YSI *incorporated*

YSI 2730

Monitor and Control
Accessory

User's Manual

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1. Introduction

1.1 Product Description

The YSI 2730 Monitor and Control Accessory allows “on-line” monitoring and control of sterile systems over long periods of time without contamination using the 2700 SELECT. It also provides an alternative means of interfacing the YSI 2700 SELECT biochemistry analyzer with external measurement/control systems. The product consists of the monitor (purge) pump, solenoid valve assembly, external sample chamber, circuit board, new instrument EPROM firmware, interface cable and a users manual.

When installed on the YSI 2700 SELECT, the monitor pump may draw sample from a process stream, bioreactor or other suitable source and deliver sample to the external chamber of the instrument. Once delivered to the external chamber, the 2700 SELECT Sipper Tube rotates out to the chamber to aspirate a preprogrammed volume of sample. The 2700/2730 system can operate unattended for days or weeks, provided sufficient reagent supply is considered.

The Monitor Pump is a dual channel style pump, thus excess sample (waste) is actively pumped from the external sample chamber while fresh sample is being delivered. This strategy helps to minimize the dead volume in the chamber while controlling excess sample removal. 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 external sample chamber and deliver fresh sample. The flow rate of the pump and the purge time can be varied and is programmed via the 2700 software.

The Solenoid Valve assembly allows multiplexing between the sample stream and an antiseptic stream. This preserves sterility by filling the end of the sampling line with an antiseptic after every sample.

The analog output section of the product creates a voltage signal which is proportional to the concentration of the analyte. The YSI 2730 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 for each chemistry, in discrete steps, to accommodate 1, 2, 3, or 4 times the calibrator concentration. The YSI 2730 also provides three discrete signal outputs (TTL logic level) to control external pumps which can be used to replenish nutrients or optimize byproduct concentrations.

The installation of the YSI 2730 accessory precludes turntable (YSI 2710) operation. The YSI 2730 uses the Auxiliary output connector on the back of the YSI 2700 instrument.

1.2 Features

Monitor

- Prevents host contamination for at least six months when antiseptic system is properly used
- Retrofittable to all 2700’s with software version 2.41 or higher
- User programmable sample flow rate
- User programmable purge time
- User-selected anti-septic cycle
- Autoclavable pump and tubing
- Allows analysis of discrete samples without affecting monitoring

Analog/Control

- Dual selectable analog outputs
- PID control
- Normal or inverted TTL outputs
- Allows analysis of discrete samples without initiating regulation

1.3 Product Specifications

Monitor

Size:
External Chamber..... 0.75 x 0.75 x 0.88 inches
Pump Head..... 2.0 x 2.2 x 0.85 inches

Pump Motor..... 13.6 VDC, 2-40 rpm, 22 inch-ounce torque (power source is 2730 Board)

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)

Analog/Control

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

Full Scale Concentration..... User selectable via software as 1, 2, 3 or 4 x Calibrant Concentration.

Resolution..... 1:4096 or 0.02% FS,
2.44 mv on +10.00 VFS,
1.22 mv on +5.00 VFS

Maximum Offset..... ±4 LSB

Linearity..... ±1 LSB

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

Logic output drive..... 0 and 5 VDC nominal at 4 milliamps

Logic Input levels ..... < 0.8 VDC = logic 0,
> 3.5 VDC = logic 1

1.4 Digital Signals

Signal	Direction	Description
Ready	output	Active High, set immediately after analog outputs have been updated. This signal will reset itself immediately prior to updating the analog outputs if not reset externally via the Ack\ signal input.
Ack\	input	Active low, resets Ready output, minimum width >10ms.
SysErr	output	Active High, indicates 2700 not ready to sample.
Filtrate	output	external sample pump control.
BLK. Pump	output	feed/diluent pump control for Black Probe Chemistry.
WHT. Pump	output	feed/diluent pump control for White Probe Chemistry.

2. Installation

2.1 Unpacking

Remove the parts from the internal shipping container. Be careful not to discard any parts or supplies. Check off all items on the Packing List and inspect all assemblies and components for damage. In the event of damaged or missing parts, contact YSI Technical Support or your Dealer Representative immediately. Refer to APPENDIX B for phone, fax and address information.

2.2 Installation

The YSI 2730 Monitor and Control accessory requires a YSI 2700 SELECT biochemistry analyzer installed with software version 2.41 or higher for purposes of compatibility. To install the accessory a small flat-head screwdriver, a #2 Phillips screwdriver, needle-nose pliers and a 5/16″ or small adjustable wrench are needed. The steps are as follows:

1. Turn off instrument power using the switch on the rear of the 2700 case. Do not unplug the power cord.

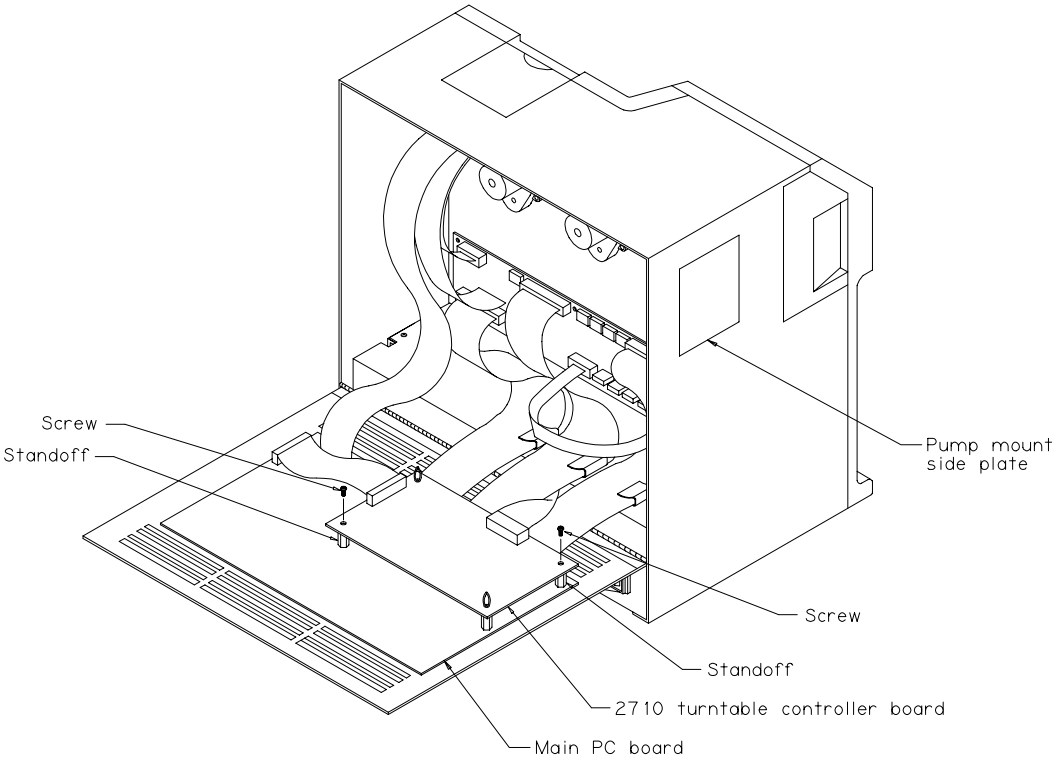


Figure 1 PC Board Installation

2. Remove the two screws on the upper rear of the instrument to allow the hinged back panel to open. Open the rear panel to expose the main printed circuit board and the smaller "piggyback" YSI 2710 turntable controller board as shown in Figure 1.
3. Discharge any static electricity from your body by touching the YSI 2700 chassis momentarily.

4. Remove the turntable controller board by disconnecting the two cables which plug into it. Disconnect the cables at the controller board itself, then remove the two mounting screws that hold the board to the standoffs (hold the standoffs with a wrench or pliers if necessary). Remove the board and place it aside for a moment.

5. Refer to Figure 2 to help you find the location of the 28 pin EPROM IC U11. Note the orientation of the IC, specifically the position of the "notch" at the bottom of the part near the battery holder.

