

Voyager-DE™ STR Biospectrometry™ Workstation

Version 5 Series Software

Service Reference and Troubleshooting Guide

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Version 5 Series Software

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Safety and Compliance Information

This section includes:

- Instrument safety
- Safety and EMC standards
- Laser safety

Instrument Safety

In This Section

This section includes:

- Notes, Hints, Cautions, and Warnings
- Safety symbols
- Before operating this instrument
- Material Safety Data Sheets (MSDSs)
- General Warnings

Notes, Hints, Cautions, and Warnings

Notes, Hints, Cautions, and Warnings are used in this document as follows.

A Note provides important information to the operator and appears as:

NOTE: *If you are prompted to insert the boot diskette into the drive, insert it, and then press any key.*

A Hint provides helpful suggestions not essential to the use of the system and appears as:

Hint: *To avoid complicated file naming, use Save First to Pass or Save Best Only modes.*

A Caution provides information to avoid damage to the system or loss of data and appears as:

CAUTION

Do not touch the lamp. This may damage the lamp.

A Warning provides specific information essential to the safety of the operator and appears as:

WARNING

CHEMICAL HAZARD. *Wear appropriate personal protection and always observe safe laboratory practices when operating your system.*

Remarques, recommandations et avertissements

Une remarque fournit une information importante à l'opérateur et se présente ainsi:

REMARQUE: Si on vous demande d'insérer la disquette de démarrage dans le lecteur, insérez-la puis appuyez sur n'importe quelle touche.

Une recommandation fournit une information destinée à éviter des détériorations du système ou la perte de données:

RECOMMANDATION

La lampe peut être endommagée. N'y touchez pas.

Un avertissement fournit une information indispensable à la sécurité de l'opérateur et se présente ainsi:

AVERTISSEMENT

Conformez-vous toujours aux règlements du laboratoire quand vous utilisez votre système.

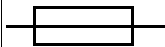
Safety Symbols

The following symbols may be displayed on the system. These symbols may also appear next to associated warnings in this document.

Electrical Symbols

The following chart is an illustrated glossary of electrical symbols that may be displayed on your instrument. Whenever such symbols appear on instruments, please observe appropriate safety procedures.

	This symbol indicates the on position of the main power switch.
	This symbol indicates the off position of the main power switch.
	This symbol indicates the on/off position of a push-push main power switch.
	This symbol indicates that a terminal may be connected to another instrument's signal ground reference. This is not a protected ground terminal.
	This symbol indicates that this is a protective grounding terminal that must be connected to earth ground before any other electrical connections are made to the instrument.
	A terminal marked with this symbol either receives or delivers alternating current or voltage.

	A terminal marked with this symbol can receive or supply an alternating and a direct current or voltage.
	This symbol appears next to the values of the fuses required by the system.
	WARNING: This symbol indicates the presence of high voltage and warns the user to proceed with caution.
	WARNING: This symbol alerts you to consult the manual for further information and to proceed with caution.

Non-electrical Symbols

The following is an illustrated glossary of non-electrical safety alert symbols that may be displayed on your instrument.

	WARNING: This symbol illustrates a heater hazard. Proceed with caution when working around these areas to avoid being burned by hot components.
	This symbol indicates that a laser is present inside the instrument.

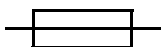
Symboles des Alertes de Sécurité

Les symboles suivants peuvent être affichés sur le système. Dans ce document, ces symboles peuvent aussi apparaître à côté des avertissements auxquels ils s'associent.

Symboles Électriques

Le tableau suivant donne la signification de tous les symboles électriques qui figurent sur les appareils. En présence de l'un de ces symboles, il est impératif de se conformer aux consignes de sécurité appropriées.

	Position <i>MARCHE</i> de l'interrupteur d'alimentation principal.
	Position <i>ARRÊT</i> de l'interrupteur d'alimentation principal.
	Positions <i>MARCHE-ARRÊT</i> de l'interrupteur d'alimentation principal à bouton poussoir.
	Borne pouvant être reliée à la mise à la terre d'un autre appareil. Ce n'est pas une borne de mise à la terre protégée.

	Borne de mise à la terre de protection devant être reliée à la terre avant d'effectuer tout autre raccordement électrique à l'appareil.
	Borne recevant ou fournissant une tension ou un courant de type alternatif.
	Borne pouvant recevoir ou fournir une tension ou un courant de types alternatif et continu.
	Ce symbole apparaît à côté des valeurs des fusibles requis par le système.
	AVERTISSEMENT: Indique la présence d'une haute tension et avertit l'utilisateur de procéder avec précaution.
	AVERTISSEMENT: Avertit l'utilisateur de la nécessité de consulter le manuel pour obtenir davantage d'informations et de procéder avec précaution.

Symboles Non Électriques

Le tableau suivant donne la signification des symboles d'alertes de sécurité non électriques qui figurent sur les appareils.

	AVERTISSEMENT: Danger associé à la présence d'un appareil de chauffage. Procéder avec précaution pour éviter de se brûler au contact de pièces ou d'éléments chauds.
	Indique que l'appareil renferme un laser.

Before Operating This Instrument

Ensure that anyone involved with the operation of the instrument is instructed in both general safety practices for laboratories and specific safety practices for the instrument. Make sure you have read and understood all related Material Safety Data Sheets.

Material Safety Data Sheets (MSDSs)

Some of the chemicals that may be used with your system are listed as hazardous by their manufacturer. When hazards exist, they are prominently displayed on the labels of all chemicals. In addition, MSDSs supplied by the chemical manufacturer provide information about:

- Physical characteristics
- Safety precautions
- Health hazards
- First-aid
- Spill clean-up
- Disposal procedures

WARNING

CHEMICAL HAZARD. Familiarize yourself with the MSDSs before using reagents or solvents.

AVERTISSEMENT

RISQUE CHIMIQUE. Il convient de se familiariser avec la MSDS (feuille de données concernant la sécurité des matériaux) avant d'utiliser des réactifs ou des solvants.

General Warnings

WARNING

FIRE HAZARD. Using a fuse of the wrong type or rating can cause a fire. Replace fuses with those of the same type and rating.

AVERTISSEMENT

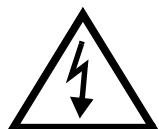
DANGER D'INCENDIE. L'usage d'un fusible de type ou de valeur nominale différents risque de provoquer un incendie. Il convient donc de remplacer les fusibles usagés par des fusibles du même type et de la même valeur nominale.

WARNING

LASER HAZARD. The laser emits ultraviolet radiation. Lasers can burn the retina and leave permanent blind spots. Do not remove instrument front or side panels or look directly into the laser beam or allow a reflection of the beam to enter your eyes. Wear proper eye protection if front or side panels are removed for service.

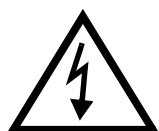
AVERTISSEMENT

DANGER LASER. Le laser émet des radiations ultraviolettes. Les lasers peuvent brûler la rétine et laisser des points aveugles permanents. Il convient de ne pas retirer le panneau avant ou les panneaux latéraux de l'appareil et de ne pas regarder directement dans le faisceau laser ou laisser une réflexion du faisceau entrer dans les yeux. Portez des protections adéquates pour les yeux si le panneau avant ou les panneaux latéraux ont été retirés afin d'effectuer l'entretien.



WARNING

ELECTRICAL SHOCK HAZARD. Severe electrical shock can result by operating the instrument without the front or side panels. Do not remove instrument front or side panels. High voltage contacts are exposed with front or side panels removed.



AVERTISSEMENT

RISQUE DE DÉCHARGE ÉLECTRIQUE. Des décharges électriques sérieuses peuvent résulter du fonctionnement de l'appareil lorsque le panneau avant et les panneaux latéraux sont retirés. Ne pas retirer le panneau avant ou les panneaux latéraux. Des contacts haute tension sont exposés lorsque les panneaux sont

WARNING

CHEMICAL HAZARD. To prevent eye injury, always wear eye protection when working with solvents.

AVERTISSEMENT

RISQUE CHIMIQUE. Pour éviter les blessures aux yeux, porter toujours des protections pour les yeux lorsque vous manipulez des solvants.

WARNING

PHYSICAL INJURY HAZARD. Use the Voyager-DE Biospectrometry Workstation only as specified in this document. Using this system in a manner not specified may result in injury or damage to the system.

AVERTISSEMENT

DANGER DE BLESSURES CORPORELLES. Veuillez suivre avec attention les indications figurant dans ce document lorsque vous utilisez la Station de Travail de Biospectrométrie Voyager. Un usage différent de la station pourrait causer un accident ou endommager le système.

WARNING

CHEMICAL HAZARD. Before handling any chemicals, refer to the Material Safety Data Sheet provided by the manufacturer, and observe all relevant precautions.

AVERTISSEMENT

RISQUE CHIMIQUE. Avant de manipuler des produits chimiques, veuillez consulter la fiche de sécurité du matériel fournie par le fabricant, et observer les mesures de précaution qui s'imposent.

Safety and EMC (Electromagnetic Compliance) Standards

US Safety Standards Safety

This instrument has been tested to and complies with standard ANSI/UL 3101-1, "Electrical Equipment for Laboratory Use; Part 1: General Requirements", 1st Edition. It is an ETL Testing Laboratories listed product.

WARNING

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

Canadian Safety and EMC Standards

Safety

This instrument has been tested to and complies with standard CSA 1010, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements". It is an ETL Testing Laboratories listed product.

Sécurité

Cet instrument a été vérifié avec la norme CSA 1010, «Spécifications de sécurité du matériel électrique utilisé pour les mesures, les contrôles et dans les laboratoires ; Partie 1 : Spécifications générales», et il est conforme à cette norme. C'est un produit homologué par les ETL Testing Laboratories.

EMC

[This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.](#)

[Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.](#)

European Safety and EMC Standards



Safety

This instrument meets European requirements for safety (EMC Directive 73/23/EEC). This instrument has been tested to and complies with standard EN61010-1 "Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use".

EMC

This instrument meets European requirements for emission and immunity (EMC Directive 98/336/EEC). This product has been evaluated to the EN55011:1992, Group 1, Class B "Radiated Emissions", and EN50082-1:1992, "Generic Immunity".

Laser Safety

Laser Classification

The Voyager-DE™ Biospectrometry™ Workstation uses a standard nitrogen laser and an optional Nd:YAG laser. Under normal operating conditions, the instrument laser is categorized as a Class I laser. Under certain conditions during servicing, when interlocks have been circumvented, the lasers fall into the following categories and can cause permanent eye damage:

- Nitrogen—Class IIIb
- Nd:YAG—Class IV

The Voyager-DE Biospectrometry Workstation complies with Title 21, U.S. Government DHEW/BRH Performance Standards, Chapter 1, Subchapter J, Section 1040, as applicable.

Laser Safety Features

The following safety features are included on the Voyager-DE Biospectrometry Workstation:

- Cabinet is designed to prevent access to collateral laser radiation exceeding the accessible emission limits in Performance Standards for Laser Products, 21 CFR 1040.10.
- Top, front, back, and side panels have interlock switches that disable the laser when panels are opened or removed.
- Safety labels for Class I standards are affixed to the unit.

Laser Safety Requirements

To ensure safe laser operation, note the following:

- The system must be installed and maintained by an Applied Biosystems Technical Representative.
- Top, front, back, and side panels must be installed during instrument operation. When front and side panels are installed, there should be no detectable radiation present. If front or side panels are removed when the laser is operational, you may be exposed to laser emissions in excess of Class 1 rating.
- Do not remove labels or disable safety interlocks.

Additional Safety Information

Refer to the user manual provided with the laser for additional information on government and industry safety regulations.

Required Customer-Provided YAG Laser Safety Measures

Before servicing a system using the YAG laser, the customer is required to provide safety precautions. The YAG accessory supplied with the Voyager-DE STR is a class I laser, which is considered not capable of producing damaging radiation levels during operation. When maintenance requires an Applied Biosystems field service engineer to defeat the interlocks protection system for the instrument, the YAG laser is classified as a class IV laser. A class IV laser poses hazards to the eye and skin not only from the direct beam but in some cases also from the diffuse reflection. These lasers can be considered a fire hazard and may also produce laser-generated air contaminants and hazardous plasma radiation.

Therefore before you can perform maintenance or service on the YAG Laser while at the customer facility, the customer must:

- Provide the appropriate Laser Warning Signs. These signs shall be conspicuously displayed in a location where they will best serve to warn any and all onlookers.
- Provide the appropriate safety glasses/goggles to their employees if they are in the area while the laser is being serviced. The safety glasses/goggles must be rated for a YAG laser with a wavelength of 355 nm.
- Provide and document laser safety training to their employees on the hazards associated with a YAG laser.
- Remove all employees from the area where maintenance to the YAG laser is being performed.

In addition, all customers must be in compliance with the ANSI standard Z136.1-1993, American National Standard for the Safe Use of Lasers.

How to Use This Guide

Purpose of This Guide

The Applied Biosystems *Voyager-DE Biospectrometry Workstation Service Reference and Troubleshooting Guide* provides the following:

- Reference information such as theory and circuit board functionality
- Troubleshooting procedures and tables
- Contact information

Audience

This guide is intended for novice and experienced Voyager workstation field service engineers, technical support, and technical trainers.

Structure of This Guide

The Applied Biosystems *Voyager-DE Biospectrometry Workstation Service Reference and Troubleshooting Guide* is divided into chapters and appendices. Each chapter page is marked with a tab and a header to help you locate information within the chapter.

The table below describes the material covered in each chapter and appendix.

Chapter	Contents
Chapter 1. System Overview	Describes the parts of the system and software.
Chapter 2. Voyager-DE STR Workstation Electronics Theory	Describes the function, theory, and specifications for each Voyager workstation circuit board. Also includes tables of connectors, switches, and test points.
Chapter 3. Before Servicing the Workstation	Provides laser safety information, procedures for venting and powering up after venting.
Chapter 4. Voyager Diagnostics Software	Introduces the Voyager 32-Bit Diagnostic Software for Windows NT® platform.
Chapter 5. Troubleshooting by Components	Includes step-by-step procedures for troubleshooting and using the Diagnostics software for selected components.
Chapter 6. Troubleshooting by Symptoms	Provides symptoms, error codes, possible causes, and corrective actions.
Appendix A. Technical Support and Training	Describes how to contact Technical Support. Also includes how to obtain technical documents and customer training.
Appendix B. Assembly Drawings	Shows the locations of many components. Provides detailed drawings of some components.
Appendix C. Electronic Drawings	Electronic interconnect diagrams and circuit board drawings
Appendix D. Isolating Components Using Direct Bus Access	Describes how to write data directly to the bus through the Diagnostics Software Direct Bus Access control page.

Related Documentation

These related documents are shipped with each Voyager-DE STR system:

- **Voyager-DE™ Biospectrometry™ Workstation User Guide**—Refer to this guide for detailed procedures and reference information on using the Voyager-DE Biospectrometry Workstation.
- **Voyager-DE™ Biospectrometry™ Workstation Getting Started Guide**—Use this guide to learn the basics of operating the system. It provides step-by-step information for running your first experiment.
- **Data Explorer™ Software User Guide**—Use this guide to learn how to use the Data Explorer software to process and analyze data.
- **GPMW General Protein/Mass Analyzer for Windows**—Use this booklet to learn how to use the GPMW software.
- **Acqiris® Digitizers User Manual**—If the system includes an Acqiris digitizer, use this document to learn about this digitizer's functions that are not described in this document or in the *Voyager-DE Biospectrometry Workstation User Guide*.
- **LeCroy®**—If the system includes a LeCroy digitizer, use this document to learn about functions that are not described in this document or in the *Voyager-DE Biospectrometry Workstation User Guide*.
- **Tektronix® TDS 520A, 524A, 540A, and 544A Digitizing Oscilloscope User Manual**—If your system includes an Tektronix oscilloscope, use this document to learn about functions not described in the *Voyager-DE Biospectrometry Workstation User Guide*.
- **Printer documentation** (depends on the printer customer purchases)—Use this documentation to set up and service the printer.
- **Microsoft® Windows NT® User Guide** and related documents—Use this guide to learn detailed information about the Microsoft Windows NT user interface.

