Operator’s Manual

Cavro® RSP 9000 II Series

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20726507-G

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Cavro® RSP 9000 II Series

Tecan Systems, Inc.
2450 Zanker Road
San Jose, CA 95131 USA
T 1 408 953 3100, Toll Free 1 800 231 0711
F 1 408 953 3101
E-mail: tecansystemsinfo@tecan.com
Web Site: www.tecansystems.com

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Document Status Sheet

Title:	Cavro® RSP 9000 II Series Operator’s Manual		
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Version	**Revision**	**Issue**	**Major changes**
1	E		Rewrite of manual
1	F		Updates to mechanical drawings, electrical drawings, spare parts list
1	G		Correction to table B-4

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TECAN.

1 Getting Started

1.1 About This Reference

1.1.1 Introduction

This technical reference is designed to describe the installation, operation, and maintenance of the Cavro® RSP 9000 II Series. In this reference, the assumption is made that the reader is technically proficient in electrical, mechanical, and software engineering. All of the necessary drawings and specifications are included to facilitate the integration of the RSP 9000 II into your project.

All questions about the RSP 9000 II, available options, and this reference should be directed to a Tecan customer support representative.

1.1.2 Warnings, Cautions, and Notes

There are three informational notices used in this reference. These notices are designed to highlight important information or to warn the user of a potentially dangerous situation.

WARNING! *Indicates a possibility of severe personal injury, loss of life, or equipment damage if instructions are not followed.*

Caution! *Indicates a possibility of equipment damage if instructions are not followed.*

Note: *Gives helpful information about the RSP 9000 II.*

1.1.3 Abbreviations, Symbols, and Measurements

Both the SI (System International), and English Standard abbreviations/ measurements are used. However, the “English Standard” measurements have been converted from SI. A complete listing of abbreviations and symbols can be found in Appendix A, “Symbols and Abbreviations”.

1.1.4 Related References

All of the following documents, are related to the RSP 9000 II and may help in integrating the RSP 9000 II into your instrumentation:

- Tecan Molo-X Stepper Motor Controller/ Driver Manual

Contact your customer support representative for a listing of all current and future options.

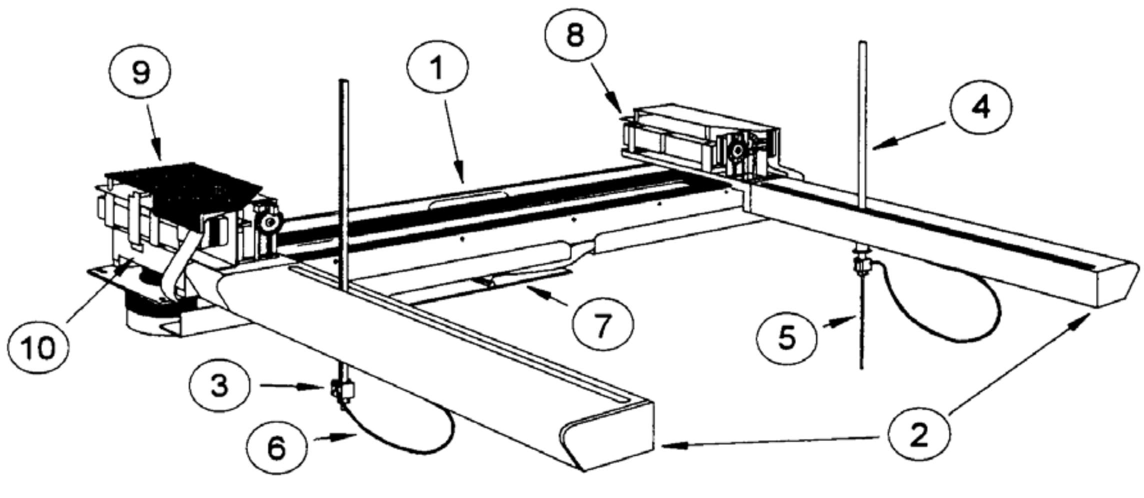
1.2 General Information

1.2.1 RSP (Robotic Sample Processor)

The RSP 9000 II is a robotic module that allows the systems integrator to build a complete sample handling system with minimal effort. This instrument has modular electronics and a sophisticated command set which when combined with diluters, valves, stirrers, and various other options, can perform virtually any sample handling operation. The electronics on the RSP 9000 II coordinates the communication between the robotic and other smart devices through a single RS-232 cable.

Complete instrument specifications can be found in Appendix B, “Instrument Specifications”. The major components of the RSP 9000 II are shown in Figure 1-1.

Figure 1-1 *RSP 9000 II Components*



1. X-frame
2. Arms
3. Insulation Block
4. Z-rack
5. Sampling Tip
6. Coax Cable
7. CCU-9000
8. ADRI-9 Board
9. ADRI-9 Board Cover
10. X-slide

1.2.2 Communications

The RSP 9000 II requires an external host to function. The external device communicates through an RS-232 interface with the CCU. The CCU handles all communications within the RSP including additional diluters, valves, etc. The format of the communication between the PC and the RSP are ASCII commands that are packaged in a Tecan protocol. (See Chapter 3, "Communications".)

1.3 Principles of Operation

1.3.1 Overview

The RSP 9000 II is a robotic module which has three functional axes: X/Y/Z. Each axes has its own intelligent control and stepper motor. The RSP 9000 II is designed to move its sampling tip(s) to specified locations, detect liquid, and control other optional microprocessor-driven smart devices.

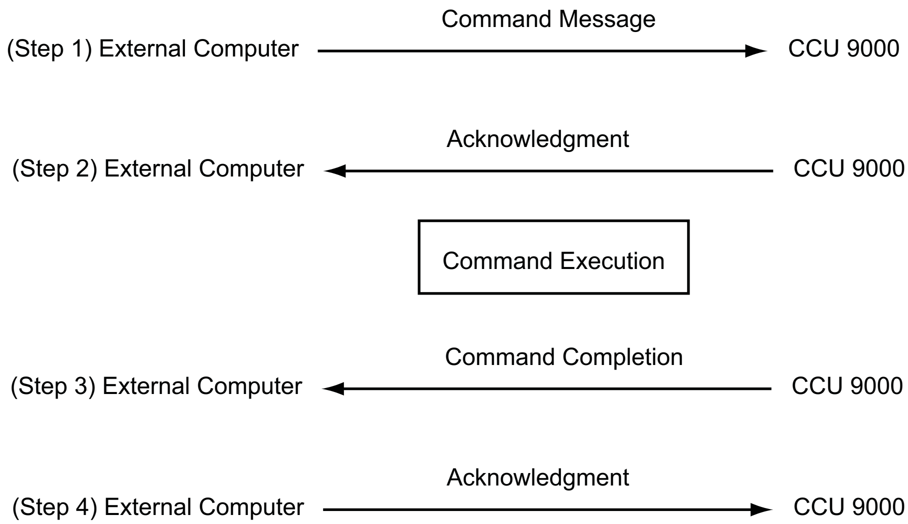
The RSP 9000 II Series hardware is based on a modular design concept in which the major functions are performed by different components of the instrument. The main components of the RSP 9000 II are:

- Central Control Unit (CCU-9000)
- Arm (ADRI-9) Board
- X/Y/Z Movement Mechanism
- Initialization Devices
- Variable Sensitivity Liquid Detector (ALIDUM)
- Optical Step Loss Detectors

1.3.2 Central Control Unit (CCU)

The CCU-9000 receives commands through an RS-232C connector from the external computer. After receiving a command, the CCU-9000 returns an acknowledgment message to the external computer. The CCU-9000 then forwards the approved command to the proper device and sends a "completion" message to the external computer once the device finishes its task. The CCU-9000 waits for a final "received" message from the external computer. (See Figure 1-2). Communication between the external computer and CCU-9000 is full duplex. This allows both systems to transmit simultaneously to each other. The CCU also contains the drive electronics for the X-axes motor(s) and connectors for communicating with devices such as pumps, valves, etc.

Figure 1-2 *Flow of Communication (Handshake)*



1.3.3 ARM (ADRI-9) Board

The ADRI-9 board is located on the back of each arm. This board contains the drive electronics for the motors for the Y and Z axes. The motor drivers are contained in the Molo-X modules. The Molo-X interfaces with the step loss detectors and the ALIDUM variable sensitivity liquid level detector.

1.3.4 X/Y/Z Movement Mechanism

The RSP 9000 II movement mechanism is supported by a machined aluminum extrusion called the X-frame. Mounted on the X-frame are the X-axis guide rails and a X-stepper motor for each arm. The X-slide is attached to the X-axis guide rails by three rollers and belt-driven with the X-stepper motor. Together, these parts guide the right and left movement of the arm. The X motor is controlled by the CCU 9000.

The following items are mounted on the arm(s):

- ADRI-9 electronics board
- Liquid Level Sensor Module (ALIDUM)
- Y -direction stepper motor
- Z-direction stepper motor
- Square shaft pinion
- Y-axis guide rails
- Z-bearing
- Z-rack
- Insulation block and probe

The Y-block is attached to the Y-axis guide rails with three rollers and is belt-driven by the Y-stepper motor that guides the front to rear movement of the Y-axis.

The Z-rack is placed through the Y-block and is driven by a square shaft attached to the Z-stepper motor. Attached to the Z-rack is the insulation block and the sampling tip.

The square shaft pinion, Z-bearing, and Z-motor control the up and down movement of the Z-rack. The Y/Z-motors are powered and controlled by electronics located on the ADRI-9 board. Each motor has its own microprocessor control that allows the drives to run simultaneously.

Depending on the RSP 9000 II configuration, two such X/Y/Z movement mechanisms may be present; one for each arm. Because two arms share the same X-slide, special safeguards have been built into the firmware to prevent collisions.

1.3.5 Initialization Devices

The RSP 9000 II uses two methods to initialize each robotic arm. The X and Y movement mechanisms are initialized by slotted optical switches. Metal flags are mounted to the X-frame and Y -block. When the flags are detected by the slotted optical switches, the movement mechanisms are initialized.

The Z-movement mechanism is initialized by using the ALIDUM liquid level sensing module. When the metal flag on the top of the insulation block contacts the initialization ring, the Z-axis is initialized.

1.3.6 Variable Sensitivity Liquid Detector (ALIDUM)

Each sampling tip on the RSP 9000 II is connected to a variable sensitivity liquid detector (ALIDUM) module which is mounted on the ADRI-9 board. The liquid detector enables the sampling tip to detect ionic solutions upon contact. (See Section 2.8, ”Setting the Sensitivity of the Liquid Level Sensor”, on page 2-10 for instructions for setting the sensitivity of the ALIDUM.)

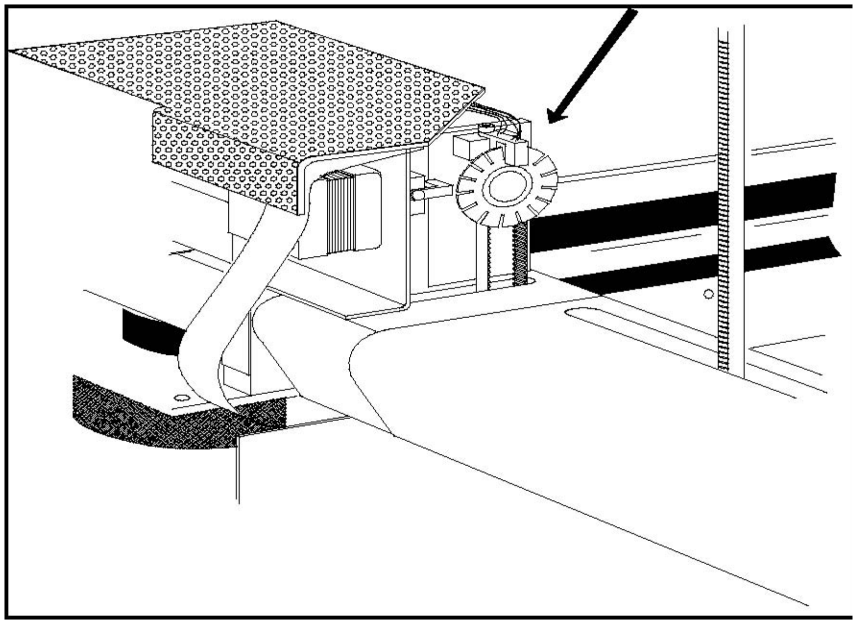
The detectors operate by monitoring capacitance between the sampling tip and the instrument work surface which is grounded to the RSP 9000 II. When the sampling tip touches a liquid surface there is a change in capacitance, which generates a detection signal in the ALIDUM. The liquid detection system generates a signal when entering and leaving the liquid. The following modules make up the liquid detection system:

- ALIDUM module
- Sampling tip
- Insulation block

1.3.7 Step Loss Detection (SLD)

The SLD system utilizes slotted optical switches to monitor all of the stepper motors. An encoder wheel is mounted to the shaft of each stepper motor. The encoder wheels move between the slotted optical switches, which allows the Molo-X to monitor the number of steps each motor has turned. This system ensures “positive tracking” of the sampling tip’s location and the detection of lost steps in the X/Y/Z-directions during operation (see Figure 1-3). Should step loss be detected, an error message is sent to the computer.

Figure 1-3 *Step Loss Detector on Z-axis Motor*



The CCU board is auto-detecting the presence of the SLD option. In case the SLD sensor does not generate the expected signal during the first move after power-up, the SLD functionality is turned off.

WARNING! *It is strongly recommended that the detected SLD status is overwritten using the following commands after the first initialization of each axis. This needs to be repeated after each power cycle.*

For all instruments:

- *#19XP12,1*
- *#19YP12,1*
- *#19ZP12,1*

For a dual-arm instrument, also include:

- *#29XP12,1*
- *#29YP12,1*
- *#29ZP12,1*

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2 Hardware Installation

2.1 Mounting Considerations

The RSP 9000 II should be mounted on a rigid frame. It is recommended that a cross brace be installed on the frame for a two arm system to reduce any swaying which can cause loss of steps.

The RSP 9000 II liquid detection system requires that the work surface and X-frame be connected to the same electrical ground. This can be accomplished by mounting the RSP 9000 II to metal supports, which in turn are mounted to a metal work surface. However, the supports for the RSP 9000 II can be made of nonconductive material, but an electrical connection from the X-frame must be made to the metal work surface.

Note: *When using the ALIDUM variable sensitivity level sensor, the work surface should be a metal plate that is grounded to the frame of the RSP 9000 II. This plate can be covered with virtually any coating, providing that the coating does not greatly reduce capacitance between the work surface and the samples.*

Note: *Complete mounting specifications can be found in Appendix C, "Mechanical Drawings".*

2.2 Unpacking the Instrument

2.2.1 Visual Inspection

Look at the exterior of the box and check for the following:

- Water damage or discoloring
- Cuts or gashes
- Collapsed corners
- Crushed top or sides
- Missing shipping straps

Note: *If any of the above items are found, contact a customer support representative immediately.*

2.2.2 Removing the Instrument from the Box

Caution! *Before removing the RSP 9000 II from the box, prepare the mounts as shown in Appendix C, depending on your particular setup. Setting the instrument down incorrectly can cause damage.*

Before unpacking the RSP 9000 II, make sure there is sufficient space to lay out the instrument and its accessories. This makes checking the contents of the box against the packing list easier. Follow the steps below to prevent damage to the instrument.

1 Remove shrink wrap from outside of shipper.

2 Cut the straps on the top of the shipping box.

3 Remove upper portion of shipping box.

4 Remove the inner container.

5 Cut the tape along the top of the inner container, making sure that the cutting device does not touch the RSP 9000 II.

6 Unfold the inner container until all four sides are flush with the floor.

7 Remove the small accessory box from the packaging.

Caution! *Do not lift the RSP 9000 II by the arm(s). Damage to the X/Y/Z movement mechanism may occur.*

8 Grip the instrument by the X-frame, just below the arms and gently lift the RSP 9000 II out of the packaging.

9 Secure the RSP 9000 II to its prepared mounts.

Caution! *Do not place the RSP 9000 II down on the CCU-9000 board. Damage to the electronics may occur.*

10 Open the small accessory box and place the contents on an open surface.

11 Check to make sure that all parts on the packing list have been received.

Note: *If any parts are missing from the packing list, call a customer support representative immediately.*

2.3 Setting Up the Instrument

2.3.1 Instrument Mounting

Mount the RSP 9000 II utilizing all six mounting holes: four bolt holes, and two indexing pin holes. (See Appendix C.) The following tools are required to install the RSP 9000 II:

- Allen wrenches (2, 2.5, 3, and 5 mm)
- Screw Driver (flat, 2 mm)

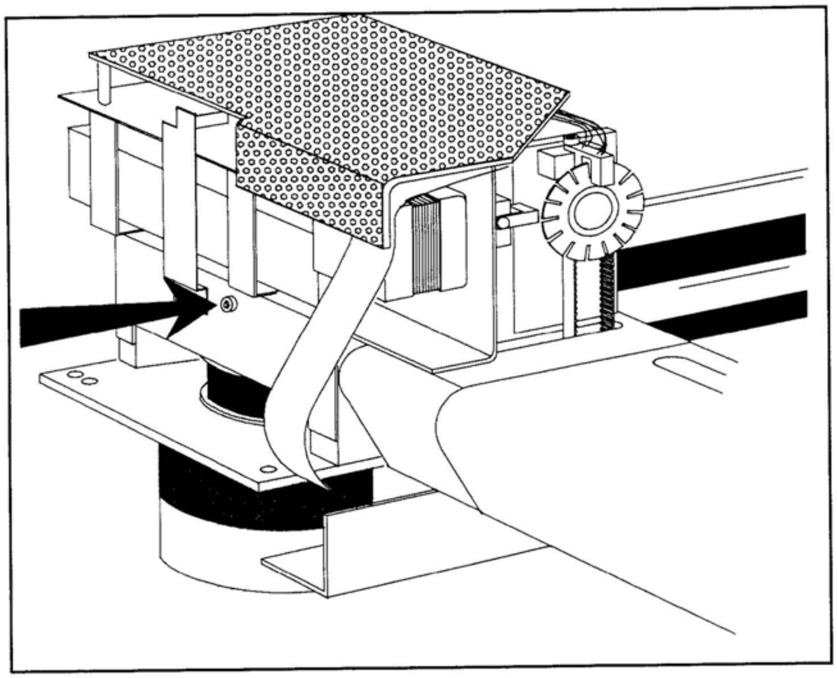
WARNING! *Make sure complete instrument provides appropriate shielding to prevent operators from being injured while the arms are moving.*

2.3.2 Instrument Setup

The following assembly instructions should be followed to prevent damage to the instrument.

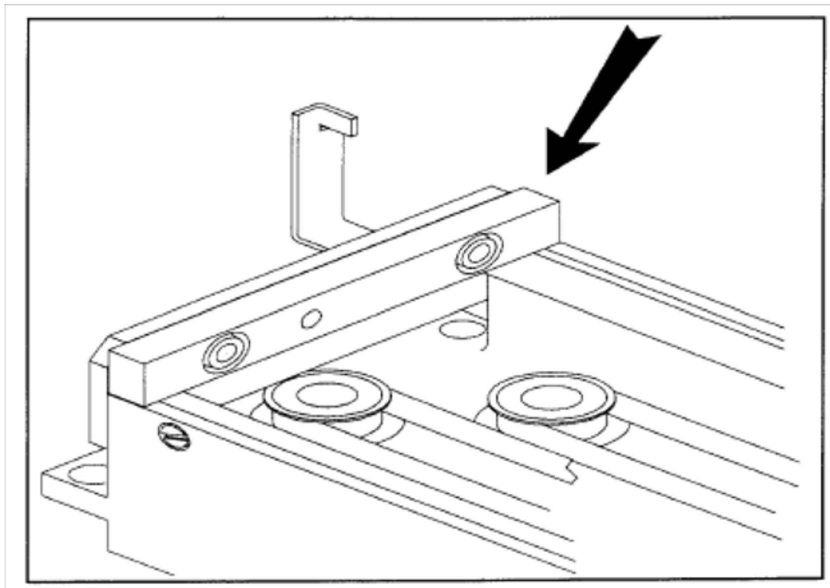
1 Remove the "red" transport screw(s), located at the end(s) of the X-frame. (See Figure 2-1.)

Figure 2-1 *Removing the Transport Screws*



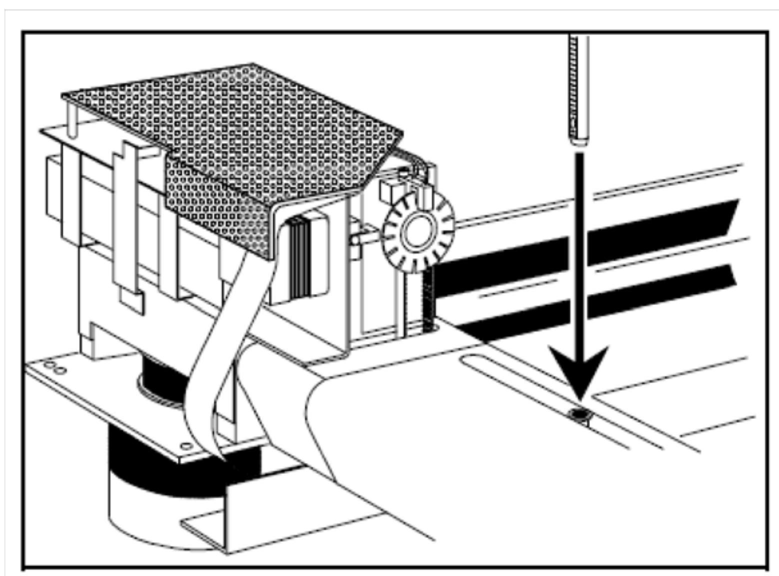
2 Move arm(s) toward center of X-axis. Remove transport bracket(s). (See Figure 2-2.)

