SERVICE MANUAL

SmartLyte®

Electrolyte Analyzer

Na^+ / K^+ / Cl^- / Ca^{++} / Li^+

DIAMOND

Smart Lab Solutions

SMARTLYTE ELECTROLYTE ANALYZER is a Registered Trademark of Diamond Diagnostics Inc.

The Diamond Diagnostics SMARTLYTE analyzer is for In Vitro Diagnostic use.

Diamond Diagnostics Inc
333 Fiske Street
Holliston, MA 01746

CE

Diamond Diagnostics Kft
Óradna Street 6
1044 Budapest Hungary

The information in this manual was correct at the time of printing. However, Diamond Diagnostics Inc continues to improve products and reserves the right to change the specifications, equipment, and maintenance procedures at any time without notice.

If the system is used in a manner differently than specified by Diamond Diagnostics Inc., the protection provided by the equipment may be impaired. See warning and hazard statements.

Important Information!

This Service Manual contains important warnings and safety information to be observed by the user.

This instrument is only intended for one area of application which is described in the instructions. The most important prerequisites for application, operation and safety, are explained to ensure smooth operation. No warranty or liability claims will be covered if the instrument is applied in areas other than those described or if the necessary prerequisites and safety measures are not observed.

The instrument is only to be operated by qualified personnel capable of serving these prerequisites.

Only accessories and supplies either delivered by or approved by DIAMOND are to be used with the instrument.

Due to the operating principle of the instrument, analytical accuracy not only depends on correct operation and function, but also upon a variety of external influences beyond the manufacturer's control. Therefore, the check results from this instrument must be carefully examined by an expert, before further measures are taken based on the analytical results.

Instrument adjustment and maintenance with removed covers and connected power mains are only to be performed by a qualified technician who is aware of the dangers involved.

Instrument repairs are only to be performed by the manufacturer or qualified service personnel.

For a detailed service training video for your SmartLyte Analyzer, please visit:
http://www.diamonddiagnostics.com/video/video_SmartLyte.htm

Symbol	Explanation
	Attention symbol - Refer to the Operator's Manual or Service Manual for further instructions. This symbol is located on the inside of the instrument.
	Type B instrument symbol - An instrument of the B type falls under safety categories I, II, or III, or has an internal power supply providing the required insulation against discharge current and reliable ground connections.

Important Information!

Operating Safety Information

- This instrument falls under Safety Category I.
- This instrument is a Class B instrument.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference's, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been checked and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does not cause harmful 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 or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio TV technician for help

Caution:

- The instrument is designed as a conventional device (closed, not waterproof type).
- Do not operate the instrument in an explosive environment or in the vicinity of explosive anesthetic mixtures containing oxygen or nitrous oxide.
- This instrument is suitable for continuous operation.
- The power plug is to be plugged into a ground socket only. When using an extension cord, make sure that it is of the proper size and is properly grounded.
- Any breakage of the ground lead inside or outside the instrument or a loose ground connection can cause a hazardous condition when operating the instrument. Intentional disconnection of the grounding is not permitted.
- When replacing the fuses, make sure that they are of the same type and rating as the original fuses. Never use repaired fuses or short-circuit the fuse holders.

Operating Safety Information

1. Introduction

The Service Manual for the SMARTLYTE Electrolyte Analyzer contains the technical information needed to ensure easy fault identification. This manual is intended to be complementary to the Operator's Manual where detailed instructions for operation, maintenance and troubleshooting are provided.

As for all clinical instrumentation, a thorough understanding of the principles of operation is prerequisite to attempting service of this product. Training along with experience will enhance the use of this manual.

Service and repair of the SMARTLYTE analyzer should be performed only by qualified repair technicians. Care should be taken when removing the covers as hazardous voltages are exposed. Use only accepted electronic check procedures and static protection when replacing and handling all electronic parts.

This manual is divided into 9 chapters to facilitate location of technical information. Chapter 2 provides specifications and operating configuration information. Chapter 3 includes flow charts for all system functions and detailed operation of system check procedures. In Chapter 4, all mechanical, fluidic and electronic assemblies are described. Chapter 5 outlines routine maintenance and troubleshooting procedures. Chapter 6 includes electronic adjustments and Chapter 7 provides the system block diagram and all circuit schematic diagrams and wiring interconnection information. In Chapter 7, part identification, location and description is provided by the illustrated parts list. Finally, in Chapter 8 interface specifications are provided for the RS232 output.

2. General Description

Specifications

2.1. Reported Configurations

		Measuring	Range	Resolution
Whole Blood Serum Plasma				
	Sodium Na^+	40 - 200 mmol/L		0.1 mmol/L
	Potassium K^+	1.5 -15 mmol/L		0.01 mmol/L
	Chloride Cl^-	50 - 200 mmol/L		0.1 mmol/L
	Calcium Ca^{++}	0.3 - 5.0 mmol/L		0.01 mmol/L
	Lithium Li^+	0.2 – 5.5 mmol/L		0.001 mmol/L
Urine				
	Sodium Na+	1 - 300 mmol/L		1.0 mmol/L
	Potassium K+	5 - 120 mmol/L (60 - 120 mmol/L w. addit. dilution)		0.1 mmol/L
	Chloride Cl-	1 - 300 mmol/L		1.0 mmol/L

Calcium and Lithium are not measured in urine samples.

2.2. Operating Configurations

Sample type	Whole blood, serum, plasma, urine
Sample device	Syringe, sample cup, collection tube
Sample size	95 uL
Analysis time	50 seconds
Sample rate	60 per hour

Measurement

Sodium (Na^+) sensor	Ion-selective, flow-through, glass capillary electrode
Potassium (K^+) sensor	Ion-selective, flow-through, liquid membrane electrode
Chloride (Cl^-) sensor	Ion-selective, flow-through, liquid membrane electrode
Calcium (Ca^{++}) sensor	Ion-selective, flow-through, liquid membrane electrode
Lithium (Li^+) sensor	Ion-selective, flow-through, liquid membrane electrode
Reference System	Open liquid junction, flow-through electrode
Calibration	Fully automatic 1 point with each sample 2 point every 4 hrs (Lithium, 3 point)
Standby	Suspends Calibrations
Warm-up time	1 minute
Temperature	Room temperature, 15 - 32° C, 60 - 90° F
Humidity	Maximum 85% relative humidity, non-condensing
Data management	Quality Control memory storage, 3 levels, 500 values each; calculation of mean, standard deviation, and coefficient of variation (CV) Samples, 1000 measurements
Diagnostic Programs	User-controlled diagnostics, YES/NO operation via the display or Keyboard
Electronics	Microprocessor-controlled
Display	LCD dot-matrix, 2 line, and 16 characters per line
Printer	Integral thermal printer, 16 character width

Interface	RS232C Serial Port, USB Ports, 2 for Keyboard (provided) and Barcode Scanner (Optional)
Electrical requirements	100 - 240 V, 50/60 Hz, 1.4 A max. Self-adjusting
Nominal power Consumption	50 W
Dimensions	
Height	12.2"; 335mm
Width	12.4"; 315m
Depth	12.0"; 295mm
Weight	approx. 13 lbs; 6kg
Classifications	
Safety category	IB (according to EN 60601-1, IEC 601-1)
Device type	
Mode of operation	Continuous operation
Protection classification	IP 20
Explosion protection	The device is not designed for operation in explosive environments.
Approvals	CSA, IEC 1010 (TUV/GS), CE, FCC Class B

Data subject to change without notice. Technical information is supplied for general informational purposes only.

3. Software Operation

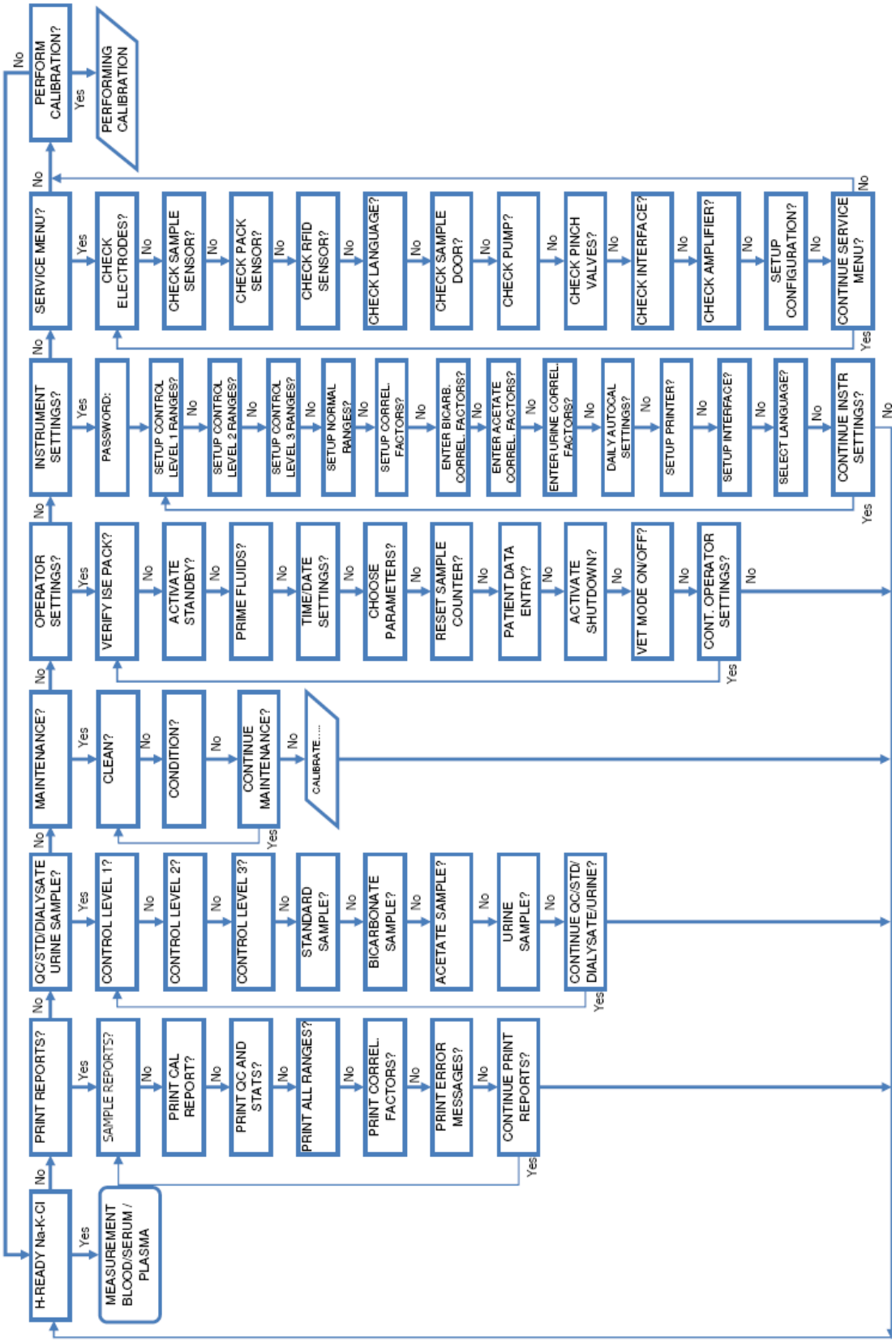
3.1. Software Operation - SMARTLYTE

Software operation of the SMARTLYTE analyzer can be accessed by YES/NO selection on the analyzer front panel or through the function keys in the keyboard. The following flow chart diagrams are provided to identify operating sequences of the SMARTLYTE Analyzer:

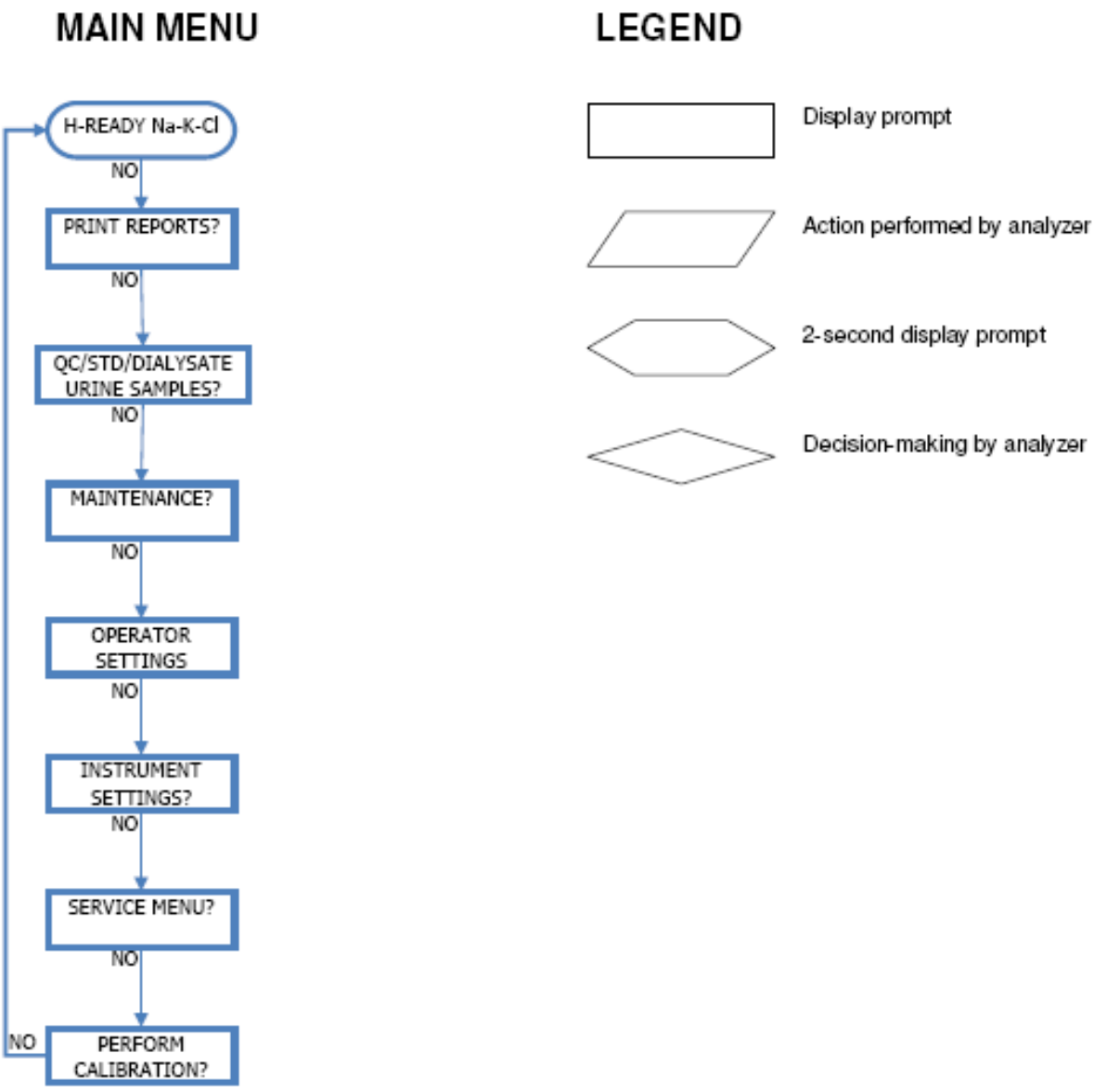
1. Overall Program Operating Flow
2. Main Menu
3. Measurement Sequence
4. Print Reports Menu
5. QC/Standard/Dialysate/Urine Sample Menu
6. Maintenance Menu
7. Operator Settings Menu
8. Instrument Settings Menu
9. Service Menu
10. Calibration Sequence

The SERVICE MENU is also provided with a more detailed description of each check configurations for use in checking instrument subassemblies.

