142	21.96	
12/12/2019 13:11				Glutamine	2B	5	mmol/L	30	20	3.7581	20.7332	3.7445	16.9762		NaN		0.0315	21.96	
12/14/2019 16:42				Ascorbic Acid	1B	1	g/L	45	25	2.2676	23.8498	1.6895	21.5822		11.0659		4.9728	27.99	(No previous calibration-Probe1B)
12/14/2019 16:45				Ascorbic Acid	1B	1	g/L	45	25	1.5976	23.3035	1.6564	21.7059		11.0883		2.54	27.77	
12/14/2019 16:48				Fructose	1A	10	g/L	45	25	0.4497	82.6217	0.9934	82.172		NaN		12.0484	27.62	(No previous calibration-Probe1A)
12/14/2019 16:52				Fructose	1A	10	g/L	45	25	0.7571	82.8973	1.4755	82.1402		NaN		13.2981	27.57	

7.4 Help

Touch the [Help] icon to display the Help selections as shown below.

7.4.1 About

Touch the [About] tab to display the About screen. This screen provides information about the instrument ID and serial number, the current software (App) version, hardware, and IP address.



7.4.1.1 Machine ID

The default Machine ID is the instrument serial number. Touch the Machine ID button to enter a custom ID for this instrument. Enter the new ID and touch [Done].

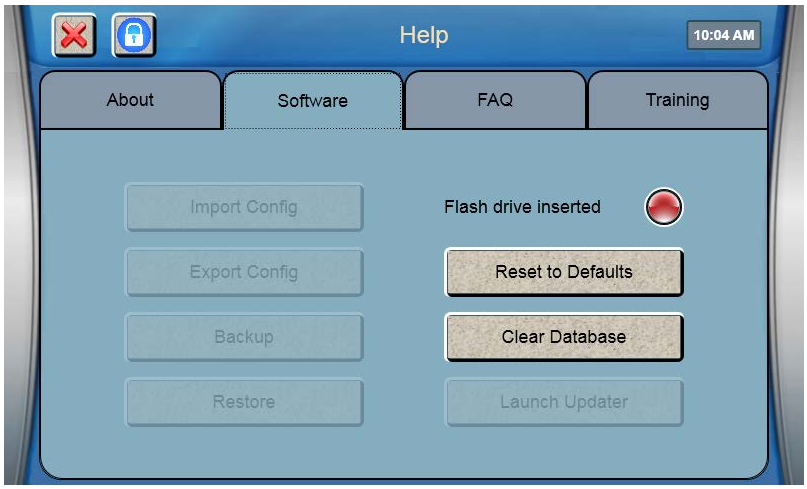
NOTE: The Machine ID is used as the file name for data files.

7.4.2 Software

The 2900 Series software can be updated via a flash drive inserted into the USB port. See the YSI web site at www.ysi.com for available updates. Install the update as shown in section 7.4.2.6 below.

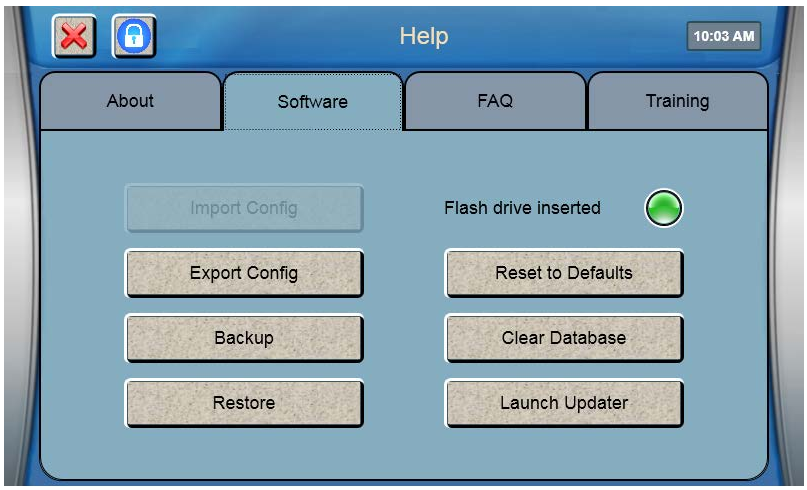
From the Help menu, touch the [Software] tab to display the Software screen.

NOTE: If 21 CFR Part 11 mode is enabled, only an Administrator can access the Software tab.



7.4.2.1 Export Configuration

Insert a flash drive and wait for the Flash Drive Inserted light to change to green.



Press [Export Config] to save the current instrument configuration to the flash drive.

NOTE: The configuration file can be imported at a later date to restore the instrument configuration.

7.4.2.2 Backup

Press [Backup] to backup the current instrument setup, database, log files, and 21 CFR 11 audit files to the flash drive.

7.4.2.3 Restore

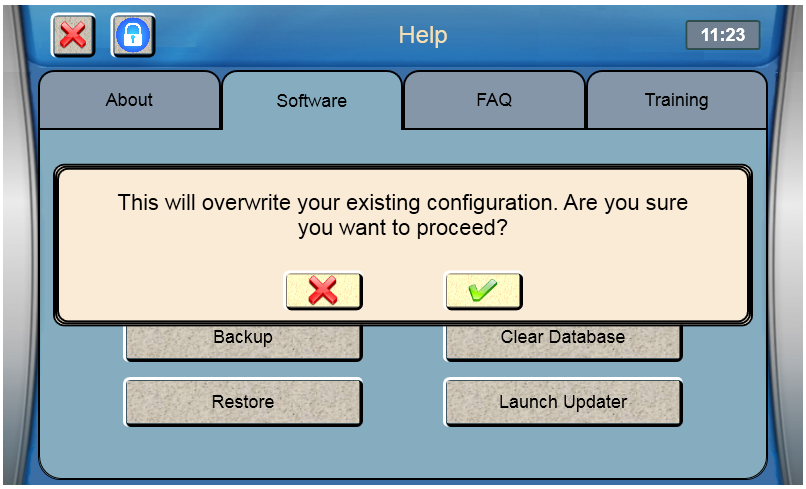
Press [Restore] to restore a previous backup file for this analyzer from a flash drive.

7.4.2.4 Default

To default all instrument settings, except 21 CFR Part 11, to the factory values, touch [Reset to Defaults].

NOTE: After resetting the instrument to default settings, the sipper must be realigned with ALL locations to prevent sipper damage.

.



7.4.2.5 Clear Database

NOTES: Make sure all sample data, calibration data and audit logs have been exported before clearing the database!

The Clear Database function is not available when 21 CFR Part 11 Mode is enabled.

Clearing the database deletes all 21 CFR Part 11 administrators and users!

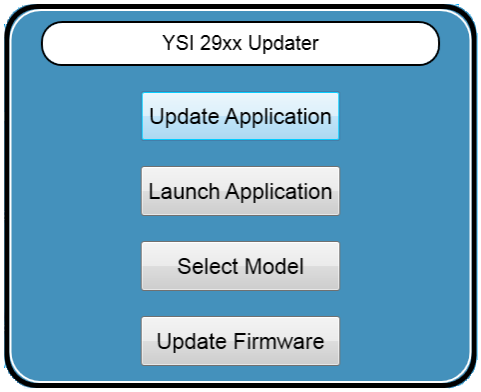
Press [Clear Database] to clear all saved sample and calibration data. Clearing old data from the database will reduce the amount of time required to export and save sample data.

7.4.2.6 Update Software

From the Help screen, Software tab, insert the flash drive containing the software update in the instruments' USB port.

After the Flash Drive Inserted light changes to green, touch the [Launch Updater] button.

The 2900 Series Updater will be displayed.



Touch the [Update Firmware] button to install the new firmware.

Touch the [Update Application] button to install the new software.

When the Installation is complete, the analyzer will reboot. Remove the flash drive.

NOTE: Updating the software will clear all sample data. After updating the software, the sipper must be aligned with all positions.

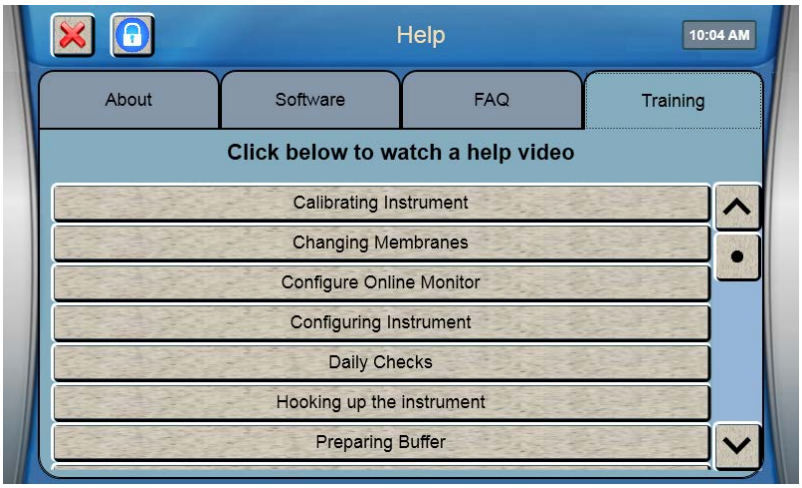
The [Select Model] button is only used to change the model after performing a hardware upgrade (adding an additional module).

7.4.3 FAQ

From the Help menu, touch the [FAQ] tab to display frequently asked questions and answers.

7.4.4 Training

From the Help menu, touch the [Training] tab.



Connect headphones or speakers to the instruments audio port on the right side of the display.

Touch the button of the training video you wish to view.

While the video is playing, you may touch the screen to stop the video and return to the Training screen.

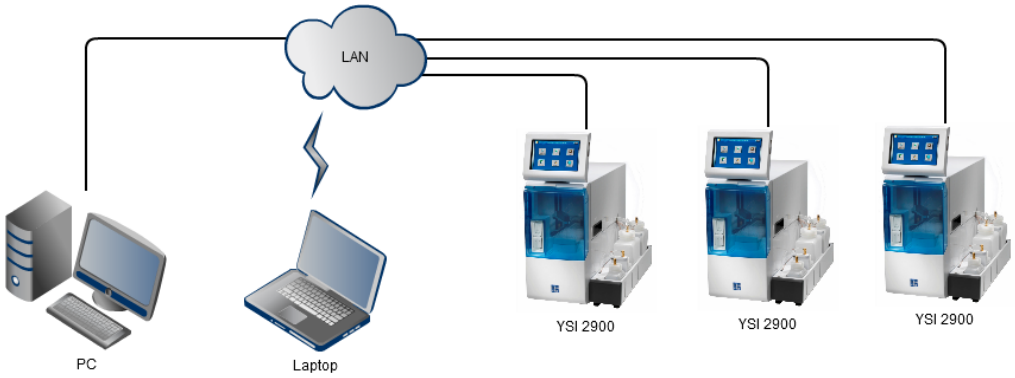
7.5 Connectivity

7.5.1 Ethernet Port

Connect one or more 2900 Series instruments to a LAN or router via the RJ45 Ethernet port.

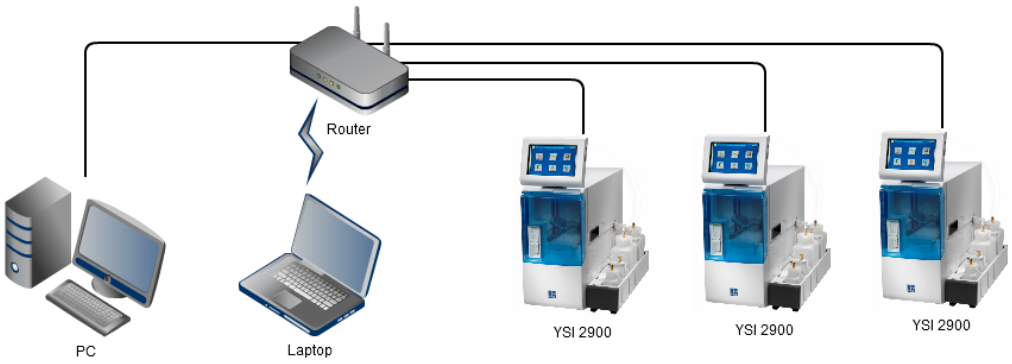
LAN (Shared Network Connection)

Connect one or more 2900 Series instruments to a LAN via the RJ45 Ethernet port.



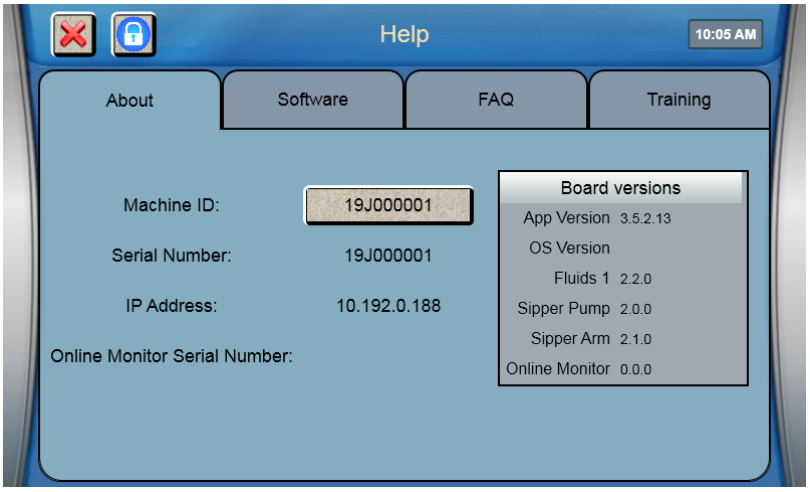
Router (Private Network Connection)

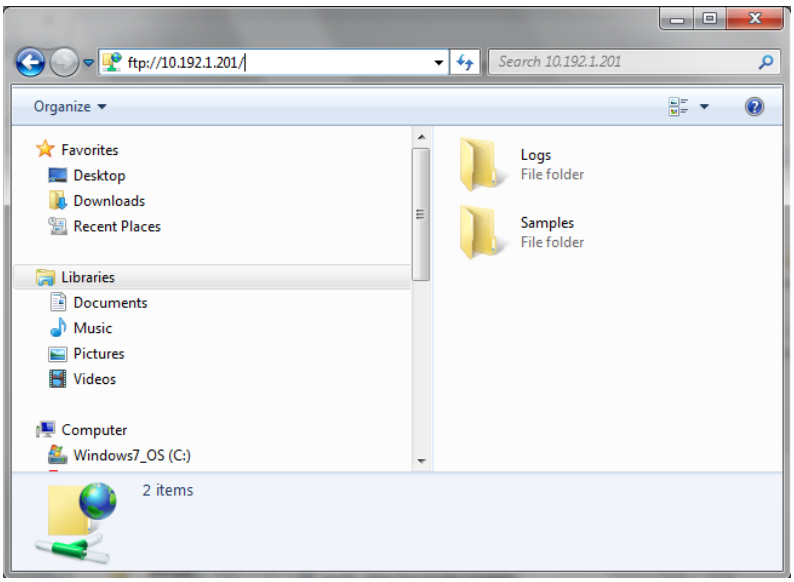
Connect one or more 2900 Series instruments to a router (DHCP server) via the RJ45 Ethernet port.



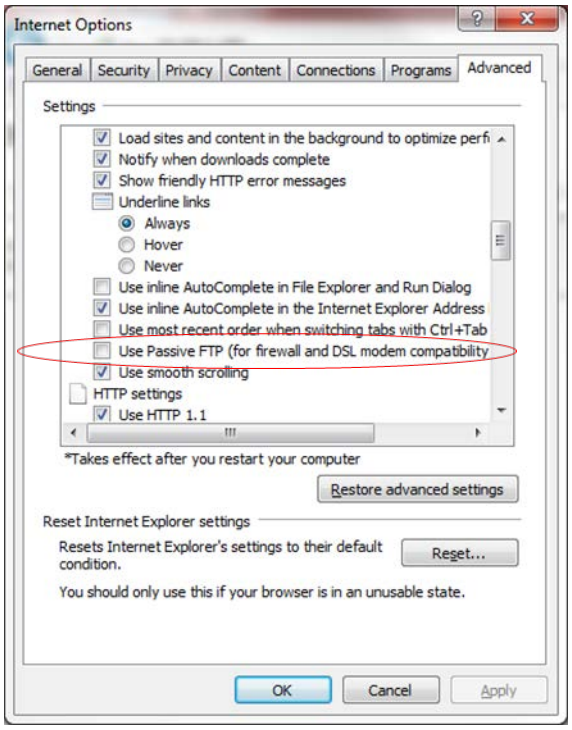
Accessing Stored Data

Access the data stored in a 2900 Series connected to a LAN or router via ftp. See *7.4.1 About* to view the instrument's current IP address.





If you are unable to connect via ftp, make sure the "Passive ftp" option is **not** checked under Advanced Internet Options on your computer:



Sample and calibration data files are stored in the Samples folder of the 2900 Series. The file names are:

BioSample_Machine ID.csv
BioCalibration_Machine ID.csv
ISESample_Machine ID.csv
ISECalibration_Machine ID.csv

7.5.2 RS232 Port

The RS232 serial port supports the YSI 2901 Printer, YSI 2940 or 2980 Multi-Channel Online Monitor, YSI 2920 OPC Data Manager, or remote commands.

OPC

Connect the YSI 2920 OPC Data Manager to export data to an OPC-enabled SCADA, bioprocess management system or data historian.

Printer

Connect the optional YSI 2901 Printer to the RS232 port for a hard copy of calibration and sample reports.

Remote Commands

For details of available remote command functions, please contact YSI Technical Support.

8. Chemistry Setup

In this section, you will learn about each standard chemistry setup for single chemistry configurations and then dual chemistry configurations per module.

In order to configure your instrument to measure a particular chemistry analyte, you need to:

- Approximate the analyte concentration or range of concentrations to be measured.
- Decide if you must dilute your sample, and, if required, determine an appropriate dilution factor and diluent.
- Decide what calibration value(s) is appropriate for the range of concentrations under study.
- If possible, account for any interferences to your reading. Methods to do these corrections are described below.

Once you make the above determinations, you can decide whether one of the standard setups described below will be appropriate or whether you will need to customize your setup.

8.1 Sample Volume

The sample volume range is 10 to 50 μL. However, this is a nominal volume. The instrument does not depend on an accurate absolute value, but rather reproducible aspirations. This allows the calibrator probe signal to be stored in memory and provide a reference value used to internally calculate sample readings.

NOTE: Do not change the ISE sample size from the default value of 25uL.

8.2 Measurement Parameter Information

For most standard applications, specifications and recommended parameter settings are outlined below under each chemistry.

8.2.1 Choline

This is a direct reading of Choline in solution at the enzyme sensor. The enzyme Choline Oxidase is immobilized in the enzyme membrane.

$$\text{Choline} + 2O_2 \xrightarrow[\text{Chol Oxidase}]{} 2H_2O_2 + \text{Betaine}$$

System Buffer	YSI 2357
Calibrator Std	YSI 2772
Linearity Std	YSI 2773
Membrane	YSI 2771
Membrane Color	Orange
Detection Range	5–450 mg/L
Calibration Point	175 mg/L
Linearity Check Point	450 mg/L
Sample Size	25 µL
End Point	45 sec
Precision (CV,n=10)	2% or 4 mg/L, whichever is greater
Linearity	±2% or 4 mg/L, whichever is greater (5 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	7 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water or 2357 Buffer.
- Although the YSI 2772 Choline calibrator solution is prepared using choline bitartrate, the concentration is expressed as mg/L of choline cation. If you prefer to express the sample as a salt of choline, you must enter an "adjusted" calibration value when configuring your instrument measurement parameters.

For example, to express results as a choline hydroxide value, program the calibrator value as 204 mg/L when using the YSI 2772 Choline Standard calibrator solution. Your results will now reflect the concentration of choline hydroxide in the sample. Assumptions and calculations are as follows:

choline hydroxide FW = 121.2

free choline FW = 104.2

(121.1 ÷ 104.2) x 175 mg/L = 203.55 = 204 mg/L (rounded up)

Equivalent values for other choline salts may be calculated in a similar manner.

Potential Interferences.

Tests with equimolar concentrations of various vitamins, and other ingredients of nutritionals, showed little or no interference. On a scale where Choline = 100%, those substances that produced more than 0.5% response were Riboflavin (1.1%), Pyridoxine (1.5%), Ascorbic Acid (0.8%), and Thiamine (1.3%). Vanillin, an artificial flavor ingredient, may produce interference levels exceeding 10% (mole/mole), and should be tested separately for your individual formulations if known to be present.