Figure 2-2 *Removing the Transport Brackets*



3 Insert the Z-rack into the bottom of the Z-bearing with the set screw cavity at the bottom. The teeth should be oriented away from the flat side of the arm. (See Figure 2-3.)

Figure 2-3 *Inserting the Z-rack into the Z-bearing*



Note: *The teeth of the left arm Z-rack must face to the left and the teeth of the right arm Z-rack must face to the right when inserting them into the Z-bearings.*

Caution! *Do not force the Z-rack into the Z-bearing. The Z-bearing may be damaged if excessive force is used while inserting the Z-rack. Turn the square shaft pinion (on the underside of the arm) if the Z-rack does not slide easily into the Z-bearing.*

4 Position the Z-rack so equal amounts are visible above and below the arm.

5 Remove a sampling tip and the sampling tip set screw from the accessory bag.

6 Insert the system tubing through the top of the Z-rack until it extends 3 cm (1.2 in) from the bottom.

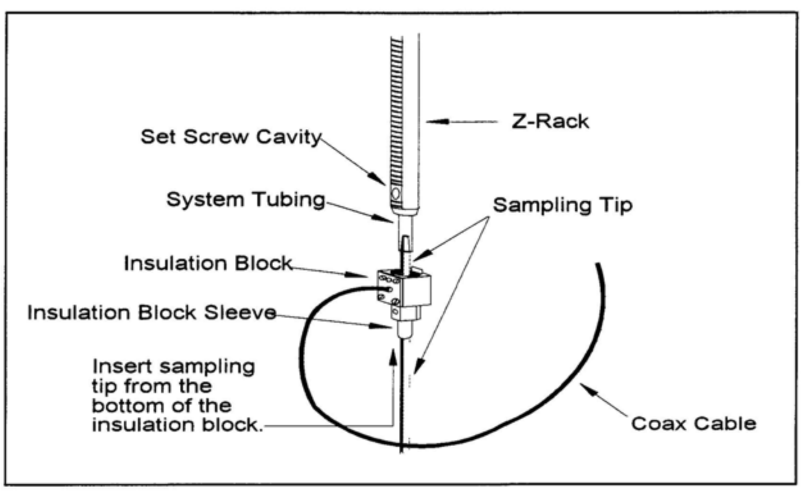
Note: *The system tubing is not supplied with the RSP 9000 II and is only needed for liquid handling applications.*

Caution! *Electrostatic discharge to the sampling tip may damage the ALIDUM.*

7 Insert the non-Teflon coated end of the sampling tip through the sleeve of the insulation block until approximately 1 cm (0.4 in) is visible through the top. (See Figure 2-4.)

8 Attach the system tubing to the non-Teflon coated end of the sampling tip.

Figure 2-4 *Connecting the System Tubing*



9 Install the insulation block on the Z-rack so that the insulation block sleeve is facing down and the coax cable is to the left for the left arm and to the right for the right arm. Ensure that the coax cable is not twisted when it is attached to the Z-rack.

10 Maintaining the insulation block position in Step 9, push the insulation block onto the Z-rack until firmly seated.

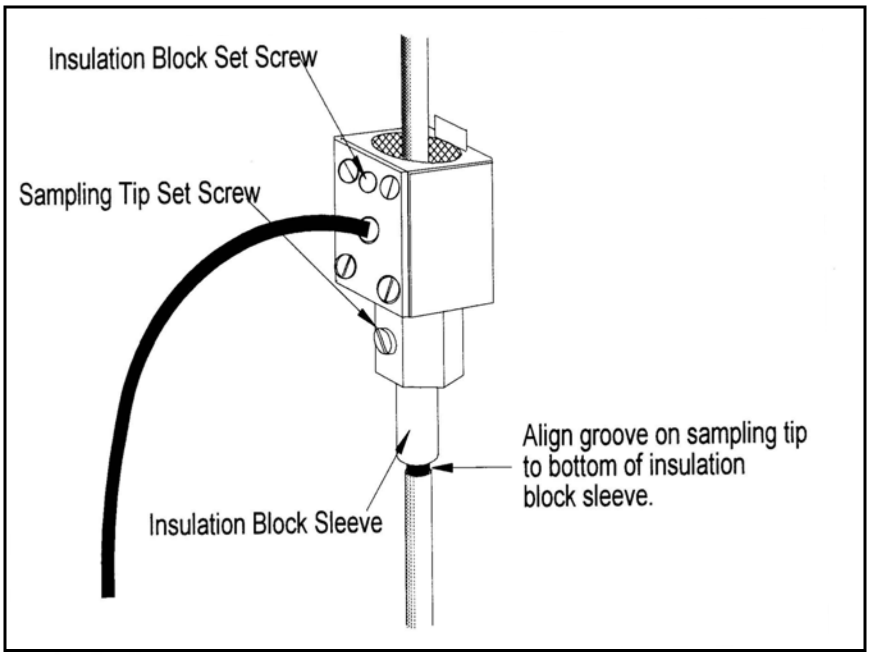
11 With an allen wrench, tighten the insulation block set screw (clockwise) until it makes contact with the Z-rack. (See Figure 2-5.)

12 Install the sampling tip set screw and turn it clockwise into the threaded hole in the insulation block sleeve.

13 Gently adjust the sampling tip with the attached tubing through the insulation block until the alignment groove on the sampling tip is aligned with the bottom of the insulation block sleeve.

14 While holding the sampling tip in position (Step 13), tighten the sampling tip set screw.

Figure 2-5 *Securing the Sampling Tip*



2.4 Power Supply Requirements

Note: *Recommended power supplies are listed in Appendix F, “RSP 9000 II Series Spare Parts List”.*

Note: *Customers are responsible to provide power supplies that comply to local and application-specific safety requirements.*

The power supply specifications below apply to all current models of the RSP 9000 II. Please note the difference in amperage between the one and two arm instruments. These specifications are for the RSP 9000 II with **no options connected**.

Instrument	Voltage	Ripple Voltage	Current
One arm	24 VDC (+10 /- 10%)	≤0.5V peak to peak @ 100Hz typical	2.5 A @ 24 VDC
Two arm			4 A @ 24 VDC

The power supply specifications were tested using the following default speeds:

Item	X-axis	Y-axis	Z-axis
Start Speed	50 steps/s	200 steps/s	400 steps/s
End Speed	4000 steps/s	4000 steps/s	4000 steps/s
Acceleration	10000 steps/s^2	20000 steps/s^2	30000 steps/s^2

2.5 Connecting the Power

1. Locate the "J2" connector on the CCU-9000 board for 24 VDC power input. (See Figure D-1, “CCU Board Layout” on page D-1.)
2. Insert the 2-pin power plug on the power cable into the "J2" connector on the CCU-9000, making sure the pins are properly aligned.
3. Check to make sure that the plug is fully seated in its connector on the CCU-9000 board.
4. Attach the other end of the power cable to an appropriate 24 VDC power supply, making sure that the red wire is connected to the positive terminal.

2.6 Running Self Test

WARNING! *Ensure that all objects are removed from the work surface. Keep all body parts out of the operating range of the arm(s) when the RSP 9000 II is in operation.*

2.6.1 Overview

The self test of the RSP 9000 II is designed to check the X/Y/Z-movement mechanism. Once activated, the self test will perform 27 moves to random positions for each arm. After finishing these moves, the RSP 9000 II will initialize and report (through the use of LEDs) any detection of lost steps. The self test will also report any collisions. The self test will repeat this cycle (reporting any errors found) until the power is turned off.

2.6.2 Starting the Self Test

1 Turn off the power to the RSP 9000 II.

2 Turn the address switch on the CCU-9000 board to position "F". (See switch SW I on Figure D-1, “CCU Board Layout” on page D-1.)

3 Ensure that all items are removed from the work surface and that all axes can move through their full mechanical ranges.

Caution! *The maximum machine range is used in the self test. If the RSP 9000 II is not mounted properly, the probe will crash into the work surface. Make sure the machine range in the instrument setup is adjusted to the Z height of the instrument or damage may occur. (See Appendix B, “Instrument Specifications” for default machine ranges for each RSP 9000 II model.*

4 Turn on the power to the RSP 9000 II. The self test will run until the power is turned off.

Note: *There will be approximately a three second delay before the self test starts.*

2.6.3 Reading the Light Emitting Diodes (LEDs)

The LEDs on the CCU-9000 board are used to display the Normal Operation Signal, Self Test Signal, Lost Steps Detected Signal, and Hardware Error Signal. There are two sets of LEDs on the instrument: LED 1, for the left arm, and LED 2, for the right arm. (See Figure 2-6.)

Figure 2-6 *Left and Right LEDs*

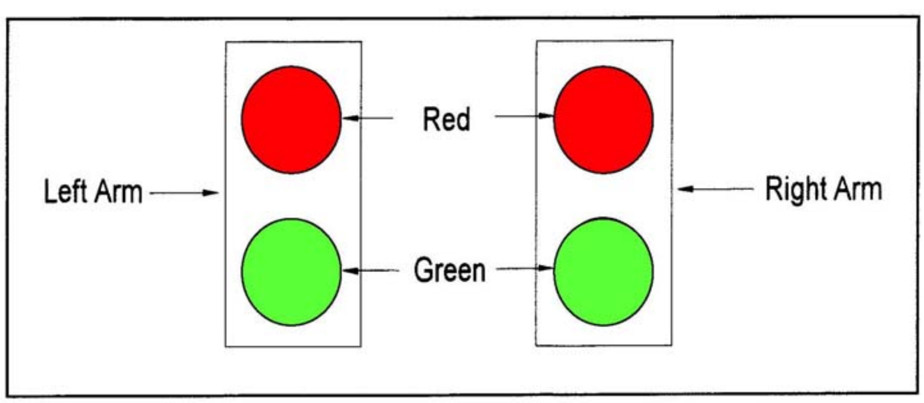


Table 2-1 *LED Functional Description*

LED 1/LED 2	**MODE OF OPERATION Blinking (on once per sec)**	**DETECTION OF LOST STEPS Rapid Blinking (on twice per sec)**	**DETECTION OF HARDWARE PROBLEM (remains lit)**
Green Red Red & green	Normal mode OK Self test OK Firmware download	Detected X-axis Detected Y-axis Detected Z-axis	Problem on X-axis Problem on Y-axis Problem on Z-axis

Note: *The LEDs will signal the first error detected until the instrument is turned off.*

Note: *LED 1 and LED 2 are separate indicators for the left and right arms. If lost steps are detected on one arm, only that arm LED will signal lost steps. (See Figure 2-6, "Left and Right LEDs" on page 2-9.)*

2.7 Connecting the External Computer

1 Locate the J 15 connector on the CCU-9000 board for the RS-232 C serial interface cable. (See Figure D-1, "CCU Board Layout" on page D-1.)

2 Take the 10-pin plug on the external computer to CCU-9000 cable and insert it into the J15 connector on the CCU-9000 board. Connect the other end of the cable to the proper com port on the external computer.

2.8 Setting the Sensitivity of the Liquid Level Sensor

The RSP 9000 II has a variable sensitivity liquid level sensor (ALIDUM) that can be set at three different levels. The level sensor is set at the "standard" setting at the factory. If additional sensitivity is needed, the sensitivity of the liquid level sensor can be selected by a combination of software commands (SS) and setting switches SW3 and SW4 on the ADRI-9 board. Table 2-2 shows the switch positions needed to obtain the standard, high and very high sensitivity settings.

The following is the procedure for setting the hardware switches.

1 Remove the perforated cover on top of the ADRI-9 board.

2 Locate the red switches SW3 and SW4 at the back of the ADRI-9 board, shown in Figure D-3, "ADRI-9 Board Layout" on page D-3.

3 Set the switches SW3 and SW4 to the desired sensitivity using the chart below.

Table 2-2 *ALIDUM Sensitivity Settings*

ALIDUM Sensitivity	Sensitivity Factor	SW3 Setting*	SW4 Setting*	Software Setting+
Standard	1	Disable	N/A	N/A
Standard	1	Enable	High	SS0
High	3			SS1
Standard	1		Very High	SS0
Very High	5			SS1

*See switch settings on ADRI-9 Board
+See software sensitivity command SS [sensitivity] on page 4-9.

WARNING! *Use only de-ionized water or aqueous buffer solution as system liquid (a conductivity < 500 μS/cm).*

WARNING! *The RSP 9000 II Liquid detection capability can be affected by EMI. Make sure the overall instrument, in which the RSP 9000 II component is being used in, is tested under the required EMI exposure.*

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3 Communications

3.1 Communications Protocol Definition

All communication with the RSP 9000 II is initiated by an external computer sending a command message to the CCU-9000.

If the command message is received correctly by the CCU-9000, an acknowledgment message is returned to the external computer and the command is executed. Upon completion of the command, the CCU-9000 sends an answer message to the external computer. If the answer message is received correctly by the external computer, an acknowledgment message is sent to the CCU-9000.

If either the external computer or CCU-9000 does not receive or understand a transmitted message, no acknowledgment is returned. The sender, not receiving an acknowledgment, will retransmit the message after a 900-millisecond delay. If a command message is understood by the CCU-9000, but the acknowledgment is not understood by the external computer, the external computer will retransmit the command message up to four times. The CCU-9000 receiving the repeated command message, checks the sequence number and discards the repeated command. However, it will send another acknowledgment message to the external computer. This system ensures that repeated command messages will only be executed once.

The transmission system used for the CCU-9000 is full duplex. The external computer can send messages to different devices without receiving acknowledgment for the previously sent message.

In the case of multiple block retransmissions, there may be time synchronization errors in the robotic functions; however, the probability of such an occurrence is minimal. (See Appendix H, “ASCII Chart--Codes For U.S. Characters”.)

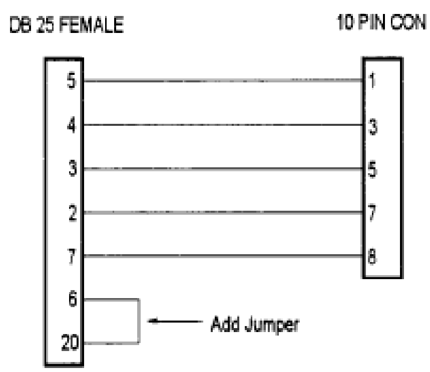
Note: *The external computer can only send one command message per device until it receives an acknowledgment message from that specific device. The CCU-9000 can send an acknowledgment of a previously addressed device while receiving a command or acknowledgment from another device.*

3.1.1 Communications Setup

Serial communications link:	RS-232-C
CCU-9000 connector:	Fujitsu 10-pin crimp
Data transmission rate:	9600 baud (bps)
Data Format:	8 bits 1stop bit no parity

__Note:__ The communications cable supplied with the RSP 9000 II is wired for use with Tecan software programs that have their own com port drivers. When using other programs with DOS com port drivers, the com port cable must be modified by soldering a jumper wire between pin #6 and pin #20 (See Figure 3-1.) This modification routes the signal to the proper pins on the com port so that the DOS program will recognize that the RSP 9000 II is connected.

Figure 3-1 *Modification to Communication Cable*



3.1.2 Vertical Redundancy Checksum

For each data message that is transferred, a vertical redundancy checksum (VRC) is generated and transmitted at the end of the message.

All data bytes in a message block are "XORed" to form an 8-bit checksum, which is sent as the last character of a message block. The receiving processor compares the transmitted value to a computed value. If the computed and transmitted values match, an error-free transmission is assumed by the processor.

3.2 Command Message Block Format

Command Message Block Fields	Description of Block Fields in Command Message
STX	Start of text character: ASCII hexadecimal [02] (Typed: CTRL-B)

Command Message Block Fields	**Description of Block Fields in Command Message**								
Control	Control byte (see Table 3-1)								
	Bit No.:	7	6	5	4	3	2	1	0
	Data:	0	1	0	0	Rep	Seq#2	Seq#1	Seq#0
Arm Address	ARM: ASCII typed [1..2] (Left arm = 1; Right arm = 2)								
Device Address	DEVICE: ASCII typed [1..9] (Example: arm = 8, diluters =[1..4])								
Message Block	Command Message: variable length (ASCII/typed)								
ETX	End of Text Character: ASCII Hexadecimal [03] (typed: CTRL-C)								
VRC	Vertical Redundancy Checksum (XOR of all characters, including STX and ETX) (Binary)								

Table 3-1 *Control Byte of the Command Message*

Bit	Mnemonic	State	Definition
7	---	0	Always = 0
6	---	1	Always = 1
5	---	0	Always = 0
4	---	0	Always = 0
3	Rep	01	Command message sent on the first attempt Command repeated
2	Seq#2	0= off1=on	Message sequence number to device [1..7] On for message 4, 5, 6, and 7
1	Seq#1	0 = off1 = on	Message sequence number to device [1..7] On for message 2, 3, 6, and 7
0	Seq#0	0 = off1 = on	Message sequence number to device [1..7] On for message 1, 3, 5, and 7

Note: *If the control byte is hexadecimal [40], the message is an acknowledgment (ACK). An ACK message does not contain an error code or answer message. If bit 3 is equal to "1", then the sequence is repeated. (See Table 3-1.)*

3.3 Acknowledgment Message Format

Acknowledgment Message Block Fields	Description of Block Fields in Acknowledgment Message
STX	Start of Text Character: ASCII hexadecimal [02], (typed CTRL-B)
Control	Control Character (always hexadecimal 40).
Arm Address	ARM: ASCII [1..2] (Left Arm = 1; Right Arm = 2)
Device Address	Device: ASCII typed [1..9] (Example, arm = 8 and diluters =[1..4])
ETX	End of Text Character: ASCII hexadecimal [03], (typed CTRL-C)
VRC	Vertical Redundancy Checksum (XOR of all characters including STX and ETX) (BINARY)

3.4 Answer Message Format

Answer Message Block Fields	Description of Block Fields in Command Message
STX	Start of text character: ASCII hexadecimal [02] (Typed: CTRL-B)
Control	Control byte (see Table 3-1) Bit 7 6 5 4 3 2 1 0No.:Data: 0 IVA Done Rep Seq#2 Seq#1 Seq#0
Arm Address	ARM: ASCII typed [1..2] (Left arm = 1; Right arm = 2)
Device Address	DEVICE: ASCII typed [L.9] (Example: arm = 8, diluters =(1..4])
Error Code	Only sent if bit-4 of Control Byte (Done) is set to 0
Answer Block	Answer Message: variable length (ASCII/typed)
ETX	End of Text Character: ASCII Hexadecimal (03] (typed: CTRL-C)
VRC	Vertical Redundancy Checksum (XOR of all characters, including STX and ETX) (Binary)

Table 3-2 *Control Byte of the Answer Message*

Bit	Mnemonic	State	Definition
7	---	0	Always = 0
6	---	1	Always = 1

Bit	Mnemonic	State	Definition
5	IVA	0 1	Address OK Invalid arm or device address
4	Done	0 1	Device Error: Error code to follow Answer completed without error
3	Rep	0 1	Command message sent on the first attempt Command repeated
2	Seq#2	0 = off 1 = on	Message sequence number to device [1..7] On for message 4, 5, 6, and 7
1	Seq#1	0 = off 1 = on	Message sequence number to device [1..7] On for message 2, 3, 6, and 7
0	Seq#0	0 = off 1 = on	Message sequence number to device [1..7] On for message 1, 3, 5, and 7

Note: *If the Control Byte is Hexadecimal [40], the message is an acknowledgment (ACK.) An ACK message does not contain an error code or answer message. If bit 3 is equal to 1, then the sequence is repeated.*

3.5 Communication Sequence Example

The sequence illustrated below shows the typical transfer of data between the external computer and the CCU-9000. This example also shows how two commands can be sent and processed individually by the CCU-9000.

1 External Computer to CCU-9000 Initialize the left arm.

STX	Control	Arm #	Device#	Message	ETX	VRC
<Ctrl-B>	01000001	1	8	PI	<Ctrl-C>	P
02h	41h	31h	38h	50h 49h	03h	50h

2 External Computer to CCU-9000
Initialize the right arm.

STX	Control	Arm #	Device#	Message	ETX	VRC
<Ctrl-B>	01000010	2		P1	<Ctrl-C>	P
02h	42h	32h	38h	50h 49h	03h	50h

3 CCU-9000 to External Computer
Acknowledgment message for right arm initialization.

STX	Control	Arm #	Device#	ETX	VRC
<Ctrl-B>	01000000	1	8	<Ctrl-C>	H
02h	40h	31h	38h	03h	48h

Note: *This acknowledgment might be sent to the external computer at the same time the initialization command for the second arm is received from the computer.*

4 CCU-9000 to External Computer
Acknowledgment message for left arm initialization.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	2	8	<Ctrl-C>	K
02h	40h	32h	38h	03h	48h

5 CCU-9000 to External Computer
Left arm has completed initialization.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01010001	1	8	<CtrlC>	Y
02h	51h	31h	38h	03h	59h

6 External Computer to CCU-9000
Acknowledgment for answer to left arm initialization complete.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	1	8	<CtrlC>	H
02h	40h	31h	38h	03h	48h

7 CCU-9000 to External Computer
Right arm has completed initialization.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01010010	2		<CtrlC>	Y
02h	52h	32h	38h	03h	59h

8 External Computer to CCU-9000

Acknowledgment for answer to right arm initialization complete.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	2	8	<CtrlC>	K
02h	40h	32h	38h	03h	48h

Note: *The CCU-9000 does not chain commands to the same device. Therefore, the external computer must receive a "completion of command message" before another command is sent to the same device or a command overflow error will occur.*

3.6 Communication Error Sequence

The sequence illustrated below demonstrates the communication error between the instrument and the external computer in case no acknowledgment has been received from the instrument.