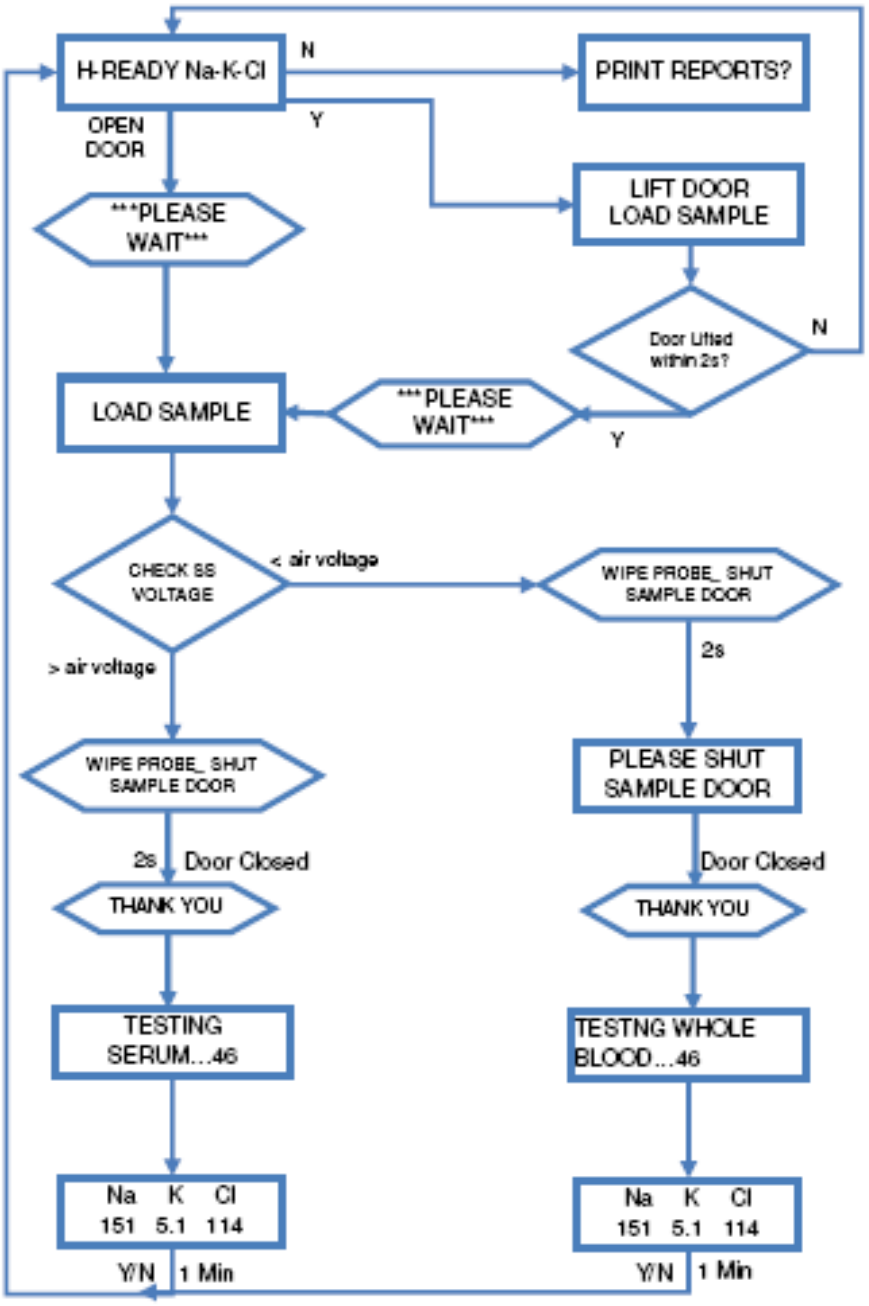
1. OVERALL FLOW



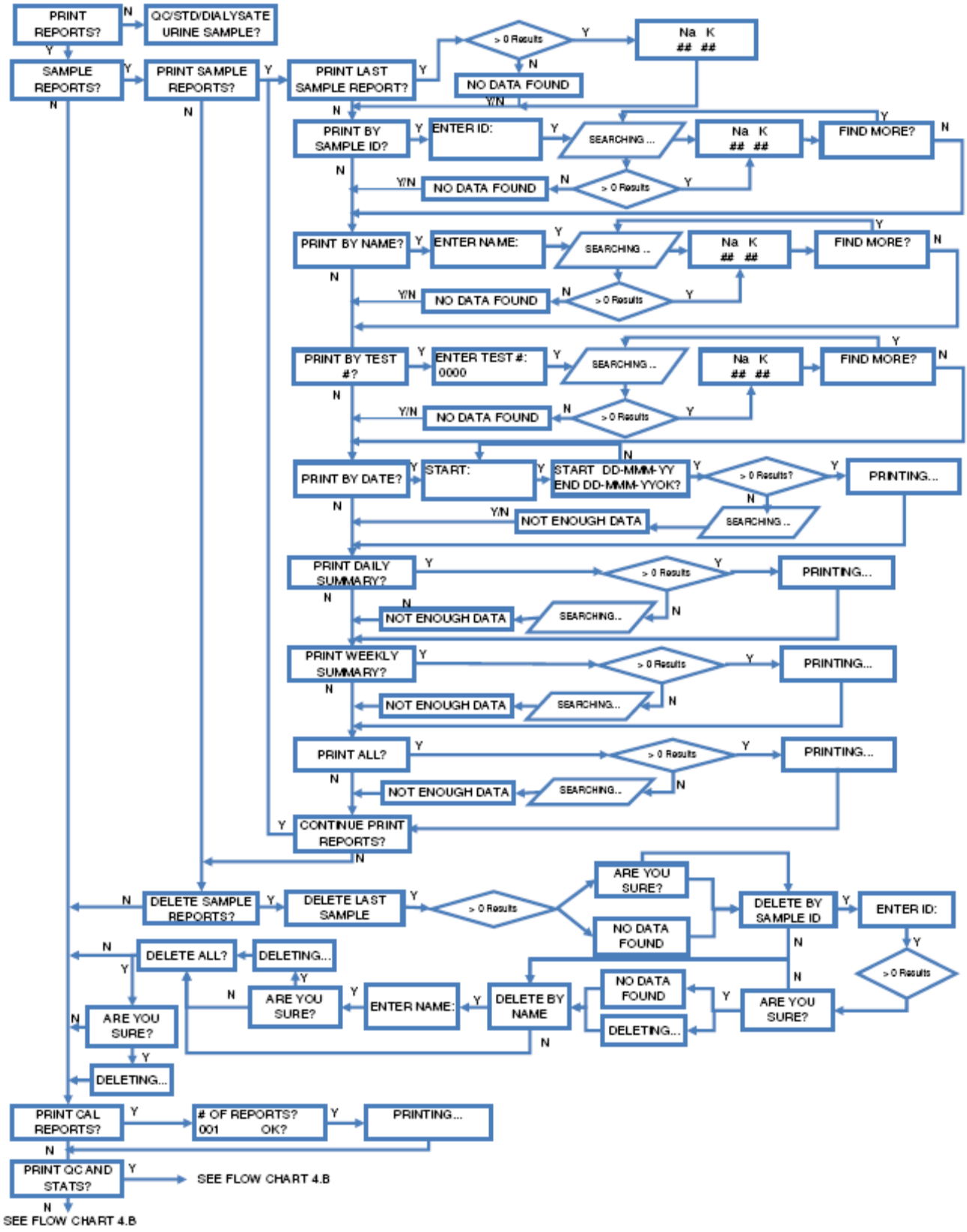
2. MAIN MENU - HUMAN



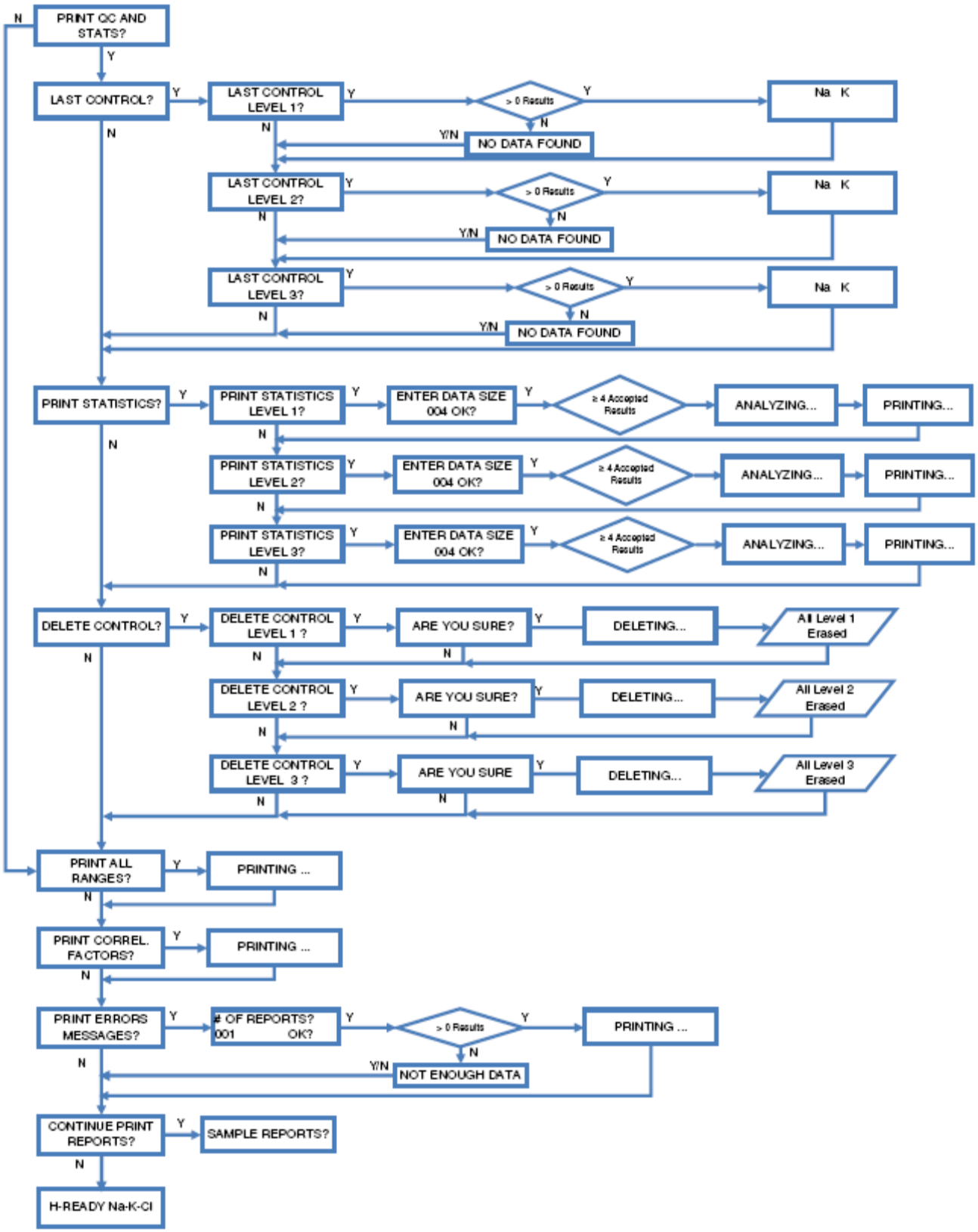
3. MEASUREMENT SEQUENCE



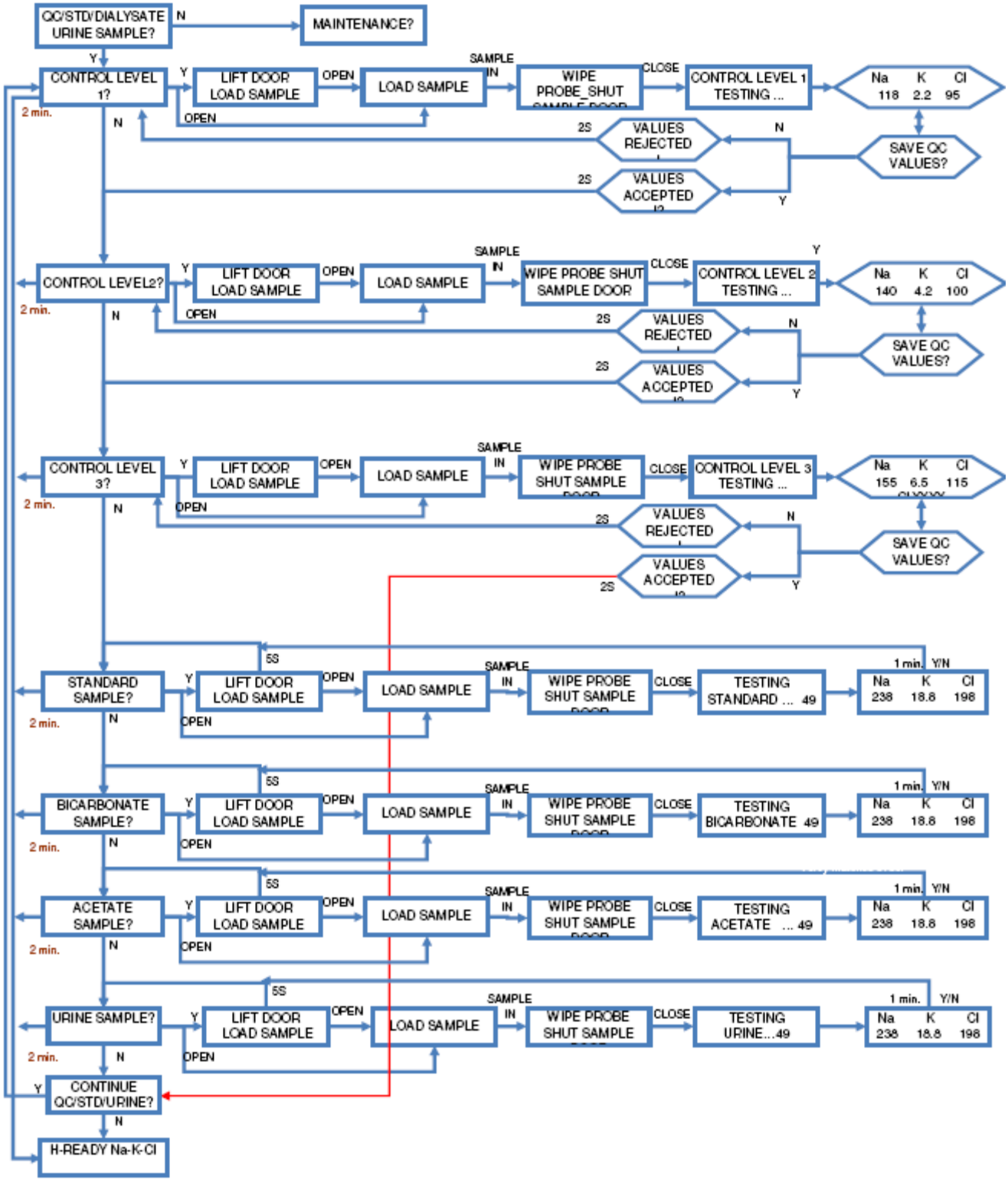
4.A. PRINT REPORTS-SAMPLES



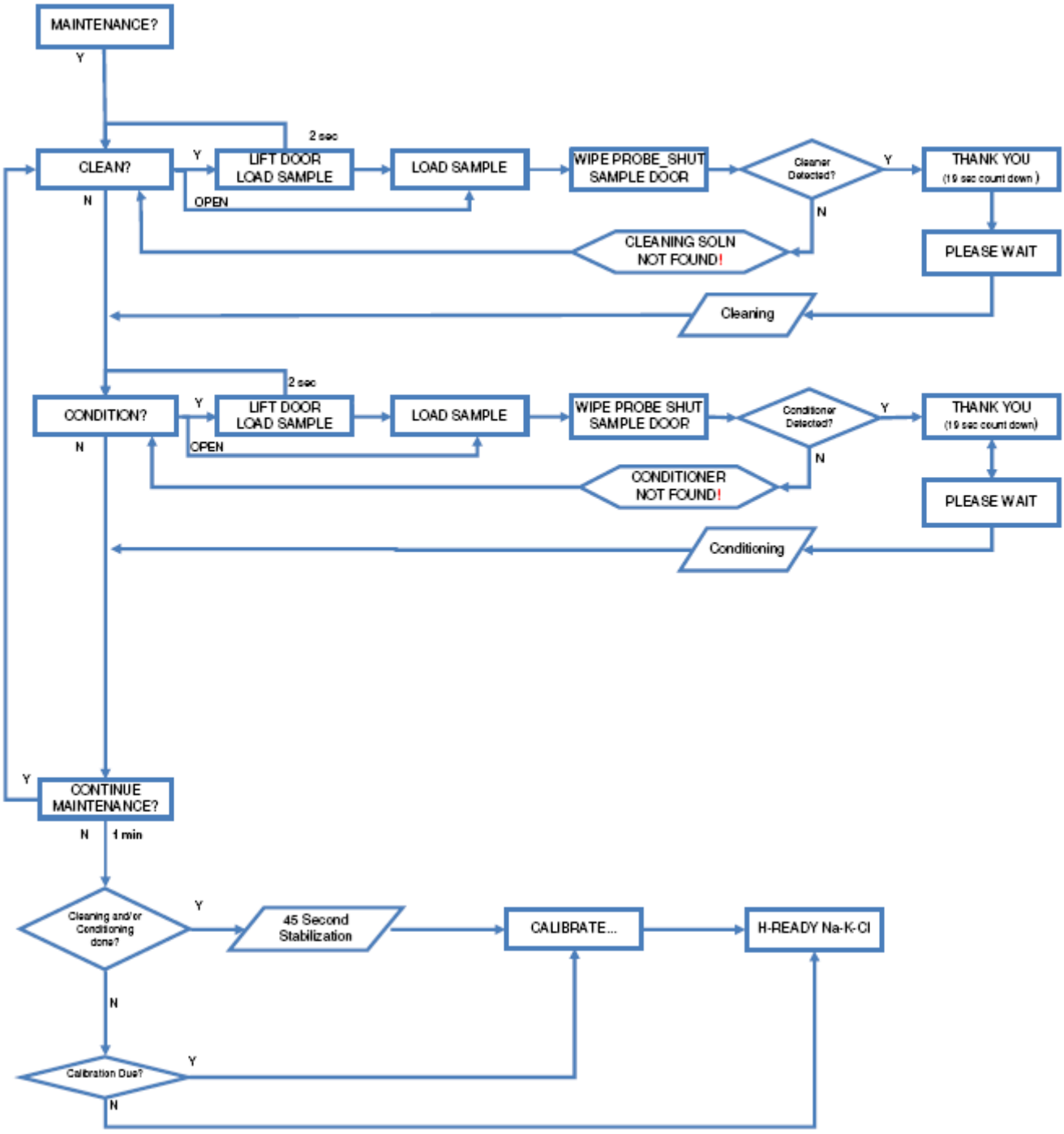
4.B PRINT REPORTS – QC ETC.