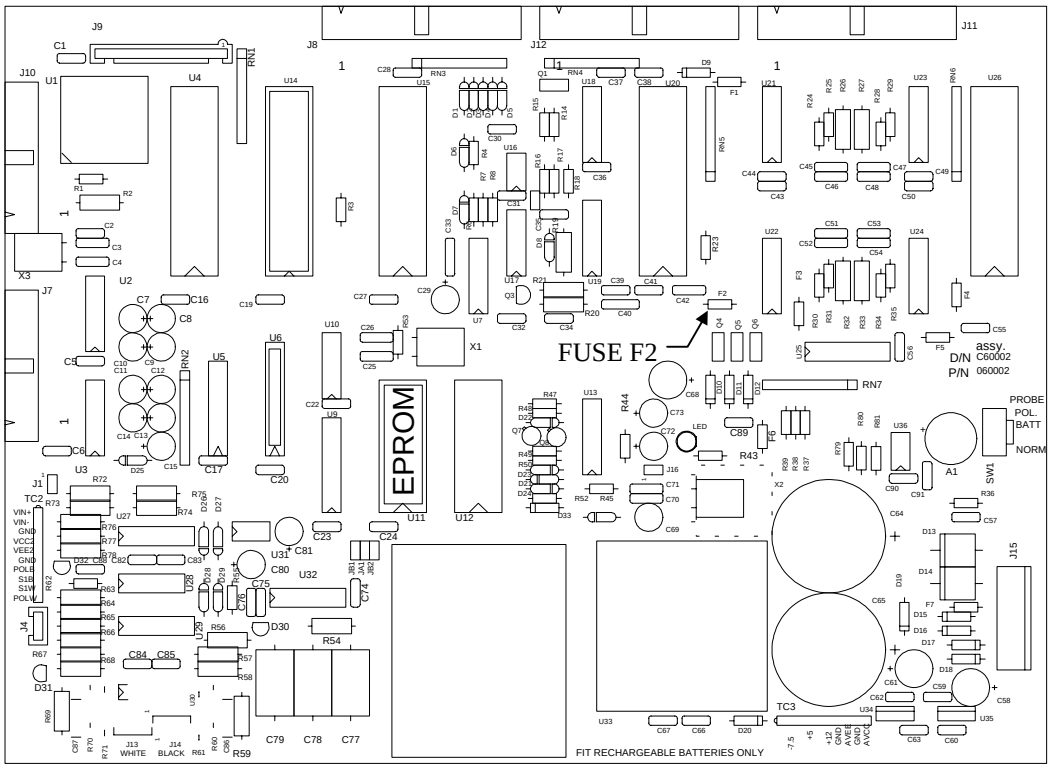


Figure 2 Eprom Installation

6. Discharge any static electricity again by touching the YSI 2700 chassis momentarily.

7. Remove the IC U11 from its socket using a small flat-head screw-driver or pocket knife. Make sure to place the screwdriver under the IC and not the socket before you start to pry it up. Avoid bending the pins. Best results are obtained by alternately prying one end of the IC and then the other.

8. Once the old EPROM has been removed, make sure that all the pins are straight on the new 2730 EPROM and install it in the U11 socket. Make sure that the orientation of the IC (the position of the notch) agrees with that of the part that was just removed. Once all the pins are aligned, gently press it into its socket.

9. Refer to Figure 2 to help you find the location of the fuse F2. This 1 amp fuse must be removed and replaced with the 2 amp fuse provided. Carefully remove the old 1 amp fuse by grasping the green body with your hand and pulling on each end until it comes out of the socket. Install the new 2 amp fuse by carefully pushing each end into the socket (a small amount at a time) with needle-nose pliers. See Figure 3.

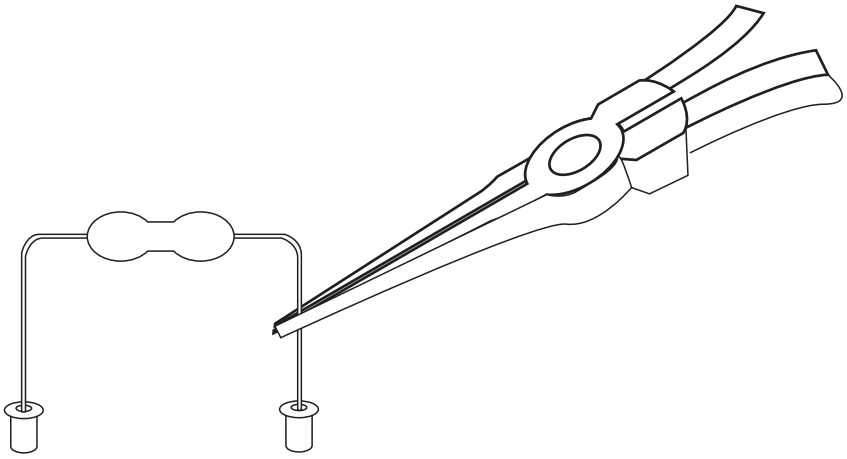


Figure 3 Fuse Installation

10. Next, discharge any static electricity again, then remove the new YSI 2730 printed circuit board from its anti-static bag. Install the circuit board where the 2710 turntable board was, as shown in Figure 1, using the two screws and washers removed earlier. Attach the two ribbon cables in their previous positions.
11. Using a small adjustable wrench (5/16", if available) loosen and remove the two locknuts securing the pump mount side plate from the inside of the instrument as shown in figure 1. Remove the side plate. Save the locknuts.
12. Install the Monitor Pump/Solenoid Valve Assembly from the inside by positioning the two studs through the Pump/Valve Mounting Plate. Be certain that the solenoid valve is above the pump. Refer to Figure 4. Reuse the two 5/16" locknuts that were removed above and secure the Pump/Valve Assembly.
13. Plug the Pump Motor lead (six conductor) into the socket marked J4 on the 2730 PC board. (The connector is keyed for proper installation.) Plug the Solenoid Valve lead (two conductor) into the socket marked J3. Route the leads in such a way as to avoid any interference when the back plate is rotated back into place.
14. Next swing open the front panel of the 2700 and remove the side access plate on the left side of the 2700 near the front of the instrument. This is the area through which the 2700 Sipper Tube will move to reach the External Sample Chamber. Again use a small adjustable wrench (5/16", if available) to loosen and remove the two locknuts securing the side access plate.

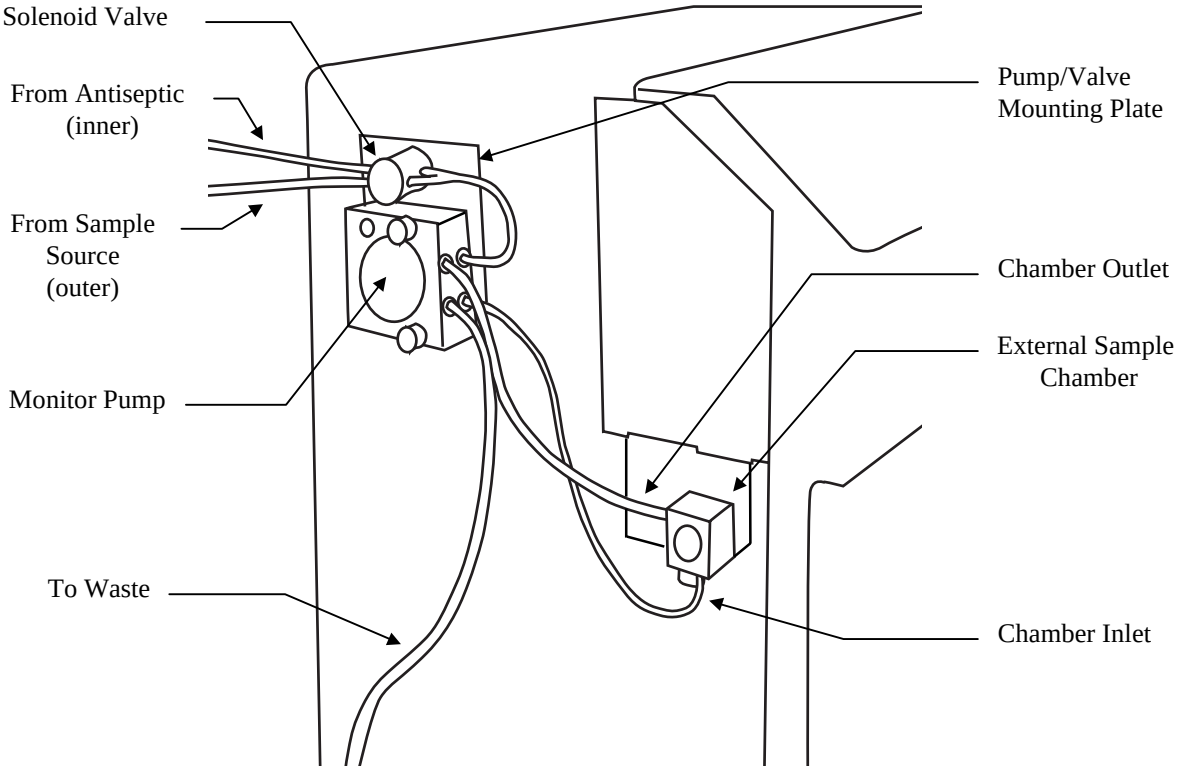


Figure 4 Pump Installation

15. Slip the External Sample Chamber assembly over the sheet metal edge of the 2700. Use one of the 5/16" locknuts with the flat washer provided to loosely hold the bracket/chamber assembly in position for now. See Figure 4 for orientation.

16. Connect the tubing as shown in Figure 4. The 2 inches of small tubing coming from the outside position of the solenoid valve goes to the sample source. The 2 inches of small tubing from the inside position of the solenoid valve goes to the antiseptic. Extend these with the silicone tubing provided to a length that suits your setup. The 6 inches of small tubing coming out of the pump head slips over the stainless steel chamber inlet. The 6 inches of large tubing coming from the pump slips over the barbed chamber outlet. The remaining 3 foot length of large tubing goes to a suitable waste container (not included).

17. Close the rear panel door and replace the two screws which hold it. Be careful not to snag any cables when closing the door.

18. Install the supplied label on the back of the instrument to indicate that it is equipped with the 2730 hardware. This is intended to prevent others from using the instrument with the turntable (doing so would damage the 2730 circuits).

19. Install the supplied tubing installation diagram on the side of the 2700 case as shown in Figure 5.

20. Repower the instrument. The printer should print a heading showing 2700 configuration (single or dual channel) and the new software version (2.81).