8.2.2 Ethanol

This is a direct reading of Ethanol in solution at the enzyme sensor. The enzyme Alcohol Oxidase is immobilized in the enzyme membrane.

$$\text{Ethanol} + O_2 \xrightarrow[\text{Alcohol Oxidase}]{} H_2O_2 + \text{Acetaldehyde}$$

System Buffer	YSI 1579
Calibrator Std	YSI 2790
Linearity Std	YSI 2790
Membrane	YSI 2786
Membrane Color	Green
Calibrator Location	Station 2 (Tube holder)
Detection Range	0.04–3.20 g/L
Calibration Point	2.00 g/L
Linearity Check Point	3.20 g/L
Sample Size	15 µL
End Point	45 sec
Precision (CV,n=10)	2% or 0.02 g/L, whichever is greater
Linearity	±2% or 0.02 g/L, whichever is greater (0.04 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	5 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- The linear range of ethanol is quite limited. If you are concerned about linearity, monitor the upper range of concentration on a regular basis. You may benefit by preparing and using a calibrator with an ethanol concentration close to your sample concentration.
- If you prepare your own ethanol calibrator, prepare a solution with ionic strength. Level sensing depends on a conductive solution. A 0.1% K_2EDTA solution as a diluent acts as both a conductive solution and a preservative. Normal saline solution (0.9%) is also an acceptable diluent.
- **Your sample should be methanol-free.** Methanol can be a significant interference, since it is a good substrate for Alcohol Oxidase. Propanol and butanol are very weak substrates of Alcohol Oxidase and usually do not present an interference problem.
- Controlling evaporation of ethanol from both sample and calibrator is important. The use of some type of test tube cover (eg., prepunctured film) will help. Frequently replacing the calibrator solution with fresh solution will also minimize the effects of evaporation on measurement integrity.
- If the ionic strength of your samples is too low for the sipper to detect the fluid, turn off sipper fluid detection and use fixed depth.

8.2.3 Galactose

This is a direct reading of galactose in solution at the enzyme sensor. The enzyme Galactose oxidase is immobilized in the enzyme membrane.

$$\text{Galactose} + O_2 \xrightarrow[\text{Gal Oxidase}]{} H_2O_2 + \text{Galactose Dialdehyde Derivative}$$

System Buffer	YSI 2705
Calibrator Std	n/a[4]
Linearity Std	n/a
Membrane	YSI 2702
Membrane Color	White
Detection Range	~0.1–25 g/L
Calibration Point	~2 g/L (recommended)
Sample Size	25 µL
End Point	30 sec
Typical Working Life	~10 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- Always use fresh YSI 2705 Buffer in an opaque buffer bottle, such as the YSI 2935 when installing a new Membrane. Do not expose the 2705 Buffer to light any more than necessary before it is installed in the 2935 Bottle.
- **The sample should be lactose-free**. Lactose, glycerol, and other galactosides such as raffinose and stachyose are substrates for galactose oxidase. They may interfere by producing artificially high galactose readings.
- The enzyme membrane integrity test involving the use of YSI 2363 Potassium Ferrocyanide solution is not informative since ferrocyanide exists in the 2705 system buffer.
- YSI believes that you will be able to measure this analyte for many applications in the range specified. However, YSI makes no claims with respect to precision or linearity. User will need to prepare the calibrator and linearity standards for your application as YSI does not currently offer galactose standard solutions.

[4] YSI does not currently offer galactose calibrator standard solutions.

8.2.4 D-Glucose (Dextrose)

This is a direct reading of glucose in solution at the enzyme sensor. The enzyme glucose oxidase is immobilized in the enzyme membrane.

$$\text{Glucose} + O_2 \xrightarrow[\text{Glu Oxidase}]{} H_2O_2 + \text{D-Glucono-}\delta\text{-Lactone}$$

System Buffer	YSI 2357
Calibrator Std	YSI 2776
Linearity Std	YSI 1531
Membrane	YSI 2365
Membrane Color	Dark red
Detection Range	0.05–9.0 g/L at 13, 15 & 25 µL sample size 0.05–18.0 g/L at 10 µL sample size (1.80 g/L Cal Point) 0.05–25.0 g/L at 10 µL sample size (2.50g/L Cal Point)
Calibration Point	1.80 g/L 2.50 g/L
Linearity Check Point	9.0 g/L
Sample Size	25 µL
End Point	30 sec
Precision (CV,n=10)	2% or 0.02 g/L, whichever is greater
Linearity	±2% or 0.02 g/L, whichever is greater (0.05 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	21 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- If a solution must be prepared from solid glucose, use the following diluent and allow about 15 minutes before measuring the sample. This is required for glucose, which must equilibrate alpha and beta anomers (mutarotational equilibrium). If your reading is lower than expected, you may need to wait slightly longer for equilibration.

  Diluent: 40 g/L NaH_2PO_4
  10 g/L Na_2HPO_4
  Reagent water

  Both heat and the presence of phosphate accelerate mutarotational equilibration.
- For applications requiring linearity performance to 25.0 g/L, YSI 2777 (25.0 g/L glucose, 2.50 g/L lactate) may be used as a linearity standard provided the calibrator is YSI 2776 (2.50 g/L glucose, 0.50 g/L lactate) and the sample size is 10 µL.
- For applications requiring linearity performance to 18.0 g/L, YSI 2748 (18.0 g/L glucose, 1.78 g/L lactate) may be used as a linearity standard provided the sample size is 10 µL.

8.2.5 L-Glutamate (L-Glutamic Acid)

This is a direct reading of L-glutamate in solution at the enzyme sensor. The enzyme L-Glutamate Oxidase is immobilized in the YSI Glutamate Membrane.

$$\text{L-Glutamate} + O_2 \xrightarrow[\text{Glut Oxidase}]{} H_2O_2 + \alpha\text{-Ketoglutarate} + NH_3$$

System Buffer	YSI 2357
Calibrator Std	YSI 2755
Linearity Std	YSI 2756
Membrane	YSI 2754
Membrane Color	Yellow
Detection Range	15–1460 mg/L
Calibration Point	731 mg/L
Linearity Check Point	1462 mg/L
Sample Size	25 µL
End Point	30 sec
Precision (CV,n=10)	2% or 8 mg/L, whichever is greater
Linearity	±2% or 8 mg/L, whichever is greater (15 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	7 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- If you want to measure MSG (monosodium glutamate, monohydrate) and express the results as mmol/L of MSG, the calibration parameters listed above are all appropriate. If you want to express results as a w/v measurement, such as mg/L MSG, then correction for the sodium and water components is necessary.

To express results as an MSG value, change the glutamate units to a w/v expression, and enter one of the following: 936 mg/L, 0.936 g/L, or 0.094 %. Use YSI 2755 Calibrator Standard (5.00 mmol/L Glutamate) to calibrate the instrument. Sample results will then reflect MSG concentration.

Potential Interferences

Tests with equimolar concentrations of other amino acids and related substances showed little or no interference. On a scale where Glutamate = 100%, those substances that produced more than 0.5% response were L-Aspartate (0.7), L-Tyrosine (1.4), L-Histidine (0.7), and L-Glutamine (1.1). Glutamate cannot be ruled out as a contaminant in the Glutamine solution.

8.2.6 L-Glutamine

This is a direct reading of glutamine in solution at the enzyme sensor. Two enzymes are co-immobilized in the YSI Glutamine Membrane: Glutaminase and Glutamate Oxidase. Through this chain of reactions the amount of hydrogen peroxide liberated is directly proportional to the amount of glutamine.

L-Glutamine $\xrightarrow{\text{Glutaminase}}$ L-Glutamate + NH_3

L-Glutamate + O_2 $\xrightarrow{\text{Glut Oxidase}}$ H_2O_2 + α-Ketoglutarate + NH_3

System Buffer	YSI 2357
Calibrator Std	YSI 2736
Linearity Std	YSI 2737
Membrane	YSI 2735
Membrane Color	Magenta
Detection Range	30–1169 mg/L
Calibration Point	731 mg/L
Linearity Check Point	1169 mg/L
Sample Size	20 µL
End Point	30 sec
Precision (CV,n=10)	4% or 15 mg/L, whichever is greater
Linearity	±4% or 15 mg/L, whichever is greater (30 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	5 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- **The sample must be glutamate-free**, or at least contain levels low enough not to interfere with the glutamine reading. Since the glutamine membrane contains glutamate oxidase, glutamate will produce a probe signal. See *8.2.19 Simultaneous L-Glutamate and L-Glutamine* to measure glutamate and glutamine simultaneously.
- Specs shown are for simultaneous measurement of glutamine and glutamate.

8.2.7 Glycerol

This is a direct reading of glycerol in solution at the enzyme sensor. The enzyme Galactose oxidase is immobilized in the enzyme membrane.

$$\text{Glycerol} + O_2 \xrightarrow[\text{Gal Oxidase}]{} H_2O_2 + \text{Glycerol Aldehyde Derivative}$$

System Buffer	YSI 2705
Calibrator Std	YSI 7141
Linearity Std	YSI 7142
Membrane	YSI 7140
Membrane Color	Magenta
Detection Range	0.75–40.0 g/L
Calibration Point	25.0 g/L
Linearity Check Point	40.0 g/L
Sample Size	10 µL
End Point	30 sec
Precision (CV,n=10)	3% or 0.03 g/L, whichever is greater
Linearity	±3% or 0.03 g/L, whichever is greater (0.75 to Cal Point) ±5% or 0.75 g/L, whichever is greater (Above Cal Point to Range Max)
Typical Working Life	10 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- **The sample should be lactose-free.** Lactose and other galactosides such as galactose, raffinose and stachyose are substrates for galactose oxidase. They may interfere by producing artificially high glycerol readings.
- The enzyme membrane integrity test involving the use of YSI 2363 Potassium Ferrocyanide solution is not informative since ferrocyanide exists in the 2705 system buffer.
- Always use fresh YSI 2705 Buffer in an opaque buffer bottle, such as the YSI 2935, when installing a new YSI 7140 Glycerol Membrane. Do not expose the 2705 Buffer to light any more than necessary before it is installed in the 2935 Bottle.
- For maximum performance on the first day the glycerol membrane is installed, calibrate before every sample.
- If membrane sensitivity drops below 5nA, increase sample size as required.
- Reduce loss in membrane sensitivity over time by calibrating glycerol membranes every 2 to 4 hours while the instrument is idle.
- Decontaminate the 2935 Buffer bottle and cap at least monthly with an authorized cleaning solution (see Section 9.1).

8.2.8 Hydrogen Peroxide

This is a direct electrochemical reading of hydrogen peroxide at the enzyme probe. A structure similar in appearance to an enzyme membrane is used at the probe surface. This membrane contains immobilized nonenzymatic protein to produce diffusion properties similar to those exhibited by YSI Enzyme Membranes.

The electrochemical reaction, which is common to all YSI Enzyme Sensors, is the following:

$$H_2O_2 \xrightarrow{\text{Platinum anode}} 2H^+ + O_2 + 2e^-$$

System Buffer	YSI 2357
Calibrator Std	n/a[5]
Linearity Std	n/a[5]
Membrane	YSI 2701
Membrane Color	Yellow
Detection Range	3–300 mg/L
Calibration Point	~30 mg/L (recommended)
Sample Size	25 µL
End Point	30 sec
Typical Working Life	~21 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

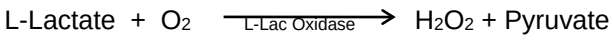
Special Considerations:

- Since hydrogen peroxide is typically used to calibrate the YSI Blank Membrane, the enzyme catalase is a concern. Catalase destroys hydrogen peroxide. Buffer pretreatment may be required.
- If you suspect an electrochemical interference (as opposed to an enzymatic interference), you may want to use one channel to qualitatively monitor for an interference effect.
- Typical electrochemical interferences include phenols, mercaptans, hydroxylamine, hydrazine and analines. If you suspect a particular substance, you may want to configure one of your probes with a blank membrane and calibrate it as described above under Hydrogen Peroxide. Then run your sample and check for activity at the Blank Membrane. It is not quantitative, but may provide useful information about your sample.
- YSI believes that you will be able to measure this analyte for many applications in the range specified. However, YSI makes no claims with respect to precision or linearity. User will need to prepare the calibrator and linearity standards for your application as YSI does not currently offer hydrogen peroxide standard solutions.

[5] YSI does not currently offer hydrogen peroxide standards.

8.2.9 L-Lactate

This is a direct reading of L-Lactate (L-Lactic Acid) in solution at the enzyme sensor. The enzyme L-Lactate Oxidase is immobilized in the enzyme membrane.



System Buffer	YSI 2357
Calibrator Std	YSI 2776
Linearity Std	YSI 1530
Membrane	YSI 2329
Membrane Color	Gray
Detection Range	0.05–2.70 g/L
Calibration Point	0.5 g/L
Linearity Check Point	2.67 g/L
Sample Size	25 µL
End Point	30 sec
Precision (CV,n=10)	2% or 0.03 g/L, whichever is greater
Linearity	±2% or 0.03 g/L, whichever is greater (0.05 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	14 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- D-Lactate is not a substrate for L-Lactate Oxidase. Therefore, the 2900 Series cannot directly measure D-Lactate. If you have a known racemic mixture of lactates, the L-Lactate value multiplied by 2 should give you the total lactate value.

8.2.10 Lactose

This is a direct reading of lactose in solution at the enzyme sensor. The enzyme Galactose oxidase is immobilized in the enzyme membrane.

$$\text{Lactose} + O_2 \xrightarrow[\text{Gal Oxidase}]{} H_2O_2 + \text{Galactose Dialdehyde Derivative}$$

System Buffer	YSI 2705
Calibrator Std	YSI 2783
Linearity Std	YSI 2784
Membrane	YSI 2702
Membrane Color	White
Detection Range	0.05–25 g/L
Calibration Point	5.0 g/L
Linearity Check Point	25.0 g/L
Sample Size	25 µL
End Point	30 sec
Precision (CV,n=10)	2% or 0.02 g/L, whichever is greater
Linearity	±2% or 0.02 g/L, whichever is greater (0.05 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	10 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water.
- Always use fresh YSI 2705 Buffer in an opaque buffer bottle, such as the YSI 2935 when installing a new Membrane. Do not expose the 2705 Buffer to light any more than necessary before it is installed in the 2935 Bottle.
- **The sample should be galactose-free.** Galactose, glycerol, and other galactosides such as raffinose and stachyose are substrates for galactose oxidase. They may interfere by producing artificially high lactose readings.
- The enzyme membrane integrity test involving the use of YSI 2363 Potassium Ferrocyanide solution is not informative since ferrocyanide exists in the 2705 system buffer.

8.2.11 Methanol

This is a direct reading of Methanol in solution at the enzyme sensor. The enzyme Alcohol Oxidase is immobilized in the enzyme membrane.

$$\text{Methanol} + O_2 \xrightarrow{\text{Alcohol Oxidase}} H_2O_2 + \text{Formaldehyde}$$

System Buffer	YSI 1579
Calibrator Std	YSI 2726 Solution A
Linearity Std	YSI 2726 Solution B
Membrane	YSI 2725
Membrane Color	Black
Calibrator Location	Station 2 Tube Holder
Detection Range	0.1–2.50 g/L
Calibration Point	1.00 g/L
Linearity Check Point	2.50 g/L
Sample Size	15 µL
End Point	30 sec
Precision (CV,n=10)	2% or 0.02 g/L, whichever is greater
Linearity	±2% or 0.02 g/L, whichever is greater (0.1 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	5 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- The linear range of methanol is quite limited. If you are concerned about linearity, monitor the upper range of concentration on a regular basis. You may benefit by preparing and using a calibrator with a methanol concentration close to your sample concentration.
- If you prepare your own methanol calibrator, prepare a solution with ionic strength. Level sensing at the Tube Holder depends on a conductive solution. A 0.1% K2EDTA solution as a diluent acts as both a conductive solution and a preservative. Normal saline solution (0.9%) is also an acceptable diluent.
- **Your sample should be ethanol-free.** Ethanol can be a significant interference, since it is a good substrate for Alcohol Oxidase. Propanol and butanol are very weak substrates of Alcohol Oxidase and usually do not present an interference problem.
- Controlling evaporation of methanol from both sample and calibrator is important. The use of some type of test tube cover (eg., prepunctured film) will help. Frequently replacing the calibrator solution with fresh solution will also minimize the effects of evaporation on measurement integrity.

8.2.12 Sucrose

This is a direct reading of Sucrose in solution at the enzyme sensor. Three enzymes are co-immobilized in the YSI Sucrose Membrane: Invertase, Mutarotase, and Glucose Oxidase. Through this chain of reactions the moles of hydrogen peroxide liberated is directly proportional to the moles of sucrose.

$$\text{Sucrose} + H_2O \xrightarrow[\text{Invertase}]{} \alpha\text{-D-Glucose} + (\text{Fructose})$$

$$\alpha\text{-D-Glucose} \xleftrightarrow[\text{Mutarotase}]{} \beta\text{-D-Glucose}$$

$$\beta\text{-D-Glucose} + O_2 \xrightarrow[\text{Glu Oxidase}]{} H_2O_2 + \text{D-Glucono-}\delta\text{-Lactone}$$

System Buffer	YSI 2357
Calibrator Std	YSI 2780
Linearity Std	YSI 2778
Membrane	YSI 2703
Membrane Color	Blue
Detection Range	0.1–25.0 g/L
Calibration Point	5.0 g/L
Linearity Check Point	25.0 g/L
Sample Size	25 µL
End Point	30 sec
Precision (CV,n=10)	2% or 0.02 g/L, whichever is greater
Linearity	±2% or 0.02 g/L, whichever is greater (0.1 to Cal Point) ±5% (Above Cal Point to Range Max)
Typical Working Life	10 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water or YSI buffer.
- **The sample must be glucose-free**, or at least contain levels low enough not to interfere with the sucrose reading. Since the sucrose membrane contains glucose oxidase, glucose will produce a probe signal.
- See 8.2.17 Simultaneous Glucose and Sucrose for sucrose specifications when measuring glucose and sucrose simultaneously.

8.2.13 Xylose

This is a direct reading of xylose in solution at the enzyme sensor. The enzyme pyranose oxidase is immobilized in the enzyme membrane.

$$\text{D-Xylose} + O_2 \xrightarrow[\text{Pyranose Oxidase}]{} H_2O_2 + \text{D-xylosone}$$

System Buffer	YSI 2357
Calibrator Std	YSI 2767
Linearity Std	YSI 2768
Membrane	YSI 2761
Membrane Color	Orange
Detection Range	0.5–30.0 g/L
Calibration Point	20.0 g/L
Linearity Check Point	30.0 g/L
Sample Size	13 µL
End Point	45 sec
Precision (CV,n=10)	2% or 0.5 g/L, whichever is greater
Linearity	±10% (0.5 to Range Max)
Typical Working Life	10 days

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- If sample dilution is required, use reagent water or YSI buffer.
- **The sample must be glucose-free**, or at least contain levels low enough not to interfere with the xylose reading, since glucose will react with pyranose oxidase.
- See *8.2.18 Simultaneous Glucose and Xylose* for xylose specifications when measuring glucose and xylose simultaneously.

Response to Related Sugars:

The relative magnitude of interference of related sugars is listed below. Note that relative responses may vary with both sample matrix and membrane lot.

Pyranose Oxidase substrates (relative response, based on equal concentrations):

Xylose = 1.0

Glucose = 0.8

Galactose = 0.6

Cellobiose = 0.02

Mannose = < 0.002

Arabinose = 0.01

Fructose = < 0.002

8.2.14 Simultaneous Ammonium and Potassium

This is a direct reading of Ammonium and Potassium in solution at the ISE.

	A Probe	B Probe
Chemistry Name	Ammonium	Potassium
System Buffer	YSI 2970	
Calibrator Std	YSI 2972	YSI 2971
Linearity Std	YSI 7173 and YSI 7179	
ISE Probe	YSI 2974	YSI 2975
Reference Probe	YSI 2976	
Sample Size	25 µL	
Detection Range	10–500 mg/L	20–1000 mg/L
Calibration Point	500 mg/L	1000 mg/L
Check Point	100 mg/L	200 mg/L
End Point	30 sec	
Precision (CV,n=10)	5% or 10 mg/L, whichever is greater	5% or 20 mg/L, whichever is greater
Linearity	±5%	
Typical Working Life	90 days	

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Special Considerations:

- Sodium may be an interferent to the measurement of ammonium with some samples. The interference is relatively small on a weight/weight basis (<1%). The 2900 Series does not automatically compensate for the presence of sodium. In order to check the potential sodium interference, YSI provides 7173 NaCl Check Solution (4 g/L Na^+). Presented as a sample, the effect of sodium on the ammonium sensor (and to a lesser extent on the potassium sensor) can be determined. If you determine this sodium presence is a significant factor in your measurement, you may use the result of the 7173 measurement to correct ammonium readings.
- Do NOT change the ISE module sample size from the default value of 25uL.