Reference Documentation

These reference documents are shipped with each Voyager-DE STR system:

- *Varian Turbopump Instruction Manual*
- *Varian Turbocontroller Instruction Manual*
- *Varian Multigauge Controller Manual*
- *Mechanical Pump Operating Instructions*
- *LSI Nitrogen Laser Manual*
- *Omega DIO-PC-48 Manual*
- *Power I Single Output SPL Series Data Sheet*
- *GAST Compressor Operating and Maintenance Instructions*

The customer also receives the appropriate manual for the digitizer included with the system:

- *LeCroy™ Embedded Signal Analysis Products Operator's Manual LSA1000 Series and LeCroy™ Embedded Signal Analysis Products Remote Control Manual LSA1000 Series*
- *GPB Software Reference Manual + Tek Manuals*

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1 System Overview

This chapter contains the following sections:

1.1	Voyager-DE™ STR Biospectrometry™ Workstation Overview	1-2
1.2	Voyager-DE™ STR Laser Safety.....	1-4
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1.1 Voyager-DE™ STR Biospectrometry™ Workstation Overview

The Voyager-DE™ STR Biospectrometry™ Workstation ([Figure 1-1](#)) is a floor-standing MALDI-TOF mass spectrometer that includes a reflector analyzer.

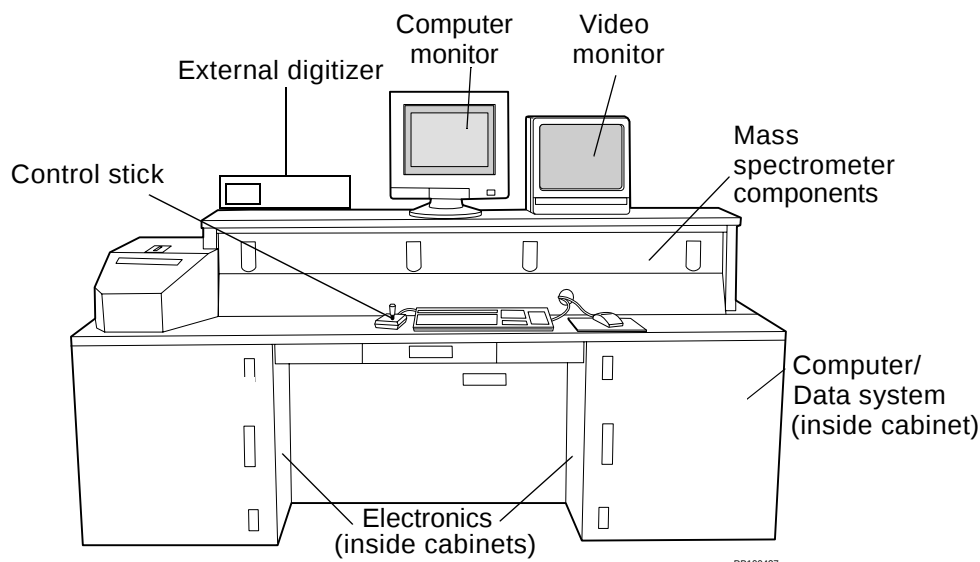


Figure 1-1 Voyager-DE STR Biospectrometry Workstation

Workstation Components

Major components of the Voyager-DE STR Biospectrometry Workstation include a:

- **Mass spectrometer**—A time-of-flight mass spectrometer, described in [Section 1.3, Voyager-DE STR Workstation Components](#). See the *Voyager User Guide* for more information. The Voyager workstation uses a 337-nm wavelength nitrogen laser.
- **Computer/Data system**—A computer that operates the Voyager workstation control software and the Voyager processing software. You control the mass spectrometer using the computer.
- **Digitizer**—An analog-to-digital converter that allows the signals from the mass spectrometer to be transferred to the computer.
- **Video monitor**—A monitor that displays a real-time video image of the sample spot on the sample plate in the mass spectrometer.
- **Control stick**—A peripheral device that allows you to control the position of the sample plate in the mass spectrometer and to start and stop acquisition. The control stick allows you to:
 - Align a sample plate in the path of the laser
 - Start and stop acquisition
 - Save data

Accessories and Options

Customers can purchase the following Voyager workstation options from Applied Biosystems:

- **CID**—Collision-induced dissociation capability to enhance fragmentation in Post-Source Decay (PSD) analysis. For more information, see the *Voyager User Guide*, Enhancing Fragmentation with CID. The hardware needed for the CID option is factory-installed. However, the workstations are plumbed for CID only when the customer orders this option.
- **Nd:YAG**—An integrated external 355-nm wavelength neodymium yttrium aluminum-garnet laser. The Nd:YAG Laser Option is compatible with any Voyager-DE STR workstation with a serial number of 4154 or later.
- **GPAW (General Protein Mass Analysis for Windows®)**—A factory-installed software package useful for protein-specific applications, theoretical digest, and post source decay (PSD) fragmentation.
- **CD-ROM Reader/Recorder**—A device for storing or backing up data on CD-ROM media.
- **Test standards kits**—Useful for Voyager workstation optimization and applications. Kits available include:
 - Sequazyme™ Peptide Mass Standards Kit
 - Sequazyme™ C-Peptide Sequencing Kit
 - Sequazyme™ Oligonucleotide Sequencing Kit

1.2 Voyager-DE™ STR Laser Safety

Laser Classification

The Voyager-DE™ Biospectrometry™ Workstation uses a standard nitrogen laser and an optional Nd:YAG laser. Under normal operating conditions, the instrument laser is categorized as a Class I laser. Under certain conditions during servicing, when interlocks have been circumvented, the lasers fall into the following categories and can cause permanent eye damage:

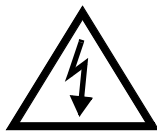
- Nitrogen—Class IIIb
- Nd:YAG—Class IV

The Voyager-DE Biospectrometry Workstation complies with Title 21, U.S. Government DHEW/BRH Performance Standards, Chapter 1, Subchapter J, Section 1040, as applicable.

Laser Safety Features

The following safety features are included on the Voyager-DE Biospectrometry Workstation:

- Cabinet is designed to prevent access to collateral laser radiation exceeding the accessible emission limits in Performance Standards for Laser Products, 21 CFR 1040.10.
- Top, front, back, and side panels have interlock switches that disable the laser when panels are opened or removed.
- Safety labels for Class I standards are affixed to the unit.



WARNING

ELECTRICAL SHOCK AND LASER HAZARD. In External Trigger mode, the nitrogen laser energy storage capacitors are charged, and the laser is ready to fire at any time. When you perform service on the laser in External Trigger mode, remove jewelry and other items that can reflect the beam into your eyes or the eyes of others. Wear laser safety goggles and protect others from exposure to the beam. Post a laser warning sign.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. When instrument covers are removed, high voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles and post a laser warning sign at the entrance to the laboratory when you remove covers for service.

WARNING

LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing service.

Laser Safety Requirements

To ensure safe laser operation, note the following:

- The system must be installed and maintained by an Applied Biosystems Technical Representative.
- Top, front, back, and side panels must be installed during instrument operation. When front and side panels are installed, there should be no detectable radiation present. If front or side panels are removed when the laser is operational, you may be exposed to laser emissions in excess of Class 1 rating.
- Do not remove labels or disable safety interlocks.

Additional Safety Information

Refer to the user manual provided with the laser for additional information on government and industry safety regulations.

Required Customer-Provided YAG Laser Safety Measures

Before servicing a system using the YAG laser, the customer is required to provide safety precautions. The YAG accessory supplied with the Voyager-DE STR is a class I laser, which is considered not capable of producing damaging radiation levels during operation. When maintenance requires an Applied Biosystems field service engineer to defeat the interlocks protection system for the instrument, the YAG laser is classified as a class IV laser. A class IV laser poses hazards to the eye and skin not only from the direct beam but in some cases also from the diffuse reflection. These lasers can be considered a fire hazard and may also produce laser-generated air contaminants and hazardous plasma radiation.

Therefore before you can perform maintenance or service on the YAG Laser while at the customer facility, the customer must:

- Provide the appropriate Laser Warning Signs. These signs shall be conspicuously displayed in a location where they will best serve to warn any and all onlookers.
- Provide the appropriate safety glasses/goggles to their employees if they are in the area while the laser is being serviced. The safety glasses/goggles must be rated for a YAG laser with a wavelength of 355 nm.
- Provide and document laser safety training to their employees on the hazards associated with a YAG laser.
- Remove all employees from the area where maintenance to the YAG laser is being performed.

In addition, all customers must be in compliance with the ANSI standard Z136.1-1993, American National Standard for the Safe Use of Lasers.

1.3 Voyager-DE STR Workstation Components

Components Overview

The components of the Voyager-DE STR Biospectrometry workstation (shown in [Figure 1-2](#) and described in the sections that follow) are the:

- Sample loading chamber
- Main source chamber
- Laser system
- Flight tube
- Mirror chamber
- Digitizer
- Computer system, video system, and Voyager software

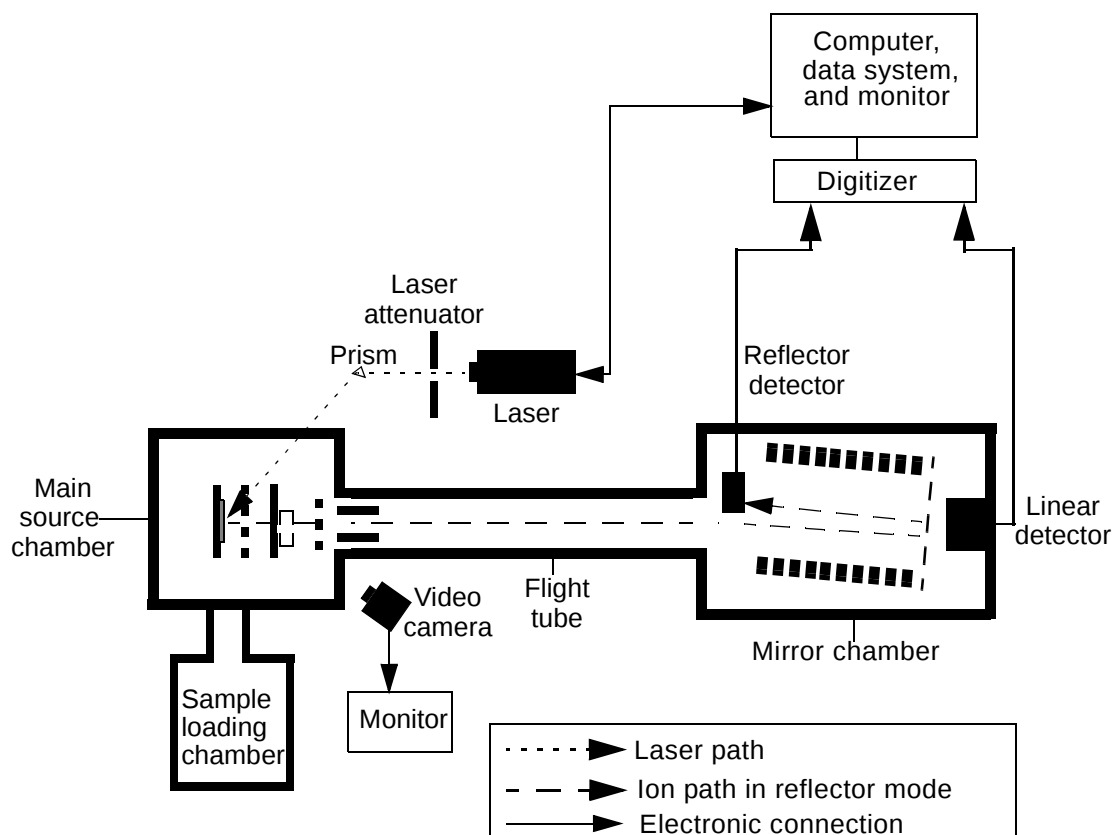


Figure 1-2 Voyager-DE STR Workstation

1.3.1 Sample Loading Chamber

Overview

The sample loading chamber ([Figure 1-3](#)) transports the sample plate between vacuum chambers at various pressures.

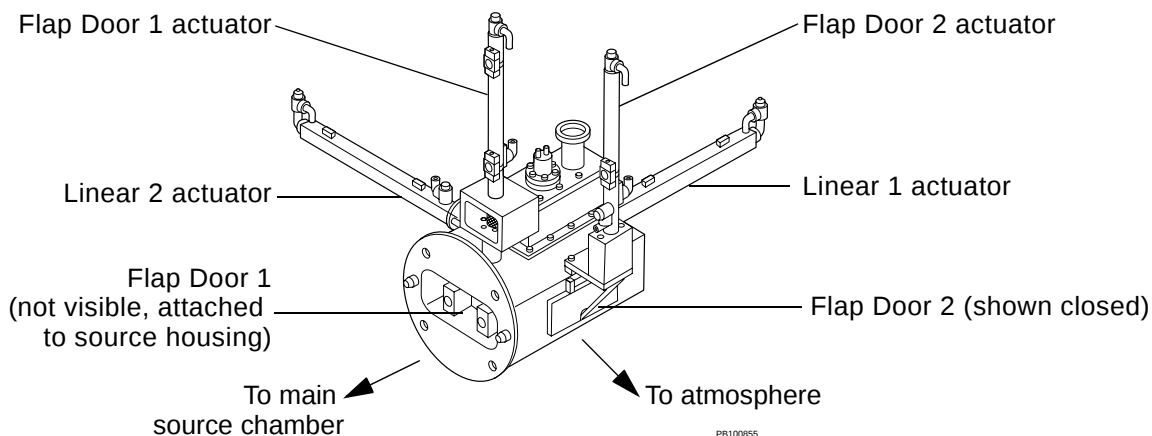


Figure 1-3 Voyager-DE STR Workstation Sample Loading Chamber

The sample loading chamber system consists of:

- **Linear actuators**—Two pneumatic actuators that control the load/eject movement of the sample plate.

Linear 1 actuator, with a magnetic grabber, transports the sample plate between the sample loading chamber and the main source chamber. It places the sample plate on and removes the sample plate from the sample stage.

Linear 2 actuator, with its sample transporter, transports the sample plate into and out of the sample loading chamber.

- **Flap door actuators**—Two pneumatic actuators that control the opening of the flap doors that maintain vacuum pressure.

Flap Door 1 separates the sample loading chamber and the main source chamber. Flap Door 1 is spring-loaded. The spring maintains positive pressure in the closed (extended) position, maintaining integrity of the seal when the compressor is off.

Flap Door 2 separates the external atmosphere and the sample loading chamber.

Pneumatic System

An on-board air compressor provides up to 60 PSI (4.13 bar) to the pneumatic system that controls the sample-handling actuators and flap-door valves. For the actuators to operate correctly, a minimum of 15 PSI (1.03 bar) is needed. The integrated compressor is activated only during plate ejection and loading.

1.3.2 Main Source Chamber

The main source chamber houses the ion source, a high-voltage region for ionizing, desorbing, and accelerating ions. [Figure 1-4](#) shows the main source chamber for systems with serial numbers 4154 and later.