21. Next align the Sipper Tube with respect to the 2700 Sample Chamber as you would do in 2700 Setup. Very likely this has already been done on your unit.

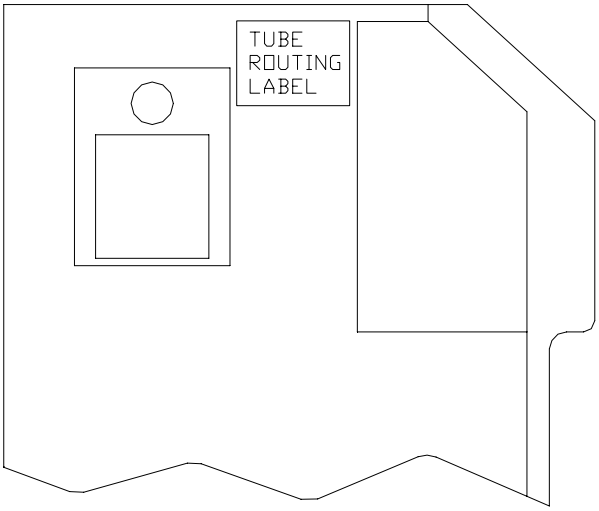


Figure 5 Tube Routing Label

22. Activating monitoring software. Refer to Software Flow Chart (Figure 9). Press the MENU key, then choose 2-Setup, then 3-RunMode, then 4-Monitor. Six selections are shown. Set the Monitor default parameters to those shown below, confirming each by pressing the ENTER key. You may change parameters later to fit your application.
    - Purge time change 0 to 40 seconds.
    - Station # change 1 to 5 (note #4 is for turntable position)
    - Interval change 0 to 30 minutes. This is time between samples.
    - Precal 0
    - Flow 2000
    - Antiseptic YES
23. Set up a waste container, a test sample solution (e.g., glucose standard), and a test antiseptic solution (e.g., reagent water). You may want to add some food dye to the test sample solution to better visualize what is happening.
24. Press the MENU key to return to the Main Menu. Again press the MENU key, then 1-Service, then 5-Monitor. This menu level allows you to align the Sipper Tube with the External Sampling Chamber and to prime the External Pump (Purge Pump).
25. Select 3-External Chamber to move the Sipper Tube to Station #5 (external chamber). Now adjust the Chamber Bracket forward or backward to align the Sipper, and the Thumb Screw to adjust the chamber side to side. Visually align the Sipper over the conical opening to the External Chamber.
26. Now test the alignment using the "Sipper down" command. Tighten the locknut on the inside of the 2700 and the thumb screw under the Chamber Bracket while the Sipper Tube is in the External Chamber. Use the up and down commands to retest. Press 0 to exit.
27. Select 1-Pump Sample to prime the inlet line. The test solution should move through the solenoid valve to the peristaltic pump, then on to the chamber inlet. Eventually segmented flow (air and fluid) will be observed in the waste line exiting the chamber toward the pump. The pump shuts off after 40 seconds, as programmed. You may shut off the pump at any time by pressing the [1] key.

28. Select 2-Pump Antiseptic to prime the antiseptic line. The test antiseptic solution should move through the solenoid valve to the peristaltic pump, then on to the chamber inlet. Segmented flow (air and fluid) will be observed in the waste line exiting the chamber toward the pump. The pump shuts off after 35 seconds. You may shut off the pump at any time by exiting the Service menu.
29. The Monitor and Control Accessory is now installed. Now configure the 2700 SELECT measurement and run mode parameters as required for your application. Refer to Section 2 Setup in your 2700 SELECT USER'S MANUAL.

Be sure to re-program all appropriate parameters before using the 2700.

3. Configuration

3.1 Monitor

All monitor parameters are configured through the 2700 software. See Section 5.2 SETUP to configure the monitor parameters.

3.2 Analog/Control

The factory default settings for the Analog Outputs are +5 VDC Full scale for both channels. The default configuration for the polarity of the Black, White and Filtrate Pump Control Outputs is normal (not inverted). See the following sections if you have special Analog/Control Output requirements.

3.2.1 Full Scale Voltage

The Digital-to-Analog Converters on the YSI 2730 circuit board may be individually configured to provide either +5 volts or +10 volts full scale. The JP1 jumper positions 3 through 6 control this parameter. Positions 3 and 4 affect the white channel output and positions 5 and 6 affect the black channel output. Figure 6 identifies the parameter controlled at each jumper position.

JP1 SETTINGS

JUMPER POSITION	EFFECT
1	AUX 10 = RAW 17 VOLTS
2	AUX 10 = REG 13.0 VOLTS
3	WHT DAC FULL SCALE = +5V
4	WHT DAC FULL SCALE = +10V
5	BLK DAC FULL SCALE = +5V
6	BLK DAC FULL SCALE = +10V

Figure 6 JP1 Settings

WARNING: Only one jumper per output should be installed! Installing two jumpers per channel could damage the circuit components.

3.2.2 Full Scale Concentration

The voltage output of the analog interface is scaled relative to the calibration concentration. The user can configure the analog output for each channel to represent 1, 2, 3, or 4 times the calibration concentration. These outputs are not configured on the PCB. This configuration option is provided via software in the setup menu. See Section 5.2.6 ANALOG/CONTROL to set this parameter.

3.2.3 Discrete Output Polarity

Three of the discrete control outputs can be configured to obtain either normal or inverted output. These three outputs are the Black channel pump control, the White channel pump control and the filtrate pump control output. Switch SW1 on the 2730 PCB contains four dip switches. Switches 1 through 3 control the outputs. Switch 4 is not used. Figure 7 depicts the relationship between the switch placement and the polarity of each output.

SW1 Settings for Output Polarity

Output	Switch	Closed	Open
Black	1	Inverted	Normal
Filtrate	2	Inverted	Normal
White	3	Inverted	Normal
Not Used	4	N/A	N/A

Figure 7 Output Polarity

4. Interfacing

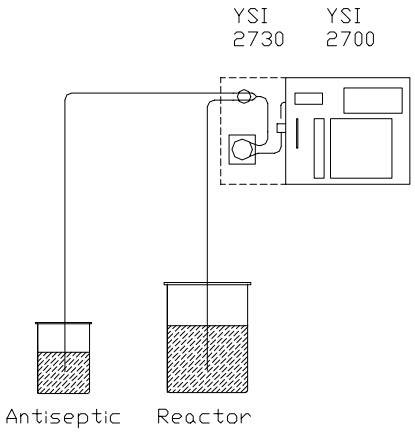
4.1 Sample Interface

Several methods exist for obtaining the sample for analysis on the YSI 2700. For discrete sampling the fixed stations (#2 and #3) may be adequate. In many process monitoring and/or control applications the sample must be transported (pumped) to the analyzer. When configured appropriately the 2700 SELECT 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 2700/2730 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 2730 Monitor and Control accessory.

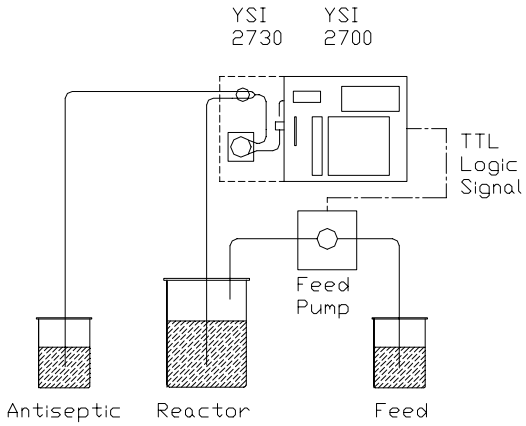
4.1.1 Filtrate Pump

The filtrate pump control output from the YSI 2730 is provided to control a user-supplied external pump for pumping the sample from its point of origin to the 2700. The timing of this signal is the same as the purge pump of the YSI 2730 accessory and is setup inside the "Monitor" part of the RunMode menu. This option is normally not used since the 2730 monitor pump can transport most samples to the external chamber. If an external filtrate pump is used, the flow rate must be maintained at or above 570µL/minute in order to guarantee that the sipper does not aspirate air during the sampling process.