1 External Computer to CCU-9000

Initialize the left arm.

STX	Control	Arm #	Device#	Message	ETX	VRC
<CtrlB>	01000001	1	8	PI	<CtrlC>	P
02h	41h	31h	38h	50h 49h	03h	50h

Note: *No acknowledgment was received from the CCU-9000 after 900 ms.*

2 External Computer to CCU-9000

Initialization command resent for left arm.

STX	Control	Arm #	Device#	Message	ETX	VRC
<CtrlB>	01001001	1		PI	<CtrlC>	X
02h	49h	31h	38h	50h 49h	03h	58h

3 CCU-9000 to External Computer

Acknowledgment message for left arm initialization.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	1	8	<CtrlC>	H
02h	40h	31h	38h	03h	48h

4 CCU-9000 to External Computer
Left arm has completed initialization.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01010001	1	8	<CtrlC>	Y
02h	51h	31h	38h	03h	59h

5 External Computer to CCU-9000
Acknowledgment for answer to left arm initialization complete.

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	1		<CtrlC>	H
02h	40h	31h	38h	03h	48h

3.7 Instrument Error Sequence

The sequence illustrated below demonstrates returning of a device error by the instrument. For a list of instrument errors, please see the following section.

If an instrument error occurs, the bit #4 from the control byte is set to 0. In this case, the instrument error is returned in the fifth byte of the instrument answer, right after the device address byte. The error byte returned represents the error code added to the hexadecimal constant 40:

ErrByte = ErrCode + 40h

For example, if the instrument returns error 20 (which is 14h), the error byte will be:

ErrByte = 14h + 40h = 54h (hexadecimal)

If there is no error (control bit 4 is set to 1), there is no error byte returned and the device address is followed by ETX.

Here is an example of the communication sequence:

1 External computer to CCU-9000

Initialize the left arm

STX	Control	Arm #	Device#	Message	ETX	VRC
<CtrlB>	01000001	1	8	PI	<CtrlC>	P
02h	41h	31h	38h	50h 49h	03h	50h

2 CCU-9000 to External computer
Acknowledgment message for left arm initialization

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	1	8	<CtrlC>	H
02h	40h	31h	38h	03h	48h

3 CCU-9000 to External Computer (Answer)

Note: *An error "Initialization Error" (Error No. 1) has occurred during initialization. The instrument sends back Error byte 41, which corresponds to device error 1.*

(ErrByte = 40h + 1h = 41h)

STX	Control	Arm #	Device#	ErrByte	ETX	VRC
<CtrlB>	01000001	1	8	**01000001**	<CtrlC>	
02h	41h	31h	38h	**41h**	03h	08h

4 External computer to CCU-9000
Acknowledgment for receiving the answer from CCU-9000

STX	Control	Arm #	Device#	ETX	VRC
<CtrlB>	01000000	1	8	<CtrlC>	H
02h	40h	31h	38h	03h	48h

3.8 Device Error Codes

Error Code	Device No. 8	All Other Devices
1	Initialization error	Initialization error

Error Code	Device No. 8	All Other Devices
2	Invalid command	Invalid command
3	Invalid operand	Invalid operand
4	Invalid command sequence	Invalid command sequence
5	Device not implemented	Device not implemented
6	Time out error	Time out error
7	Device not initialized	Device not initialized
8	Command overflow	Command overflow
9	No liquid detected with ZX-command	Reserved
10	Entered move for Z-axis out of range	Reserved
11	Not enough liquid detected with ZX-command	Reserved
12	No liquid detected with ZZ-command	Reserved
13	Not enough liquid detected with ZZ-command	Reserved
14	Reserved	Reserved
15	Reserved	Reserved
16	Reserved	Reserved
17	Arm collision avoided	Reserved
18	Reserved	Reserved
19	Reserved	Reserved
20	Step loss detected on X-axis	Reserved
21	Step loss detected on Y-axis	Reserved
22	Step loss detected on Z-axis	Reserved
23	Step loss detected on X-axis of opposing arm	Reserved
24	ALIDUM pulse time out	Reserved
25	Tip not fetched (used with DiTi option)	Reserved
26	Tip crash (used with DiTi option)	Reserved
27	Tip not clean (used with DiTi option)	Reserved

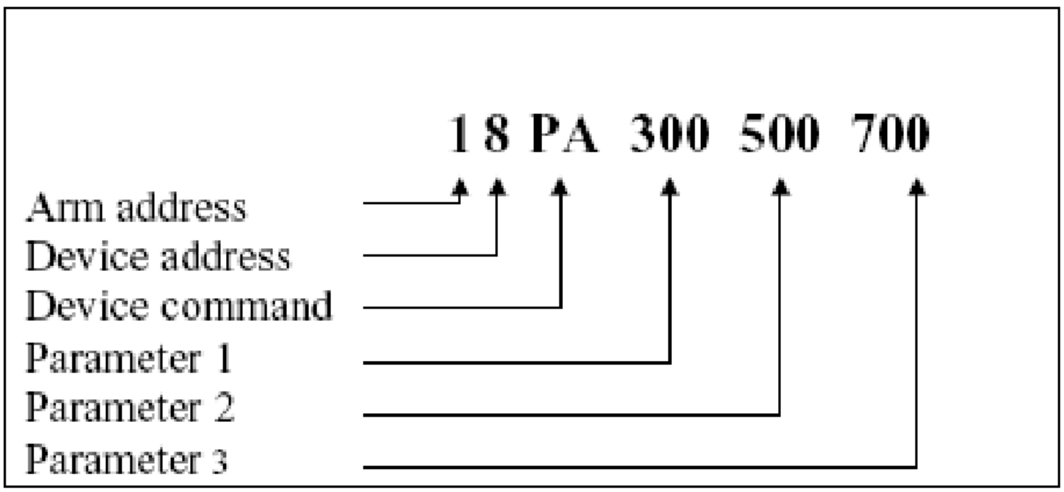
Note: *Error codes [1..8] are common errors for all devices. Error codes [9..63] are device-specific.*

4 Command Set

4.1 Command String Structure

Each command the RSP 9000 II sends or receives contains information that allows transparent or processed communication to occur between devices. There are five parts to each system command:

- Arm address (1 or 2)
- Device address (device to be controlled)
- Device command (action to be performed)
- Required or optional parameters



WARNING! *Ensure that all objects are removed from the work surface. Keep all body parts out of the operating range of the arm(s) when the RSP 9000 II is in operation.*

4.1.1 Arm Address

The arm address is a logical indicator for devices. The number “1” tells the RSP 9000 II that the device being called upon is logically connected to the left arm address (single arm for one arm instruments). The number “2” tells the RSP 9000 II that the device being called upon is logically connected to the right arm address. The left arm, being a physical device, is assigned to arm address 1 and the right arm is assigned to arm address 2.

4.1.2 Device Address

The device address tells the RSP 9000 II which “device” is receiving the following command/parameter(s) and allows the CCU-9000 to control transparent and controlled communications. Below is a listing of device addresses and their meanings.

Device Address	Device
Device 9	Interactive motor drive control (Molo-X)
Device 8	X, Y, and Z arm commands
Device 7	Not used
Device 6	Fast Wash
Device 5	Not used
Device 4	Diluter
Device 3	Diluter
Device 2	Diluter
Device 1	Diluter

Note: *There are four different device numbers on each arm for diluters so they can operate independently from one another.*

4.1.3 Device Command

The device command is a single or dual letter command that is sent to a specific device for execution. Some device commands have no parameters; however, other device commands have several. A complete listing of the RSP 9000 II device commands can be found later in this chapter. Descriptions of the device commands indicate what parameters are required or optional and give examples of proper usage. All device commands for RSP 9000 II supported options can be found in their respective manuals.

4.1.4 Parameters

Parameters are specific to each command. Parameters are explained in the command summary for each individual command, including ranges and whether the parameter is required or optional.

4.1.5 Words to Know Before Continuing

Refer to the following terms in Appendix I before continuing; they will aid in your understanding of the commands and how they are used:

Absolute field	Defined field	Coordinate
Fixed position	Position	Rack
Tray	Tracking speed	Offset
Position counter	RAM	Mnemonic
SLD	Volatile memory	Nonvolatile memory
ALIDUM	Sensitivity	Diti

4.2 Command Syntax Rules

- Never insert spaces between the “arm address,” “device address,” and “device command.”
- There must always be one or more spaces between parameters, and between the device command and the first parameter.
- All parameters are shown enclosed by square brackets “[ ]”, but are only used for visual effect. Do not place them in command lines.
- All parameters which can be omitted must be replaced with a comma (placeholder).
- The “*” symbol indicates parameters which will retain their old values when omitted. Example: 18PF [FixPosNo] [X*] [Y*] [Z*]
- The “°” symbol indicates parameters which will have their value set to “0” when omitted. Example: 18PA [X°] [Y°] [Z°]
- Parameters without the “*” or “°” symbol cannot be omitted.

4.3 Device Commands

Use the following list to locate individual commands:

4.3.1 Set Commands (Device #8)

OM [x*] [y*] [z*]

Set Overall Machine Limitation

This command sets the physical limitation range (in volatile RAM) of the RSP 9000 II. It is used as a safety for the SM/SA-commands to ensure that the X / Y / Z-axes ranges cannot be set to invalid machine positions. After firmware is downloaded, the OM-command range is set to 1000, 1000, 1000. After definition, maximal range can be stored in non-volatile memory with the OW-command.

[x*] [y*] [z*] =	X / Y / Z coordinates in steps [0..8000] (Preset on delivery) (Default = 1000)
Generated Errors:	(3) Invalid operand

OT [x*] [y*] [z*]

Set Self-Test Range

This command sets the range of operation in each axis used during self-test. See Section 2.6, "Running Self Test", on page 2-8 for instructions on how to operate the instrument in self-test mode.

[x*] [y*] [z*] =	X / Y / Z coordinates in steps [0..limit set by OM-command]

OX / OY / OZ [initOffset*]

Set Initialization Offset for X / Y / Z

This command sets the initialization offset to the entered parameter [initOffset] for the given axis. The offset parameter entered is implemented only after an initialization command is given. After definition, the new offset can be stored in non-volatile memory with the OW-command.

[initOffset*] =	Steps to be offset from the zero position. [5..100] (Defaults: X = 5, Y = 5, Z = 20)
Example:	18OX50

Sets the initialization offset for the X-axis to 50 steps. However, there is no physical movement of the arm. The new offset entered will take effect at the next X-axis initialization. Effective range of each axis is the overall machine range (OM) minus the offset for that axis.

Generated Errors: (3) Invalid operand

XO / YO / ZO [±relOffset]*

Adjust Initialization Offset Relative to OX / OY / OZ Setting

This command offsets the X / Y / Z-axis plus or minus the entered number of steps [±relOffset]. The entered parameter [relOffset] is added to the current offset. This command affects the OX / OY / OZ setting. The relative movement cannot exceed the range for the OX / OY / OZ-commands. After definition, the new offset can be stored in non-volatile memory with the OW-command.

[±relOffset] = $0 \leq (\text{initOffset} + \text{relOffset}) \leq 100$

Example: 18XO 50

If initOffset is currently at 5 for the X-axis and then 18XO 50 is given, the X-axis moves +50 steps to an offset coordinate of 55. The next initialization will offset to this location.

Generated Errors: (3) Invalid operand

OW

Write Parameters to EEPROM

This command writes all parameters of both arms set by the following commands to the EEPROM (nonvolatile memory):

- OM-command (overall machine range limitations)
- OX / OY / OZ-commands (initialization offsets)
- XO / YO / ZO-commands (relative initialization offsets)
- SL-command (liquid search speed)
- FX / FY / FZ-command (drive speeds, acceleration, and step size)
- SN-command (general purpose numeric parameters)

Generated Errors: None

Caution! *This command will always save the current value for each listed command. Only use this command when you are certain that the intended changes you want to save are the only ones made to this instrument since the last power-up..*

OR

Read Parameters Back from EEEPROM and Overwrite Current Settings

This command restores all currently-saves parameter values from the EEPROM into operating memory. This is performed automatically at power-up. Previously set values in the operating memory will be lost unless they are written to the EEPROM using the OW-command prior to using this command.

SM [x] [y*] [z*]*

Set Range for Absolute Field

The SM-command sets the absolute field range (in volatile RAM) for all axes of the instrument. If the system has two arms, the range of [x*] determines the minimal distance between the arms (the higher [x*] the smaller the minimal distance.) The machine range cannot exceed the maximal values defined by the OM-command. After the system starts, the SM-command values are the same as the OM-command values.

[x*] [y*] [z*] =	Set maximum X / Y / Z-axis coordinates for absolute field range in steps.
Example:	18SM 2500, 1500, 1000

Sets the absolute field range (in steps) for the left arm to 2500 / 1500 / 1000 (X / Y / Z).

Generated Errors:	(3) Invalid operand

SA [zm] [zs*] [zd*] [zt*]*

Set Z-Parameters for Absolute Field

The SA-command sets (in volatile RAM) four Z-axis heights for the absolute field. The SA-values are valid until the SA-command is either re-entered or until the RSP 9000 II is turned off. The only time these values are in effect is when the machine is traveling in the absolute field.

Note: *This travel position is also valid for reagent positions.*

[zm*] =	Maximum Z-axis height to search for liquid. (This should be the lowest working position in the absolute field.)
[zs*] =	Start height for the Z-axis to turn on liquid detection. The instrument searches for liquid between zs and zm.
[zd*] =	Dispense height for the Z-axis.
[zt*] =	Z-axis travel height (valid for fixed positions).
Example:	18SA 500 400 380 200

Left arm Z-axis positions for the absolute field set to 500 steps for maximum Z-position to search for liquid, 400 steps for start position for the Z-axis to turn on liquid detection, 380 steps for dispense height for Z-axis, and 200 steps for Z-axis travel height.

Generated Errors:	(3) Invalid operand

SZ

Set Z-Travel Position for the Next X / Y Move Only

SL [sf]*

Set Z-drive Liquid search frequency

The SL-command sets the search speed (in volatile RAM) the Z-axis will use while moving from Z-start to Z-Max.

[sf*] =	The search speed from Z-start to Z-Max. [5..1500] (Default = 900)
Generated Errors:	(3) Invalid operand

SN [n] [value]

Set Numeric General Purpose EEPROM Value

A set of ten integer values may be set for each arm (and stored permanently in EEPROM by the OW-command) to make machine-dependent data available to application programs. These values can be retrieved by the RN-command.

[sf*] =	Parameter value for the arm [1..10]
[value] =	Integer value to set [-32,768..32,767]

SP [onOff]

Set Position Recovery

If SP is set to on, the RSP 9000 II tries to reposition the arm when step loss is detected to the position from the last command executed. If the RSP 9000 II loses steps while trying to recover from the first lost steps, the arm will stop. If SP is set to off, the RSP stops immediately upon the detection of lost steps and does not attempt position recovery. (An error message will be generated.) SP-command parameters are stored in volatile RAM.

Note: *This command requires the step loss detection option*

[onOff*] =	ON = 1, OFF = 0 (Default at start-up = "0") (If omitted, the value of [onOff] is toggled.)
Generated Errors:	(3) Invalid operand

SS [sensitivity]

Set Liquid Detection Sensitivity

Sets the ALIDUM sensitivity (in volatile RAM) for the ZX / ZZ-commands. The SS-command remains valid until the SS-command is re-entered or until the power is turned off.

[sensitivity] =	0 = low sensitivity (default) 1= high or very high sensitivity selected by SW4 on the ADRI-9 board (only available if SW3 on ADRI-9 board is set to “enable.”) See the figure of the ADRI-9 board in Appendix C, “Mechanical Drawings”.
Generated Errors:	(3) Invalid operand

FX [startFreq] [endFreq*] [accel*] [initFreq*] [stepSize*]*

Set X-Ramp Parameters

This command sets the X-axis stepper motor ramp settings (in volatile RAM).

[startFreq*] =	Start speed in Hz	[50..200] (Default : 50)
[endFreq*] =	End speed in Hz	[50..4400] (Default : 4000)
[accel*] =	Acceleration in kHz/s^2	[3..40] (Default : 10)
[initFreq]	Initialization speed in Hz	[5..400](Default: 150)
[stepSize]	Step size in mm x 10,000	[100..5000]
Generated Errors:	(3) Invalid operand	

FY [startFreq] [endFreq*] [accel*] [initFreq*] [stepSize*]*

Set Y-Ramp Parameters

This command sets the Y-axis stepper motor ramp settings (in volatile RAM).

[startFreq*] =	Start speed in Hz	[50..200] (Default : 50)
[endFreq*] =	End speed in Hz	[50..4400] (Default : 4000)
[accel*] =	Acceleration in kHz/s^2	[3..80] (Default : 20)
[initFreq]	Initialization speed in Hz	[5..400] (Default: 150)
[stepSize]	Step size in mm x 10,000	[100..5000]
Generated Errors:	(3) Invalid operand	

FZ [StartSp] [EndSp*] [Accel*] [initFreq*] [stepSize*]*

Set Z-Ramp Parameters

This command sets the Z-axis stepper motor ramp settings (in volatile RAM).

[StartSp*] =	Start speed in Hz	[50..800] (Default : 400)
[EndSp*] =	End speed in Hz	[50..4400] (Default : 4000)

[Accel*] =	Acceleration in kHz/s^2	[3..80] (Default : 30)
[initFreq]	Initialization speed in Hz	[5..400] (Default: 150)
[stepSize]	Step size in mm x 10,000	[100..5000]
Generated Errors:	(3) Invalid operand	

ST [t]

Set Tip Option

Switches between normal tip and use of the Disposable Tip (DiTi) option.

[t]	Tip option: 0 = Standard tip (default at start up) 1 = DiTi implemented (Z offset is set to 60)
Example:	#18ST1

Sets detection mode to DiTi option.

4.3.2 Diagnostic Commands (Device #8)

RG [drive]

Report Total Moves Done

This command reports a move counter value for the requested axis. A move is a change in position in a single direction. This can be as short as one step or as long as the entire range of operation.

An initialization, for example, is counted as two moves in the X-axis and Y-axis. One move towards the initialization flag and a short move away from the flag, creating the initialization offset.

[drive] =	Axis to report: 0 = X 1 = Y 2 = Z

RA [item], [taskNum]

Report Diagnostic Values

[item] Value	[taskNum] Value	Reported Value
0	0	max. CPU load in % (resets value)
	1	current CPU load in %
1	1..N	task name
2		task priority
3		unused stack
4		used stack
5		stack size

OW 99

Clear Both EEPROM First Time Patterns

OW 99,1

Clear EEPROM Extension Pattern Only

The EEPROM contains three sets of data:

- Machine ranges, init offsets, and digital I / O mode (OM, OX / OY / OZ, XO / YO / ZO, SD-commands)
- Setup extensions: speeds, step sizes, numeric values (FX / FY / FZ, SL, SN-commands)
- Diagnostics counters (recording total moves done)

Upon power-up, the firmware checks the first time patterns. If a pattern is missing, the according set will be initialized with the default values.

Example: #OW 99,1

Clears the extension pattern only; at the next power-up, the EEPROM will be re-initialized with the default values for all speed and step sizes (set-2).

4.3.3 Diagnostic Commands (Device #9)

RV

Report Supply Voltage (Power Voltage Vpp)

This command reports the current supply voltage (24V) in 1/10 Volt (± 1.5 V). For example, a reported value of 242 is equivalent to 24.2 volts.

4.3.4 Arm Positioning Commands (Device #8)

Device #8 commands are used to control the arm(s) of the RSP 9000 II. These commands are used with command arm / device #18 and #28.

PI

Position Initialization X / Y / Z-axes

This is the command which must be sent to initialize the right and left arms (X / Y / Z-axes). No X / Y / Z-movement commands for device #8 are accepted before the PI command is executed. When the PI command is entered, the X / Y / Z-axes move to their initialization positions. When the initialization flag of each axis has been detected, they move to an initial offset position. This position is assigned coordinate value of “0”. Each individual axis may be initialized and moved separately (see XI / YI / ZI-commands).

Example:	18PI

Initialization of the left arm X / Y / Z-axes.

Generated Errors:	(3) Invalid operand

FI

Fake Initialization X / Y / Z-axes

Caution! *This command performs no physical initialization of the instrument. It is intended for software test purposes only. Incorrect usage may damage the instrument.*

Caution! *To avoid crashing, always retract the Z-axis before initiating any other movement commands.*

Note: *On a two-arm instrument an arm can only be moved in the X-direction after the other arm has been initialized; otherwise, error 17 (arm collision avoided) occurs.*

The FI-command tells the firmware (sets flag) that the X / Y / Z-axes have been initialized; however, no mechanical initialization is executed. The current position coordinates of each axis are still valid. If power is disconnected and turned on, using the FI-command will give all axes positions the position value of “0”.

Example:	18FI

Fake initialization of the left arm.

Generated Errors:	none

XI / YI / ZI [speed]*

Position Initialization for X / Y / Z-Axes

This function may be necessary after an arm collision or if the accuracy is bad due to lost steps. For example, the XI-command initializes the X-axis of the defined arm. An override motor speed (not stored in memory) for axis initialization may be placed at the end of the command, but to achieve the proper initialization position of any axis, the XI / YI / ZI-command must be given without the [speed*] parameter.