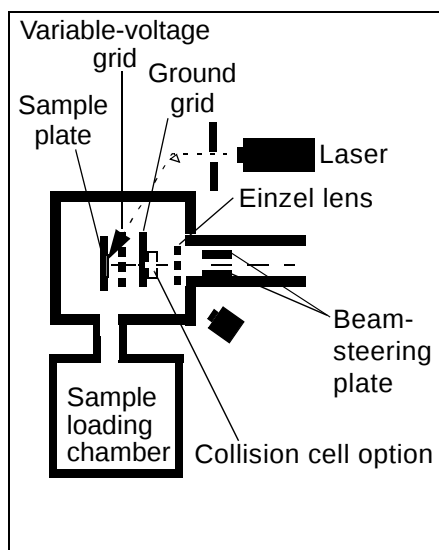


Figure 1-4 Voyager-DE STR Workstation Main Source Chamber (Top View)

[Figure 1-5](#) shows typical voltages applied for main source chamber components of Voyager-DE STR instruments with serial numbers of 4154 and later.

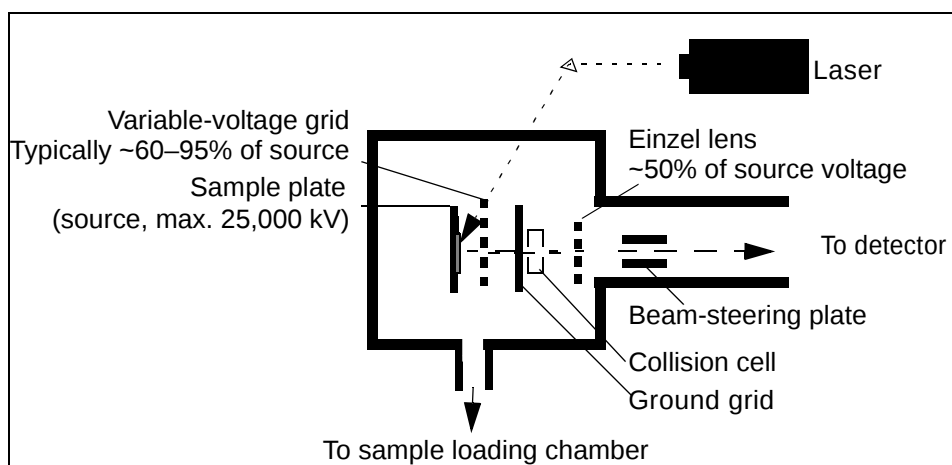


Figure 1-5 Typical Voltages of Source Chamber Components

For more information, see the following sections in the *Voyager User Guide*:

- Optimizing Acquisition Settings
- Setting Accelerating Voltage, and Optimizing Grid Voltage%

For Voyager-DE STR instruments with a serial number of 4154 and later, the main source chamber includes a:

- **Sample plate and sample stage**—The source of ions. The sample plate and sample stage ([Figure 1-3](#) on page 1-7) are supplied with voltage (source, up to 25,000 V) for acceleration of ions into the flight tube.
- **Variable-voltage grid**—A grid supplied with voltage to fine-tune ion acceleration. Typical voltage settings are shown in the following table:

Mode	Typical Variable-Voltage Grid Settings (Percent of Source Voltage)
Linear, Delayed-Extraction mode	~94 to 95%
Reflector mode	~65 to 75% (higher with PSD)

When the Delayed-Extraction switch is open in Delayed-Extraction mode, the source plate and variable-voltage grid have approximately the same voltage. When the Delayed-Extraction switch is closed, the sample source plate has higher voltage than the variable-voltage grid. This causes ions of the same polarity to accelerate out of the main source chamber.

- **Ground grid**—The ground surface for formation of the potential gradient to the variable-voltage grid. Charged ions stop accelerating at the ground grid, but retain their initial velocity. After the ground grid, the ions enter the field-free region of the analyzer.
- **Collision cell**—A chamber available as the collision-induced dissociation (CID) option for enhanced fragmentation in PSD analysis.
- **Einzel lens**—A three-element ([Figure 1-6](#)), cylindrical, electrostatic lens ([Figure 1-7](#)) designed to organize the stream of ions into a narrow, straight beam. Electrostatic lenses focus charged particles in the same way as optical lenses focus light.

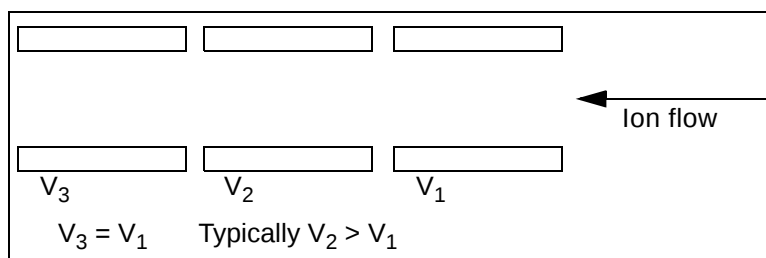


Figure 1-6 Potentials Configuration of an Einzel Lens (Cross Section)

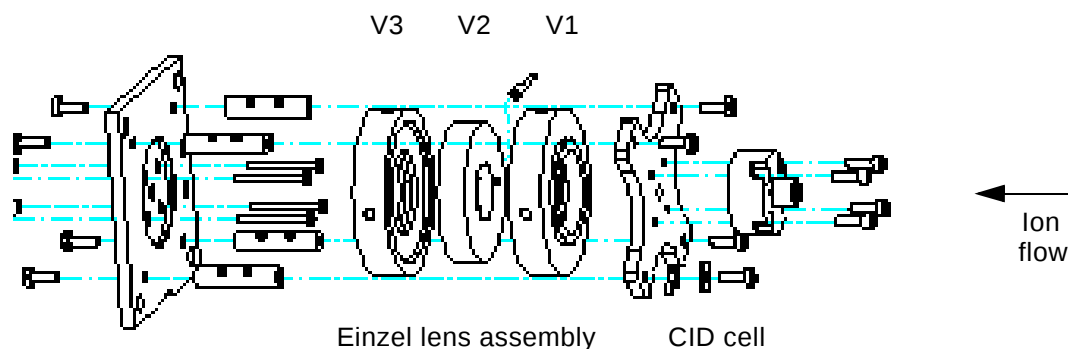


Figure 1-7 Einzel Lens Assembly Expanded View

The potentials of the first and third elements are the same. As the ion stream passes through the einzel lens, the ions are repelled toward the center of the cylinder, forming a collimated beam at a focal distance farther down the flight path. The focal length depends on the dimensions of and the potentials applied to the lens elements.

- **Beam-steering plates**—Two pairs of parallel plates that maintain the correct path (horizontal and vertical) for the beam to strike the detector. You tune the beam voltage to optimize ion focusing.

1.3.3 Laser System

Laser System Overview

The standard laser is a 337.1 nm-beam nitrogen laser. It produces 3-ns-wide pulses at up to 20 pulses per second. For Voyager workstation with serial numbers 4154 and later, an optional 355 nm wavelength Nd:YAG laser unit can be purchased.

When all the Voyager workstation covers (top, front, side, back, and rear covers) are installed, no detectable radiation is present, and the nitrogen laser is classified as a Class 1 laser. Similarly, if all Voyager workstation covers and the YAG laser unit covers are installed, the YAG laser unit is classified as a Class 1 laser.

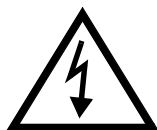
The Voyager workstation covers have interlock switches that disable the laser when the covers are removed.

When maintenance requires a field service engineer to defeat the interlock protection system, the radiation may be present in excess of Class 1 limits. Under certain conditions during servicing, when interlocks have been circumvented, the lasers can cause permanent eye damage and therefore are classified in the following categories:

- **Nitrogen laser**—Class IIIb
- **Nd:YAG laser**—Class IV

A class IV laser poses hazards to the eye and skin not only from the direct beam but, in some cases, also from diffuse reflection. These lasers can be considered fire hazards, which also may produce laser-generated air contaminants and hazardous plasma radiation. See the Safety and Compliance Information section in the front of this manual for safety precautions to be taken by the customer before performing service on the YAG Laser.

For more safety information, see the Safety and Compliance Information section in the front of this manual and the documentation provided by the laser manufacturer.



WARNING

ELECTRICAL SHOCK AND LASER HAZARD. When instrument covers are removed, high voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles and post a laser warning sign at the entrance to the laboratory when you remove covers for service.

WARNING

LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing the alignment.

Nitrogen Laser Structure

Components of the nitrogen laser module include the:

- Shutter (manual slide mechanism)
- Plasma cartridge module
- Low-voltage power supplies
- High-voltage power supplies
- Trigger transformer board

All controls for the laser unit are on the rear panel of the laser unit ([Figure 1-8](#)).

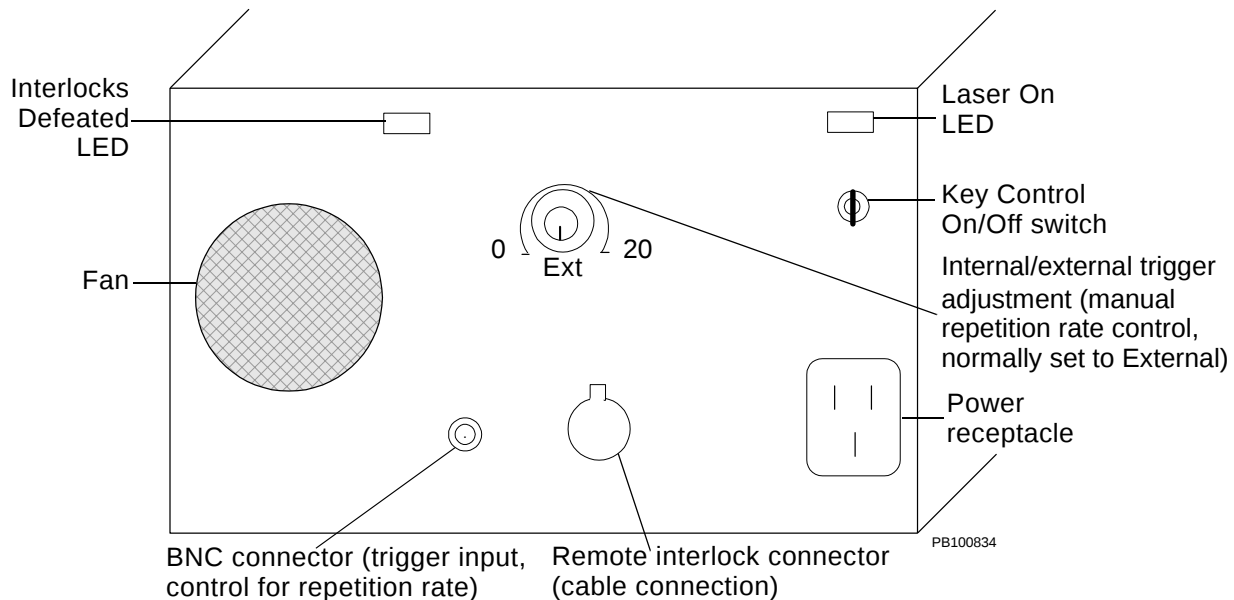


Figure 1-8 Nitrogen Laser Control Panel

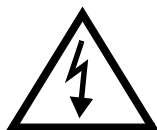
The components of the nitrogen laser control panel and their functions are as follows:

- **Interlocks Defeated LED**—When lit (green), indicates that the laser is ready to fire. When dim, the cover or remote interlock is open, and the laser will not fire.
- **Laser On (Radiation Emission) LED**—When lit (red), indicates that the laser is powered on and may emit radiation.
- **Key Control On/Off Switch**—Turns on or off the electrical power to the laser. You can remove the key only in the “Off” position. The Laser On LED indicates the state.
- **Power Receptacle**—Receives a grounded standard three-wire power plug for 110 (± 20 V) 3 A operation. The power cord must not be longer than 6 feet (1.8 m). The power cord is factory-installed.
- **Remote Interlock Connector**—Connects a cable to a remote location from which you can interrupt operation of the laser.

- **Internal/External Trigger Adjustment**—Provides control of internal manual and external trigger pulse-repetition rate.

Internal Trigger mode allows you to manually vary the pulse-repetition rate continuously from 0 to 20 pulses per second. To increase the pulse repetition rate, you turn the knob clockwise. Use Internal Trigger mode for diagnostic purposes only.

External Trigger mode is the standard mode for Voyager workstation operation. In this mode, external electrical signals are sent through the BNC trigger input connector to set the pulse-repetition rate up. To set External Trigger mode, turn the knob fully counterclockwise until you feel a switch action.



WARNING

ELECTRICAL SHOCK AND LASER HAZARD. In External Trigger mode, the nitrogen laser energy storage capacitors are charged, and the laser is ready to fire at any time. When you perform service on the laser in External Trigger mode, remove jewelry and other items that can reflect the beam into your eyes or the eyes of others. Wear laser safety goggles and protect others from exposure to the beam. Post a laser warning sign.

- **BNC Connector (Trigger Input)** —The external trigger requires a TTL signal of 1 microsecond or longer. The input of the trigger is protected with an opto-isolator that minimizes EMI/RF interferences. The cable is an RG58C/U BNC cable, 4 feet (1.2 m) or shorter.
- **Fan**—Moderates the temperature of the nitrogen laser unit.

WARNING

LASER BURN HAZARD. An overheated laser can cause severe burns if it contacts skin. DO NOT operate the laser when it cannot be cooled by its cooling fan. Always wear laser safety goggles.

Nitrogen Laser Beam Path

Figure 1-9 shows the path of the laser beam through the Voyager-DE STR mass spectrometer.

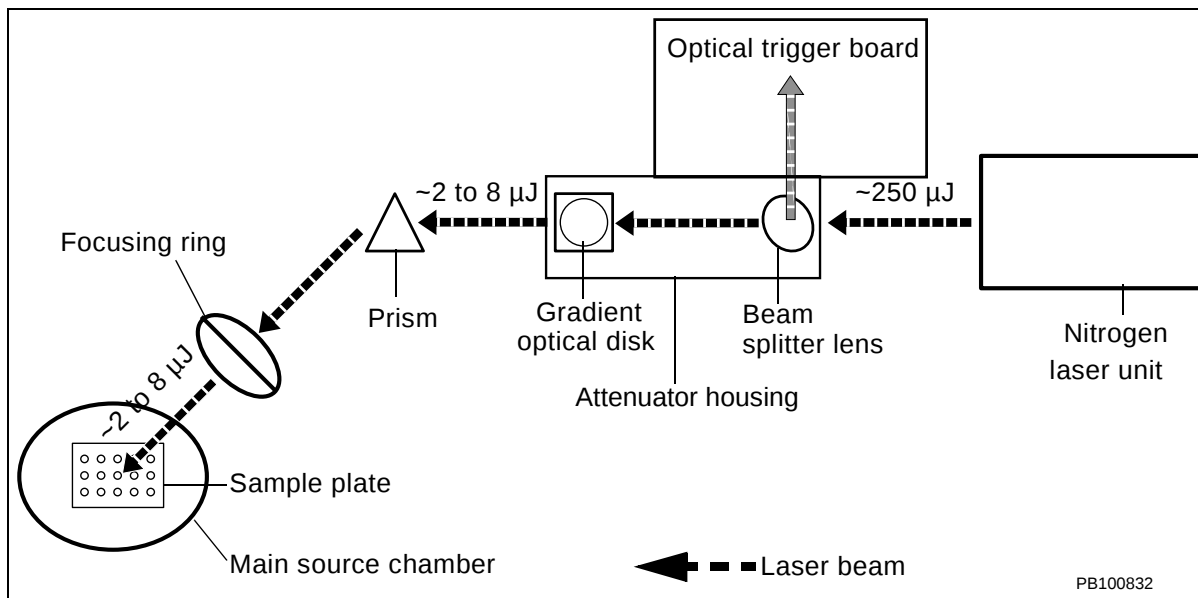


Figure 1-9 Nitrogen Laser Beam Path

When the laser is triggered, the emitted laser beam strikes the beam splitter lens. A small part of the beam is reflected to the optical trigger board, providing timing signals for the following components:

- Digitizer
- Delayed-Extraction pulse delay
- Timed Ion Selector pulse delay
- Low-Mass Gate

The remaining part of the laser beam passes through the beam splitter lens to a laser attenuator. The laser attenuator is a 0 to 3 OD (optical density) gradient optical disk that decreases or increases the intensity of the laser beam. As the laser is firing, you adjust the attenuation by pressing the Control+Page Up and Control+Page Down keys on the computer keyboard. The Control window must be active.