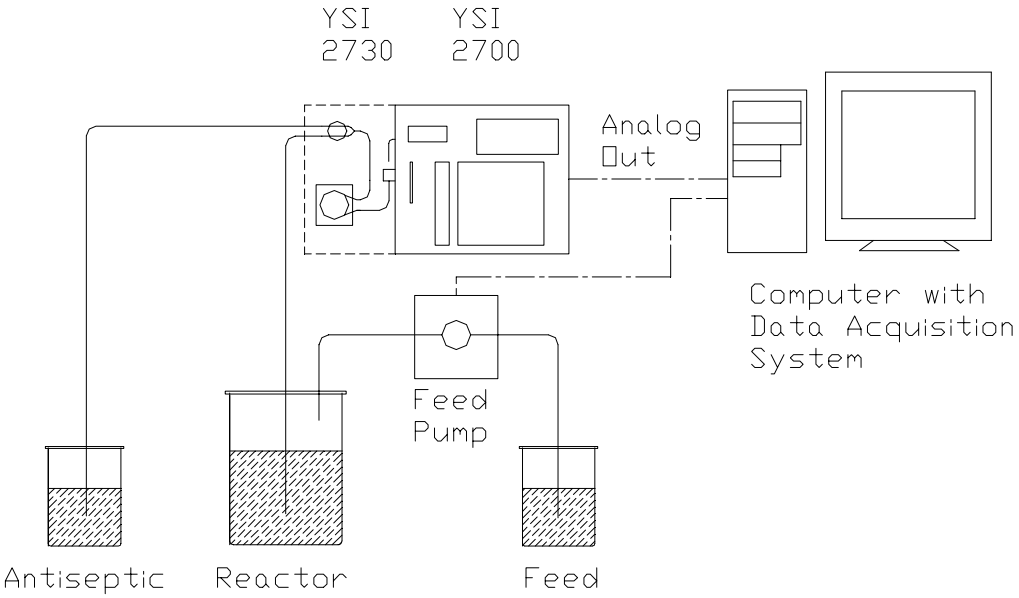
4.1.2 Examples



Monitor Only



Monitor with 2730 Control



Monitor with Computer Control

4.2 Electrical Interface

4.2.1 Analog Outputs

The YSI 2700 analyzer is capable of performing an analysis approximately every two minutes; it is therefore incapable of producing a truly continuous signal which represents the instantaneous analyte concentration. It is because of this "semi-continuous" nature of the instrument that the YSI 2730 interface provides additional signals to aid in synchronizing the reading of the analog outputs. In addition to the two analog outputs (one output per chemistry, black and white channels), two 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" signal is output from the YSI 2730 and is set to a logic 1 when the analog output signals have been updated. This signal indicates to the host system that the analog voltages are "new" and that they represent the most recent reading of the analyte concentrations. The host system (the external system to which the YSI 2730 is connected) then can send a logic 0 to the "ACK" input of the YSI 2730. This "ACK" (acknowledge) signal response from the host resets the READY line of the YSI 2730 to its low state before the next sample is ready. Figure 8 shows the typical signal pattern that would occur during two sample update cycles. The READY signal will reset itself immediately prior to updating the analog outputs if not reset externally via the ACK\ signal input.

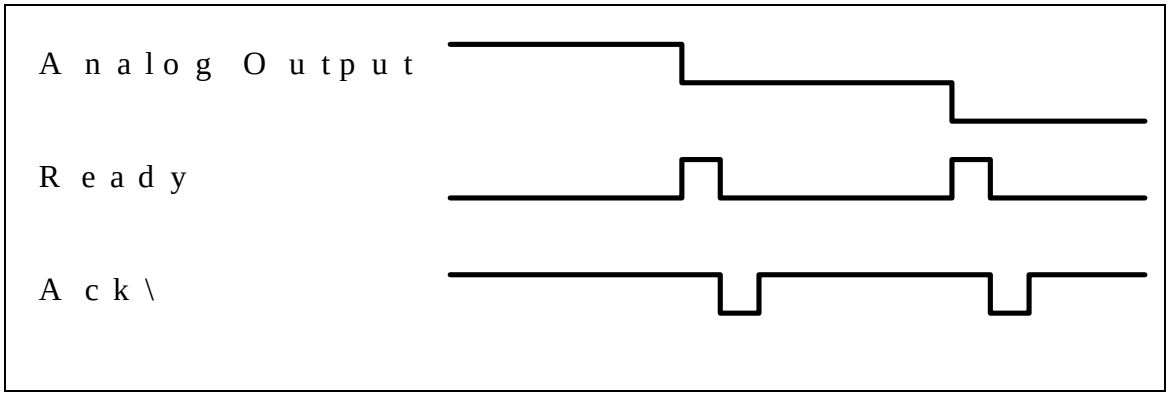


Figure 8 Handshake Signals

4.2.2 Pump Control Outputs

Three discrete outputs are provided on the YSI 2730 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 Black Channel Pump, White Channel Pump 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 determined by the position of switch SW1 on the 2730 PC board (See Section 3.2.3). Assuming no inversion enabled by the user, the output turns on the pump with a +5 voltage output, exclusive of any logic inversion imposed by the user supplied buffering circuitry.

4.2.3 Auxiliary Connector / Signal List

On the back of the YSI 2700 instrument is the 15 pin "D" type connector labeled "AUXILIARY" where the 2730 signals emanate. The following table relates the signals with the connector pin positions and cable wire colors.

2730 Signal	AUXILIARY pin#	Wire color
Ground	1	Black/White
Ground	2	Orange/Black
Ground	3	Blue/Black
Ground	4	Red/White
Ground	5	Black
+5 Volts	6	White
White Pump Control	7	Green/White
SysErr	8	Blue/White
White Analog Output	9	Green/Black
Black Analog Output	10	Green
Black Pump Control	11	Red/Black
Filtrate Pump Control	12	Red
Power Out	13	Blue
Ack\	14	White/Black
Ready	15	Orange
Chassis Ground	None	Shield

5. Basic Operation

IMPORTANT: The following instructions were written assuming a familiarity with the YSI 2700 SELECT Biochemistry Analyzer. If you ordered the 2700 and 2730 together and are setting up for the first time, you should refer to the 2700 SELECT USER'S MANUAL for instructions. Once you have successfully set up and operated the 2700 in the discrete sampling mode, you may proceed with the 2730 Monitor and Control Accessory installation and setup.

If you are familiar with YSI 2700 SELECT operation, you may proceed with the setup and operation instructions that follow.

5.1 Software

Features specific to the YSI 2730 have been added to the **Setup** and **Service** sections of the 2700 menu structure. Figure 9 shows the new structure with the 2730 features in bold lettering. The following section briefly describes the 2730 menu options.

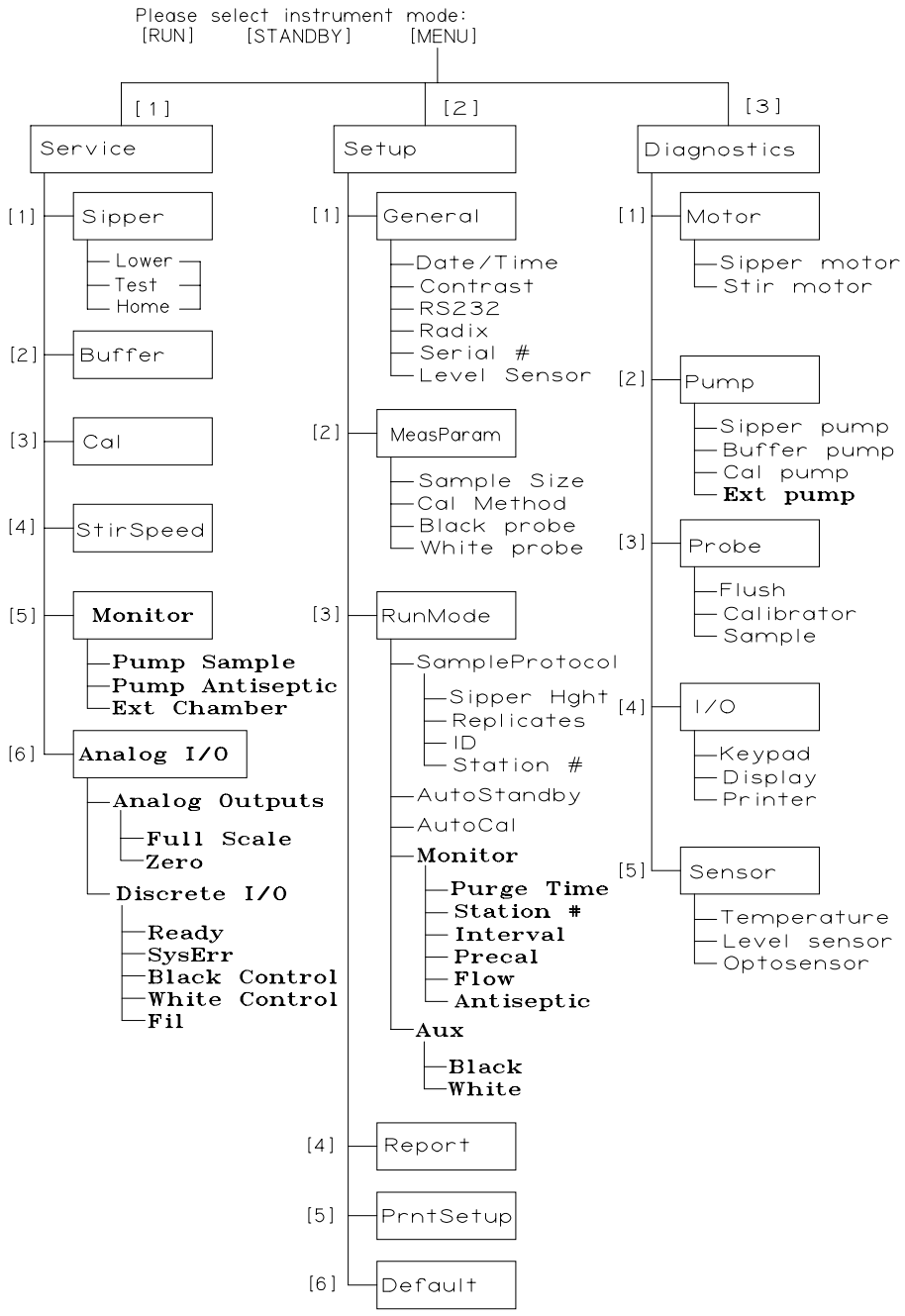


Figure 9 Software Flow Chart

5.2 Setup

5.2.1 Monitor

As described in Section 2, Installation, there are six menu selections under Monitor Setup that you must consider. Briefly, they are:

External Pump Purge Time.....Time in seconds required to deliver fresh sample from your source to the External Sampling Chamber

Station #.....Station number where the Sipper Tube will go for a monitor sample, usually station #5 the external sampling chamber

Interval.....Time in minutes between monitor samples

PreCal .....Time in minutes before the monitor sample when an autocalibration will be initiated

Flow.....The flow rate of the monitor pump in uL/min

Antiseptic.....Antiseptic cycle on or off

Flow Rate -vs- 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 external chamber 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 needle. Figure 10 shows the flow rates and minimum time needed to purge the tubing lines from the solenoid valve to the external sample chamber. 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.