8.2.15 Simultaneous Glucose and L-Lactate

Refer to the sections above on Glucose and L-Lactate for theoretical and special considerations. Then follow the instructions below to set up your instrument for simultaneous determination.

	A Probe	B Probe
Chemistry	Glucose	L-Lactate
System Buffer	YSI 2357	
Calibrator Std	YSI 2776	
Linearity Std	YSI 1531	YSI 1530
Membrane	YSI 2365	YSI 2329
Sample Size	25 µL	
Unit of Conc.	g/L	
Cal Value	2.50	0.50
End Point	30 sec	

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required

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8.2.16 Simultaneous Glucose and Sucrose

Refer to the sections above on Glucose and Sucrose for theoretical and special considerations. Then follow the instructions below to set up your instrument for simultaneous determination.

	A Probe	B Probe
Chemistry	Sucrose	Glucose
System Buffer	YSI 2357	
Calibrator Std	YSI 2780	YSI 2776
Linearity Std	YSI 2778	YSI 1531
Membrane	YSI 2703	YSI 2365
Sample Size	25 μL	
Unit of Conc.	g/L	
Cal Value	5.00	2.50
End Point	30 sec	

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Since the Sucrose Membrane (2703) utilizes a chain of enzyme reactions and the final reaction is a "glucose measurement", free glucose in a sample will be measured at the Sucrose Sensor. By using the information at the Glucose Sensor, this free glucose is automatically subtracted in the instrument software.

Sucrose Specifications:

When simultaneously measuring glucose and sucrose, the sucrose precision and linearity are as follows:

Precision (CV,n=10): 4% or 0.04 g/L, whichever is greater

Linearity: ±5%

Special Considerations:

- When measuring glucose and sucrose, the glucose and sucrose sensors must be located in the same module.
- The combined total of glucose + sucrose cannot exceed 25 g/L. The glucose concentration cannot exceed 10 g/L if the combined total is near 25 g/L, since a glucose concentration that high combined with 15 g/L sucrose will saturate the Sucrose probe. If either of these conditions occur, you should dilute your sample to bring it into a reasonable range.
- The ability to select sample size (10 to 50 μL) may help you optimize your system, especially if very high or very low concentrations of one or the other of these substrates is a problem. The optimal probe current for a calibrator is about 10 nA. See 4.11 Check Probe Currents, to learn more about measuring your probe signal.
- If the glucose concentration in your sample exceeds the sucrose concentration, the subtraction of a large glucose "signal" from a smaller sucrose "signal" may result in significant errors in the sucrose reading. An alternative method involves using two different, and appropriate dilutions of the sample to first measure free glucose, then treat one sample with invertase and analyze for glucose liberated from the sucrose. Contact YSI Technical Support or your dealer representative for an application note explaining this approach in detail.

8.2.17 Simultaneous Glucose and Xylose

Refer to the previous sections on Glucose and Xylose for theoretical and special considerations, then follow the instructions below to set up your instrument for simultaneous determination.

	A Probe	B Probe
Chemistry	Glucose	Xylose
System Buffer	YSI 2357	
Calibrator Std	YSI 2776	YSI 2767
Linearity Std	YSI 1531 (or 2356)	YSI 2768
Membrane	YSI 2365	YSI 2761
Sample Size	13 µL	
Unit of Conc.	g/L	
Cal Value	2.50	20.0
End Point	45 sec	

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Since the xylose membrane also responds to glucose, the xylose measurement is based on an algorithm that simultaneously measures both xylose and glucose. The algorithm utilized takes into account the responsiveness of the xylose membrane to glucose and the slight response of the glucose membrane to xylose.

Special Considerations:

- When measuring glucose and xylose, the glucose and xylose sensors must be located in the same module.
- As with most analytical methods there is a concentration range that provides optimal accuracy and precision. The YSI xylose and glucose methods are specified independently for performance; however these two analytes frequently occur together.

Glucose and Xylose Specifications:

When simultaneously measuring glucose and xylose, the glucose and xylose precision and linearity are as follows:

Precision (CV,n=10): 2% or 0.1 g/L, whichever is greater

Linearity: ±5% or 0.5 g/L, whichever is greater

8.2.18 Simultaneous L-Glutamate and L-Glutamine

Refer to the previous sections on L-Glutamate and L-Glutamine for theoretical and special considerations, then follow the instructions below to set up your instrument for simultaneous determination.

	A Probe	B Probe
Chemistry	Glutamine	Glutamate
System Buffer	YSI 2357	
Calibrator Std	YSI 2736	YSI 2755
Linearity Std	YSI 2737	YSI 2756
Membrane	YSI 2735	YSI 2754
Sample Size	20 μL	
Unit of Conc.	mmol/L	
Cal Value	5.00	5.00
End Point	30 sec	

Note: See *Appendix B – Concentration Unit Conversion* if concentration unit conversion is required.

Since the Glutamine Membrane (2735) utilizes a chain of enzyme reactions and the final reaction is a “glutamate measurement”, free glutamate in a sample will be measured at the Glutamine Sensor. By using the information at the Glutamate Sensor, this free glutamate is automatically subtracted in the instrument’s software. The algorithm looks basically like this:

(“Total Glutamate” - “Free Glutamate”) = Glutamine

Total Glutamate is the combined glutamine and glutamate probe signal. Free Glutamate is the glutamate not derived from Glutamine reaction.

Special Considerations:

- The ability to select sample size (10 to 50 μL) may help you optimize your system, especially if very high or very low concentrations of one or the other of these substrates is a problem. The optimal probe current for a calibrator is about 10 nA.
- When measuring glutamate and glutamine, the glutamate and glutamine sensors must be located in the same module.

9. Operational Checks and Maintenance

9.1 Cleaning, Disinfecting, and Decontaminating

Proper precautionary lab practices should be followed when handling biological hazards.

Authorized cleaning and disinfecting agents include:

- Sodium hypochlorite, 0.5% free available chlorine
- Isopropanol, 70%
- Ethanol, 70%
- NaOH, 0.5N

CAUTION: Do not use cleaning solutions on ISE probes (they will be damaged).

Authorized rinsing agents include:

- Deionized (DI) Water
- Distilled Water
- Purified Water
- Water For Injection (WFI)—must be cooled

9.1.1 Touch Panel

Clean the touch panel with glass cleaner or isopropanol. Do not use sodium hypochlorite (bleach).

9.1.2 Decontamination Procedures

Wipe the instrument case with mild soap and water, do not immerse. If necessary, isopropanol may be used.

Remove and discard all tubing. New tubing is provided in the preventive maintenance kit. Empty the waste bottle and wash with authorized disinfecting agent. Remove sample module, Sipper Tube, Test Tube Holders/racks and probes according to instructions.

Thoroughly clean with authorized disinfecting agent, then rinse with authorized rinsing agent (see Section 9.1). Remove probes and discard enzyme membranes. Clean enzyme probes with isopropanol only, rinse with authorized rinsing agent (see Section 9.1). Do not clean ISE probes unless you plan to replace them. Clean up all spills, then reassemble.

9.2 Daily Maintenance

9.2.1 Empty the Waste Bottle(s)

Carefully pull the waste tube out of the hole in each waste bottle. Unscrew the lid from the waste bottle then lift the waste bottle out of the bottle tray.

If the 2900 Series is used for medical research or biological testing, dispose of the waste bottle contents in a manner suitable for biohazardous waste. The YSI reagents used in the 2900 Series are non-toxic and, unless otherwise specified, consist of a phosphate salt buffer with small amounts of preservatives. Refer to reagent bottle labels and Material Safety Data Sheets for more information.

Rinse and dry only the bottom of the waste bottle cap. Ensure the SMA connector is dry. If the SMA connector gets wet, dry thoroughly with a lint-free tissue. For best results, let air dry for 2 hours.

Slide the waste bottle back into the bottle tray and screw the lid back onto the bottle. Insert the waste tube into the hole in the bottle.

9.2.2 Check the Calibrator Bottle(s)

If the fluid level is low or the bottle has been in the instrument longer than the working life (as stated on the bottle), install a new bottle of calibrator solution.

After installation, [Prime] the Calibrator. If you are calibrating from a test tube, evaporation is a major concern. Calibrating with calibrator that has experienced any significant evaporation will cause inaccurate test results. Consider changing calibrator daily, or more often, if required.

9.2.3 Check the Buffer Bottle(s)

Replace the buffer if the bottle is low or the buffer has been in the instrument longer than 1 week. Clean the buffer bottle and cap with an authorized cleaning solution (see Section 9.1), then rinse well with authorized rinsing agent (see Section 9.1) before installing fresh buffer. You may find it convenient to make more than one liter of buffer at a time, in order to have it on hand to replenish the buffer bottle. Prepare the buffer in a clean bottle with cap and store any excess at room temperature.

After a buffer change, [Prime] the buffer system. Buffer should be exiting the Sipper inside the sample module and overflowing to waste. You may need to initiate a second or third run of the buffer pump to complete the priming process.

9.2.4 Check for Leaks

Examine the instrument for leaks. These are caused either by loose connections or worn tubing.

9.2.5 Clean up Spills

Spills should be cleaned up promptly to prevent biohazard build-up and corrosion. Clean any spills of biological material from the sample area.

9.2.6 Daily Operational Checks

To verify proper instrument performance, perform the daily operational checks described in Section 5.1.1 Enzyme Membrane Integrity Test and 5.1.2 Linearity Test.

9.3 Monthly Maintenance

9.3.1 Calibration Pumping System Maintenance

Perform this procedure at least once a month to minimize the possibility of contamination. Depending on application and use, more frequent cleaning may be required. The most convenient time to perform this maintenance is before installation of a new bottle of calibration standard.

Prepare about 100 mL of one of the authorized cleaning solutions (see Section 9.1) and place this solution in a clean calibrator bottle. Install the bottle in the calibrator bottle position(s) you use.

From the Service screen, Pumps tab, touch [Off] to turn on the pump for the calibrator bottle position to flush the cleaning solution through the pump tubing and calibrator well and to the waste bottle. After 3 minutes, touch [On] to turn the pump off. Wait 7 minutes.

Remove and discard the authorized cleaning solution, then rinse the bottle thoroughly with authorized rinsing agent (see Section 9.1). Next, add authorized rinsing agent to the bottle, reinstall the Cal bottle inside the bottle tray.

From the Service screen, Pumps tab, touch [Off] to prime the calibrator for 3 to 5 minutes to rinse the tubing and cal well. After 3 to 5 minutes, touch [On] to turn the pump off.

Remove the Cal Cap Assembly. From the Service screen, Pumps tab, touch [Off] to flush the line with air. After 1 minute, touch [On] to turn the pump off. Wipe the cal cap and steel tubes with a clean laboratory tissue.

Install a new bottle of calibration standard and mark the installation date on the bottle.

From the Service screen, Pumps tab, touch [Off] to prime the fresh calibrator through the tubing and cal well. After 2 minutes, touch [On] to turn the pump off.

Repeat this entire procedure for any additional calibrator bottle positions that you use.

9.3.2 Buffer Pumping System Maintenance

Perform this procedure at least once a month to minimize the possibility of contamination. Depending on application and use, more frequent cleaning may be required. The most convenient time to perform this maintenance is before installation of a new bottle of buffer.

Prepare about 300 mL of one of the authorized cleaning solutions (see Section 9.1) and place this solution in a clean buffer bottle. Install the bottle in the buffer bottle position(s) you use.

From the Service screen, Pumps tab, touch [Off] to turn on the pump for the buffer bottle position to flush the cleaning solution through the pump tubing and to the waste bottle. After 3 minutes, touch [On] to turn the pump off. Wait 7 minutes.

Remove and discard the authorized cleaning solution, then rinse the bottle thoroughly with authorized rinsing agent (see Section 9.1). Next, add authorized rinsing agent to the bottle, reinstall the Buffer bottle inside the bottle tray.

From the Service screen, Pumps tab, touch [Off] to prime the buffer pump for 3 to 5 minutes to rinse the tubing. After 3 to 5 minutes, touch [On] to turn the pump off.

Empty the buffer bottle.

Remove the Bufferl Cap Assembly. From the Service screen, Pumps tab, touch [Off] to flush the line with air. After 1 minute, touch [On] to turn the pump off. Wipe the buffer cap and steel tubes with a clean laboratory tissue.

Fill the buffer bottle with fresh buffer.

From the Service screen, Pumps tab, touch [Off] to prime the fresh buffer through the tubing and sipper. After 2 minutes, touch [On] to turn the pump off.

Repeat this entire procedure for any additional buffer bottle positions that you use.

9.3.3 Bottle Cap Cleaning

Clean the buffer and calibrator bottle caps using one of the authorized cleaning solutions (see Section 9.1). Rinse with authorized rinsing agent and dry the bottle caps. Dry the SMA connector thoroughly with a lint-free tissue. For best results, let air dry for 2 hours.

9.3.4 Sample Module Cleaning

For applications requiring more frequent cleaning of the sample module, including stir bar and O-rings, clean as described in Section *9.4.1 Sample Module Cleaning* below.

9.4 Preventive Maintenance – 6 months or 1000 Hours

Before performing maintenance on the 2900 Series, **ALWAYS** turn the instrument off and unplug the power cord from the wall outlet.

Perform the maintenance procedures in this section every 6 months or 1000 hours sample ready, whichever occurs first. Depending on application and use, more frequent maintenance may be required.

The YSI Preventive Maintenance Kit contains all supplies necessary. For the 2900D, use the 2988 PM Kit. For the 2950D, use the 2989 PM Kit.

9.4.1 Sample Module Cleaning

It is necessary to periodically clean the sample modules.

From the Service screen, [Sipper] tab, touch the button under Location. Select [Station 1-P96] to move the sipper to away from the sample module.

Grasp the hand hold in the right side cover of the instrument and pull up and out to remove the cover.

Lift the cover off the left side of the instrument.

Unscrew the three thumbnuts on top of each sample module.

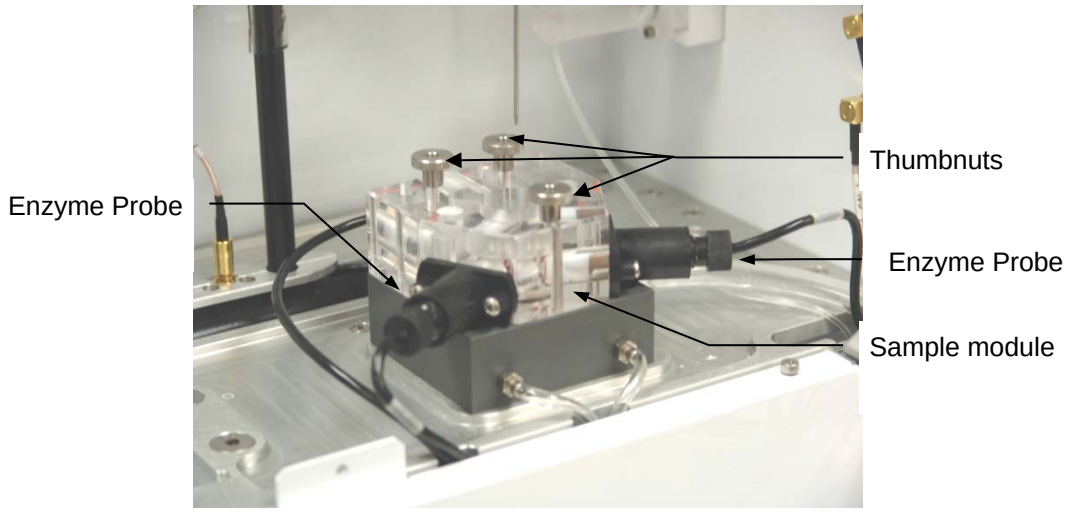


Figure 9-1

Unscrew and remove the enzyme/ISE probes and the temperature probe from each sample module. Place the ISEs and reference electrodes in 2970 Buffer solution to prevent them from drying out.

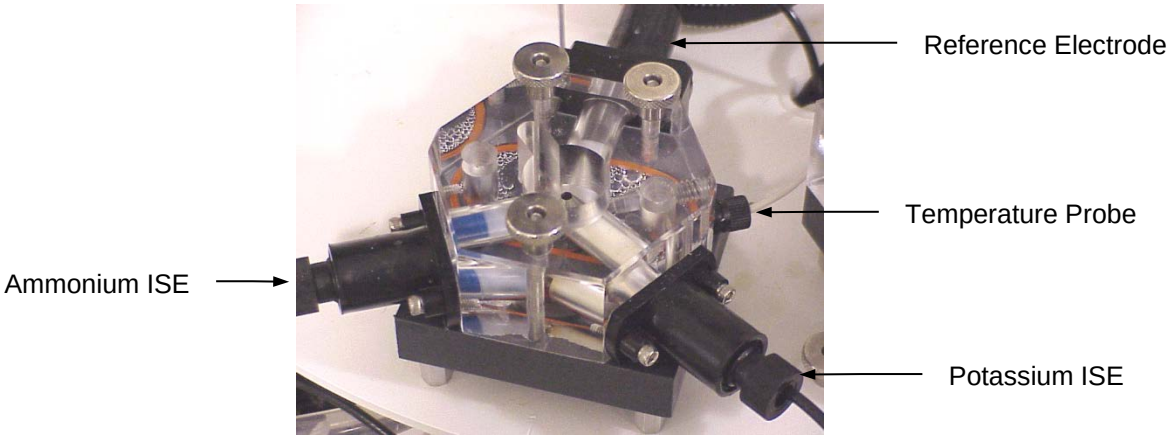


Figure 9-2

Remove the sample modules. Remove and discard the small magnetic stir bar inside each module. Immerse the modules in the authorized disinfecting agent (see Section 9.1) for a maximum of 10 minutes. If soiling or residue is visible, the module may be immersed in a water filled room temperature sonification bath for a maximum of 10 minutes. After cleaning, rinse the modules for 3 to 5 minutes with authorized rinsing agent (see Section 9.1). Wipe dry with a lint-free tissue.

9.4.2 Waste Module Cleaning

Unscrew the three hex screws from the top of waste module 1. Disconnect the calibrator and waste tubing and remove the waste modules from the base plate.

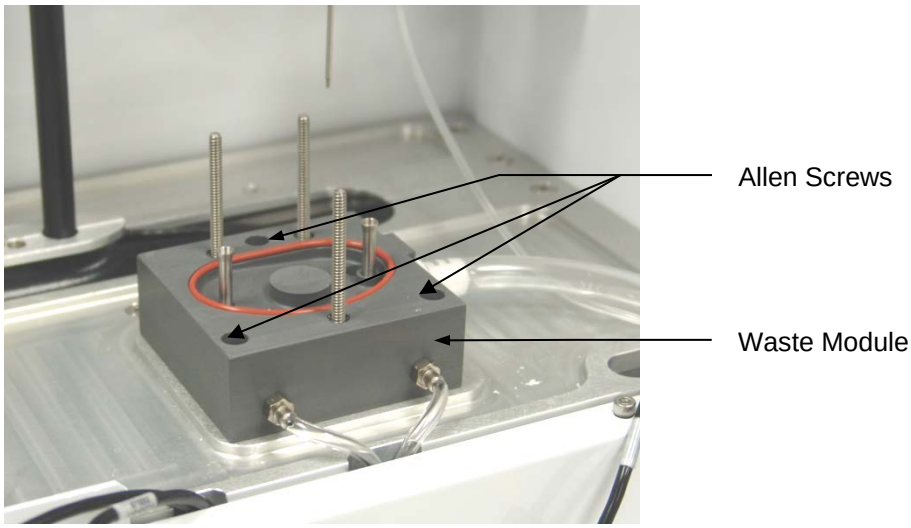


Figure 9-3

Immerse the waste modules in authorized disinfecting agent (see Section 9.1). After cleaning, rinse the modules for 3 to 5 minutes with authorized rinsing agent (see Section 9.1). Wipe dry with a lint-free tissue.

Remove the O-rings from the base plate. Clean up any salt deposits or fluid on the base plate. Be sure that the base plate and all other parts are dry.

9.4.3 Enzyme Probe Cleaning

With normal use, enzyme sensors may become fouled and cease to operate normally. A fouled sensor's output current will decrease and calibration may become unstable. Follow the steps below to clean the probes.

9.4.3.1 Sensor Maintenance

It is necessary to maintenance the enzyme sensors when the PM kit is installed and periodically as needed.

1. Remove the enzyme Membrane and hold the probe with the electrodes facing up.
2. Wad a small portion of a lint free tissue and wet it with 70% isopropyl alcohol.
3. Using your thumb, press the alcohol soaked wad against the probe's surface and rotate the probe back and forth.
4. Rinse the probe with authorized rinsing agent (see Section 9.1).
5. Install a new membrane on the probe (see Section 4.9.1), then install the probe in the sample module.