The attenuated beam passes through a prism, which directs the laser beam through a focusing ring (a lens assembly) and into the ion source.

The output beam exiting the nitrogen laser unit is approximately 250 μJ. Depending on the attenuation setting, approximately 2 to 8 μJ enters the main source chamber and is allowed to strike the sample.

1.3.4 Flight Tube (Drift Tube)

Overview

The flight tube is free of electromagnetic fields (no accelerating forces are present), allowing ions to drift at a velocity inversely proportional to the square root of their masses. (That is, the lighter an ion, the faster it drifts; the heavier an ion, the slower it drifts.) The flight tube is also referred to as the drift tube.

At the entrance to the flight tube of an instrument with a serial number of 4154 and later, there are an einzel lens ([Figure 1-10](#)) and four beam-steering plates. Voltage applied to the einzel lens and beam-steering plates focuses the beam and directs the ions to the detector.

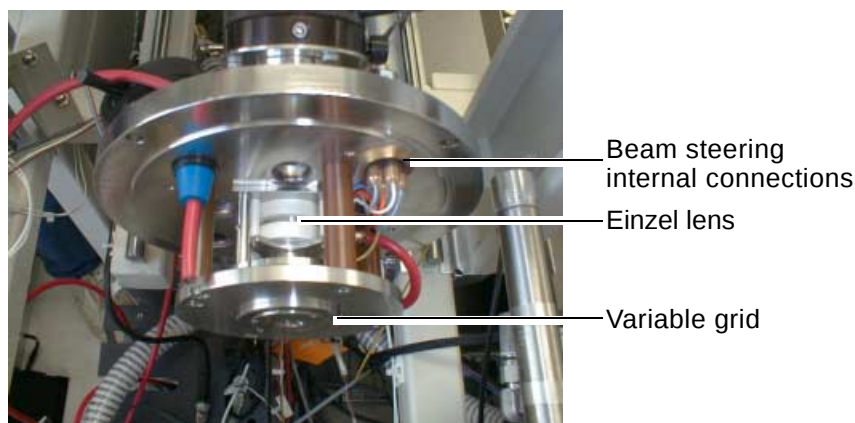


Figure 1-10 Ion Exit Flange Showing the Einzel Lens Assembly

Timed Ion Selector (TIS) for PSD and CID Applications

The flight tube contains a Timed Ion Selector (TIS). The TIS is a Bradbury-Nielson gate, a device that allows ions only of a selected mass range and associated fragments to pass through to the detector. The TIS deflects other ions.

When the TIS is turned on, voltage (± 950 V) is applied to the selector to deflect unwanted ions. At the time that corresponds to the ions of interest, voltage is turned off, and the ions of interest pass to the detector ([Figure 1-11](#) on page 1-16). After the ions pass through the selector, voltage is turned on again, to deflect ions of non-interest.

The TIS is used during post source decay (PSD) applications to selectively allow the precursor ion and associated fragments to reach the mirror chamber. The TIS deflects other ions. This feature allows one molecule (species) to be analyzed without interference from others present in the original sample.

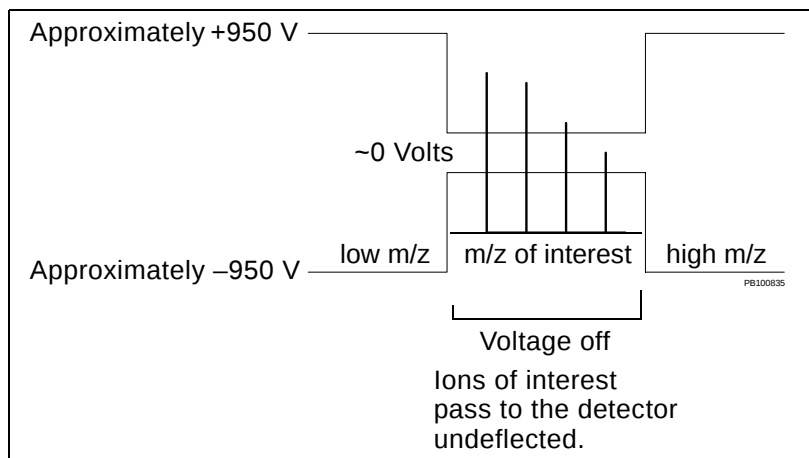


Figure 1-11 Diagram of TIS Function

The TIS is controlled by the same type of high frequency counter as the delayed extraction (DE) function. Switches and jumpers on the Pulse Generator board determine the mode of operation (DE or TIS). For information, see Section 2.4.2, Pulse Generator Board (V750063).

1.3.5 Mirror Chamber

Overview

The Voyager-DE STR workstation offers two flight-path modes of operation, Linear and Reflector. The mirror chamber houses the linear detector, reflector, and reflector detector. The detectors measure ion abundance over time and send an analog signal to the digitizer for conversion to mass spectra (see [Section 1.3.6, Digitizer](#)). The detector may consist of a single multichannel plate or dual multichannel plates.

Low-Mass Gate Function

The low-mass gate function screens out low-mass ions. Low-mass ions from the matrix are not of interest, yet they can be produced in quantities large enough to overload the detector. The Low-Mass Gate delays application of full high voltage to the detector microchannel plate until after the matrix ions pass. The microchannel plates have an inherent gain recovery time, and the delay of full high voltage preserves the gain until a region of interest. When the full high voltage to the detector is delayed, ions strike the detector but generate only a weak signal.

Linear Mode

In Linear mode, the ion beam travels approximately 2 meters down the flight tube directly to the linear detector. The shorter flight path allows greater sensitivity. This flight path is appropriate for analyzing high mass (greater than 5 to 15 kDa) and other samples, such as DNA.

The linear detector:

- Measures ion abundance over time.
- Is used in Linear mode only; it is not used in Reflector or PSD mode.
- Is the most sensitive mode. Fragments, neutral molecules, and molecular ions arrive at the detector at the same time and less sample fragmentation is observed.
- Is a hybrid high-current detector (HCD). The HCD ([Figure 1-12](#)) consists of a single microchannel plate, a fast scintillator, and a photomultiplier. Earlier instruments (serial numbers 4115, 4114, 4111 and earlier) can be upgraded with HCD.

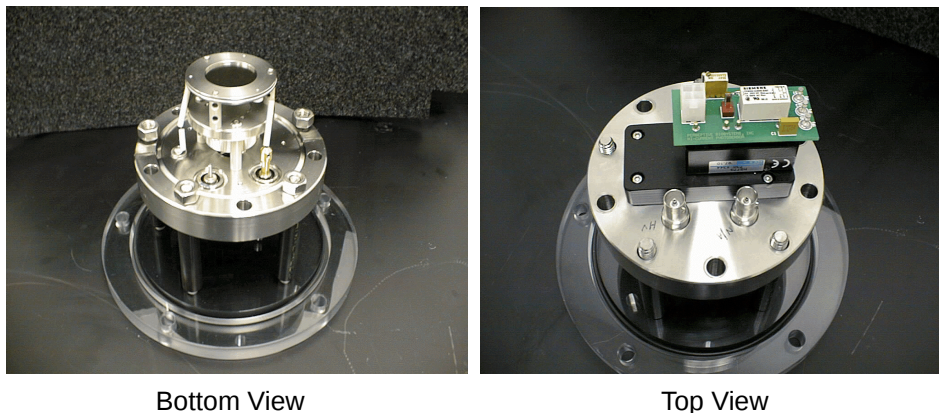


Figure 1-12 High-Current Detector

Reflector Mode

In Reflector mode, the ion beam travels approximately 2 meters down the flight tube to the reflector mirror where the beam is reflected an additional meter to the reflector detector. Reflector mode offers higher resolution and greater mass accuracy because of the longer flight path and action of the reflector. Reflector mode is commonly used for analyzing lower mass ions and in PSD analysis.

The reflector is a single-stage, gridded mirror that focuses energy and reverses the direction of the ions. Ion reflection:

- Filters out neutral molecules
- Corrects time dispersion due to initial kinetic energy distribution
- Provides greater mass accuracy and resolution

The reflector ([Figure 1-13](#) on page 1-18) is a series of parallel, equally-spaced disks with coaxial holes, separated by insulators. [Figure 1-14](#) on page 1-18 shows the time-focusing of ions of identical mass (and energy) within the mirror. Time-focusing results in improved resolution.

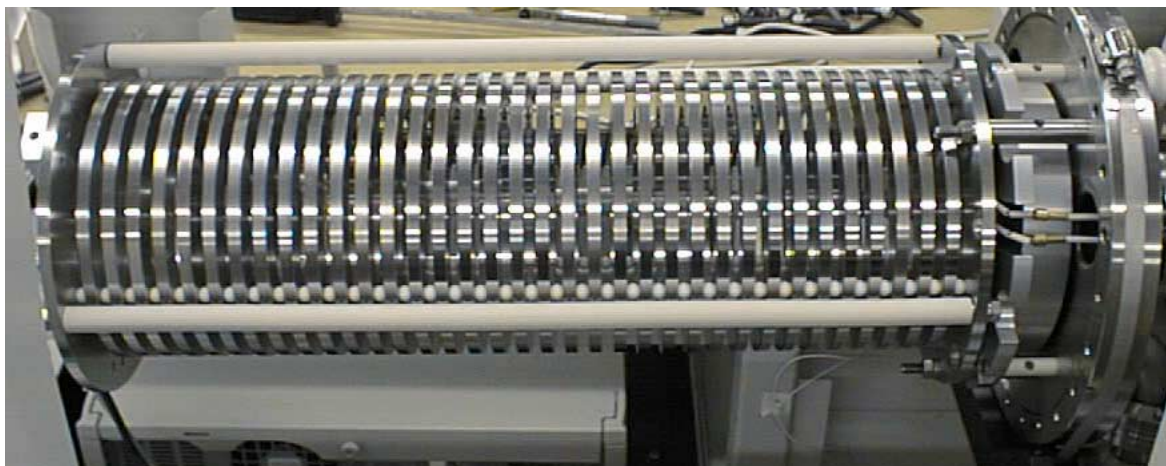


Figure 1-13 Reflector

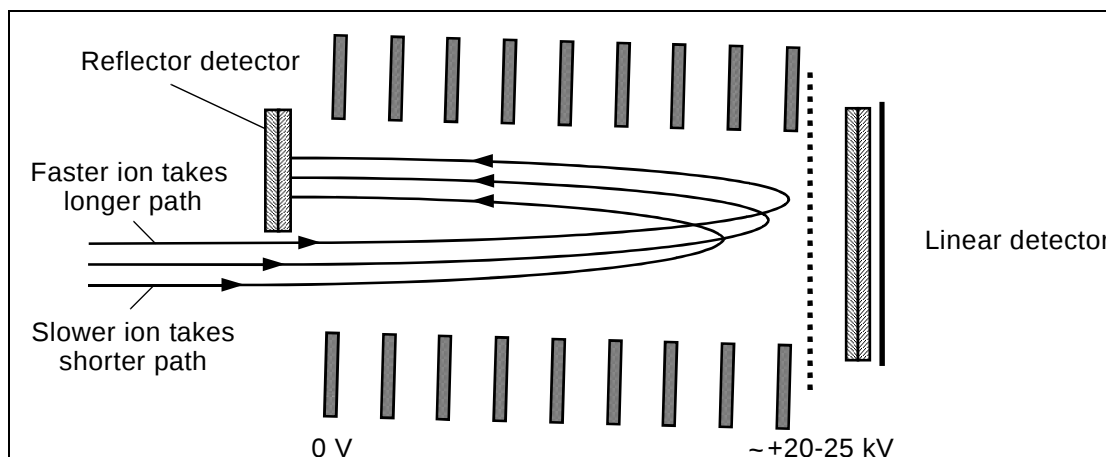


Figure 1-14 Reflector Cross Section Diagram

The disk potentials are determined by the reflector voltage and series resistor network, such that their potentials gradually increase as the ions penetrate farther into the mirror. The final disk has a potential that is slightly higher than the source (accelerating) voltage, so that all charged ions are forced to reverse direction before they reach the back of the mirror. Neutral molecules are not deflected.

The Voyager-DE STR workstation reflector is tilted down one degree off axis. The slight tilt allows the reflector detector to be placed off-axis to avoid blocking incoming ions and minimize incidental collisions. This configuration also ensures that the paths of incoming and reflected ions do not overlap.

The reflector detector:

- Measures the abundance of reflected ions over time
- Is a dual microchannel plate optimized for response time
- Has a grounded shield to protect the ions from stray electromagnetic fields
- Is positioned perpendicular to the ion beam for improved performance

1.3.6 Digitizer

The digitizer converts the analog signal from a detector to a digital signal that can be transmitted to the computer. Currently, Voyager-DE STR requires a 2 GHz digitizer (minimum) for optimal performance. Supported digitizers are listed below:

- **LeCroy™ (2 GHz)**—Provides real-time display of spectra. Requires a dedicated Ethernet board and Voyager 5.0 or later software.
- **Tektronix™ (2 GHz and 4 GHz)**—Requires a GPIB Card and IEEE cable. Works with Voyager 4.51 software and Voyager 5.0 and later software.
- **Acqiris (2 GHz)**—Provides real-time display of spectra. Requires Voyager 5.1 or later software. Installs in the computer PCI slot.

See the *Voyager User Guide* for information on connecting the digitizer.

1.3.7 Computer and Video Systems

Computer System

The Voyager-DE STR Biospectrometry Workstation (serial numbers 4154 and later) includes the following IBM®-compatible computer hardware components:

- Minimum computer configuration of Pentium III® 500 MHz CPU, with a 6.4 GB hard disk and 128 MB random access memory (RAM)
- 3.5-inch HD (high density), 1.44 MB floppy disk drive
- CD-ROM drive, integrated sound card
- Integrated 10/100 MB 3COM® Ethernet adapter card on the motherboard
- VGA compatible color monitor
- WIN95 Spacesaver Quiet Key, 104-key keyboard
- Microsoft-compatible mouse
- Control stick
- Optional laser printer

NOTE: The manufacturer-installed integrated sound card is disabled before the Voyager workstation is shipped. The sound card can interfere with the loading of drivers and the functioning of the Voyager stepper motors. Also, screen savers may interfere with Voyager system performance.

Computer monitor

To produce the spectral trace displayed on the computer monitor, m/z values are plotted against intensity (Figure 1-15). The Voyager software calculates m/z from the measured drift time. Intensity is calculated from the number of ions reaching the detector at a given time. Intensity is referred to as ion intensity (abundance) or signal intensity.

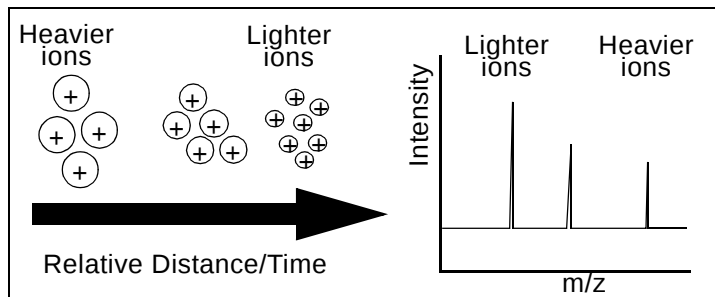


Figure 1-15 Time-of-Flight Analysis

Video System

The Voyager-DE STR video monitor displays a black and white real-time sample image (100 times magnification) of the sample spot in the sample chamber as viewed through the video camera. The camera turns on when the vacuum system is started.