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		

Figure 10 Minimum Purge Time

5.2.2 Antiseptic

The antiseptic solution may be defined by the user. Typical solutions might include 1% sodium hydroxide or 0.25% hypochlorite in reagent water.

5.2.3 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 2700. Refer to Section 8.1, Tubing Replacement, before installing the tubing in the solenoid valve. The antiseptic cycle must be enabled (see Section 5.2.1) and the antiseptic solution must be primed immediately after the tubing is reconnected (see Section 5.3.1).

The 2730 may be used for process monitoring and/or control applications without the use of an antiseptic. Refer to Section 5.2.1.

5.2.4 Make-Up Cycle

The make-up cycle occurs after the 2730 has pumped sample from the sample source for the user programmed amount of time and the sipper is ready to aspirate. At this point, the solenoid valve switches to the antiseptic position and the monitor pump flow rate changes from the user programmed rate to approximately 580µL per minute. This prevents the sipper from drawing all the sample out of the external chamber and aspirating air. If the antiseptic cycle is disabled by the user, the solenoid valve still switches to the antiseptic position and air or fluid is pumped through the antiseptic line during the make-up cycle. The antiseptic line must be kept free from obstructions even if the antiseptic cycle is not used. A dry 0.2 micron filter may be inserted upstream from the solenoid valve to prevent contamination in the air from entering the antiseptic line during the make-up cycle.

Warning: The antiseptic line must not be blocked off even if the antiseptic cycle is disabled.

5.2.5 Autocalibration

In addition to setting monitoring parameters, you may want to consider your calibration strategy. In default settings, autocalibrations are programmed to occur after every 5 samples or every 15 minutes, whichever occurs sooner. Autocalibrations are also initiated if the temperature drifts more than 1°C in the chamber housing the enzyme electrodes, or if the calibration current shifts by more than 2% from a previous calibration, or if one of several sample errors (e.g., unstable baseline) is detected. However, all of these parameters can be changed or disabled.

The Autocalibration Parameters are listed below. Refer to the YSI 2700 SELECT USER'S MANUAL, Section 5, Menu Selections for more detail.

- Temperature.....Degrees C drift between calibrations
- Time.....Time in minutes between autocalibrations
- Sample.....Number of samples performed between autocalibrations
- Cal Shift.....Precision as % compared to previous calibration
- Sample Error.....On/Off to detect errors related to system problems

When in the monitoring mode and when the 2700 is stabilized in terms of calibration drift, you will likely want to change some of these parameters to minimize interference of calibration with monitor sampling. For example, you may elect to disable autocalibrations related to time and number of samples, then use the PreCal option under Monitor Setup. Alternatively, you may elect to disable time and calibrate after some number of samples, or after some fixed time has elapsed. There is no "best configuration". It really depends on your particular application.

Generally, you will not want to change temperature drift, cal shift or sample error parameters, since these can be indicators of system problems. However, the flexibility to disable is there and may be exercised. If you are writing a software program to remotely command the 2700/2730 system (via the RS232 port), you may want to disable all autocalibration parameters and bring calibration frequency totally under your software program control.

5.2.6 Analog /Control

The control signals for the white and black channel pumps are configured from the "SETUP" menu via the "RunMode" option. Once in the RunMode, sub menu option 5, " Aux" (Auxiliary), will expose two choices, Black channel setup or White channel setup. The two channel setups are identical but specific to the channel involved (see the following). These parameters allow you to control pumps that will feed additional nutrients or diluent to a reactor in order to achieve a desired set point.

Black or White Channel Setup

The channel control setup menus prompt users for four pieces of information, the analyte set point, Time-Per-Unit error (TPU), the method of control (error direction) and the full scale concentration of each analog output. The first three parameters pertain to control while the forth pertains to the analog output for that channel. The following describes the setup considerations for each item.

1. Set Point

This parameter is the concentration at which the analyte will be regulated. It is assumed to be entered in the units ascribed to the analyte (e.g. g/L, mg/L, etc.).

Caution: Setting or changing this parameter while controlling will reset the integral portion of the PID algorithm and will therefore affect regulation. See Section 6.

2. Time-Per-Unit error (TPU)

This is a factor that is computed by the user and entered into the instrument to allow it to perform proportional control of the analyte in a quasi-static volume such as a fermentor or bioreactor. It reflects the amount of time that the correction pump must be engaged to correct for an error in concentration equal to the unit of measure (e.g. g/L, mg/L, etc.). In the case where analyte is added when the concentration falls below the set point the optimal feed stock concentration and the TPU factor are calculated according to the following formulae;

To calculate the minimum feed stock concentration use the following formula:

$$\mathbf{Cnc} = \frac{\mathbf{(SI * Mrc * Vol) / (.8 * SI)}}{\mathbf{Dlv}}$$

Where:

SI = 2700 Sampling Interval in minutes.

Mrc = Maximum rate of change of the analyte concentration in the analyte's unit of measure per minute per liter of volume (e.g. g/min/L).

Vol (Average controlled volume of reactor in Liters) = $\frac{\text{(largest volume + smallest volume)}}{2}$

Dlv = feed pump rate of delivery in liters/min.

NOTE: Cnc = correction feed stock concentration in the analyte's unit of measure.

To calculate TPU use the following formula:

TPU = (1 / Cpdlv) * Vol

Where:

Cpdlv = Correction pump delivery rate in the analyte's unit of measure per second (e.g. mg/second, g/second, etc).

Vol (Average controlled volume of reactor in Liters) = $\frac{\text{(largest volume + smallest volume)}}{2}$

NOTE: Time-Per-Unit error in seconds per unit of measure liter (e.g. 50 seconds/gram liter).

Example:

You are trying to regulate a 5.0 Liter bioreactor at 1.00 g/L glucose concentration. The actual volume of broth in the reactor is maintained at 3.5 Liters. You know from previous fermentations of that the maximum consumption rate of glucose is approximately 28.5 g/L/hr. The feed pump delivery rate is 0.1 L/min. The 2700 sampling interval is 5 minutes.

The lowest acceptable concentration of glucose feedstock (**Cnc**) is calculated as follows:

Sampling Interval = **SI** = 5 minutes
Maximum rate of change = **Mrc** = 28.5 g/L/hr = 0.475 g/L/min.
Reaction Volume = **Vol** = 3.5 Liters
Feed pump delivery rate = **Dlv** = 0.1 L/min.
Minimum Glucose feedstock concentration = (**Cnc**)

$$\mathbf{Cnc} = \frac{\mathbf{(SI * Mrc * Vol) / (.8 * SI)}}{\mathbf{Dlv}}$$

$$\mathbf{Cnc} = \frac{(5 * 0.475 * 3.5) / (0.8 * 5)}{0.1}$$

$$\mathbf{Cnc} = \frac{8.3125 / 4.0}{0.1} = 20.78 \text{ g/L glucose}$$

The Time-Per-Unit error (**TPU**) for this setup is calculated as follows:

Pump rate (in seconds) = (0.1 L/min.) / (60 sec/min.) = 0.00166 L/sec.
Feed Delivery Rate = **Cpdlv** = 20.78 g/L * 0.00166 L/sec = 0.035 g/sec.

TPU = (1 / Cpdlv) * Vol

TPU = (1 / 0.035) * 3.5

TPU = 101

The TPU parameter has another important function in the 2730 software**. PID regulation is enabled whenever this parameter is not zero (**See Section 6). No pump control output will occur if this parameter is set to zero.

3. Error Direction

This parameter is set to either "under" or "over". Selecting "under" means that the user wishes to regulate to the set point in an environment where the analyte is <u>being consumed</u> and as such tends to fall <u>under</u> 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. Selecting the "over" error direction assumes that the correction applied by the controller will have the effect of diluting or removing analyte to perform regulation.

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

4. Analog Output

The voltage output of the analog interface is scaled relative to the calibration concentration. The user can configure the analog output for each channel to represent 1, 2, 3, or 4 times the calibration concentration.

The output for each chemistry will track sample concentration as long as any chemistry other than "None" has been selected from the measurement parameters menu. A channel that has been configured as "None" will remain at 0 volts at the analog output. The analog outputs will change with the sample result for each channel, black or white, regardless from which station the sample was obtained.

