Agilent 7600-AS Automatic Sample Change System

User Guide

Agilent Technologies

Notices

Manual Part Number

91-002695-00A

Edition

First edition, May 2011

Printed in USA

Agilent Technologies, Inc.
3501 Stevens Creek Blvd.
Santa Clara, CA 95051 USA

Warranty

The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Restricted Rights Legend

U.S. Government Restricted Rights. Software and technical data rights granted to the federal government include only those rights customarily provided to end user customers. Agilent provides this customary commercial license in Software and technical data pursuant to FAR 12.211 (Technical Data) and 12.212 (Computer Software) and, for the Department of Defense, DFARS 252.227-7015 (Technical Data -Commercial Items) and DFARS 227.7202-3 (Rights in Commercial Computer Software or Computer Software Documentation).

Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

1 Introduction

The 7600-AS Automatic Sample Change System provides fast, safe, and reliable automatic sample changing for up to 96 MR samples in standard Varian spinner turbines. It utilizes a standard SCARA (Selective Compliant Articulated Robot Arm) to manipulate the samples and to provide system level control.

The 7600-AS is designed for use with standard Varian 400 MR and 400–700 MHz VNMRS systems. The 7600-AS is integrated with Varian VnmrJ 2.3A or later software. The 7600-AS includes a simple user interface that increases user safety and sample security through controlled access to the trays.

The system can accommodate MR tubes from 1 to 10 mm in diameter and up to 9” in length, in addition to certain J-Young tubes up to 7” in length. Samples are arrayed in a standard 96 well plate format (8 rows marked A through H × 12 numbered columns) in two removable trays. Reflective sensors on the robot and an included upper barrel module provide sample presence sensing.

About This Guide

This user guide gives the necessary information to operate the 7600-AS Automatic Sample Change System. The first two chapters give detailed information about safety and system components.

The Operation chapter describes common tasks, system commands, and important features of the 7600-AS. The Troubleshooting and Error Codes chapter describes troubleshooting techniques, and it contains a reference of error codes, causes, and corrective actions. The Maintenance chapter describes how to ensure your 7600-AS continues to work properly and reliably.

Safety Certification

The 7600-AS is CE certified. This includes testing to the following specifications:

- EN61326-1 (EMC Requirements, Part 1: General Requirements)
- EN61326-2-1 (EMC Unprotected Applications)
- FCC 47CFR 15B c1A (Unintentional Radiators, Class A)
- EN_ISO 10218-1, Part 2 (Safety Requirements for Robots in Industrial Environments, Part 2, Robot Systems)
- UL 1740 (Standards for Robots and Robotic Equipment)
- CAN/CSA Z434 (Standard for Industrial Robots and Robot Systems)

Operating Conditions

This section describes operating prerequisites and conditions for the 7600-AS.

Environmental

Ambient temperature (operating): The system is designed to be operated in a laboratory environment having a temperature between 18 C to 25 C.

Ambient temperature (storage): -25 C to +55 C

Humidity (operating and storage): 20 to 80% Relative Humidity, non-condensing.

Altitude: Up to 3000 m.

Mechanical

Robot payload: 4 kg max at the robot wrist mounting plate.

Robot hand gripper: 1 turbine, 1 test tube with test sample.

Robot speed: 250 mm/s (10 in/s) max.

Pneumatics: Clean dry air (CDA) or nitrogen regulated to 482 kPa (70 psig).

Size: See Table 1 on page 9.

Table 1 Dimensions and Weights

	400 MHz	500 MHz	600 MHz	700 MHz	Robot
Height in Crate (in) cm	(55) 140	(55) 140	(55) 140	(55) 140	(45) 144
Width in Crate (in) cm	(36) 92	(36) 92	(36) 92	(36) 92	(41) 104
Length in Crate (in) cm	(77(196	(92) 234	(99) 252	(105) 267	(24) 61
Weight in Create (lb) kg	(500) 230	(520) 237	(530) 241	(540) 246	(154) 70
Height Uncrated (in) cm	(64.3) 168.3	(78.0) 200.4	(85.3) 216.6	(91.0) 231.1	31) 79
Width Uncrated (in) cm	(24) 61	(24) 61	(24) 61	(24) 61	(36) 91
Weight Uncrated (lb) kg	(265) 120	(280) 127	(291) 132	(298) 135	(75) 34

Electrical

- Rating: 90 to 264V ac, 50 to 60 Hz, 900VA max.
- Fuses: 90 to 132V ac: 6.3A, 250V ac Type T;
  180 to 264V ac: 3.2A, 250V ac Type T
- Short circuit rating (interrupting rating): 1500A @ 250V ac;
  0.7 to 0.8 power factor

1 Introduction

2
Warning and Caution Symbols

This user guide helps you establish operating conditions that permits safe and efficient use of your equipment. Special considerations and precautions are shown in the form of NOTES, CAUTIONS, and WARNINGS as described below. You must operate your equipment in accordance with this user guide and any additional information provided by Agilent. Contact Agilent Technologies if you have any questions regarding the safe and proper use of your equipment.

The following warning and caution notices illustrate the styles used in this user guide for safety precaution notices and explain when each type is used.

CAUTION Alerts you in situations when failure to observe instructions could result in serious damage to the equipment or loss of data.

WARNING **Alerts you in potentially hazardous situations that could result in serious injury or death to humans or animals, or significant property damage.**

CAUTION **STRONG MAGNETIC FIELD**
Strong magnetic fields are present that may impact magnetic media.

WARNING **STRONG MAGNETIC FIELD**
Strong magnetic fields are present that may impact implanted or attached medical devices.

WARNING **SHOCK HAZARD**
Hazardous voltages are present inside the instrument. Disconnect from main power before removing screw-attached panels. No user serviceable parts inside the system.

WARNING **BURN HAZARD**
Very hot or cryogenically cold surfaces may be exposed. Use proper skin protection.

WARNING **EYE HAZARD**
Eye damage could occur either from flying particles, chemicals, or UV radiation. Use proper eye and face protection.

WARNING **MOVING PARTS**
Keep hands and fingers away.

WARNING

FIRE HAZARD
The potential for fire may be present. Follow user guide for safe operation.

WARNING

CHEMICAL HAZARD
Hazardous chemicals may be present. Avoid contact especially when replenishing reservoirs. Use proper eye and skin protection.

WARNING

EXPLOSION HAZARD
The potential for explosion may exist because of type of gas or liquid used.

CAUTION

CLASS 1 LASER
Class 1 invisible laser radiation present. Avoid long term viewing of laser.

General Safety Precautions

Follow these safety procedures to ensure safe equipment operation:

- Perform periodic leak checks on all supply lines and pneumatic plumbing.
- Do not allow gas lines to become kinked or punctured. Put lines away from foot traffic and extreme heat or cold.

Electrical Hazards

- Disconnect the instrument from all power sources before removing protective panels to avoid exposure to potentially dangerous voltages.
- When it is necessary to use a non-original power cord plug, make sure the replacement cord adheres to the color-coding and polarity described in the user guide and all local building safety codes or local electrical legislation.
- Replace blown fuses with fuses of the size and rating stipulated on the fuse panel or in this user guide.
- Replace faulty or frayed power cords immediately with the same type and rating.
- Make sure that voltage sources and line voltage match the value for which the instrument is wired.

Compressed Gas Cylinders

- Store and handle compressed gases carefully and in strict adherence to safety codes.
- Secure cylinders to an immovable structure or wall.
- Store and move cylinders in an upright, vertical position. Before transport, remove regulators and install cylinder cap.
- Store cylinders in a well-ventilated area away from heat, direct sunshine, freezing temperatures, and ignition sources.
- Mark cylinders clearly so there is no doubt as to their contents.
- Use approved regulators and connections only.

Warning Notices

Observe the following precautions during installation, operation, maintenance, and repair of the instrument. Failure to comply with these warnings or with specific warnings elsewhere in Varian documentation violates safety standards of design, manufacture, and intended use of the instrument. Varian assumes no liability for customer failure to comply with these precautions.

WARNING **Remain outside the 5 gauss perimeter from the centerline of the magnet, if you have implanted or attached medical devices such as pacemakers and prosthetic parts.**

The superconducting magnet system geneates strong magnetic fields that can affect operation of some cardiac pacemakers or harm implanted or attached devices such as prosthetic parts and metal blood vessel clips and clamps.

Pacemaker wearers should consult the documentation provided by the pacemaker manufacturer or contact the pacemaker manufacturer to determine the effect on a specific pacemaker. Pacemaker wearers should also always notify their physician

and discuss the health risks of being in proximity to magnetic fields. Wearers of metal prosthetics and implants should contact their physician to determine if a danger exists.

Refer to the documentation supplied with the magnet for the size of a typical 5-gauss stray field. Check this gauss level after the magnet is installed.

WARNING **Keep metal objects outside the 10-gauss perimeter from the centerline of the magnet.**

The strong magnetic field surrounding the magnet attracts objects containing steel, iron, or other ferromagnetic materials, which includes most ordinary tools, electronic equipment, compressed gas cylinders, steel chairs, and steel carts. Unless restrained, such objects can suddenly fly towards the magnet, causing possible personal injury and extensive damage to the probe, dewar, and superconducting solenoid. The greater the mass of the object, the more the magnet attracts the object.

Use only non ferromagnetic materials, for example, plastics, aluminum, wood, nonmagnetic stainless steel, and so on, in the area around the magnet. If an object is stuck to the magnet surface and cannot easily be removed by hand, contact Agilent service for assistance.

Refer to the documentation supplied with the magnet for the size of a typical 10 gauss stray field. Check the gauss level after the magnet is installed.

WARNING **Only qualified maintenance personnel removes equipment covers or makes internal adjustments.**

Dangerous high voltages that can kill or injure exist inside the instrument. Before working inside a cabinet, turn off the main system power switch located on the back of the console.

WARNING **Do not substitute parts or modify the instrument.**

Any unauthorized modification could injure personnel or damage equipment and potentially terminate the warranty agreements or service contract. Written authorization approved by an Agilent product manager is required to implement any changes to the hardware of an Agilent MR spectrometer. Maintain safety features by referring system service to an Agilent service office.

WARNING **Do not operate in the presence of flammable gases or fumes.**

Operation, with flammable gases or fumes present, creates the risk of injury or death from toxic fumes, explosion, or fire.

WARNING **Leave area immediately in the event of a magnet quench.**

If the magnet should quench (sudden appearance of gasses from the top of the dewar), leave the area immediately. Sudden release of helium or nitrogen gasses can rapidly displace oxygen in an enclosed space creating a possibility of asphyxiation. Helium displaces air from the top of a room and cold nitrogen can displace air from the lower levels of a room. Do not return until the oxygen level returns to normal.

WARNING **Avoid helium or nitrogen contact with any part of the body.**

Cold gasses or liquids (helium and nitrogen) contacting the body can cause an injury similar to a burn. Never put your head over the helium and nitrogen exit tubes on top of the magnet. If cold gasses or liquids contact the body, get immediate medical attention, especially if the skin is blistered or the eyes are affected.

WARNING **Do not look down the upper barrel.**

Unless the probe is removed from the magnet, never look down the upper barrel. You could be injured by the sample tube as it ejects pneumatically from the probe.

WARNING **Do not exceed the boiling or freezing point of a sample during variable temperature experiments.**

A sample tube subjected to a change in temperature can build up excessive pressure, which can break the sample tube glass and cause injury by flying glass and toxic materials. To avoid this hazard, establish the freezing and boiling point of a sample before doing a variable temperature experiment.

WARNING **Support the magnet and prevent it from tipping over.**

The magnet dewar has a high center of gravity and could tip over in an earthquake or after being struck by a large object, injuring personnel and causing sudden, dangerous release of nitrogen and helium gasses from the dewar; the magnet must be supported by at least one of two methods: with ropes suspended from the ceiling or with the antivibration legs bolted to the floor. Refer to the 7600-AS Automatic Sample Changer Pre-installation Instructions for details.

WARNING **Do not remove the relief valves on the vent tubes.**

The relief valves prevent air from entering the nitrogen and helium vent tubes. Air that enters the magnet contains moisture that can freeze, causing blockage of the vent tubes and possibly extensive damage to the magnet. It could also cause a sudden dangerous release of nitrogen and helium gasses from the dewar. Except when transferring nitrogen or helium, be certain to secure the relief valves on the vent tubes.

WARNING **On magnets with removable quench tubes, keep the tubes in place except during helium servicing.**

On Agilent 200 MHz and 300 MHz 54 mm magnets only, the dewar includes removable helium vent tubes. If the magnet dewar should quench (sudden appearance of gasses from the top of the dewar) and the vent tubes are not in place, the helium gas would be partially vented sideways, possibly injuring the skin and eyes of personnel beside the magnet. During helium servicing, when the tubes must be removed, follow the instructions and safety precautions given in the documentation supplied with the magnet.

Caution Notices

Observe the following precautions during installation, operation, maintenance, and repair of the instrument. Failure to comply with these cautions or with specific cautions elsewhere in Agilent documentation, violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for customer failure to comply with these precautions.