9.4.4 ISE Cleaning

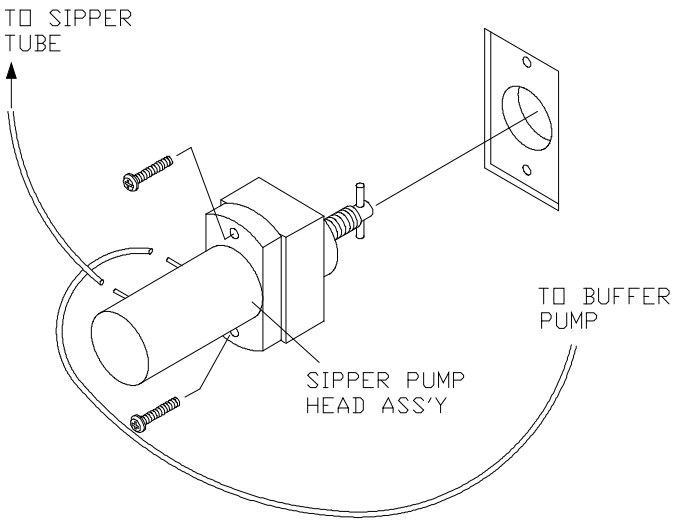
Under normal use, it is not necessary to clean the ISE probes. However, if the probes become fouled or contaminated by the sample composition, they may be cleaned as follows:

1. Soak the ISE with distilled or deionized water for 30 minutes.
2. Recondition the ISE by soaking it in YSI 2970 buffer solution for 4 hours.

9.4.5 Sipper Pump Seal Replacement

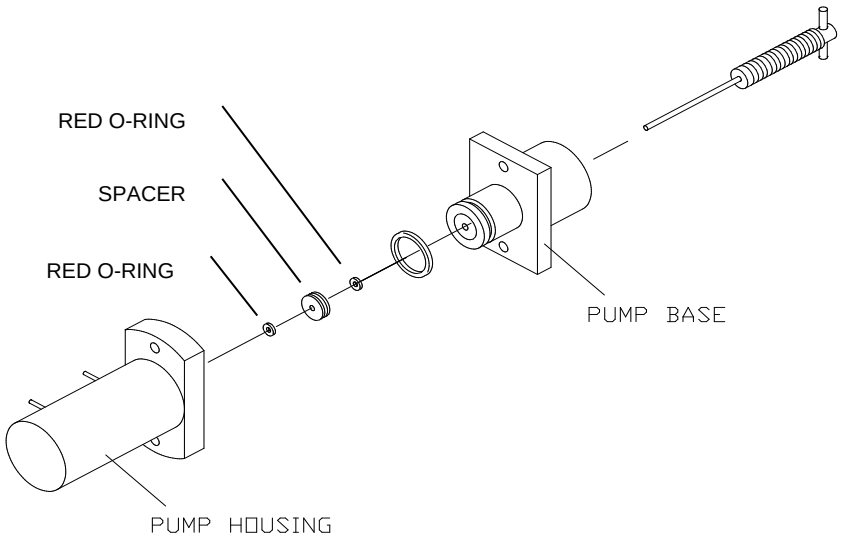
Replace the Sipper Pump seals every 6 months. Heavy usage may warrant more frequent replacement.

Disconnect the tubing from the Sipper Pump. Remove the two hex screws from the Sipper Pump head and remove it from the instrument wall (see Figure 9-4).



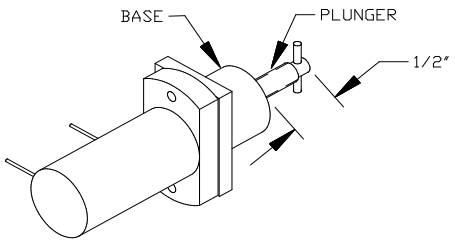
Sipper pump head
Figure 9-4

Pull the white pump base from the clear pump housing. Immerse the clear pump housing in authorized disinfecting agent (see Section 9.1). After cleaning, rinse the pump housing for 5 minutes with authorized rinsing agent (see Section 9.1). Wipe dry with a lint-free tissue. Make sure the metal pipes where the tubing connects are not blocked or restricted. Replace the O-ring seals as shown in Figure 9-5. New seals are supplied in the Preventive Maintenance Kit. Be sure to reinstall the black spacer between the two small red O-rings.



Sipper pump seal replacement
Figure 9-5

Reassemble the pump, position the plunger as shown in Figure 9-6 and install it back on the instrument.



Sipper pump plunger position

Figure 9-6

⚠ WARNING: When re-installing the pump head assembly, the plunger <u>MUST</u> extend at least 1/2″ from the base of the pump (see Figure 9-6). This will assure proper alignment between the pump head and the drive hub.

9.4.6 Bottle Tubing

Disconnect the tubing and unscrew the cable connectors from the buffer, waste and calibrator bottles on each side of the instrument.

Lift the bottle tray on the right side of the instrument up and remove it. Remove the bottles from the tray(s) and clean the bottles and caps with the appropriate disinfecting agent (see 9.1 Cleaning, Disinfecting, and Decontaminating).

Remove the two hex screws holding the pump cover on each side of the instrument. Lift the covers up and remove them.

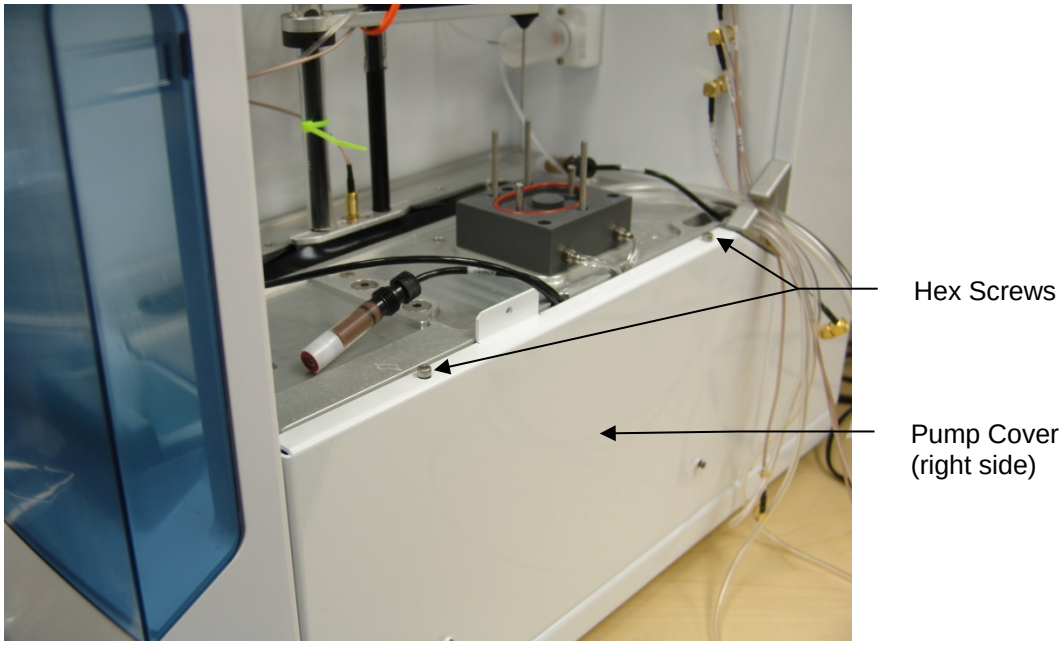
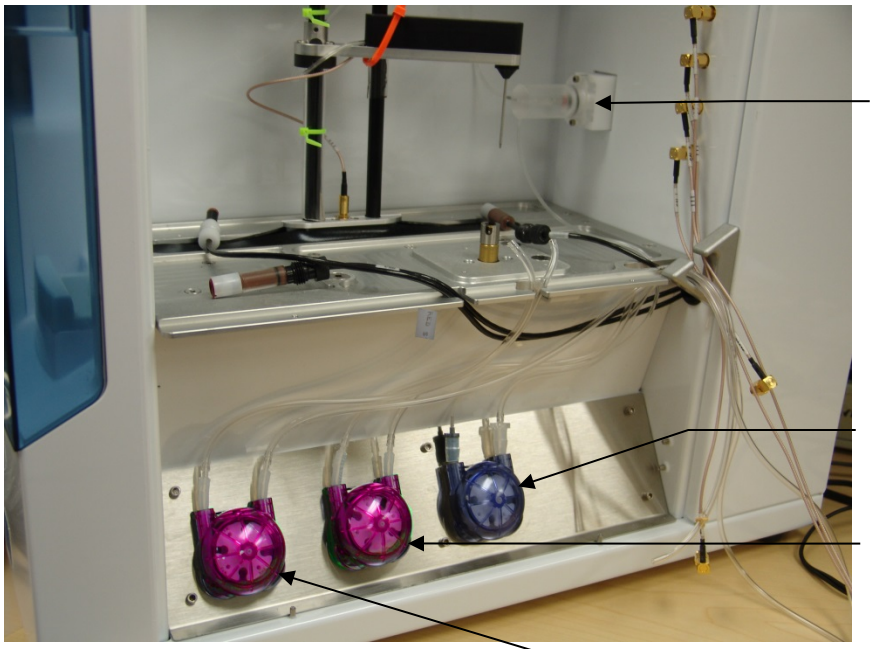
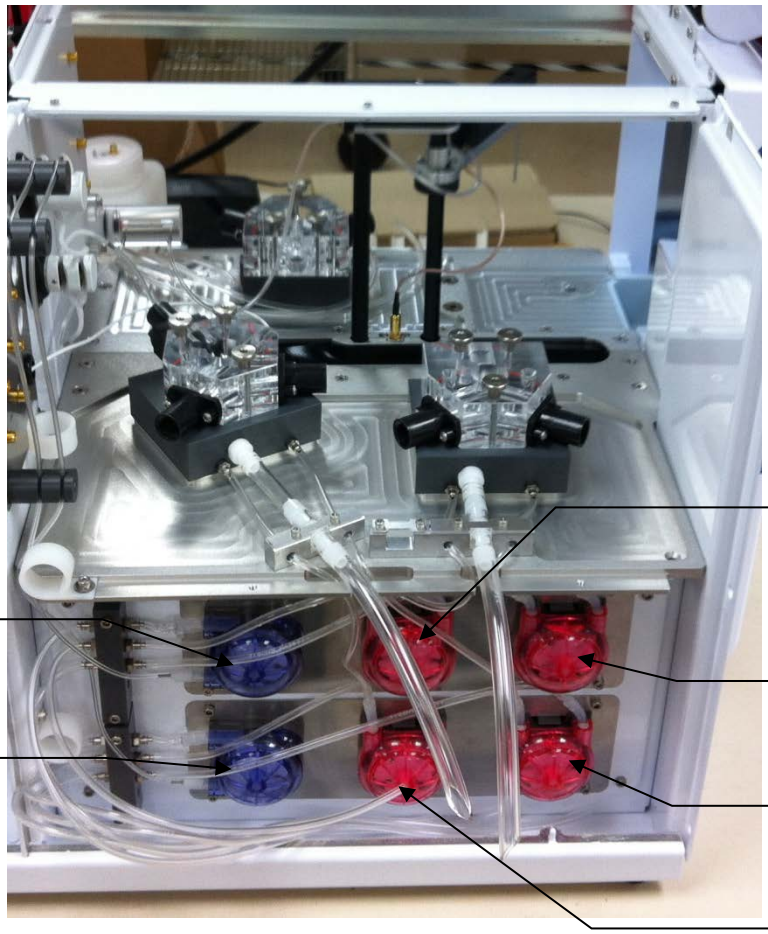


Figure 9-7



Pumps – Right side
Figure 9-8



Pumps – Left side
Figure 9-9

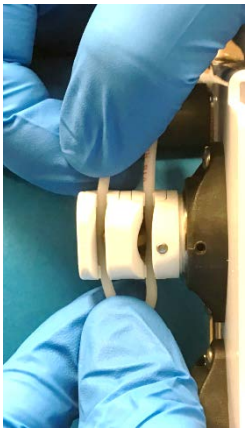
9.4.7 Pump Tubing Replacement

Tubing life depends on instrument usage. The buffer and calibrator pump tubing should be replaced at least every 6 months or 1000 hours sample ready.

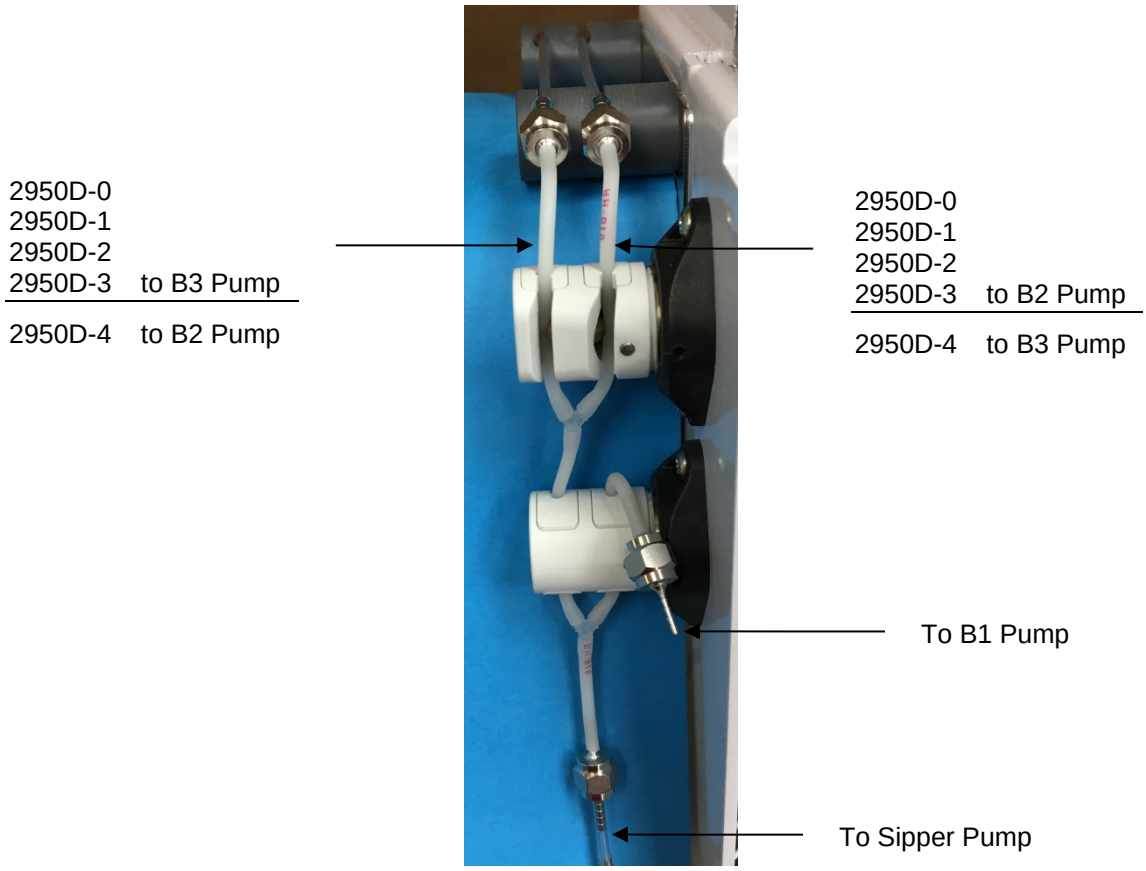
NOTE: The buffer pump tubing and calibrator pump tubing each require a different type of grease. It is important to apply the correct grease to each type of tubing.

9.4.7.1 Buffer Valve Tubing (2950 only)

Remove the old tubing from the valves by grasping each tube on both sides of the valve and pulling it straight out. To ensure correct operation and prevent premature tubing failure, install the new valve tubing as follows:



1. Connect the end of the clear section of buffer valve tubing to the inner port of the sipper pump.
2. Insert the short section of valve tubing close to the first Y (near the clear section) into the inner channel of the bottom valve. Hold the tubing on both sides of the valve and push it straight into the valve channel until it snaps in. Try not to stretch the tubing.
3. From the Service screen Pumps tab, touch the [OFF] button under Bottom Valve to turn ON the Bottom Valve.
4. With the bottom valve ON, insert the long section of valve tubing close to the first Y (near the clear section) into the outer channel of the bottom valve. Hold the tubing on both sides of the valve and push it straight into the valve channel until it snaps in.
5. From the Service screen Pumps tab, touch the [ON] button under Bottom Valve to turn OFF the Bottom Valve.
6. Insert the one section of valve tubing close to the second Y into the inner channel of the top valve. Hold the tubing on both sides of the valve and push it straight into the valve channel until it snaps in.
7. From the Service screen Pumps tab, touch the [OFF] button under Top Valve to turn ON the Top Valve.
8. Insert the other section of valve tubing close to the second Y into the outer channel of the top valve. Hold the tubing on both sides of the valve and push it straight into the valve channel until it snaps in.
9. From the Service screen Pumps tab, touch the [ON] button under Top Valve to turn OFF the Top Valve.
10. Verify that all valve tubing is inserted fully into the channels of both valves.



9.4.7.2 Buffer Pump Tubing

Pull out firmly on the top edge of each pump head cover (left edge of Buffer Pump 2 and 3). The pump head cover should snap off. See Figure 9-10 and Figure 9-11 below.

Figure 9-10

Figure 9-11

Remove the pump tubing from each pump.

Install Buffer Tubing

Apply plenty of buffer grease (included with the new buffer pump tubing) to the new buffer pump tubing. Apply the grease to the large diameter section of each tubing. Do not apply calibrator pump grease to the buffer pump tubing.

Insert the new pump tubing around the pump roller assembly and into each buffer pump. Make sure the small white fitting with the small diameter tubing is on the left side of pump 1 (bottom for pumps 2 and 3).

Place a blue pump head cover onto each buffer pump and press until it snaps into place.

For Buffer Pumps 2 and 3, insert the small diameter tubing through the holes in the manifold. Connect the end of the small diameter tubing to the buffer valves as described below.

Connect Buffer Tubing

Connect the small diameter tubing from Buffer Pump 1 to the inner channel of the bottom valve.

Thread the small diameter tubing from Buffer Pump 2 (Buffer Pump 3 for 2950D-4 only) through the inner channel of the three tubing holders and connect it to the inner channel of the top valve.

Thread the small diameter tubing from Buffer Pump 3 (Buffer Pump 2 for 2950D-4 only) through the outer channel of the three tubing holders and connect it to the outer channel of the top valve.

Connect the larger diameter tubing from the top of buffer pumps 2 and 3 to the top fitting of each manifold.

Connect Buffer bottle tubing marked B2 and B3 to the matching fittings on the opposite side of the manifolds.

9.4.7.3 Calibrator Pump Tubing

C1A

Note that the tubing for C1A is slightly longer than C1B.

Apply plenty of calibrator grease (included with the new calibrator pump tubing) to the longer section of new calibrator pump tubing. Do not apply this calibrator pump grease to the buffer pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C1A. Make sure the short section of tubing is on the left side of the pump. The tubing attached to this fitting connects to the left fitting on waste module 1.

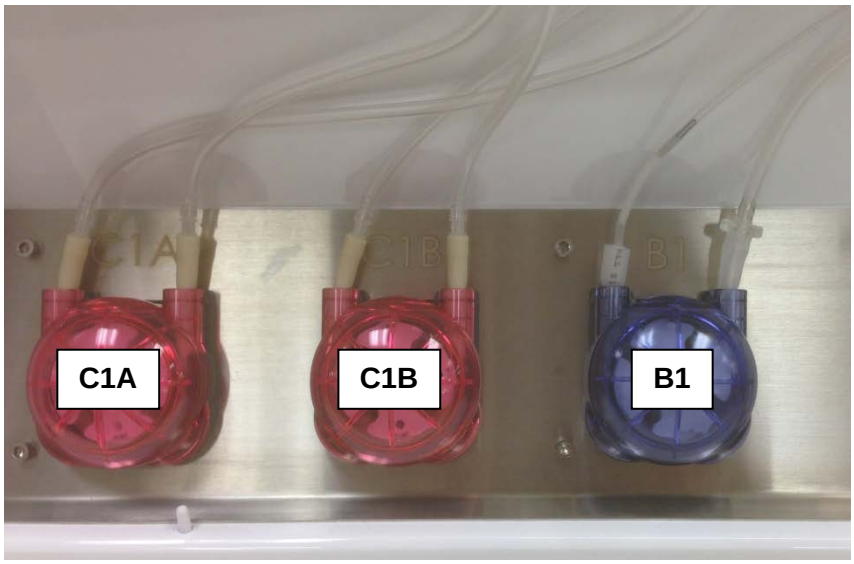
Place a red pump head cover onto the cal pump and press until it snaps into place.