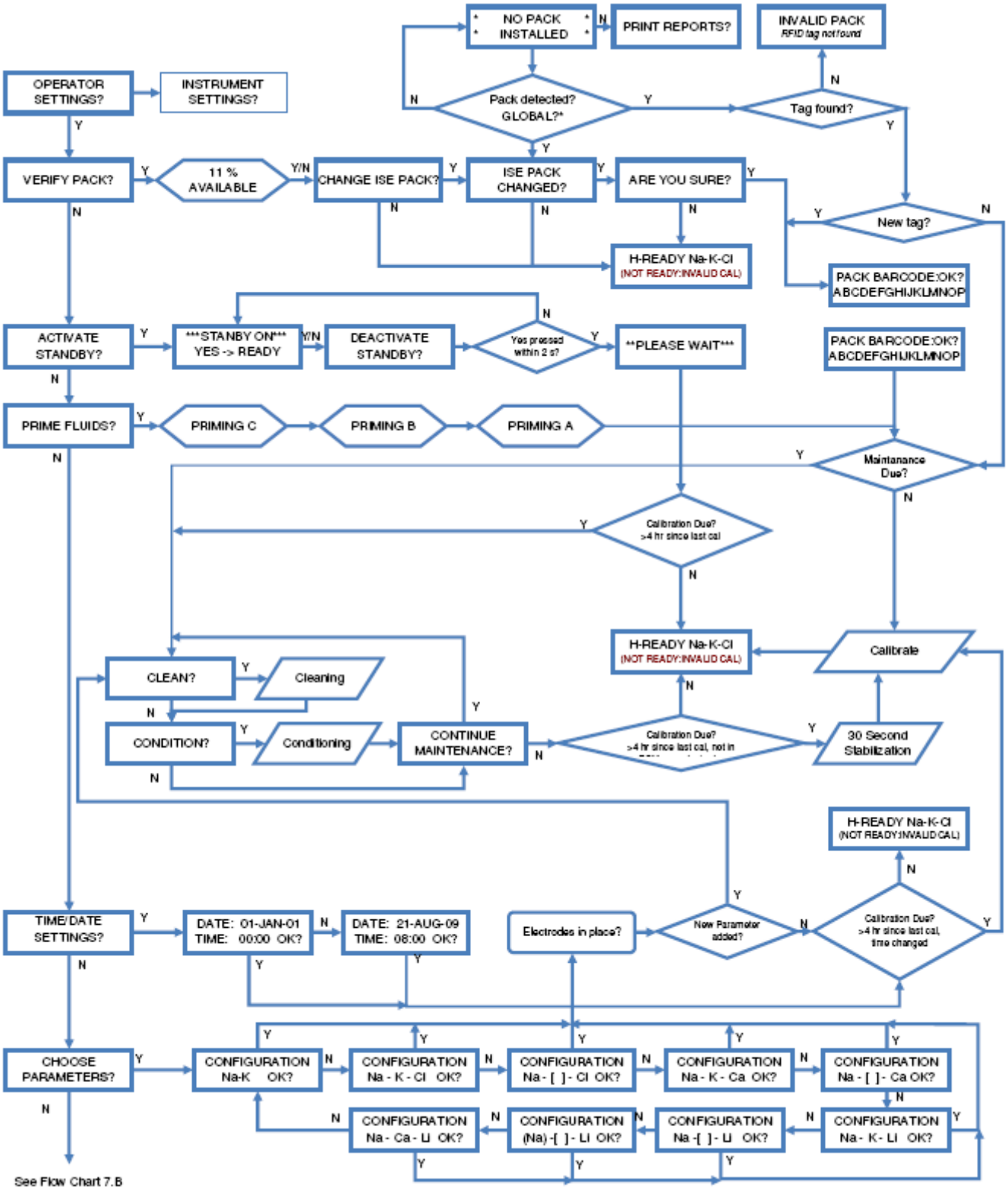
5. QC-STD-DIALYSATE-URINE SAMPLE



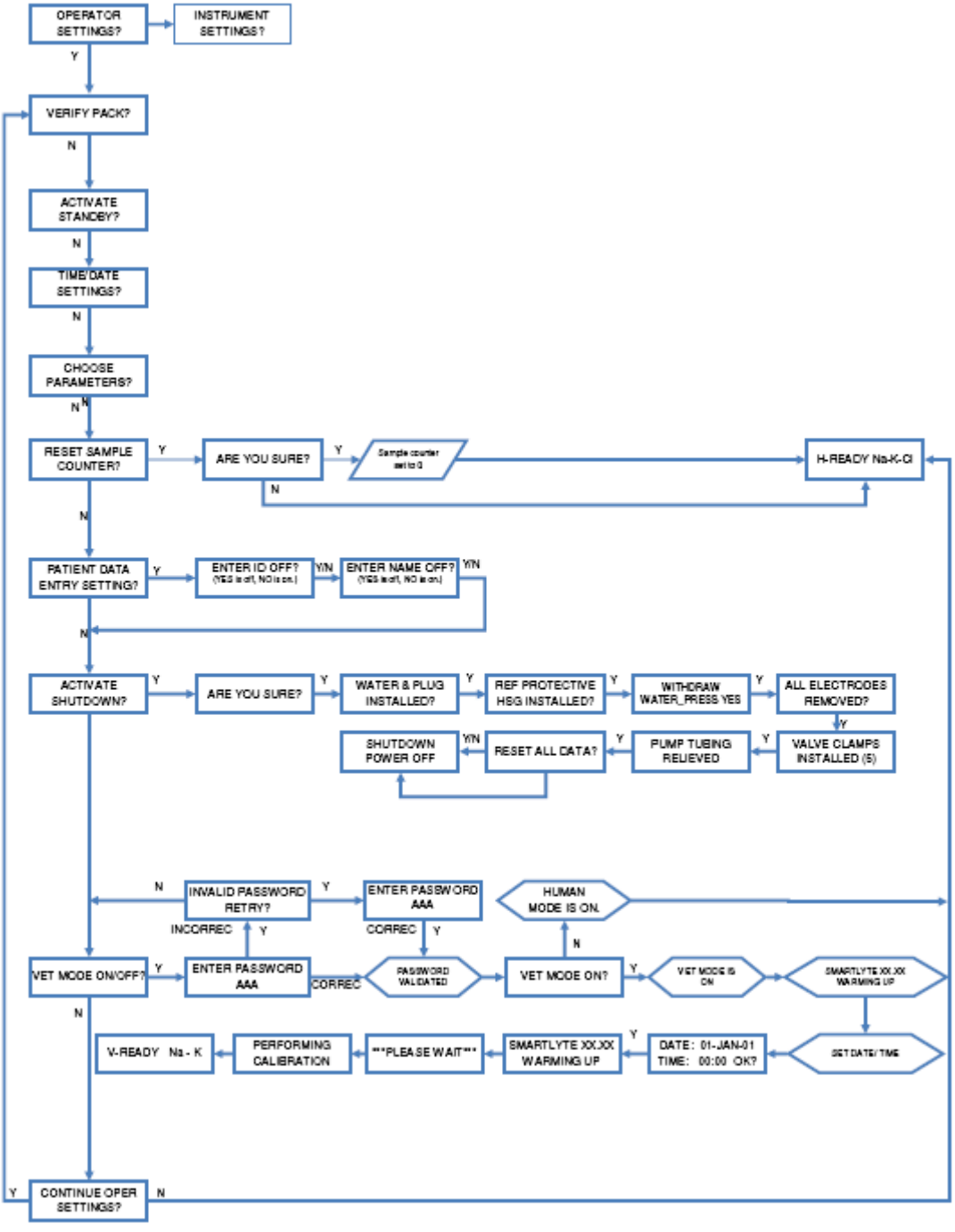
6. MAINTENANCE



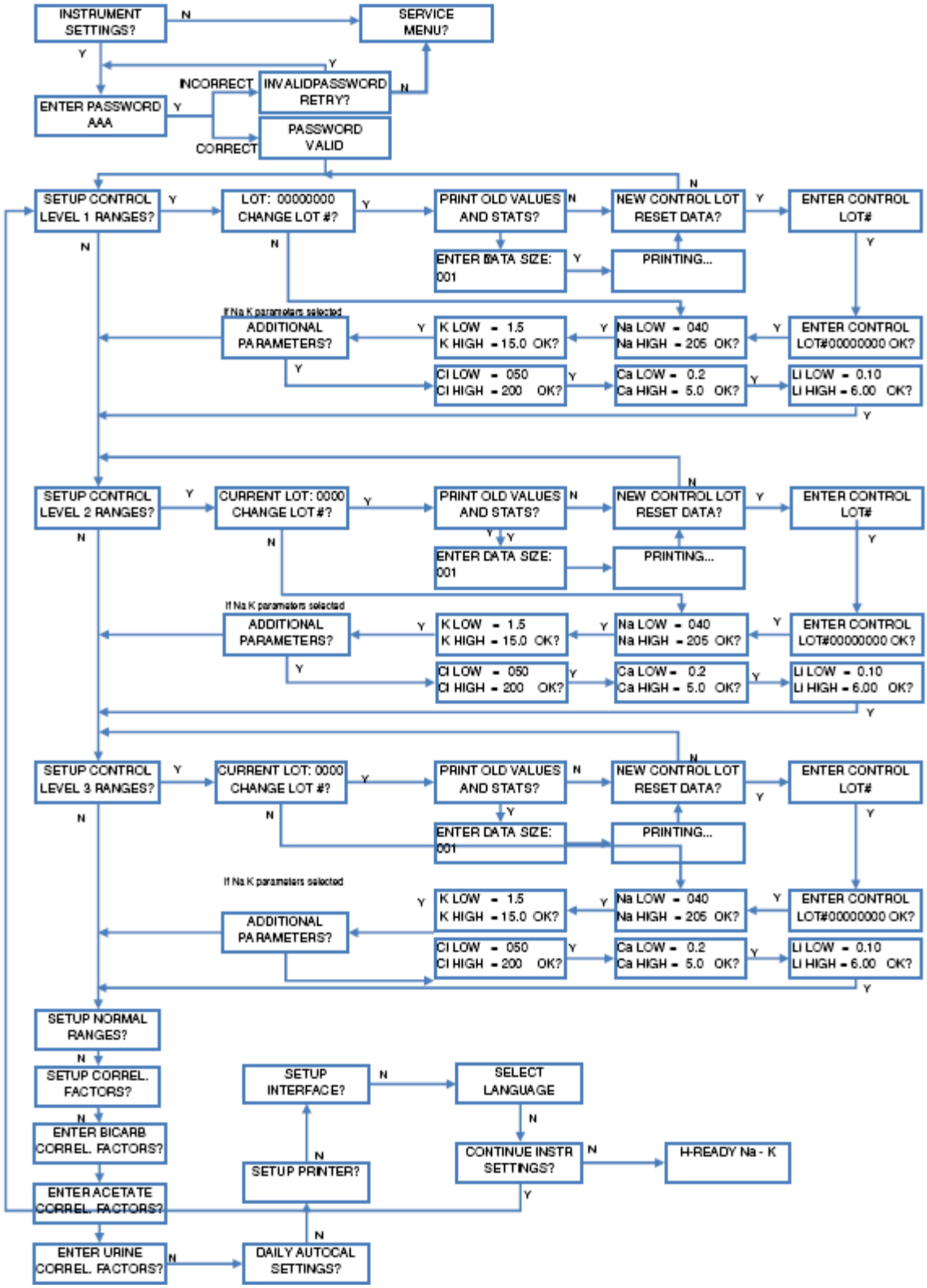
7.A. OPERATOR SETTINGS H TO V



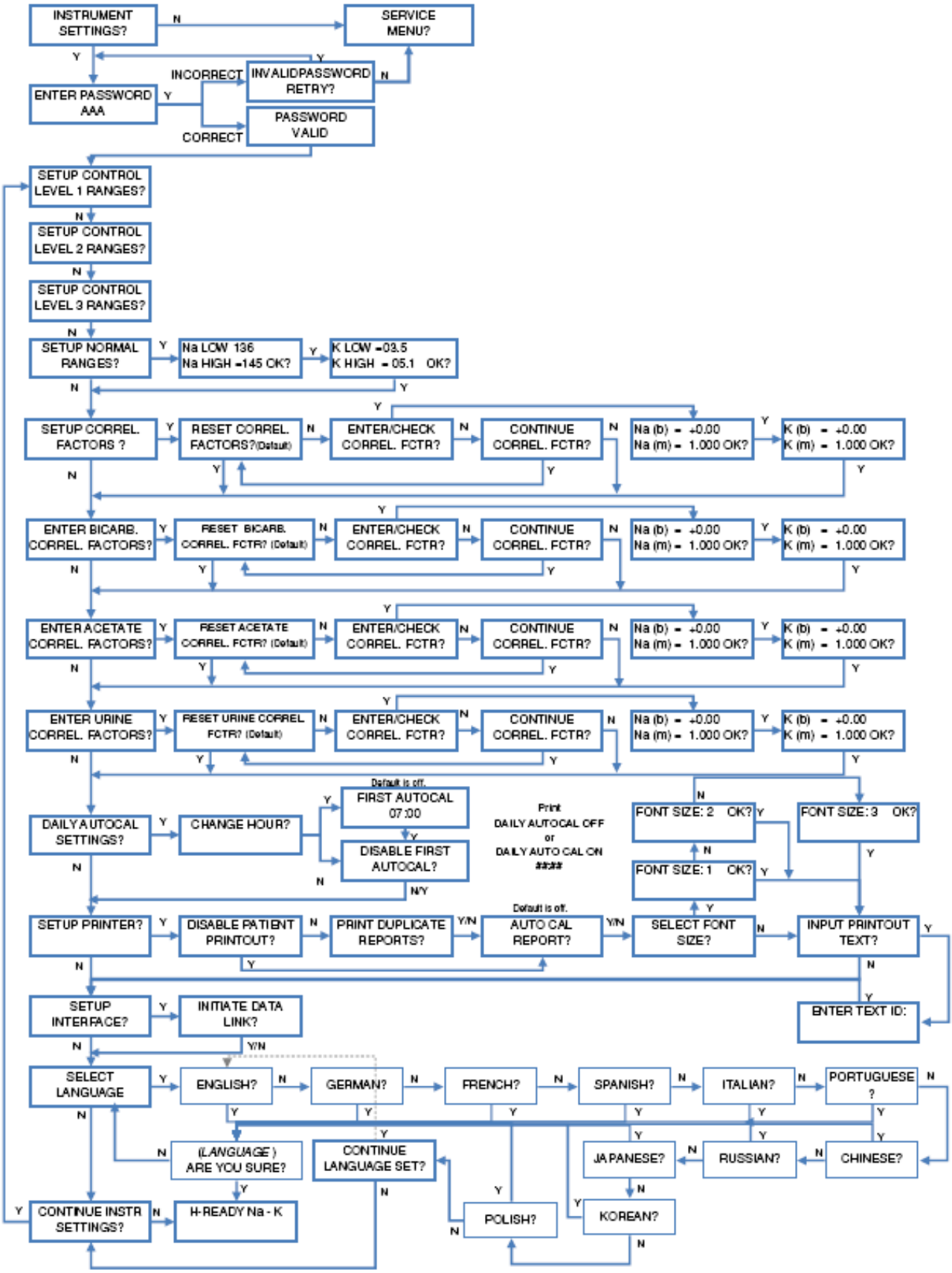
7.B. OPERATOR SETTING H TO V



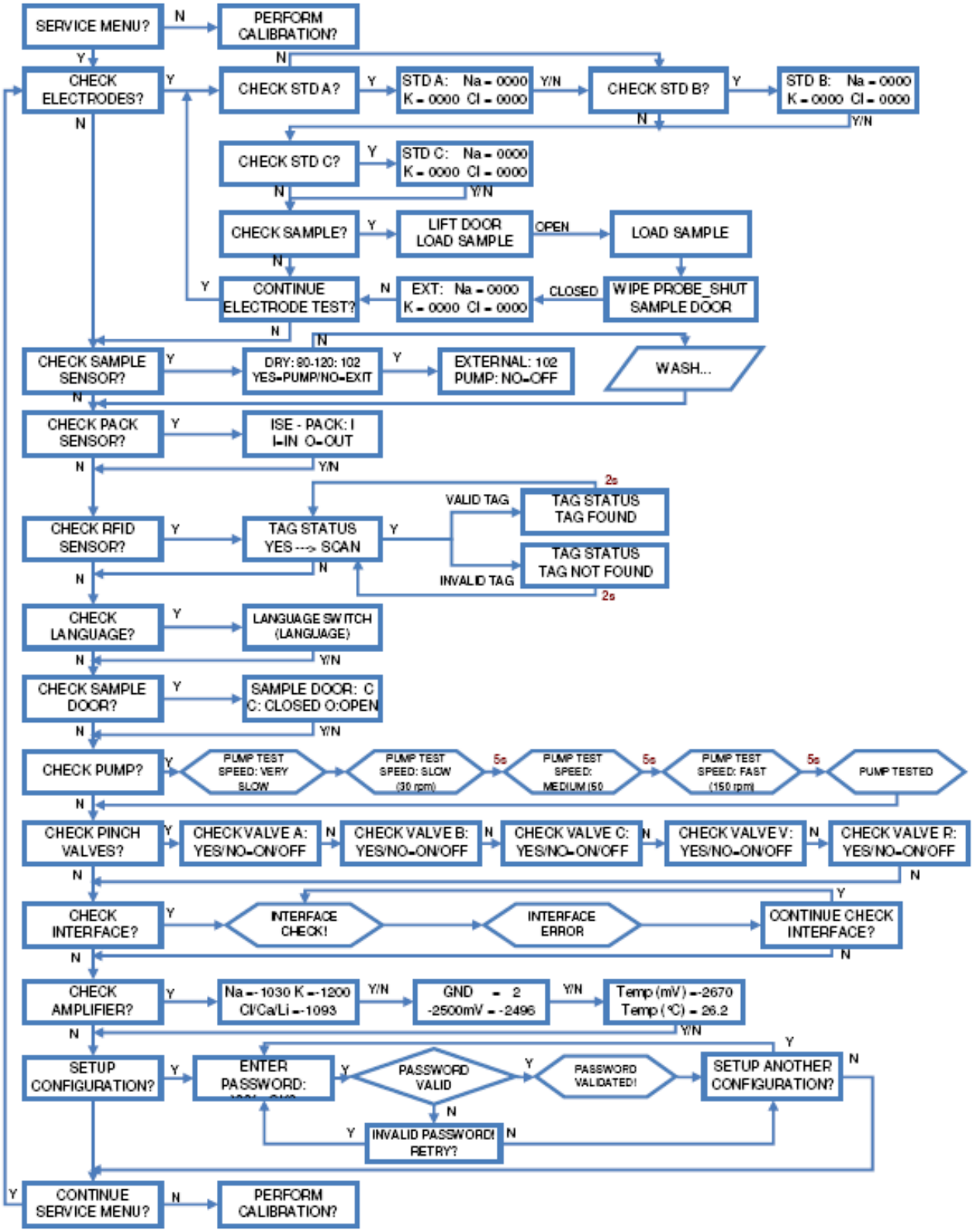
8.A. INSTRUMENT SETTINGS QC



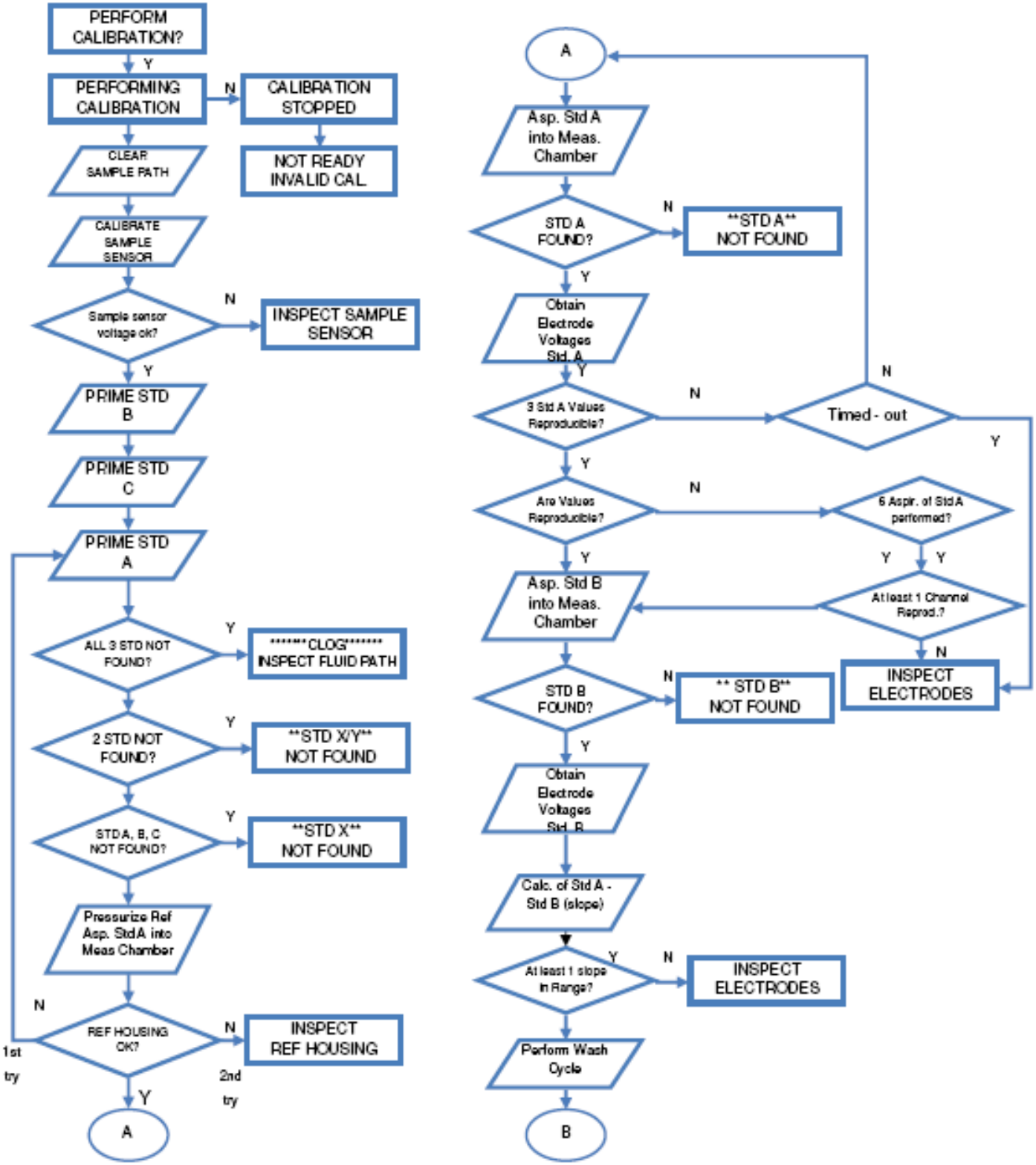
8.B. INSTRUMENT SETTINGS OTHERS



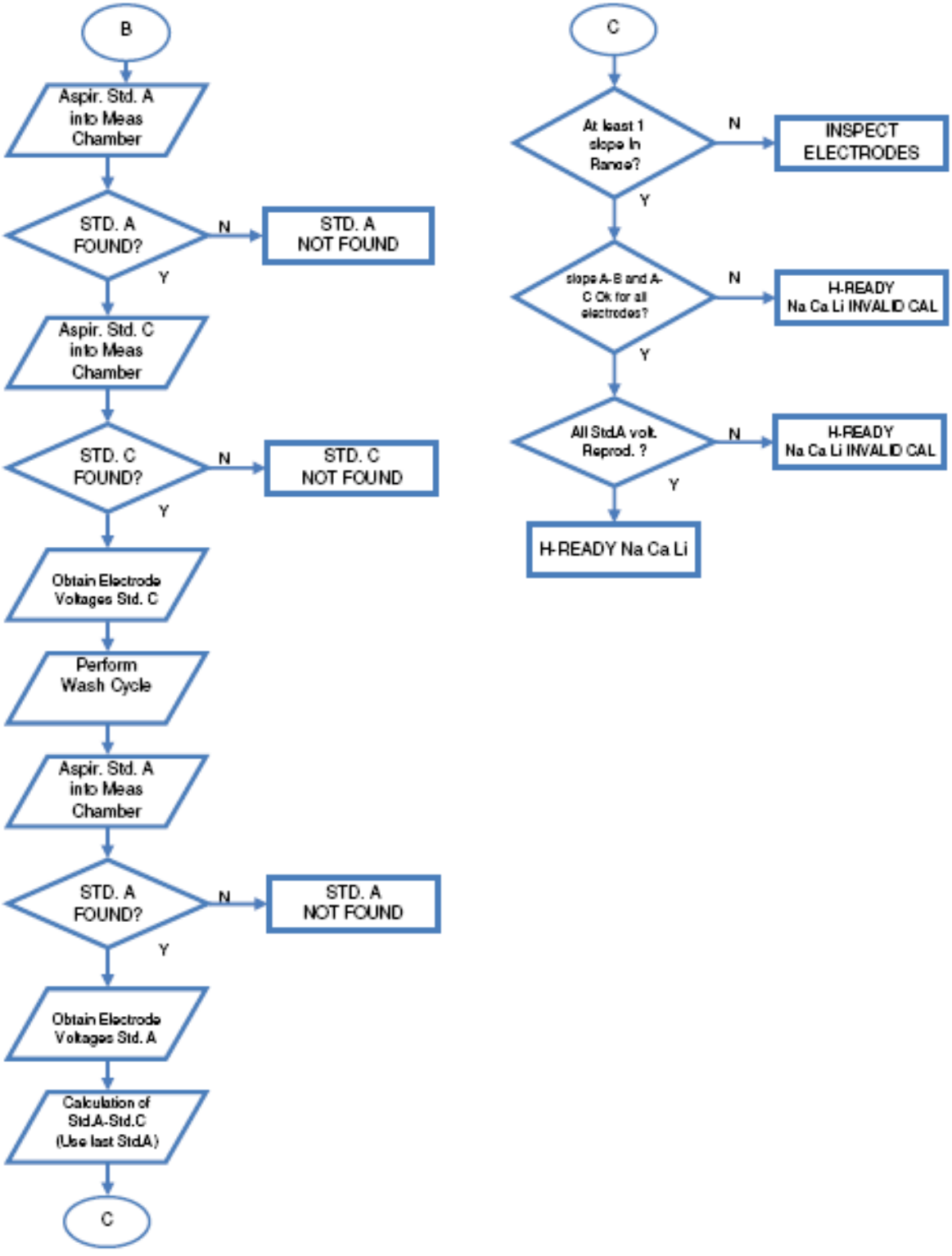
9. SERVICE MENU



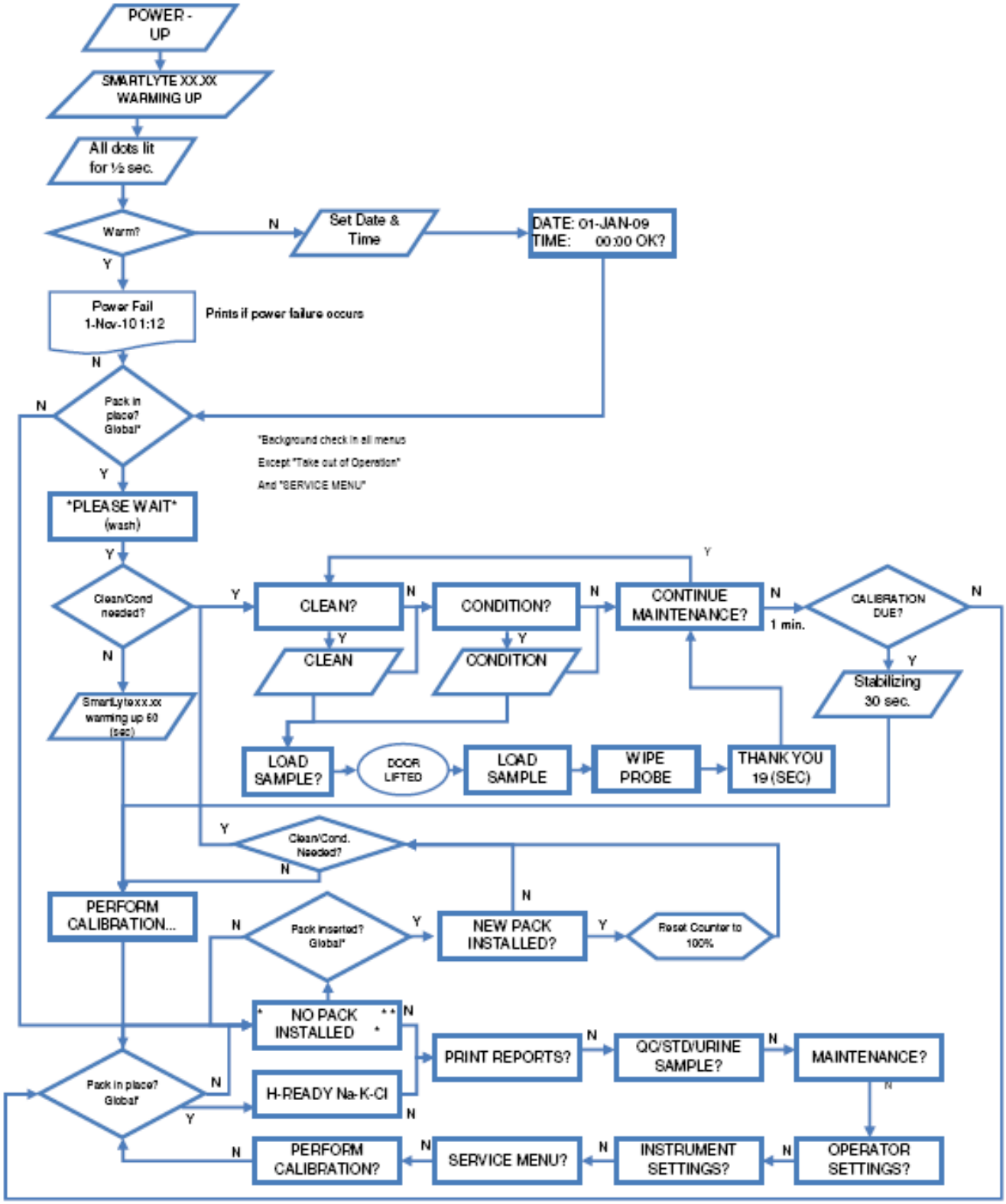
10.A. PERFORM CALIBRATION



10.B. PERFORM CALIBRATION



11. POWER-UP


POWER - UP
SMARTLYTE XX.XX WARMING UP
All dots lit for ½ sec.
Warm?
N
Set Date & Time
DATE: 01-JAN-09 TIME: 00:00 OK?
Y
Power Fail 1-Nov-10 1:12
Prints if power failure occurs
N
Pack in place? Global*
N
Y
"Background check in all menus
Except "Take out of Operation"
And "SERVICE MENU"
PLEASE WAIT (wash)
Y
Clean/Cond needed?
Y
CLEAN?
N
CONDITION?
N
CONTINUE MAINTENANCE?
N
1 min.
CALIBRATION DUE?
N
Y
CLEAN
Y
CONDITION
Y
Y
Stabilizing 30 sec.
N
SmartLyte xx.xx warming up 60 (sec)
LOAD SAMPLE?
DOOR LIFTED
LOAD SAMPLE
WIPE PROBE
THANK YOU 19 (SEC)
Y
Clean/Cond. Needed?
N
PERFORM CALIBRATION...
N
Pack inserted? Global*
Y
NEW PACK INSTALLED?
N
Y
Reset Counter to 100%
* NO PACK INSTALLED **
N
PRINT REPORTS?
N
QC/STD/URINE SAMPLE?
N
MAINTENANCE?
N
Pack in place? Global
N
Y
H-READY Na-K-Cl
N
N
PERFORM CALIBRATION?
N
SERVICE MENU?
N
INSTRUMENT SETTINGS?
N
OPERATOR SETTINGS?

12. KEYBOARD FUNCTIONAL KEYS

VERIFICATION NOTES Verify each function using accessory listed

FUNCTION KEYS	Description	Keyboard	Computer
F1	Analyze		
F2	Results		
F3	QC/STD		
F4	MAINTENANCE		
F5	OPERATOR SETTINGS		
F6	INSTUMENT SETTINGS		
F7	SERVICE MENU		
F8	PERFORM CALIBRATION		
F9	STANDBY		
F10	SERVICE LOGIN		
RIGHT ARROW	NEXT		
LEFT ARROW	PREVIOUS		
DOWN	YES		

3.2. Service Menu

The SERVICE MENU (mode provides a menu of service check functions to assist in failure diagnosis and identification. A logic flow chart is provided for reference of the sequences included in the SERVICE MENU mode.

CHECK ELECTRODES

This mode allows for the measurement and display of electrode voltages. STD A, STD B or an external sample can be measured to determine electrode performance and provide measurement data useful in locating electrode calibration faults. Each electrode configuration will be displayed and the electrode voltage associated with the sample type selected can be observed.

Example Displays:

Std. A: Na=1582 K= 654 Cl=-904

Std. B: Na=237 K=-988 Cl=647

Ext: Na=1321 K=-598 Cl=-127

CHECK SAMPLE SENSOR

In this mode, the sample sensor output is displayed which is useful for electrical adjustment or for troubleshooting sample sensor faults. A dry sample sensor should display a value of approximately 100 with a range of 80 to 120. After verifying a dry sensor, aspiration of a clear fluid (i.e., water) should increase the displayed value by at least 40 units.

Example Display:

DRY 80 -120: 102 YES=Pump/No=Exit

External: 153 Pump: NO=OFF

CHECK FLUID PACK SENSOR

In this check, the Fluid Pack Sensor detects whether the Fluid Pack is in place. “I” indicates that the Fluid Pack is in place, “O” indicates that it is either not present or not completely seated.

Example Display

Fluid Pack: I I=In O=OUT

CHECK LANGUAGE

This mode displays the language selected for display and printout.

Example Display

Language: English

To change the language, press the **NO** key until [**INSTRUMENT SETTING?**] is displayed. Then select **YES**. Press **NO** to scroll through the menu until [**SELECT LANGUAGE?**] is shown. Press **YES**. Upon entering this menu the language can be set to English, German, French, Spanish, Italian, or Portuguese. Press **YES** when the desired language is displayed on the screen. After confirming the selection, the language will be reset automatically.

CHECK SAMPLE DOOR

This check verifies the operation of the sample door light gate and its associated circuitry. The display indicates an “O” or “C” depending on the position of the door.

Example Display

Sample Door: C C: Closed/O: Open

CHECK PUMP

This check turns on the peristaltic pump at each of the four pump speeds. The display indicates for two seconds each pump speed while each pump speed is being checked. Observe that the peristaltic pump changes speed as is indicated on the display.

* * * Check Pump * * * Very Slow Speed	* * * Check Pump * * * Slow Speed
* * * Check Pump * * * Medium Speed	* * * Check Pump * * * Fast Speed

VALVE CHECK

This turns on/off each solenoid valve as indicated and is useful to verify both electronic control and mechanical operation of each solenoid valve.

CHECK INTERFACE

The Interface Check can be used to verify correct operation of the RS232C serial port. To operate this check, jumper pin 2 and pin 3 of the rear interface connector prior to invoking the check. During the interface check, the analyzer sends out a check string and checks if it is received within a set period of time. If correct operation is observed after completion of the check, **INTERFACE_OK** will be displayed. If not Interface Error will be displayed.

CHECK AMPLIFIER

The Amplifier Check displays ground, reference and output voltage of each input amplifier. The values displayed for each electrode channel will be dependent on the electrode inputs and may vary. Display of the ground should read between -10mV and +10mV with the reference voltage reading between -2490mV and -2510mV. An additional display indicating the temperature voltage and temperature in degrees C is available to verify the temperature adjustment.

CHECK RFID SENSOR

A compatible Fluid Pack must be installed for this test, otherwise an error will be returned. This option allows the RFID system to be verified. The RFID system includes the RFID board and a compatible Fluid Pack. During the test, the instrument sends a signal to a tag in the Fluid Pack. If the RFID transponder receives a signal from the Fluid Pack, TAG FOUND will be displayed.

ENTER CONFIG CODE

CONFIG CODES are available and allow additional programming features. Following is a listing of the available CONFIG CODES and functions.

SET	RESET	Code Description
AME	EMA	Dialysates in Acetate matrix can be analyzed.
BCE	ECB	Dialysates in Bicarbonate matric can be analyzed.
CPC		Connect to PC to load software
CSC		Clears all codes and return to factor default
ECM	MCE	Allows the operator to run the instrument in the economy mode. The instrument will enter the STANDBY MODE. This occurs at the time of the next 2-point calibration when no samples have been analyzed since the last 2-point calibration.
HRS	SRH	Provides one additional digit of resolution for each parameter for blood and serum samples. QC and Standard samples are always displayed with high resolution. Urine samples are always displayed in low resolution.
LCR		Prints lease counter report.
MGC	CGM	This config code is available only in the mode SMARTLYTE analyzer and enables Ca++ values to be displayed in mg/dL. The normal mode displays values in mmol/L. QC and Standard results are always displayed in mmol/L.
PMI		This code will print the model information of the SMARTLYTE
PSC		Prints service codes.
QCF	FCQ	When this code is enabled, QC values will be reported in direct ISE measurement instead of flame-equivalent values. In this mode, correlation factors are NOT applied to the measured values.
TBO	OBT	This disables the beep.
TDV	VDT	Allows printing of the electrode voltages for sample measurements and calibrations.
R14	V48	These codes allow the dealer to enter their own password for those instruments will be released based on number of tests.
RST		Erases all data from memory including correlation factors, QC Ranges, stored patient, QC data and lease count.
FPC		Displays the fluid pack counter used to monitor pack consumption. **Note:** For SW versions 12.07.C5 and 13.07.C5 and higher.

ANALYZER RESET

Press **YES** and **NO** keys simultaneously and turn power off and back on to provide a total reset of the instrument. **CAUTION!** All QC Data and Instrument programming will be lost. Switching from human to vet or vet to human resets all previously saved data as well.

FAIL SAFE SQ UPLOAD (SW Versions 12.07.C5 and 13.07.C5 and higher)

In situations where instrument doesn't initialize completely due to wrong software upload or peripheral issues, bootloader mode which allows upload of software to clear the error can be entered directly by following these steps –

1. Turn instrument off.
2. Press YES button.
3. While pressing the YES button, turn on the instrument.
4. Wait for 30 seconds.
5. Instrument is now in programming mode.
6. New software can be uploaded using provided steps.

WARM-UP BYPASS

Press **YES** and **NO** keys simultaneously during instrument warm-up.

4. *Description of Modules*

4.1. Mechanical Assemblies

4.1.1. Front Door Assembly

The front door assembly is comprised of the following parts, Front Door, **CN-4002**, EMI Window, **CN-4193**, Plastic Window, **CN-4092** and Door Magnets.

The front door can be removed by moving the analyzer to the edge of a work surface so the analyzer door, when opened, will extend past the edge of the work surface. First remove small ground connector, then ground screw, external tooth washer, right angle tab, and hex nut. Then with one hand, hold the analyzer door near the right side hinge pin and, with the other hand, gently apply pressure to the middle rear area of the door. This will allow the right hinge pin to clear the retaining hole in the main chassis. The door can then be removed from the analyzer.

The window is comprised of two layers, the EMI window and the plastic window. Both can be replaced in the field by gently pressing from the rear of the window and snapping the EMI and plastic window out toward the front of the door. During replacement the EMI window should be placed over the opening first, ensuring good contact of the EMI window adhesive with the copper tape on the frame of the window. Next the Protective window is applied over the EMI window.