1.4 Voyager-DE STR Workstation Supporting Systems

Electronics

Electronics (including circuit boards and power supplies) are described in Chapter 2, Voyager-DE STR Workstation Electronics Theory.

Power Supplies

The Voyager-DE STR workstation operates with two power supply systems: low voltage and high voltage. For more information, see Chapter 2, Voyager-DE STR Workstation Electronics Theory.

Vacuum System

The vacuum system uses multiple pumps and valves to create and maintain a sealed vacuum environment. See Section 6.1.5, Vacuum System, for more information.

Voyager Software

The Voyager-DE STR software is bidirectional and communicates with the hardware and software.

Through the control stick and mouse, the Voyager control software allows you to:

- Align a sample plate in the path of the laser
- Start and stop acquisition
- Save and transfer data to the processing software

Voyager software and computer systems have evolved from using Microsoft® Windows® 3.11 to Microsoft Windows NT® 4.0 platforms (32-bit structure).

For newer Voyager-DE STR workstations, the Dell computer is shipped from the factory with:

- Microsoft Windows NT 4.0
- Voyager software (includes Voyager version 5.0 and later Instrument Control Panel and Sequence Control Panel, and Data Explorer™ version 3.4 and later software)
- Microsoft Office 2000 (Small Office Suite)
- NT Service Pack 5
- Internet Explorer

Software Features

Voyager version 5.0 and later software includes:

- **Voyager Instrument Control Panel**—Controls the mass spectrometer for calibration and data acquisition.
- **Voyager Sequence Control Panel**—Works with the Instrument Control Panel and Data Explorer. Allows you to acquire and process data automatically. You can acquire multiple samples using the same or different instrument settings (.BIC) files.
- **Data Explorer Software**—Allows post-processing analysis of mass spectral data. Replaces the GRAMS software.
- **Instrument Hardware Controller (IHC)**—For instruments running Voyager software versions 5.0 and later, runs in the background to record errors in the NT event log. Interfaces with instrument control and data acquisition software.

In manual mode, you start the computer then manually launch the IHC from the Windows NT control panel. In automatic mode, the IHC launches when you start the computer.

- **Voyager Diagnostics Software**—Provides diagnostic system status and manual operation of Voyager-DE STR hardware. Allows you to troubleshoot or isolate electrical, mechanical, and vacuum problems or to test the system after repairing or replacing parts. See Chapter 4, Voyager Diagnostics Software for an overview of the diagnostics software. Using each control page during troubleshooting is detailed in various sections in Chapter 5, Troubleshooting by Components, and in Appendix D, Isolating Components Using Direct Bus Access.

The Voyager Diagnostics software for NT platform enables you to control the hardware components when the Instrument Hardware Controller (IHC) and Instrument Control Panel (ICP) are shut down. You can run the diagnostics software whether the instrument is operating under vacuum or at atmosphere (ATM).

2 Voyager-DE STR Workstation Electronics Theory

This chapter contains the following sections:

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2.2.1	AC Distribution Board (V750053)	2-5
2.2.2	DAC (Digital-to-Analog Converter) Board (V750025)	2-9
2.2.3	DC Distribution Board (V750034)	2-11
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2.1 Electronics Theory Overview

Electronics

Most of the electronics for the Voyager-DE STR are in the two cabinets below the mass spectrometer components ([Figure 2-1](#) and [Figure 2-2](#)).

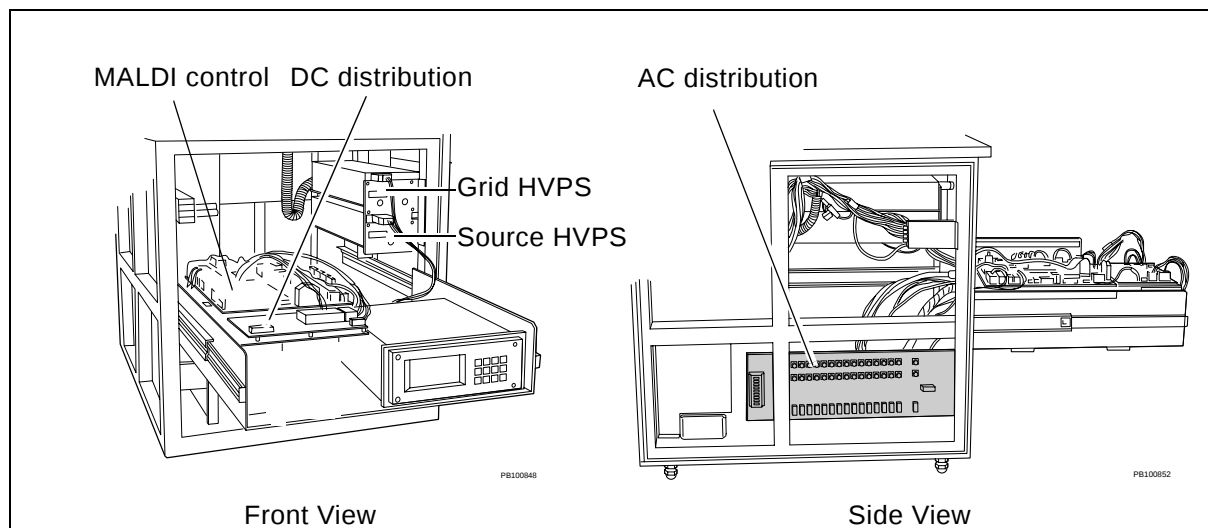


Figure 2-1 Electronics in Left Cabinet

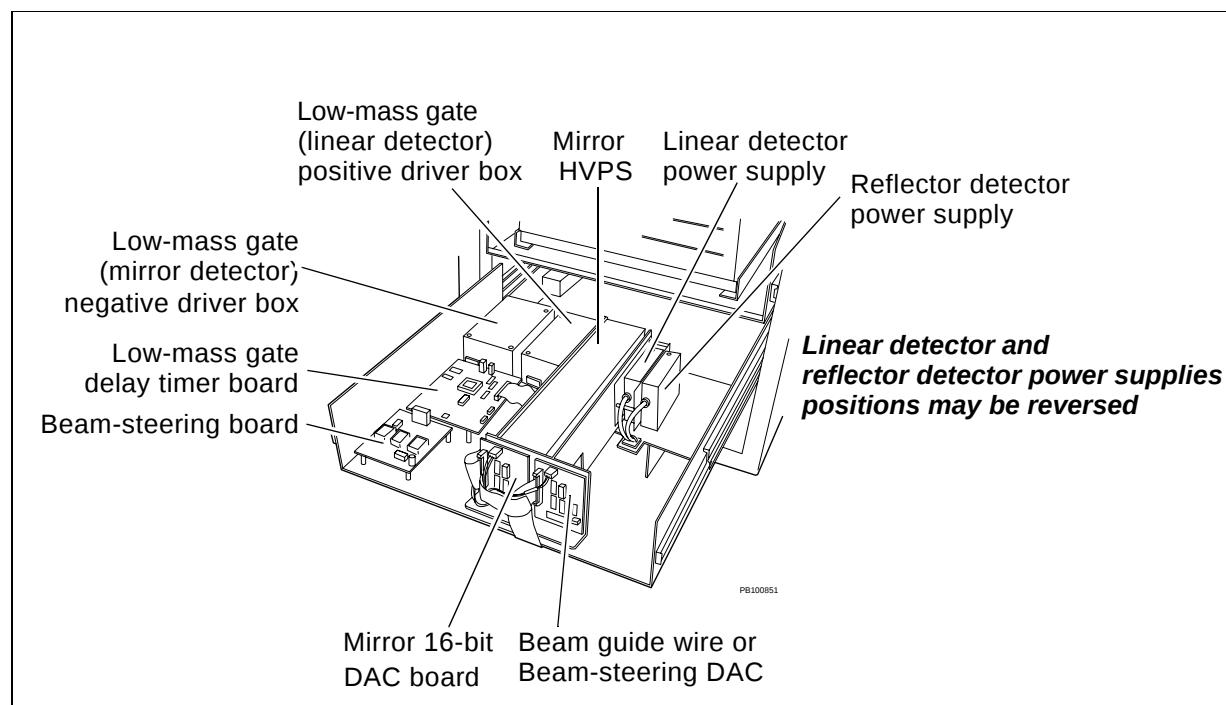


Figure 2-2 Electronics in Right Cabinet Bottom Drawer

Two circuit boards, the 48-bit I/O board and stepper motor board, are within the computer ([Figure 2-3](#)). The computer is housed on the top drawer of the right cabinet.

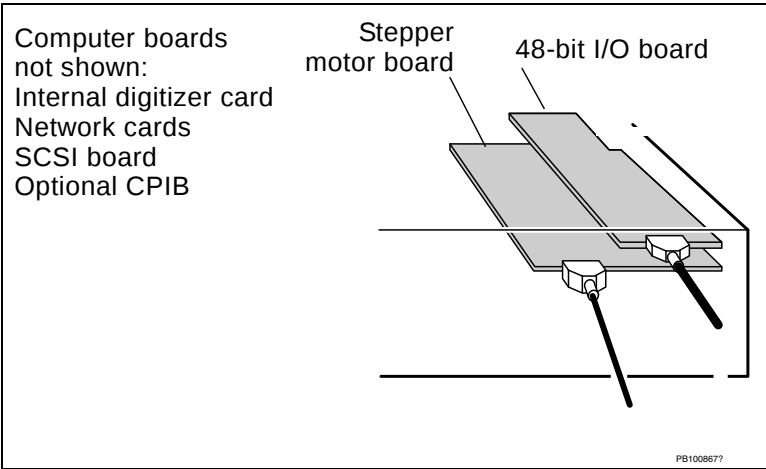


Figure 2-3 Circuit Boards in the Computer (Right Cabinet, Top Drawer, Rear View)

Circuit Board Descriptions

The circuit board descriptions in this chapter detail the:

- Logic
- Specifications
- Connections, Switches, and Test points

Interconnect Diagram

An overall cable connection diagram that shows how the electronics interact with each other is available in Appendix C, Electronic Drawings.

Additional Electronics Information

Additional information is available on the MALDI Product Support web site of the Applied Biosystems intranet. The MALDI Product Support web site path is:
<https://gene.peintranet.net/> (login to the intranet is needed), Departments, Product Support, Voyager Support.

The table below provides paths to electronic schematics, bulletins, and recently-encountered problems.

Information	Path from Voyager Support Web Site Home Page
Circuit board schematics	Service Documentation, Service Training Schematics
Service bulletins	Alerts-Bulletins-Notes, Voyager Electronics
Electronics problems recently-encountered by field service engineers	Link to the MALDI *****Knowledge database***** . At the MALDI Knowledge database, select Electronics

2.2 Electronics Common in Most Voyager-DE STR Instruments

2

Most Voyager-DE STR instruments have the following electronics:

- AC Distribution V750053
- DAC Board V750025
- DC Distribution Board V750034
- Low-Mass Gate: positive, negative, and detector filter bias
- Timed Ion Selector (TIS) Assembly V700471
- TTL Output Opto-Trigger PCA V750065

[Figure 2-4](#) shows the housing of these electronics.

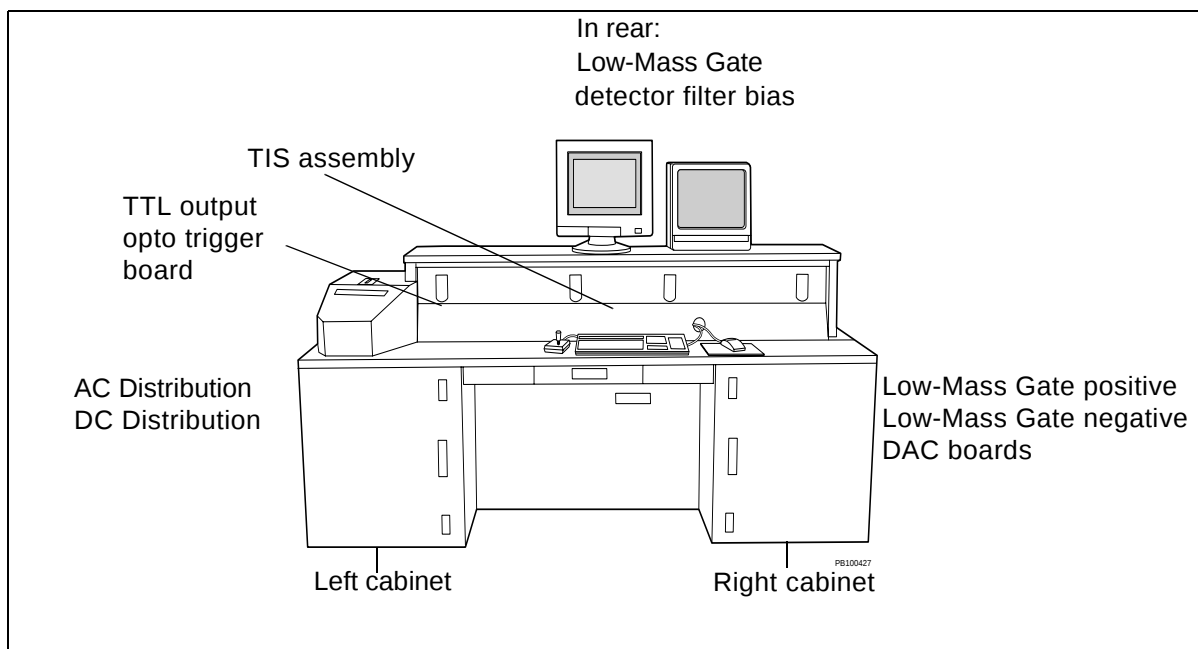


Figure 2-4 Housing of Electronics Common in Most Instruments

2.2.1 AC Distribution Board (V750053)

Overview

The AC Distribution board ([Figure 2-5](#)):

- Selects the proper auto-transformer tap
- Fuses both sides of the power line
- Provides a “Fuse OK” LED for each output
- Gates the compressor AC power with the autosampler “Load” position

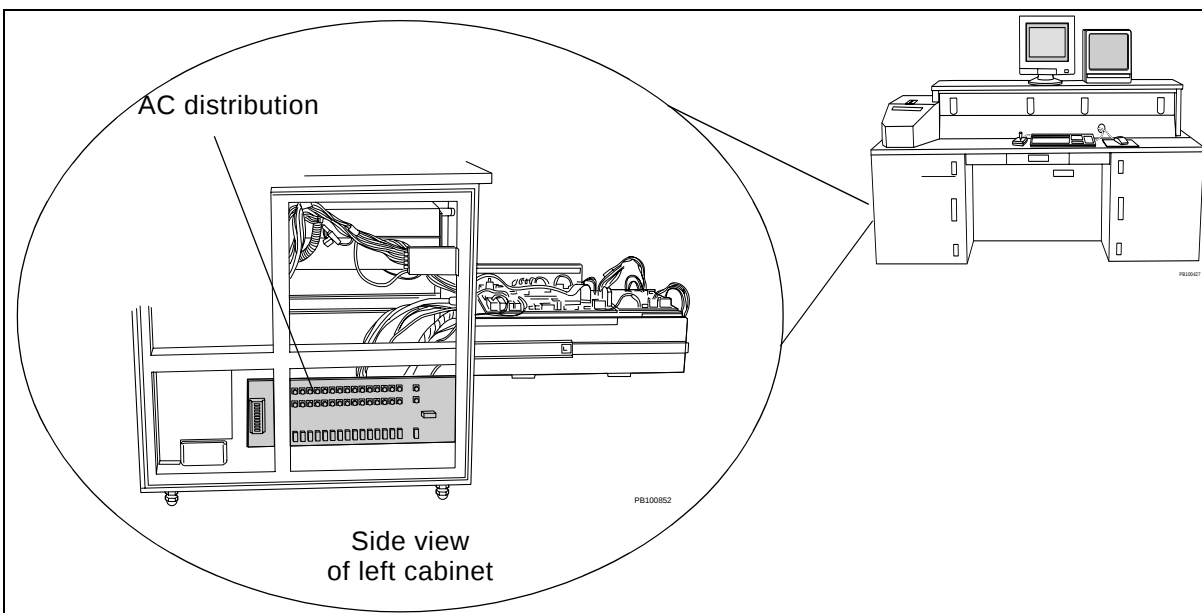


Figure 2-5 AC Distribution Board

Theory

Terminal Block, J16

This terminal block connects the auto-transformer to the PCA and allows you to connect the auto-transformer taps to select the proper line voltage. Accommodated line voltages are:

- 100 V
- 120 V
- 220 V
- 240 V

Fusing, F1A,B Through F15A,B

Both sides of the power line (neutral and hot) are fused.