CAUTION Keep magnetic media, ATM and credit cards and watches, outside the 5 gauss perimeter from the centerline of the magnet.

The strong magnetic field surrounding a superconducting magnet can erase magnetic media such as floppy disks and tapes. The field can also damage the strip of magnetic media found on credit cards, automatic teller machine (ATM) cards, and similar plastic cards. Many wrist and pocket watches are also susceptible to damage from intense magnetism.

Refer to the documentation supplied with the magnet for the size of a typical 5 gauss stray field. Check this gauss level after the magnet is installed.

CAUTION Keep the computers (PC) beyond the 5 gauss perimeter of the magnet.

Avoid equipment damage or data loss by keeping PCs away from the magnet. Generally, keep the PC beyond the 5-gauss perimeter of the magnet. Refer to the 7600-AS Automatic Sample Changer Pre-installation Instructions for magnet field plots.

CAUTION Check helium and nitrogen gas flow meters daily.

Record the readings to establish the operating level. The readings will vary somewhat because of changes in barometric pressure from weather fronts. If the readings for either gas should change abruptly, contact qualified maintenance personnel. Failure to correct the cause of abnormal readings could result in extensive equipment damage.

CAUTION Take electrostatic discharge (ESD) precautions to avoid damage to sensitive electronic components.

Wear grounded antistatic wristband or equivalent before touching any parts inside the doors and covers of the spectrometer system. Also, take ESD precautions when working near the exposed cable connectors on the back of the console.

Radio Frequency Emission Regulations

The covers on the instrument form a barrier to radio frequency (RF) energy. Removing any of the covers or modifying the instrument may lead to increased susceptibility to RF interference within the instrument and may increase the RF energy transmitted by the instrument in violation of regulations covering RF emissions. You must maintain the instrument in a condition that does not violate RF emission requirements.

RF emissions from Varian MR equipment has been measured and compared with IEEE/ ANSI C95.1-1991, "Standard for Safety Levels with Respect to Human Exposure to RF Radiation." The RF tests included general measurements of systems with particular interest directed toward amplifiers, transmitter boards, and probes. With maximum observe transmitter and decoupler transmitter power applied (parameters tpwr and dpwr set to 63), measurements were taken both 12 inches away and as close as possible to the RF source while the source was installed in the console or magnet. The results of the tests found that RF emissions from Varian MR equipment either were not detectable or were detectable at levels far below the IEEE/ANSI C95.1-1991 standard levels.

Ventilation

Air ventilation must be adequate to displace the liquid helium (LHe) gas during a quench, especially when using any type of volatile liquid for variable temperature experiments. The liquid helium volume for room ventilation considerations is 60 LHe maximum volume. Consult with a safety engineer on this subject. Gaseous helium or nitrogen exhausted from the magnet displaces oxygen and causes asphyxiation if not properly ventilated.

During a magnet quench, the evaporated helium is exhausted from the manifold by the pressure relief valves. The amount of gas depends on the amount of liquid helium held by the magnet at the time of the quench. But, it is unlikely that a magnet quench will boil off the total amount of helium. Also, remember that vented helium gas fills the room from the ceiling down, so set up fans and ducts accordingly.

The expansion ratio of liquid helium at room temperature is about 740:1, which means that one liter of liquid helium expands to about 740 liters of helium gas.

For fans rated in LPM (liters per minute), multiply the LHe maximum volume (60 by 740) to get an idea of the helium gas that the fan should be capable of displacing.

For fans rated in CFM (cubic feet per minute), multiply the LHe maximum volume by 26.13 (includes expansion ratio) to get an idea of the total amount of helium gas that the fan should be capable of displacing (for example, a magnet that holds 60 liters of LHe requires a fan that can displace about 1,568 ft^3 of helium gas).

On magnets, where a quench vent and duct work is used to direct the helium gas out of the area during a quench, you must make the orientation of the quench vent and its duct work so that it does not interfere with a four inch (10.2 cm) radius cylinder extending up from the room temperature bore of the magnet.

Electrostatic Discharges

Electrostatic discharges less than 15 kV generally do not result in any perceivable errors or problems. Discharges greater than 15 kV, however, might result in loss of data and errors perceivable to the operator. Discharges greater 25 kV can cause damage to the equipment.

To prevent electrostatic discharge damage, the system must be installed on vinyl-covered floors and be properly grounded. If carpeting is installed, the carpet must contain only a small percentage of nylon and be installed over antistatic pads. Alternatively, regular use of a good quality antistatic spray can help considerably in alleviating the problem. Whenever you touch or handle a printed circuit board, wear grounded wrist straps.

CAUTION Many components in the system contain highly sensitive electronic devices that must be protected from electrostatic discharges by proper floor coverings and grounding practices. A person walking across a nylon carpet or wearing synthetic fabrics can generate an electrostatic charge that can discharge to the next object that is touched. If this happens to the system, the system components can be damaged. An overly dry atmosphere also tends to create an electrostatic charge. As with any system based on integrated circuits, the system is susceptible to static spikes, both those generated on the power line and those generated in the lab area, which must be suppressed.

Safety Hazards of Strong Magnetic Fields

You must understand and plan for the potential safety hazards of strong magnetic fields for devices, such as certain pacemakers. Check for these hazards after a particular magnet has been installed.

WARNING

Cardiac pacemaker wearers must remain outside the 5-gauss perimeter from the magnet until safety is clearly established. An MR superconducting magnet generates strong magnetic and electromagnetic fields that can inhibit operation of some cardiac pacemakers, which could result in death or serious injury. Consult the pacemaker user documentation, contact the manufacturer, or confer with a physician to determine the effect on a specific pacemaker. Agilent provides signs with each system to warn pacemaker wearers of this hazard.

Pacemakers

Cardiac pacemaker wearers must not enter a zone that would subject a cardiac pacemaker to a magnetic intensity that could cause adverse effects. In some instances, this zone might include space on the floors directly above and below the magnet. For assistance in determining the effect of a system on pacemaker, consult the pacemaker user documentation, contact the pacemaker manufacturer, or confer with a physician to determine the effect on a specific pacemaker. Actual levels vary. Check for safety hazards after a particular magnet has been installed.

Magnetic Field Exposure

MR workers are often exposed to high levels of static magnetic fields. No conclusive scientific evidence exists indicating adverse health effects at current exposure levels.

The 400-MR shielded magnet contains the high-level fields within the cryostat body.

An article by the American Conference of Governmental Industrial Hygienists (ACGIH) entitled "Threshold Limit Values and Biological Exposure Indices, 5th ed." states the following:

"Routine occupational exposures should not exceed 60 millitesla (mT)-equivalent to 600 gauss-whole body or 600 mT (6000 gauss) to the extremities on a daily [8 hour], time-weighted average basis. A flux density of 2 tesla (20,000 gauss) is recommended as a ceiling value."

3
System Components

The 7600-AS consists of the following components: a SCARA with a turbine sensing gripper assembly, a support tower, a console user interface, a system interface, a safety enclosure with integrated doors and two sample trays, an Upper Barrelmodule, and a magnet motion detector.

Figure 1 Sample change system

SCARA with Gripper

The SCARA is a general-purpose automation robot designed for light to medium payloads (up to 4 kg) in tabletop environments. It is fast, quiet, and virtually maintenance free. The robot utilizes brushless dc motors with absolute encoders to drive each of the three axes of motion (z, rotation about the base and rotation about the elbow). A controller with the ability to drive up to four axes of motion as well as handling multiple I/O signals and a 24V dc power supply are located in the base of the robot. Motion and I/O control are coordinated using custom software written to interface with you and the Varian VnmrJ operating software. The robot is cycle tested and calibrated at the factory to ensure reliable out-of-the-box operation upon installation. The robot is shown in Figure 1 on page 28.

Upon system power up, the robot is ready for operation. The absolute encoders enable the system to be operational immediately. No homing is required. The controller is powered during an E-Stop event, so once the E-Stop is cleared, the system is able to resume without operator intervention or re-homing.

The robot gripper assembly, also shown in Figure 1 on page 28, is pneumatically driven. It consists of custom electroless nickel plated aluminum gripper fingers attached to the pneumatic actuator and a side mounted reflective sensor, which is used to check sample presence and to determine whether or not a position in a rack is occupied. The metal gripper fingers are designed to grasp standard Varian MR spinner turbines.

SCARAs provide system space efficiency and flexibility in within a confined space. They move in a way that is analogous to the human arm with rotational degrees of freedom about a shoulder joint and an elbow joint. SCARAs can operate in either a right-handed or a left-handed configuration. The 7600-AS system operates in a right-handed configuration only as shown in Figure 1 on page 28.

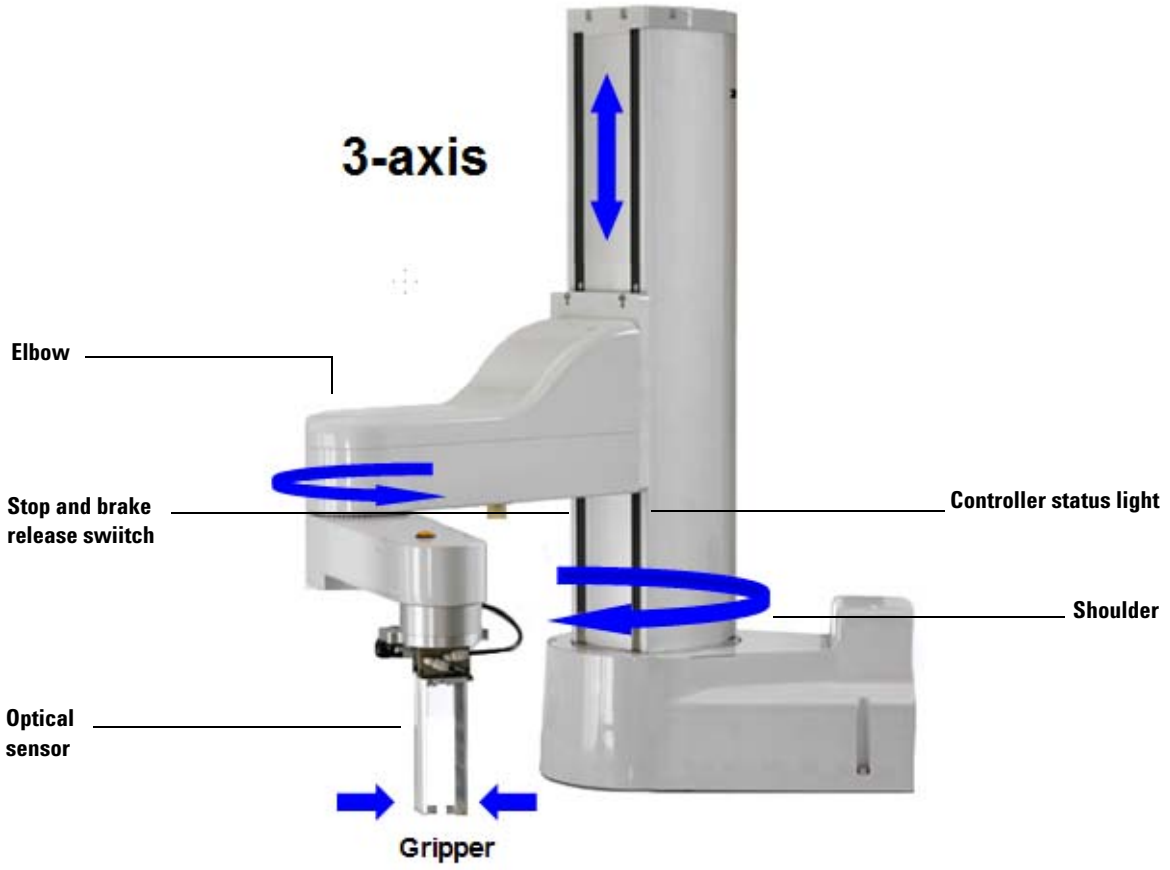

Figure 2 SCARA shown in the right-handed configuration

Support Tower

The tower assembly is designed to position the robot, sample trays, and safety enclosure in the proper location next to the magnet. It is fastened to studs installed into the floor to provide structural rigidity and positional consistency with respect to the magnet Upper Barrelassembly.

It may also be supported using an optional floor mounting kit (Agilent Part Number 910000540). The system should be leveled by the installer during installation to ensure that the two trays are in a plane parallel to the base of the robot. If the system is moved then it must be leveled.

Console User Interface

The primary system interface is located on the console near the bottom of the tower assembly. It includes an LCD screen to show system status, error messages, and the location of the sample presently in the magnet.

Three LEDs are located below the LCD screen to show system readiness at a glance.

- Green indicates that the system is ready for a command; flashing green indicates that the robot is executing a command.
- Yellow indicates that the doors are open; flashing yellow indicates that a door open request has been received.
- Red indicates that the system is non-operational.