C1B

Apply plenty of grease (included with the new pump tubing) to the shorter section of new calibrator pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C1B. Make sure the short section of tubing is on the left side of the pump. The tubing attached this fitting connects to the right fitting on waste module 1.

Place a red pump head cover onto the cal pump and press until it snaps into place.



C2A

Apply plenty of grease (included with the new pump tubing) to the longer section of new calibrator pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C2A. Make sure the short section of tubing is on the left side of the pump. The tubing attached this fitting connects to the left fitting on waste module 2.

Place a red pump head cover onto the cal pump and press until it snaps into place.

Connect the tubing from the right side of the pump to the second fitting from the top of the top manifold.

Connect Cal bottle tubing marked C2A to the matching fitting on the opposite side of the manifold.

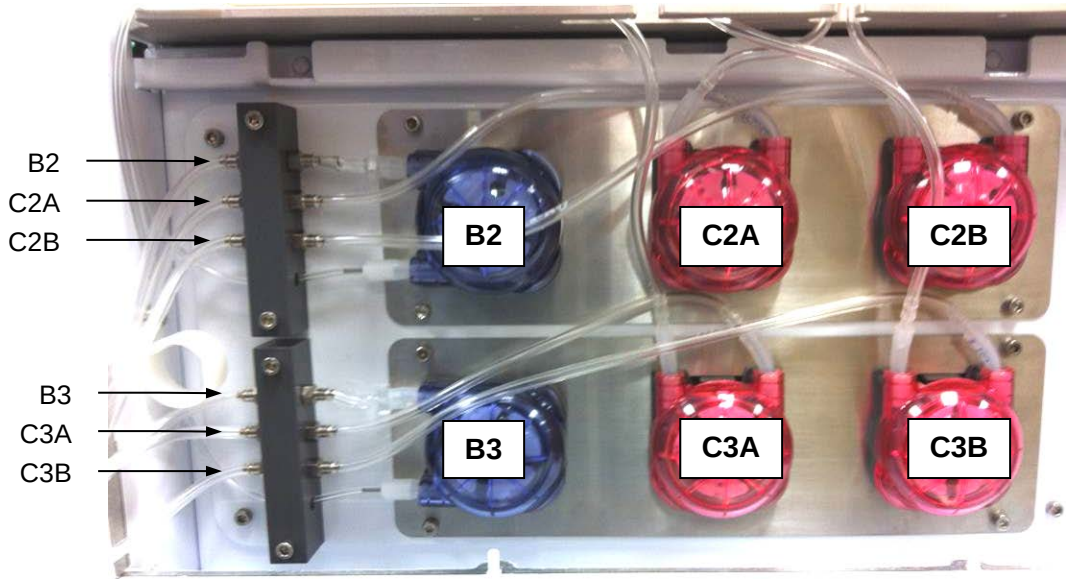


Figure 9-12

C2B

Apply plenty of grease (included with the new pump tubing) to the shorter section of new calibrator pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C2B. Make sure the short section of tubing is on the left side of the pump. The tubing attached this fitting connects to the right fitting on waste module 2.

Place a red pump head cover onto the cal pump and press until it snaps into place.

Connect the tubing from the right side of the pump to the bottom fitting of the top manifold.

Connect Cal bottle tubing marked C2B to the matching fitting on the opposite side of the manifold.

C3A

Apply plenty of grease (included with the new pump tubing) to the longer section of new calibrator pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C3A. Make sure the short section of tubing is on the left side of the pump. The tubing attached this fitting connects to the left fitting on waste module 3.

Place a red pump head cover onto the cal pump and press until it snaps into place.

Connect the tubing from the right side of the pump to the second fitting from the top of the bottom manifold.

Connect Cal bottle tubing marked C3A to the matching fitting on the opposite side of the manifold.

C3B

Apply plenty of grease (included with the new pump tubing) to the shorter section of new calibrator pump tubing.

Insert the new pump tubing around the pump roller assembly and into calibrator pump C3B. Make sure the short section of tubing is on the left side of the pump. The tubing attached this fitting connects to the right fitting on waste module 3.

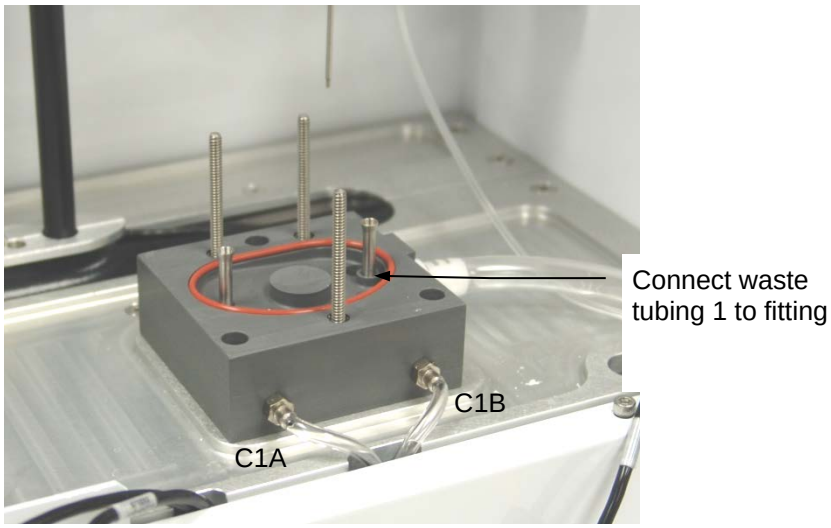
Place a red pump head cover onto the cal pump and press until it snaps into place.

Connect the tubing from the right side of the pump to the bottom fitting of the bottom manifold.

Connect Cal bottle tubing marked C3B to the matching fitting on the opposite side of the manifold.

9.4.8 Install Waste Modules

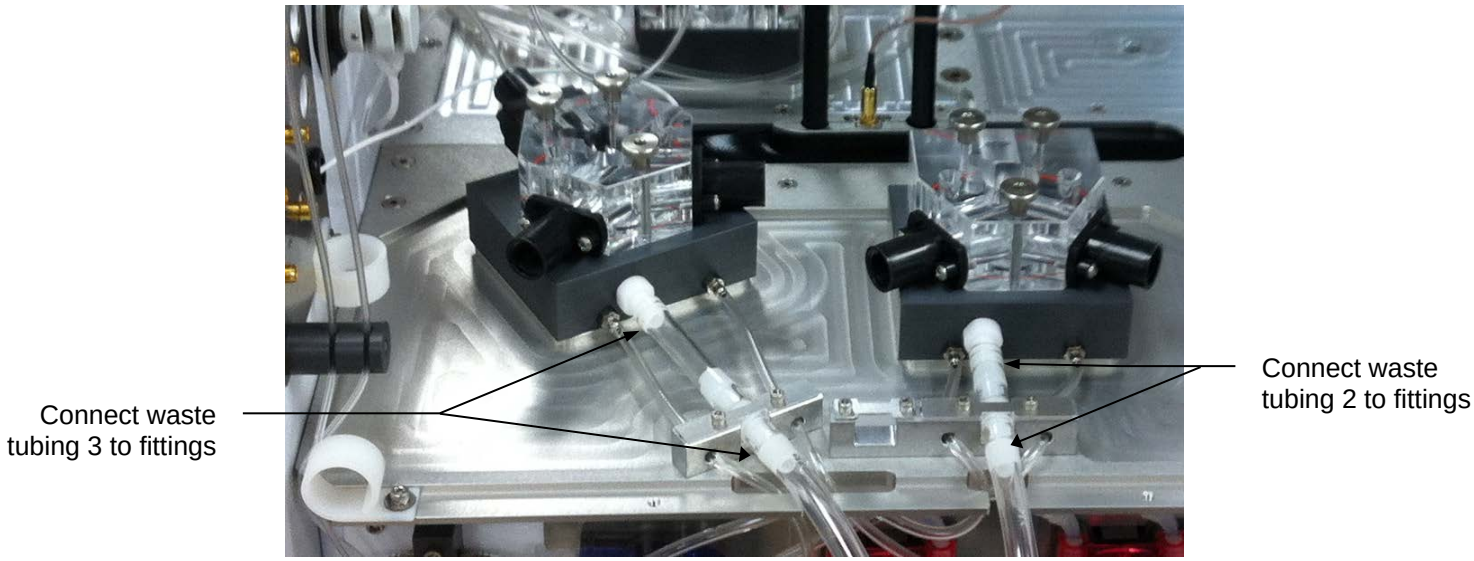
After cleaning, flush the waste modules with copious amounts of authorized rinsing agent (see Section 9.1) to remove any traces of the disinfecting agent. Install new O-rings in the base plate under each waste module. Reinstall waste module 1 using the three hex screws previously removed. Slide waste modules 2 and 3 over the threaded rods. Connect the ends of the new calibrator tubing to the fittings on the side of each waste module. Connect CA to the left fitting and CB to the right fitting of each module.



Calibrator and Waste Tubing (Module 1)
Figure 9-13

9.4.9 Waste Tubing

Slide the new waste tubing onto the large fitting on the side of each waste module.



Calibrator and Waste Tubing (Modules 2 and 3)
Figure 9-14

9.4.10 Install Sample Modules

After cleaning, flush the sample modules with copious amounts of warm water, then rinse with authorized rinsing agent (see Section 9.1) to remove any traces of the disinfecting agent. Install the sample modules. Remember to install the stir bar and the module seal O-ring. Secure the sample modules using the three thumb nuts. Install new O-rings on the temperature probes, then install the temperature probes into each sample module.

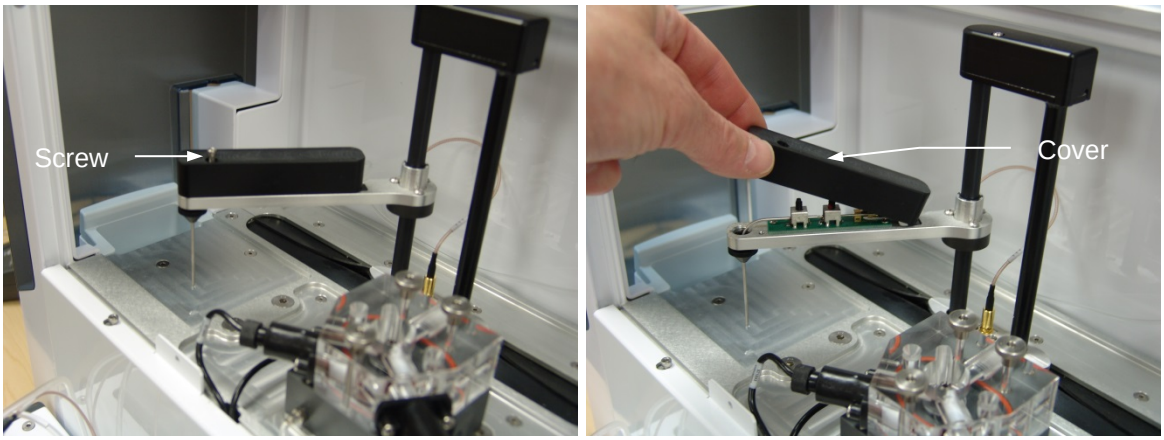
Be sure to clean the enzyme probes before installing them in the sample module.

9.4.11 Sipper Replacement

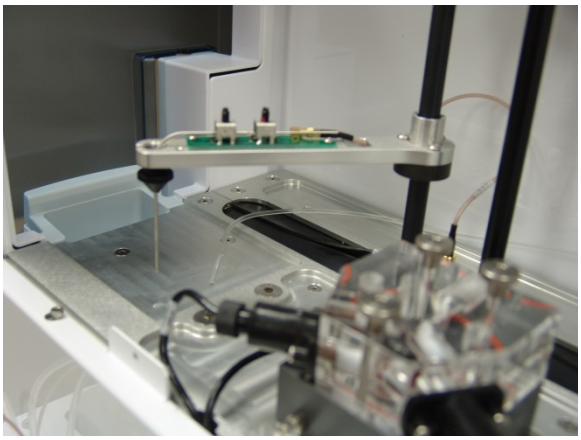
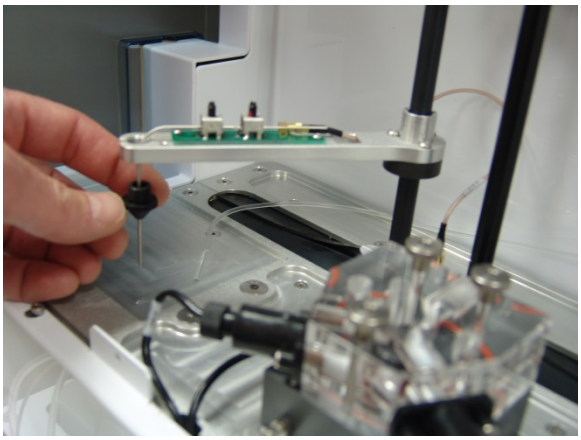
⚠ Caution: Touch a bare metal chassis screw before handling the sipper tube to prevent possible damage due to an electrostatic discharge.

The Sipper can be damaged if it is not properly aligned or if its alignment is disturbed. Inspect the Sipper for straightness and condition of the Teflon jacket separating the two stainless steel tubes. If the Teflon jacket is torn, replacement of the Sipper is required. Follow the steps below to replace the Sipper.

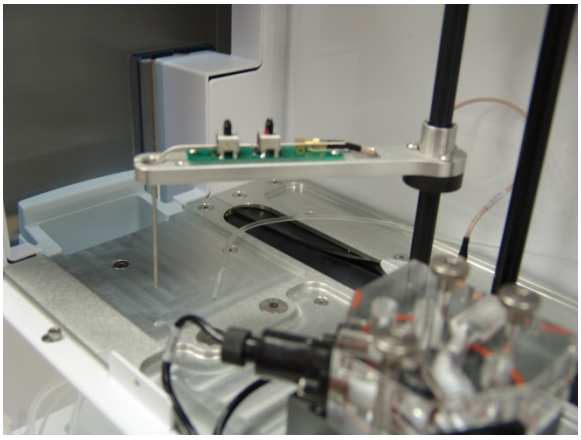
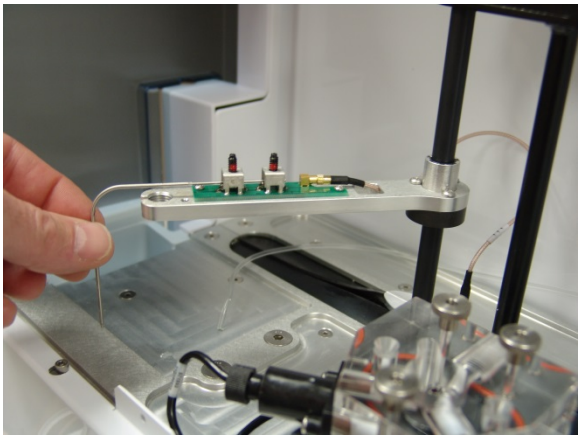
From the Service screen, Sipper tab, move the sipper to Location [Station 1-P96] to allow access to the sipper.



Remove the screw holding the sipper arm cover, then raise the cover up and slide it out of the sipper arm. Disconnect the tubing from the sipper.

Unscrew the sipper cone, slide it down and remove it from the sipper. Loosen the two needle mount screws two turns, then remove the sipper by sliding it straight out of the mounts.

Carefully insert the long thin end of the new sipper and slide it into the mounts. Slide the sipper cone up the sipper and screw it into the sipper arm. Be sure the sipper is centered in both mounts. Tighten the mount screws gently until they contact the sipper, then tighten an additional ¼ turn (**do not over tighten**). Connect new tubing from the Preventive Maintenance Kit to the new sipper. Install the sipper arm cover and secure using the hex screw (**do not over tighten**).

Route the new sipper tubing behind the sipper assembly and connect the other end to the front connector of the sipper pump.

9.4.12 Calibrate Sipper

Align the Sipper with the sample modules as described in 4.5 Align Sipper.

9.4.13 Install Bottles

Temporarily place the bottle trays next to the instrument and install the bottles. Connect the tubing and cables to the bottles. Be sure to install new reagents in the clean bottles.

9.4.14 Install Membranes and ISEs

Install new membranes and ISEs as prescribed.

9.4.15 Prime Fluid System

Prime the buffer and calibration systems. After checking for any leaks, reinstall the pump covers on both sides of the instrument and slide the bottle trays into position.

Calibrate the instrument and run the daily checks to confirm operation.

9.5 Fuse Replacement

It may be necessary to replace the fuse in the back of the 2900 Series. New fuses may be purchased from YSI or obtained from many local electrical component suppliers. Be sure to obtain the correct fuse rating as indicated below.

⚠ **CAUTION: UNPLUG THE INSTRUMENT FROM THE MAINS SUPPLY**, then unplug the other end of the power cord from the back of the instrument.

Using your fingers, grasp the right edge of the fuse holder and slide it out until it stops, then rotate it to the right to expose the fuse. Only the upper compartment of the fuse holder is used. Carefully slide the fuse out of the fuse holder.

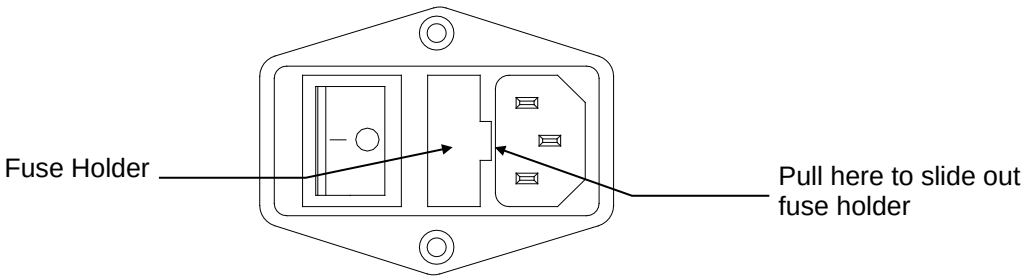


Figure 9-15

9.5.1 Fuse Requirements

Fuse Type: 100–240VAC Operation
2.0 Amp (YSI #571238)
Slow-blow (T Type), 250 volt, 5mm x 20mm

Slide a new fuse into the upper compartment of the fuse holder. Rotate the fuse holder until it is straight, then push it back into the instrument.

With the power switch in the off (O) position, plug the power cord into the instrument and then into the power mains. Refer to Section *1 Basic Setup* to confirm correct power up response.

9.6 2960 Maintenance

9.6.1 Tubing Replacement

Replacement of pump tubings, sample and waste line tubings and solenoid valve tubings is application-dependent. The recommended replacement is 350 hours for the silicone waste tubing and 3 months for all other tubings, including the PharMed® pump tubing, solenoid valve tubing, antiseptic tubing and sample source tubing. The 2990 Preventive Maintenance Kit provides a complete set of tubings for the 2960.

If you elect to clean tubings, see Section 9.1 for a list of authorized cleaning solutions. Be certain you flush well with authorized rinsing agent (see Section 9.1) before putting the 2960 back into use.

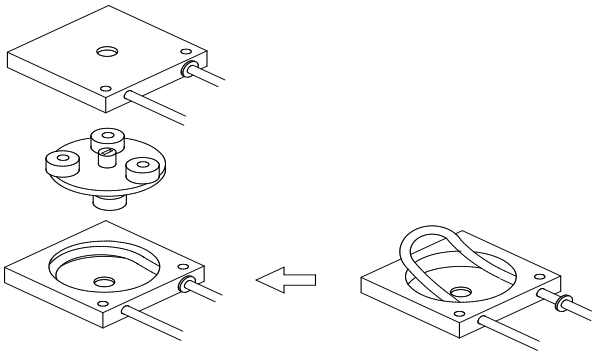
9.6.1.1 Pump Tubing Replacement

Before changing pump tubing, first study the tubing connections carefully. The peristaltic pump body is dual channel and the roller assembly rotates counterclockwise. The inlets for both sample and waste lines are on the right as you face the mounted pump body. The sample lines and sample pump tubings are nearer the 2960 case. The waste line is closest to you. The pump waste tubing contains a retainer (plastic washer) on the inlet (right) side of the pump. The sample pump tubing contains a retainer (plastic washer) and a plastic tab attached on the inlet (right) side. Refer to Figure 9-16 below for diagrammatic details.

To change pump tubing, remove the two thumb screws securing the pump assembly to the 2960 and remove the pump. Next, lower the pump body to a working surface, remove the two O-rings holding the pump together and separate the two halves of the pump body. Then remove the roller assembly, noting the slot in one end of the center shaft of the assembly. This slot must engage with the pump motor shaft on the 2960. Be certain to orient the "slot end" correctly on reassembly.