[speed*] =	Temporary override of the motor speed, in steps/s	X-axis: [5..400] (Default : 150)
		Y-axis: [5..800] (Default : 400)
		Z-axis: [5..800] (Default : 650)

Example:	18XI

X-axis initialization of the left arm (default speed).

Example:	18YI 600; #18YI

Y-axis initialization of the left arm (speed 600 steps/s), then reinitialization with the default speed to ensure proper initialization position.

Generated Errors:	(1) Initialization Error. Initialization was not successful.

PA [X°] [Y°] [Z°]

Position Absolute for All Axes

The PA command moves the X / Y / Z-axes to the entered coordinates (in steps) in the absolute field. After using this command, all Z-positions set with the SA command are in effect.

[X°] [Y°] [Z°] =	Coordinates in the absolute field.

Note: *See Appendix B, “Instrument Specifications” for the maximum range (in steps) of each axis.*

Example:	28PA 300 300 300

Moves the right arm (in steps) to position 300 / 300 / 300 (X / Y / Z).

Example: 28PA 200 500

Moves the right arm (in steps) to position 200 / 500 / 0 (X / Y / Z).

Example: 28PA, , 400

Moves the right arm (in steps) to position 0 / 0 / 400 (X / Y / Z).

Generated Errors: (3) Invalid operand -- out of range (machine setup)
(17) Arm collision avoided -- X-axis only

XA [x°]

Position Absolute for X-Axis

Moves the X-axis individually to an absolute position (in steps) leaving the other two axes unchanged.

Caution! *The command uses absolute field parameters; it does NOT use a range specified for defined fields or fixed positions. The movement is direct and may cause the Z-axis to crash with work surface components if used improperly.*

[x°] = A coordinate in the X-axis range. (Range is defined by SM-command settings.)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis range in steps.*

Example: 18XA 300

Moves the left arm's X-axis to coordinate 300 leaving the Y / Z-axes in the same position prior to the command being executed.

Generated Errors: (3) Invalid operand -- out of range (machine setup)
(17) Arm collision avoided -- X-axis only

YA [y°]

Position Absolute for Y-Axis

Moves the Y-axis individually to an absolute position (in steps) leaving the other two axes unchanged.

Caution! *The command uses absolute field parameters; it does NOT use a range specified for defined fields or fixed positions. The movement is direct and may cause the Z-axis to crash with work surface components if used improperly.*

[y°] = A coordinate in the Y-axis range. (Range is defined by SM-command settings.)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis range in steps.*

Example: 18YA 300

Moves the left arm's Y-axis to coordinate 300 leaving the X / Z-axes in the same position prior to the command being executed.

Generated Errors: (3) Invalid operand -- out of range (machine setup)

ZA [z°]

Position Absolute for Z-Axis

Moves the Z-axis individually to an absolute position (in steps) leaving the other two axes unchanged.

[z°] = A coordinate in the Z-axis range. (Range is defined by SM-command settings.)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis range in steps.*

Example: 18ZA 300

Moves the left arm's Z-axis to coordinate 300 leaving the X / Y-axes in the same position prior to the command being executed.

Generated Errors: (3) Invalid operand -- out of range (machine setup)

XR [±x°]

Position Relative for X-Axis

Moves the X-axis relative to its actual position [±x]. All other axes remain unchanged.

Caution! *The command uses absolute field parameters; it does NOT use Max-range parameters specified for defined fields or fixed positions. The movement of any axis is direct and may cause the Z-axis to crash with work surface components if used improperly.*

[±x°] = The number of steps to position X-axis from current location.

Example: 18XR20

Moves the left arm's X-axis 20 steps from the initialization position.

Generated Errors: (3) Invalid operand--out of range (machine setup)
(17) Arm collision avoided -- X-axis only

YR [±y°]

Position Relative for Y-Axis

Moves the Y-axis relative to its actual position [±y]. All other axes remain unchanged.

Caution! *The command uses absolute field parameters; it does NOT use Max-range parameters specified for defined fields or fixed positions. The movement of any axis is direct and may cause the Z-axis to crash with work surface components if used improperly.*

[±y°] =	The number of steps to position Y-axis from current location.
Example:	18YR20

Moves the left arm's Y-axis 20 steps from the initialization position.

Generated Errors:	(3) Invalid operand--out of range (machine setup)

ZR [±z°]

Position Relative for Z-Axis

Moves the Z-axis relative to its actual position [±z]. All other axes remain unchanged.

[±z°] =	The number of steps to position Z-axis from current location.
Example:	18ZR20

Moves the left arm's Z-axis 20 steps from the initialization position.

Generated Errors:	(3) Invalid operand--out of range (machine setup)

XS [±x°] [speed]*

Position Relative, Slow Speed

Moves the X-axis relative to its actual position ±x. All other axes remain unchanged. Same as XR-commands, but a tracking speed may be entered.

[±x°] =	Number of relative steps.
[speed*] =	Speed in steps/s [5..400] (Default : 150)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis ranges in steps.*

Caution! *The command uses absolute field parameters; it does NOT use the X-range specified for defined fields or fixed positions. The movement of any axis is direct and may cause the Z-axis to crash with work surface components if used improperly.*

Example: 18XS 100 100

Moves the left arm's X-axis downward 100 steps with a speed of 100 steps/s. The Y / Z axes will not move.

Generated Errors: (3) Invalid operand--out of range (machine setup)
(17) Arm collision avoided -- X-axis only

YS [±y°] [speed]*

Position Relative, Slow Speed

Moves the Y-axis relative to its actual position ±y. All other axes remain unchanged. Same as YR-command, but a tracking speed may be entered.

[±y°] =	Number of relative steps.
[speed*] =	Speed in steps/s [5..800] (Default : 400)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis ranges in steps.*

Caution! *The command uses absolute field parameters; it does NOT use the Y-range specified for defined fields or fixed positions. The movement of any axis is direct and may cause the Z-axis to crash with work surface components if used improperly.*

Example: 18YS 100 100

Moves the left arm's Y-axis downward 100 steps with a speed of 100 steps/s. The X / Z axes will not move.

Generated Errors: (3) Invalid operand--out of range (machine setup)

ZS [±z°] [speed]*

Position Relative, Slow Speed

Moves the Z-axis relative to its actual position ±z. All other axes remain unchanged. Same as ZR-command, but a tracking speed may be entered.

[±z°] =	Number of relative steps.
[speed*] =	Speed in steps/s [5..800] (Default : 400)

Note: *Check Appendix B, "Instrument Specifications" to find the individual axis ranges in steps.*

Example: 18ZS 100 100

Moves the left arm's Z-axis downward 100 steps with a speed of 100 steps/s. The X / Y axes will not move.

Generated Errors: (3) Invalid operand--out of range (machine setup)

4.3.5 Rack Definition Commands

SF [nn] [x*] [y*] [z*]

Set Coordinates for a Fixed Position

The SF-command is used to set up to 50 fixed positions within the absolute field.

[nn] =	Fixed position number [1..50]
[x*] [y*] [z*]	Coordinates in steps
Example:	18SF1 1000 500 500

Sets fixed position #1 (reagent1) in steps to 1000 / 500 / 500 (X / Y / Z).

Generated Errors: (3) Invalid operand.

SR [nn] [zm*] [zs*] [zd*]

Set Z-Parameters for a Fixed Position

This command sets the Z-parameters for fixed position [nn]. The Z-axis travel height parameter is set by the SA-command setting.

[nn] =	Fixed position number [1..50]
[zm*]	Maximum height for liquid detection (SM-range)
[zs*]	Start height for liquid detection (SM-range)
[zd*]	Dispense position for Z-axis (SM-range)
Example:	18SR 4 1500 150 600

For fixed position number 4, sets maximum Z-position for liquid detection to 1500, the start position for liquid detection to 150 and the dispense height for the Z-axis to 600.

Generated Errors: (3) Invalid operand.

SW [n] [xx*] [yy*] [zz*]

Set Coordinates for Waste Station n

The SW-command sets fixed positions (in volatile RAM) for the waste stations in the absolute field.

[n] =	Waste station number [1..3] (Stored as fixed position number [51..53].)
[xx*] [yy*] [zz*] =	X / Y / Z-coordinates (in steps).
Example:	18SW 1 1100 200 600

Sets waste station #1 (fixed position #54) for the left arm to 1100/200/600

Generated Errors:	(3) Invalid operand

SC [n] [xx] [yy*] [zz*]*

Set Coordinates for Cleaner Station n

The SC-command sets fixed positions (in volatile RAM) for the cleaner stations in the absolute field.

[n] =	Cleaner station number [1..3] (Stored as fixed position number [54..56].)
[xx*] [yy*] [zz*] =	X / Y / Z-coordinates (in steps).
Example:	18SC 2 1100 225 600

Sets cleaner station #2 (fixed position #52) for the left arm to 1100 / 225 / 600(X / Y / Z).

Generated Errors:	(3) Invalid operand

D% [ps] [nc*] [nr*] [x0*] [y0*] [x1*] [y1*] [xof*] [yof*]*

Set Parameters for a Defined Field (Rectangular)

This command defines a field in the form of a matrix. When stepping through such a rack, start at the first position and scan the rows column by column (or the columns row by row) and wrap around to the first position. If an offset is defined, every second row (X offset) or column (Y offset) is shifted relative.

% =	[A..Z] (Placeholder for tray identifier)
[ps*] =	Position sequence (0 = left/right; 1 = front/rear)
[nc*] =	Number of columns in defined field.
[nr*] =	Number of rows in defined field
[x0*] [y0*] =	First corner position
[x1*] [y1*] =	Second corner position
[xof*] =	X-offset of row displacement
[yof*] =	Y -offset of column displacement
Generated Errors:	(3) Invalid operand.

D% [ps] [np*] [nc*] [xc*] [yc*] [r1*] [a1*] [r2*] [a2*]*

Set Parameters for a Defined Field (Circular)

This command defines a field in the form of concentric circles. When stepping through a circular field, start in the first position (Xcenter + Radius 1/Ycenter by Angle 0) of the first circle. After reaching the last position of the first circle, this function jumps to the first position of the second circle. After the last position of the second circle it wraps around to the first position of the circle.

% =	[A..Z] (Placeholder for tray identifier.)
[ps*] =	Position sequence: (2 = clockwise; 3 = counterclockwise
[np*] =	Total number of positions per circle [1..1000] If 2 circles, total number of positions = TotNum Posx2!
[nc*] =	Number of concentric circles [1..2]
[xc*] =	Center X-position for all circles
[yc*] =	Center Y-position for all circles
[r1*] =	Radius of 1st circle, in 0.1 mm (0.0039 in.)
[a1*] =	Angle of 1st position, in 0.001 Radians
[r2*] =	Radius of 2nd circle, in 0.1 mm (0.0039 in.)
[a*] =	Angle of 2nd position, in 0.001 Radians
Generated Errors:	(3) Invalid operand.

D% [rt] [rn*] [x*] [yf*] [yl*]*

Set Parameters for a Defined Field (Linear Rack)

The D%-command for the Linear Rack Drive defines the position and type of rack and assigns it to a LiRa. There are three types of racks available. All of these racks can be assigned a Defined Field, but only one at a time (with one D%-command). At least one rack must be assigned for every mounted LiRa. All of the racks used must have their Z-positions defined separately (E%-command).

% =	[A..Z] (Placeholder for tray identifier.)
[rt*] =	17 : Type 1 (8-position) 18 : Type 2 [2..16 position, variable] 19 : Type 3 (4-position) (for available 4-position rack)
[rn*] =	Linear rack number [1..2]
[x*] =	X-coordinate for all rack locations
[yf*] =	Y-coordinate for the first tube in rack
[yl*] =	Y-coordinate for the last tube in rack

Generated Errors:	(3) Invalid operand.

E% [zm*] [zs*] [zd*] [zt*]

Set Z-Parameters for a Defined Field

This command sets the Z-position for trays to the entered parameters. This command may not be used until the tray is defined by the D%-command.

% =	[A..Z] (Placeholder for tray identifier.)
[zm*] =	Maximum Z-axis position
[zs*] =	Start position for liquid search (ALIDUM)
[zd*] =	Dispense position for Z-axis
[zt*] =	Axis travel height
Generated Errors:	(3) Invalid operand.

4.3.6 Rack Positioning Commands

PF [p]

Move to Fixed Position

This command moves the Z-rack to a predefined fixed position implemented with the SF or SR-commands.

[p] =	A fixed position number between [1..50]. If 0, then p is set to 1.

Note: *If [p] is between 1 and 50, it can also be used as a reagent number.*

Example:	18PF 1

Left arm is moved to the fixed position #1.

Generated Errors:	(3) Invalid operand--Invalid [p] (17) Arm collision avoided -- X-axis only.

G% [pos] [rt] [min] [max]

Get Tip at Given Position

At tip pick-up, the number of gained steps must be within [min..max]. If the number of gained steps is greater than [max], a Tip Crash error is generated. If the number of gained steps is less than [min], the tip is considered to be not fetched, and a Tip Not Fetched error is generated.

% =	Tray number as implemented (A...Z).
pos =	Position in tray
rt =	Rack type (0 = normal rack type; for future expansion)
min =	minimum number of steps gained at tip pickup [5..20] (default: 10)
max =	maximum number of steps gained at tip pickup [40..100] (default: 60)

FT [x] [y] [Zstart] [Zend] [min] [max]

Get Tip At Position X / Y

[x] [y] =	X / Y position of tip
[Zstart] =	Move fast down to [Zstart], then start pickup
[Zend] =	by moving slowly down to Zend
min =	minimum number of steps gained at tip pickup [5..20] (default: 10)
max =	maximum number of steps gained at tip pickup [40..100] (default: 60)

BF [pos] [steps]

Discard Tip

Discards a disposable tip at position [pos] in waste bag that is defined as a reagent rack.

Note: *At least the true number of steps gained at tip pickup must be specified to ensure successful removal; too large a number may lead to a crash of the tip head at its upper mechanic.*

[pos] =	Position in the reagent rack defined as waste bag position.
[steps] =	Number of steps needed to remove a tip successfully [40..80] default=60.
Example:	#18BF7,60

Discards tip at position 7 with 60 retract steps.

BT [x] [y] [z] [steps]

Discard Tip at Position X / Y / Z

[x] [y] [z] =	X / Y / Z position of tip
[steps] =	Number of steps needed to remove a tip successfully [40..80] default=60.

PR [p]

Move to Reagent Position

This command moves to a reagent position. It performs the same function as the PF-command, since reagent and fixed positions are the same.

[p] =	Reagent number relates to fixed position [1..50]
Example:	18PR 1

The left arm is moved to the reagent position defined as Number 1.

Generated Errors:	(3) Invalid operand--Invalid [p] (17) Arm collision avoided -- X-axis only.

ZD [±z°]

Move to Z-Dispense Height

Moves the Z-rack to the dispense height defined for the position. If the current location of the Z-rack is not in a defined field, it moves to the dispense height defined by the SA-command setting plus or minus the number of steps indicated by [±z°].

[±z°] =	Offset to the defined dispense height.
Example:	18ZD +50

Moves the left arm's Z-rack 50 steps lower than the predefined Z-dispense height.

Generated Errors:	(3) Invalid operand -- Entered absolute Z-parameter is out of range.

ZM [±z°]

Move to Z-Max Height

This command moves the Z-rack to the Z-max height, defined for the current position. If the current location of the Z-rack is not in a defined field, it moves to the Z-max defined by the SA-command setting, plus or minus the number of steps indicated by [±z°].

[±z°] =	Offset to the defined maximal Z-position.

Example:	28ZM -20

Moves the right arm's Z-rack 20 steps higher than the predefined Z-maximum height.

Generated Errors:	(3) Invalid operand -- Entered absolute Z is out of range.

ZT [±z°]

Move to Z-Travel Height

The ZT command moves the Z-rack to the travel height defined for the current position (plus or minus entered number of steps). If the current location of the Z-rack is not in a defined field, it moves to the dispense height defined by the SA-command setting (plus or minus the number of steps indicated by [±z°].

[±z°]=	Offset to the defined Z-travel height.
Example:	18ZT

Moves the left arm's Z-rack to the defined Z-travel height.

Generated Errors:	(3) Invalid operand -- Entered absolute Z out of range.

ZX [zs°] [za°] [Z-Max]*

Move Z-Rack, Detect Liquid, Submerge

The ZX-command moves the Z-rack to Z-start and then searches downward until it detects liquid or reaches Z-Max. If no liquid is detected, the Z-rack will move back up to position “0” and generate error code 9 (no liquid detected). If liquid is detected, the Z-rack will be lowered to the specified [zs°] steps and verify that the [za°] steps can be lowered before reaching Z-max. If this is not possible, error code 11 (not enough liquid) is generated.

[zs°] =	Submerge distance (in steps).
[za°] =	Required distance to maximum Z-coordinate for liquid detection (in steps).
[Z-Max*] =	Override Z-max height of current position (in steps)
Generated Errors:	(3) Invalid operand (9) No liquid detected (11) Not enough liquid detected (27) Tip not clean (Diti AC only)

ZZ [zs°] [za°] [Z-Max]*

Move Z-Rack, Detect Liquid, Submerge

Same as the ZX-command, but the Z-rack will remain at Z-Max upon error. The reported error codes are different.

[zs°] =	Submerge distance (in steps).

[za°] =	Required distance to maximum Z-coordinate for liquid detection (in steps).
[Z-Max*] =	Override Z-max height of current position (in steps)
Generated Errors:	(3) Invalid operand (12) No liquid detected (13) Not enough liquid detected (27) Tip not clean (Diti AC only)

PW [n]

Move to Waste Position Location

The PW-command moves the Z-rack to one of three predefined waste positions [n] defined with the SW-command.

Note: *This command will only work if the waste positions being called upon have been predefined. If they are not defined, the arm will move to coordinates 0 / 0 / 0 (X / Y / Z).*

[n] =	Waste position [1..3] Waste position [1..3] corresponds to PF [54..56] If 0 is specified, then n = 1.
Example:	18PW 1

Moves the left arm to the predefined waste position #1.

Generated Errors:	(3) Invalid operand--Invalid [n] (17) Arm collision avoided -- X-axis only

PC [n]

Move to Cleaner Position

The PC-command moves to one of three predefined cleaner positions defined with the SC-command.

[n] =	Cleaner position [1..3] Cleaner position [1..3] corresponds to PF [51..53] If 0 is specified, then n = 1.

Note: *This command will only work if the cleaner positions have been predefined using the SC-command. If they are not defined, the arm will move to coordinates 0 / 0 / 0 (X / Y / Z).*

Example:	18PC 1

Moves the left arm's three axes to cleaner position #1.

Generated Errors:	(3) Invalid operand--Invalid [n] (17) Arm collision avoided -- X-axis only

U% [xx°] [yy°] [zz°]

Rack Position Absolute for All Axes

The U%-command performs the same function as the PA-command, but the Z-height of the specified defined field is used instead of the SA-command settings.

Subsequent commands may use the Z-pos setup of tray %.

% =	Tray number as implemented (A...Z).
[xx°] [yy°] [zz°] =	Coordinates in the absolute field. [zz°] sets temporary Z-travel, if specified (as ZS-command).
Generated Errors:	(3) Invalid operand. (17) Arm collision avoided.

G% [pos],[rt],[min],[max*]*

Get a Tip

Picks up a disposable tip from a defined tray [tray], at position [pos].

At tip pickup, the number of gained steps must be between [min*] and [max*]. If the number of gained steps is greater than [max*], a Tip Crash error is generated; if the number of gained steps is less than [min*], a Tip Not Fetched error is returned.

% =	Tray number as implemented (A...Z).
[pos] =	Position in tray (1...max. position as defined).
[rt] =	Rack type (0 = normal rack).
[min] =	Minimum number of steps gained with tip pick up [5..20] default 10.
[max] =	Maximum number of steps gained until crash alarm [40..100] default 60.
Example:	#18GA1,,15,40
Generated Errors:	(25) Tip Not Fetched (26) Tip Crash

T% [nn] [rt]*

Move to Defined Field Position

The T%-command moves the arm's axes to a defined field. If the last move was already in the same defined field, the travel height of the defined field is used; otherwise the travel height of the absolute field is used.

If both [nn] and [rt*] are omitted, then [nn] is set to 0 and incremented to the next position with wraparound.

% =	[A..Z] (Placeholder for defined field identifier).
[nn] =	Rack position, if 0 or omitted, increment to next position. The position counter is set to the value of the last position accessed.
[rt*] =	Linear rack type 0 = Normal rack, not linear rack 16 = move near linear rack (type yet unknown) 17 = rack type 1 (8-pos) 18 = rack type 2 (2..16 pos, variable) 19 = rack type 3 (4-pos)
Example:	#18TA1 (move to tray-A position 1) do 240 (loop count of 240) #18TA (tray A, using arm 1) od (end of loop)
Generated Errors:	(3) Invalid operand. (17) Arm collision avoided.

4.3.7 Report Commands

RV [Firmware°]

Report Firmware Version

RV0 =	Reports firmware version and date in this format: “RSP9000-Vn.nn-MM/YY”
RV1 =	Reports boot EPROM version and date in this format: “RSP9000-BOOT-Vn.nn-MM/YY”
Generated Errors:	(3) Invalid operand.

RX/RY/RZ 0* [Sel°]

Report Current Parameters for All Axes

This command reports the current parameters of the X / Y / Z-axis. Only one axis parameter can be reported at a time.

0* =	A zero must be entered after the command and before the [Sel].