The door access request button is located adjacent to the LCD. Press this button to open the doors. The system allows access when the robot is idle. Once you have pushed the button, the doors remain unlocked for two minutes before locking again. If the doors are open and a command is received from VnmrJ, then a system error is reported if the doors are not closed within three minutes. A three-minute countdown timer shows in the LCD.

A primary, keyed power switch is located on the side of the console along with a high power enable button. This button is required to enable power to the robot motors. An Emergency Off switch (E-Stop) is located in the center of the console. These items are shown in Figure on page 31.

Figure 3 User interface

System Interface

The system interface is located at the base of the tower in the rear. It includes connections for communication (Ethernet), power (110–240V ac), and air (CDA at 70 psi). (Figure 3).

Figure 4 System interface panel

Safety Enclosure and System Access Doors

The safety enclosure, located at the top of the tower structure, is designed to protect you from inadvertent contact with the robot, as well as to control access to the MR samples in the queue. To access the sample trays, you must request access by pushing the access request button. The system determines when it is safe to do so and provides access by unlocking the doors and moving the robot to a safe position away from the trays.

Figure 5 Safety enclosure and doors

When the doors are unlocked, high power to the motors and system pneumatics are disabled. You can then manually move the robot in the x-y plane if necessary. While the doors are open, you may remove and replace the system trays if desired.

Once you close the doors, the system automatically locks them, restores high power to the robot to enable it to move, and finally uses the robot laser sensor to ensure that the trays are both present.

If a command is received while the doors are opened, it is buffered for three minutes. If the doors are not closed within three minutes, then the robot responds to the host that it was unable to process the request because the doors were open. You must close the doors and resubmit the automation request.

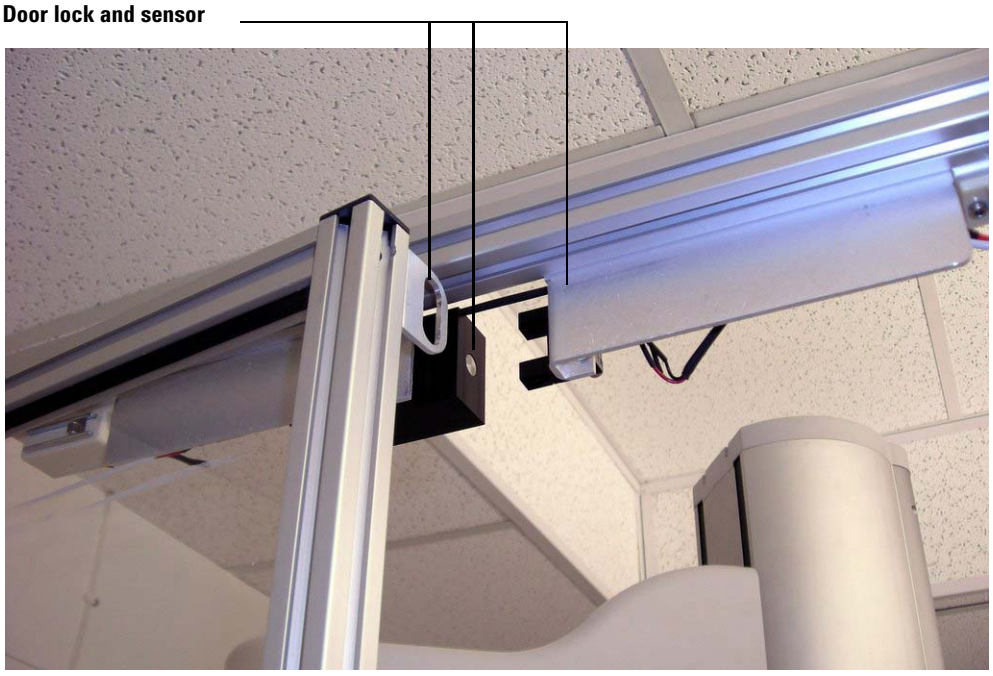

Figure 6 Close up view of door lock assembly

Trays

Two separate removable sample trays, each containing spaces for 48 samples on a grid of 8 rows (A–H) × 6 columns (1–6), are provided for a maximum of 96 samples to be queued. Additional trays are available for batch processing samples if required. The trays are designed so that you can match samples from a standard 96 well plate if desired.

Figure 7 Sample trays

Upper Barrel Module

The Upper Barrel module is used to provide a consistent place for sample drop off and pick up. The module consists of a pneumatically actuated mechanism that is used to capture the sample during eject and to hold the sample prior to insert.

Additionally, the Upper Barrel module includes a reflective sensor that detects the sample when it is ejected or inserted. This sensor is used to dynamically adjust the z position of the Upper Barrel by sensing the bottom of the spinner turbine as it is inserted, and then by computing the new position. This allows the system to adjust automatically to events such as fluctuations in magnet leg pressure or changes in VT that would cause the Upper Barrel to expand.

The Upper Barrel module goes onto the Upper Barrel until it is seated flush with the top of the Upper Barrel. You may remove the module for manual operation, or you can use the bypass switch on the module to manually activate the mechanisms.

If you remove the module, take special care not to overtighten the setscrew used to secure the module. If you overtighten it, you can deform the Upper Barrel tube and cause samples to become stuck. An E-Stop switch is also included for additional safety. The following figures show the module and the sensor.

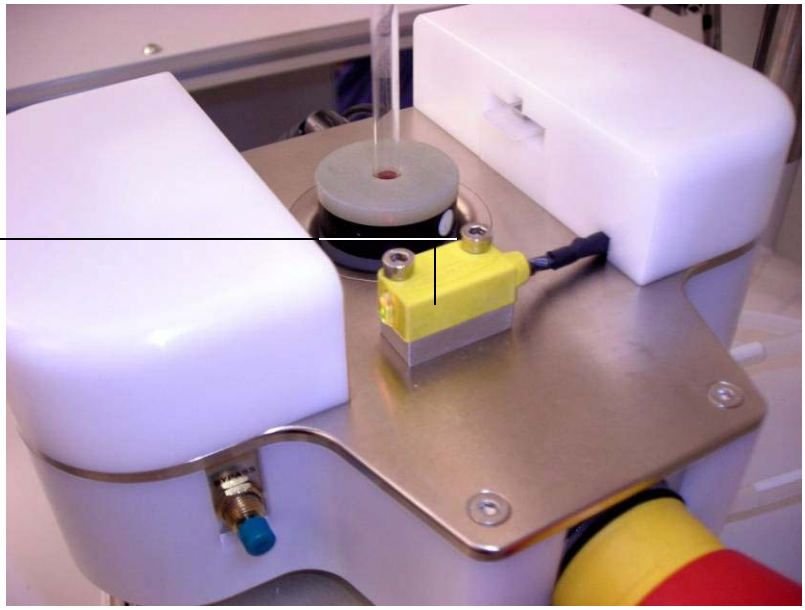

Figure 8 Upper Barrel module with sample in the captured position

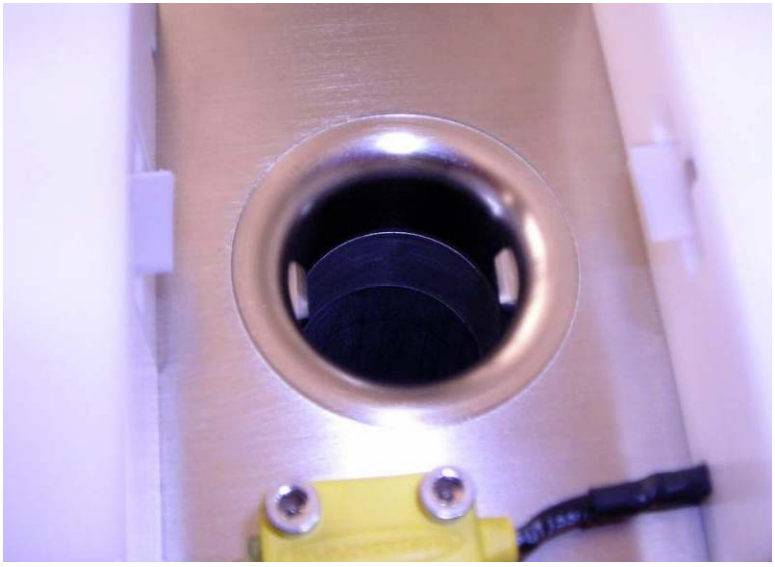

Figure 9 Upper Barrel module with sample catch mechanism engaged

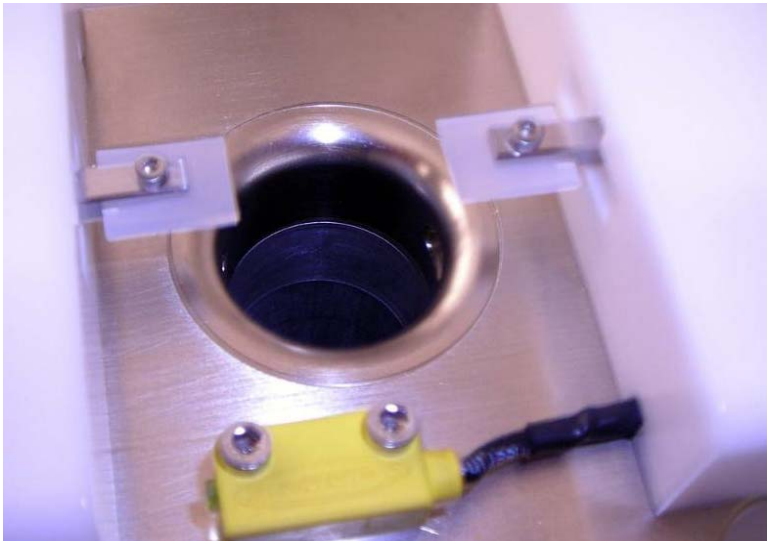

Figure 10 Upper Barrel module in the ready to catch state

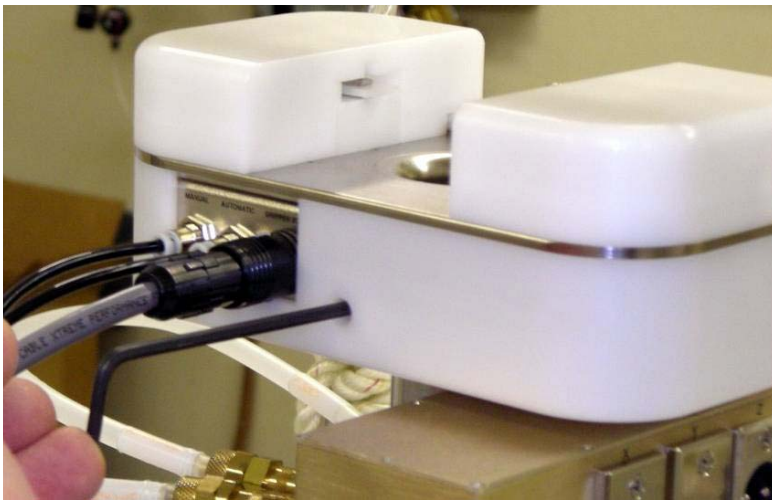

Figure 11 Tightening the setscrew to secure the module to the Upper Barrel

NOTE Tighten gently to prevent deformation of the Upper Barrel tube.

Magnet Motion Sensor

A magnet motion sensing system is located on the back of the support tower to detect gross magnet motion, which would interfere with sample delivery or retrieval. The system consists of a through-beam laser sensor. It is fastened to the tower and a plate with an alignment hole that is attached to the magnet flange.

The robot checks the status of this sensor assembly only during operations where it is directly over the Upper Barrel. When the sensor is tripped, the robot waits up to 20 seconds for the fault to clear before aborting the operation. If the fault is cleared

within 20 seconds, the robot continues with the operation. If the fault is not cleared, the robot returns to the home position and reports an error to the VnmrJ host.

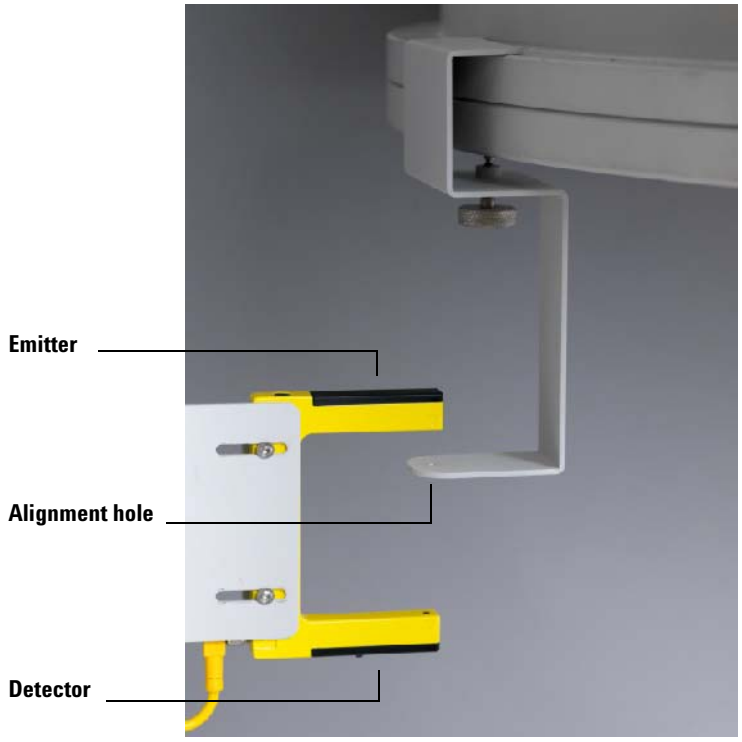

Figure 12 Magnet motion detector assembly

4 Operation

The 7600-AS has been integrated with Agilent VnmrJ Software version 2.3A and later. Refer to the latest VnmrJ software documentation for specific instructions regarding operation of the sample changer from the host software. The system is designed to work with VnmrJ in the same manner as previous sample changers like the SMS system.