LEDs

For every output connector, an LED is provided to indicate that the fuses are intact. The LED is unlit when one or both fuses are blown.

Compressor Relay and Diodes

J15, the output connector for the compressor, is gated through a relay. This relay allows only J15 power when the autosampler is in the Load Position (both the x-load and y-load microswitches are closed).

The diodes are necessary so the “ground” that is present in the Load Position is seen by both the compressor relay and control board logic.

Output Connectors

All fifteen output connectors (except J15, the compressor power) are identically powered.

Label

A label on the board provides the current revision of the board, fuse values, and the destination of each output connector.

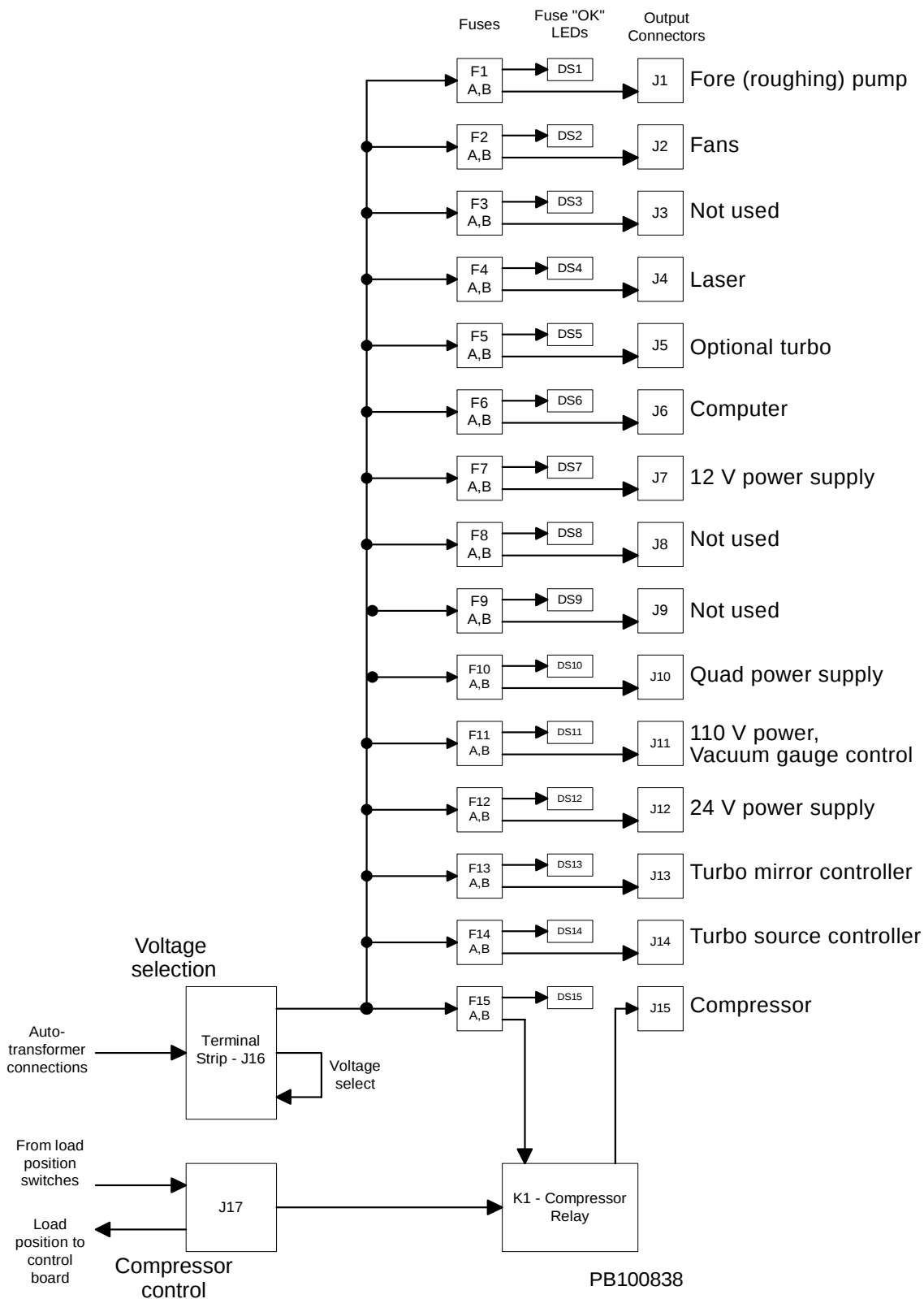


Figure 2-6 AC Distribution Board Block Diagram

Connectors and LEDs**Table 2-1 Connectors and LEDs on the AC Distribution Board**

Item	Name	Function	Type
Connectors	J1–J14	Output connectors	3-position MATE-N-LOK
	J15	Compressor power	3-position MATE-N-LOK
	J16	Terminal block	2 × 8 terminal block
	J17	“Load Position” in, out	4-position Mini-Fit™
LEDs	DS1–DS15	Fuse “OK” LEDs	LED

2.2.2 DAC (Digital-to-Analog Converter) Board (V750025)

Overview

This DAC circuit board converts a digital code from the computer to an analog output voltage. Each DAC (Digital-to-Analog Converter) board has a unique address that is set by its DIP switches.

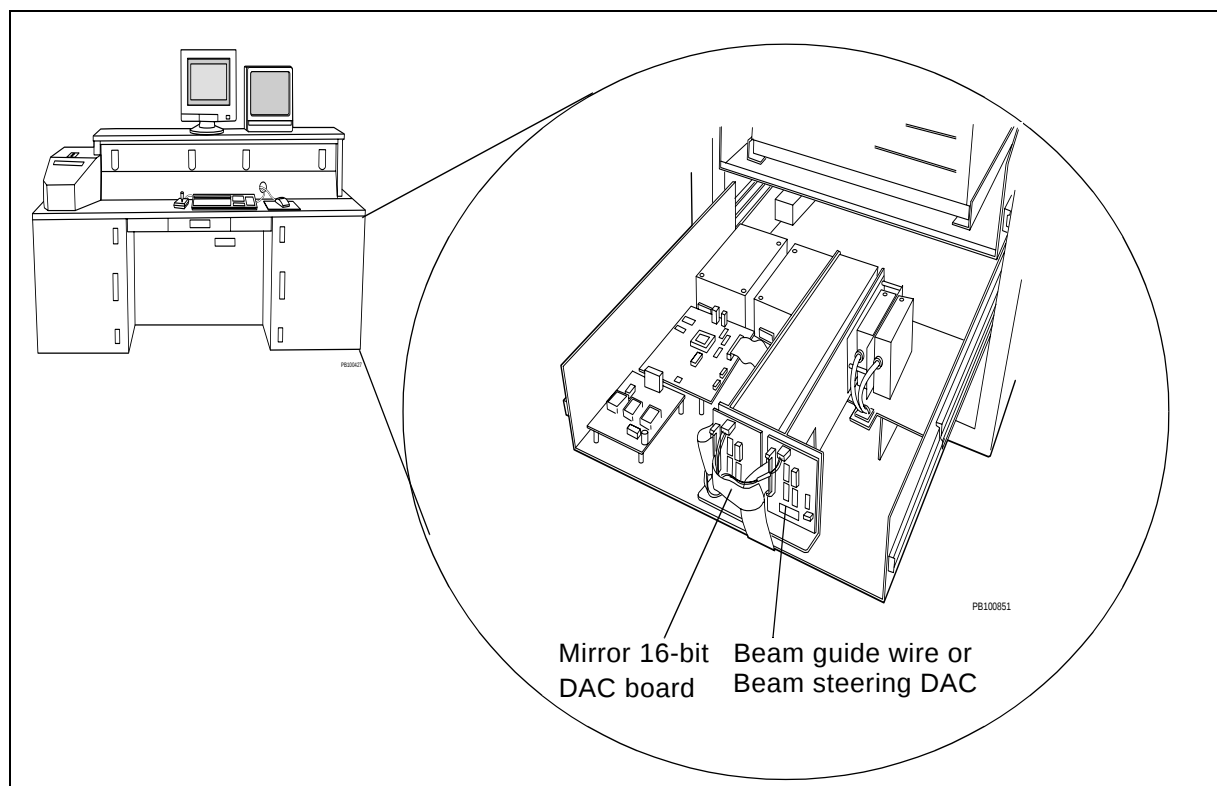


Figure 2-7 DAC Board Locations

Theory

Address

The computer address is compared to the board address by U3. If the address is correct, the Chip Select (CS*) on the DAC chip is asserted, and the chip is selected.

Data

Data is loaded on the bus sometime after the address is loaded. The 16-bit data is buffered through U2 and U5 and passed to the DAC chip.

Load and Latch

The computer sends a Load Data (LD*) and a Latch pulse that are buffered through U6B. When the load and latch are asserted, the DAC loads the data from the bus.

DAC

The DAC uses a 5 V reference generated by the U4 regulator.
Voltage out is 0 to 10 V analog.

Connectors

[Table 2-2](#) describes the connectors.

Table 2-2 Connectors on the DAC PCA Board

Item	Name	Function	Type
Connectors	J1	Bus connection	34-pin ribbon
	J2	DAC Vout	4-pin MTA
	J3	Power +5V, +15 V, –15 V	5-pin MTA
	J4	Power +5 V, +15 V, –15 V	6-pin Mini-Fit
	J5	DAC Vout	2-pin Mini-Fit

2.2.3 DC Distribution Board (V750034)

Overview

The DC Distribution board distributes the following DC voltages from the power supplies to individual circuit boards: +5 V, -5.2, +12 V, ± 15 V, and +24 V.

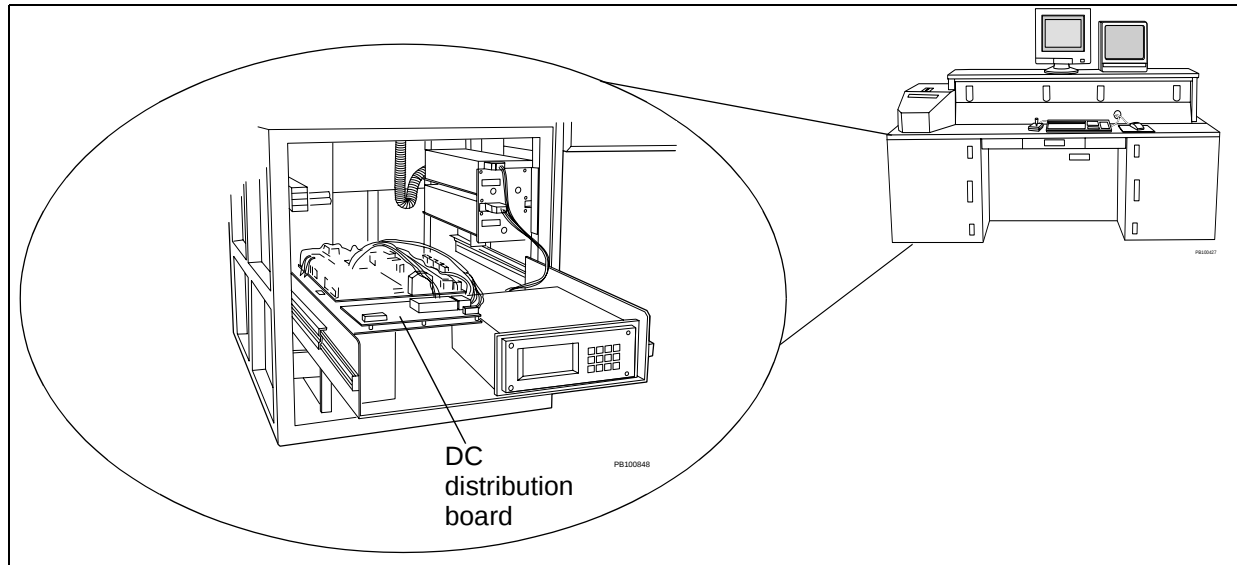


Figure 2-8 DC Distribution Board Location

Theory

Older versions of the Voyager-DE STR have three power supplies connected to this board:

- Quad supply (+5 V, -5.2 V, ± 15 V)
- 12 V supply (+12 V)
- 24 V supply (+24 V)

More recent versions have a single power supply that provides +5 V, ± 15 V, and +24 V.

Connectors, Test Points, and LEDs**Table 2-3 Connectors, Test Points, and LEDs on the DC Distribution PCA Board**

Item	Name	Function in Single Power Supply	Function in Three Power Supplies	Type
Connectors	J1	Power input +5 V, ± 15 V	Power input +5 V, ± 15 V, -5.2 V	12-pin Mini-Fit
	J2	Power input +24 V	Power input +24 V	8-pin Mini-Fit
	J3	(Not used)	Power input +12 V	6-pin Mini-Fit
	J4	DE Pulse Generator board +5 V, ± 15 V	DE Pulse Generator board +5 V, ± 15 V, -5.2 V	10-pin Mini-Fit
	J5	Control board +5 V, ± 15 V, +24 V	Spare +5 V, -5.2 V, ± 15 V, +24 V, +12 V	12-pin Mini-Fit
	J6	Spare +5 V, ± 15 V, +24 V	Spare +5 V, -5.2 V, ± 15 V, +24 V, +12 V	12-pin Mini-Fit
	J7	Timed Ion Selector board +5 V, ± 15 V	Timed Ion Selector board +5 V, ± 15 V, -5.2 V	10-pin Mini-Fit
	J8	Test points board +5 V, ± 15 V, +24 V	Test points board +5 V, -5.2 V, ± 15 V, +24 V, +12 V	12-pin Mini-Fit
	J9	Spare +5 V, ± 15 V, +24 V	Spare +5 V, -5.2 V, ± 15 V, +24 V, +12 V	12-pin Mini-Fit

(continued)

Table 2-3 Connectors, Test Points, and LEDs on the DC Distribution PCA Board (Continued)

Item	Name	Function in Single Power Supply	Function in Three Power Supplies	Type
Connectors (continued)	J10	DAC +5 V, ± 15 V	DAC +5 V, ± 15 V	10-pin Mini-Fit
	J11	DAC +5 V, ± 15 V	DAC +5 V, ± 15 V	10-pin Mini-Fit
	J12	DAC +5 V, ± 15 V	DAC +5 V, ± 15 V	10-pin Mini-Fit
	J13	DAC +5 V, ± 15 V	DAC +5 V, ± 15 V	10-pin Mini-Fit
	J14	Fan, +24 V	Fan, +24 V	2-pin Mini-Fit
	J15	Compressor relay, +24 V	Compressor relay, +24 V	2-pin Mini-Fit
	J16	Solenoid valves, +24 V	Solenoid valves, +24 V	2-pin Mini-Fit
	J17	48 Bit I/O, +5 V, +24 V	48-Bit I/O +5 V, +24 V	6-pin Mini-Fit
	J18	Timed Ion Selector box, +5 V, +24 V	Timed Ion Selector box, +5 V, +24 V	6-pin Mini-Fit
	J19	(Not used)	DVDT, +24 V	2-pin Mini-Fit
	J20	(Not used)	Opto trigger, +12 V	2-pin Mini-Fit
	J21	(Not used)	Stepper motor, +12 V	2-pin Mini-Fit
	J22	(Not used)	Flight (drift tube) PS, +12 V	2-pin Mini-Fit
	J23	Distribution board +24 V	Distribution board, +24 V	4-pin Mini-Fit
	J24	Control board, +24 V	Control board, +24 V	4-pin Mini-Fit
	J25	Lift switch	Lift switch	4-pin Mini-Fit
	J26	High-Voltage switch box +5 V, +24 V	High-Voltage switch box, +5 V, +24 V	6-pin Mini-Fit
Test Points	TP1	+5 V	+5 V	TP1
	TP2	+15 V	+15 V	TP2
	TP3	-15 V	-15 V	TP3
	TP4	(Not used)	-5.2 V	TP4
	TP5	(Not used)	+12 V	TP5
	TP6	+24 V	+24 V	TP6
	TP7	Ground	Ground	TP7

(continued)

Table 2-3 Connectors, Test Points, and LEDs on the DC Distribution PCA Board (Continued)

Item	Name	Function in Single Power Supply	Function in Three Power Supplies	Type
LEDs	LED1	–15 V indicator	–15 V indicator	LED1
	LED2	(Not used)	–5.2 V indicator	LED2
	LED3	+5 V indicator	+5 V indicator	LED3
	LED4	+15 V indicator	+15 V indicator	LED4
	LED5	+24 V indicator	+24 V indicator	LED5
	LED6	(Not used)	+12 V indicator	LED6

2.2.4 Low-Mass Gate Delay Timer Board (V750069, V750073)

Overview

The Low-Mass Gate Delay Timer (Detector Voltage Delay Timer, DVDT) PCA is used to delay application of full high voltage to the detector MCP (microchannel plate) until the matrix ions pass. The microchannel plates have an inherent gain recovery time, and the delay of full high voltage preserves the gain until a region of interest.