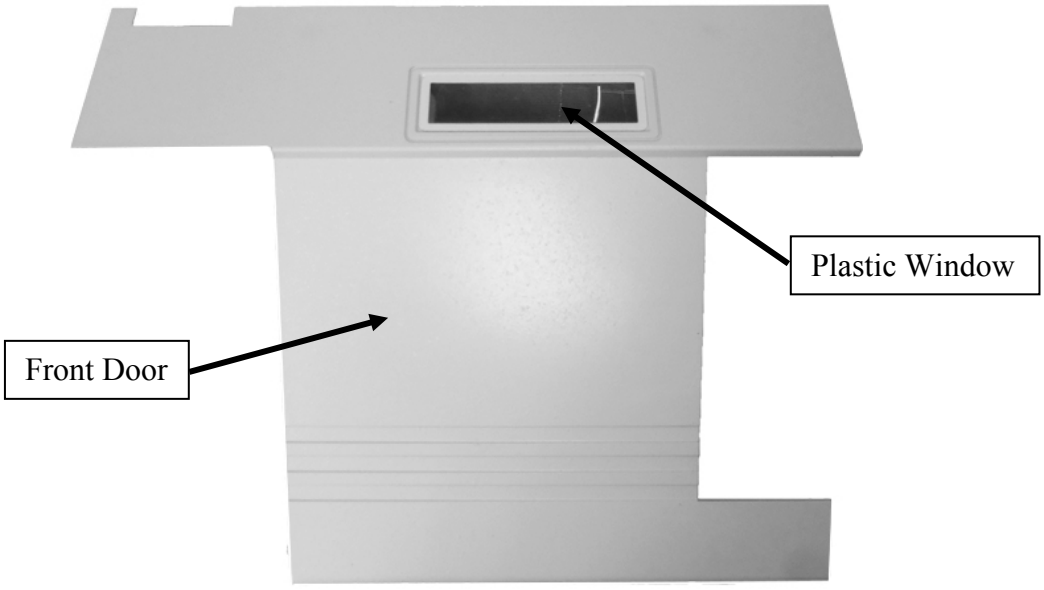


Fig. 4-1

4.1.2. Aspiration Assembly

This module is comprised of the Aspiration Subassembly, **CN-A4010** and the sample probe, **AV-BP5006D**.

The sample probe and fill port are designed for easy replacement. The sample probe can be removed as a one-piece assembly including the intake tubing which connects the sample probe to the electrode module through the sample sensor. To remove the sample probe, first disconnect the intake tubing from the sample sensor on the right side of the electrode tray. Then open the sample door and grasp the probe near the white holder block and pull up to unsnap the sample probe from its position. To replace the assembly, align a replacement sample probe in the white holder block and press the replacement assembly into place. Connect the tubing to the sample sensor.

To remove the fill port assembly, pull the fill port holder towards the front for easy access. Then, press the two plastic tabs on the fill port to allow removal of the fill port from the fill port holder.

To remove the aspiration assembly, three screws must be removed. To remove the two rear screws first ensure power is off and remove the rear panel. The rear panel can be moved away from the unit for easier access by unplugging the power supply and ground cables from the CPU board. The CPU board can be removed after disconnecting the cables and the seven screws which secure the CPU board to the case. Remove the grounding screw and star washer on the left side of the CPU board first. The cable on the left is the valve board cable and the one at the top of the CPU board is the display cable. Once the valve board is exposed, disconnect the aspiration assembly connector which is the far left connection.

The two rear screws can now be removed using a hex key. Then, remove the front securing screw, the sample intake tubing and the reagent supply tubing (red tag) from the fill port. The aspiration assembly can now be removed from the front of the analyzer for replacement. Reference the Illustrated Parts diagram in Section 8 for a detailed parts diagram of the aspiration assembly.

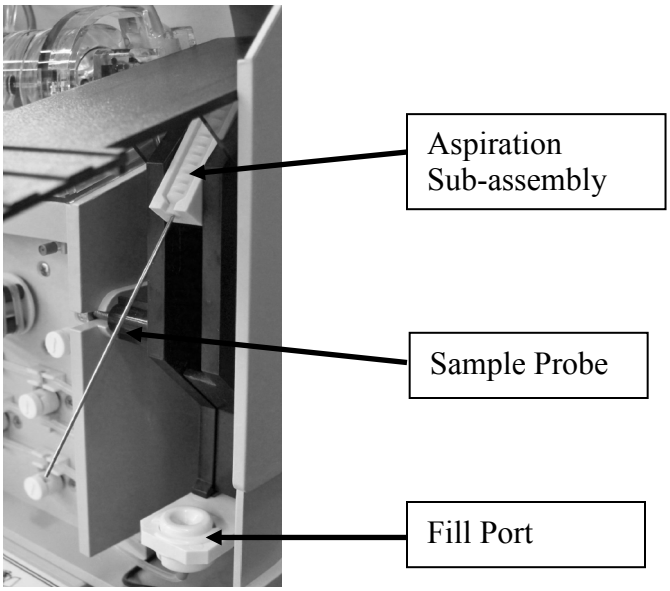


Fig. 4-2

4.1.3. Electrode Tray Assembly

This assembly is comprised of the electrode tray**, CN-A4011**, and the sample sensor, **AV-BP5036D.**

To remove the electrode holder assembly from the analyzer, first unplug the sample intake tubing on the right side of the assembly where the sample sensor is located. Then disconnect the sample sensor cable, unplug the reference solution tubing connector and last, disconnect the waste tube (green tag) from the left side of the electrode tray. The electrode tray assembly can now be removed by pressing the two plastic tabs on the right and left side of the module and sliding the module towards you. Continue to press the plastic tabs to completely release the tray and remove the assembly from the analyzer. The sample sensor (on the right) and the electrode locking mechanism can be removed and replaced by removing the screws on the underside of the tray. The Illustrated Parts List in Section 8 provides a detailed reference of the parts of this assembly.

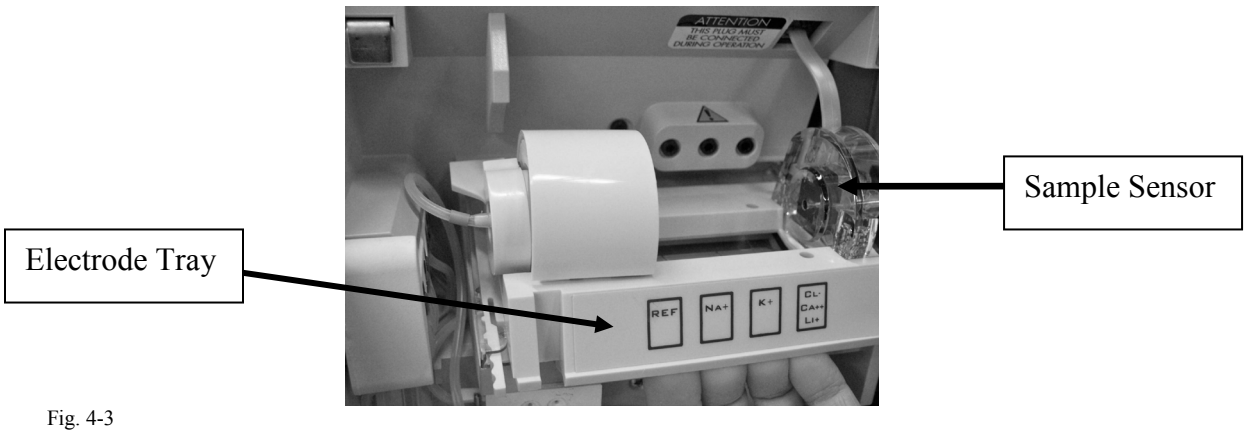


Fig. 4-3

4.1.4. Peristaltic Pump Rotor CN-A4014

Replacement of rotor assembly of the peristaltic pump can be accomplished by removing the pump tubing and firmly pulling the rotor assembly away from the instrument. To replace the rotor assembly, align the rotor with the flat on the motor shaft and press the replacement roller into position.

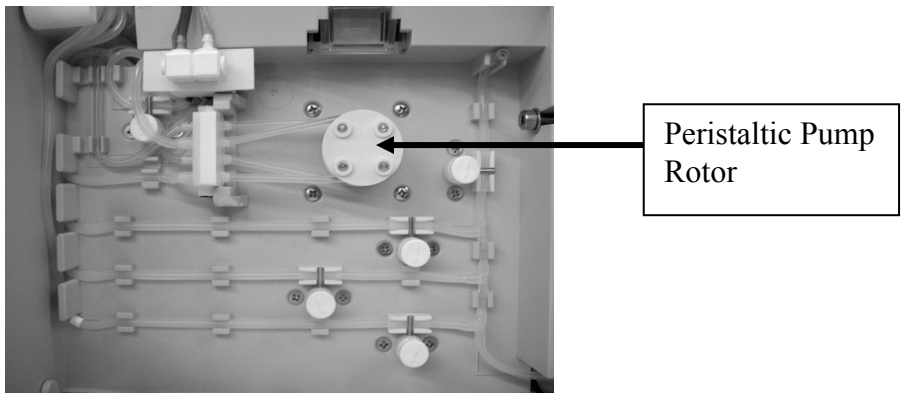


Fig. 4-4

4.1.5. Peristaltic Pump Motor CN-A4012

To remove the motor, first remove the rear panel and CPU Board as described in Sections 4.1.8 and 4.1.9. Now, the electrical connector on the valve board can be accessed to unplug the motor connector (See Figure 4-5). The motor can now be removed by removing four screws located on the front of the housing near the peristaltic pump.

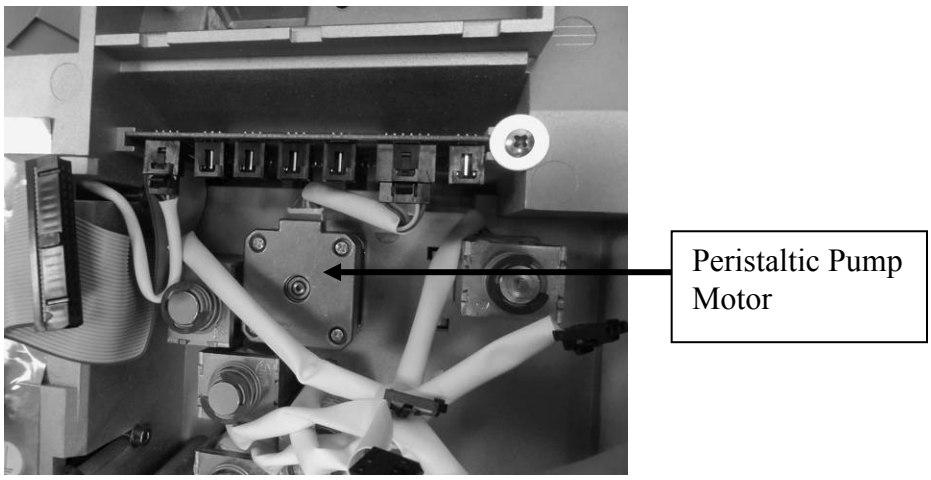


Fig. 4-5

Fig. 4-5

4.1.6. Solenoid Valve Assembly

The solenoid valve assembly is comprised of the following parts: the solenoid valve subassembly, **CN-A4015**, the crimp pin, **CN-4155**, and the indicator cap, **CN-4018**. There are 5 solenoid valves, one each for Standard A (A), Standard B (B), Standard C (C), Reference Solution (R), and Air(V).

The removal of each solenoid valve is identical. On the front of the analyzer, first remove the indicator cap, which holds the crimp pin in place. Locate the opening of the indicator cap where the solenoid shaft is visible. Slide the indicator cap off the solenoid valve shaft in the direction of the arrow. This exposes the crimp pin which can now be removed from the solenoid shaft.

If the crimp pin and/or cap need to be replaced at this time, energize the solenoid as described in **Section 3.2 (Valve Check).** This extends the solenoid shaft to the outer most position for ease in replacing the crimp pin and indicator cap.

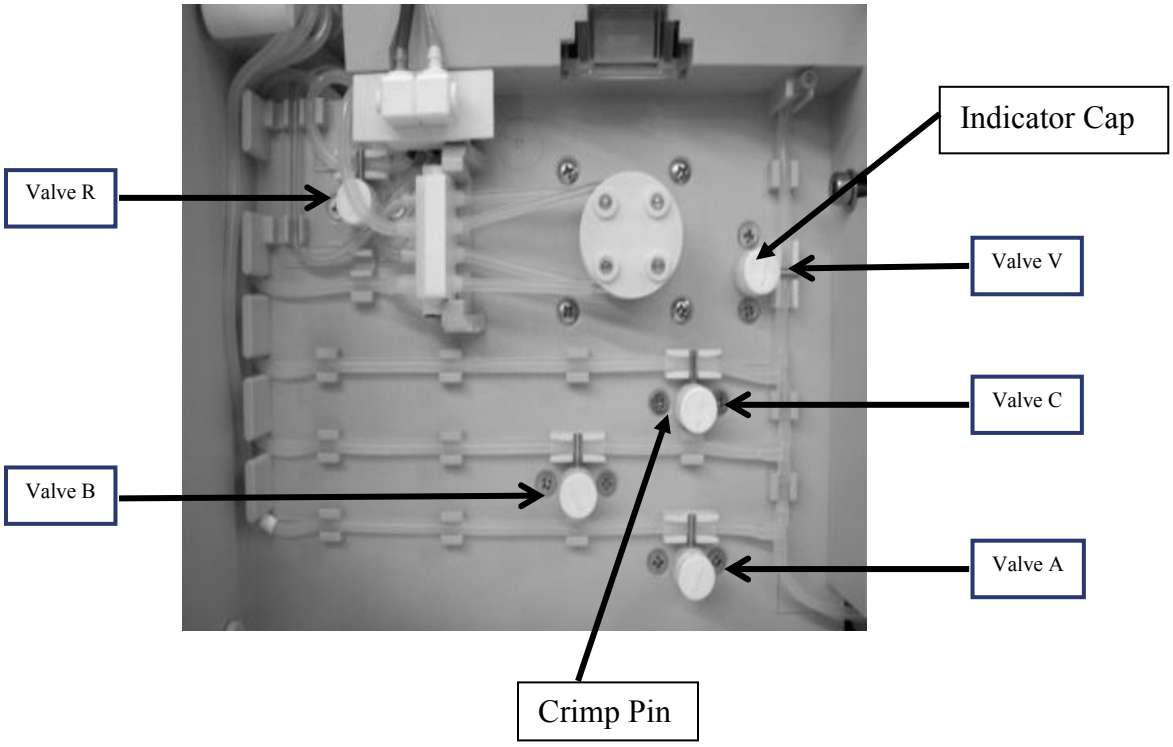


Fig.4-6

To remove the solenoid valve subassembly, first remove the crimp pin, indicator cap, and the two screws on each side of the solenoid shaft. Remove the rear panel and the CPU Board so that the valve board and solenoids can be accessed. Each solenoid has an electrical connection to the valve board which must be unplugged prior to removal of the solenoid. See figure below for connections.

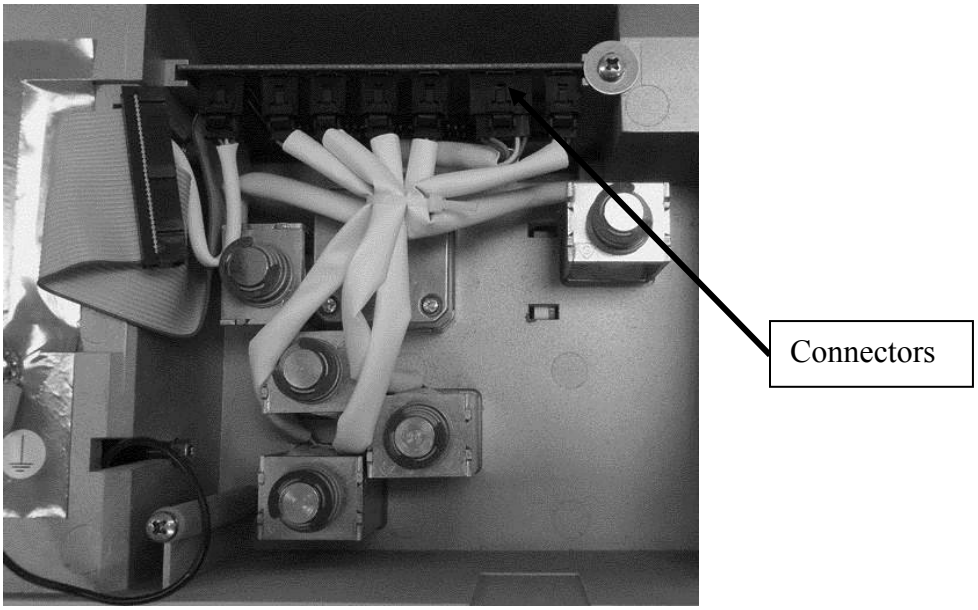


Fig.4-7

4.1.7. Printer Assembly CN-A4020/CN-A4060

Ensure the power to the instrument is off before removing the printer. Partially slide the paper tray out so that the paper roll can be torn from the printer. Completely remove the paper roll and the paper tray. Slide fingers under the printer assembly and pull the printer towards you along the printer board guides on the analyzer. This will disengage the printer from the CPU board and enable removal of the assembly from the front of the analyzer.

Removal of the printer should be performed for replacement and for removal of a paper jam. To replace the printer, locate the printer board guiding tracks and slide a printer onto the analyzer. Press firmly into place to ensure proper connection of the printer to the CPU board.

Note: Never attempt to dislodge paper from the printer with a paper clip or similar object to avoid damage to the print head or printer platen.

CN-A4020 ***CN-A4060***

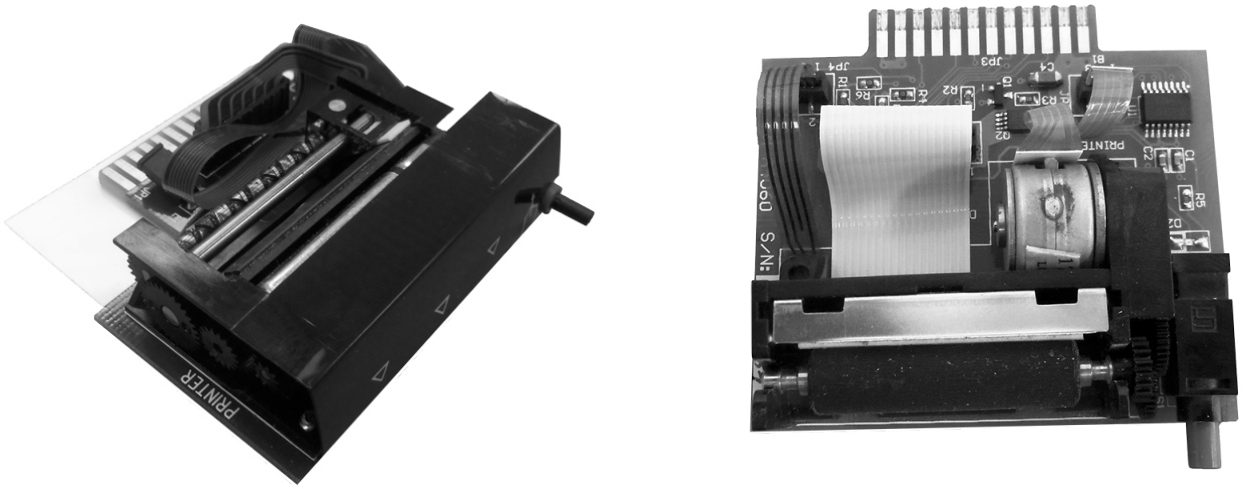
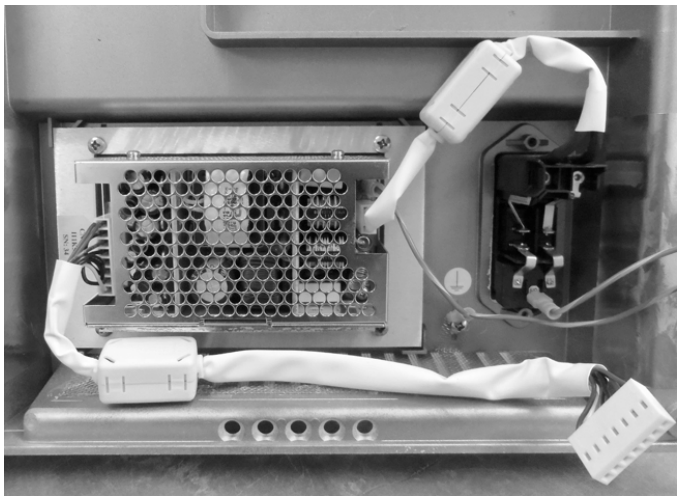


Fig.4-8

4.1.8. Power Supply Subassembly CN-A4019

The power supply subassembly is located on the rear panel and is comprised of the power supply assembly and the main power receptacle. To remove the rear panel assembly, ensure that the power cord has been disconnected. Remove the four corner screws to expose the rear panel. Disconnect the ground wires and connector from the CPU board and front case. The power supply module located on the rear panel assembly can now be removed by removing the four screws securing the power supply mounting plate to the rear panel. The main power receptacle can be replaced by removing the two screws on the rear panel holding this assembly.



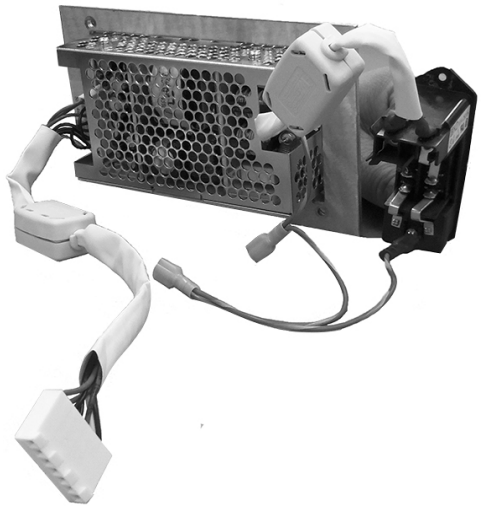


Fig. 4-9

4.1.9. CPU Board CN-A4053/CN-A4061

After the rear panel (Section 4.1.8) has been removed, the CPU Board is accessible for removal. This circuit board can be removed by removing the seven screws with their respective plastic washers securing the board to the housing and by disconnecting electrical connectors from the power supply module, display board and valve board. The electrode push pins can now be replaced by simply pulling the connecting pin from its socket. When installing the board, make sure to place the plastic washers under the screw heads.

Back

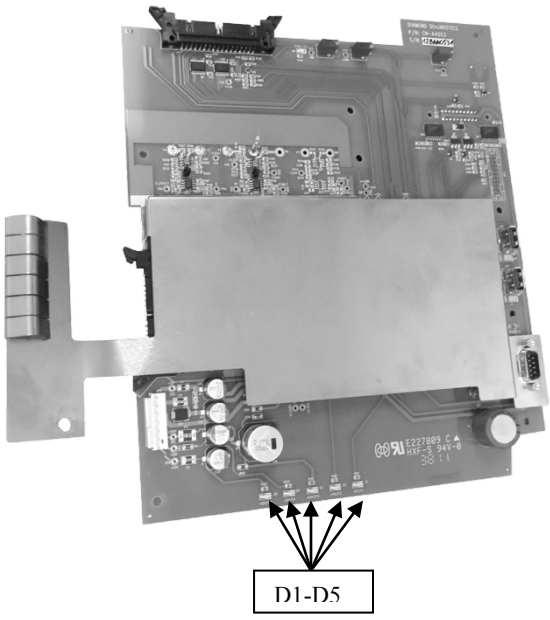


Fig. 4-10

Front

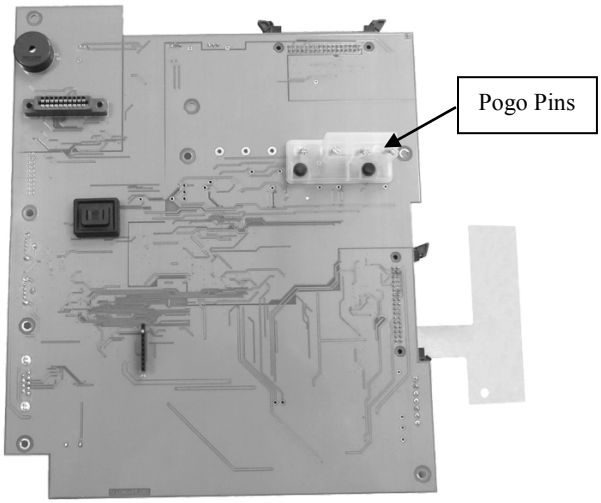


Fig. 4-11

4.1.10. RFID Board CN-A4054

RFID board is attached to the CPU board at JP10. This board must be connected all the time to the CPU board for proper functioning of the instrument. DO NOT unplug the RFID board while the CPU board is powered ON.