Remove the old tubing, removing tubing retainers as required. The 2990 Preventive Maintenance Kit contains new retainers and fittings. Clean the inside of the pump housings as needed. A small amount of lubricant helps to control noise ("squeaks") when the pump rollers are turning. Appropriate lubricant is provided in the maintenance kit. Using a tissue or swab, lightly coat the inside of the pump body chambers and rollers with lubricant before installing tubing.

Install the new pump tubing as shown in the figure below.



When installing new pump tubing, first thread the waste line tubing through one chamber of the pump body. Install the roller assembly (slot in center shaft oriented up) into the pump body chamber. It will help to twist the roller assembly as you install it to more easily capture the tubing in between the rollers and chamber wall. Once in place, install the retainer and adjust the lengths of tubing on each side, locating the retainer on the inlet side of the pump chamber. You should have about 3 inches on the inlet (right) side.

Next install a retainer washer on the sample line and insert the tubing through the outer pump chamber such that the plastic retainer tab and washer will be located on the right when mounted.

Reassemble the 2 pump housings insuring they mate flush. Rotate the halves so that the mounting holes are aligned. Secure the two pump housings together with the O-rings.

Finally, resecure the pump body assembly to the 2960 using the two thumb screws.

Reconnect the tubing as shown in Figure 9-16 below.

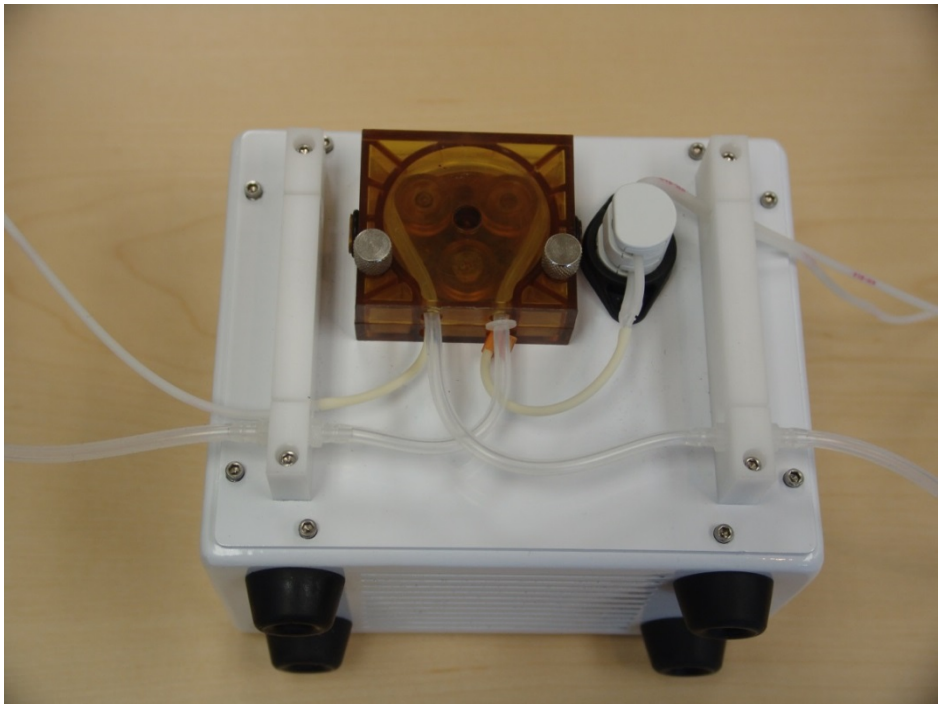


Figure 9-16

Repower the instrument, if necessary. From the Service menu, Monitor tab, check pump function for proper flow direction. Also listen for any unusual sounds that suggest strain on the pump motor. This may indicate binding or twisting of the newly installed tubing.

9.6.1.2 Solenoid Valve Tubing Replacement

Before changing solenoid valve tubing first study the tubing placement carefully. The sample flows through the outer slot of the solenoid valve and the antiseptic flows through the inner slot (closest to the 2960 case). The sample and antiseptic lines are connected together with a Y-shaped fitting on the outlet side of the solenoid valve.

To change solenoid valve tubing, grasp the tubing at each end close to the valve and pull it up out of the slot.

To install the solenoid valve tubing, refer to the instructions below.

NOTE: The following procedure should be followed when installing the solenoid tubing to ensure correct valve operation and prevent premature tubing failure.

1. From the Service menu, Monitor tab, touch the Opened Valve [Antiseptic] button and change it to [Sample] to energize the solenoid.

2. Install the Sample Tubing in the outer solenoid valve slot. Make sure that the tubing lies completely at the bottom of the slot. **Do not stretch the tubing**.

3. Touch the Opened Valve [Sample] button and change it to [Antiseptic] to de-energize the solenoid.

4. Install the Anti-septic Tubing in the inner solenoid valve slot. Make sure that the tubing lies completely at the bottom of the slot. **Do not stretch the tubing**.

NOTE: If the tubing is stretched, the walls may become too thin for the valve to operate properly.

9.6.2 Monitor Sample Cup

There are two approaches to cleaning the Monitor sample cup.

- You may use the monitor pump to draw cleaning solution through the system. See Section 9.1 for a list of authorized cleaning solutions. To clean the "funnel" near the tip of the cup, use a swab or direct a stream of cleaning agent at the area while the pump is running. Remember, waste must be actively removed from the cup. Gravity alone will not insure draining of the cup.

- Alternatively, you may remove the cup and clean it. Note: Do not attempt to remove the stainless steel inlet tube from the cup. Remember to realign the sipper with the cup before initiating another monitor run.

The cup body is machined from acetyl copolymer (tradename, Celcon). The outlet fitting is polypropylene. Cleaning the cup with boiling water and/or steam sterilization will not harm the cup parts.

10. Storage

During normal use, the 2900 Series should be left with the power on at all times. It should also have an adequate supply of buffer for any installed Membranes or ISEs. This will keep the enzyme probes polarized and ready for use and prevent the reference ISE from drying out.

10.1 Instrument Storage

If the 2900 Series is not going to be used for 2 weeks or longer, remove the buffer and calibrator solutions from the bottles and replace them with authorized rinsing agent (see Section 9.1). Flush the rinsing agent through the system thoroughly, empty the bottles, reinstall them in the instrument and prime the system with air. After all the fluid has been pumped from the system, drain the sample modules by temporarily removing one probe. Reinstall the enzyme probes and store the instrument with the membranes in place.

Store the instrument in an environment from 15–35°C, 10–75% humidity (non-condensing).

10.2 Enzyme Membrane Storage

Extra membranes should be refrigerated until use. Once installed, Membranes should remain in the appropriate buffer solution and not allowed to dry out.

10.3 ISE Storage

10.3.1 Reference ISE

Do not allow the reference ISE to dry out. Always store it wet (in ISE buffer solution).

10.3.2 Ammonium/Potassium ISE

For storage of 5 days or less, store the ammonium and potassium ISEs wet (in ISE buffer solution). For storage greater than 5 days, store the ammonium and potassium ISEs dry and in a dark enclosure.

10.4 Instrument Handling/Transport

Before transporting, drain all fluids as described above and secure the sipper assembly.

Transporting the instrument may require two people.

11. Troubleshooting

This section provides a systematic approach to establishing the cause of an instrument malfunction. Before taking any corrective action, be certain you have collected as much pertinent information as possible.

To establish probable cause, you should:

- Review any error/warning messages displayed. They should indicate any problems.
- Review the reports for trends in data and errors. Use the detailed format to obtain as much information as possible. An explanation of the report data is covered in this section.
- Check reagent and Membrane installation dates. Compare the elapsed time to the recommended time.
- Look and listen for problems (fluid leaks, salt build-ups, air bubbles in the sample module, loose connections, noisy components, etc.).
- Review Section 7.2, to learn more about how you can test individual components of the 2900 Series.
- Use the troubleshooting chart in this section to assist you in identifying the problem, then use the chart to guide you to a corrective action.

If the problem cannot be resolved, contact YSI Technical Support. When communicating with service personnel, please indicate the serial number of the instrument. If writing or transmitting an email or FAX for assistance, please include a thorough description of the problem and copies of printouts, if possible.

11.1 Printout Information

For troubleshooting, or even daily log information, the "detail" report format is preferable. The Detail Report provides a complete description of the sensors for a calibration or sample. Information for all the sensors, as well as the temperature probe, is included.

11.1.1 Enzyme Sensors

Listed below are example printouts and explanations of the Detail format information for enzyme sensors.

Sample Report (Detail)

```
======================
 Sample Results Report
======================
Batch:     Test Batch-1

Analyte         P96_A01
----------------------
1A:Glucose     4.82 g/L
  IB nA            2.11
  NPL nA          32.65
  PL Slope nA/m    0.69
  Temp (C)         25.9
----------------------
Volume (uL)          25
Dilution Factor      x1
Fri 9/9/2020 10:59:37
 YSI 2950 – 20F000025
======================


======================
 Sample Results Report
======================
Batch:     Test Batch-1
Analyte:        P96_A01
----------------------
1B:Lactate     1.82 g/L
  IB nA            2.11
  NPL nA          32.65
  PL Slope nA/m    0.69
  Temp (C)         25.9
----------------------
Volume (uL)          25
Dilution Factor      x1
Fri 9/9/2020 10:59:37
 YSI 2950 – 20F000025
======================
```

Calibration Report (Detail)

```
======================
     Cal Report [1]
======================
 Cal Shift
1A:Glucose     2.50 g/L
  IB nA             1.79
  NPL nA           17.63
  FB nA             1.51
  PL Slope nA/m     0.42
  IB Shift        -0.65%
  NPL Shift        3.64%
  Temp (C)          25.9
----------------------
1B:Lactate     0.50 g/L
  IB nA             0.88
  NPL nA            9.81
  FB nA             0.76
  PL Slope nA/m     0.42
  IB Shift        -1.95%
  NPL Shift        1.64%
  Temp (C)          25.9
----------------------
End Point (sec)      30
Volume (uL)          25
Fri 9/9/2020 10:59:37
   YSI 2950 – 20F000025
======================
```

Sample Report (Brief)

```
======================
 Sample Results Report
======================
Batch:     Test Batch-1
Analyte:        P96_A01
----------------------
1A:Glucose     4.82 g/L
Fri 9/9/2020 10:59:37
======================



======================
Sample Results Report
======================
Batch:     Test Batch-1
Analyte:        P96_A01
----------------------
1B:Lactate     1.82 g/L
Fri 9/9/2020 10:59:37
======================
```

Calibration Report (Brief)

```
======================
     Cal Report[2]
======================
1A:Glucose     2.50 g/L
  IB nA            3.24
  NPL nA          17.63
  NPL Shift       -0.64%
1B:Lactate     0.50 g/L
  IB nA            2.28
  NPL nA          11.81
  NPL Shift        0.47%
----------------------
Fri 9/9/2020 10:59:37
======================
```

IB nA (Initial Baseline Current). The initial baseline current is monitored before a sample or calibration. The IB current must be stable and below 6 nA.

NPL nA (Net Plateau Current). This is the peak current minus the baseline current. The minimum acceptable plateau current is 5 nA. The maximum plateau current allowed is 100 nA for calibrations and 625 nA for samples.

xNPL nA (cross Net Plateau Current). Net plateau current of the other sensor in the module. For chemistry combinations that are automatically compensated for interference.

FB nA (Final Baseline Current). The final baseline current is printed for calibrations and samples. The baseline current is monitored during the buffer flush and compared to the initial baseline current.

IB shift (Baseline Shift). The final and initial baselines are compared and reported as percent shift. A negative baseline shift is not uncommon with newly-installed Membranes. High concentration samples may yield positive baseline shifts. An excessive positive shift can be an indicator of the presence of an interfering substance. The message 'Final baseline error' is printed when the instrument cannot adequately flush the sample module.

PL Slope (Slope of the plateau). The slope is reported in nanoamps per minute. A newly installed membrane may have an elevated plateau slope. An excessive slope can be an indicator of the presence of an interfering substance.

End Point is the time from dispensing the sample into the sample module until the instrument reads the probe signal. The default value for most chemistry setups is 30 seconds. The value that you have selected in Setup is displayed in the report. Note: This is not through-put time, but rather best thought of as "reaction" time or "probe signal development" time.

NPL shift (Calibration Shift). A calibration result is compared to the previous calibration result and the percent shift is reported. The default setting is 2%. That is, if the shift is greater than 2%, the instrument performs another calibration. Note that the 2900 Series attempts to calibrate each sensor up to 5 times before aborting calibration for that sensor. You may select Cal shift values that better suit your application. Excessive calibration shifts may be caused by faulty membranes, newly installed membranes or air in the sample module.

Temperature (Sample module Temperature). The sample module temperature is measured during a calibration and a sample. The results of a sample are temperature corrected. The 2900 Series works at sample module temperatures between 15° and 35°C. The instrument only measures and displays temperatures between 10° and 50°C.

11.1.2 Ion Selective Electrodes

Listed below are example printouts and explanations of the information for ISE sensors.

Calibration Report (Brief)

```
  ==Calibration Report==
         Probe3A
500 mg/L NH4+          2972
            NH4+     K+
           -----    -----
Avg:       24.32     1.46
Std Dv:     0.03     0.17


         Probe3B
1000 mg/L K+           2971
            NH4+     K+
           -----    -----
Avg:        6.12    37.43
Std Dv:     0.17     0.02

      ---------------
->Coef:       0.19     0.02
->Slp:       57.18    60.05
      ---------------
Tue 10/25/2020 11:08:32
==========================
```

Calibration Report (Detail)

```
  ==Calibration Report==
         Probe3A
500 mg/L NH4+          2972
            NH4+     K+
           -----    -----
IB(mV):    28.01    26.97
NPL(mV):   24.31     1.43

IB(mV):    28.09    27.03
NPL(mV):   24.36     1.65

IB(mV):    28.10    27.06
NPL(mV):   24.30     1.31

Avg:       24.32     1.46
Std Dv:     0.03     0.17

  End Point          30 sec
  Sample size         25 uL
  Temperature       21.50 C

         Probe3B
1000 mg/L K+           2971
            NH4+     K+
           -----    -----
IB(mV):    28.40    26.98
NPL(mV):    6.97    37.42

IB(mV):    28.50    26.97
NPL(mV):    6.31    37.45

IB(mV):    28.63    27.02
NPL(mV):    6.09    37.42

Avg:        6.12    37.43
Std Dv:     0.17     0.02

  End Point          30 sec
  Sample size         25 uL
  Temperature       21.50 C
      ---------------
->Coef:       0.19     0.02
->Slp:       57.18    60.05
      ---------------
   Tue 10/25/2020 11:08:32
    YSI 2950 – 20J000024
==========================
```

Sample Report (Brief)

```
========================
  Sample Results Report
========================
Batch:       TestBatch-1
Analyte:         P96_B02
------------------------
3A: Ammonium     106 mg/L
Wed 10/04/2020 1:31:09
========================


========================
  Sample Results Report
========================
Batch:       TestBatch-1
Analyte:         P96_B02
------------------------
3B: Potassium    193 mg/L
Wed 10/04/2020 1:31:09
========================
```

Sample Report (Detail)

```
========================
  Sample Results Report
========================
Batch:             P96-1
Analyte:         P96_B02
------------------------
3A: Ammonium     105 mg/L
 IB mV              20.62
 NPL mV              8.23
 xNPL mV             1.23
 PL Slope mV/m       0.23
Temp (C)            25.33
Volume (uL)            25
Dilution Factor        x1
Wed 10/04/2020 1:31:09
  YSI 2950D – 20J000024
========================


========================
  Sample Results Report
========================
Batch:             P96-1
Analyte:         P96_B02
------------------------
3B:Potassium     196 mg/L
 IB mV              25.83
 NPL mV             13.25
 xNPL mV             2.23
 PL Slope mV/m       0.13
Temp (C)            25.33
Volume (uL)            25
Dilution Factor        x1
Wed 10/04/2020 1:31:09
  YSI 2950 – 20J000024
========================
```

IB mV (Initial Baseline Voltage). The initial baseline voltage is monitored before a sample or calibration. The IB voltage must be stable and between -40 and 60 mV.

NPL mV (Net Plateau Voltage). This is the peak voltage minus the baseline voltage.

xNPL nA (cross Net Plateau Current). Net plateau current of the other sensor in the module.

PL Slope (Plateau Slope). The slope is reported in mV per minute. An excessive slope can be an indicator of ISE problems.

Avg (Average). The average PL voltage for the calibration sequence (last 3 cycles of each calibrator).

Std Dv (Standard Deviation). The standard deviation of the PL voltage for the calibration sequence (last 3 cycles of each calibrator). Must be less than 0.2.

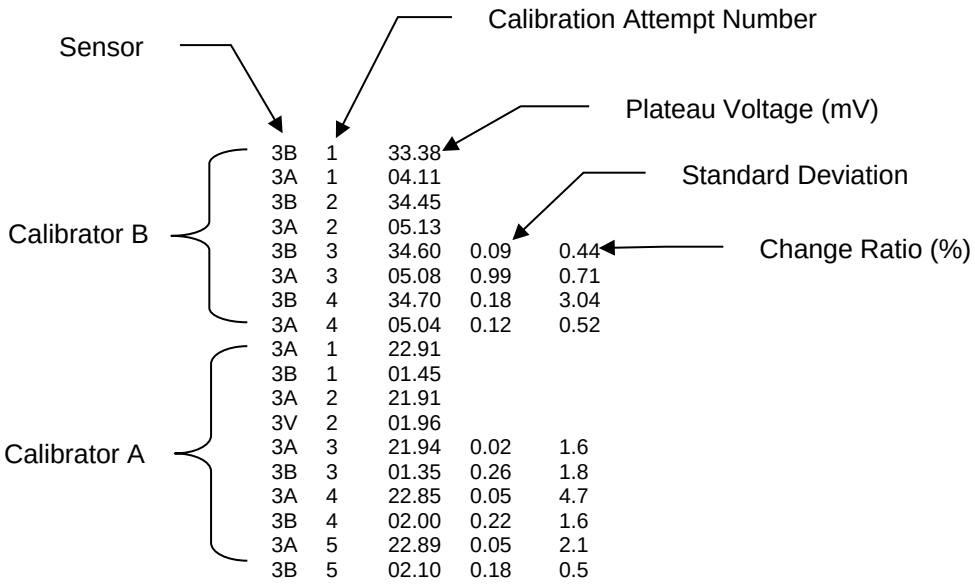
->Coef (Selectivity Coefficient). The response of the ISE to one calibrator vs. the other calibrator. Calculated during the last 3 cycles of each calibrator. Must be greater than zero and less than 0.3 for ammonium; greater than zero and less than 0.1 for potassium. Depending on the application, the 2950 may operate with an ammonium coefficient as high as 0.40, provided it passes the daily checks in section 5.1. However, it is the user's responsibility to determine if operation is acceptable for their specific application.

->Slp (Slope). The response of the ISE in mV per decade over the range of calibrator solutions. Must be greater than 52 mV/decade.

End Point is the time from dispensing the sample into the sensor module until the instrument reads the probe signal. The value for ISEs is 30 seconds.

Temperature (Sensor module Temperature). The sensor module temperature is measured during a calibration and a sample. The 2900 Series works at sensor module temperatures between 15° and 35°C. The instrument only measures and displays temperatures between 10° and 50°C.

As the 2900 Series is calibrating the ISEs, it prints out information for each sensor as shown below. Calibrations are repeated until the standard deviation of both sensors is less than 0.20 (or the Change Ratio is less than or equal to 1.2%) for each calibration solution.