A discrete sample performed at a sample station different than the monitor station <u>will</u> <u>not</u> affect the analog output.

5.3 Service

5.3.1 Monitor

From the Service Menu option 5, "Monitor", if selected will present three options; 1-Pump Sample, 2-Pump Antiseptic and 3-External Chamber.

Pump Sample

Selecting this option allows the user to prime the sample line.

Pump Antiseptic

This option is used to prime the antiseptic solution.

External Chamber

This option is used to align the external chamber with the sipper needle. When this option is selected, the sipper will swing out of the 2700 and stop above the external sample chamber. Option 2-Down will allow the sipper needle to be lowered to test external chamber alignment.

5.3.2 Analog /Control

From the Service Menu option 6. "Analog I/O" if selected will present two options; 1-Analog outputs and 2-Discrete I/O.

Analog Outputs

Selecting this option will allow the user to drive both DAC outputs to full scale (+5 or +10 volts) or to zero volts with a key press.

Discrete I/O

This option allows the user to toggle the state of each logic output between 0 and +5 volts.

6. PID Control

The control algorithm incorporated into the 2730 software is a variant of the Proportional-Integral-Derivative (PID) algorithm used in many process controllers today. 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. The 2730 control algorithm is no exception. 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.

6.1.1 Assumptions

1. Regulation is begun (enabled) when the analyte concentration is within ±10% of the set point.
2. The sampling interval is <u>regular</u>. 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.

A discrete sample performed at a sample station different than the monitor station <u>will</u> <u>not</u> initiate regulation or affect analog output.

7. Printed Setup Information

The following is an example of the Printed Setup Information. See APPENDIX C in the 2700 SELECT USER'S MANUAL for details on how to get a printout of your setup. The bold type highlights the Monitor and Analog/Control sections. In the Monitor Section the 2700 is set up to monitor from station #5 (the external chamber) every 3 minutes. The purge time for the pump is 40 seconds, the flow rate is 2000 uL/Minute and no calibration is performed before (precal) the sample. In the Analog/Control Section the full scale analog voltage of the black and white channels is reached when the sample concentration measured is 1 times the calibrator value (2.50 g/L in this case). The TPU (Time-Per-Unit-Error) for the black pump control is 10 seconds per unit of measure (per g/L in this case). The white TPU is 0 (disabled). The black control set point is 1.00 g/L and the white control set point is 0.

INSTRUMENT SETUP

Sample Size 25 uL
SamStation #: 2
CalMethod: One station
BLACK PROBE
Chemistry : Dextrose
Unit: g/L
Calibrator: 2.50
Endpoint: 30 Sec
CalStation#: 1
WHITE PROBE
Chemistry : Dextrose
Unit: g/L
Calibrator: 2.50
Endpoint: 30 Sec
CalStation: 1
AUTOCAL
SampleError: ON
Temperature: 1°C
Time: 15 Min
Sample : 5 Sam
Cal Shift : 2 %
RUN MODE
Replicates : OFF
Sample ID : OFF
Sip Height : Medium
Autostandby: 2 Hr
MONITOR
MonStation#: 5
SamInterval: 3 Min
Precal : 0 Min
Purge time : 40 Sec
Flow Rate : 2000 uL/Min
Antiseptic : ON

ANALOG/CONTROL
Black FS : 1 X CAL
TPU : 10 Sec
Set : 1.00
White FS : 1 X CAL
TPU : 0 Sec
Set : 0
RS-232
Baud rate : 9600
Data : Seven bit
Stop : One bit
Parity : Even
Handshake : RTS/CTS
XON char : 17
XOFF char : 19
Mode : Non-multidrop
Address: 38
GENERAL
Radix mark : "."
Level sensor: OFF
Cal Report : Brief
SampleReport : Brief
DateFormat : MM/DD/YY
Software revision: 2.83
YSI 2700D
Wed 08/09/98 11:54:26
---

8. Service

8.1 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 6 months for all other tubings, including the PharMed® pump tubing, solenoid valve tubing, antiseptic tubing and sample source tubing. The 2731 Preventive Maintenance Kit provides a complete set of tubings for the YSI 2730 Monitor and Control Accessory.

If you elect to clean tubings, solutions such as 70% isopropanol, 0.5% hypochlorite, and mild detergents in water are acceptable cleaning agents. Be certain you flush well with water before putting the 2730 Monitor and Control system back into use.

8.1.1 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 top as you face the mounted pump body. The sample lines and sample pump tubings are nearer the 2700 SELECT case wall. The waste line is closest to you. The pump waste tubing contains a retainer (plastic washer) on the inlet (top) side of the pump. The sample pump tubing contains a retainer (plastic washer) and a plastic tab attached on the inlet (top) side. Refer to Figure 3 for diagrammatic details.

To change pump tubings, remove the two thumb screws securing the pump assembly to the pump motor sideplate. 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 protruding through the 2700 SELECT case wall. Be certain to orient the "slot end" correctly on reassembly.

Remove the old tubing, removing tubing retainers as required. The 2731 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 tubing as shown in Figure 11, Installing Pump Tubing. 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 6 inches (15 cm) on the inlet side.

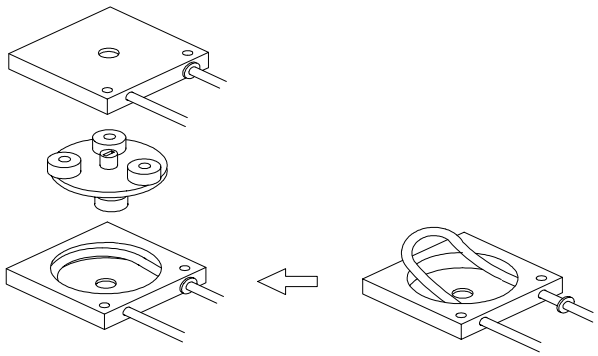


Figure 11 Installing Pump Tubing

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 top 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 2700 sideplate using the two thumb screws.

Reconnect the tubing as shown in Figure 3. Repower the instrument, if necessary. Enter Service mode and 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 tubings.

8.1.2 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 instrument 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. Next, disconnect each tubing from the Y-shaped fitting and the inline couplings.

To install the solenoid valve tubing, refer to Figure 4 and 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 2700 main menu press [MENU], 3-DIAGNOSTIC, 2-PUMP then 4-EXTERNAL PUMP. This will energize the solenoid and engage the pump.

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. Press 4-EXTERNAL PUMP to stop the pump and 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.

8.2 External Chamber

There are two approaches to cleaning the external sample chamber.

- You may use the monitor pump to draw cleaning solution through the system. Reagents such as 70% isopropanol, 0.5% hypochlorite, and a detergent in warm water are all acceptable cleaning agents. To clean the "cone" near the tip of the chamber, 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 chamber. Gravity alone will not insure draining of the chamber.

- Alternatively, you may disassemble the chamber and clean parts individually. Refer to Figure 15 for an exploded view of the chamber assembly. There are relatively few parts and no tools are needed.

Note: Do not attempt to remove the stainless steel inlet tube. Remember to realign the chamber (described in Section 2, Installation) before initiating another monitor run.

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

8.3 Troubleshooting

This section provides a simple, but systematic, approach to establishing the cause of the most common monitor station malfunctions. Symptoms related to 2730 Monitor and Control Accessory are somewhat limited. Most problems will be related to monitor pump function and/or tubing obstructions.

Refer to Section 8 (Troubleshooting) in the 2700 SELECT USER'S MANUAL as an extension of this troubleshooting section.

Before taking corrective action related to any problem, be certain to collect as much pertinent data as possible. Try to make use of the 2730 service and diagnostic routines to test potential problem areas.

If you cannot resolve a problem, contact YSI Technical Support for help (See APPENDIX B). When you communicate with service personnel, please indicate the serial number of the 2700 SELECT and the serial number of the 2730 Monitor and Control Accessory. Also indicate software revision number, if known. If you are writing or transmitting a FAX, include a thorough description of the problem. Include printouts in the "detail" report format, if possible.

SYMPTOM

The 2700 SELECT Sipper Tube misses the External Chamber.

POSSIBLE CAUSES: (1) The 2700 SELECT Sipper Tube has become misaligned, possibly through a physical disturbance or (2) the Station # is assigned to some number other than "5".

CORRECTIVE ACTIONS: (1) Realign the Sipper Tube. Refer to the 2700 SELECT USER'S MANUAL for instructions. (2) Recheck for the appropriate assignment of the Monitor Station (Section 5.2.1).

SYMPTOM

The 2700 SELECT does not appear to recognize the Monitor Station.

POSSIBLE CAUSE: The 2730 Monitor Pump has not been assigned a purge time.

CORRECTIVE ACTION: Access the 2700 SELECT setup menu and assign a nonzero value to External Pump Purge Time (Section 5.2.1).

SYMPTOM

The 2730 Monitor (Purge) Pump is running, but no sample flowing.

POSSIBLE CAUSE: There is an obstruction in the sample tubing or external chamber.

CORRECTIVE ACTION: Remove the sample tube connected to the chamber inlet port while the pump is running. If fluid flows, the obstruction is in the chamber 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 2730 External Chamber when the Monitor Pump runs.

POSSIBLE CAUSE: The 2730 Monitor Pump tubing is not configured properly and fluid in the waste line is trying to flow backwards.