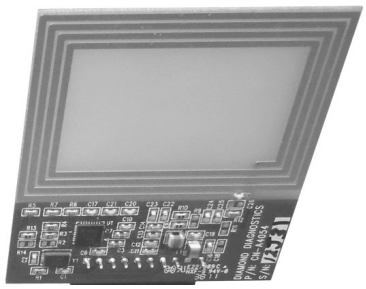


Fig. 4-12

4.1.11. Valve Board CN-A4018

The rear panel and CPU board, referenced in 4.1.9 and 4.1.10, must be removed to gain access to the lamp board. Remove one screw with washer on the right side which holds the board in place and remove the seven electrical connectors to slide this board out.

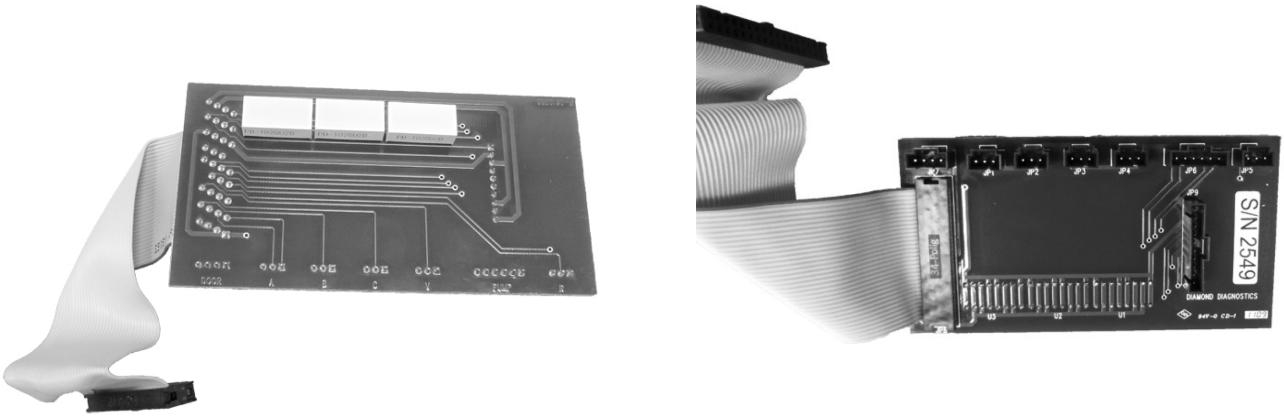


Fig. 4-13

4.1.12. Display Board CN-A4017/CN-A4059

The rear panel and CPU board, referenced in 4.1.9 and 4.1.10, must be removed to gain access to the display board. To remove the display board, unplug the sample sensor cable from the front, remove the ribbon cable from the CPU board. Then remove three screws and 50 degree spacers to remove the display board.

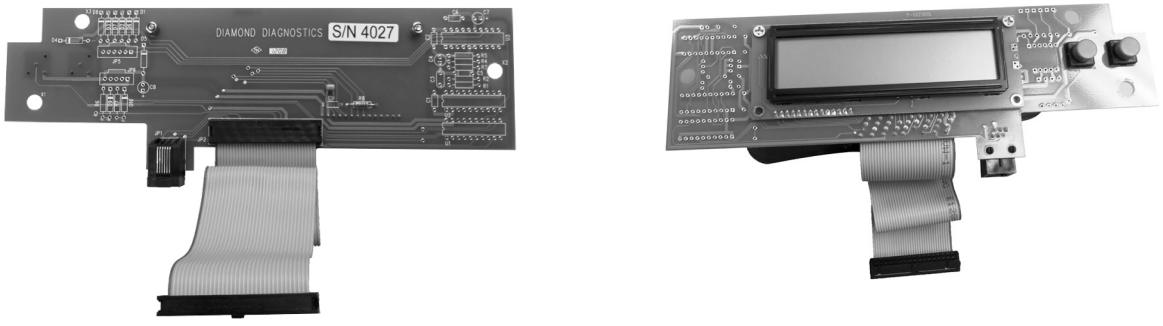


Fig. 4-14

4.2. Fluid Pack

4.2.1. Standard A

Standard A, STD A, is drawn to the electrode module by vacuum provided by the peristaltic pump. When STD A is to be aspirated into the electrode module, solenoid valve A is opened and solenoid valves B, C, V and R are closed. STD A is drawn from the Fluid Pack, to the fill port, through the sample probe up to the sample sensor. When the sample sensor detects fluid, solenoid valve V is opened and solenoid valve A is closed as the peristaltic pump continues to pump STD A into the electrode module. At the trailing edge of the STD A is air. When the sample sensor detects air, the peristaltic pump stops. Standard A should fill the electrode module. During the time STD A is aspirated into the electrode module, the reference housing is pressurized due to the peristaltic pump providing pressure to the reference solution line and solenoid valve R being closed. A small amount of reference solution is forced out through the reference junction to provide contact to the sample.

4.2.2. Standard B and C

The process for STD B and STD C is identical to that of STD A with the exception of the operation of solenoid valves B and C. These solenoid valves are operated in reverse order of STD A aspiration.

4.2.3. Reference Solution

The reference solution is circulated back into the fluid pack. The reference housing has an in and an out port. It is filled automatically using the second winding of the peristaltic pump and solenoid valve R. The reference solution connector allows for the reference housing tubing to be plugged into the reference solution circuit. As the peristaltic pump aspirates reference solution, solenoid valve R is opened to allow excess solution to be pumped into the reference return line of the Fluid Pack.

4.2.4. Waste Liquids

Calibration standards and sample waste are all pumped out of the left side of the electrode module (green-banded tubing) through the peristaltic pump to the waste line and waste bag of the Fluid Pack. An internal one-way valve is incorporated into the waste bag to prevent waste products from leaking out of the Fluid Pack.

FLUIDIC DIAGRAM

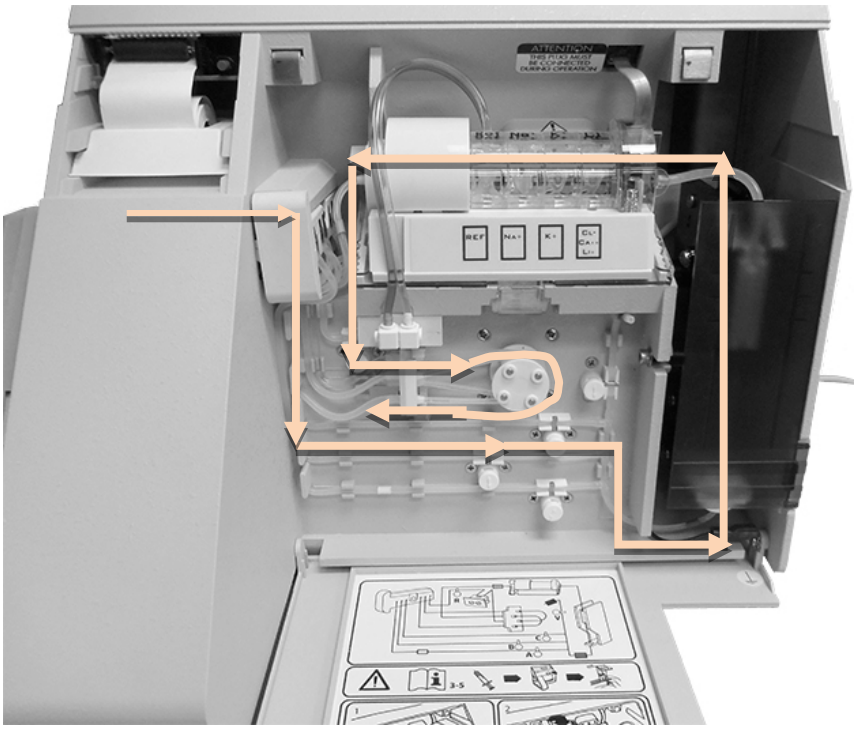


Fig. 4-15

4.2.5. Pinch Valve Tubing Set, AV-BP5193D

The pinch valve tubing set is supplied as a pre-cut tubing harness with the fluidic interconnections preassembled. Replacement of the tube set should be performed annually. For removal of the tubing, first remove the Fluid Pack from the reagent compartment. This will allow the removal of the white TPR block which is the connection between the Fluid Pack and the tubing. Next, follow the procedure outlined in Section 4.1.6 to remove the indicator cap and crimp pin from each solenoid valve to enable fluidic tubing to be easily removed at each solenoid. Pull the two pump windings of the peristaltic pump tube set off the pump rotor and pull out the white reference solution tube connector. Remove the white TPR reference solution block by grasping the front of the block and pulling it out of the analyzer. Disconnect the green tagged tube from the electrode tray and the red tagged tube from the bottom of the fill port. All tubes can now be removed and discarded.

Fit the replacement tubing harness and assemble in reverse order as disassembly. Reference the Tube Diagram on the inside front cover of the analyzer for correct tube locations.

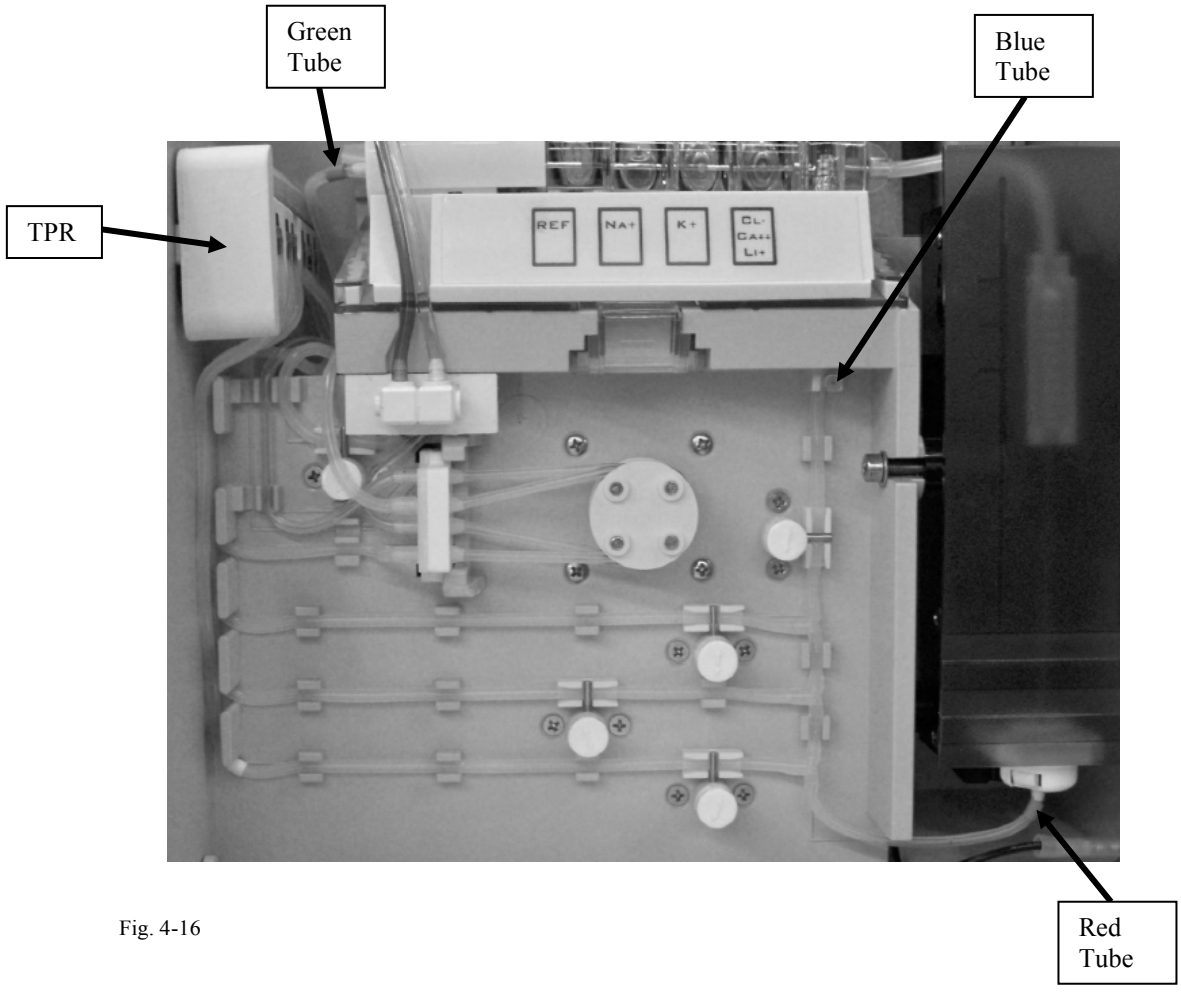
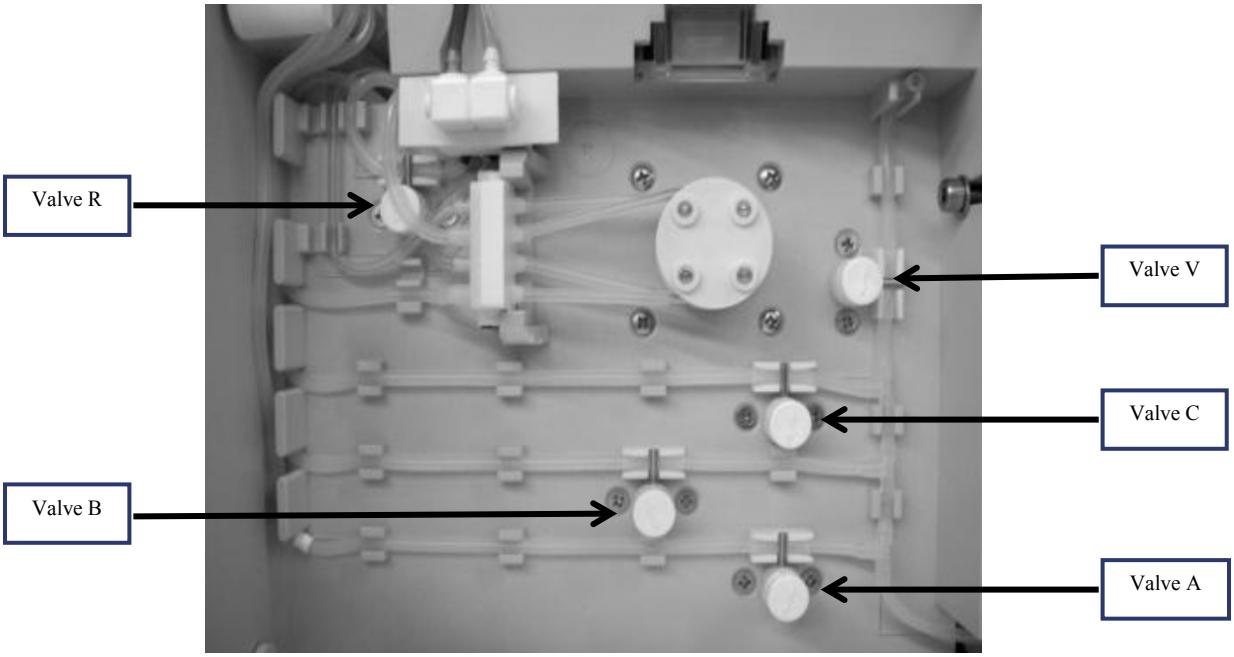


Fig. 4-16

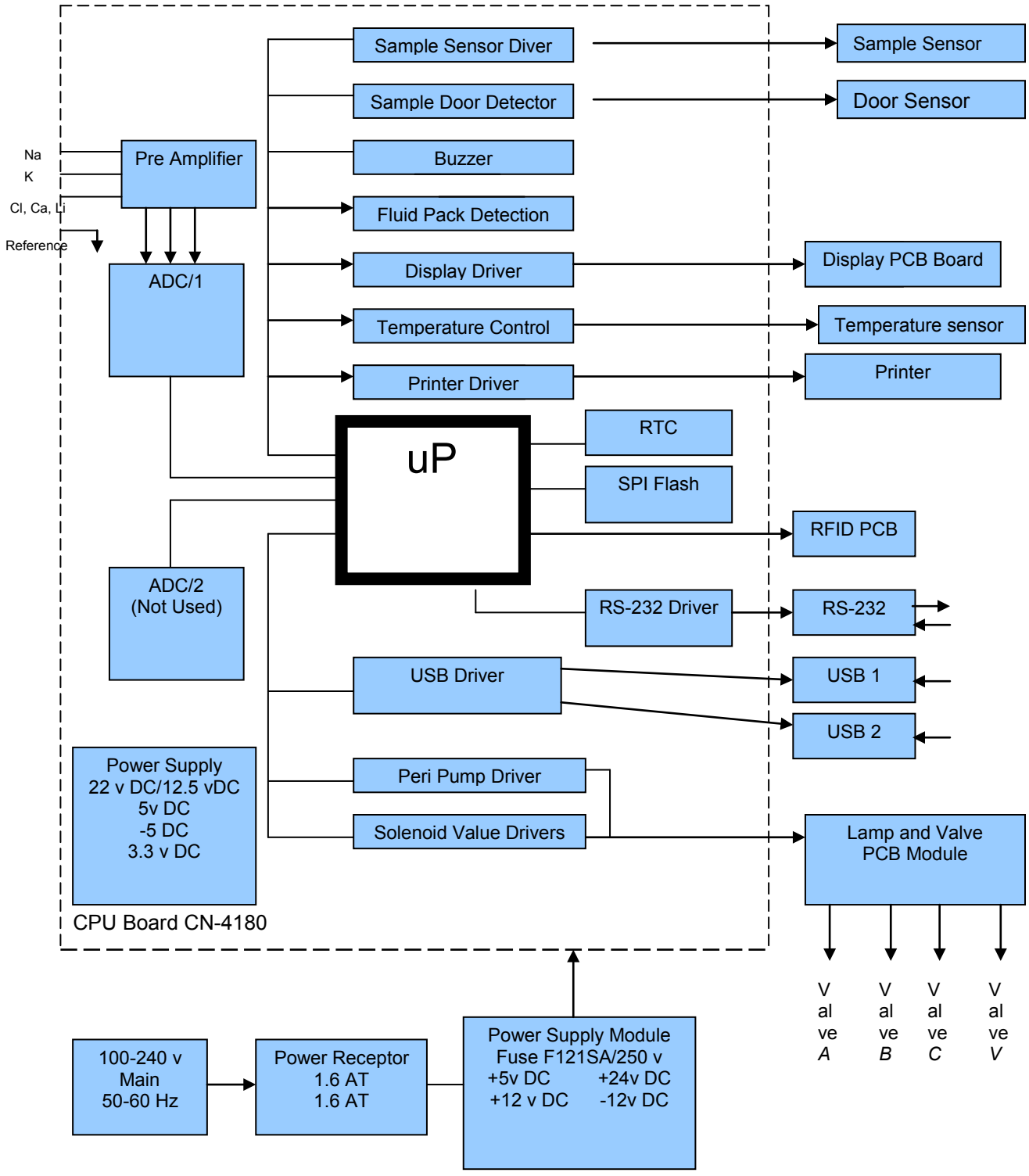


R: reference V: vent A,B,C: Std A,B,C

Fig. 4-17

4.3. Electronics

Block Diagram of Smartlyte



4.3.1. CPU Board

Power Circuits

Power is supplied to this circuit board through connector JP3 from the power supply assembly. Check points are provided to measure supply voltages. The following list identifies the check points.

TEST POINT	VOLTAGE	TEST POINT	VOLTAGE
TP1	+12 VDC	TP2	-12 VDC
TP3	+24 VDC	TP4	2.5 VREF
TP5	2.5 V REF	TP6	PVCC
TP7	SAMPLE IN	TP8	+5 VDC
TP9	TEMP OUT	TP10	REF OUT
TP11	Cl^-/Ca^+/Li OUT	TP12	K OUT
TP13	Na OUT	TP14	NOT USED
TP15	NOT USED	TP16	2.045 VDC
TP17	NOT USED	TP18	-VREF
TP19	-1.2 V REF	TP20	+2.5 VA
TP21	-2.5 VA	TP22	3.3 VDC
TP23	10 V REF	TP24	DGND
TP25	AGND		

Moreover, light emitting diodes Dl through D5 located at the bottom of the CPU board also provides indicators that each supply voltage is present on the board. Since each LED is connected in series after the fuse, a blown fuse results in the respective LED off. The following list identifies the fuses and LEDs for each respective DC supply voltage:

FUSE	LED
F1	D1
F2	D2
F3	D3
F4	D4
F5	D5

Microprocessor

The LM 3S5B91 Microprocessor represented as W6, can be located beneath the metal shielding. This processor is responsible for controlling most of the peripherals, including: ISE signal processing, printing, displaying, data storage, serial communication and USB interfacing.

CPU Shielding

Four additional voltage regulator circuits are mounted inside the CPU board, -5VDC; +5VDC; 3.3VDC and 24/12VDC (see block diagram). SMPS technology used to generate these voltages requires a shield to protect the instrument from the 400 kHz and the harmonics generated internally.

Fluid Pack Sensor

SMARTLYTE analyzer uses fluid packs for calibration, sample analysis, and waste storage. To ensure that the fluid pack is present, an optical reflective sensor is used. The optical sensor has an LED with a photo-detector. The photo-detector signal is used to determine presence of fluid pack.

Valve Drivers

All the solenoids for the valves A; B; C; V and R are controlled from power transistors Q1 to Q5. To open a solenoid, a pulse of voltage 22-24 VDC is applied for 0.5 seconds. Then the voltage drops to 12.5 VDC to hold the solenoid. This feature is applied to conserve energy and prevent overheating the valves.

Pump Motor Driver

The Pump driver circuit IC U7 provides the drive and control for the peristaltic pump. The processor through commands: /PUMPEN and PUMPSTEP drive the IC U7 to provide necessary control for the peristaltic pump stepper motor in the terminals PHASE A; PHASE B; PHASE C and PHASE D.

Input Amplifiers

IC U27; U28; and U29 Provide high to low input impendence matching for each electrode (Na; K; Cl; Ca; and Li) input. IC U25; U25; and U26 provide the offset values and necessary gain for each electrode.

Temperature Sensor circuit

This circuit creates a temperature –depended voltage which is converted by software to degree C. R190 can be adjusted to correct temperature setting.

Analog Channel and A/D Converter

The analog inputs from the amplifiers are connected to IC U21 and U22 ADC1 and ADC2 converters. ADC 2 is in the schematic for future developments.

JP Connector explanation in the CPU board.

In order to fulfill all responsibilities of the CPU board and the program installed on it, is equipped with a number of connectors to interface it with all peripherals. The description of the JP connectors is as below:

JP1 - Graphic printer connector
JP2- NA
JP3 - Power connector receptacle.
JP4 - Display connector
JP5 – Valve board connector
JP6- NA
JP7 – Serial DB9 RS232 Connector
JP8 – USB1 Connector
JP9 – USB 2 Connector
JP10- RFID connector
JP11- JTAG connector

4.3.2. Valve Board CN-A4018

The valve board contains the LED array used to illuminate the measuring chamber and the interconnectors used for all solenoids, the peristaltic pump and the door sensor. A ribbon cable from the CPU Board supplies the electrical connection for each signal through connector JP5.

4.3.3. Display Board CN-A4017/CN-A4059

The graphic display module TH16032A has a 160x32 resolution. The backlight is adjustable and allows for changing the contrast. In the same board are all connection for YES and NO buttons as well sample sensor and temperature sensor. The connection of the display board with CPU board is done through ribbon cable connected to JP4 in the CPU board. The new display board is equipped with two potentiometers for controlling the backlight and the contrast in the display.

Note: Graphics Display is not compatible as a direct replacement with previous generation.

4.3.4. Graphic Printer CN-A4060

A graphics printer with 192 dots of a TP series has improved the quality and the speed of printing. The new schematic printer allows the selection of three different fonts and has a speed 6 times faster than the previous generation.

Note: Graphics Display is not compatible as direct replacement with previous generation.

Shielding and Grounding in SMARTLYTE

Beside the shield for eliminating the internal noise from the power supply, the entire SMARTLYTE is equipped with a protective shield to prevent the influence of magnetic fields, and other noise sources in the laboratory. The internal protective shield creates a **"Faraday Cage"** that protects instrument measurements from outside noise. This shield is also grounded with a grounding wire in the power receptacle in the power switch input.

5. Maintenance and Troubleshooting

Maintenance procedures for the SMARTLYTE Electrolyte Analyzer require minimal time by the operator to perform. The procedures outlined below should be performed by the schedule indicated. Detailed instructions for these procedures can be found in the Operator's Manual describing the correct method to perform routine analyzer maintenance.

5.1. Maintenance

Daily Maintenance

- Perform cleaning cycle.
- Perform conditioning cycle.

Weekly Maintenance

- Clean sample probe and fill port.
- Clean analyzer surfaces.

Monthly Maintenance

-Clean reference electrode housing.

Six Month Maintenance

-Replace peristaltic pump tubing.

Annual Preventive Maintenance

- Replace complete tubing set.
- Replace fill port assembly
- Replace sample probe.
- Replace sample sensor Quad-ring.
- Check sample sensor voltage.
- Check sample temperature.