A value selector [Sel°] is needed:

1 - Report error steps upon last initialization

2 - Report acceleration [steps/ramp]*

3 - Report start frequency [steps/s]

4 - Report end frequency [steps/s]

5 - Report initialization frequency [steps/s]

7 - Report liquid search frequency [steps/sec] (RZ only)

8 - Report initialization offset

9 - Report actual machine range (set by SM-command)

10 - Report overall machine limitations (set by OM-command)

11 - Report test range

12 - Report step size (in mm x 10,000)

Example: 18RX0,3 (report start frequency of X-axis)

Generated Errors: (3) Invalid operand.

Note: The CCU reports your acceleration in units of "steps/ramp" while the units for setting the acceleration are in units of" kHz/s^2"

To convert the reported acceleration to KHz/s^2, please use the following conversion formula:

((end freq)^2 - (start freq)^2) / (2 * (reported acceleration) * 1000)

End Frequency in steps/sec

Start Frequency in steps/sec

Reported acceleration in steps/ramp

§ The multiplier of 1000 converts results from Hz to KHz

RM

Report Z-Max Assigned to Current X / Y-Position

If the X / Y position is a defined field, the value is given from the Z-position defined for the specific rack. Otherwise, it is taken from the SA-command setting.

Generated Errors: (None)

RS

Report Z-Start Assigned to Current X / Y-Position

If the X / Y position is a defined field, the value is given from the Z-position defined for the specific rack. Otherwise, it is taken from the SA-command setting.

Generated Errors:	(None)

RD

Report Z-Dispense Assigned to Current X / Y-Position

If the X / Y position is a defined field, the value is given from the Z-position defined for the specific field. Otherwise, it is taken from the SA-command setting.

Generated Errors:	(None)

RT

Report Z-Travel Assigned to Current X / Y-Position

If the X / Y position is a defined field, the value is given from the Z-position defined for the specific field. Otherwise, it is taken from the SA-command setting.

Generated Errors:	(None)

RC

Report Capture Position

The capture position is the Z-position where liquid detection system detects a change in the capacitance for the first time using the ZS-command.

Generated Errors:	(None)

RE

Report Capture Events

This command reports the number of times the ALIDUM detects a change in capacitance (for example, during a ZS-command). This counter is reset with each Z move command.

Generated Errors:	(None)

RF [nn]

Report X-Coordinate of a Fixed Position

This command reports X-axis position of the Fixed Position [nn].

[nn] =	Fixed position number
Generated Errors:	(3) Invalid operand

RN [n]

Report Numeric General Purpose EEPROM Value

A set of ten integer values for each arm may be set and stored permanently in EEPROM to make machine-dependent data available to application programs.

[n] =	Integer value for the arm [1..10]

RL [n°]

Report Liquid Detection Z-values and Parameters in Effect

This command reports the values of the Z-axis using the following values for [n]:

0 -	Report Z-max of current X / Y position (See RM-command.)
1 -	Report Z-start of current X / Y position (See RS-command.)
2 -	Report Z-dispense of current X / Y position (See RD-command.)
3 -	Report Z-travel of current X / Y position (See RT-command.)
4 -	Report capture position (See RC-command.)
5 -	Report capture events (See RE-command.)
6 -	Report current liquid detection sensitivity.
7 -	Report liquid detection fast speed.
8 -	Report liquid detection slow speed.

Example: 18RL2 (reports Z-dispense height of current position)

Generated Errors: (3) Invalid operand.

Q% [RackPos]

Report X-Coordinate of Position in a Defined Field

Note: *The Q%-command must be sent as a single command embedded in square brackets (for example, [#18QA 12]).*

% =	Placeholder for defined field identifier [A..Z]
[RackPos] =	Position number
Generated Errors:	(None)

4.3.8 Device #6 Commands

Note: *Digital I/O's not used for the MiniWash may be abused for other purposes*

- *output: standard digital output; negative logic (active = lo)*
- *input: standard digital input (0..5V DC) pulled up by a 10 KΩ resistor*

SW [tt°]

Activate (Set) the MiniWash Pump

Note: *A timed SW-command sets the device as busy; no other command will be accepted until the specified length of time has elapsed. Use #9 KW-command to stop a MiniWash while the device is busy.*

[tt] =	Length of time to run the MiniWash pump, in 0.1 seconds. If no time is specified (or 0), the pump will stay on indefinitely. [0..600]
Example:	16SW 10
Generated Errors:	(3) Invalid operand.

CW [tt]

De-activate (Clear) the FastWash Pump

Note: *A timed CW-command sets the device as busy; no other command will be accepted until the specified length of time has elapsed.*

[tt] =	Length of time to stop the FastWash pump, in 0.1 seconds. If no time is specified (or 0), the pump will stay off indefinitely. [0..600]

RW [inOut]

Report FastWash Status

[inOut] =	0 = report output status set by the SW- or CW-command.
	0 = off (output hi); 1 = active (output lo)
	1 = report logic level of digital input

4.3.9 Device #9 Interactive Motor Drive Control Commands

The device #9 commands allow the user to have absolute control of the arm(s) while device #8 is busy. It also gives the user direct control over the Molo-X by ignoring all safety features of the CCU, e.g., arm collision control. The third function of the device #9 allows digital input/output line control.

SX / SY / SZ

Stop X / Y / Z-Drive Movement Immediately

This function is recommended only to stop the movement of the XS / YS / ZS-commands. If other movements are stopped with these commands, the axis must be reinitialized. If position recovery is set to on, the arm will try to reposition after stopping.

Generated Errors:	(23) Step loss detected on opposite arm (device #8).

RX/RY/RZ , [Sel°]*

Report Current Parameters for All Axes

This command reports the current parameters of the X / Y / Z-axis. Only one axis parameter can be reported at a time.

Note: *This command performs the same functions as the RX / RY / RZ-commands for device #8, except that it can retrieve the data if device #8 is busy.*

,* =	A comma must be entered after the command and before the [Sel].

A value selector [Sel°] is needed:

1 -	Report error steps upon last initialization
2 -	Report acceleration [steps/ramp]
3 -	Report start frequency [steps/s]
4 -	Report end frequency [steps/s]
5 -	Report initialization frequency [steps/s]
7 -	Report liquid search frequency [steps/sec] (RZ only)
8 -	Report initialization offset
9 -	Report actual machine range (set by SM-command)
10 -	Report overall machine limitations (set by OM-command)
11 -	Report test range
12 -	Report step size (in mm x 10,000)

Generated Errors:	(3) Invalid operand.

SD [num] [Direct°]

Set Digital I/O Direction of Given I/O Line on ADRI-9 Board Connector

Four digital I/O lines are available for each arm (device #19 and #29). Digital I/O-line 1, 2, and 3 can be configured to be either input or output; digital I/O-line 4 is input only.

I/O Line	Function	CCU Connector	ADRI9 Connector
I/O-1	ALID sensitivity switching (output)	-	J8
I/O-2	DiTi Air detection (output)	-	J8
I/O-3	FastWash (output)	left J19; right J26	J8
I-4	input only - available (input)	left J19; right J26	J8

If I/O lines are in use by these options, the according I/O lines may not be abused for other purposes.

[InOutNo] =	[1..3]
[Direct°] =	Direction of entered pin [0 = input, 1= output]

Example: 19SD 1,1

Sets the I/O line 1 to an output.

Generated Errors: (3) Invalid operand

Note: *See Appendix C for more information on the ADRI-9 Board Connectors (J8, SW2, SW3).*

SL [InOutNo] [Value°]

Set Output Value for Digital I/O Line

The I/O pin that needs to be set high or low must first be defined as a output with the SD-command.

[InOutNo] =	Digital I/O line [1..3]
[Value°] =	0 = output lo 1 = output hi

Example: 19SL2,1

Sets the I/O pin number 2 to 1 (high).

Generated Errors: (3) Invalid operand

__Note:__ See Appendix C for more information on the ADRI-9 Board Connectors (J8, SW2, SW3).

RL [InOutNo]

Report Logic Level on Digital I/O Line

[InOutNo] =	Digital I/O line [1..4]
Generated Errors:	(3) Invalid operand

__Note:__ See Appendix C for more information on the ADRI-9 Board Connectors (J8, SW2, SW3).

RD [InOutNo]

Reports Signal Direction of Digital I/O-Pin on ADRI-9 Board Connector

The command returns 0 if the I/O line is set to output and 1 if it is set to input.

[InOutNo] =	Digital I/O line [1..3]
Example:	19RD 1

Indicates whether I/O 1 is set as an input or output.

Generated Errors:	(3) Invalid operand

__Note:__ See Appendix C for more information on the ADRI-9 Board Connectors (J8, SW2, SW3).

__Caution!__ The following commands ignore the arm movement safety features of the CCU and should only be used after contacting Tecan. An additional manual is needed to use these commands (Molox Stepper Motor Controller/Driver Manual).

X% / Y% / Z% [p1, p2, p3]

Direct Control of Molox

These commands allow the user to communicate directly to the Molox for the X / Y / Z-axes and disregard all arm control safety features.

% =	Is a placeholder for Molox command mnemonics.
[p1..p3] =	The command parameters for Molox as described in Tecan's Molox Stepper Motor Controller/Driver Manual.
Generated Errors:	(Molox errors)
Example:	

T% [Adr] [p1] [p2] [p3]

Direct Control of Molox at Address

This command is used to communicate with any device on the Molox chain. It can be used with either device number “19” or “29” to communicate with any Molox.

% =	Placeholder for Molox command mnemonics.
[Adr] =	The RS-485 chain address of the Molox.
[p1..p3] =	The command parameters for Molox as described in Tecan's Molox Stepper Motor Controller/Driver Manual.

Example:

4.3.10 Device #9 Door Lock Commands

The following commands are used to control the “Lock” connector (J12) on the CCU board. This connector can be used to operate a door lock with feedback.

The maximum power output is rated to 1A (24V).

The feedback is detected using a standard digital output (0..5V), pulled up by a 10KΩ resistor.

SK [onOff]

Set Door Lock

[onOff] =	0 = unlock (deactivate) 1 = lock (activate)

RK [inOut]

Report Door Lock Status

[inOut] =	0 = report output status set by SK-command 1 = report logic level of feed-back input at J12

4.3.11 Device #9 Digital I/O Commands

The following commands are used to control the “Stop” connector (J14) on the CCU board. This connector can be used to operate a stop button with feedback.

The digital output is a standard digital signal (0..5V). Power-up status = High. The input signal is a standard digital signal (0..5V), pulled down by a 5.7KΩ resistor. The input is debounced by an RC with a time constant of approximately 1 ms, and clamped to Vcc to protect against overvoltage.

SS [onOff]

Set Digital I/O

[onOff] =	0 = set output low 1 = set output high

RS [inOut]

Report Digital I/O Status

[inOut] =	0 = report output status set by the SS-command 1 = report logic level of feedback input at J14

4.3.12 Device #9 MiniWash Commands

The following command can be used to stop the MiniWash while it is in operation. The standard #6 command for the MiniWash (SW), when used with a time parameter > 0, will remain busy until the set time has elapsed. If the pump needs to be stopped during that time, the following command must be used.

KW [onOff]

Stop MiniWash

[onOff] =	0 = off (output high) 1 = on (output low)

4.3.13 Alternate Diluter Commands

Note: *Tecan software programs do not accept the following Tecan diluter report commands. Therefore, the listed commands must be used.*

Integrator Commands	Tecan Diluter Commands	Description
RZ	?	Report absolute plunger position, in steps
RS	F	Report buffer status
RD1	%	Report number of valve movements
RD2		Report lost valve steps
RD3	*	Report voltage
RZ1	?1	Report start speed

Integrator Commands	Tecan Diluter Commands	Description
RZ2	?2	Report top speed
RZ3	?3	Report cutoff speed
RQ	Q	Report operational status (0: busy, 1: ready)

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5 Service

5.1 Maintenance

Maintenance must be performed on a regular basis in order to maintain the accuracy and precision of the RSP 9000 II. Table 5-1 outlines the proper intervals to check or replace components of the instrument.

Note: *Maintenance routines can be found in Section 5.2, "Routines", on page 5-2.*

The following definitions are used within the maintenance schedule.

C = Clean this item

X = Perform service

R = Replace component

S = Special case

T = Perform functional test

- = No action necessary

Tab. 5-1 *Maintenance Schedule*

Item	Daily	Weekly	6 Months
Insulation block cable	-	X	R
Sampling tip	C	C/X	R
Z-rack	-	C	C
Overall System	-	-	C
Lubrication	-	-	S
Liquid Level Detection	-	T	T

5.2 Routines

5.2.1 Sampling Tip

The sampling tip must be cleaned daily/weekly and replaced when bent or when the Teflon coating is damaged.

Caution! *Electrostatic discharge to the sampling tip may damage the ALIDUM.*

1. Turn off power to the RSP 9000 II.
2. Examine the Teflon coating on the sampling tip to ensure that it is not cracked or chipped. If the Teflon coating is damaged, replace the sampling tip. (See Section 5.3.1, “Replacing the Sampling Tip”, on page 5-4.)
3. Clean the sampling tip by wiping gently with a lint-free cloth dampened with isopropyl alcohol.

5.2.2 Z-rack

The Z-rack must be cleaned weekly.

Note: *Do <u>not</u> use alcohol or solvents when cleaning the Z-rack.*

1. Turn off power to the RSP 9000 II.
2. With a lint-free cloth, wipe the Z-rack thoroughly. If necessary, use a toothbrush to remove dust or dirt from the teeth of the Z-rack.

5.2.3 Insulation Block/Cable Assembly

The insulation block/cable assembly must be inspected weekly and replaced every six months. Examine the coax cable where it connects to the insulation block. If there is any residue, liquid, or if the cable is cracked at this connection, replace the insulation block/cable assembly.

Note: *Instructions on how to replace the insulation block/cable assembly can be found in Section 5.3.2, “Replacing the Insulation Block/Cable Assembly”, on page 5-4.*

5.2.4 Cleaning

The RSP 9000 II must be cleaned every six months. However, if the instrument is operated in a dusty or humid environment, it must be cleaned more often. Follow the instructions to prevent damage to the instrument.

Caution! *Use only isopropyl alcohol and a lint-free cloth to clean the RSP 9000 II. Other cleaning agents may affect the performance of the instrument. Never clean the X/Y axis guide rails or Z-rack with alcohol or solvents. Serious damage to the instrument may occur.*

1. Turn off the power to the RSP 9000 II.
2. Clean the Z-rack.
3. Clean the sampling tip.
4. Wipe the arm(s) using a lint-free cloth dampened with isopropyl alcohol to remove any residual dust.
5. Wipe the inside of the flex cable channel using a lint-free cloth dampened with isopropyl alcohol.

Caution! *Do not wipe the X or Y-axis guide rails. The guide rails are lubricated with a grease which does not require removal unless found to be "extremely" dirty.* *See Section 5.2.5, "Lubrication", on page 5-3 for instructions.*

6. Wipe the inside of the X-frame with a lint-free cloth dampened with isopropyl alcohol, ensuring that the lubricant on the X-axis guide rails is not removed.
7. Wipe the square shaft pinion located underneath the arm(s) using a lint-free cloth dampened with isopropyl alcohol.

Caution! *When cleaning the square shaft pinion, ensure no alcohol enters the Z-bearing or is wiped on the Y-axis guide rails.*

5.2.5 Lubrication

The RSP 9000 II does not require lubrication under normal operating conditions. If the lubricant applied at the factory should be wiped away or if the X/Y axis guide rails become dirty, cleaning and lubrication is necessary. Follow the instructions below when applying lubricants.

1. Turn off the power to the RSP 9000 II.
2. Move the arm(s) to the far right side of the X-frame.
3. Clean the X-axis guide rails using a lint-free cloth and isopropyl alcohol.
4. While moving the arm(s) to the left side of the X-frame, clean the three roller bearings mounted to the base of the X-slide.
5. Wipe the section of the X-axis guide rail that was covered by the arm(s).

Note: *A list of recommended lubricants can be found in Section B.7, "Other", on page B-6.*

6. Using a finger tip, apply a thin film of lubricant to both X-axis guide rails.
7. If the Y-axis guide rails are dirty, perform Step 2 through Step 6 for the X-axis components.

5.3 Part Replacement

5.3.1 Replacing the Sampling Tip

1 Turn the power off.

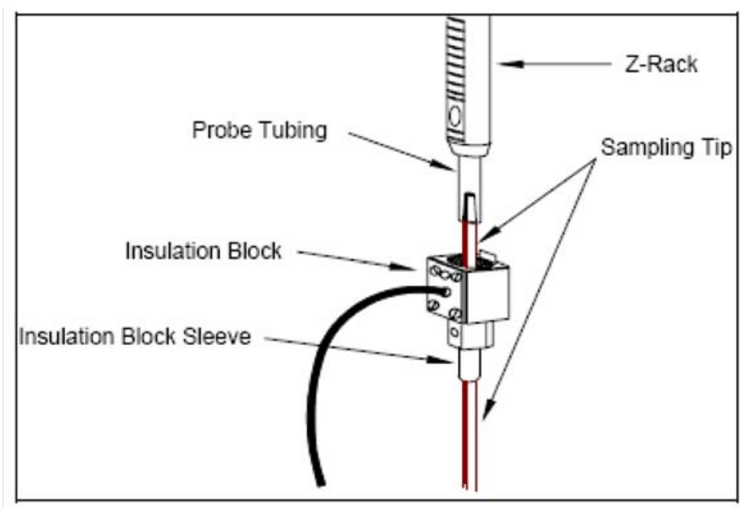
2 Loosen the sampling tip set screw using a screwdriver. (See Figure 5-1.)

3 Loosen the insulation block set screw using an allen wrench.

4 Gently pull downward on the insulation block until the system tubing is approximately 2 cm below the Z-rack.

Caution! *Electrostatic discharge to the sampling tip may damage the ALIDUM.*

Figure 5-1 *Removing the Sampling Tip*



5 While holding the sampling tip, remove the system tubing.

6 Remove the sampling tip from the insulation block.

Caution! *Do not slide the Teflon coated end of the sampling tip through the insulation block. The Teflon coating may be damaged.*

7 To reinstall the sampling tip, refer to Section 2.3, “Setting Up the Instrument”, Step 6 through Step 14.

5.3.2 Replacing the Insulation Block/Cable Assembly

1 Turn off the power to the RSP 9000 II.

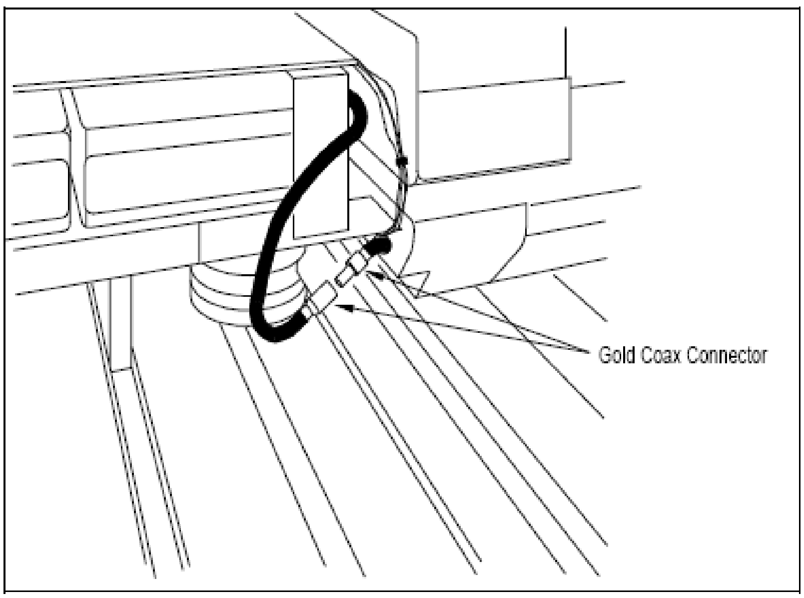
2 Remove the sampling tip. Refer to Section 5.3.1, “Replacing the Sampling Tip”, on page 5-4.

3 Remove the plastic cable binder underneath the arm(s) holding the coax cable.

Note: *Use a small wire cutter to remove the plastic cable binder. A new cable binder is included with each replacement insulation block assembly.*

4 Push the coax cable through the back-end of the arm(s) until the gold connector is visible. (See Figure 5-2 to locate the coax cable connector.

Figure 5-2 *Disconnecting the ALIDUM Coax Cable*



5 Disconnect the coax cable by gently sliding back the releasing cover on the insulation block side of the gold connector. This will release the cable from the ALIDUM cable.