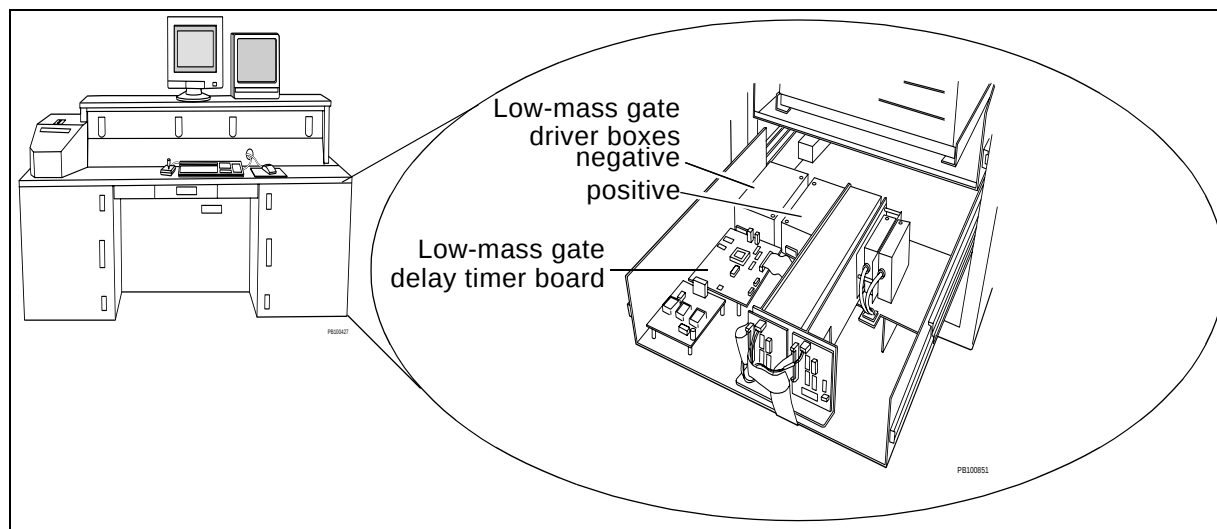


Figure 2-9 Low-Mass Gate Driver Boxes and Delay Timer Board Locations

During instrument operation, the board:

- Captures an input trigger
- Counts off a fixed delay, then counts off a pre-programmed delay corresponding to the Low-Mass Gate value
- Outputs a pulse of fixed width

The circuit has 222-ns resolution and an 8-bit maximum delay with an 8- μ s offset, which corresponds to a delay range of 8-to-65 μ s.

Theory

The low-mass gate delay timer circuit can be divided into the following blocks ([Figure 2-10](#)):

- 18 MHz clock
- Trigger buffer and sync
- Latches
- Counters (used as delays)
- Address decoder
- Integrator
- Regulators
- Drivers

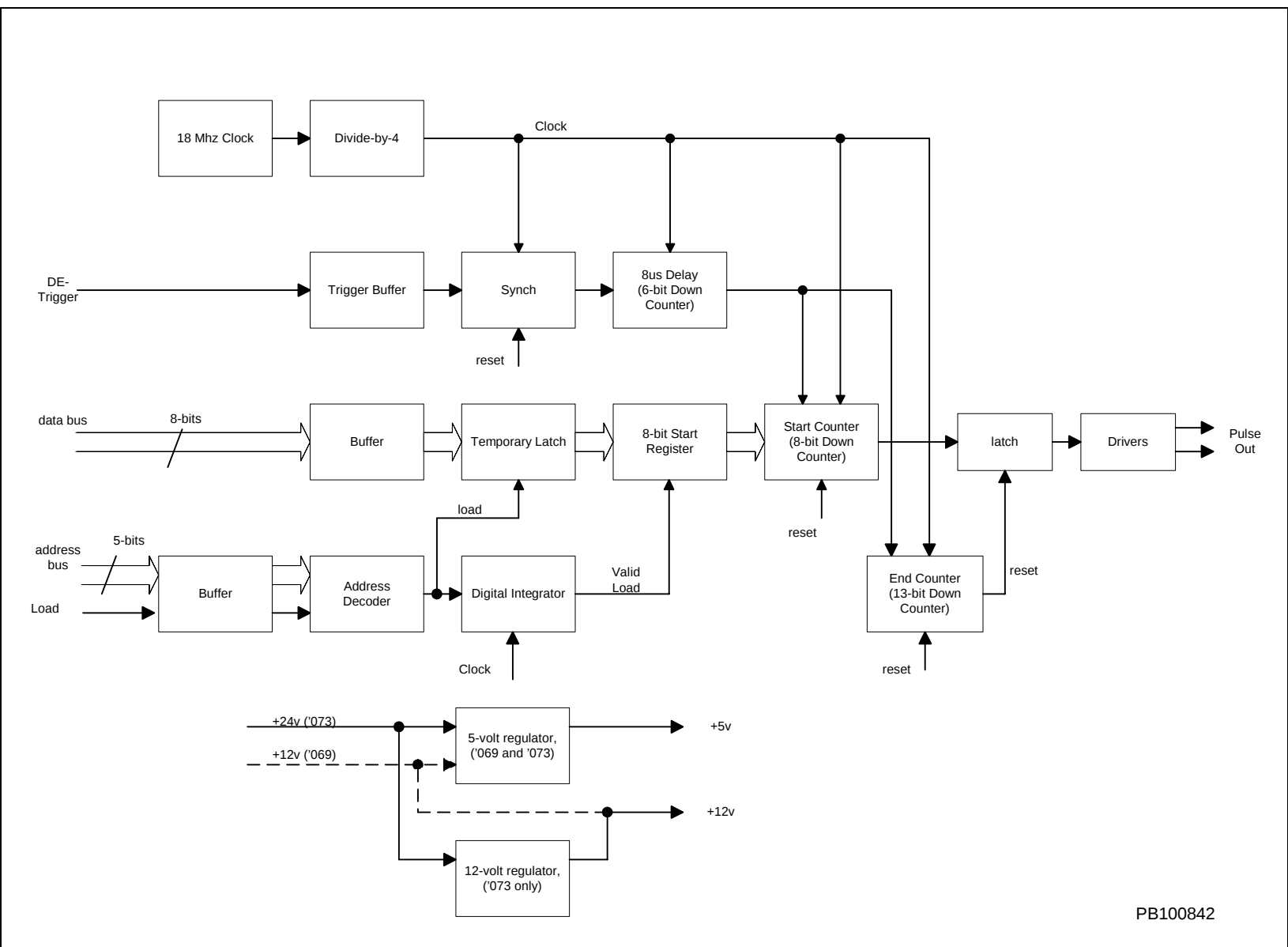


Figure 2-10 Low-Mass Gate Delay Timer Board Block Diagram

18 MHz Clock and Divide-by-Four

The clock generates a 220-ns (4.5 MHz) timbales used by the counters, synchronizer, and address decoder.

Trigger Buffer

The trigger buffer takes a 3-to-12 V asynchronous pulse event, buffers it to 5 V, synchronizes it to the 4.5 MHz clock, then presents it as an enable signal to the three counters. The pulse event is the DE Trigger.

Start Register

The start register contains the 8-bit delay loaded off the data bus.

Counters

There are three down-counters:

- **Offset delay**—Hard-coded. Offsets the delay by 8 μ s.
- **Programmable delay**—Loaded off the data bus. Provides 8-bit value corresponding to the desired delay (after the 8- μ second offset).
- **End delay**—Hard-coded. Ends the delayed pulse and resets the circuit at approximately 1 s.

When a trigger signal is received from the Trigger Buffer:

1. The first counter counts off an 8- μ s offset.
2. After the 8- μ s, the delay counter and the reset counter begin counting down.
3. When the start counter reaches zero, a latch is set high as the start of the delayed pulse.
4. When the reset counter reaches zero, the latch is reset as the end of the delayed pulse. The rest of the circuit is also reset, and counters are reloaded in preparation for the next input trigger.

Address Decoder and Digital Integrator

The address decoder decodes the address lines and the load control line. The decoded load latches the data on the address bus to a temporary latch. The width of the decoded load is then measured with a digital integrator, and the appropriate action is taken, as indicated in [Table 2-4](#).

Table 2-4 Address Decoding Criteria and Actions

If Decoded Load Is ...	The Signal Is ...	Action Taken
Longer than 1.1 μ s	Data	The data is latched through to the start register and the delay counter.
Shorter than 1.1 μ s	Noise	The load is ignored.

Drivers

The line drivers take the delayed pulse from the programmable logic circuit and provide enough current to drive the cabling to devices.

Regulators

The original release of the V750069 DVDT board is powered by +12 V provided by the system. An onboard regulator supplies +5 V for the board.

The next release, board V750073, is powered by +24 V. Two regulators are present on the board: one to provide +5 V and one to provide +12 V for the low-mass gate and flight-tube (drift-tube) power supply circuits.

Types of Signals

The input signals to the DVDT board consist of:

- A trigger event (on newer systems, a DE pulse; on older systems, a laser trigger)
- A computer-generated enable signal
- Data and address lines from the Voyager bus
- +24 V or +12 V

The output signals from the pulse generator consist of:

- A delayed pulse to the low-mass gate packs
- Power connections to the low-mass gate packs
- Power connection to the flight-tube (drift-tube) power supply

Connectors, Headers, Jumpers, Test Points, and Switches

**Table 2-5 Connectors, Headers, Jumpers, Test Points, and Switches
on the Low-Mass Gate Timer PCA**

Item	Name	Function	Type
Connectors	J1	Voyager bus	34-position dual-row header
	J2	DE pulse in/pwr out (not normally used)	3-position 0.1-inch header
	J3	+12 V power in (V750069;earlier models only)	4-position 0.1-inch header
	J4	DE pulse in (not normally used)	3-position 0.1-inch header
	J5	Delayed pulse to Linear Low-Mass Gate PCA	5-position 0.1-inch header
	J6	Delayed pulse to Reflector Low-Mass Gate PCA	5-position 0.1-inch header
	J7	Enable in from control board	4-position 0.1-inch header
	J8	DE pulse in	BNC
	J9	Flight-tube (drift-tube) power out	2-position Mini-Fit
	J10	+24 V power in (V750073;later models only)	4-position Mini-Fit
	J11	Programming header	10-position dual-row header

(continued)

**Table 2-5 Connectors, Headers, Jumpers, Test Points, and Switches
on the Low-Mass Gate Timer PCA (Continued)**

Item	Name	Function	Type
Switches	S1	Reset	Push button
	S2	First 5 dips determine address Sixth dip not connected Seventh dip selects XL Eighth dip ties enable to Oscillator enable 3-Bit Addressing Defaults: S2-1 is on S2-2 is off S2-3 to 5 are on S2-6 to 8 are off 5-Bit Addressing Defaults: S2-1 is on S2-2 is off S2-3 is on S2-4 to 5 are off S2-6 to 8 are off	8-position DIP
Test Points	TP1	Pulse in	NA
	TP2	Pulse out 1	NA
	TP3	Pulse out 2	NA
	TP4	+12 V	NA
	TP5	+5 V	NA
	TP6	Comparator out	NA
	TP7	18 MHz clock	NA
Diodes	D1	Pulse in	NA
	D2	Pulse out	NA
	D3	Low-Mass Gate on	NA
	D4	+5 V	NA
	D5	+12 V	NA

2.2.5 Low-Mass Gate Driver Boxes (V700635, V700643) and Detector Filter Bias (V750032)

Overview

Low-mass ions from the matrix usually are not of interest, yet they can be produced in such large quantities that they may overload the detector. The Low-Mass Gate (LMG) is used to delay applying full high voltage to the detector microchannel plate until the matrix ions pass. The microchannel plates have an inherent gain recovery time, and the delay of full voltage preserves the gain until a region of interest. During the period the full voltage to the detector is delayed, ions strike the detector but only a weak signal is generated.

There are two versions of the LMG. [Figure 2-10](#) and [Figure 2-11](#) show the locations of the circuit appropriate boards. The two versions are:

- **Positive Pulse PCA**—Mounted in a box that has two MHV (Medium High Voltage) connectors ([Figure 2-13](#)). This PCA controls a single plate MCP (microchannel plate) detector associated with the High Current Detector.
- **Negative Pulse PCA**—Mounted in a box that has three MHV (Medium High Voltage) connectors ([Figure 2-14](#)). This PCA controls a dual MCP (chevron) detector and is associated with the Detector Filter Bias (DFB) PCA.