The only difference is a graphical representation of the Study Queue that corresponds to the two sample trays provided with the 7600-AS system. The following figure shows a representative view of the Study Queue interface for the 7600-AS.

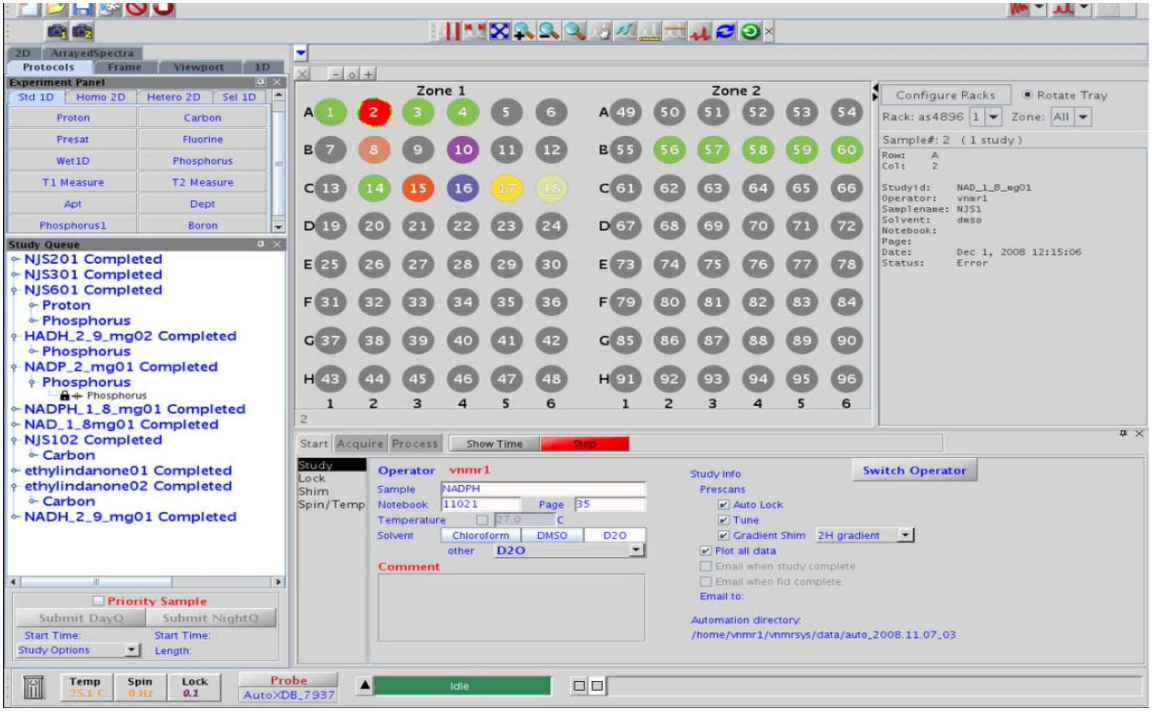

Figure 13 VnmrJ Study Queue interface

This manual provides specific instructions for the operation and setup of the sample changer itself. The following sections describe the power-up sequence, working with samples, the sequence of events during PUT and GET routines, using the E-Stop switch, operation in manual mode; and instructions for teaching tray positions.

Starting the System

You must perform the following before starting the system:

- Ensure that the power cord is attached and plugged into a 100/240V 50-60 Hz inlet.
- Ensure that the Ethernet cable is attached to the rear panel jack.
- Ensure that the inlet pressure is regulated to 60 psi (as shown on the pressure gauge on the rear panel).
- Ensure that all samples are removed from the robot hand gripper, ejected from the upper barrel, and removed from the upper barrel module.
- Ensure that the trays are installed and the doors are closed.
- Ensure that the **E-Stop** switch is released.
- Ensure that the robot is positioned into the right-handed configuration as shown in Figure 14 on page 46. That is, the external arm link containing the gripper is rotated around the elbow joint as a right arm is normally oriented.
- Ensure that there is sufficient eject airflow to eject sample turbines.

NOTE Different probes require different eject airflow settings.

Figure 14 Right-handed orientation

NOTE The arm is bent around the elbow joint like a right arm.

Figure 15 Left-handed orientation is incorrect, the system does not operate in this orientation

Once the previous items are checked, follow this procedure:

1 Turn the main power to **ON** using the key switch located on the side of the main console.

Figure 16 Key switch and **START** button

Wait approximately 30 seconds while the controller boots up. The **LCD** display is blank and then a message is shown requesting that the **E-Stop** switch be reset (if it is not already) and the **START** button be pressed.

2 Press the **START** button.

The **START** button enables high power to the robot motors. Once pressed, the robot moves to the ready position and performs a tray check. It confirms the presence of trays 1 and 2 using the reflective sensor. When that is complete, the robot returns to the home position and then flashes a message reading **Ready** in line two of the **LCD** and line one is blank. The system is now ready for use.

Adding or Removing Samples from the System

You may add or remove samples from the system individually or in batches. To gain access to the tray workspace:

1 Press the door **Access Request** button on the front of the console (Figure 3 on page 32).

Once the request is made, the system blinks the yellow **LED** on the front of the panel to acknowledge the request. The system then unlocks the doors and turns the yellow light solidly to **ON**, when the robot has completed all outstanding operations in its queue.

a Open the doors to add or remove samples.

b Once you are finished, close the doors.

c Now, the doors get automatically locked.

d After adding or removing the samples, update the VnmrJ host **Study Queue** to reflect the changes.

While adding or removing samples, note the following:

- Do not place a new sample into the hole occupied by the sample under test. The **LCD** screen shows the position occupied by this sample. The system retains a memory map of all of the occupied holes in the trays. This map is constructed as it manipulates samples as instructed by the VnmrJ host software. When the doors are opened, the map is reset.
- After the doors are closed and a request made by the host to retrieve the sample under test, the system checks the status of the memory map. If the hole location is shown as unknown, then the robot checks the status of the hole with the laser sensor prior to executing the retrieve command. This check prevents the system from damaging samples that are improperly submitted. You must physically move the sample in order to recover.
- While the doors are open, high power to the robot motors is disabled, as is the air supply to all pneumatic cylinders. Once you close the doors, the robot first checks to ensure that both trays are still installed. Then, it returns to a ready position.

- If a command is received from VnmrJ while the doors are open, the system buffers it for three minutes. If you do not close the doors within that time frame, an error is reported to the VnmrJ host. If you close the doors within that time frame, the robot executes that command after checking the trays.
- If an inadvertent request for access is made, you can clear it by pressing the access request button a second time.

System Cycle Description during VnmrJ Put and Get Commands

The VnmrJ host primarily asks the robot to perform **PUT** (put sample X into the magnet) and **GET** commands (get sample from magnet and put into specific hole location). The sequence for each command is described in the following:

Put command (put sample in upper barrel)

This command moves a sample from the sample tray location to the upper barrel module and then inserts the sample into the magnet for MR analysis.

The sequence of events is:

1. Verify that the system is ready (E-Stop, magnet motion sensor, and air pressure).
2. Verify that the requested sample number is valid (within valid tray/sample range).
3. Verify that the robot gripper and the upper barrel gripper are open and empty.
4. Move the robot arm to a safe z position above the work surface and then move the robot arm over the sample tray location.
5. Move the robot arm down and verify that a sample is present in the specified tray location using the laser sensor.
6. Grip the sample, move the arm up to a safe z position, and then move from predefined path to a position above the upper barrel. Continuously monitor the sample, ensuring it is present in the gripper while in transit.
7. Lower the sample and move it to a location slightly above the turbine detection sensor.
8. Slowly lower the sample until the sensor detects it. Recalculate the z position and descend to the drop-off position and then open the robot gripper (with the upper barrel module gripper in the closed state).

9 Move the robot up to a safe z position and then back to the home position. Open upper barrel module gripper and allow sample to descend into the magnet for MR analysis.

NOTE The system continuously monitors the magnet motion detector status only while the robot gripper is directly over the upper barrel. If the sensor is tripped, the robot stops and waits for up to 20 seconds for the fault to clear. If the fault is not cleared in 20 seconds, the robot issues an error and returns the sample to its tray location.

Eject sequence (eject sample to upper barrel gripper)

The VNMRS system, in coordination with the 7600-AS, controls sample eject. It ejects and inserts samples directly from the host software.

When an eject command is issued, this sequence occurs:

1 VnmrJ issues eject command.

2 Eject air turns on.

3 VnmrJ waits for 30 seconds for the 7600-AS system to send a response that the sample is detected and captured.

During this time, the sample is detected; the 7600-AS waits for a few seconds and then closes the gripper to capture the turbine.

If no sample is detected in the 30-second window, then VnmrJ performs an insert and then ejects the sample again. This time, if the sample is not detected within 30 seconds, then it is inserted again, VnmrJ stops, and an error is issued.

The eject airflow must be set high to enable the sample to rise high enough in the upper barrel module to be detected by the sensor. The system is designed to tolerate excessive eject airflow, so the system works more reliably with higher eject airflow. Marginal airflow causes the system to fail to detect and capture the turbine. Different probes may require different eject air settings. You must verify that samples are ejecting properly, prior to running the system in an automated mode.

Get command (retrieve sample from magnet)

This command retrieves a sample from the magnet and returns it to the requested tray location. This location can be different from the position from which the sample was retrieved. Every location in the system tray status map can have three possible states:

- **Occupied (1)**
- **Empty (0)**
- **Unknown (–1)**

If an attempt is made to place a sample into a tray location with an unknown status, the robot will physically check the status of the location using the laser sensor prior to executing the **GET** command. If the hole is occupied, it will issue an error. If it is empty, it will execute the command.

The general sequence for the **GET** command is:

1. Verify that the system is ready (E-Stop, magnet motion sensor, air pressure are all OK)
2. Verify that the sample number is valid (within the valid tray/sample range).
3. Verify that the robot gripper is empty and that a sample is present in the upper barrel gripper module.
4. Verify that the sample location is empty (the robot will perform a status check using the laser sensor if the memory location is unknown).
5. Move the robot arm to a safe z position above the work surface and then to a position over the upper barrel and the sample.
6. Descend to the previously computed z location, grip sample and ascend. Check sample presence using the reflective sensor on the gripper during transit.
7. Move to the safe z position and then traverse through the via points to the specified tray location.
8. Descend to the tray z location and release the sample.
9. Move robot to the safe z position and then to the home position.

The system continuously monitors the magnet motion detector status only while the robot gripper is directly over the upper barrel and descending to retrieve the sample. It is not monitored while ascending with a sample gripped. If the sensor is tripped, the robot stops and waits for up to 20 seconds for the fault to clear. If the fault is not cleared in 20 seconds, the robot issues an error and returns to the home position without gripping the sample.

Magnet motion detector

The magnet motion detector is designed to prevent damage to the sample due to gross position changes of the magnet. The system is designed to react immediately during **PUT** and **GET** operations if the robot is either placing or retrieving the sample when the arm is over the upper barrel.

If the magnet is jostled due to incidental contact, then the system will pause while the magnet stabilizes. Typically, this will only take a few seconds. However, if a major event such as a loss in magnet leg pressure occurs, then the system will be prevented from continuing due to the resultant misalignment of the detector and the magnet. The system will turn on the red **LED**, move the robot to the home position and wait until the fault is cleared. However, the power to the robot motors and pneumatics will not be disabled The system will not be able to execute **PUT** or **GET** commands until the fault is cleared.

Emergency Off Switch (E-Stop)

As the name implies, push the **Emergency Off Switch** when it is necessary to immediately stop the system. **E-Stop** switches are located on the front console and on the upper barrel module. The **E-Stop** switches are wired directly into the high power enable for the robot motors, so pressing either one will immediately disable robot motion.

Additionally, the **E-Stop** switches are tied into the pneumatics control so all air will be disabled. This will unlock the doors and put the upper barrel module gripper into the closed (sample held) position. The robot gripper is pneumatically actuated so that it is normally closed via spring action, so a sample in the gripper will not be dropped. The **Red LED** on the console will light until the switch or switches are reset and green **START** button is pressed.