6 To remove the insulation block assembly, carefully pull the coax cable forward through the arm.

7 Install the new insulation block and feed the cable from the front through the hole in the arm mounting block.

8 Attach the gold connector to the matching connector on the coax cable. Be sure that the connector is firmly seated.

9 Reinstall the sampling tip. (Refer to Section 5.3.1, “Replacing the Sampling Tip”, on page 5-4.)

10 Adjust the ALIDUM coax cable until all of the slack is removed from behind the arm(s).

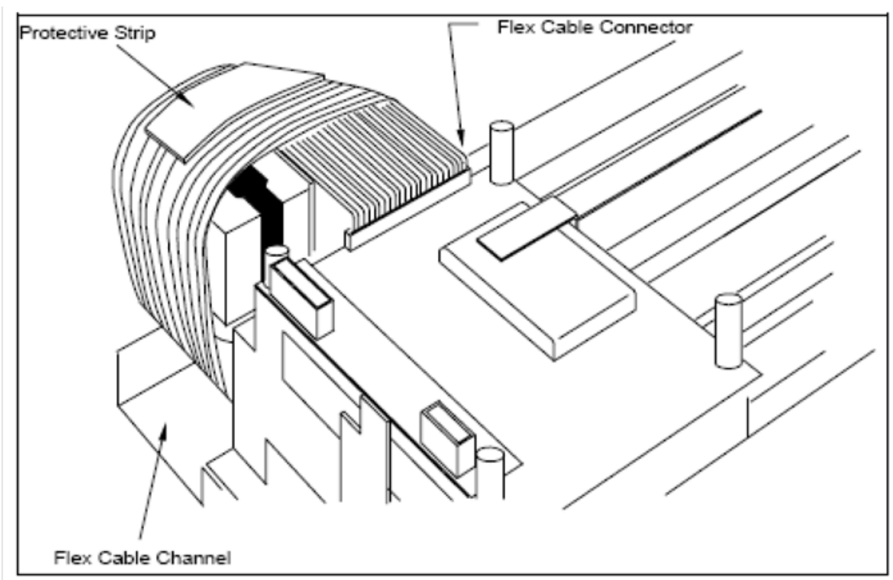
Caution! *Ensure the ALIDUM coax cable is not twisted or kinked.*

11 Fasten the coax cable to the arm using the new plastic cable binder provided.

5.3.3 Replacing the Flex Cable

1. Turn off the power to the RSP 9000 II.
2. Remove the ADRI-9 board cover.
3. Disconnect the flex cable from the ADRI-9 board by holding the connector at its ends and gently pull straight upward.
4. Open the flex cable clamp located underneath the flex cable guide (located just right of the CCU-9000).
5. Remove the four screws which hold the CCU-9000 board in place.
6. Lower the CCU-9000 board approximately 2 cm.
7. Disconnect the flex cable from the CCU-9000 board.
8. Remove old cable noting how it is routed over and under the flex cable supports.
9. Inspect the new flex cable ensuring that the foam protective strip is attached to the ADRI-9 end of the cable. (See Figure 5-3.)

Figure 5-3 *Installing the Flex Cable*



10. Connect the end of the flex cable with the foam protective strip to the ADRI-9 board. (See Figure 5-3.)
11. Run the flex cable through the flex cable channel and flex cable clamp.
12. Carefully push the connector of the flex cable onto its appropriate base on the CCU-9000 board.

13 Reattach the CCU 9000 board to the X-frame using all four allen screws.

14 Close the flex cable clamp.

Caution! *Make sure the flex cable is not twisted or kinked and is lying flat in the flex cable channel.*

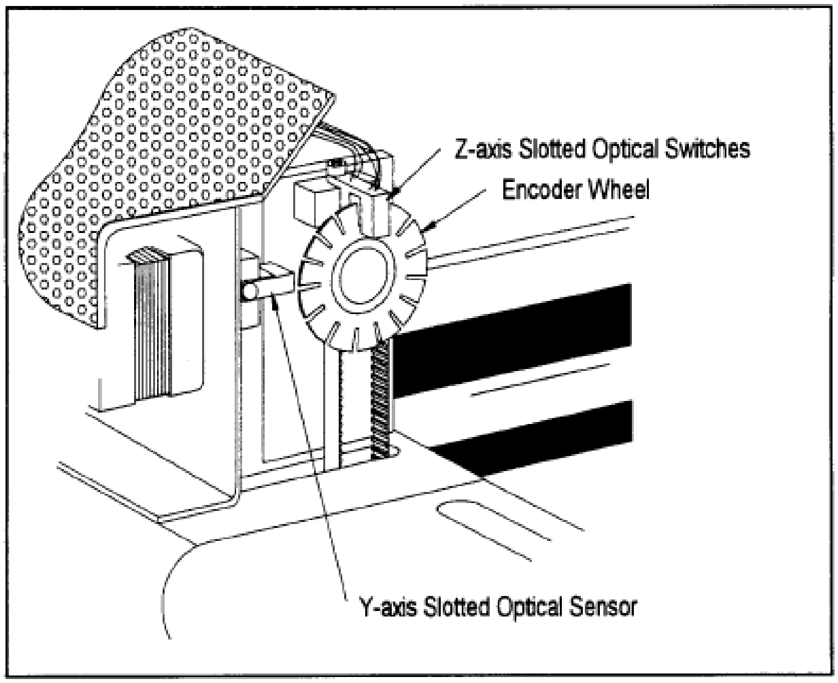
15 Reattach the ADRI-9 board cover.

5.3.4 Replacing the Y- and Z-axis Optical SLID Sensors

1. Turn off the power to the RSP 9000 II.
2. Remove the ADRI-9 board cover.
3. Remove the screw holding the Y-/Z-axis slotted optical sensor in place. (See Figure 5-4.)
4. Using wire cutters, cut the plastic cable binders holding the optical sensor wires in place.
5. Loosen the ALIDUM bracket.
6. Disconnect the slotted optical sensor connector from its base on the ADRI-9 board.
7. Run the wires of the new slotted optical sensor under the ALIDUM bracket.
8. Attach the connector of the new slotted optical sensor to its base on the ADRI-9 board.
9. Tighten the ALIDUM bracket.
10. Attach the new slotted optical sensor.
11. Replace all three cable binders ensuring that all the cables are bound together. Space the cable binders approximately 2 cm apart.
12. Reattach the ADRI-9 board cover.

Caution! *Make sure the screws for the ADRI-9 board cover do not sever the slotted optical sensor cables.*

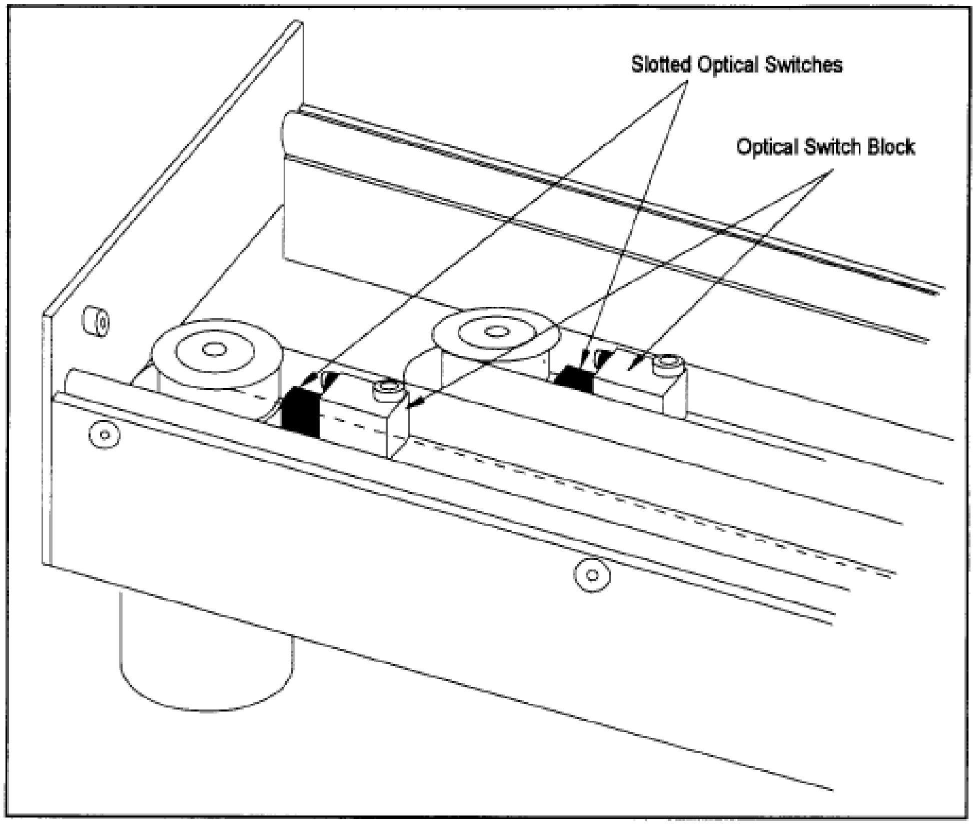
Figure 5-4 *Y-axis and Z-axis Slotted Optical Sensors*



5.3.5 Replacing the X-aids Optical (SLD) Sensor

1. Turn off the power to the RSP 9000 II.
2. Move the arm(s) to the center of the RSP 9000 II.
3. Remove the allen screw from the optical sensor block. (See Figure 5-5.)

Figure 5-5 *Optical Switch Block*



4 Remove the four screws that hold the CCU-9000 board in place.

5 Cut the plastic cable binders (using small wire cutters) that hold the slotted optical sensor wires in place.

6 Unplug the slotted optical sensor connector from its base on the CCU-9000 board.

7 Pull the optical sensor block and the slotted optical sensor away from the X-frame.

8 Remove the allen screw holding the slotted optical sensor to the optical sensor block.

9 Attach the new slotted optical sensor to the optical sensor block.

10 Feed the wires of the slotted optical sensor through the hole in the top of the X-frame. (Located by the X-axis motors.)

11 Guide the optical sensor block back into its original position.

12 Attach the optical sensor connector into the appropriate base on the CCU-9000 board.

13 Secure the loose wires of the optical sensor (using the plastic wire binders included) to the other wires underneath the X-frame.

14 Attach the CCU-9000 board to the X-frame.

Caution! *Ensure no wires or cables leading to the CCU-9000 are creased or twisted.*

Caution! *Ensure the slotted optical sensor is not touching the encoder wheel.*

15 Attach the optical sensor block to the X-frame.

5.3.6 Replacing the ALIDUM

1 Turn off the power to the RSP 9000 II.
2 Remove the ADRI-9 board cover.
3 Remove the ALIDUM bracket.

Note: *Notice how the optical sensor wires run underneath the ALIDUM bracket.*

4 Carefully unseat the ALIDUM from the ADRI-9 board.

Note: *Only lift up on the ALIDUM until the pins are free from the ADRI-9 board.*

5 Follow the coax wire out of the ALIDUM to the gold connector.
6 Disconnect the ALIDUM from the coax cable by separating the gold connectors. (See Figure 5-2.)
7 Discard the old ALIDUM.
8 Install the new ALIDUM by following these directions in reverse order (Step 6 through Step 1).

5.3.7 Replacing the ADRI-9 Board

1 Turn off power to the RSP-9000.
2 Remove the ADRI-9 board cover.
3 Disconnect all cables from the ADRI-9 board.

Note: *Document where the cables connect to the ADRI-9 board. A diagram of the ADRI-9 board can be found in Appendix C, “Mechanical Drawings”. Remember to disconnect the ALIDUM cable.*

4 Remove the four hexagon spacers from the ADRI-9 board.
5 Remove the ADRI-9 board.

Note: *Do not try to lift the ADRI-9 board straight up. Turn the board a little to the left or right and then lift.*

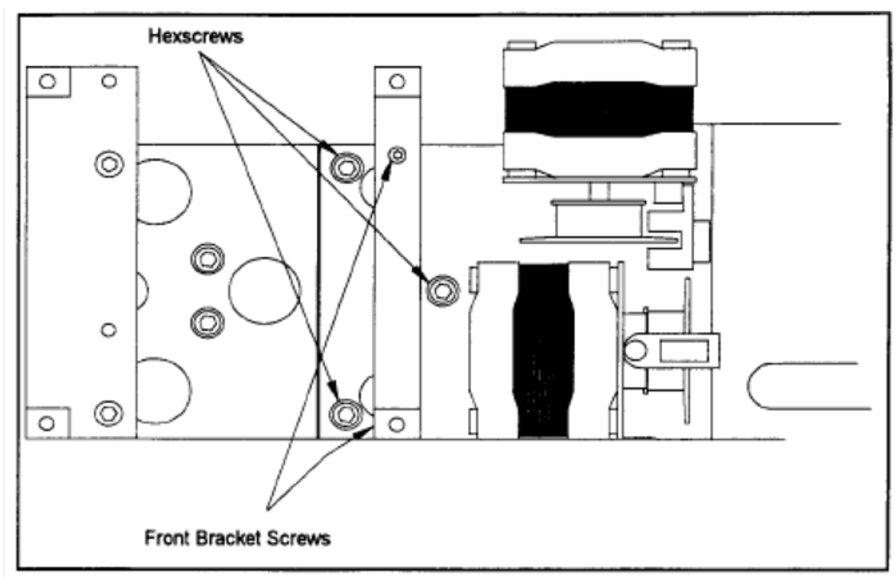
6 Install the new ADRI-9 board by following these steps in reverse.

Caution! *Ensure the red SW switches on the new ADRI-9 board are set in the same positions as the ADRI-9 board that was removed. The* RSP 9000 II *will not function properly if the SW1 switch is set in the wrong position. (See Appendix C, “Mechanical Drawings”.)*

5.3.8 Replacing the Arm

1 Turn the power off.
2 Remove the Z rack, insulation block and sampling tip. (See Section 5.3.1, “Replacing the Sampling Tip”, on page 5-4.)
3 Remove the ADRI-9 board. (See Section 5.3.7, “Replacing the ADRI-9 Board”, on page 5-10.)
4 Remove the front ADRI-9 bracket by removing the two 2.5 mm screws. (See Figure 5-6.)

Figure 5-6 *Removing the Arm [top view]*



5 Remove the three hex screws holding the arm on to the X-slide. Remove the arm.
6 Install the new arm by following these directions in reverse order (Step 6 through Step 1).

5.3.9 Replacing the CCU-9000 Board

1. Turn off the power to the RSP 9000 II.
2. Remove the four screws holding the CCU-9000 board to the X-frame. Unplug all the wires connecting to the CCU-9000 board.

***Note:** Document where the connectors plug into the CCU-9000 board. (See Appendix C, "Mechanical Drawings".)*

3. Remove the old CCU-9000 board.
4. Follow these steps in reverse order to install the new CCU-9000 board.

5.4 Troubleshooting

5.4.1 Error #1: Initialization Error

Possible Cause	Corrective Action
General	
Flex cable defective	Replace flex cable
Fuse FU 1 or FU2 on CCU-9000 defective	Replace fuses /call customer support
Mechanical movement blocked	Check movement mechanism for obstructions
CCU-9000 board defective	Replace CCU-9000 board
X-axis	
Fuse FU3 or FU4 defective on CCU-9000	Replace fuses /call customer support
X-motor defective	Replace X-motor
X-motor to CCU-9000 cable lose	Check cable connections
X-initialization flag bent	Adjust flag into slotted optical sensor
Slotted optical sensor defective on ADRI-9	Replace ADRI-9 board
Selector switch SW-1 on ADRI-9 set wrong	Select right or left arm switch setting
Arm locked in place	Remove shipping block and screw
Y-axis	
Y-motor defective	Replace Y-motor
Y-initialization flag bent	Adjust flag into slotted optical sensor

Possible Cause	Corrective Action
Slotted optical sensor defective	Replace slotted optical sensor on Y-motor
Connection from optical sensor to ADRI-9	Check cable connection
ADRI-9 board defective	Replace ADRI-9 board
Y-belt defective	Replace or adjust belt
Z-axis	
Cable connection from ADRI-9 to Z-motor	Check cable connection
ALIDUM defective	Replace ALIDUM
Initialization flag bent	Replace insulation block
ADRI-9 board defective	Replace ADRI-9 board
Z-motor defective	Replace Z-motor
Final test procedure:	Self test, P1, X1, Y1, Z1 commands

5.4.2 Error #2: Invalid Command

Possible Cause	Corrective Action
Program failure	Refer to software manual
Entered unknown command	Refer to command set
Final test procedure:	None

5.4.3 Error #3: Invalid Operand

Possible Cause	Corrective Action
Program failure	Refer to software manual
Command parameters out of valid range	Refer to command set
Wrong setup ranges	Check instrument setup ranges
Final test procedure	None

5.4.4 Error #4: Invalid Command Sequence

Possible Cause	Corrective Action
Program failure	Refer to software manual
Final test procedure	None

5.4.5 Error #5: Device Not Implemented

Possible Cause	Corrective Action
Device not receiving power	Check power supply and cables
No communication to device	Check communication
Cable broken or plug unseated	Check all cables and connections
Electronics board broken	Replace electronics board
Address switch not properly set	Set device with correct address
Communications protocols do not match	Refer to technical manuals
Final test procedure	None

5.4.6 Error #6: Time-out Error

Possible Cause	Corrective Action
Device not responding	Check communications
Time limit exceeded	Check device
Final test procedure	None

5.4.7 Error #7: Device Not Initialized

Possible Cause	Corrective Action
Program failure	Refer to software manual
Initialization command not sent before	Initialize device using other devices
Final test procedure	None

5.4.8 Error #8: Command Overflow

Possible Cause	Corrective Action
Program failure	Refer to software manual
Command line too long	Refer to command set
Too many commands on one line	Refer to command set
Final test procedure	None

5.4.9 Error #9 and #12: No Liquid Detected

Possible Cause	Corrective Action
Liquid volume too small	Increase liquid volume
Deionized liquid is used	Test to ensure ionic liquid is being used
Liquid is not in close proximity to electrical ground plane of instrument	Decrease gap between liquid and electrical ground plane of instrument
Poor cable connections	Check ALIDUM cable connection
ALIDUM cable defective	Replace Insulation Block/Cable
ALIDUM defective	Replace ALIDUM
ALIDUM sensitivity set too low.	Adjust ALIDUM sensitivity
Flex cable defective	Replace flex cable
Final test procedure	None

5.4.10 Error #10: Entered Move for Z-axis Out of Range

Possible Cause	Corrective Action
Tried to move lower than Z-max	Enter Z-parameter less than Z-max
Program failure	Refer to software manual
Final test procedure	None

5.4.11 Error #11 and # 13: Not Enough Liquid Detected

Possible Cause	Corrective Action
Not enough liquid to aspirate	Add liquid
Wrong Z-max defined	Adjust Z-parameters in setup firmware
Tube diameter incorrectly defined, or invalid [zq] parameter in the ZZ- or ZX-command	Define in rack definition
Final test procedure:	None

5.4.12 Error #17: Arm Collision Avoided (two arm instrument)

Possible Cause	Corrective Action
Second arm not initialized before moving	Initialize second arm first arm
Tried to move X-slide to a position where it would hit the other X-slide, or invalid X-range specified	Position X-slide out of the way
Final test procedure:	None

5.4.13 Error #20, #21, #22, and #23: Step Loss Detected

Possible Cause	Corrective Action
Acceleration rate too high	Reset acceleration rate with FX/FY/FZ-commands
Mechanical movement blocked	Check for blocked movement mechanism
Slotted optical sensor for SLD is defective	Replace slotted optical sensor
Encoder wheel for slotted optical sensor	Replace or tighten slotted encoder wheel loose or defective
Stepper motor defective	Replace stepper motor
Final test procedure	Self test

5.4.14 Error #24: ALIDUM Pulse Time-out

Possible Cause	Corrective Action
ALIDUM sensitivity too high or low	Adjust ALIDUM sensitivity
ALIDUM defective	Replace ALIDUM
ALIDUM cable defective	Replace insulation block/cable
Final test procedure	Check with ZX/ZZ-command

5.4.15 Error #25: Tip Not Fetched (Used with Diti A or C Options)

Possible Cause	Corrective Action
No tips present	Replace or refill the tip rack
Probe not aligned with tips	Check tip positioning in the tip rack

5.4.16 Error #26: Tip Crash (Used with Diti C Options)

Possible Cause	Corrective Action
Probe not aligned with tips	Check positioning in the tip rack
Tip rack or support rack not installed properly	Check positioning of the tip rack and tip support rack
Incompatible brand of tip used	Check if correct brand of tip is used

5.4.17 Error #27: Tip Not Clean (Used with Diti A or C Options)

Possible Cause	Corrective Action
Used or clogged tip	Remove tip, abort and restart program
DiTi air detection channel blocked with	Dry air channel with absorbent paper points fluid

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A Symbols and Abbreviations

Symbol	Meaning	Symbol	Meaning
+	Plus or positive	A	Ampere (Amp)
-	Minus or negative	AC	Alternating Current
°	Degree(s)	Hz	Hertz
Ω	Ohm(s)	cm	Centimeter
×	Multiply by	DC	Direct Current
÷	Divide by	kg	Kilogram
=	Equal to	m	Meter
±	Plus or minus	mm	Millimeter
≠	Not equal to	N	Newton
≈	Approximately equal to	V	Volt
<	Less than	W	Watt
>	Greater than	ft	Foot
ø	Diameter	in	Inch
:	Ratio	lbs	Pounds
Ctrl	Control key on keyboard	s	Second
$\sqrt{}$	Square root	°C	Degrees Celsius
Σ	Summation of	°F	Degrees Fahrenheit
π	Pi (3.14159)	min.	Minimum
Δ	Delta	max.	Maximum
∞	Infinity	sf	Start frequency
( )	Parentheses (highlighted text)	ef	End Frequency
[ ]	Brackets (enclose parameters)	acc.	Acceleration
{ }	Braces (enclose commands)	step	The smallest addressable increment for X/Y/Z movement (a half step for motors)
#	Number symbol	@	At

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B Instrument Specifications

B.1 Dimensions

<table>
<tr><th>Item</th><th>RSP-9321</th><th>RSP-9621</th><th>RSP-9351</th><th>RSP-9352</th><th>RSP-9651</th><th>RSP-9652</th><th>RSP-9682</th><th>RSP-9692</th></tr>
<tr><td>Number of Arms</td><td>1</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Overall Length</td><td colspan="2">520 mm (20.47 in.)</td><td colspan="4">780 mm (30.71 in.)</td><td>976 mm (38.43 in.)</td><td>1332 mm (52.44 in.)</td></tr>
<tr><td>Overall Depth</td><td>407 mm (16.02 in.)</td><td>557 mm (21.93 in.)</td><td colspan="2">407 mm (16.02 in).</td><td colspan="4">557 mm (21.93 in.)</td></tr>
<tr><td>Overall Height</td><td colspan="8">183 mm. (7.20 in.)</td></tr>
<tr><td>Instrument Weight</td><td>8.5 kg (18.7 lbs.)</td><td>9 kg (19.8 lbs.)</td><td>10.5 kg (23.1 lbs.)</td><td>13 kg (28.7 lbs.)</td><td>11 kg (24.3 lbs.)</td><td>14 kg (30.9 lbs.)</td><td>16 kg (35.3 lbs.)</td><td>18.5 kg (40.8 lbs.)</td></tr>
</table>