CORRECTIVE ACTION: Check Section 8.1 and correct tubing configuration.

SYMPTOM

Monitor Station results appear to be lower than expected and excess air is observed in the 2700 SELECT sample chamber.

POSSIBLE CAUSE: The 2700 Sipper Tube is not properly aligned in the vertical plane, i.e., not moving down far enough into external chamber. Some sample, then air is being aspirated.

CORRECTIVE ACTION: Realign the 2700 Sipper Tube so that the end of the tube appears to extend past the temperature probe, as viewed through the front of the clear 2700 Sample Chamber. Refer to the 2700 SELECT USER'S MANUAL for Sipper Tube Alignment.

SYMPTOM

Fluid leaking; appears to be coming from the Monitor Pump.

POSSIBLE CAUSE: Either the coupling between the sample line and sample pump tubing is leaking or a pump tubing has failed.

CORRECTIVE ACTION: Locate the leak. If inside the pump, refer to Section 8.1 to replace pump tubing.

SYMPTOM

Sipper aspirates antiseptic instead of sample (sample results read approximately zero).

POSSIBLE CAUSE: Tubing routed incorrectly in solenoid valve.

CORRECTIVE ACTION: Check tubing routing per Section 8.1.2.
NOTE: Replace membrane if damaged by antiseptic.

FOR PROBLEMS NOT IDENTIFIED IN THE ABOVE CHART CONTACT YSI TECHNICAL SUPPORT FOR ASSISTANCE. REFER TO APPENDIX B FOR PHONE, FAX AND ADDRESS INFORMATION.

8.4 Schematic Diagram

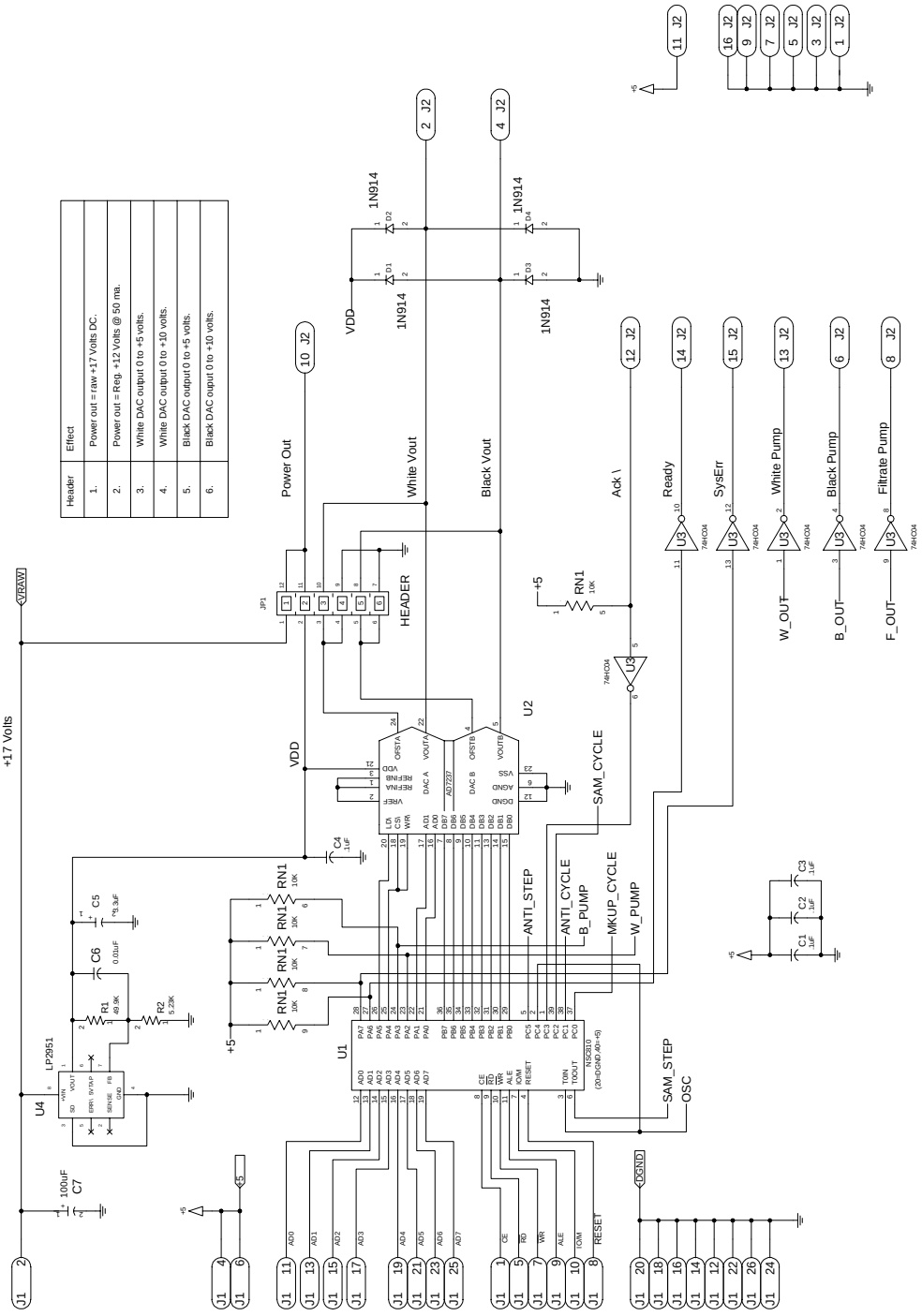


Figure 12 Schematic 1

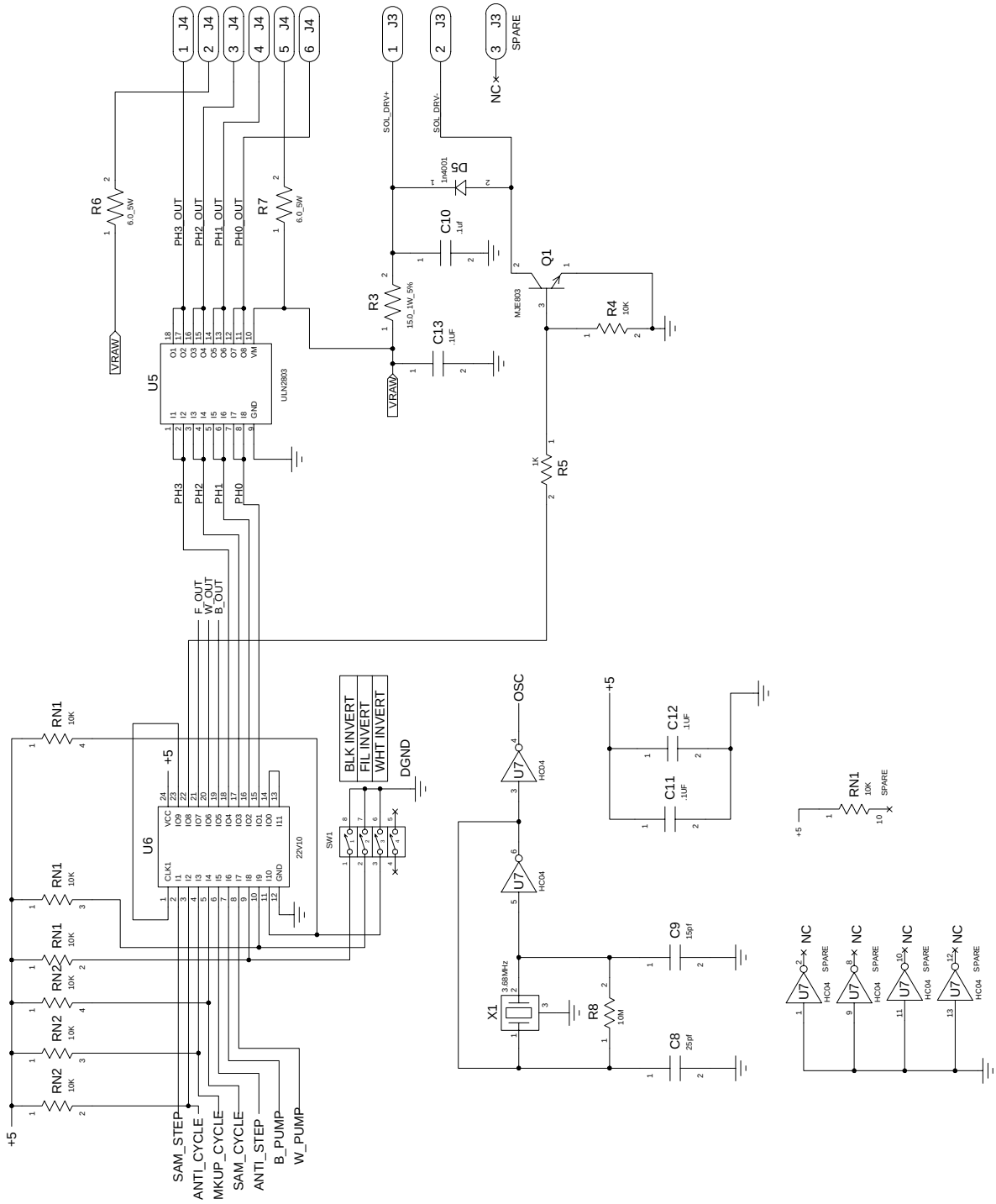


Figure 13 Schematic 2

8.5 Parts List

REF #	PART NO.	DESCRIPTION
N/A	2731	Preventive Maintenance Kit
N/A	110430	PC board assembly
N/A	062428	Fuse, PCB, 2 Amp, 125V, fast act.
N/A	027709	Cable, interface

8.5.1 Monitor Pump/Solenoid Assembly

Refer to reference numbers in the diagram on the following page (Figure 14).