While either **E-Stop** switch is activated, power is provided to the robot controller so the system status is maintained. The host software does not continuously monitor the robot system status, so **MR control** and the **study queue** are not affected unless a command is issued or was issued. If a command was active, then the robot will immediately report the fault to the VnmrJ host. If a command is issued while an **E-Stop** switch is pressed, the system will buffer it for 3 minutes. If the **E-Stop** switches are not released within that time frame, an error will be reported to the VnmrJ host. The **LCD** display message is shown in Figure 17

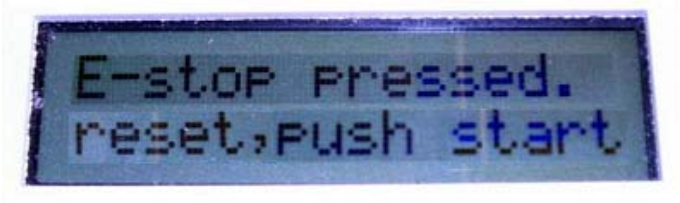

Figure 17 E-Stop error message

Recovery

Follow these steps to restart the system after the **E-Stop** switch has been pressed.

1 Clear the condition that caused the event.

2 Manually remove any samples left in either the upper barrel module gripper or the robot gripper. Return to the sample tray if appropriate. See .Figure 18.

Figure 18 Manual removal of sample from robot gripper

3 Ensure that robot is placed in the Right Handed orientation. (See Figure 14 on page 46 for more information about the right-handed orientation.)

4 Ensure that the trays are installed correctly.

5 Close the doors.

6 Twist the **E-Stop** switch (switches) to reset them. The button should move up.

7 Press the **START** button on the side of the console. The system will then go through the startup sequence described in "Starting the System" on page 45.

Manual Bypass Operation

The 7600 AS is intended to operate in automatic mode only. From time to time, customers may wish to bypass automation to use the MR system in walk-up, manual mode

To use in manual mode:

1. Turn the main power to **OFF** using the **key switch** on the side of the console. **Key switch** location is shown in Figure 15 on page 47. Ensure that the robot is off to prevent accidental injury.
2. Either remove the upper barrel module assembly or, if the manual use will be for a short period of time, use the bypass button located on the upper barrel module to insert or remove samples.

You must use the manual **insert/eject lever** to insert or eject samples manually in conjunction with the bypass button to open and close the gripper. See theFigure 19 on page 59 andFigure 20 on page 60.

Pressing the **green bypass** button allows the sample to fall to the probe or sample to come up past the gripper capturing mechanism, so the **bypass** button must be pressed in conjunction with the sample **insert/eject** lever as shown.

The standard VnmrJ insert and eject commands can be used to insert or to eject a sample while the robot is active. This feature is intended to allow you to abort a test or to start a hot test. Note that the **E-Stop** switch should be depressed whenever accessing the upper barrel gripper assembly.

To manually eject a sample at the upper barrel:

1. Turn Main Power to **OFF**.
2. Press and hold the **green manual bypass** button on the upper barrel gripper.
3. Flip the lever to **EJECT** on the **eject/insert air** manual control box.
4. When the sample moves past the grabbing arms, release the **bypass butto**n to grab the sample.

To manually insert a sample at the upper barrel:

1 Turn Main Power to **OFF**.

2 Flip the lever to **EJECT** on the **eject/insert air** manual control box.

3 Wait for air upper barrel air to be turned on.

4 Press and hold the **green bypass** button on the upper barrel gripper.

5 Flip the switch to **INSERT** on the **eject/insert air** manual control box.

6 Wait for the sample to move past the grabbing arms then release the **manual bypass** button.

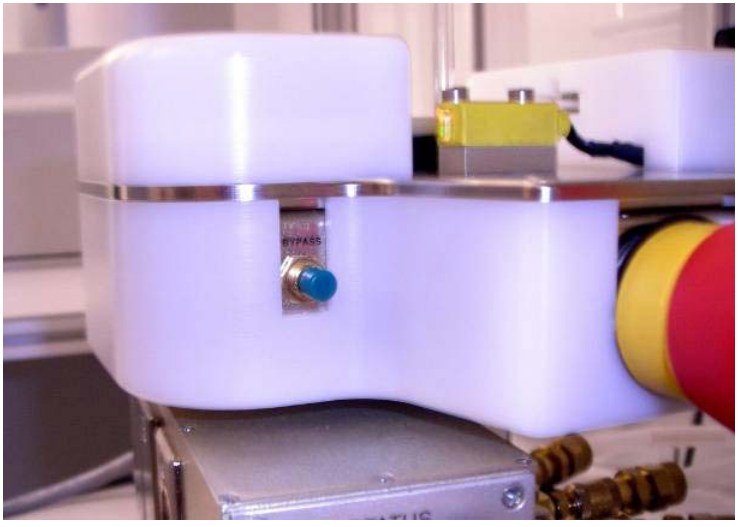

Figure 19 **Manual bypass** button to activate upper barrel gripper

Figure 20 **Manual Insert/Eject** lever to be used in conjunction with **Bypass** button for manual insert/eject

Teaching Tray Positions

During installation the robot is taught the upper barrel pick up location and 3 points per tray. These positions can be retaught using the procedure in this section if there are changes to these positions caused by events such as releveling the trays or moving the upper barrel gripper out of position.

Obtain equipment to teach the autosampler robot

- Tray calibration tool (p/n 01922686)
- Upper barrel calibration tool (p/n 01922685)
- Calibration tools are provided with the 7600-AS
- Windows computer/laptop with Ethernet port
- Internet Explorer (IE) version 6 or newer
- Firefox or any other Web browser will not work
- Ethernet cable (straight)

Set windows ethernet lan settings for 7600-AS

This will need to be done prior to connecting to the Ethernet port of the automated sample changer.

1 Verify 7600-AS IP address.

The default 7600-AS IP address is 172.16.0.249. On systems which have an IP conflict, the robot is assigned a different address. The 7600-AS IP address can be obtained from the `/etc/hosts` file. At an Unix prompt enter: `more /etc/hosts`.

The 7600-AS IP address is on the line with “V-Autosampler.”

2 Power on computer/laptop.

3 Click the **Start** button in Windows on the computer/laptop.

4 Select **Network connections**.

5 Select **Local area network**.

6 Click **Properties**.

7 Scroll down and select **Internet Protocol (TCP/IP)**.

Change network settings

The screen shown in Figure 21 appears. The computer/laptop has to have a different IP address than the 7600-AS but must be on the same subnet.

1 Click **Properties**

2 For robot IP address 172.16.0.249, enter the following:

```
IP Address:172.16.0.244
Subnet: 255.255.255.0
Default gateway :( Leave blank)
```

3 For other IP address <xxx>.<yyy>.<zzz>.249 enter the following (where x, y and z are digits from V-autosampler IP address):

```
IP Address: <xxx>.<yyy>.<zzz>.244
Subnet: 255.255.255.0
Default gateway: (Leave blank)
```

4 Click **Advanced** select **Automatic** metric in the **IP Settings** tab.

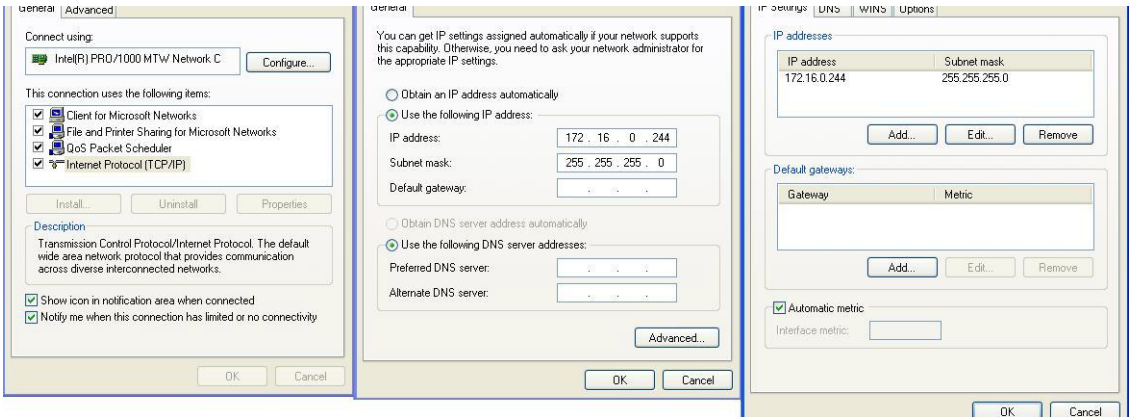

Figure 21 Changing network settings (for example, autosampler IP address 172.16.0.244)

Set internet explorer settings for 7600-AS

1. Open Internet Explorer 6 or higher.
2. Click the **Tools** menu.
3. Click **Internet Options**.
4. Click the **Connections** tab.
5. Click the **LAN Settings** button.
6. Clear the check boxes **Automatically detect settings** and **Use a proxy server for your LAN**.
7. Verify the **Bypass proxy server for local address** check box is selected.
8. Click **OK** and close these two windows

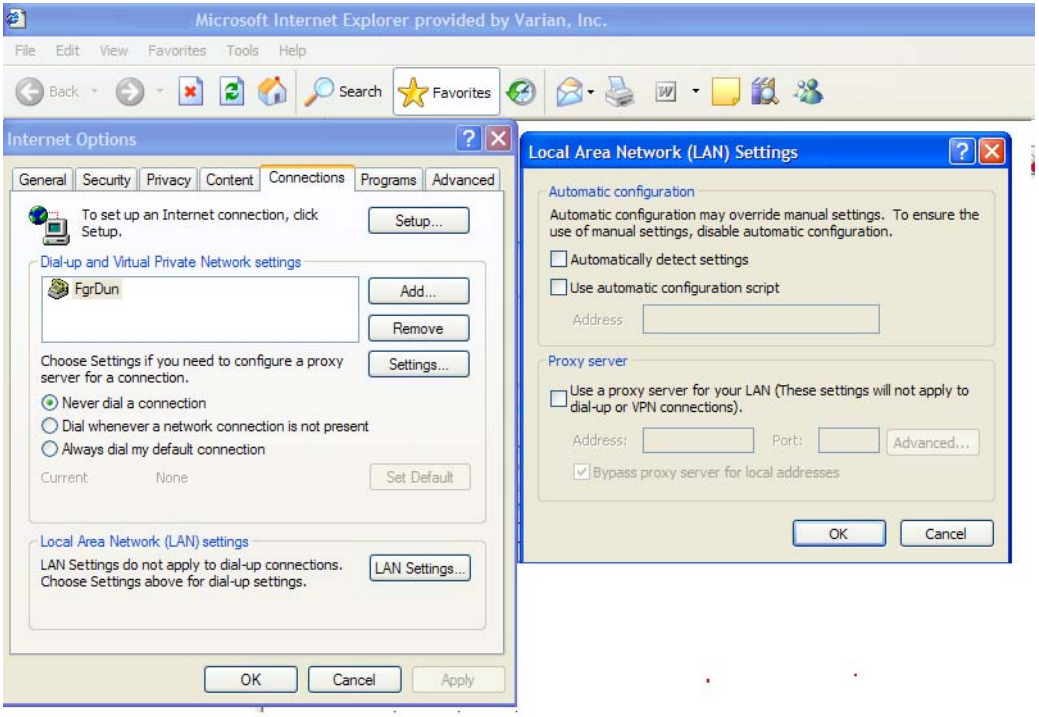

Figure 22 E LAN Settings

Start the calibrating interface

1. Press down the **Emergency Stop (E-Stop)** switch, and then twist and release the **Emergency Stop** switch. This will stop the robot and release air pressure in the robot arm gripper.
2. Connect a Windows-based computer to the Ethernet hub of the MR Console or to the 7600-AS Ethernet port on the back of the tower using an Ethernet cable.
3. Open Internet Explorer (version 6 or later; Firefox or any other Web browser will NOT work.)
4. In the URL, type:
   `http://<robot_ipaddress>/ROMDISK/web/Opr/master/masterfs.html`

   where <*robot_ip_address*> is the IP address verified in section "Set windows ethernet lan settings for 7600-AS" on page 61, typically 172.16.0.249).