5.2.Error Messages and Troubleshooting

STATUS: INVALID CALIBRATION

This message is only displayed when a calibration has been interrupted by pressing NO, opening the sample door, or none of the electrodes are calibrated. Perform a calibration to return to the H-READY Mode.

STD A NOT FOUND

This message is displayed when the sample sensor is unable to properly detect the STD A solution in a programmed time period. As the analyzer draws a sample of STD A, the leading edge of the solution is detected by the sample sensor. The sample sensor must also detect a continuous flow of STD A Solution into the sample chamber, lasting several seconds, without encountering air bubbles. After several seconds, the trailing edge of the STD A sample is sensed, the peristaltic pump stops and measurement occurs.

Possible causes and remedies:

- Check for air leaks preventing the Standard from being drawn into the chamber. Ensure that all O-rings are in place. There must be a continuous draw of standard solution, free of air bubbles. Check solenoid V for proper sealing of the vent line. Check fill port to ensure the absence of air leaks.
- Check for clots or crystals formed in the STD A tubing or electrode chamber.
- Ensure that the sample sensor is plugged in securely and perform Check Sample Sensor to ensure sensor is operating correctly. Clean, adjust or replace sample sensor to correct sample sensor operation.
- Replace peristaltic pump tube set to ensure proper sample aspiration.
- Check the fluid remaining in the Fluid Pack. If less than 5% remains, replace the Fluid Pack.
- Prime system; look for fluid flow through system.

STD B NOT FOUND
STD C NOT FOUND

The system for drawing STD B or C is like that of STD A. If STD A is drawn properly and STD B or C is not detected, check STD B tubing for crystallization. Perform checks for STD A detection problems to correct. During the calibration sequence, STD B or C is drawn into the measuring chamber prior to STD A, therefore check if STD A calibrant can be properly detected to isolate possible fluidic faults. If neither STD A, B nor C are detected check for air leaks or blockages within the fluidic path.

INSPECT SAMPLE SENSOR

The sample sensor must provide a reading of 80 - 120 when air is detected.

Perform Check Sample Sensor to observe sample sensor response. When clear fluid (e.g. water) is aspirated, the sample sensor display must indicate an increase of at least 40 units. For blood samples (not transparent), the reading should decrease by at least 40 units. The sample sensor is calibrated with air during each calibration.

Possible causes and remedies:

- Clean sample sensor using CLEANING procedure.
- Check for correct drying of measuring chamber during the wash cycle.
- Replace peristaltic pump tube set.
- Check and adjust sample sensor to correct adjustment. This adjustment can be accessed through the rear cover vent slot and is located at the top center on the circuit card.
- Replace sample sensor assembly.

INSPECT REFERENCE HOUSING

The reference electrode is pressurized by injecting STD A while R valve is closed. The back pressure formed in the reference housing causes the STD A solution to flow back toward the sample sensor. When the STD A solution is detected by the sample sensor, the R valve is opened to release the pressure. If the sample sensor does not detect STD A as it moves back, INSPECT REFERENCE HOUSING will be displayed.

Possible causes and remedies:

- Check for clogged reference housing and clean per monthly maintenance procedures.
- Check and ensure that reference tubing is securely connected at the tubing connector.
- Check for proper filling of the reference housing and ensure that reference solution reagent level allows complete filling of the reference housing.
- Check for bubble-free aspiration of STD A.
- Check O-Rings to ensure they are present in all electrodes and sample sensor
- Prime SMARTLYTE and repeat calibration

SHUT DOOR

This message occurs when either of two conditions exists.

1. Sample door is not closed within 20 seconds after samples are in place.

2. Sample door has been opened and no sample is detected within 20 seconds.

Possible causes and remedies:

- Close sample door within the time allowed.
- Check needle mechanism light gate.
- Check whether sample sensor is plugged in.

SAMPLE NOT FOUND

This message is displayed when any of the following conditions occur:

1. During sampling, either a bubble in the sample is detected or the sample size is smaller than the minimum sample required.

2. The sample door is opened and no sample is fed into the analyzer.

3. Sample door is not closed within 20 seconds after sample is detected.

Possible causes and remedies:

- Check whether the sample sensor is plugged in and perform CHECK SAMPLE SENSOR to verify that it operates correctly.
- Check sample draw and look for clots or leaks in the sampling system.

CLEANING SOLUTION NOT FOUND

When the cleaning cycle has been initiated, the analyzer checks for proper aspiration of the cleaning solution using the sample sensor. If solution is not detected in the proper time, above error message will be displayed.

Possible causes and remedies:

- Ensure that a sufficient volume of cleaning solution is presented for aspiration and no air bubbles are present as solution is aspirated.

- Check to ensure that the solution is being aspirated through the sampling mechanism correctly. The sample path must be free of leaks or clots.

- Verify that sample sensor is properly plugged in and perform the CHECK SAMPLE SENSOR to verify the correct operation of the sample sensor.

- Check pump tubing and replace as necessary to ensure a correct pump rate.

CONDITIONER NOT FOUND

When the conditioning cycle has been initiated, the analyzer checks for proper aspiration of the conditioning solution using the sample sensor. If the solution is not detected in the proper time, this error message will be displayed.

Possible causes and remedies:

- Ensure that a sufficient volume of conditioning solution is presented for aspiration and no air bubbles are present as solution is aspirated.
- Check to ensure that the solution is being properly aspirated through the sampling mechanism. The sample path must be free of leaks or clots.
- Verify that sample sensor is correctly plugged in and perform the CHECK SAMPLE SENSOR to verify its proper operation.
- Check pump tubing and replace as necessary to ensure correct pump rate.

INTERFACE CHECK ERROR

This message is displayed only during the ACTIVATE INTERFACE. Pins 2 and 3 must be shorted together to perform the ACTIVATE INTERFACE. Make sure that the pins are not shorted to chassis ground.

Possible cause and remedy:

- Call Product Support

PRINTER JAM OR DEFECT

This message is displayed when the printer head is jammed and tries to print. It is a temporary message that is displayed for 2 seconds and then sample results are displayed. To clear paper jam remove printer from the analyzer and remove jammed paper. Replace printer and retry. The printer can be removed by grasping the rear edge of the printer assembly and pulling it to the front. The printer can be removed with the Analyzer power on. To free up jammed paper, turn the small gears on the left side of the printer module.

INSPECT ELECTRODES

This message is displayed when either of the following conditions is present.

1. More than six aspirations of STD A does not result in three consistent STD A readings for all electrodes.

2. The difference between voltage A and B is out of specification for all channels.

Possible causes and remedies:

- Electrodes are not plugged in. Check the slide mechanism to ensure it is in the correct position and firmly pushed into electrode connectors.
- Perform MAINTENANCE.
- Check or replace reference electrode.
- Replace Fluid Pack.
- Check connection from shielding to ground to determine if electrical short is present.
- Call Product Support.

NA INVALID CAL
K INVALID CAL
CL INVALID CAL
CA INVALID CAL
LI INVALID CAL

These messages will be displayed when a specific electrode does not calibrate properly during a calibration sequence. If more than six standard draws are required or the difference between STD A and STD B voltages is out of range, the INVALID CALIBRATION message will be displayed for each channel which exhibits either of these conditions. A copy of the calibration report should be printed to provide the electrode output voltages measured during calibration. The electrode voltage range table identifies correct voltage ranges for each electrode configuration. If the difference between STD A and STD C is out of range for Li^+ or Na^+, LI INVALID CAL will be displayed.

Possible causes and remedies:

- Check to ensure calibration reagents are transported correctly. Check for leaks, blockages, bubbles, or improper pump flow rate.
- Check or replace Fluid Pack
- Check whether electrodes are plugged in properly. Check the slide mechanism to ensure it is in the correct position and firmly pushed into electrode connectors. Clean and/or replace electrode.
- If A-C is out of range for Na+, repeat the calibration or replace the Fluid Pack
- Check or replace CPU Card.

ELECTRODE VOLTAGE RANGES

Electrode	Standard A	Standard B	Standard C	Allowed difference A-B	Allowed difference A-C
Na^+	- 600 to +2400	-1600 to +2000	-600 to +2400	+250 to +680	-50 to +50
K^+	- 700 to +1000	-2500 to +500	-700 to +1000	+470 to +1200	-40 to +40
Cl^-	- 3100 to +500	-1000 to +3000	-3100 to -100	-370 to -860	not used
Ca^{++}	- 3100 to +1000	-2300 to +2500	-3100 to +1000	-350 to -660	-150 to +150
Li^+	- 3100 to +1900	-3600 to +1400	-2600 to +3400	+1 to +760	-1730 to -285

INSPECT FLUID PATH

After completion of sample measurement or calibration, the analyzer will monitor the sample sensor to determine if the sample path has been cleared. This message will be displayed if the sample path has not been cleared.

Possible causes and remedies:

- Check for blockages in the sample path, especially in the sample probe, the tubing to the sample sensor and in the sample sensor.
- Check sample sensor is securely plugged in and check sample sensor under SERVICE MENU to ensure correct operation.
- Check peristaltic pump and tubing are correct and all tubing is properly in place.

Run Prime Function, Run Calibration

↓↓↓↓ ↑↑↑↑

In case the analyzer displays arrows up or arrows down instead of sample results, the concentration of the sample is outside of the measurement range.

Possible causes and remedies:

- If the sample is a urine sample, arrows up instead of the K+ result indicate that further dilution of the specimen is required.
- Check for proper sample preparation.
- Ensure that the sample is correctly aspirated into the measuring chamber and ensure small air bubbles are not present.
- Check for proper aspiration of STD A.

↓ ↑

On the SMARTLYTE, the calibration report will print an arrow up or down instead of the actual temperature, if the temperature measured is out of range (10.0°C -40.0°C) or when calibration values are higher or lower than specifications. The temperature sensor is located in the right side electrode holder.

Possible causes and remedies:
• Ensure that sample sensor cable is securely plugged in.

• Check whether room temperature is within specified limits (15°C to 32°C / 60°F to 90°F).

• Perform temperature adjustment procedure.

• Replace CPU board or right side electrode holder.

ERR

The analyzer will display ERR in place of sample results when the analyzer is unable to obtain valid voltage readings from the electrode (A/D over- or underflow).

Possible causes and remedies:
• Ensure that the electrodes are securely in place and plugged into the analyzer.

• Check to ensure proper filling of the reference electrode has occurred.

• Ensure proper sampling and proper sample preparation. Check for air bubbles in the sample.

• Check Amplifier to verify electrode voltages

EXECUTE MAINTENANCE

This message will be printed at the end of a sample report when cleaning or conditioning has not been performed within the last 24 hours. This message is printed only. Perform maintenance to clear this message.

CHANGE

When the monitored fluid level in the Fluid Pack is less then 0% remaining, the analyzer will display change FLUID PACK. Replace the Fluid Pack following the instructions outlined in the Operator Manual.

VALVE OVERTEMP! INSPECT VALVES

In case one of the valve solenoids overheats or is not connected properly, the message VALVE OVERTEMP! INSPECT VALVES will be displayed. Each solenoid incorporates a thermo-fuse, which will reset automatically.

Possible causes and remedies:

- Turn power off for at least one hour.
- Check fuse F3 (24V).
- Check whether room temperature is within specified limits (15°C to 32°C / 60°F to 90°F).
- Ensure all the pinch valves are connected properly.

6. *Adjustments*

The SMARTLYTE Electrolyte Analyzer has been designed to require minimal electronic adjustment. Diamond Diagnostics recommends adjusting the sample sensor circuit after changing the sample sensor during routine troubleshooting or during annual maintenance procedures. The temperature adjustment is active and requires the temperature adjustment check plug for correct calibration of the temperature circuit.

6.1. Sample Sensor Adjustment

Press F7 in the keyboard to access **SERVICE MENU** and here you need to access **SAMPLE SENSOR CHECK**. By confirming, instruments will remove solutions from sampling path. On the top right corner of the screen, a number between the ranges of 0 to 240 is shown. Sample sensor potentiometer (R189) is located on the top of the CPU board (See Fig. 6-1).

Adjust R189 until the value 100 is reached in the display. After this adjustment, open sample door, press **YES** or **ENTER**, and introduce water in the sample probe. When liquid arrives in the sample sensor, the number on the screen will change. Displayed values must be 50 points or higher that the adjusted value (80-120 range).

Note: R189 can be accessed through the rear cover vent slots.

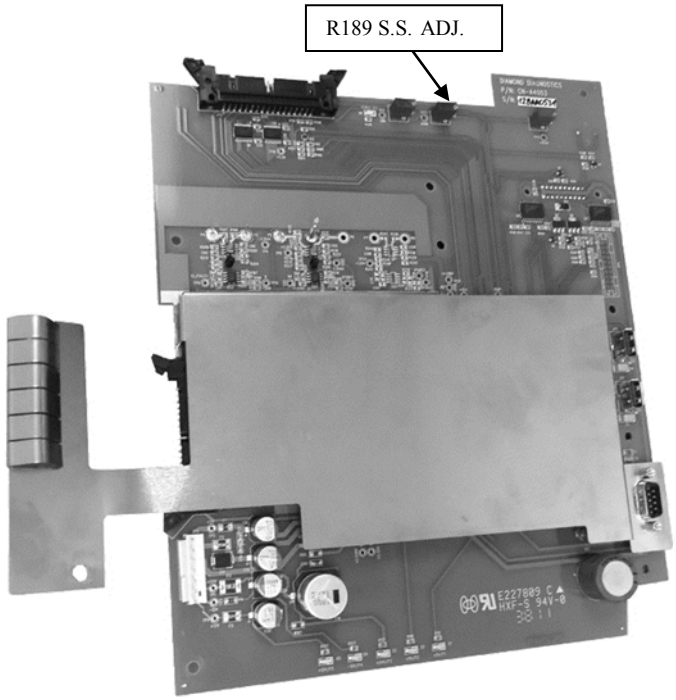


Fig. 6-1

6.2. Temperature Adjustment

Press **F7** in the keyboard to access **SERVICE MENU**. Scroll down **SERIVCE MENU** and select **CHECK AMPLIFIER**. If electrodes are installed, the instrument will display the amplifier mV status. If electrodes are not installed, the instrument will display 4095 as its status.

By pressing **NO** in the Touch Pad or **NEXT** in the keyboard twice, the instrument will show temperature screen in mV and in C degree. (Upper row displays mV values and bottom row displays temperature in degrees Celsius.

Dye to the closed door, the instrument in the measuring chamber has a temperature higher than room temperature.

Please insert a probe of a calibrated thermometer, in the top of the sample sensor. Adjust **R190** (located in the top right corner of the CPU board) to match values of the thermometer reading with displayed values in the second row in the screen (See Fig. 6-2).

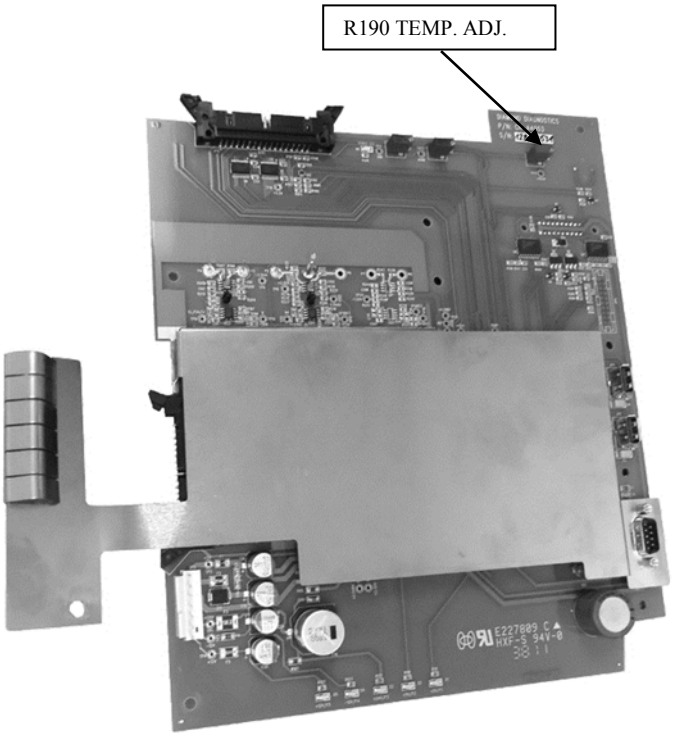


Fig. 6-2

6.3.Display, Contrast and Backlight Adjustment

The new display board CN-A4059 is equipped with contrast and backlight adjustment possibilities. This adjustment is done in the factory and is not in normal procedure to adjust or readjust in the field.

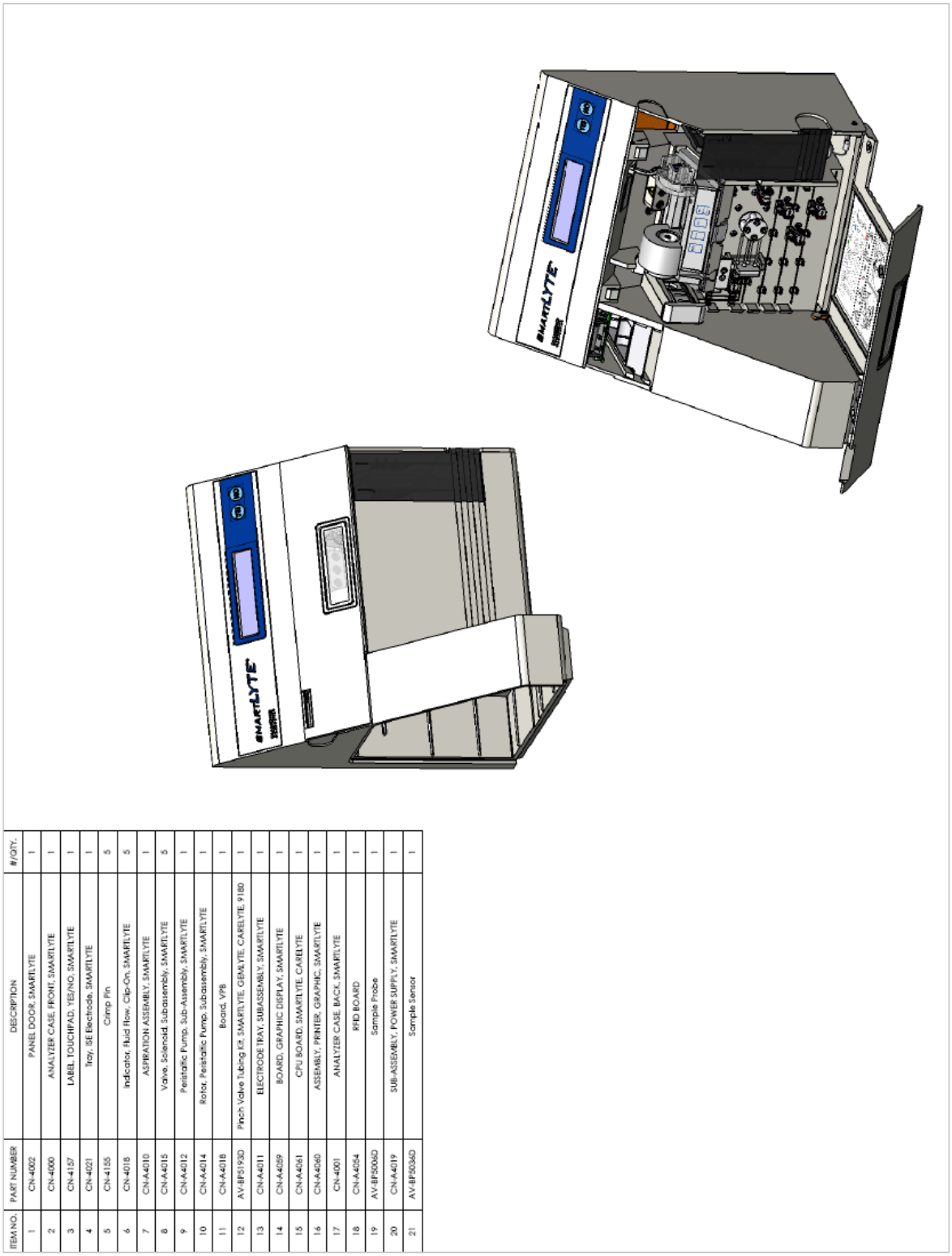
Fig. 6-3 shows the location of these potentiometers in the display board. **R1** is for the contrast and **R2** is for backlight.

Note: R1 and R2 potentiometers are NOT accessible through the rear cover. Any adjustment needs to be done with the back cover open.