Note: *Instrument weights may vary due to the installation of different options.*

B.2 X-axis Data

Item		RSP-9x21	RSP-9x51	RSP-9x52	RSP-9x82	RSP-9x92
X-Travel Range	mm	383	643	566	762	1117
	in.	15.08	25.31	22.28	30.00	43.98
	steps	1714	2878	2533	3410	4999
Initialization Offset	steps	5-100				
Tip to Tip Minimum Distance	mm	N/A		30		
	in.	N/A		1.18		
Resolution per Step	mm	0.22345				
	in.	0.009				
Reproducability	mm	±0.1				
	in.	±0.004				
Start Speed	steps/s	50				
	mm/s	11				
	in/s	0.44				
End Speed	steps/s	4000				
	mm/s	894				
	in/s	35.19				
Acceleration	steps/s^2	10000				
	mm/s^2	2235				
	in/s^2	87.97				

B.3 Y-axis Data

Item		RSP-93xx	RSP-96xx
Y-Travel Range	mm	150	300
	in.	5.91	11.81
	steps	1055	2109
Initialization Offset	steps	5-100	
Resolution per Step	mm	0.14224	
	in.	0.006	
Reproducability	mm	±0.1	
	in.	±0.004	
Start Speed	steps/s	200	
	mm/s	28	
	in/s	1.12	
End Speed	steps/s	4000	
	mm/s	569	
	in/s	22.40	
Acceleration	steps/s^2	20000	
	mm/s^2	2845	
	in/s^2	112.00	

B.4 Z-axis Data

Item		All RSPs	
		1:1 Z Drive	2:1 Z Drive
Z-Travel Range	mm	165	
	in.	6.50	
	steps	1681	3362
Initialization Offset	steps	5-100	
Resolution per Step	mm	0.098175	0.0490875
	in.	0.004	0.002
Reproducability	mm	±0.1	
	in.	±0.004	
Start Speed	steps/s	400	
	mm/s	39	20
	in/s	1.55	0.77
End Speed	steps/s	4000	
	mm/s	393	196
	in/s	15.46	7.73
Acceleration	steps/s^2	30000	
	mm/s^2	2945	1473
	in/s^2	115.95	57.98

B.5 CCU-9000 Board Mating Connectors

Connectors	Quantity	Type	Manufacturer (part number)
Power supply	2	2-pin	Weidmueller /128176
RS-232 to host	l	10-pin crimp	Fujitsu/FCN 723B 01012
RS-485 to diluter	2	Dubox 1 x 4	Du Pont/65240-004
RS-485 to Molo-X	2	Dubox 1 x 4	Du Pont/65240-004

Note: *U.S. distributor for Weidmueller: Weidmueller Terminations Inc., 821 Southlake Boulevard, Richmond, VA 23236. Phone (804) 794-2877.*

B.6 Fuses

WARNING! *For continued protection against risk of fire, only replace fuses which meet the following specified types and current ratings.*

The following fuses must be used to assure safe operation of the RSP 9000 II:

Name	Location	Type
Left Arm Fuse	CCU-9000 (FU 1)	F 2.0A/250V
Right Arm Fuse	CCU-9000 (FU2)	F 2.0A/250V
Left Motor Fuse	CCU-9000 (FU3)	F 1.6A/250V
Right Motor Fuse	CCU-9000 (FU4)	F 1.6A/250V
Line Signal Fuse	CCU-9000 (FU5)	T 3.15A/250V

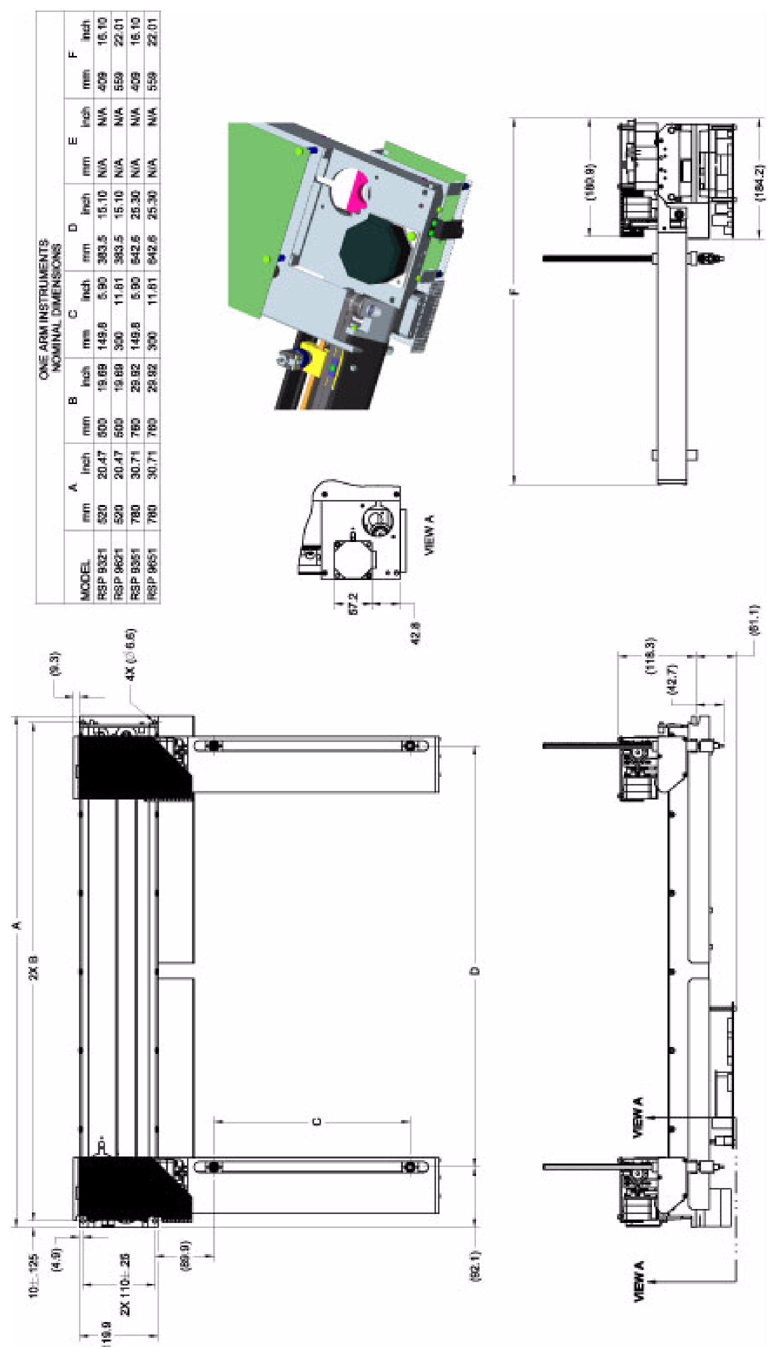
B.7 Other

The following general specifications apply to all RSP 9000 II models.

Item	Specification
Storage Temperature Range	0 - 50°C (32 - 122°F)
Operating Temperature Range	15 -40°C (59 - 104°F) Humidity 30 to 80% relative non condensing
Life Expectancy	Under evaluation
Lubrication	Kluber: Paraliq GA351 DIN: 51825 KP2K Shell: Retinax A Mobil: Savavex Grease L2
Safety	The RSP 9000 II series instrument is a UL recog-nized component. UL61010-1, 2nd edition IEC61010-2-081
Packaging	Stacked: Five units max. Box can withstand falls from 0.6 m(1.9 ft)

C Mechanical Drawings

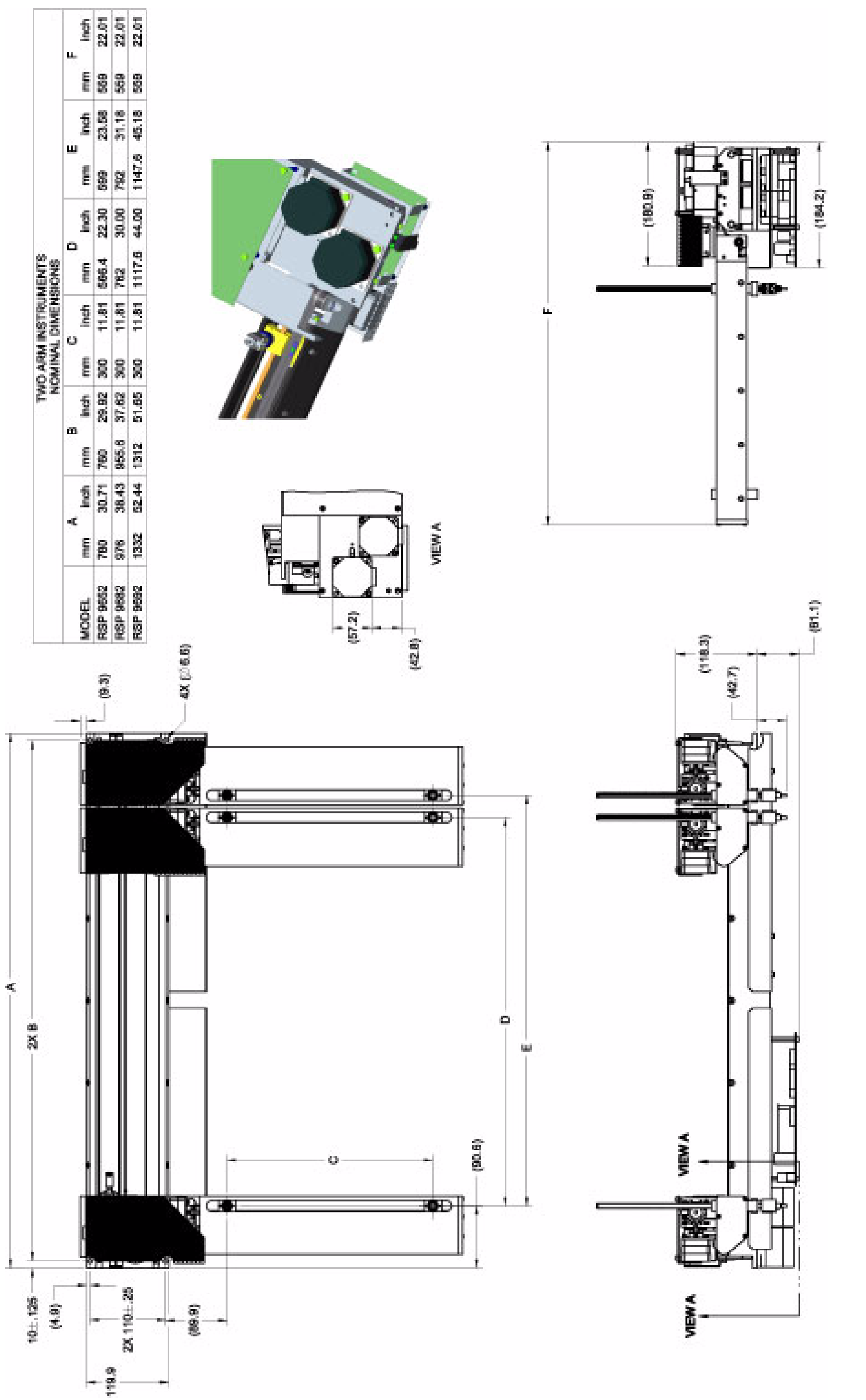
Figure C-1 *One Arm Instruments*



ONE ARM INSTRUMENTS NOMINAL DIMENSIONS

MODEL	A		B		C		D		E		F	
	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
RSP 9321	520	20.47	500	19.69	149.8	5.90	383.5	15.10	N/A	N/A	409	16.10
RSP 9621	520	20.47	500	19.69	300	11.81	383.5	15.10	N/A	N/A	559	22.01
RSP 9351	780	30.71	760	29.92	149.8	5.90	642.5	25.30	N/A	N/A	409	16.10
RSP 9651	780	30.71	760	29.92	300	11.81	642.6	25.30	N/A	N/A	559	22.01

Figure C-2 *Two Arm Instruments*



TWO ARM INSTRUMENTS NOMINAL DIMENSIONS												
	A		B		C		D		E		F	
MODEL	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
RSP 9552	780	30.71	760	29.92	300	11.81	566.4	22.30	599	23.58	559	22.01
RSP 9662	976	38.43	955.6	37.62	300	11.81	762	30.00	792	31.18	559	22.01
RSP 9862	1332	52.44	1312	51.65	300	11.81	1117.6	44.00	1147.6	45.18	559	22.01

D Electrical Drawings

Figure D-1 *CCU Board Layout*

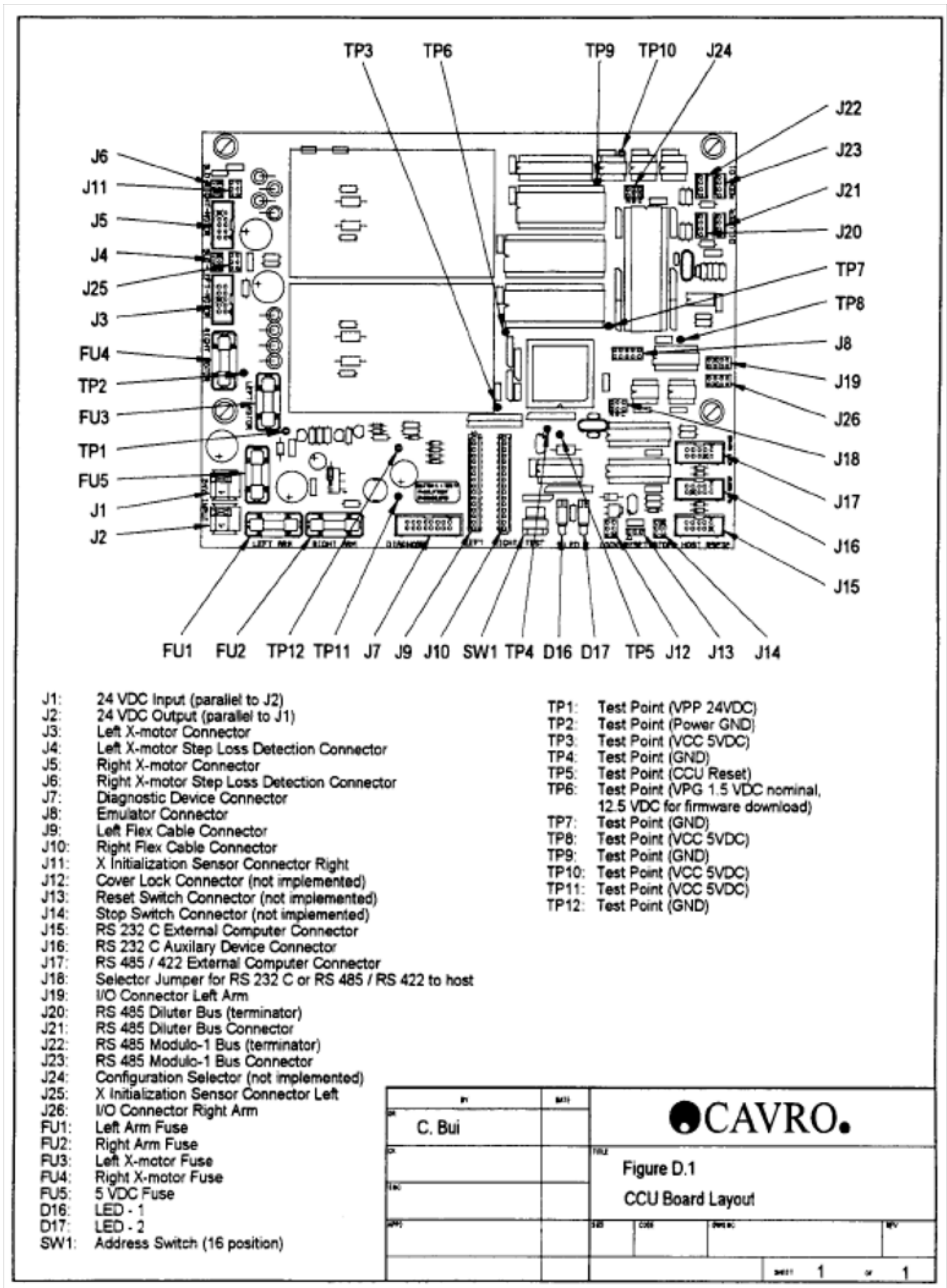


Figure D-2 *Connector Pinouts*

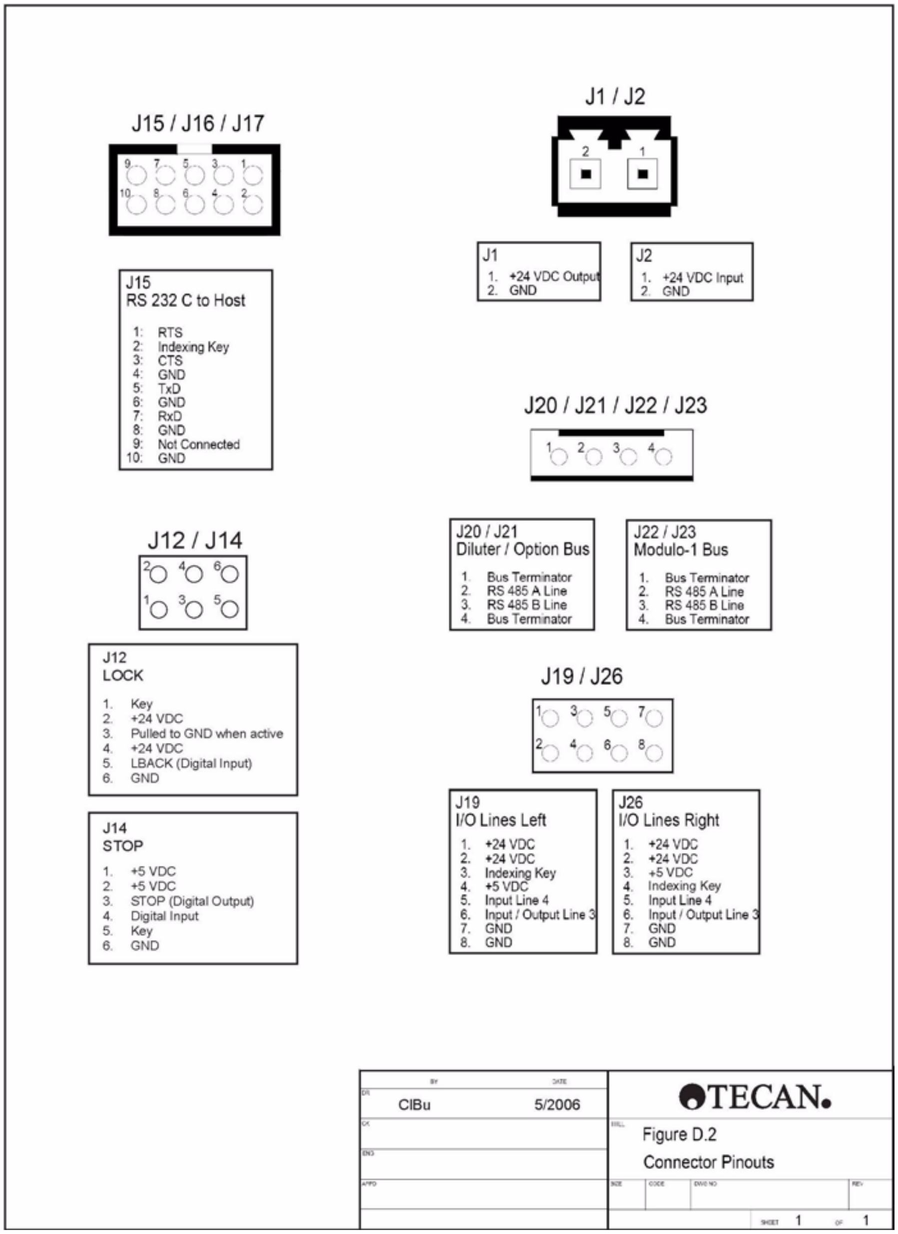
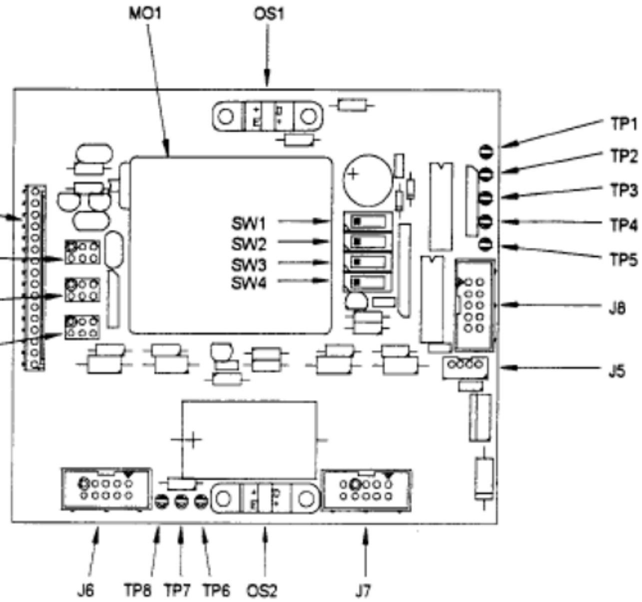


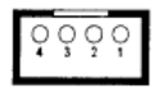
Figure D-3 ADRI-9 Board Layout



Code Description

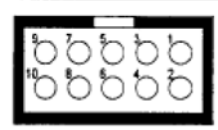
J1: Flex Cable Connector
J2: Optical Switch Connector (Y-Initialization)
J3: Optical Switch Connector (Step Loss Detection Y-axis)
J4: Optical Switch Connector (Step Loss Detection Z-axis)
J5: DITI Connector (Power / Signal)
J6: Y-axis Motor Connector
J7: Z-axis Motor Connector
J8: Switchable Input / Output Connector
MO1: ALIDUM (Adaptive Liquid Level Detector)
OS1: Optical Switch X-axis (Left Arm X-axis Initialization)
OS2: Optical Switch X-axis (Right Arm X-axis Initialization)
SW1-4: Selector Switches (see Table)
TP1: Test Point (GND)
TP2: Test Point (VCC 5VDC)
TP3: Test Point (X-axis Initialization Signal)
TP4: Test Point (Y-axis Initialization Signal)
TP5: Test Point (Liquid Detection Signal)
TP6: Test Point (Power GND)
TP7: Test Point (VPP 24VDC)
TP8: Test Point (+12VDC)

J5 Connector:



1: +12VDC
2: Liquid Detection Signal (Air Detect)
3: Air Detect ON
4: Power GND

J8 Connector:



1: Input / Output #1
2: SLD Z-axis
3: Input / Output #2
4: VCC 5VDC
5: GND
6: Liquid Detection
7: Input / Output #3
8: Input #4
9: Power GND
10: VPP 24VDC

Selector Switches:

SW1	Arm Selection Left Arm [switch] Right Arm
SW2	DITI Option Enable [switch] Disable
SW3	ALIDUM Sensitivity Switching by Software Enable [switch] Disable
SW4	Value for High Sensitivity High [switch] Very High

Standard settings for a left arm w/o DITI.