11.2 Troubleshooting Chart

SYMPTOM:	**MEASUREMENT ERROR: IB Level Error**
POSSIBLE CAUSE:	Pinched, leaking or disconnected tube.
ACTION:	Fix or replace tubing.
SECTION:	*9.4.7 Pump Tubing Replacement*
POSSIBLE CAUSE:	Sipper misaligned.
ACTION:	Check Sipper alignment.
SECTION:	*4.5 Align Sipper*
POSSIBLE CAUSE:	Sipper pump not operating properly.
ACTION:	Replace sipper pump seals.
SECTION:	*9.4.4 ISE Cleaning*
POSSIBLE CAUSE:	Stir bar not in sample module.
ACTION:	Install stir bar.
SECTION:	*9.4.1 Sample Module Cleaning*
POSSIBLE CAUSE:	Stir speed too fast or too slow.
ACTION:	Adjust stir speed.
SECTION:	*7.2.4 Stirbar*
POSSIBLE CAUSE:	Newly installed enzyme Membrane.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Newly installed probe.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Power disruption.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	7.2.3 *Modules*
POSSIBLE CAUSE:	Failing enzyme membrane.
ACTION:	Perform daily operational checks and replace membrane if necessary.
SECTION:	*5.1 Perform Daily Operational Checks*, *4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Enzyme Probe surface fouled.
ACTION:	Clean probe surface.
SECTION:	*9.4.3 Enzyme Probe Cleaning*
POSSIBLE CAUSE:	Auxiliary electrode fouled.
ACTION:	Clean Auxiliary electrode surface (temperature probe) with isopropyl alcohol.
POSSIBLE CAUSE:	Sample may contain an interfering substance.
ACTION:	Attempt to confirm interference.
SYMPTOM:	**MEASUREMENT ERROR: NPL Limit Error**
POSSIBLE CAUSE:	Sipper misaligned.
ACTION:	Check Sipper alignment.
SECTION:	*4.5 Align Sipper*
POSSIBLE CAUSE:	Stir bar not in sample module.
ACTION:	Disassemble sample module and reinstall stir bar.
SECTION:	*9.4.1 Sample Module Cleaning*

POSSIBLE CAUSE:	Newly installed enzyme Membrane.
ACTION:	Enter probe service and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Newly installed probe.
ACTION:	Enter probe service and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Calibrator solution out of spec: contaminated or installed for more than 30 days.
ACTION:	Install new calibrator.
SECTION:	*4.7 Install Calibrator Solution(s)*
POSSIBLE CAUSE:	Failing enzyme Membrane.
ACTION:	Enter probe service and check probe currents. Replace Membrane(s) if necessary.
SECTION:	*5.1 Perform Daily Operational Checks*, *4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Probe surface fouled.
ACTION:	Clean probe surface.
SECTION:	*9.4.3 Enzyme Probe Cleaning*
POSSIBLE CAUSE:	Auxiliary electrode fouled.
ACTION:	Clean Auxiliary electrode surface (temperature probe) with isopropyl alcohol.
POSSIBLE CAUSE:	Sample concentration too high, resulting in high probe current (nA).
ACTION:	Dilute sample or adjust sample size down and repeat.
SECTION:	*8.1 Sample Volume*

SYMPTOM:	**MEASUREMENT ERROR: PL Slope**
POSSIBLE CAUSE:	Stir speed too fast or too slow.
ACTION:	Adjust stir speed.
SECTION:	*7.2.4 Stirbar*
POSSIBLE CAUSE:	Newly installed enzyme Membrane.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Newly installed probe.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Failing enzyme membrane.
ACTION:	Replace membrane.
SECTION:	*5.1 Perform Daily Operational Checks*, *4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Enzyme Probe surface fouled.
ACTION:	Clean probe surface.
SECTION:	*9.4.3 Enzyme Probe Cleaning*
POSSIBLE CAUSE:	Auxiliary electrode fouled.
ACTION:	Clean Auxiliary electrode surface (temperature probe) with isopropyl alcohol.

SYMPTOM:	**FLUID ERROR: Check Bottles**
POSSIBLE CAUSE:	Low buffer or calibrator level.
ACTION:	Check bottle status at bottom of Sample screen. Refill the appropriate bottle.
SECTION:	*4.6 Prepare and Install Buffer Solution*, 4.7 *Install Calibrator Solution(s)*
POSSIBLE CAUSE:	High waste level.
ACTION:	Empty waste bottle.
SECTION:	*9.2.1 Empty the Waste Bottle*

POSSIBLE CAUSE:	Bubbles in buffer or calibrator bottle tubing.
ACTION:	Prime bottle.
SECTION:	*4.8 Prime the Fluid System*

SYMPTOM:	**INTERNAL FAILURE: Unable to Calibrate**
POSSIBLE CAUSE:	Air bubbles in calibrator tubing.
ACTION:	Prime calibrator bottles.
SECTION:	*4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Pinched, leaking or disconnected tube.
ACTION:	Fix or replace tubing.
SECTION:	*9.4.7 Pump Tubing Replacement*
POSSIBLE CAUSE:	Sipper misaligned.
ACTION:	Check Sipper alignment.
SECTION:	4.5 *Align Sipper*
POSSIBLE CAUSE:	Stir bar not in sample module.
ACTION:	Install stir bar.
SECTION:	*9.4.1 Sample Module Cleaning*
POSSIBLE CAUSE:	Stir speed too fast or too slow.
ACTION:	Adjust stir speed.
SECTION:	*7.2.4 Stirbar*
POSSIBLE CAUSE:	Newly installed enzyme membrane.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Newly installed probe.
ACTION:	Enter probe diagnostics and check probe currents.
SECTION:	*7.2.3 Modules*
POSSIBLE CAUSE:	Calibrator solution out of spec: contaminated or installed for more than 30 days.
ACTION:	Install new calibrator.
SECTION:	*4.7 Install Calibrator Solution(s)*
POSSIBLE CAUSE:	Net calibration current (PL current) below 5 nA.
ACTION:	Replace enzyme Membrane and check calibrator solution.
SECTION:	*4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Failing enzyme membrane.
ACTION:	Perform daily operational checks and replace membrane(s) if necessary.
SECTION:	*5.1 Perform Daily Operational Checks*, *4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Probe surface fouled.
ACTION:	Clean probe surface.
SECTION:	*9.4.3 Enzyme Probe Cleaning*
POSSIBLE CAUSE:	Auxiliary electrode fouled.
ACTION:	Clean Auxiliary electrode surface (temperature probe) with isopropyl alcohol.

SYMPTOM:	**ERROR: No Fluid Detected**
POSSIBLE CAUSE:	Low sample level.
ACTION:	Increase sample level in test tube.
POSSIBLE CAUSE:	Sipper Depth set too high at sample station.
ACTION:	Adjust sipper depth.
SECTION:	*4.5 Align Sipper*

POSSIBLE CAUSE:	Calibrator bottle not primed.
ACTION:	Prime calibrator bottle.
SECTION:	*4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Low calibrator solution.
ACTION:	Install new calibrator.
SECTION:	*4.7 Install Calibrator Solution(s)*
POSSIBLE CAUSE:	Pinched, blocked, leaking or disconnected tube.
ACTION:	Fix or install new tubing.
SECTION:	*9.4.7 Pump Tubing Replacement*
POSSIBLE CAUSE:	Calibrator pump not operating properly.
ACTION:	Check pump and tubing.
SECTION:	*7.2.2.3 Calibrator Pumps*
POSSIBLE CAUSE:	Fluid not conductive.
ACTION:	Use saline as diluent.
POSSIBLE CAUSE:	Sipper tip fouled.
ACTION:	Clean tip of sipper with isopropyl alcohol and a lint-free tissue.
POSSIBLE CAUSE:	Sipper mounting screws loose.
ACTION:	Check sipper mounting screws and tighten **gently** if required.
SECTION:	*9.4.11 Sipper Replacement*

SYMPTOM:	**Fail FCN Test**
POSSIBLE CAUSE:	Damaged or old membrane.
ACTION:	Replace membrane.
SECTION:	*4.8 Prime the Fluid System*

SYMPTOM:	**Fail Linearity Test**
POSSIBLE CAUSE:	Probe assignment incorrect.
ACTION:	Make correct assignment.
SECTION:	*4.10.1 Assign Chemistries to Probes*
POSSIBLE CAUSE:	Calibrator bottle assignment incorrect.
ACTION:	Make correct assignment.
SECTION:	*4.10.2 Assign Reagents*
POSSIBLE CAUSE:	Damaged or old Membrane.
ACTION:	Replace membrane.
SECTION:	*4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Calibrator bottle(s) not primed sufficiently.
ACTION:	Prime each calibrator bottle for 60 seconds.
SECTION:	*4.8 Prime the Fluid System*
POSSIBLE CAUSE:	Contaminated or old calibration or linearity standard.
ACTION:	Repeat test with new standards.
SECTION:	*5.1 Perform Daily Operational Checks*
POSSIBLE CAUSE:	Assigned concentration range beyond practical limits.
ACTION:	Redefine measurement parameters. Remake standards.
SECTION:	*8 Chemistry Setup*

SYMPTOM:	**ERROR: Motor Failure**
POSSIBLE CAUSE:	One of the motors is jammed.
ACTION:	Enter motor service and cycle the suspected motor.
SECTION:	*7.2 Service*

POSSIBLE CAUSE:	Worn sipper pump seals.
ACTION:	Replace seals.
SECTION:	*9.4.5 Sipper Pump Seal Replacement*

SYMPTOM:	**ERROR: Temperature**
POSSIBLE CAUSE:	Ambient temperature too cold or hot.
ACTION:	Operate at ambient temperatures between 15 and 35°C.

SYMPTOM:	**Printer Does Not Advance**
POSSIBLE CAUSE:	Paper or roll jammed.
ACTION:	Remove paper cover and clear obstruction. If printer still does not advance, turn printer off for 30 seconds, then back on.

SYMPTOM:	**Sipper Does Not Enter Sample module**
POSSIBLE CAUSE:	Sipper misaligned.
ACTION:	Align sipper.
SECTION:	*4.5 Align Sipper*

11.2.1 2960 Online Monitor

SYMPTOM:	**Sipper Does Not Enter Monitor Cup**
POSSIBLE CAUSE:	Sipper misaligned.
ACTION:	Align sipper.
SECTION:	*6.2 Align Sipper*

SYMPTOM:	**2900Series Does Not Recognize the Monitor**
POSSIBLE CAUSE:	USB cable or 2960 power cable not connected.
ACTION:	Check 2960 cable connections.
SECTION:	*6.1 2960 Installation*

SYMPTOM:	**2960 Pump is running, but no sample flowing**
POSSIBLE CAUSE:	Obstruction in the sample tubing or cup.
ACTION:	Remove the sample tube connected to the Monitor Cup inlet port while the pump is running. If fluid flows, the obstruction is in the cup or the waste line. If fluid does not flow, try "massaging" the tubing to try relieving the blockage. If unsuccessful, begin disconnecting tubing and forcing air or fluid through with a syringe until you locate the blockage.

SYMPTOM:	**Bubbles appear at the top of the Monitor Cup when the Monitor Pump runs**
POSSIBLE CAUSE:	2960 pump tubing is not installed properly and fluid in the waste line is trying to flow backwards.
ACTION:	Check 2960 pump tubing installation.
SECTION:	*9.6.1 Tubing Replacement, Pump Tubing Replacement*

SYMPTOM:	**Monitor sample results appear to be lower than expected and excess air is observed in the 2900 Series sample chamber.**
POSSIBLE CAUSE:	Sipper depth is not set properly at Monitor Cup.
ACTION:	Set sipper depth at Monitor Cup.
SECTION:	*6.2 Align Sipper*

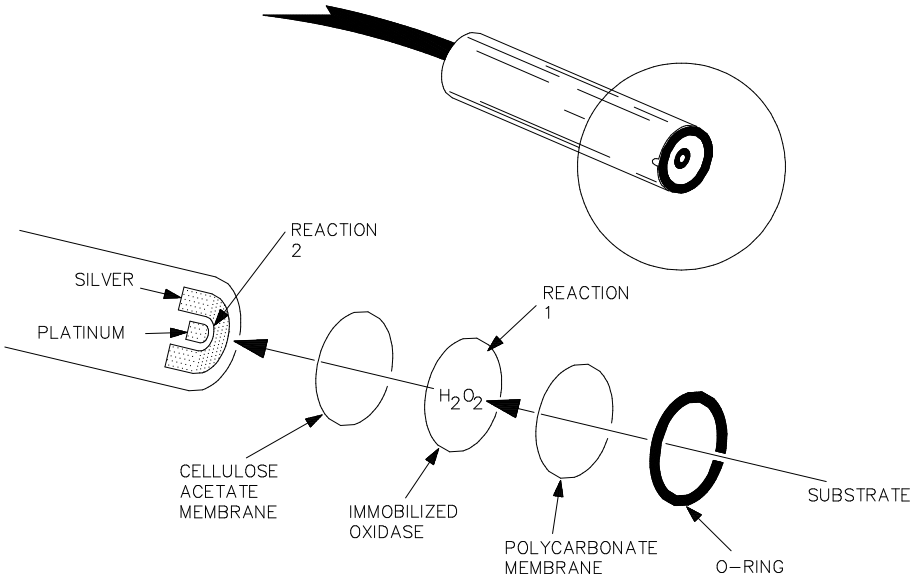
SYMPTOM:	**Fluid leaking from the 2960 Pump**
POSSIBLE CAUSE:	Pump tubing has failed.
ACTION:	Replace 2960 pump tubing.
SECTION:	*9.6.1 Tubing Replacement, Pump Tubing Replacement*

SYMPTOM:	**Sipper aspirates antiseptic instead of sample (sample results read approximately zero)**
POSSIBLE CAUSE:	Tubing routed incorrectly in 2960 solenoid valve.
ACTION:	Check 2960 valve tubing installation.
SECTION:	*9.6.1Tubing Replacement, Solenoid Valve Tubing Replacement*

12. Principles of Operation

12.1 Enzyme Sensor Technology

The enzyme sensor technology of the 2900 Series is based on the principles conceived by Dr. Leland Clark, formerly of Children's Hospital Foundation, Cincinnati, Ohio. The immobilized enzyme membrane was invented by YSI and is covered by U.S. Patent 4,073,713. This sensor technology has been used successfully since 1975.



Sensor Probe and Enzyme Membrane
Figure 12-1

Each enzyme probe is fitted with a three-layer membrane containing immobilized enzyme in the middle layer. Figure 12-1 shows an exploded view of the membrane and its relationship to the face of the probe.

The face of the probe, covered by the membrane, is situated in a buffer-filled sample module into which a sample is injected. Some of the substrate diffuses through the membrane. When it contacts the immobilized oxidase enzyme, it is rapidly oxidized, producing hydrogen peroxide. See Reaction 1, using glucose as an example.

The hydrogen peroxide (H_2O_2) is, in turn, oxidized at the platinum anode, producing electrons (Reaction 2). A dynamic equilibrium is achieved when the rate of H_2O_2 production and the rate at which H_2O_2 leaves the immobilized enzyme layer are constant and is indicated by a steady state response (Figure 12-2). The electron flow is linearly proportional to the steady state H_2O_2 concentration and, therefore, to the concentration of the substrate.

REACTION 1 (glucose): β-D-glucose + O_2 $\xrightarrow[GOx]{}$ Glucono-δ-lactone + H_2O_2

REACTION 2: H_2O_2 $\xrightarrow[Pt\ anode]{}$ $2H^+ + O_2 + 2e^-$

The platinum electrode is held at an anodic potential and is capable of oxidizing many substances other than H_2O_2. To prevent these reducing agents from contributing to sensor current, the membrane contains an inner layer consisting of a very thin film of cellulose acetate. This film readily passes H_2O_2 but excludes chemical compounds with molecular weights above approximately 200.

The cellulose acetate film also protects the platinum surface from proteins, detergents, and other substances that could foul it. However, the cellulose acetate film can be penetrated by such compounds as hydrogen sulfide, low molecular weight reducing compounds, mercaptans, hydroxylamines, hydrazines, phenols and anilines.

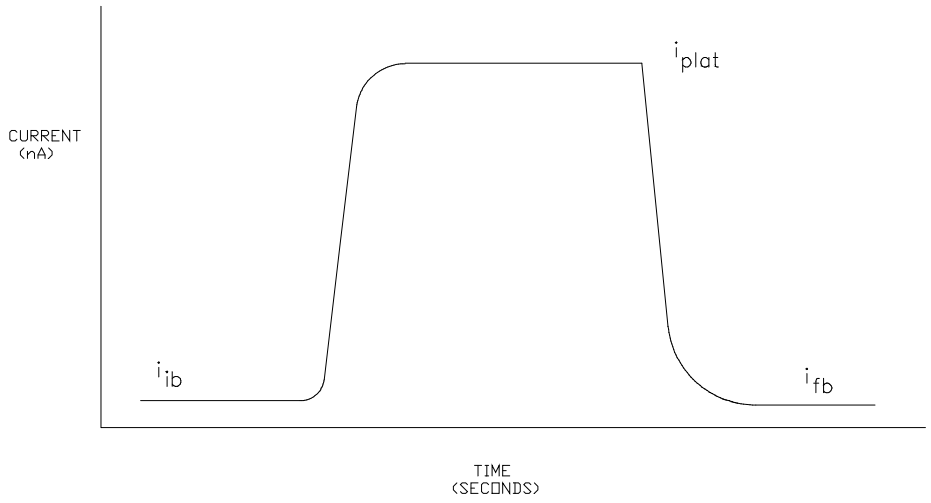
12.2 Ion Selective Electrode

An ion selective electrode (ISE) is designed to measure the concentration of an ion in a dilute solution. A membrane situated on the face of the ISE determines the selectivity of the ISE. The membrane is composed of a matrix of PVC, a layer of ionophore (a chemical which binds or surrounds the target chemical), and another matrix of PVC. In the 2950 system, this membrane is permanently connected to a disposable electrode which resides in the module module. Sample is injected through the sipper into the module and is diluted at a ratio of approximately 1 part sample to 27 parts buffer. Upon exposure of the intact ISE to the sample and buffer, ions pass through the membrane and are trapped by the ionophore. When equilibrium between the membrane and the external solution is reached, the potential across the membrane is compared to the potential measured by a reference electrode submerged in the same solution. The potential, measured in millivolts (mV), is then converted to a concentration through a series of algorithms including the modified Nicolski equation (a derivative of the Nernst equation). The relationship between the potential detected and the concentration of a solution is not linear, but rather semi-logarithmic. The slope of the semi-log plot of the modified Nicolski equation is approximately 57 mV per decade concentration.

An ammonium or potassium ISE is designed to measure the ammonium ion concentration [$NH4^+$] or the potassium ion concentration [K^+] in solution. However, as is the case with most ISEs, other ions similar in shape, size, or charge may also pass through the membrane and interfere with the measurement. In the case of ammonium and potassium, an ammonium sensor will respond to ammonium, but will also respond to a lesser extent to potassium. Likewise, a potassium sensor will also respond to ammonium to a certain extent. To correct for these interferences, during a calibration, the instrument exposes the ammonium sensor to potassium and vice versa to collect data on the level of interference of each ion with each sensor. The selectivity coefficient (SC) represents the extent to which an ion interferes with a sensor. Taking into account the selectivity coefficients, the instrument software then applies the Nicolski equation to determine the response of each sensor to the ion of interest.

12.3 Measurement Methodology

The 2900 Series employs a steady state measurement methodology. A typical enzyme sensor response is shown in Figure 12-1.



Typical Enzyme Sensor Response
Figure 12-2

When sample or calibration standard is dispensed into the sample module, it is diluted into 600 microliters of buffer. The enzyme sensor response increases and plateaus. After several seconds, the sample module is flushed with buffer and the sensor response decreases.

The net response is the difference between the plateau current (i_{plat}) and the initial baseline current (i_{ib}). Typical net responses for the 2900 Series are between 10 and 25 nA (nanoamps) for YSI calibration solutions.

12.4 Baseline Stability

The 2900 Series monitors the probe baseline activity and stability. If an unstable baseline is detected, the instrument will continue to flush the sample module with buffer. When a stable baseline is established, an automatic calibration is initiated.

After every calibration and sample, the final baseline value (i_{fb}) is compared to the initial baseline value (i_{ib}) during the flush cycle. If a significant shift is detected, the sample module continues to be flushed with buffer. As soon as the baseline recovers, buffer flushing ceases and the instrument performs its next command. There is a limit of about 3 minutes, at which time the instrument displays a baseline error message.

12.5 Calibration

To maintain a sample ready status, the 2900 Series self-calibrates. Calibrating establishes the sensors' response to a known concentration of substrate.

The enzyme sensors calibration response must be above 5 nA. A response below this value will result in an error (low PL current).

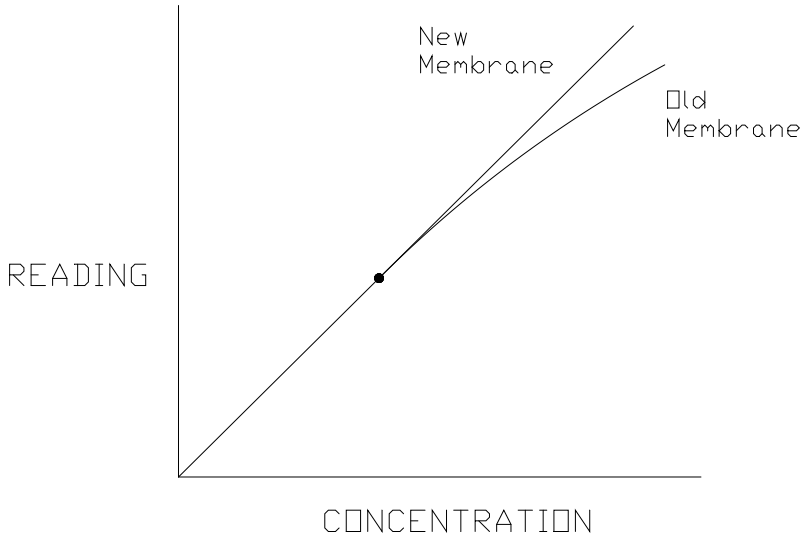
The 2900 Series self-calibrates enzyme sensors every 5 samples or 30 minutes. However, default calibration parameters can be altered to tighten or loosen calibration specifications. A manual calibration can be initiated from the [Run], [Calibrate] tab.