REF #	PART NO.	DESCRIPTION
1	110432	Pump assy, Ultem
2	110434	Solenoid/Pinch valve assy. w/bracket, tubing
3	027414	Mounting plate
4	USE 2731	*Tubing, solenoid, 1/32″
5	110433	Motor assy.
6	USE 2731	*Tubing, PharMed®, .035″ ID
7	USE 2731	*Tubing, waste, silicone, .156″ OD (4’)
8	USE 2731	*Fitting, Y, Kynar, 1/16″ ID (1)
9	USE 2731	*Fitting, straight, Kynar, 1/16″ ID (3)
10	002550	*Washer, Nylon, .141″x .312″x .031″ (2)
11	001710	Screw, Mach., 6-32 x .375″ (2)
12	002680	Washer, lock, #8, .328 x .020″ (4)
13	001740	Screw, Mach., 6-32 x .375″ (4)
14	027420	Thumbscrew (2)
15	USE 2731	*O-ring, .301″ x .070″ (2)
N/A	110439	*Tubing, silicone (.020″ ID x 25′) not shown
N/A	027423	Clamp, tubing (2) not shown

*** Included in 2731 Preventive Maintenance Kit.**

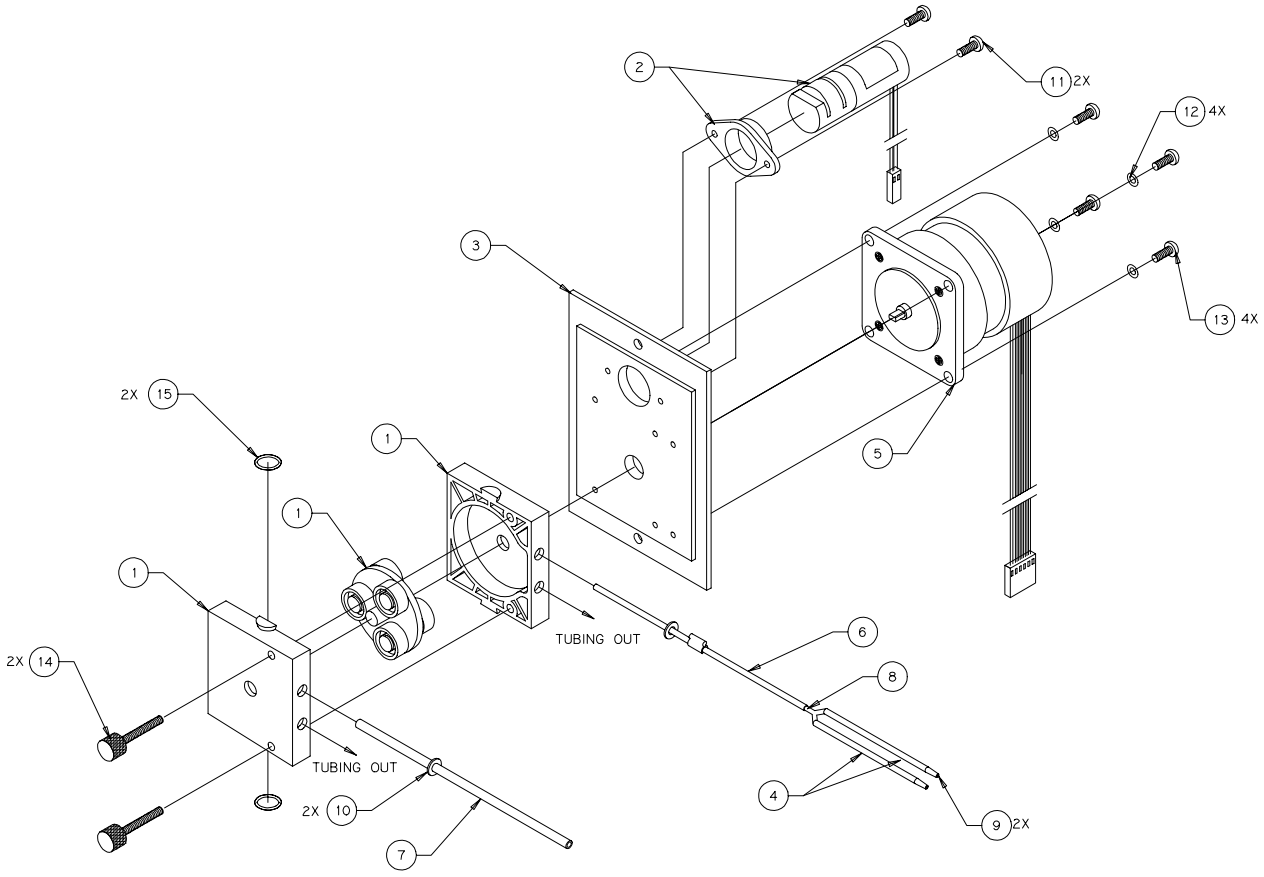


Figure 14 Monitor Pump/Solenoid Assembly

8.5.2 External Chamber Assembly

REF #	PART NO.	DESCRIPTION
1	023013	Chamber Bracket
2	023024	Compression Spring
3	110440	Chamber
4	001008	Thumb Screw
5	061994	Thumb Nut
6	061700	Outlet Fitting, 10-32, 3/32″ hose
7	069818	Flat Washer, #6, .550″ x .031″

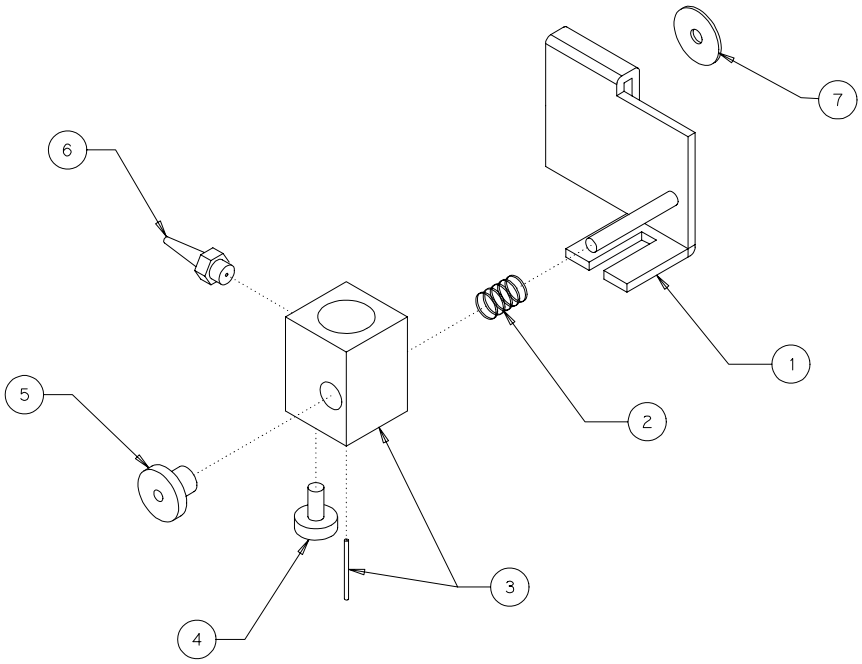


Figure 15 External Chamber Assembly

9. Appendix A - Required Notice

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

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

- 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, D.C. 20402, Stock No.0004-000-00345-4.

10. Appendix B - Warranty and Shipping Information

The YSI Model 2700 Analyzer is 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.

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.

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.

YSI Factory Service Centers

United States

YSI Incorporated • Repair Center • 1725 Brannum Lane • Yellow Springs, OH • 45387 • USA
Phone: 937 767-7241 • Fax: 937 767-9353

Europe

YSI LTD • Lynchford House • Lynchford Lane • Farnborough, Hampshire • GU14 GLT • England
Phone: 441 252 514711 • Fax: 441 252 511855

YSI Authorized Service Centers

California

Fisher Scientific ISD • 2822 Walnut Avenue, Suite E • Tustin, CA • 92681 • Phone: 800 395-5442

Georgia

Fisher Scientific ISD • 2775 Horizon Ridge Court • Suwanee, GA • 30174 • Phone: 800 395-5442

Illinois

Fisher • 1600 West Gleenlake Avenue • Itasca, Ill • 60143 • Phone: 800 395-5442

New Jersey

Fisher Scientific ISD • 52 Fadem Road • Springfield, NJ • 07081 • Phone: 800 395-5442

Pennsylvania

Fisher Scientific ISD • 585 Alpa Drive • Pittsburgh, PA • 15238 • Phone: 800 395-5442

10.1 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, or with waste water. 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 has 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. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1 gallon tap water are suitable for most disinfecting. Instruments used with waste water may be disinfected with .5% Lysol if this is more convenient to the user.
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.

10.2 Packing 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

YSI *incorporated*

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