BY	DATE	
C. BUI	7 - 18 - 95	CAVRO.
		TITLE Figure D.3 ADRI-9 Board Layout
		SIZE A REV A
		SHEET 1 OF 1

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E Command Summary

E.1 Set Commands

OM [x*] [y*] [z*]	Set Overall Machine Limitation
OT [x*] [y*] [z*]	Set Self-Test Range
OX / OY / OZ [initOffset*]	Set Initialization Offset for X / Y / Z
XO / YO / ZO [±relOffset*]	Adjust Initialization Offset Relative to OX / OY / OZ Setting
OW	Write Parameters to EEPROM
OR	Read Parameters Back from EEEPROM and Overwrite Current Settings
SM [x*] [y*] [z*]	Set Range for Absolute Field
SA [zm*] [zs*] [zd*] [zt*]	Set Z-Parameters for Absolute Field
SZ	Set Z-Travel Position for the Next X / Y Move Only
SL [sf*]	Set Z-drive Liquid search frequency
SN [n] [value]	Set Numeric General Purpose EEPROM Value
SP [onOff]	Set Position Recovery
SS [sensitivity]	Set Liquid Detection Sensitivity
FX [startFreq*] [endFreq*] [accel*] [init-Freq*] [stepSize*]	Set X-Ramp Parameters
FY [startFreq*] [endFreq*] [accel*] [init-Freq*] [stepSize*]	Set Y-Ramp Parameters
FZ [StartSp*] [EndSp*] [Accel*] [initFreq*] [stepSize*]	Set Z-Ramp Parameters
ST [t]	Set Tip Option

E.2 Diagnostic Commands (Device #8)

RG [drive]	Report Total Moves Done
RA [item], [taskNum]	Report Diagnostic Values
OW 99	Clear Both EEPROM First Time Patterns
OW 99,1	Clear EEPROM Extension Pattern Only

E.3 Diagnostic Commands (Device #9)

RV	Report Supply Voltage (Power Voltage Vpp)

E.4 Arm Positioning Commands

PI	Position Initialization X / Y / Z-axes
FI	Fake Initialization X / Y / Z-axes
XI / YI / ZI [speed*]	Position Initialization for X / Y / Z-Axes
PA [X°] [Y°] [Z°]	Position Absolute for All Axes
XA [x°]	Position Absolute for X-Axis
YA [y°]	Position Absolute for Y-Axis
ZA [z°]	Position Absolute for Z-Axis
XR [±x°]	Position Relative for X-Axis
YR [±y°]	Position Relative for Y-Axis
ZR [±z°]	Position Relative for Z-Axis
XS [±x°] [speed*]	Position Relative, Slow Speed
YS [±y°] [speed*]	Position Relative, Slow Speed
ZS [±z°] [speed*]	Position Relative, Slow Speed

E.5 Rack Definition Commands

SF [nn] [x*] [y*] [z*]	Set Coordinates for a Fixed Position
SR [nn] [zm*] [zs*] [zd*]	Set Z-Parameters for a Fixed Position
D% [ps*] [nc*] [nr*] [x0*] [y0*] [x1*] [y1*] [xof*] [yof*]	Set Parameters for a Defined Field (Rectangular)
D% [ps*] [np*] [nc*] [xc*] [yc*] [r1*] [a1*] [r2*] [a2*]	Set Parameters for a Defined Field (Circular)
D% [rt*] [rn*] [x*] [yf*] [yl*]	Set Parameters for a Defined Field (Linear Rack)
SW [n] [xx*] [yy*] [zz*]	Set Coordinates for Waste Station n
SC [n] [xx*] [yy*] [zz*]	Set Coordinates for Cleaner Station n
E% [zm*] [zs*] [zd*] [zt*]	Set Z-Parameters for a Defined Field

E.6 Rack Positioning Commands

PF [p]	Move to Fixed Position
G% [pos] [rt] [min] [max]	Get Tip at Given Position
FT [x] [y] [Zstart] [Zend] [min] [max]	Get Tip At Position X / Y
BF [pos] [steps]	Discard Tip
BT [x] [y] [z] [steps]	Discard Tip at Position X / Y / Z
PR [p]	Move to Reagent Position
ZD [±z°]	Move to Z-Dispense Height
ZM [±z°]	Move to Z-Max Height
ZT [±z°]	Move to Z-Travel Height
ZX [zs°] [za°] [Z-Max*]	Move Z-Rack, Detect Liquid, Submerge
ZZ [zs°] [za°] [Z-Max*]	Move Z-Rack, Detect Liquid, Submerge
PW [n]	Move to Waste Position Location
PC [n]	Move to Cleaner Position
U% [xx°] [yy°] [zz°]	Rack Position Absolute for All Axes

G% [pos],[rt],[min*],[max*]	Get a Tip
T% [nn] [rt*]	Move to Defined Field Position

E.7 Report Commands

RV [Firmware°]	Report Firmware Version
RX/RY/RZ 0* [Sel°]	Report Current Parameters for All Axes
RM	Report Z-Max Assigned to Current X / Y-Position
RS	Report Z-Start Assigned to Current X / Y-Position
RD	Report Z-Dispense Assigned to Current X / Y-Position
RT	Report Z-Travel Assigned to Current X / Y-Position
RC	Report Capture Position
RE	Report Capture Events
RF [nn]	Report X-Coordinate of a Fixed Position
RN [n]	Report Numeric General Purpose EEPROM Value
RL [n°]	Report Liquid Detection Z-values and Parameters in Effect
Q% [RackPos]	Report X-Coordinate of Position in a Defined Field

E.8 Device #6 Commands

SW [tt°]	Activate (Set) the MiniWash Pump
CW [tt]	De-activate (Clear) the FastWash Pump
RW [inOut]	Report FastWash Status

E.9 Device #9 Commands

SX / SY / SZ	Stop X / Y / Z-Drive Movement Immediately
RX/RY/RZ ,* [Sel°]	Report Current Parameters for All Axes
SD [num] [Direct°]	Set Digital I/O Direction of Given I/O Line on ADRI-9 Board Connector
SL [InOutNo] [Value°]	Set Output Value for Digital I/O Line
RL [InOutNo]	Report Logic Level on Digital I/O Line
RD [InOutNo]	Reports Signal Direction of Digital I/O-Pin on ADRI-9 Board Connector
X% / Y% / Z% [p1, p2, p3]	Direct Control of Molox
T% [Adr] [p1] [p2] [p3]	Direct Control of Molox at Address

E.10 Device #9 Door Lock Commands

SK [onOff]	Set Door Lock
RK [inOut]	Report Door Lock Status

E.11 Device #9 Digital I/O Commands

SS [onOff]	Set Digital I/O
RS [inOut]	Report Digital I/O Status

E.12 Device #9 MiniWash Commands

KW [onOff]	Stop MiniWash

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F RSP 9000 II Series Spare Parts List

Table F-1 RSP 9000 II Series Spare Parts List

Part No.	Description
20739434	Arm Left Complete, Yt = 300 mm/1:1
20739431	Arm Right Complete, Yt = 300 mm/1:1
20722422	Z-Rack, Z-Travel = 175 mm
20738823	Insulation Block with Cable (13")
20738821	Insulation Block with Cable (17")
20738819	Probe, Single Tip, Teflon coated
20725877	Probe, Cap Piercing
20739717	Central Control Unit (CCU), 1 arm
20739418	Central Control Unit (CCU), 2 arm
20738846	Arm Board without ALIDUM Module
20739419	ALIDUM (spare)
20737945	Opto Sensor Assembly
20739435	Cable, Flexible Arm (Left)
20739436	Cable, Flexible Arm (Right)
20739703	Cable, 2 Components DB 15
20739010	Fuse Kit (1 x 1.6A, I x 2.0A, 3 x 3.15A)
20739763	X Motor, Left
20739452	X Motor, Right
20739429	Y Motor
20738773	Z Motor (STD)
20738331	Z Motor (Cap Piercing)
20726672	Spares Screw Kit (2 Probe Screws and 4 Insultation Block Screws)

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G Implementing Pumps and Accessories

G.1 Introduction

The RSP 9000 II can be run with a variety of Tecan pumps and “smart” devices. The following is a list of Tecan products that can currently be controlled by the RSP 9000 II:

- XL 3000 Modular Digital Pumps
- XL 3000 Multi-Channel Pump Modules (2 - 8 Channels)
- XP 3000 Modular Digital Pumps
- Smart Peristaltic (SP) Pump Modules (1 - 4 Channels)
- Smart Valve (SV) Modules (3, 4 and 6 Way)

G.2 Installation and Setup of XL Devices

1 Set SW2 dip switch on the XL device to the following positions: SW2-1 Down; SW2-2 Up; SW2-3 Down; SW2-4 Down.

2 Set SW I device address switch (rotary) to position 0..7. Each device must have a separate address. Usually, First Pump = 0; second pump = 1, etc.

3 Connect XL device to RSP 9000 II using CCU/XL 3000 cable. The cable can be made (see Figure G-1) or purchased from Tecan (P/N 724102). When using XP 3000 pumps, use DB 15/edge connector adapter (P/N 725744).

4 Connect the edge connector to the back of the XL device. Connect the orange power plug to J2 connector on the CCU board. Connect blue communications plug to J21 connector on the CCU board.

WARNING! *All connectors are keyed. Check orientation of plugs before inserting into the connectors on the CCU board. DO NOT force plugs into connectors.*

5 Turn on the computer and RSP 9000 II power supply. You should immediately hear the valve(s) initialize on the XL 3000 pump(s).

G.3 Programming Pumps and Other Smart Devices

Since the XL 3000 pumps and other smart devices are controlled through the RSP 9000 II software, they must follow the RSP 9000 II nomenclature. All pump commands are proceeded by an arm and device number. All pump commands with the exception of report commands are terminated with an “R”.

Example: The command to initialize pump 1 (with address switch = 0) is #11ZR

See the device Operator's Manual for a complete list of commands. When operating the pumps with the RSP 9000 II, all commands are the same as written in the pump manuals with the exception of report commands. The changes for these commands are found in Section 4.3.13, ”Alternate Diluter Commands”, on page 4-37.

G.4 Device Address Numbers

When using an RSP 9000 II with two arms, up to eight pumps or smart devices can be controlled by commands located in either the left and/or right portions of the Integrator software.

When using a single arm RSP 9000 II, up to four pumps or smart devices can be operating using standard commands in the left Integrator program. An additional four devices can be controlled by setting up a right Integrator program or by using the special Integrator command “RESULT :=COMMAND (`...’) in the left program. For example, to initialize a fifth XL 3000 pump with a one arm RSP 9000 II, the command would be:

Result := Command (‘#21ZR’)

The following are the device numbers and address switch designations (SW2) for devices assigned to the left and right arms.

Arm	Device Number	Address Number
Left Arm - Pump 1	#11	0
Left Arm - Pump 2	#12	1
Left Arm - Pump 3	#13	2
Left Arm - Pump 4	#14	3
Right Arm - Pump 5	#21	4
Right Arm - Pump 6	#22	5
Right Arm - Pump 7	#23	6
Right Arm - Pump 8	#24	7

H ASCII Chart--Codes For U.S. Characters

Dec	Hex	Character or Function
0	00	none
1	01	Control A
2	02	Control B
3	03	Control C
4	04	Control D
5	05	Control E
6	06	Control F
7	07	Control G
8	08	Control H
9	09	HT
10	0A	LF
11	0B	VT
12	0C	FF
13	0D	Carriage Return
14	0E	S0
15	0F	S1
16	10	none
17	11	DC1
18	12	DC2
19	13	DC3
20	14	DC4
21	15	none
22	16	none
23	17	none
24	18	CAN
25	19	none

Dec	Hex	Character or Function
26	1A	none
27	1B	ESC
28	1C	none
29	1D	none
30	1E	none
31	1F	none
32	20	b/(space)
33	21	! (Roman)
34	22	"
35	23	#
36	24	$
37	25	%
38	26	&
39	27	‘(apostrophe)
40	28	(
41	29	)
42	2A	*
43	2B	+
44	2C	, (comma)
45	2D	- (en dash)
46	2E	. (period)
47	2F	/
48	30	0
49	31	1
50	32	2
51	33	3

Dec	Hex	Character or Function
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	0

Dec	Hex	Character or Function
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\ (backslash)
93	SD	]
94	5E	^ (control)
95	SF	— (em dash)
96	60	‘ (tick)
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k

Dec	Hex	Character or Function
108	6C	1
109	6D	m
110	6E	n
111	6F	0
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	{(left brace)
124	7C	I (vertical bar)
125	7D	} (right brace)
126	7E	~ (tilde)
127	7F	DEL

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I Glossary

Absolute Field

The instrument can move to any coordinate within the ranges specified by the SM command. These ranges define the absolute field. The SA-command sets the four Z-heights for the absolute field.

Accuracy

The degree of conformity of a measure to a standard or true value.

ADRI-9 Board

The electronics board that is mounted to the arm(s) of the RSP 9000 II series instruments. The ALIDUM and Molo-X components can be found on the ADRI-9 board.

ALIDUM

The ALIDUM monitors the capacitance between the sampling tip and the electrical ground (X-frame). The ALIDUM generates a signal to the CCU-9000 board when there is a sudden change in capacitance. This change can be caused by the sampling tip coming in and out of contact with an ionic solution or by the flag on the insulation block touching the initialization ring. This change in capacitance is used to detect liquids and to initialize the Z-rack.

Application

A specific job being executed on the RSP 9000 II, e.g., RIA, EIA, etc.

Application Package

A software package that allows easy implementation of applications through a series of menus on a video display terminal.

Arm

The RSP 9000 II component that is mounted to the X-slide and contains the Y and Z-axis control mechanisms.

CCU-9000 Board

The central electronics board for the RSP 9000 II Series instrumentation. The main microprocessor and flash EPROM are located on this board. The CCU-9000 board is the control center for the RSP 9000 II and all of its optional devices.

Cleaner Position

A position on the work surface that is used to clean the sampling tip(s).

Command

A combination of user entered parameters that instruct the RSP 9000 II to perform different actions. Example: #18PI This instructs the RSP 9000 II to initialize the left arm (all three axes). Commands can also be used to control optional devices.

Coordinate

Any number or set of numbers used to specify a point on one or more axes in steps.

Defined Field

A defined field is the physical description of an array of positions within an absolute field. It is defined by the X and Y coordinates of certain elements, the four different Z-heights and other parameters. A typical example of a defined field is a rectangular rack.

Device

An addressable component of the RSP 9000 II or additional option that can communicate with the CCU 9000, e.g., arm, diluter, valve, stirrer, etc.

EEPROM

Electrically erasable, programmable, read-only memory chip that contains firmware programs.

External Computer

Any microprocessor that can communicate with the RSP 9000 II according to the communications protocol found in Chapter 3.

Firmware

The term used to describe the software that is stored in a fixed form on the RSP 9000 II flash EPROM and EEPROM.

Fixed Position

A position described by X/Y/Z-coordinates within the absolute field. Every fixed position can have a Z-start, Z-dispense and Z-max heights assigned to it. The Z-travel height is taken from the absolute field.

Flex Cable

A thin 16-wire cable that is used as the medium for power/data transmission from the CCU-9000 to the ADRI-9 board.

Initialization

A term used to describe the calibration of one or more axes of the RSP 9000 II. The axes are offset to a predefined position. When the RSP 9000 II is fully initialized, the X/Y/Z-coordinates are 0, 0, 0. The RSP 9000 II operates using an absolute coordinate system that requires an X/Y/Z-calibration.

Insulation Block

Insulates the sampling tip from the Z-rack and connects the sampling tip to the ALIDUM to provide a controlled electrical flow for measuring capacitance. The insulation block also holds the metal flag that is used for initializing the Z-axis.

Intelligence Device

A microprocessor driven device that has the ability to understand and reply to commands from another microprocessor. These devices also return self generated error messages.

LED

The acronym LED stands for Light Emitting Diode. The LEDs used in the RSP 9000 II are used for indicating lost steps on an axis or hardware problem. The green LEDs should flash on and off if the RSP 9000 II is functioning properly.

LiRa

An acronym that stands for linear rack drive.

Master/Slave

These terms reflect the relationship between two devices of different RSP 9000 II components. (It can also refer to the relationship of the external computer and the RSP.) The master controls the actions of the slaves. Hence, the failure of the master effects all of the slaves. The failure of a slave does not effect any of the other slaves or the master device. The slave does not transmit a message unless requested to by the master.

Message

A computer block of data that is transmitted or received by the external computer, CCU-9000 or device.

Mnemonic

An abbreviation used to help programmers remember a variable name and what the variable means.

Molo-X

An intelligent electronic component that controls the operation of the stepper motors.

Nonvolatile Memory

Nonvolatile memory will retain all entered data until erased. Power interruptions will not erase the contents of this storage media. (An EEPROM is used on the CCU-9000 Board).

Offset

After the RSP 9000 II detects the initialization signal in one of the three axes (metal flag in Z-axis, slotted optical switch in X/Y-axes) during initialization cycle, it moves back a certain distance. This distance is the offset.

Position

A location on the work surface specified by an X/Y/Z-coordinate.

Precision

The degree of refinement with which an operation is performed.

Program

A set of instructions for a computer to execute.

Rack

The physical arrangement of tubes or containers in a holding device that can be defined on the work surface. (See “Defined Field”)

RAM

An acronym for random access memory, a memory device whereby any location in memory can be found, on average, as quickly as any other location.

Ramping

The acceleration and deceleration of stepper motors to achieve smooth movement in the X/Y/Z-axes.

RS-232 C

Electronic Industries Association (EIA) Recommended Standard 232 C defines a standard way of transmitting serial data by wire. The connection line includes lines for sending and receiving data, ground connections and usually one or more control lines. The signal voltages are 5 to 15 volts (binary 0 on the data lines, “high” or “true” on the control lines) and -5 to -15 volts (binary 1 on the data lines, “low” or “false” on the control lines). Mode of Operation: Single ended.

RS-485

The 4-wire RS-485 is the same as RS-3\232 C format; however, it allows for several drivers and receivers over a wider voltage range.

Sampling Tip

A hollow stainless steel tube that has a Teflon coated end for aspirating, dispensing and detecting liquids on the RSP 9000 II instruments.

SLD

An acronym for step loss detector (detection).

Step

A step is the smallest addressable increment of movement on the X/ Y/Z-axes. (See Appendix B for specifications for individual axis step distances.)

Tray

See “Rack” and “Defined Field”.

Valve

A device by which the flow of liquid or gas may be regulated or directed by a moving part.

Volatile Memory

A type of data storage media that will be erased if the power supply is interrupted.

Waste Position

A position on the work surface used to dispense waste from the sampling tip and system tubing.

X/Y/Z-movement

The left-right (X), front-back (Y), and up-down (Z) motion in the three axes (X/ Y//Z).

XOR

A mathematical function written in the software to produce an eight-bit checksum used in verifying if a message has been received correctly by a microprocessor.

TECAN.

Z-dispense

The height of the Z-rack at which the liquid is dispensed during liquid handling operations.

Z-max

The lowest position of the Z-rack in the absolute field or in a defined field. During a “search liquid command” the instrument will search for liquid from Z-start down to Z-max. If the Z-rack reaches Z-max without finding liquid, it stops (ZZ-command) or moves back to Z-coordinate 0 (ZX-command) and generates an error message. Certain commands can override the Z-max value.

Z-rack (toothed)

The vertical bar on the RSP 9000 II that carries the insulation block and sampling tip. The Z-rack moves in the Z-direction (up and down).

Z-start

The height of the Z-rack at which the ALIDUM is switched on during a “search liquid command” (ZX, ZZ). It is usually at the rim of the liquid container.