   The following Web page is shown:

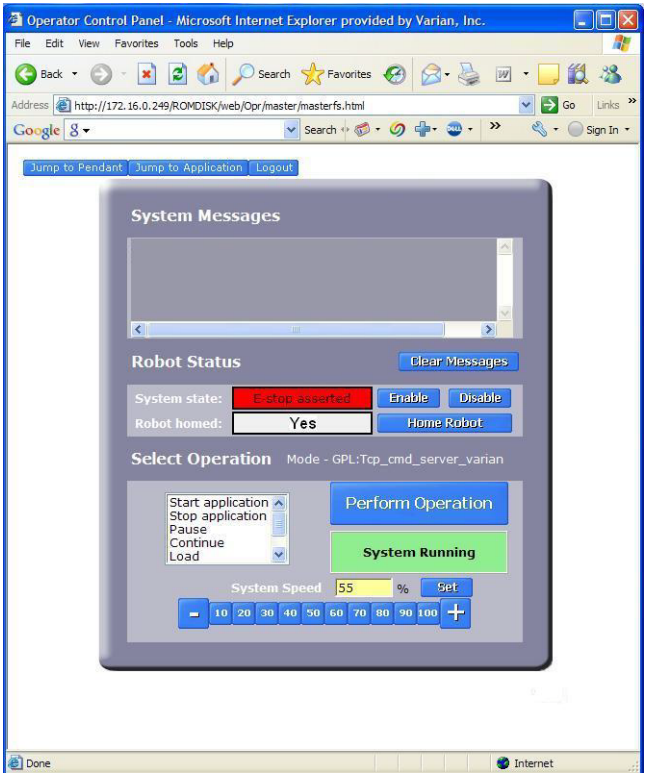

Figure 23 Operator control panel

Home robot before calibration

If the Operator **Control** panel shows **Robot Homed: Yes**, proceed to section , . If it shows **Robot Homed: No**, perform the following sequence:

1. Open the doors and keep open.
2. Release the **Emergency Stop** buttons.
3. Press the **green START** button.

CAUTION Keep hands away from robot when it is enabled.

4 Click **Enable** in the **Operator Control Panel** screen.

It will take about 10 seconds and a click noise may be heard. When finished, the screen shows the message: **System State: GPL Ready**.

5 Keep away from robot when it is enabled.

6 Click **Home Robot**.

7 Wait for it to show the message: **Robot homed: Yes**.

8 Click **Disable**.

9 Press the **Emergency stop** button on 7600-AS. Robot is now disabled.

Move the arm to the tray area

This can be done by moving the robot arm manually or using the web based virtual pendant. Then verify the robot arm is in the right-arm (righty) configuration.

To manually position the robot, rotate the robot arm at the elbow and shoulder joints, which can be rotated when the E-Stop button is pressed.

To move the Z axis:

1 Support the robot arm under the part from the elbow to the vertical column (Z axis).

2 Press and hold the brake release button located on the underside of the robot arm near the vertical column.

3 Slowly position the arm to the desired height.

4 While supporting the arm release the brake release button and wait for 2 seconds after the clicking noise occurs.

5 Now the brake is engaged and the Z axis is prevented from falling.

To position robot using the virtual web pendant:

1 Press the **E-Stop** and then release.

2 Open the doors and keep open.

3 Release the **Emergency Stop** switch.

4 Press the **green START** button.

5 Click **Jump to Pendant** in the operator control panel or enter URL:
`http://172.16.0.249/ROMDISK/web/Opr/jog/jogfs.html`

For alternate IP address use:

`http:/<robot ip address>/ROMDISK/web/Opr/jog/jogfs.html`

6 Click **Enable** and wait for **GPL Ready** to appear in **System State**. This may take 10–15 seconds.

7 Click **Home Robot** wait for **Yes** to appear in **Robot homed**. The virtual pendant shows its X, Y, and Z positions in units of mm. Joints 1 (shoulder), 2 (Z axis), and 3 (elbow) are shown in degrees.

8 Click the **World** tab.

NOTE In **World** mode, the Z axis + positive direction is up. Z axis - negative direction is down. Refer to the next figure for orientation.

CAUTION Watch the arm while moving it with the pendant to avoid damaging the system or robot arm. Jog speed is set at 10% as the default value. This can be lowered to make the robot move slower.

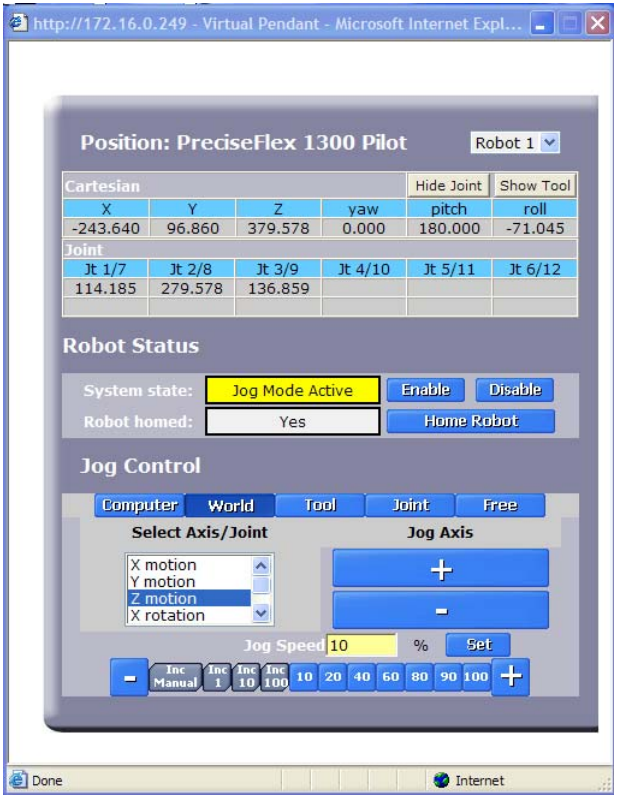

Figure 24 The Virtual Pendant

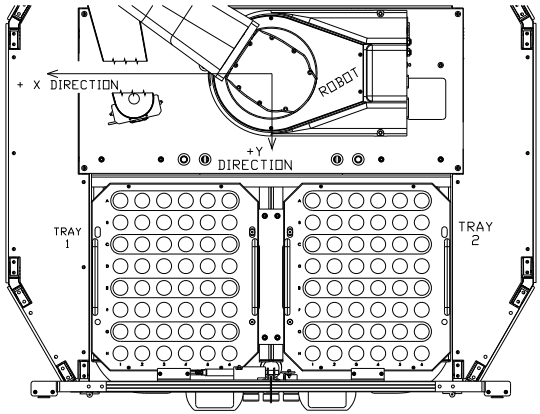

Figure 25 Robot coordinate system in **World** mode (top view)

Disable the motors of the robot arm

When you are done moving the robot with the pendant, do the following:

1 Click **Disable** and press the **E-Stop** button. The robot arm motors are now disabled.

2 Click the **Computer** tab, then close the **virtual pendant**.

NOTE Computer tab must be selected before closing the virtual pendant. This puts the robot back into the mode, which allows the MR console to control the 7600-AS.

The **virtual pendant** must be closed before continuing.

3 Open **IE** and enter in the URL to get the **Operator Control Panel**:

`http://<robot_ipaddress>/ROMDISK/web/Opr/master/masterfs.html`

where <*robot_ip_address*> is the IP address verified in "Set windows ethernet lan settings for 7600-AS" on page 61 (typically 172.16.0.249).

4 Verify the robot arm is in a right-arm (righty) configuration as shown in Figure 26.

Figure 26 Right-arm configuration

Get the setup utility menu

1 Open another **IE** window. Keep the operator **control panel screen** open.

2 Then in a URL type:

`http://<robot_ipaddress>/flash/appweb/index.asp`

where <*robot_ip_address*> is the IP address verified in section "Set windows ethernet lan settings for 7600-AS" on page 61 (typically 172.16.0.249).

This web page is shown:

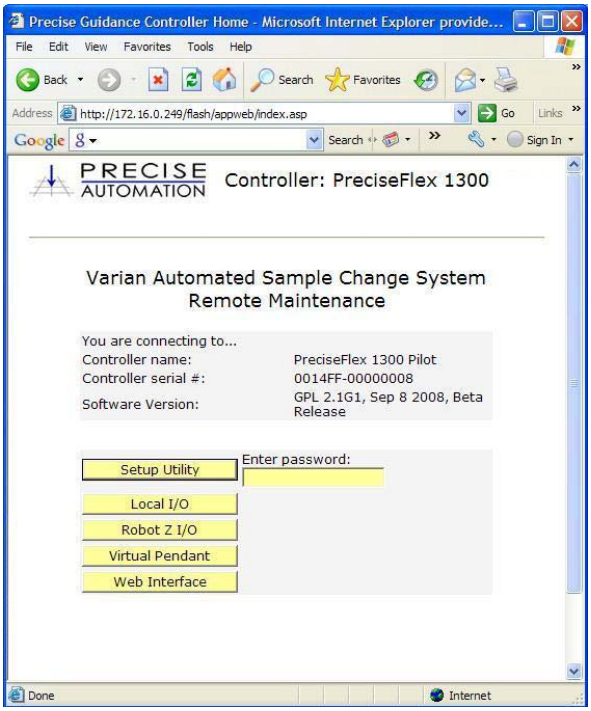

Figure 27 Application/Remote Maintenance screen

3 In the Enter password box type: `agilent 1`

The password is lower case and there are no spaces.

NOTE Do not press **ENTER** after entering the password, or you will have to re-enter it before the next step.

4 Click the **Setup Utility** button. Close this **IE** window.

5 Go back to the **operator control panel** (the other **IE** window).

The **Operator Control Panel** window now will have a mini-window called **Setup Utility Menu**.

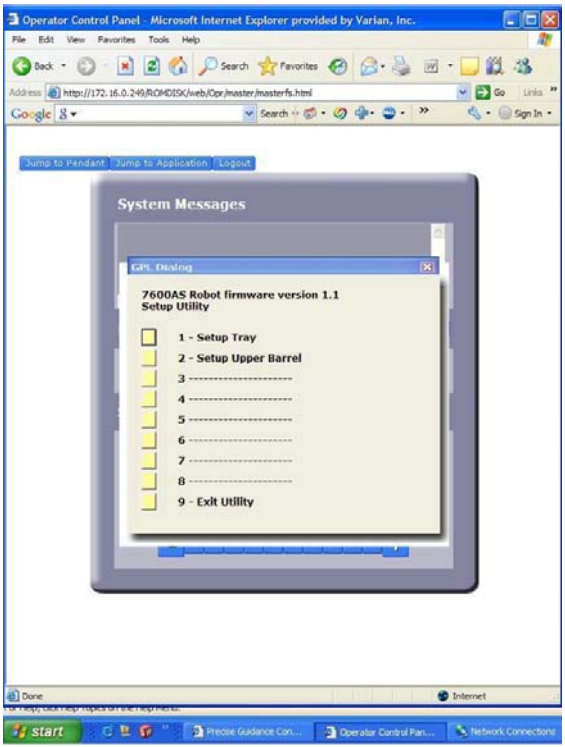

Figure 28 Maintenance screen with setup utility

6 Close the **Application/Remote Maintenance Scree**n.

7 Now the trays and the upper barrel positions can be re-taught.

Calibrate sample trays

1 Open doors.

2 Insert the tray teaching tool into the robot arm gripper.

Figure 29 Tray teaching tool in gripper

3 Select **1-Setup Tray** from the **GPL Dialog - Setup Utility** screen. A dialog window should be showing the **Tray Setup** dialog screen.

4 Click **1-Teach Tray Frame**.

Click tray **One** (Left tray) or tray **Two** (Right tray) when prompted, and then click **Next**.

5 Move the robot over the lower left location of the tray (marked **H1**).

This can be done by moving the robot manually by using the **break release** button.