A STABLE CALIBRATION IS IMPORTANT. The instrument re-establishes a calibration reference point after every calibration. If a difference of more than 2% between the present and previous net calibration values occurs, the instrument repeats calibration. The sensors' net value for a calibration (PL) is displayed and printed. An unstable calibration is displayed and printed as a "PL shift". While establishing a stable calibration, the 2900 Series will run 5 calibrations before aborting calibration for a sensor. The flexible parameter selection allows the user to disable this error mode.

In summary, by the default enzyme sensor calibration settings, recalibration will occur after every 5 samples or 30 minutes, after a calibration shift of 2% or greater, or after a sample module temperature drift of more than 1°C. After 5 attempts without successfully calibrating, the instrument aborts calibration for that sensor.

12.6 Linearity

As discussed earlier, an enzyme sensor consists of an electrode and an enzyme membrane. As a membrane ages, its response becomes non-linear (shown in Figure 12-2).



Aging Enzyme Membrane Response
Figure 12-3

Under optimal conditions the enzyme sensor response depends on diffusion limitation of the substrate. When the substrate can diffuse at a greater rate than the enzyme can turnover product, enzyme kinetics defines the response and nonlinearity is a symptom. This occurs as an enzyme membrane ages.

It is necessary to periodically check sensor linearity. YSI offers linearity standards for all of the recommended calibration values.

12.7 Temperature Compensation

The sensitivity of the sensors, in the 2900 Series, varies with temperature changes. The sample module contains a temperature probe that monitors the fluid temperature. The sample results are temperature corrected for the difference in temperature between the sample and the calibration.

12.8 Level Sensing

The 2900 Series employs level sensing on the Sipper and, optionally, in the waste, calibrator and buffer bottles.

The Sipper level sensor detects the sample surface and then travels into the sample about 3 millimeters (1/8 inch). This controlled immersion depth permits the use of sample tubes/plates that are filled to different heights without significant carry-over between samples.

The Sipper and Arm Assembly should never be touched while the unit is in operation.

The calibrator and supply bottles are monitored for low levels and the waste bottle is monitored for high level.

13. Warranty and Repair

YSI 2900 Series Biochemistry Analyzers are warranted for one year from date of purchase by the end user against defects in materials and workmanship, exclusive of batteries. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by

(i) failure to install, operate or use the product in accordance with YSI's written instructions,
(ii) abuse or misuse of the product,
(iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure,
(iv) any improper repairs to the product,
(v) use by you of defective or improper components or parts in servicing or repairing the product, or
(vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.
To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

13.1.1 Shipping Instructions

1. Clean and decontaminate items to insure the safety of the handler.
2. Complete and include the Cleaning Certificate.
3. Place the product in a plastic bag to keep out dirt and packing material.
4. Use a large carton, preferably the original, and surround the product completely with packing material.
5. Insure for the replacement value of the product.

Cleaning Certificate

Organization _____

Department_____

Address_____

City _____ State _____ Zip _____

Country _____ Phone_____

Model No. of Device _____ Lot Number_____

Contaminant (if known)_____

Cleaning Agent(s) used _____

Radioactive Decontamination Certified?

(Answer only if there has been radioactive exposure)

___ Yes ___ No

Cleaning Certified By _____

Name Date

13.1.2 Cleaning Instructions

NOTE: Before they can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected. Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, microorganisms or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification have been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at YSI, the following steps must be taken to insure the safety of our service personnel.

1. In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. See Section 9.1for a list of authorized cleaning agents. Instruments used with wastewater may be disinfected with 0.5% Lysol if this is more convenient to the user. Autoclavable products may be autoclaved.
2. The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
3. If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
4. Any product being returned to the YSI Repair Center should be packed securely to prevent damage.
5. Cleaning must be completed and certified on any product before returning it to YSI.

13.2 YSI Factory Authorized Service Centers

United States

YSI Incorporated
Repair Center
1725 Brannum Lane
Yellow Springs, OH 45387
Phone: 937 767-7241
Fax: 937 767-9353

Rochelle Scientific
1966 Tice Valley Blvd., #430
Walnut Creek, CA 94595
Phone: 877 527-8494
Fax: 707 307-7130

RJM Sales
454 Park Avenue
Scotch Plains, NJ 07076
Phone: 800 752-9055
Fax 908 322-2160

Giangarlo Scientific
162 Steuben St.
Pittsburgh, PA 15220
Phone: 412 922-8850
Fax: 412 922-9047

Europe

YSI Life Sciences
Xylem
Longfield Road
Tunbridge Wells
Kent TN2 3EY
UK
Phone: 44 1892 500400
Fax: 44 1892 543115

Asia

Smartec Scientific Corp.
7F-6, No.12, Lane 609
Sec 5, Chung-Hsing Road
San Chung
Taipei
Taiwan
Phone: 886 2 2999-5767
Fax: 886 2 2999-5759

Canada

Mandel Scientific
2 Admiral Place
Guelph, ON U1G 4N4
Canada
Phone: 888-883-3636
Fax: 519-763-2005

14. Notices

14.1 Declaration of Conformity

YSI Incorporated
1725 Brannum Lane, Yellow Springs, OH 45387 Tel +1.937.767.7241 Fax +1.937.767.9353

a xylem brand

Declaration of Conformity

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	YSI Model 2900 Series Biochemistry Analyzer
Model Number(s):	YSI 2900D, YSI 2950D-x
Directives:	EMC Directive 2014/30/EU Low Voltage Directive 2014/35/EU Machinery Directive 2006/42/EC WEEE Directive 2012/19/EU RoHS Directive 2011/65/EU FCC 47 CFR Part 15-2011 Canada ICES-003:2004
Harmonized Standards:	EN 61326-1:2013 EN 61326-2-3:2013 EN 61000-3-2:2006+A1:2009+A2:2009 EN 61000-3-3:2013 EN 61010-1:2010 3rd Edition

YSI Incorporated declares that the instrument specified above conforms to the essential requirements of the Directives and Standards specified above when installed and operated in accordance with specifications as set forth by YSI. This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, third edition, or a later version of the same standard, incorporating the same level of testing requirements.

Gregory W. Popp

Gregory Popp
Quality Manager
937-767-7241
x230
gpopp@ysi.com

14.2 Radio and Television Interference Notice

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. 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:

- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- 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, DC 20402, Stock No. 0004-000-00345-4.

15. Appendix A – Software Flowchart

The software flow chart for the 2900 Series is shown below. The main screen has six icons that control all instrument functions (shown at the top of the flowchart).

16. Appendix B – Concentration Unit Conversion

In the 2900 Series Configure menu, you have the option to assign units of concentration. There are default values set based on calibration solutions offered by YSI. Below is a table of unit conversions for these calibration solutions and other concentrations of interest.

Chemistry	g/L	mg/L (ppm)	mg/dL	% (w/v)	mmol/L	mw (g/mole)
Choline	0.18	175	18	0.018	1.68	(104)
Glucose (Dextrose)	1.80	1800	180	0.18	10.00	(180)
Glucose (Dextrose)	2.50	2500	250	0.25	13.89	(180)
Ethanol	2.00	2000	200	0.20	43.48	(46)
Galactose[6]	2.50	2500	250	0.25	13.89	(180)
L-Glutamate	0.73	731	73	0.073	5.00	(146)
L-Glutamine	0.73	731	73	0.073	5.00	(146)
Glycerol	25.0	25000	2500	2.50	271.5	(92)
L-Lactate	0.45	450	45	0.045	5.00	(89)
Lactose	5.00	5000	500	0.50	14.62	(342)
Methanol	1.00	1000	100	0.10	31.25	(32)
Peroxide[6]	0.60	600	60	0.06	17.65	(34)
Sucrose	5.00	5000	500	0.50	14.62	(342)
Xylose	20.0	20000	2000	2.00	133.3	(150)
Ammonium	0.50	500	50	0.05	27.8	(18)
Potassium	1.00	1000	100	0.10	25.6	(39.1)

If you are using a standard of a value not listed in the preceding table, refer to the example conversions below to help calculate your unit of choice.

Example Conversions

Beginning with 2.50 g/L glucose, convert this to mg\L, then % and finally to mmol/L:

1. Multiply by unit conversion(s)
2. Cancel units common in “numerator” and “denominator”
3. Multiply numbers

? mg/L = 2.50 g/L
= (2.50 g/L)(1000 mg/g) = (2.50)(1000) mg/L = **2500 mg/L**

? % (w/v) = 2.50 g/L
= (2.50 g/L)(0.1 L/dL) = (2.50)(0.1) g/dL = 0.250 g/dL
= **0.250 %** (Note: g/dL is g/100ml or percent)

? mmol/L = 2.50 g/L
= (2.50 g/L)(1 mole/180 g)(1000 mmole/mole)
= (2.50)(1/180)(1000) mmole/L = **13.89 mmol/L**

[6] Denotes that YSI does not currently offer this standard value.

16.1 Linearity Test. Concentration Unit Conversion

Chemistry	g/L	mg/L (ppm)	mg/dL	% (w/v)	mmol/L	mw (g/mole)
	0.47	473	47	0.047	4.54	
Choline	0.45	450	45	0.045	4.32	(104)
	0.43	427	43	0.043	4.10	
	9.45	9,450	945	0.945	52.5	
Glucose (Dextrose)	9.00	9,000	900	0.900	50.0	(180)
	8.55	8,550	855	0.855	47.5	
	3.36	3,360	336	0.34	73.1	
Ethanol	3.20	3,200	320	0.32	69.6	(46)
	3.04	3,040	304	0.30	66.1	
	1.54	1,535	154	0.154	9.5	
L-Glutamate	1.46	1,462	146	0.146	10.0	(146)
	1.39	1,389	139	0.139	10.5	
	1.23	1,228	123	0.123	8.40	
L-Glutamine	1.17	1,169	117	0.117	8.00	(146)
	1.11	1,111	111	0.111	7.60	
	2.80	2,806	281	0.281	31.5	
L-Lactate	2.67	2,672	267	0.267	30.0	(89)
	2.54	2,539	254	0.254	28.5	
	26.25	26,250	2625	2.63	76.8	
Lactose	25.00	25,000	2500	2.50	73.1	(342)
	23.75	23,750	2375	2.38	69.4	
	42.0	42,000	4200	4.20	456.0	
Glycerol	40.0	40,000	4000	4.00	434.3	(92)
	38.0	38,000	3800	3.80	412.6	
	2.63	2625	263	0.263	82.0	
Methanol	2.50	2500	250	0.250	78.1	(32)
	2.38	2375	238	0.238	74.2	
	26.25	26,250	2625	2.63	76.8	
Sucrose	25.00	25,000	2500	2.50	73.1	(342)
	23.75	23,750	2375	2.38	69.4	
	33.00	33,000	3300	3.30	220.0	
Xylose	30.00	30,000	3000	3.00	200.0	(150)
	27.00	27,000	2700	2.70	180.0	
	0.095	95	9.5	0.0095	5.28	
Ammonium[7]	0.100	100	10.0	0.0100	5.56	(18)
	0.105	105	10.5	0.0105	5.83	
	0.190	190	19	0.0190	4.86	
Potassium[7]	0.200	200	20	0.0200	5.12	(39.1)
	0.210	210	21	0.0210	5.37	

NOTE: The linearity concentration ranges for each chemistry are shown (top to bottom) as upper limit, theoretical, and lower limit for each of five concentration units.

[7] Range for single linearity check. Refer to *8.2.15 Simultaneous Ammonium and Potassium* for sample to sample precision.

16.2 FCN Membrane Integrity Test. Concentration Unit Conversion

Chemistry	g/L	mg/L (ppm)	mg/dL	% (w/v)	mmol/L	mw (g/mole)
Choline	0.02	15	2	0.02	0.14	(104)
Glucose (Dextrose)	0.05	50	5	0.01	0.28	(180)
Ethanol	0.05	50	5	0.01	1.09	(46)
L-Glutamate	0.06	58	5.8	0.01	0.40	(146)
L-Glutamine	0.06	58	5.8	0.01	0.40	(146)
L-Lactate	0.03	30	3	0.01	0.34	(89)
Lactose	-	-	-	-	-	(342)
Galactose	-	-	-	-	-	(180)
Glycerol	-	-	-	-	-	(92)
Methanol	0.05	50	5	0.01	1.56	(32)
Sucrose	0.10	100	10	0.01	0.29	(342)
Xylose	0.05	50	5	0.01	0.33	(150)

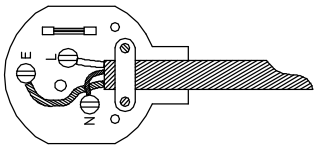
NOTE: Use the values from the preceding tables only when calibrating with the appropriate YSI calibrator solution Choline (2772), Glucose (2776 or 2747), Ethanol (2790), Sucrose (2780), L-Glutamate (2755), L-Glutamine (2736), Methanol (2726), Xylose (2767) and L-Lactate (2776).

17. Appendix C - Line Power Cord and Plug Wiring

Make sure that the cord and plug are appropriate for the power output you intend to use.

United Kingdom

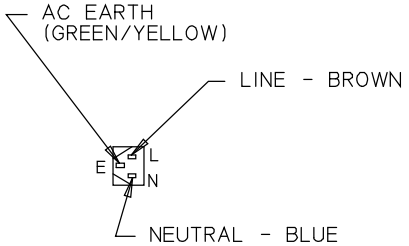
Make sure you use a plug to BS1363 and ASTA approval
Use Fuse 3A to BS1362 and ASTA approval



Green and yellow wire to E (Earth)

BROWN wire to BROWN or L (live)
BLUE wire to BLUE or N (neutral)

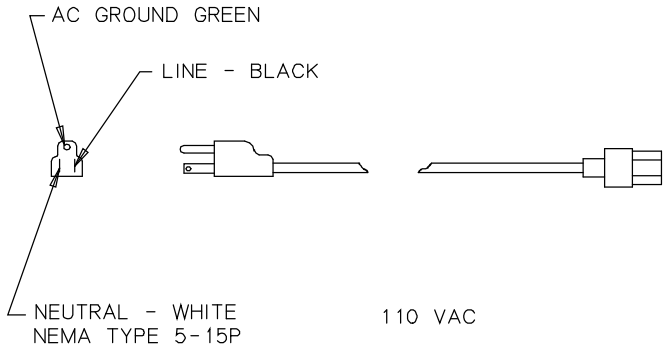
Before refitting the top cover of the plug or socket, make sure that the cable clamp is securely holding the outer sheath of the cable.



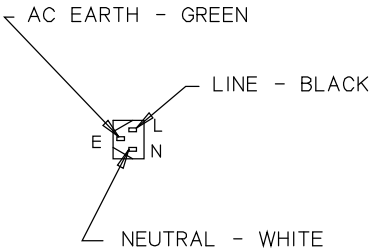
CEE TYPE 27
IEC TYPE 320

240 VAC

United States

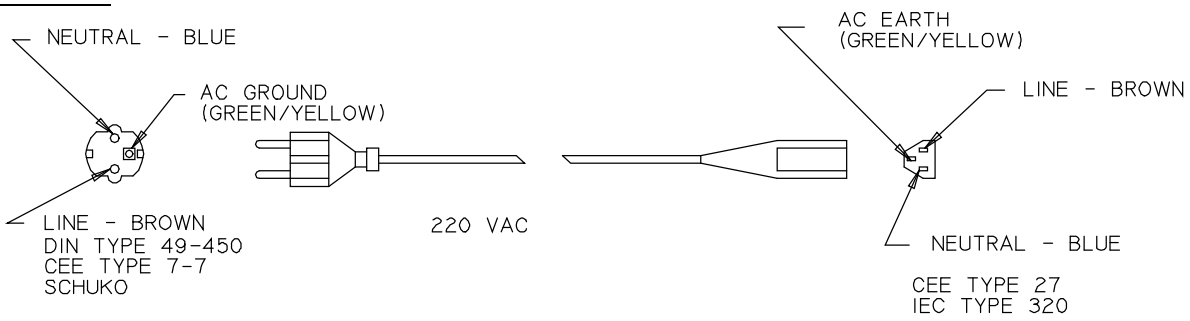


110 VAC



CEE TYPE 27
IEC TYPE 320

Europe



220 VAC

CEE TYPE 27
IEC TYPE 320

18. Appendix D - Reagents and Accessories

YSI Number	Description	Comments
1579	Carbonate Buffer	For use with Ethanol or Methanol membranes
2357	Buffer Kit (8 packs of Buffer Concentrate)	For use with Glucose, L-Lactate, Sucrose, L-Glutamate and L-Glutamine membranes.
2705	Lactose Buffer	For use with 2702 Galactose Oxidase Membranes and 7140 Glycerol Membranes
2970	Ammonium Buffer	For use with Ammonium/Potassium electrodes
2392	NaCl Solution	
2329	Lactate Membrane Kit	
2365	Glucose Membrane Kit	
2702	Galactose Oxidase Membrane Kit	For lactose or galactose
2703	Sucrose Membrane Kit	
2725	Methanol Membrane Kit	
2735	Glutamine Membrane Kit	
2754	Glutamate Membrane Kit	
2761	Xylose Membrane Kit	
2786	Ethanol Membrane Kit	
7140	Glycerol Membrane Kit	
2974	Ammonium ISE	
2975	Potassium ISE	
2976	Reference Electrode	
2736	Glutamine Standard (5.0 mmol/L)	Calibrator
2755	Glutamate Standard (5.0 mmol/L)	Calibrator
2767	Xylose Standard (20.0 g/L)	Calibrator
2780	Sucrose Standard (5.00 g/L)	Calibrator
2726	Methanol Standards Kit (1.00 g/L, 2.50 g/L)	Calibrator & Linearity Check
2790	Ethanol Standards Kit (2.00 g/L, 3.20 g/L)	Calibrator & Linearity Check
1531	Glucose Standard (9.0 g/L)	
2356	Glucose Standard (500 mg/dL)	
2368	Glucose Standard (25 mmol/L)	
1530	L-Lactate Standard (2.67 g/L)	
2747	Dual Standard (1.80 g/L Glucose, 0.45 g/L L-Lactate)	Calibrator

YSI Number	Description	Comments
2748	Dual Standard (18.0 g/L Glucose, 1.78 g/L L-Lactate)	
2776	Dual Standard (2.50 g/L Glucose, 0.50 g/L L-Lactate)	Calibrator
2777	Dual Standard (25.0 g/L Glucose, 2.50 g/L L-Lactate)	
2737	Glutamine Standard (8.0 mmol/L)	
2756	Glutamate Standard (10.0 mmol/L)	
2768	Xylose Standard (30.0 g/L)	
2778	Sucrose Standard (25.0 g/L)	
2971	Potassium Standard (1000 mg/L)	Calibrator
2972	Ammonium Standard (500 mg/L)	Calibrator
7141	Glycerol Standard (25.0 g/L)	Calibrator
7142	Glycerol Standard (40.0 g/L)	
2363	Potassium Ferrocyanide	Membrane integrity check
2751	Printer Paper	5 rolls
2901	Printer	Includes power supply and data cable
2920	OPC Data Manager Module	
2925	OPC Server Software	
2938	Bottle Rack, Single Module, Right Side	Includes bottles with caps and fluid detection cables
2935	Buffer Bottle, Opaque	For 2705 Buffer
2936	Bottle Rack, Two Modules, Left Side	Includes bottles with caps and fluid detection cables
2940	4-Channel Online Monitor System	
2941	R24 Capped Vial Tray	24 position
2942	P96 Flat Bottom 96 Well Plates	Case of 100
2943	P96 Round Bottom 96 Well Plates	Case of 100
2944	X-Pierce Films	
2945	R24 12mm Glass Vial Tray	
2947	R8 12mm Test Tube Rack	
2948	R4 16mm Test Tube Rack	
2960	Online Monitor & Control Accessory	
2980	8-Channel Online Monitor System	
2988	Preventive Maintenance Kit, 2900	Tubing, Sipper, and O-rings for 6 month maintenance
2990	Preventive Maintenance Kit, 2960	Tubing and O-rings for 6 month maintenance of 2960 Online Monitor

YSI Number	Description	Comments
2989	Preventive Maintenance Kit, 2950	Tubing, Sipper, and O-rings for 6 month maintenance

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1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

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