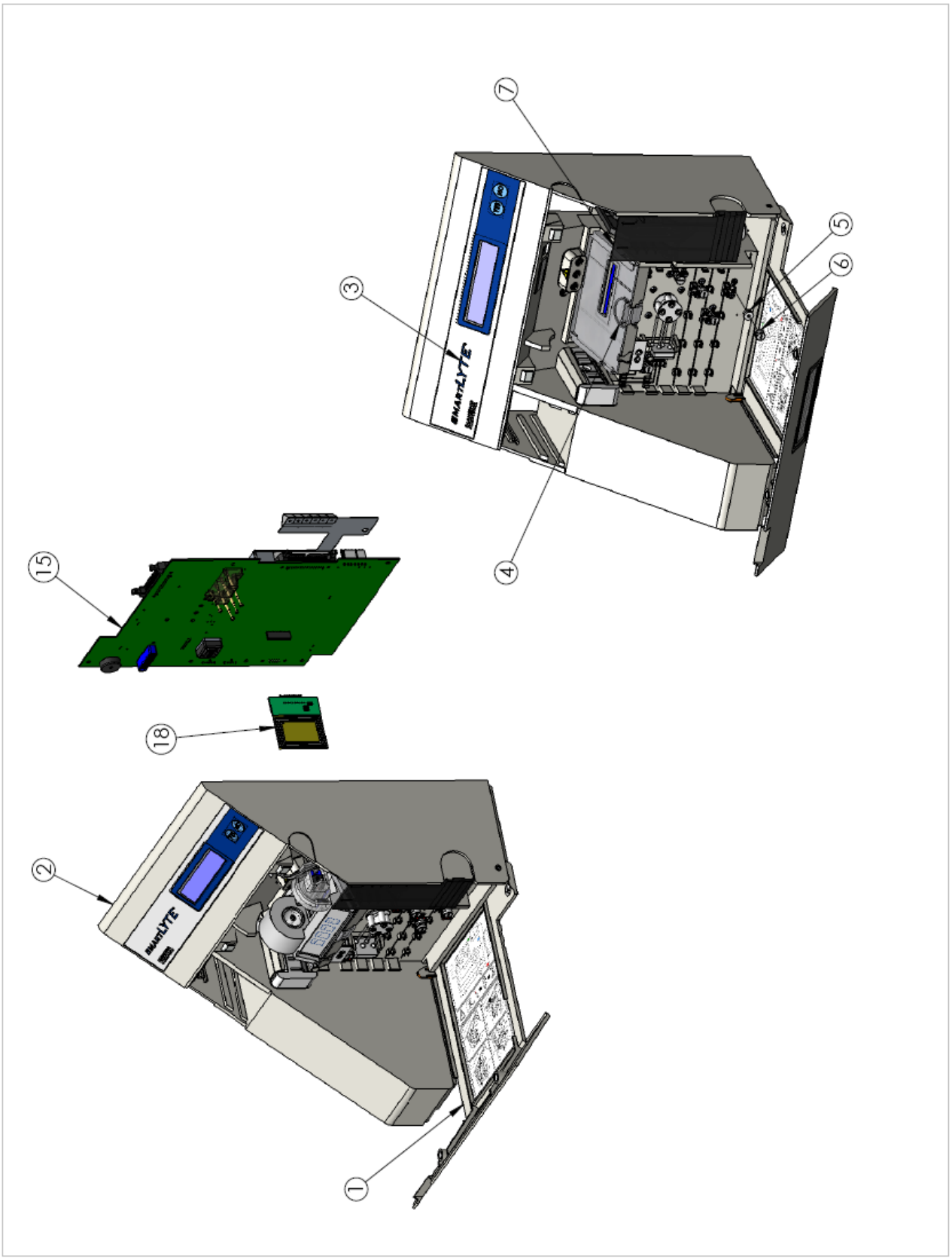
Fig. 6-3

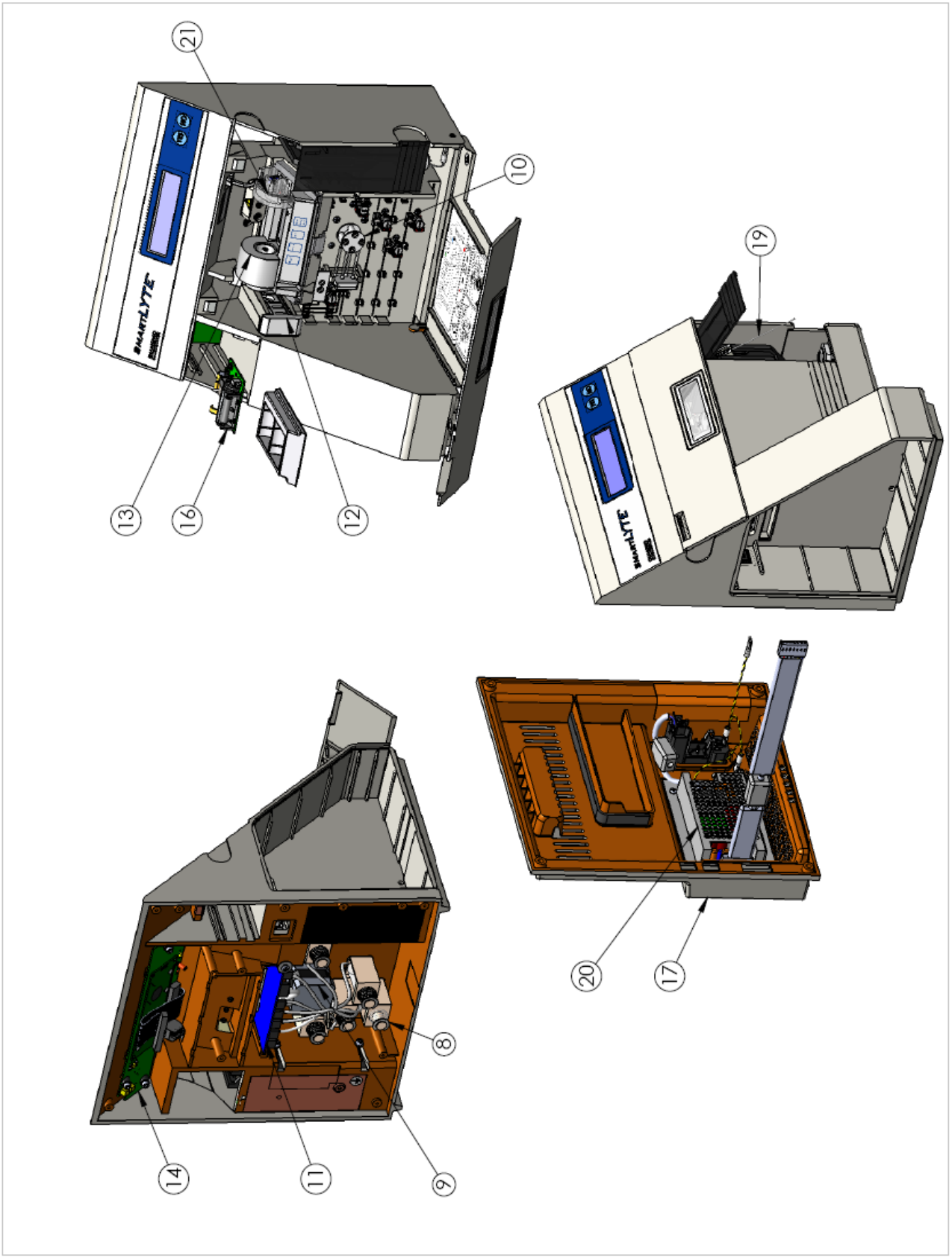
7. *Illustrated Parts List*

SMARTLYTE Assembly Drawing

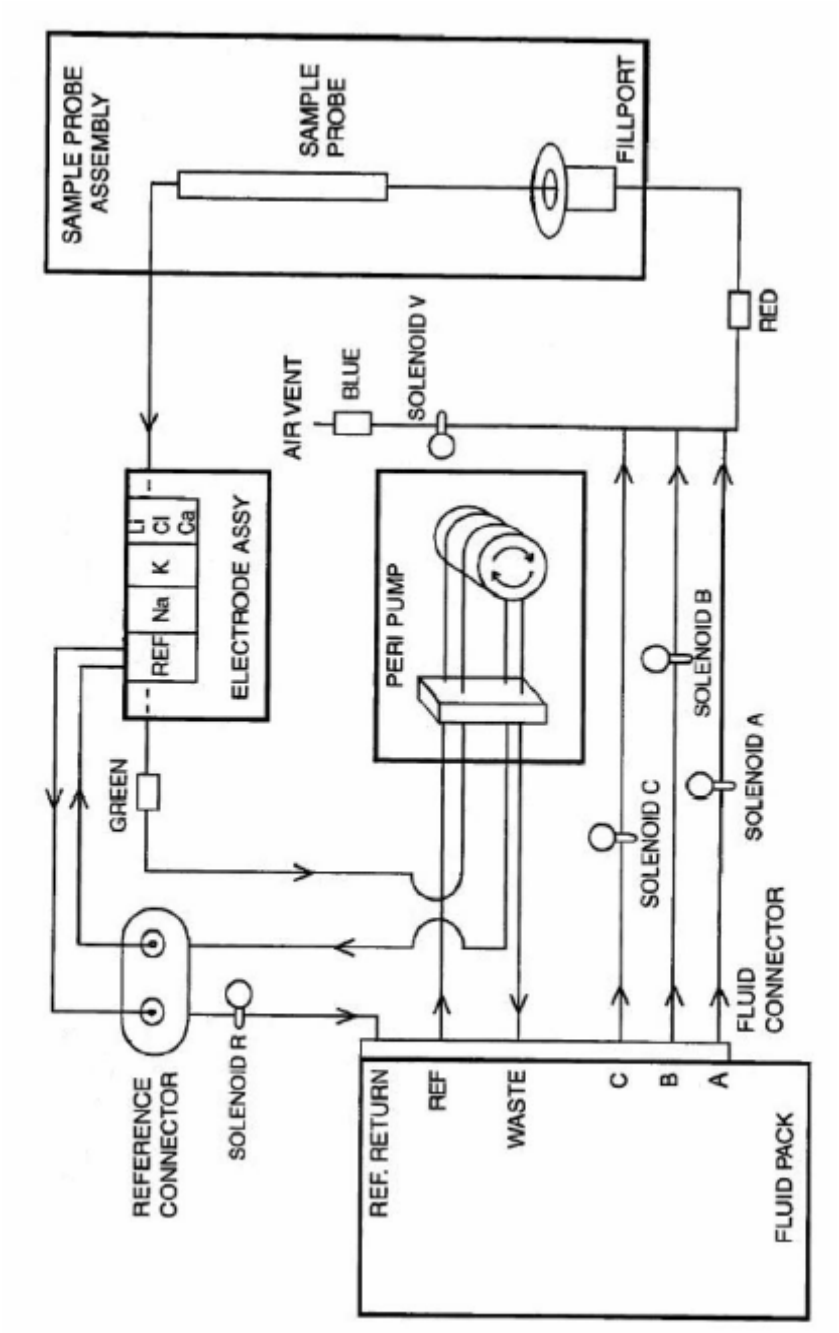


ITEM NO.	PART NUMBER	DESCRIPTION	#/QTY.
1	CN-4002	PANEL DOOR, SMARTLYTE	1
2	CN-4000	ANALYZER CASE, FRONT, SMARTLYTE	1
3	CN-4157	LABEL, TOUCHPAD, YES/NO, SMARTLYTE	1
4	CN-4021	Tray, SE Electrode, SMARTLYTE	1
5	CN-4155	Crimp Pin	5
6	CN-4018	Indicator, Fluid Flow, Clip-On, SMARTLYTE	5
7	CN-A4010	ASPIRATION ASSEMBLY, SMARTLYTE	1
8	CN-A4015	Valve, Solenoid, Subassembly, SMARTLYTE	5
9	CN-A4012	Peristaltic Pump, Sub-Assembly, SMARTLYTE	1
10	CN-A4014	Rotor, Peristaltic Pump, Subassembly, SMARTLYTE	1
11	CN-A4018	Board, VPB	1
12	AV-BPS1930	Pinch Valve Tubing Kit, SMARTLYTE, CERALYTE, 9180	1
13	CN-A4011	ELECTRODE TRAY, SUBASSEMBLY, SMARTLYTE	1
14	CN-A4059	BOARD, GRAPHIC DISPLAY, SMARTLYTE	1
15	CN-A4061	CPU BOARD, SMARTLYTE, CERALYTE	1
16	CN-A4060	ASSEMBLY, PRINTER, GRAPHIC, SMARTLYTE	1
17	CN-4001	ANALYZER CASE, BACK, SMARTLYTE	1
18	CN-A4054	RFID BOARD	1
19	AV-BPS0060	Sample Probe	1
20	CN-A4019	SUB-ASSEMBLY, POWER SUPPLY, SMARTLYTE	1
21	AV-BPS0360	Sample Sensor	1





SMARTLYTE FLUIDIC DIAGRAM



Item Replacement Parts	Description
AV-BP5006D	PROBE, SAMPLE
AV-BP5014D	KIT, SHUTDOWN
AV-BP5036D	SENSOR, SAMPLE
AV-BP5193D	KIT, PINCH TUBING
AV-BP5194D	KIT, STARTUP
CN-4018	INDICATOR, FLUID FLOW, CLIP-ON
CN-4021	TRAY, ISE ELECTRODE
CN-4070	TRAY, PRINTER PAPER
CN-A1076	PROBE, BODY SUB-ASSEMBLY
CN-A4010	ASSEMBLY, ASPIRATION
CN-A4011	SUB-ASSEMBLY, TRAY, ELECTRODE
CN-A4012	PUMP, PERISTALTIC PUMP
CN-A4013	PIN, CRIMP, FLUID PATH
CN-A4014	SUB-ASSEMBLY, ROTOR, PERISTALTIC PUMP
CN-A4015	VALVE, SOLENOID, SUBASSEMBLY
CN-A4017	BOARD, DPB
CN-A4018	BOARD, VPB
CN-A4019	SUBASSEMBLY, POWER SUPPLY
CN-A4020/CN-A4060	SUBASSEMBLY, PRINTER
CN-A4053/CN-A4061	BOARD, CPU
CN-A4054	BOARD, RFID
DD-0201	KEYBOARD
DD-0202	BARCODE SCANNER

8. Interface Specifications

8.1. Interface Information

The Diamond SMARTLYTE Electrolyte analyzer is equipped with a standard serial interface output. This interface output is intended to be used with standard commercially available computer systems.

The data transmitted through the serial interface port employs the ASCII code.

The serial interface is terminated on the rear cover with a 9-pin male DB-9 connector.

The signal levels are as follows:

- Binary 1 = -12V to -3V
- Binary 0 = +3V to +12V

Two stop bits follow the eight data bits to complete the 10 bit word.

The baud rate is set at 115200 Baud fixed.

The maximal recommended cable length is 40 feet.

The pin assignment is as follows in RS232 port are:

pin 1... sample ground... GND
pin 2...RS232IN ... . RxD
pin 3 ... RS232OUT... . TxD
pin 4...NC
pin 5... Digital ground... DGND
pin 6...NC
pin 7.. RTS
pin 8...CTS
pin 9...Print VCC
(NC=Not Connected)

Software

The patient sample data is sent at the end of each measurement, the calibration report is sent at the end of each calibration.

The interface and the printer setting are activated on the menu “instrument setting”

Note: The arrow up (e.g. out of normal range) is sent as HEX 18 (↑), the arrow down as HEX19 (↓) and the ° (degree) is sent as HEX1A (→).

8.2. Example Data String Information

Automatic Calibration Report

sx* DIAMOND SMARTLYTE*crcrlfELECTROLYTE ISEcrcrlfn3JAN92
10:51crcrlf*CALIBR REPORT *crcrlfcrcrlfDailyMaintenancecrcrlf
Performed Last : crcrlfl)2JAN92 10:3 5 crcrlfcrcrlf
STD AcrcrlfNa = -112mV (3)crcrlfK = -1392mV (3)
crcrlfCl = -106mV (3)crcrlfcrcrlfDifference A-Bcrcrlf
Na = 1402mV ()cr crlfK = 1032mV ()crcrlfCl = -1006mV ( )
crcrlfcrcrlfFluid Pack:crcrlf6 8% Remainingcrcrlfcrcrlfex

Serum Sample Report

sx* DIAMOND SMARTLYTE*crcrlfELECTROLYTE ISEcrcrlf1D3JAN92
10:5 9crcrlfcrcrlf Name:..... crcrlf .... crcrlfSample:
SERUMcrcrlfcrcrlf Sample No.13 crcrlfcrcrlfNa= 159soh mmol/LcrcrlfK
= 5.4mmol/LcrcrlfCl= 122soh mmol/Lcrcrlfcrcrlf*PERFORM DAILY
*crcrlf*MAINTENANCE ! *crcrlfcrcrlfex

8.3. Example Data String Information

A serial cable with straight through configuration is required for this process.
*To turn on communication, enter LIS service code in [**SERVICE LOGIN?**].*

Serial communication protocol

Result Format

PARAMETER	NO OF CHARACTERS	EXAMPLE
START	1	(02 H)
CODE1	1	'S' SAMPLE
CODE2 CODE3 DATA LENGTH	3 3 5	ANA ANALYSIS 000 RESERVED FOR FUTHER USE 00037
DATE TIME	6 4	ddmmyy hhmm
RACK NOS	4	0000
TUBE NOS	4	0000
TEST NOS ID NAME	5 16 16	00010 PATIENT ID PATIENT NAME
PATIENT TYPE SAMPLE TYPE	2 1	Human, Control, Animal B Blood
RESULT 1	33	Electrode Result (see break up)
RESULT 2 RESULT 3	33 33	Electrode Result (see break up) Electrode Result (see break up)
RESULT N	33	Electrode Result (see break up)
Temperature STOP	8 1	Temperature (03 H)

Rows Highlighted in Green are only valid for Sample Analysis. During calibration, these are not passed in the LIS data packet.

Start Code
Hexadecimal value [02] marks the start of data packet

Analysis Code

Description	**Code1**	**Code3**	**Code3**
Sample Analysis	S	ANA	000
Calibration	C	ION	000

Data Length
Determines the data length that follows after this block

Date
Represents date in DD-MM-YY format

Time
Represents time in HHMM format

Rack Number
Represent the rack number. Not used here. Reserved for future use!

Tube Number
Represent the sample tube number. Not used here. Reserved for future use!

Test Number
Default internal sample test number give to each sample.

Patient Id
Operator assigned 16 characters long Patient Id. Default Patient Id is 16 white spaces.

Patient Name
Operator assigned 16 characters long Patient Name. Default Patient name is 16 white spaces.

Patient Type

Patient Type	Patient Type Code
Control Sample	01
Standard Sample	02
Human Sample	03
Dog Sample	04
Cat Sample	05
Cow Sample	06
Horse Sample	07
Pig Sample	08
Sheep Sample	09
Other Animal	10

Sample Type

Sample Type	Sample Type Code
Serum	1
Blood	2
Urine	3
Standard	4
QC1	5
QC2	6
QC3	7
Bicarbonate	8
Acetate	9

Sample Result [X]

Ion result is sent out in 33 characters. Table below shows the result format:

PARAMETER	NO OF CHARACTERS	EXAMPLE
ION CODE Unit Code Value Sign Value	2 1 1 7	01 M + Positive number 0100000 1000 times Conc result
Correlation Flag	1	D Default
Error Flag Sample milli-volt sign	1 1	L Low + Positive number
Sample milli-volt Sample try Count Standard milli-volt sign	7 2 1	0343400 1000 times Sample mV 01 Number of tries for successful result + Positive number
Standard milli-volt	7	0343400 1000 times Sample mV
Standard try Count	2	01 Number of tries for successful result

Ion Code List

Ion Code Parameter	**Code**
Na K	01 02
Cl	03
Ca Li Na (Std C)	04 05 06
K (Std C)	07
Cl (Std C) Ca (Std C) Li (Std C)	08 09 10

Unit Code List

Unit Code	Unit Code
mmol/dL	M
mg/dL	G

Value Sign

This character represents if value is positive or negative. “+” represents positive and “-” negative numbers

Value

Ion concentration value is sent out in 7 Digits. This number is 1000 times the concentration determined in the analysis. For example, 01234560 represent value of 1234.56

Correlation Flag

Correlation Type	Flag Code
Default	D
User Correlation	U
MGL Correlation (for Ca)	M
Flame Correlation	F

Error Flag

Correlation Type	Flag Code
MV Range Error	V
Noise Error	N
Drift Error	D
Range Low	L
Range High	H
Too Low	<
Too High	>
Not Calibrated	X
Not Consistent	!
Cannot Measure	@
Li Cannot Measure	M

Reading 1 mV Sign

This character represents if value is positive or negative. "+" represents positive and "-" negative numbers. During calibration, this represents STD-A. During sample analysis, it represents Sample mV.

Reading 1 mV Value

Ion concentration value is sent out in 7 Digits. This number is 1000 times the concentration determined in the analysis. For example, 01234560 represent value of 1234.56. During calibration, this represents STD-A. During sample analysis, it represents Sample mV.

Reading 1 mV Try Count (**Valid only for SMARTLYTE Calibration**)

The number represents number of tries instrument ran the standard fluid before producing stable results. During calibration, this represents STD-A.

Reading 2 mV Sign

This character represents if value is positive or negative. "+" represents positive and "-" negative numbers. During calibration, this represents STD-B. During sample analysis, it represents Standard Fluid mV.

Reading 2 mV Value

Ion concentration value is sent out in 7 Digits. This number is 1000 times the concentration determined in the analysis. For example, 01234560 represent value of 1234.56. During calibration, this represents STD-B. During sample analysis, it represents Standard Fluid mV.

Reading 2 mV Try Count(**Valid only for SMARTLYTE Calibration)**

The number represents number of tries instrument ran the standard fluid before producing stable results. During calibration, this represents STD-B.

Temperature

PARAMETER	NO OF CHARACTERS	EXAMPLE
Constant	1	T
Unit Code	1	C Celsius
Value	7	0100000 100 times Actual temperature
Error Flag	1	L Low

Temperature Unit Code

Units	Unit Code
Celsius	C
Kelvin	K

Temperature Value

100 times recorded temperature value is give these 5 characters.

Temperature Flag

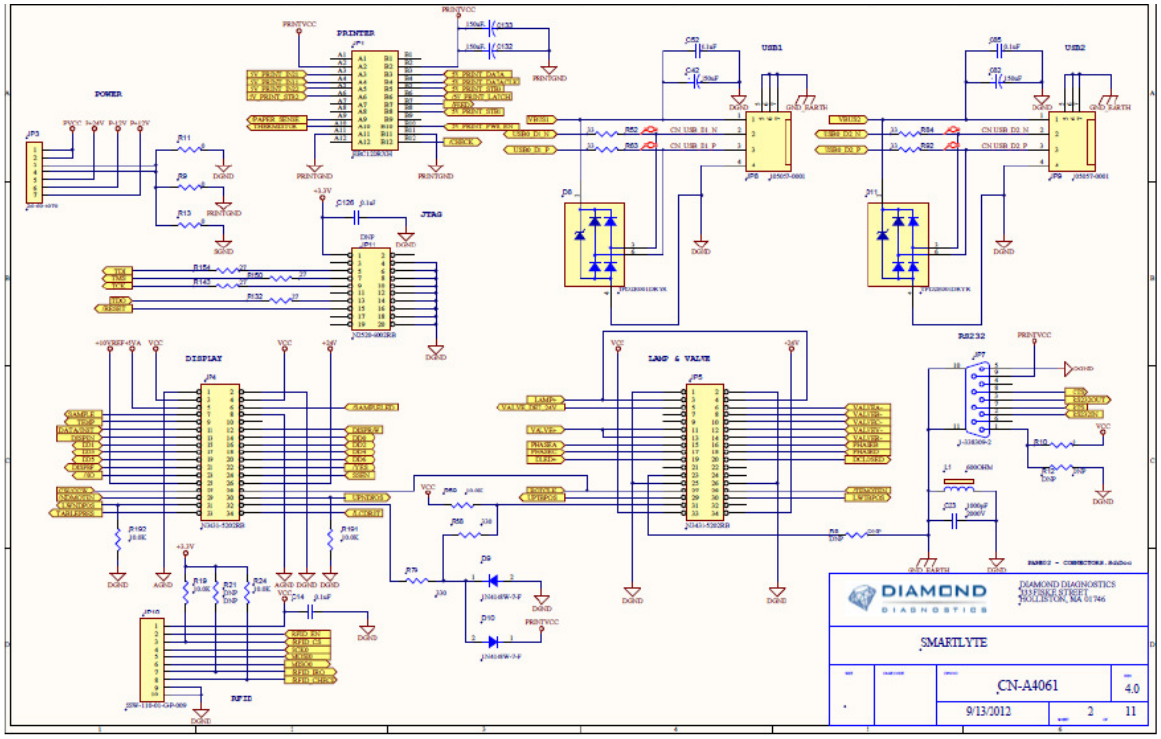
Flag Name	Code
Low	L
High	H

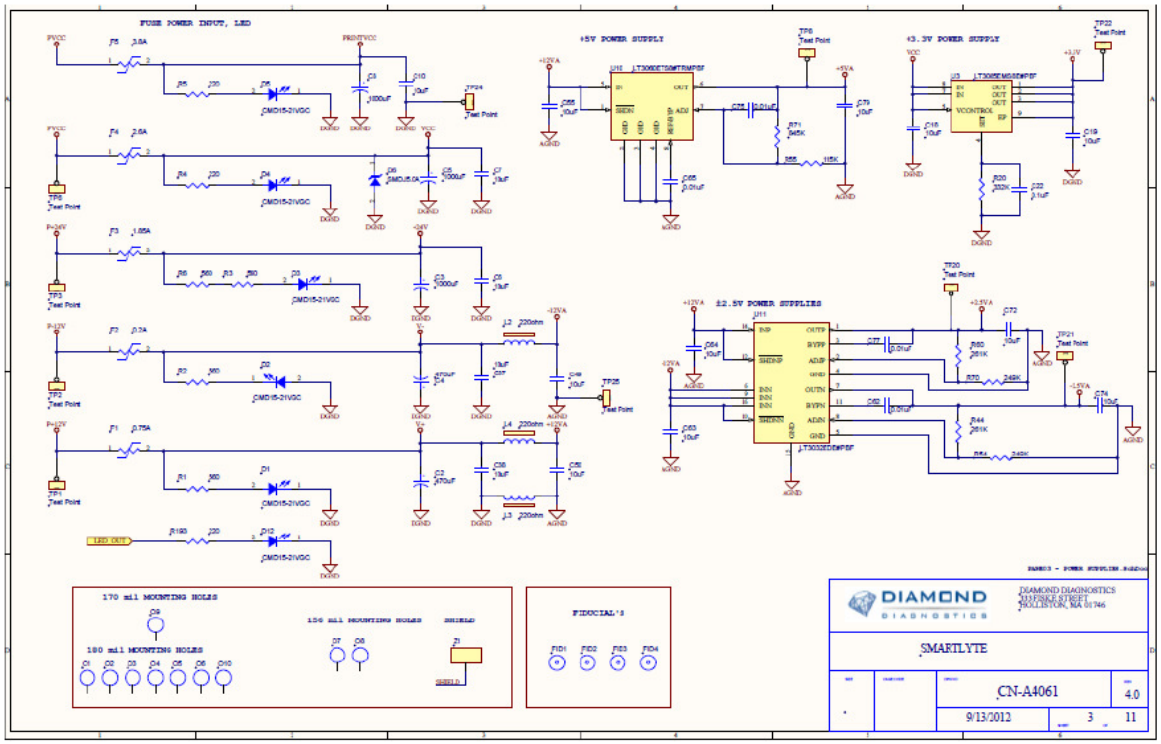
Stop Code

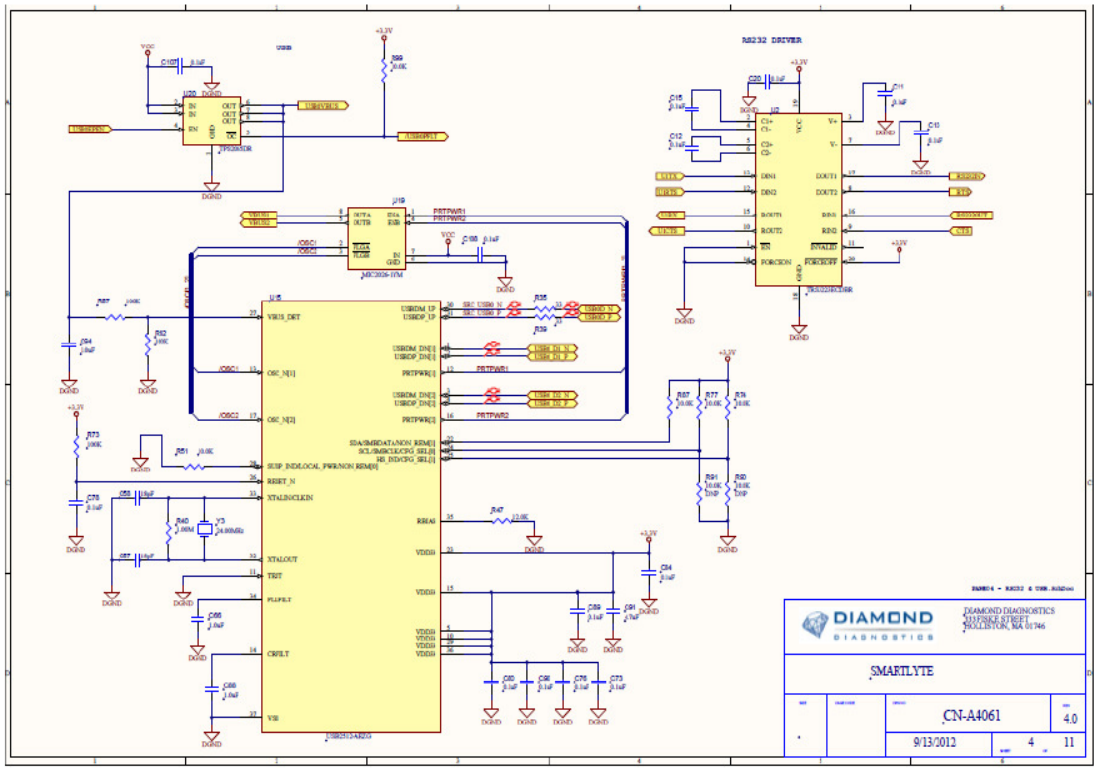
Hexadecimal value [03] marks end of data packet