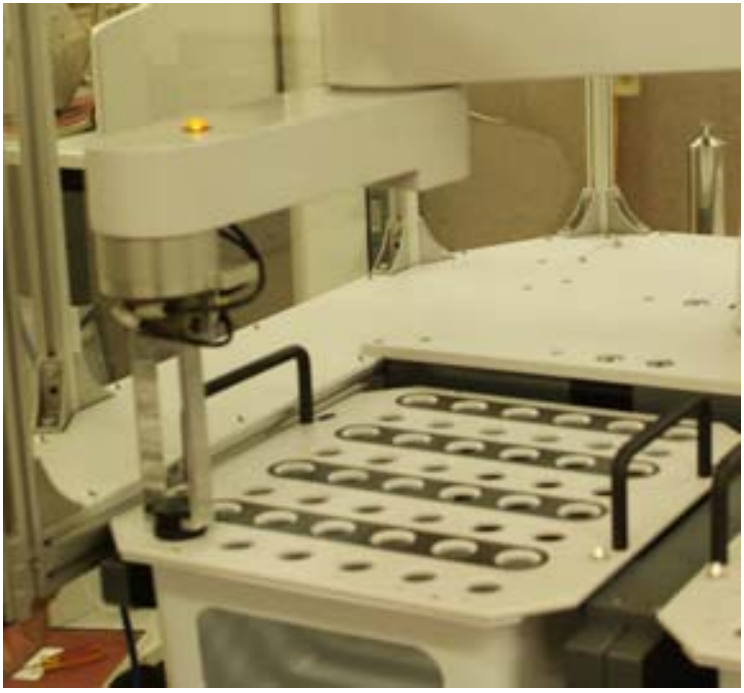

Figure 30 Sample Tray, Location **H1**

6 Make sure the sample location is empty. Then lower the robot arm until the tool is flush with the tray.

7 When the tray alignment tool is inserted in the lower left hole (marked **H1**), click **Next**.

8 Open the gripper and remove the alignment tool from the hole.

9 Move the robot to the lower right location (marked **H6**).

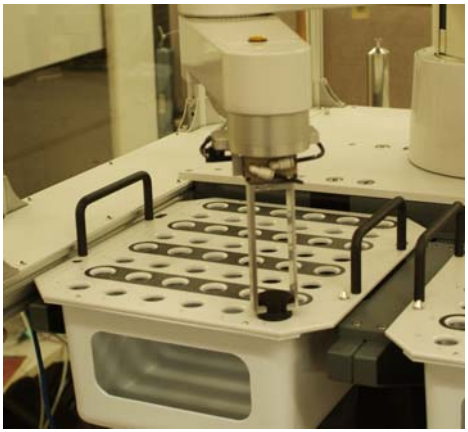

Figure 31 Sample Tray One, Location **H6**

10 Insert the alignment tool into the hole and align it to the robot arm gripper.

11 Click **Next** on the pop-up window to record the position.

12 Move the robot over the upper left tray location (marked **A1**).

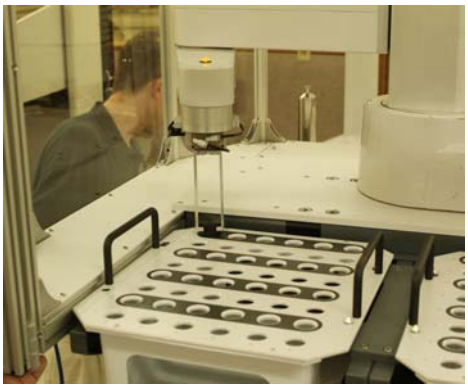

Figure 32 Sample Tray One, Location **A1**

13 Insert the alignment tool into the hole and align it to the robot arm gripper.

14 Click **Next** on the pop-up window to record the position.

15 Click **8-Save All to Flash** and then click **Yes**. When finished, click **Ok**.

16 Select **9 – Exit** to get back to the main **Setup Utility** menu.

17 Repeat all of the steps to calibrate the second tray, if tray 2 needs re-teaching.

Figure 33 Sample Tray 2, Location **H1**

Figure 34 Sample Tray 2, Location **H6**

Figure 35 Sample Tray 2, Location **A1**

Calibrate the upper barrel

1 Obtain the **upper barrel calibration** tool

.

Figure 36 Calibration tool for **upper barrel**

2 Move the robot arm close to the **upper barrel** manually or use the **virtual pendant**.

3 Verify the robot arm is in a right arm (righty) configuration as shown in Figure 37.

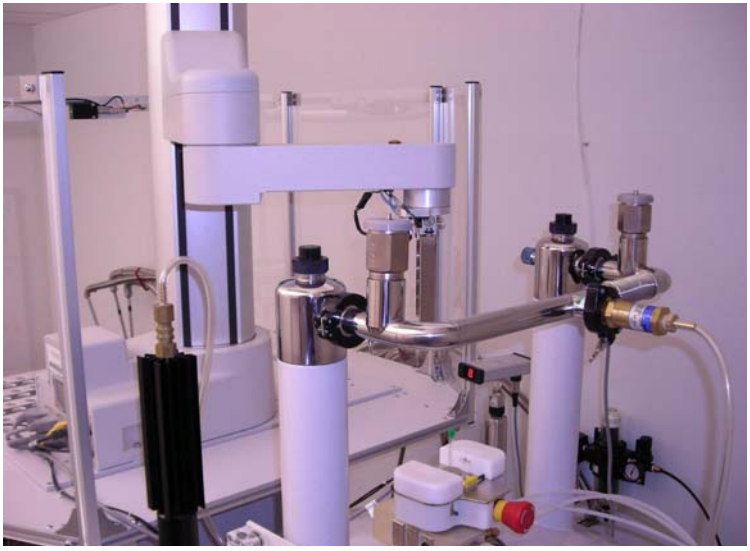

Figure 37 Robot in right-arm configuration

4 Press the **E-Stop** switch.

5 From the **Setup Utility** screen, click **2 -Setup Upper Barrel**.

6 Click **1-Teach Upper Barrel Position.**

7 Check the upper barrel gripper assembly is in the closed position and remove test tubes spinner turbines from the upper barrel gripper assembly.

8 When prompted, insert the **upper barrel calibration tool** into the **robot arm gripper**. Align the fingers with the radial groove in the tool. Press the fingers to verify the tool is centered in the fingers. Then click **Next**.

Figure 38 Insert upper barrel calibration tool

9 Move the robot over the **upper barrel gripper assembly**.

10 Align the notches in bottom of the **calibration** tool to the pins in the Upper Barrel gripper.

Figure 39 Align calibration tool to pins

11 Move the robot down to the Upper Barrel gripper so the alignment tool is aligned with the center of the hole and flush with the top plate of the gripper.

Figure 40 Teaching tool flush

12 Click **Next** to record the position.

13 Click **Yes** update the memory.

14 Click **7 -Save All to Flash.** Click **Yes** when prompted if you are sure.

15 Click **8 -Exit** to get back to the set up utility.

16 Click **9 -Exit**.

17 Go to the Virtual pendant and select the tab **World** mode.

18 Click **Z motion** in the **Select Axis/joint**.

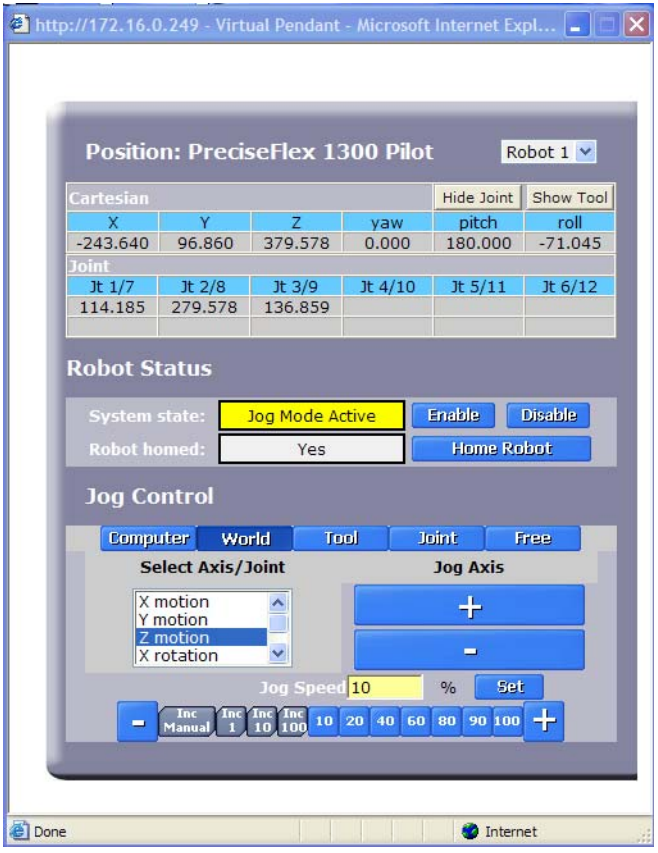

Figure 41 Virtual Pendant

19 Click **Enable**. Press the **+** button until robot arm is high enough to remove the calibration tool from the robot gripper.

20 Press the **+** button until the robot is 300 mm or higher.

21 Click **Y motion** and press the **+** button until the robot arm is inside the safety enclosure.

22 Click **Disable**. Click the **Computer** tab then close the window.

23 Verify the robot is in a right arm configuration.

24 Calibration is done.

When safe, the system can be restarted by performing the following:

1 Close the doors.

2 Release the **E-Stop** switches.

3 Press the **START** button on the side.

5
Troubleshooting and Error Codes

General Troubleshooting

Most problems are generally caused by incorrect system pressure or poor connections between the robot and host computer. Always check to ensure that the air pressure is set to a minimum of 60 psi and that the Ethernet cable is plugged in, and communicating with the host. It is also possible that the air supply hoses can become disconnected If this occurs, turn off the air supply before re-inserting the hoses Finally, check all cable connections external to the system to ensure that they are not loose.

Sample Fails to Eject (Not Captured by the Upper Barrel Module)

If the sample fails to eject or if the sample is not captured by the Upper Barrel module, there is probably either insufficient eject airflow or the upper barrel is blocked.

1 Eject airflow can vary from probe to probe and from sample to sample.

   The upper barrel module is designed to handle excessive flow using the soft, flexible rubber catch pads. These pads prevent the sample from flying out of the upper barrel. System performance is improved by using a higher flow rate.

2 Ensure that the setscrew used to secure the upper barrel module to the upper barrel does not deform the upper barrel.

   The screw should be set with minimum torque.

Sample Fails to Insert

If the sample fails to insert, the probable cause is that the sample is caught on the lip of the upper barrel. This can occur if the setscrew used to secure the upper barrel module to the upper barrel is too tight. Loosen the screw and gently re-tighten.

Sample Not Detected by Robot Gripper

If the robot gripper does not detect the sample, either the gripper sensor is not functioning properly or the turbine is not detected.

1 See “Sample Fails to Eject (Not Captured by the Upper Barrel Module)”and “Sample turbines and detection problems” for help with the turbines.

2 Check the Status light on the side of the robot gripper sensor to determine if the sensor is functioning properly. If you do not see a green light, then the sensor is not functioning properly.

Sample turbines and detection problems

The 7600-AS relies on reflective sensors to detect the MR sample turbines. These sensors are preset in the factory using representative turbines from Varian Inc. These turbines are constructed from a specially formulated epoxy-fiberglass compound for dimensional stability over temperature. The turbines are coated with a wax to enhance spinning during MR analysis. The standard process is to apply this wax to the sides of the turbine.

However, some previous versions of these turbines have wax on the top and bottom surfaces as well. The wax is absorptive, so the standard factory gain adjustments might not work as intended. If you have some of these older turbines in your lab, it is possible that the robot gripper sensor will not detect them properly. If this occurs, you can remove the wax with a small amount of acetone. The top surface will have a shiny appearance, similar to the side.

Simply use a small cloth or q-tip coated with acetone to lightly scrub the top surface of the turbine to remove the wax. Do not remove the wax from the sides of the turbine. The following figure shows a turbine with wax partially removed.

It may also be necessary to lightly sand the wax away using 600 or finer grit sand paper.

Black ink from permanent markers is absorptive. All black ink should be removed from the top surface of the turbines. Marks from other colors have not been shown to be absorptive. In general, if you need to mark your turbines for any reason, ensure that the ink will not affect the sensor.

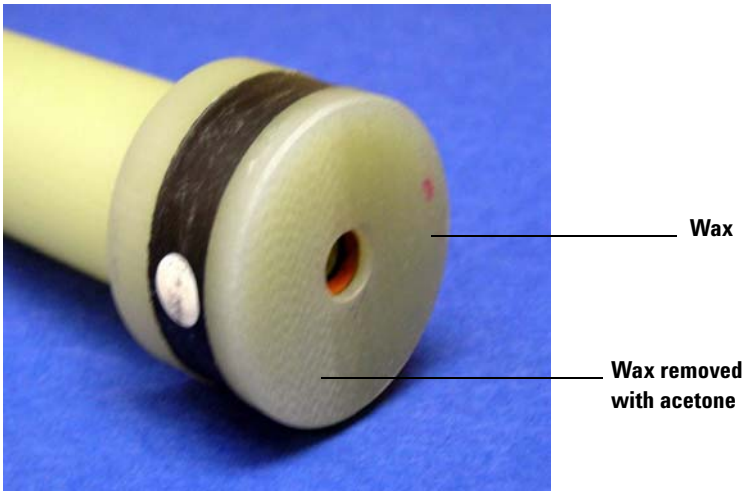

Figure 42 Turbine with wax partially removed

Power Outages

If the system is used in a region where power outages are common or a concern, the system should be used with a backup power supply. The robot gripper is designed with a spring to hold the turbine in the gripper if air pressure or power is lost. The Upper Barrel module gripper defaults to closed when no air or power is present. This prevents a turbine in the module from free-falling into the upper barrel module. The doors to the system are automatically opened when air or power is lost.

NOTE When power is restored, the robot will not automatically restart. You must press the START button on the side of the system to re-apply high power to the motors.

Agilent Technical Support can assist in sizing a proper UPS for the system if necessary.

Error Codes and Corrective Action

The following table lists all of the possible error codes for the system along with corrective action. Most of the codes should never be seen, but they are included for completeness.

The error codes are shown on the **LCD** of the 7600-AS.

Table 2 Error Codes and Corrective Actions

VnmrJ message	LCD message	Cause	Corrective action
Robot fails to move	Error code: -2004	Path of robot arm is obstructed or robot arm is mechanically stuck.	If path is obstructed remove obstruction. Call tech support if robot is stuck.
Illegal sample location number	Error code: -2005	Sample tray not detected for sample number submitted.	Verify tray 1 and 2 are present and detected.
Syntax error for command	Error code: -2006	Command syntax error.	Call Tech support.
Unknown command	Error code: -2007	Command is not recognized.	Call Tech support.
Robot gripper failed to open	Error code: -2014	Robot hand gripper air tube is not providing air to open valve. Or, gripper open- position sensor still detects flag when in open position.	Check open gripper air tube is providing air and installed to the correct valve inlet. If the air is ok, contact Tech support.
Air supply to sample changer failed	Error: Robot Air Low	Air supply at the utility panel regulator outlet is below minimum pressure.	Verify air pressure regulator on rear utility panel is set to 60-psi minimum.
No sample at tray location	Error code: -2021	Sample not detected by robot hand turbine present sensor.	If finish on turbine is waxy or reflective remove waxy finish or do not use turbine. For Agilent turbines made of G10 fiberglass clean top surface with a small amount of acetone.
Robot gripper closed unexpectedly	Error code: -2034	Loss of air to robot hand gripper inlet valves.	Check robot hand gripper tubes for leaks or loose connection at the robot hand. Reinsert air tubes into gripper if loose.

Table 2 Error Codes and Corrective Actions (continued)

Upper Barrel gripper timeout	Error code: -2046	Turbine present sensor sensed turbine at the upper barrel after an insert was attempted.	Check upper gripper. Ensure that it is cycling normally by pressing and releasing the bypass button. Ensure that the Upper Barrel Module is not over tightened. This could cause the upper barrel tube to deform causing the turbine to stick.
Open access failed	Error code: -2047	Cylinder unable to retract to open position or door interlock sensor detects lock cylinder.	Ensure that the interlock is not stuck. If it is, attempt to free it. Contact Tech support if this does not work.
Upper Barrel gripper timeout	Error code: -2046	Turbine present sensor sensed turbine at the upper barrel after an insert was attempted.	Check upper gripper. Ensure that it is cycling normally by pressing and releasing the bypass button. Ensure that the Upper Barrel Module is not over tightened. This could cause the upper barrel tube to deform causing the turbine to stick.
Open access failed	Error code: -2047	Cylinder unable to retract to open position or door interlock sensor detects lock cylinder.	Ensure that the interlock is not stuck. If it is, attempt to free it. Contact Tech support if this does not work.
Close access failed	Error code: -2048	Low or no air pressure to door interlock cylinder or cylinder blocked by locking tab.	Ensure that the air hose is properly connected. Ensure that system air is set to 60 psi. If the rod is blocked by the locking tab, Contact tech support.
Waiting for sample In Upper Barrel timed out	Error code: -2049	Upper barrel turbine present sensor did not detect turbine.	If the turbine does not reach the upper barrel sensor adjust the eject air to provide sufficient airflow for the turbine to move to a height sufficient for capture. The turbine present sensor must detect the top of the turbine.
Logic error	Error code: -2050	Robot specified error.	Record **LCD** error message and call tech support.

Table 2 Error Codes and Corrective Actions (continued)

User access timeout. Access is open	Error code: -2051	Door was open or door stayed open for more than allowed timeout of 180 s.	Close doors.
Sample detected In robot gripper	Error: Sample in Robot	Sample detected in robot hand gripper.	Remove sample from robot hand gripper.
Robot aborted with E-Stop	E-Stop pressed	One or both emergency stop was pressed.	Reset emergency stops by twisting then pull outward. Then press green START button on side.
Sample detected in upper barrel	Error code: -2054	Sample was detected in upper barrel gripper.	Remove sample from upper barrel gripper.
Robot failed to close	Error code: -2055	Robot hand gripper failed to close. Air to the close gripper valve was low/missing or open gripper valve is on. Gripper open position sensor did not detect flag on gripper finger.	Ensure that the robot hand gripper air tubes are installed into correct valve. Check robot hand gripper sensor cable is plugged in and robot open position sensor sensors flag in open position.
Sample lost from robot gripper	Error code: -2056	Sample fell from gripper. Or turbine was detected as missing due to reflective finish on turbine top surface.	Ensure that the turbine cannot fall from the gripper. Check if top surface is highly reflective. Remove reflective finish or do not use turbine.
Upper Barrel gripper failed to close	Error code: -2057	Air tubes connected incorrectly at upper barrel gripper. Upper barrel gripper arms stuck open.	Check air tube connections are automatic air tube to automatic valve. If upper gripper arm is stuck call tech support.
Upper Barrel gripper sample detection failure	Error code: -2058	UB gripper turbine present sensor did not detect turbine during an insert.	Check UB position did not change since last taught. Re-teach the UB position.
Sample still detected In robot gripper after release	Error code: -2059	Robot gripper did not open and release sample.	Call tech support.
No sample in upper barrel	Error code: -2060	Robot expected sample at upper barrel gripper.	Check if sample is present at upper barrel gripper.
Tray position is not available	Error code: -2061	Sample detected in tray position.	Remove sample from tray position. Ensure that the robot hand gripper sensor cable is plugged in.

Table 2 Error Codes and Corrective Actions (continued)

Upper Barrel gripper failed To open	Error code: -2063	No or low air pressure at barrel gripper "automatic" valve. Blockage of air tube, leak or air tube connected to wrong valve.	Check air pressure at automatic air tube.
Robot gripper fails to open and release sample	Error code:- 2064	Turbine stuck to robot hand gripper.	Call tech support.
Magnet motion fault	Error: MMD fail	Magnet motion sensor beam blocked or sensor is unplugged.	Correct magnet alignment. Ensure that the magnet motion bracket is aligned with the sensor beam. Ensure that the sensor is plugged in and connection is secured by twisting the knurled band clockwise.
No robot attached	Error code:-1009	Robot firmware did not attach robot.	Call tech support
Joint out of range	Error code: -1012	Robot joint out of range.	Put robot in right-handed (righty) configuration and away from hard stops for shoulder joint and z-axis.
Robot not homed	Error code: -1021	Robot firmware did not home.	Call tech support
Power not enabled	Error code: -1046	Robot firmware did enable robot.	Call tech support
Virtual MCP in Jog mode	Error code: -1047	Virtual pendant in jog mode.	Open virtual pendant and click **Computer** tab to put to computer mode (robot controlled by external Ethernet connection)
Motor stalled	Error code: -3105	Robot motor stalled.	Call tech support
Amplifier fault	Error code: -3110	Robot amplifier fault.	Call tech support
Brake fault	Error code: -3111	Robot brake fault.	Call tech support
Encoder battery low	Error code: -3127	Robot encoder back up battery low.	Call tech support to replace robot encoder battery.
Encoder battery down	Error code: -3128	Robot encoder battery not detected.	Call tech support

Table 2 Error Codes and Corrective Actions (continued)

Invalid encoder multi-turn data	Error code: -3129	Encoder multi turn data invalid.	Call tech support
Encoder data error	Error code: -3134	Encoder data error.	Call tech support

6
Routine Maintenance

WARNING **There are no user-serviceable parts inside.**

WARNING **SHOCK HAZARD**
Disconnect power before performaing any maintenance.

In general, the 7600-AS requires little routine maintenance. In order to maintain overall optimum performance, the following steps are recommended:

1. Clean robot gripper fingers daily using isopropyl alcohol to remove any residue.
2. Check robot gripper fingers monthly for any signs of wear or burrs that may cause the fingers to scratch the paint on the spinner turbines.
3. Check the alignment of the robot gripper fingers monthly to ensure that the sample turbines are centered in the gripper. Adjust the fingers if necessary by loosening the screws holding the gripper fingers to the actuator and then retightening.

Sample Turbines

As described in “Sample turbines and detection problems” on page 85, reflective laser sensors detect the sample turbines in the system. Consequently, the following maintenance steps are necessary:

If the sample turbines are not detected by the sensor (the system will not transfer turbines that are not detected by the sensor), then do the following:

1. Clean the top surface of the turbine with acetone using a soft cloth or Q-tip
2. Lightly scuff the top surface of the turbine using 600 grit sand paper or finer. Clean with alcohol after scuffing.
3. Do not use black ink on the top surface of the turbines. Remove the ink using a solvent or abrasively with 600 grit sandpaper.
4. During sample transfer, some residue from the gripper fingers may be transferred to the black band on the turbine. This residue may obscure the white dot on the turbine used by the spinning sensor. If you use the spinning feature, it is recommended to clean the white dot after 100 transfer cycles by wiping the dot with isopropyl alcohol using a soft cloth or Q-tip.

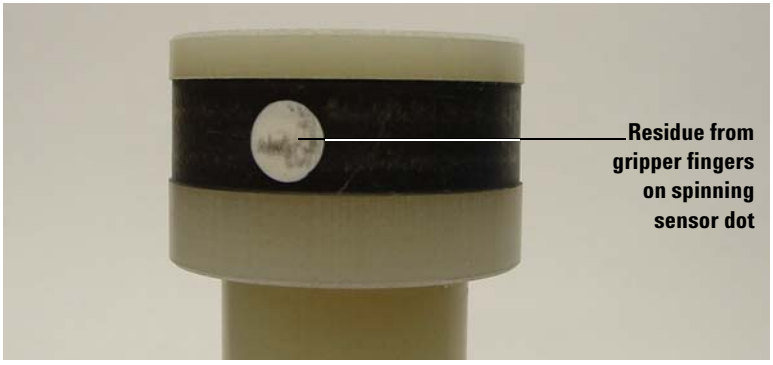

Figure 43 Sample turbine after 100 transfer cycles

Upper Barrel Module

The rubber stopping foot on the upper barrel gripper can be replaced as needed. Contact Agilent Technical Assistance for replacement parts. The p/n is 1922663, QTY 2 per gripper assembly.

Fuses

The fuses in the system interface panel for the 7600- AS are:

FOR 120V ac INSTALLATION:

Agilent p/n: 5550035400

Description: FUSE IEC SLO BLO, 5X20MM 6.3A

Mfg: Littelfuse Inc. Mfg p/n: 021506.3HXP or equivalent

FOR 240V ac INSTALLATION:

Agilent p/n: 5550037170

Description: FUSE IEC SLO BLO, 5X20MM 3.15A

Mfg: Littelfuse Inc. Mfg p/n: 02153.15HXP or equivalent

Robot

The robot used in the 7600-AS is designed to handle payloads of up to 5 kg at much higher velocities and duty cycles than are used in this application. Consequently, little if any maintenance should be required over the life of the robot.

The only maintenance that is presently known will be to change the internal encoder battery that is used to store the absolute encoder positions. The battery must be replaced if the robot is powered off for more than 25,000 hours (approximately three years) or after eight years of use.

During system startup, the **LCD** on the 7600-AS shows error code –3127 (Encoder Battery Low) when the battery needs to be replaced. The battery should be replaced within one week.

NOTE Error code –3128 (Encoder Battery Down) shows if the battery has failed. A separate procedure for replacing this battery will be published by Agilent Technical Assistance.

Trays

Keep trays clean with soap and water or alcohol and keep free of broken glass. The trays must be level in order for the system to function properly. If the trays are not level, then the robot will pick up the samples and drop them off at varying heights.

The most likely causes of a change the tray level is damage to the tray or loosening of the support screws. If the tray is not level, contact Agilent Technical Assistance for help in re-leveling the tray.

Do not use trays with loose screws. If the screws holding the tray handles or tray plate become loose, apply thread locker to the screws and re-install.

Cleaning and Glass Breakage

Keep sample trays clean by washing with soap and water or alcohol. Remove broken glass and clean before continuing operation.

Installing Robot Firmware Updates

To upgrade the robot firmware, do the following:

1. Verify 7600-AS Robot IP address.

   The default 7600-AS robot IP address: 172.16.0.249. The 7600-AS IP address can be obtained from the **/etc/hosts** file. At an Unix prompt enter: `more /etc/hosts`

   The IP address is on the line with V-Autosampler.

   Such IP addresses can be:

   172.16.0.249

   10.0.0.249

   192.168.0.249

2. Set the computer and Internet Explorer as described in "Set windows ethernet lan settings for 7600-AS" on page 61 and "Set internet explorer settings for 7600-AS" on page 63.
3. Connect to the system using an Ethernet cable (straight).
4. Press the **E-Stop** switch.
5. Turn the 7600-AS key switch to **ON**. Wait for the **LED** display to show **Agilent Technologies NMR Ready**.
6. Open Internet Explorer.
   For robot IP address 172,16,0,249 enter
   `ftp://172.16.0.249/flash/projects/`
   For alternate IP address enter `ftp://<robot IP address>/flash/projects/`
7. Open the zip file with 7600-AS firmware.
8. Open **folder projects**
9. Copy file `Tcp_cmd_server_agilent` into projects folder in the **ftp** window.

10 Wait for the file to completely transfer.

11 Close the ftp window.

12 Turn the key switch to **OFF**.

13 Wait for 30 seconds.

14 Turn the key switch to **ON**.

The system starts with the new firmware. An **LCD** message will appear in about 30 seconds. The robot does not require teaching trays or the upper barrel. The system is ready to be controlled by the **MR console**.

Agilent Technologies

Printed in USA, January 2011

91-002695-00A