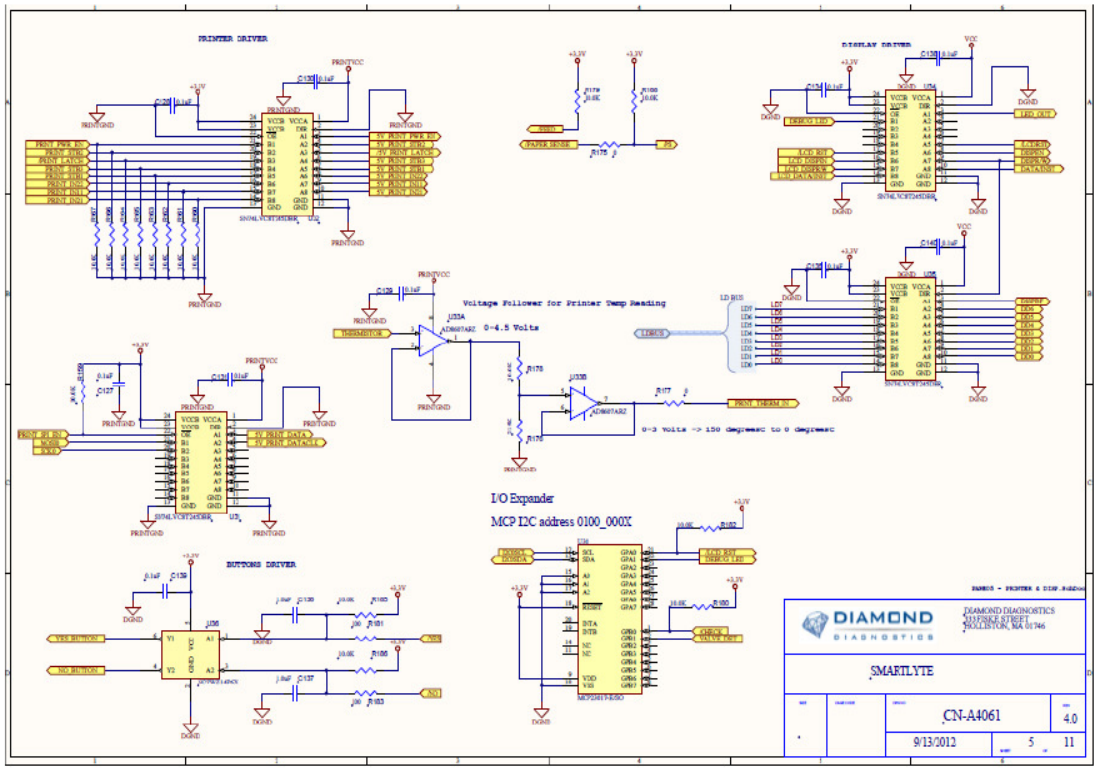
9. SMARTLYTE Schematics

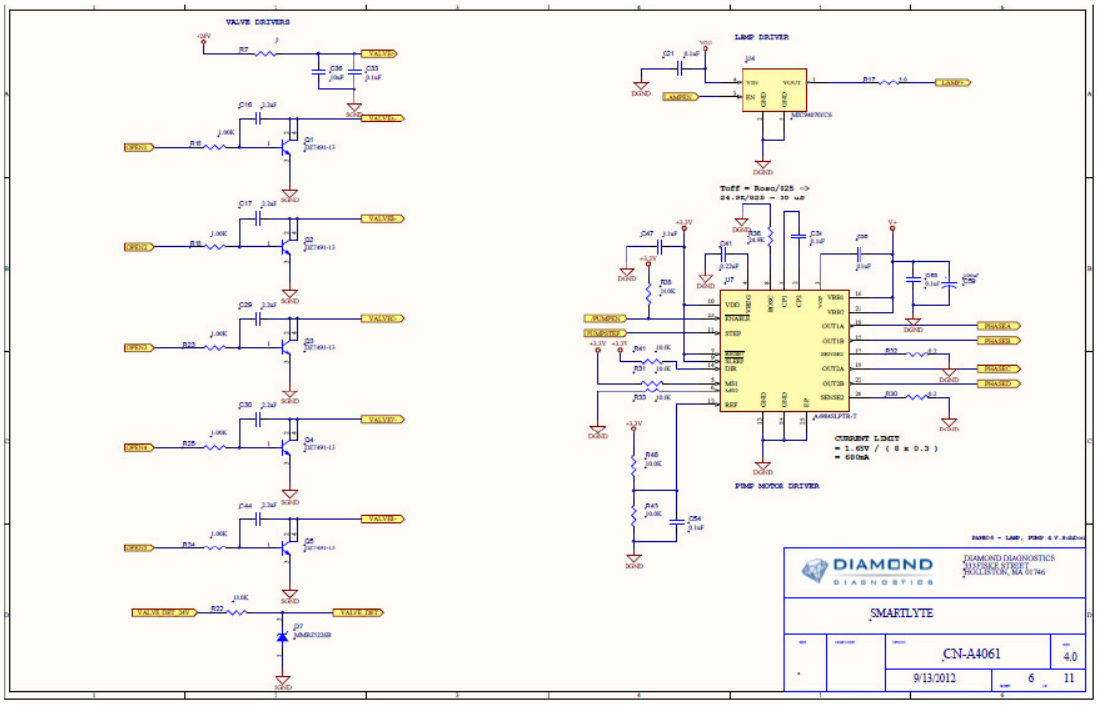
9.1. CPU Board

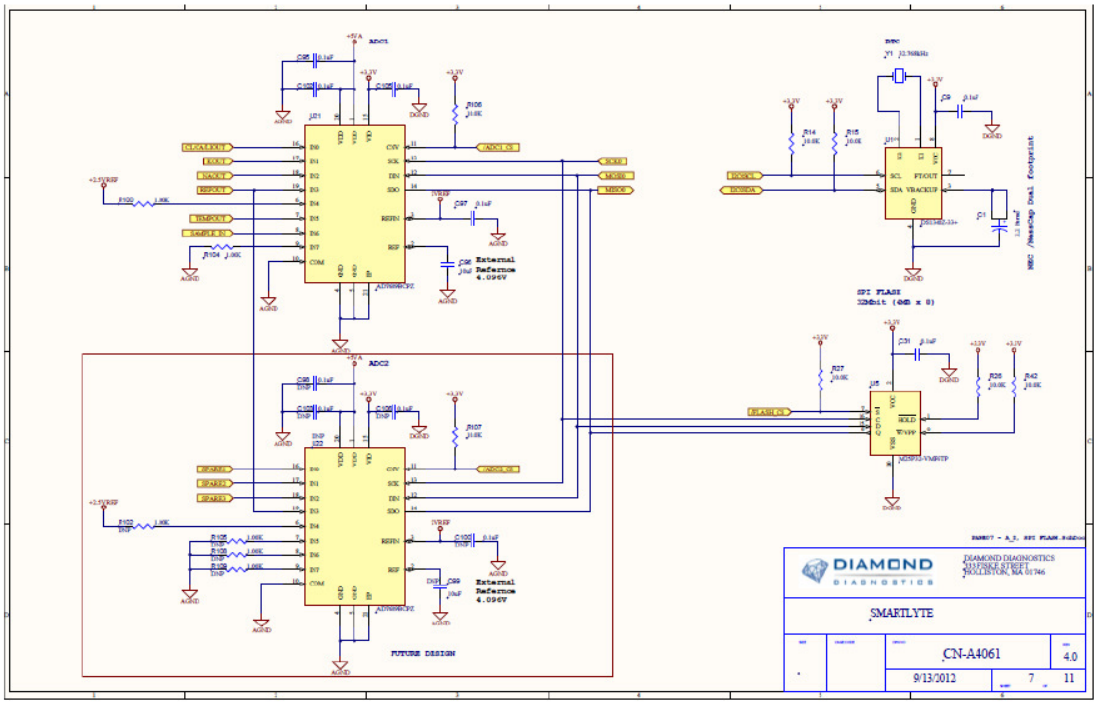


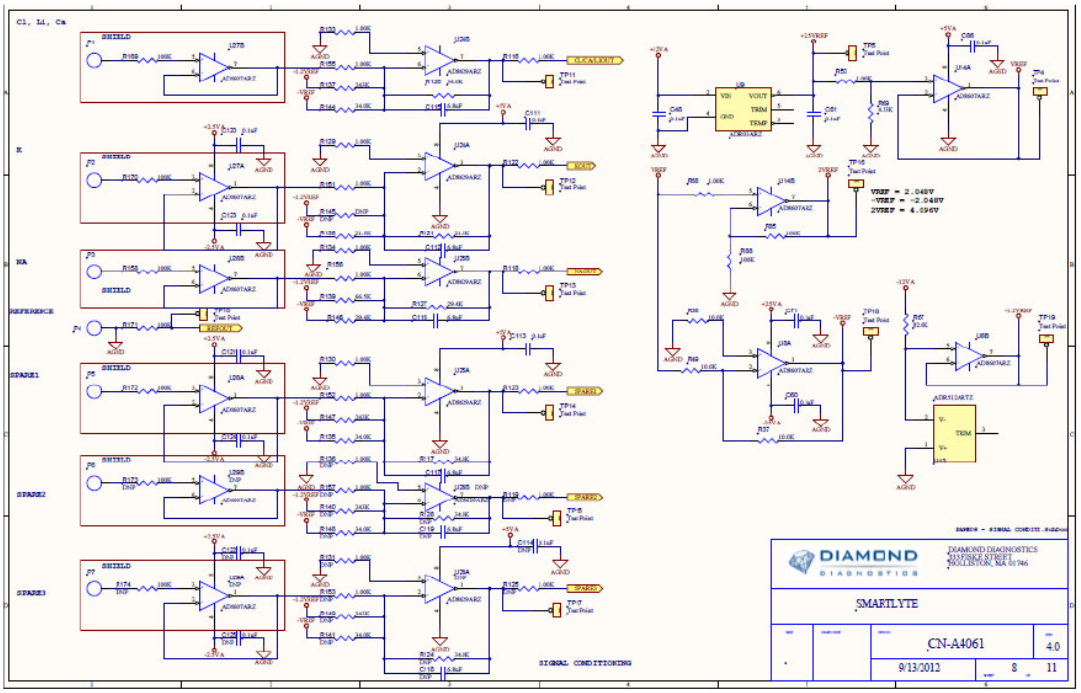


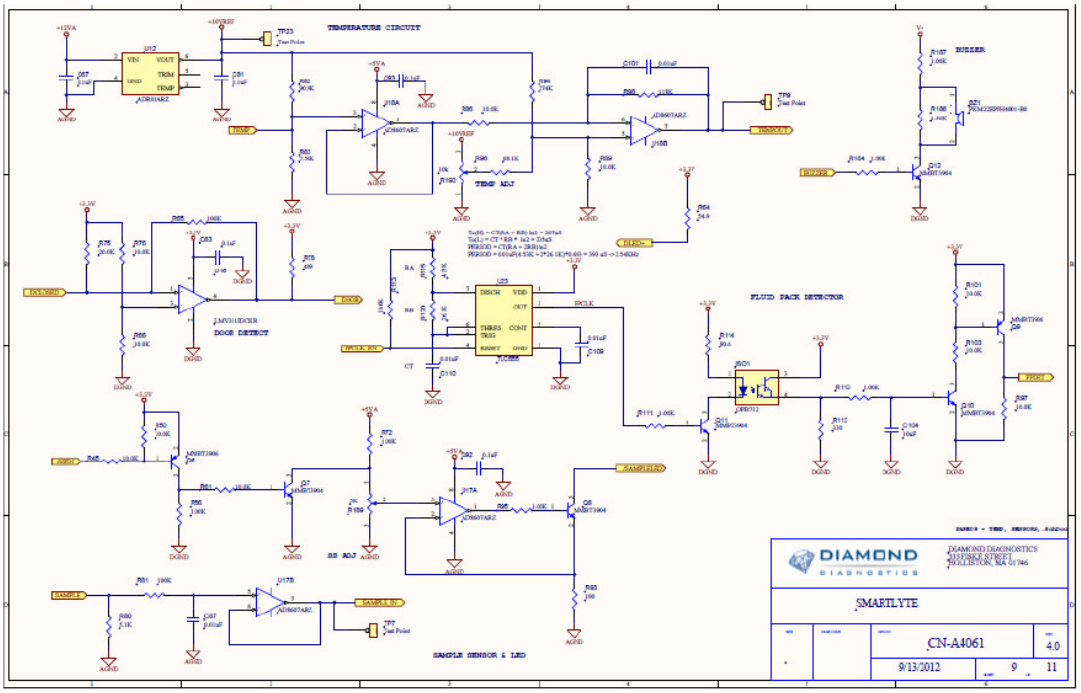

RS232 DRIVER
DIAMOND
DIAMOND DIAGNOSTICS
SMARTLYTE
CN-A4061
4.0
9/13/2012
4
11

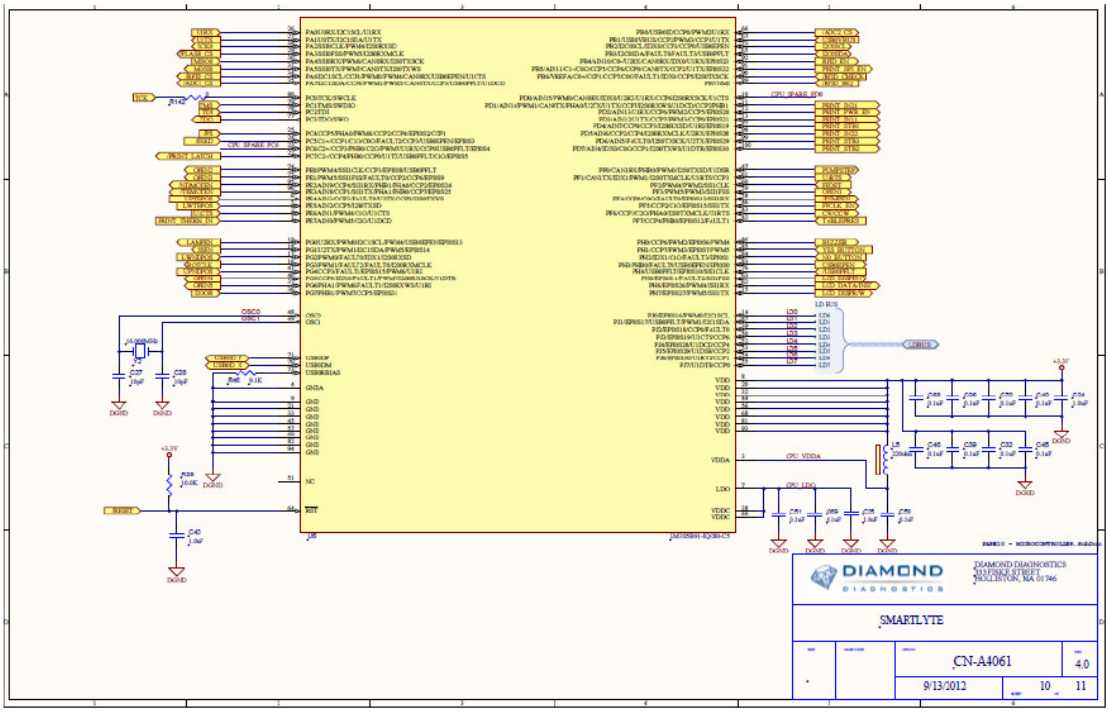

PRINTER DRIVER
DISPLAY DRIVER
Voltage Follower for Printer Temp Reading
0-4.5 Volts
0-3 Volts -> 150 Degrees C to 0 Degrees C
I/O Expander
MCP I2C address 0100_000X
BUTTONS DRIVER
DIAMOND
DIAMOND DIAGNOSTICS
SMARTLYTE
CN-A4061
4.0
9/13/2012
5
11


VALVE DRIVERS
LAMP DRIVER
PUMP MOTOR DRIVER
DIAMOND
DIAMOND DIAGNOSTICS
SMARTLYTE
CN-A4061
4.0
9/13/2012
6
11

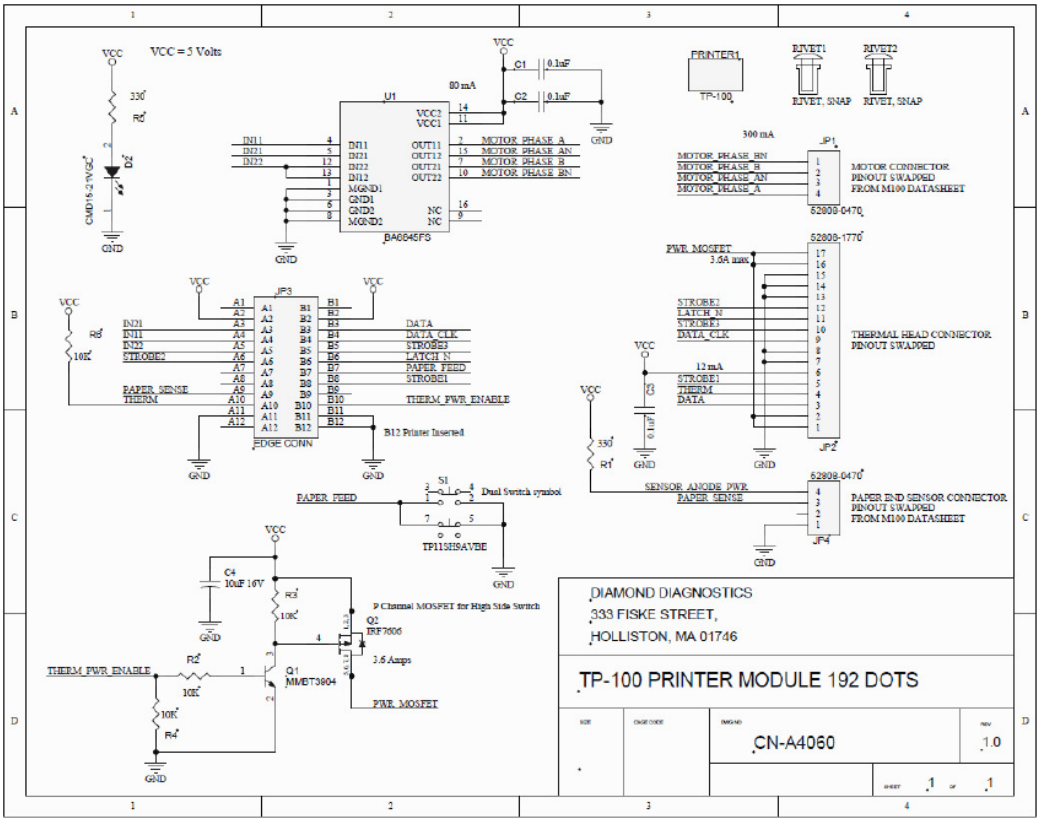

ADC1
ADC2
FUTURE DESIGN
SPI FLASH
DIAMOND
DIAMOND DIAGNOSTICS
SMARTLYTE
CN-A4061
4.0
9/13/2012
7
11


SIGNAL CONDITIONING
SMARTLYTE
CN-A4061
4.0
9/13/2012
8
11

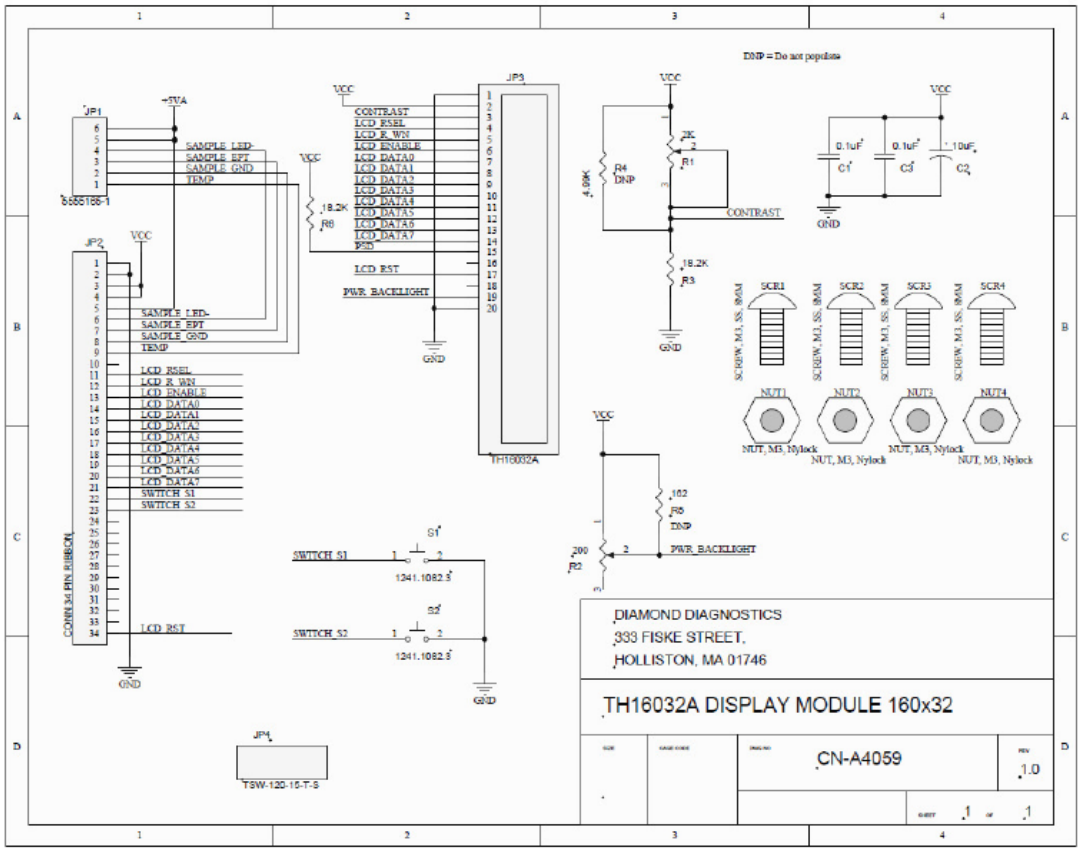

TEMPERATURE CIRCUIT
DOOR DETECT
FLUID PACK DETECTOR
SAMPLE SENSOR & LED
SMARTLYTE
CN-A4061
4.0
9/13/2012
9
11


DIAMOND
DIAGNOSTICS
DIAMOND DIAGNOSTICS
333 FISKE STREET
HOLLISTON, MA 01746
SMARTLYTE
CN-A4061
4.0
9/13/2012
10
11

9.2. Printer


VCC = 5 Volts
80 mA
BA6645FS
MOTOR_PHASE_A
MOTOR_PHASE_AN
MOTOR_PHASE_B
MOTOR_PHASE_BN
MOTOR CONNECTOR
PINOUT SWAPPED
FROM M100 DATASHEET
62909-0470
300 mA
PWR_MOSFET
3.6A max
62909-1770
STROBE2
LATCH_N
STROBE3
DATA_CLK
THERMAL HEAD CONNECTOR
PINOUT SWAPPED
12 mA
STROBE1
THERM
DATA
EDGE CONN
B12 Printer Inserted
PAPER_FEED
Dual Switch symbol
TP115H5AVBE
SENSOR_ANODE_PWR
PAPER_SENSE
PAPER END SENSOR CONNECTOR
PINOUT SWAPPED
FROM M100 DATASHEET
THERM_PWR_ENABLE
P Channel MOSFET for High Side Switch
IRF7606
3.6 Amps
PWR_MOSFET
DIAMOND DIAGNOSTICS
333 FISKE STREET,
HOLLISTON, MA 01746
TP-100 PRINTER MODULE 192 DOTS
CN-A4060
1.0

9.3. Display



9.4. Valve