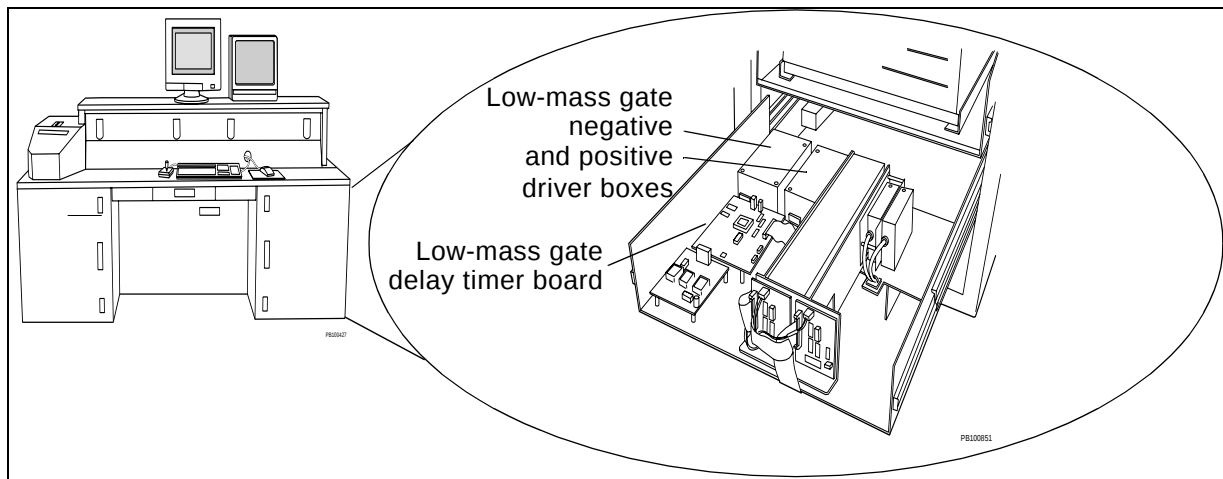


Figure 2-11 Low-Mass Gate Driver Boxes and Delay Timer Board Locations

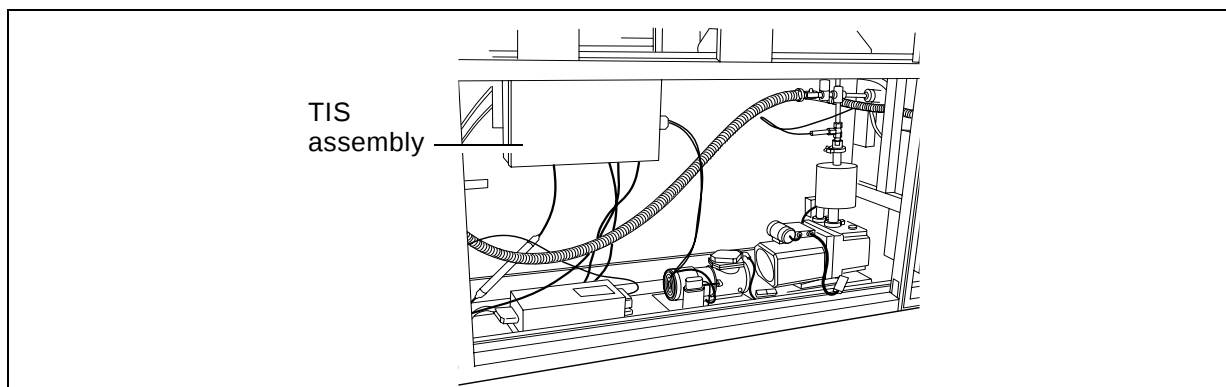
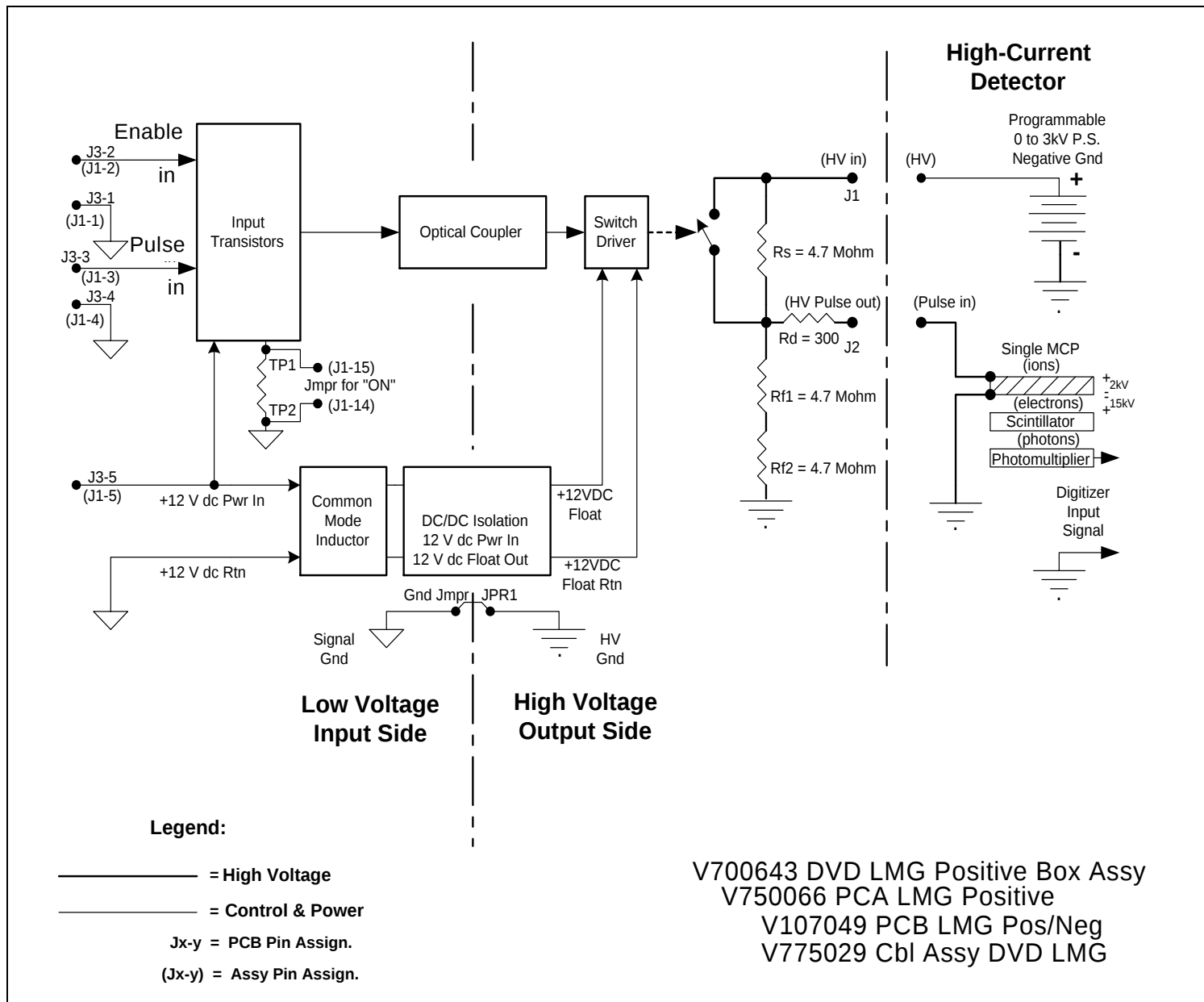
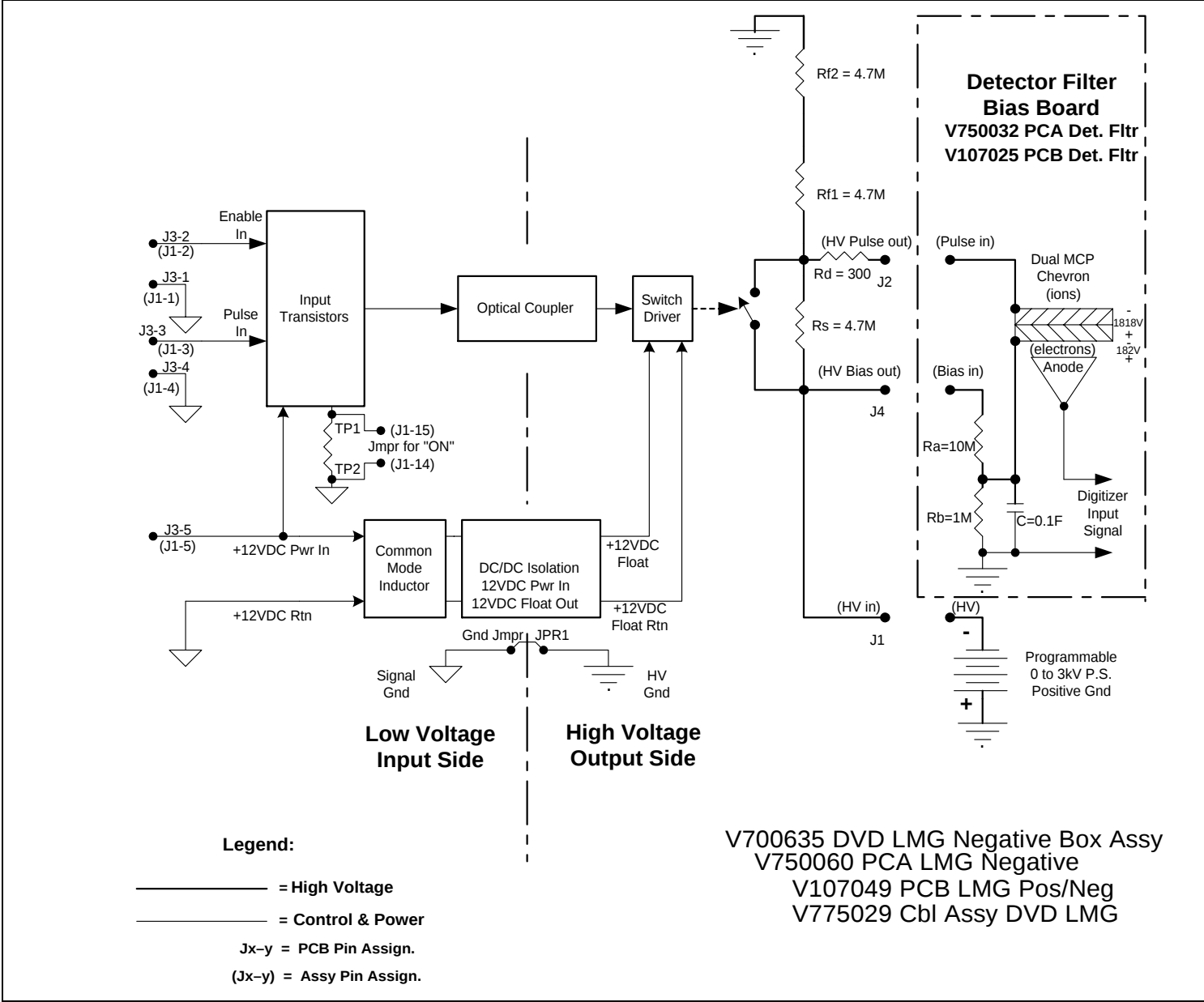


Figure 2-12 Detector Filter Bias

Figure 2-13 Block Diagram of the Low-Mass Gate Positive Pulse



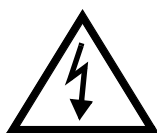


A configurable PCB is used to assemble both the positive and the negative LMG units. Both boxes also use the same internal cable. The following chart relates the part numbers for these three options.

LMG Positive	LMG Negative	Detector Filter Bias
V700643 DVD LMG Box Assembly, Positive (contains 2 MHV connectors)	V700635 DVD LMG Box Assembly, Negative (contains 3 MHV connectors)	N/A
V750066 PCA LMG Positive	V750060 PCA LMG Negative	V750032 PCA Detector Filter Bias Board
V107049 PCB LMG	V107049 PCB LMG	V107025 PCB PCA Detector Filter Bias Board
V775029 CBL Assembly, DVD LMG (internal to box assembly)	V775029 CBL Assembly, DVD LMG (internal to box assembly)	N/A

2

Theory



WARNING

ELECTRICAL SHOCK HAZARD. Potentials in the order of 3000 V dc are present on these boards. Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury.

Low-Mass Gate Switches

The Voyager Low-Mass Gate options convert a TTL input pulse into a floating high-voltage pulse. The Positive Pulse and Negative Pulse block diagrams illustrate how the TTL input logic is isolated from the floating high-voltage output circuits by the optical signal coupler and the DC/DC isolation converter. A common mode inductor chokes transient ground currents resulting from rapid high-voltage switching. The output switch is a 1 kV MOSFET. The HV voltage divider resistors are configured for positive or negative operation by jumpers on the PCB.

There are two identical inputs:

- **Pin 2**—Receives the TTL pulse. The LMG enables the detector for the duration of the pulse.
- **Pin 3**—Enables or disables the LMG function. If high, it enables the MOSFET switch continuously and the detector generates signal during the entire spectrum.

NOTE: For the detector to function properly, you must have input to either Pin 2 or Pin 3. Failure to provide this input prevents the detector from generating a signal.

The TP1-TP2 jumper is an optional disable input. The PCA has a +12 V dc power input and draws 45 mA in normal operation. Dynamic operation can be observed using Tektronix P5100, 2500 V scope probes. [Figure 2-15](#) and [Figure 2-16](#) illustrate operation in negative and positive modes and the negative and positive detector application circuits.

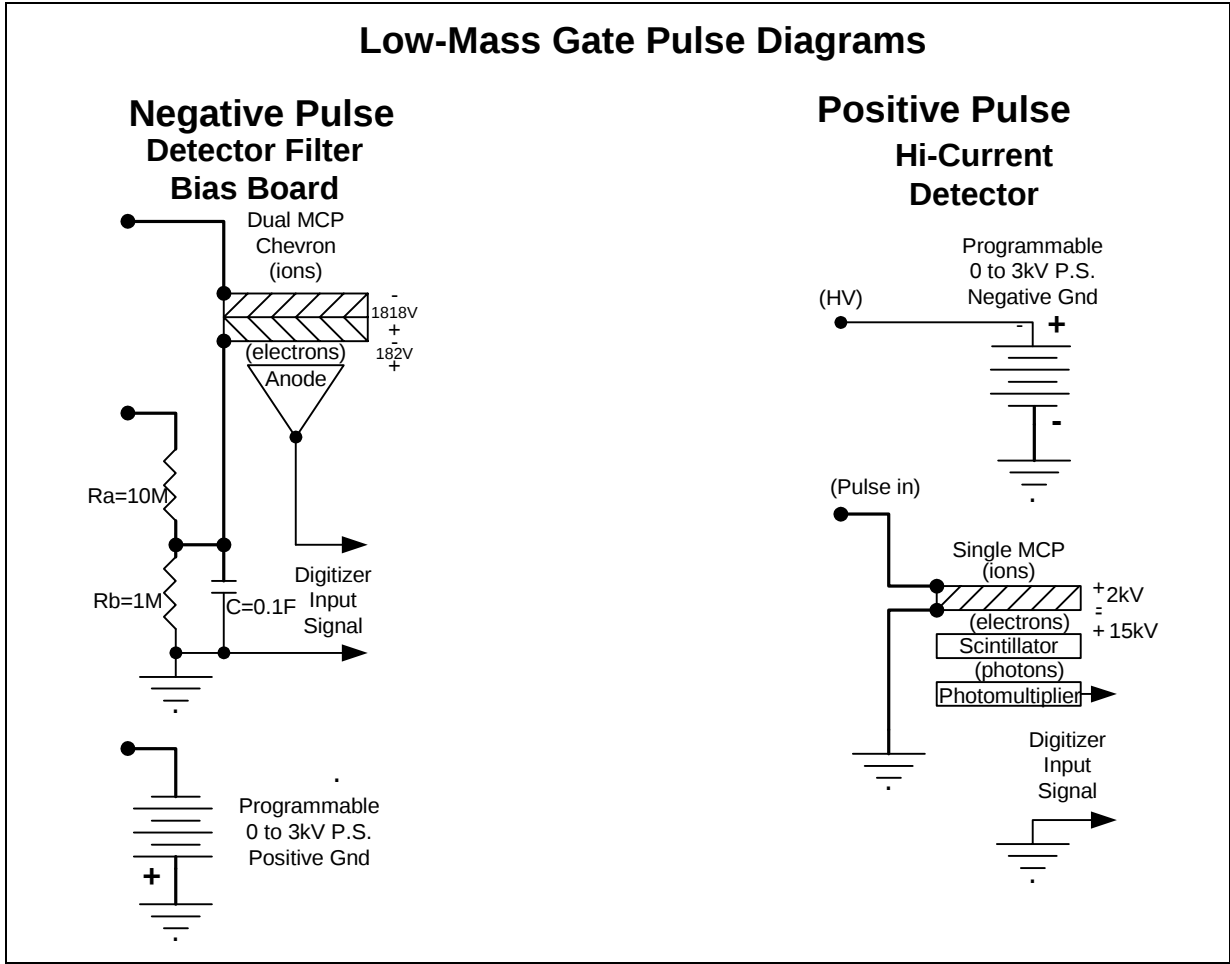


Figure 2-15 Low-Mass Gate Pulse Diagrams

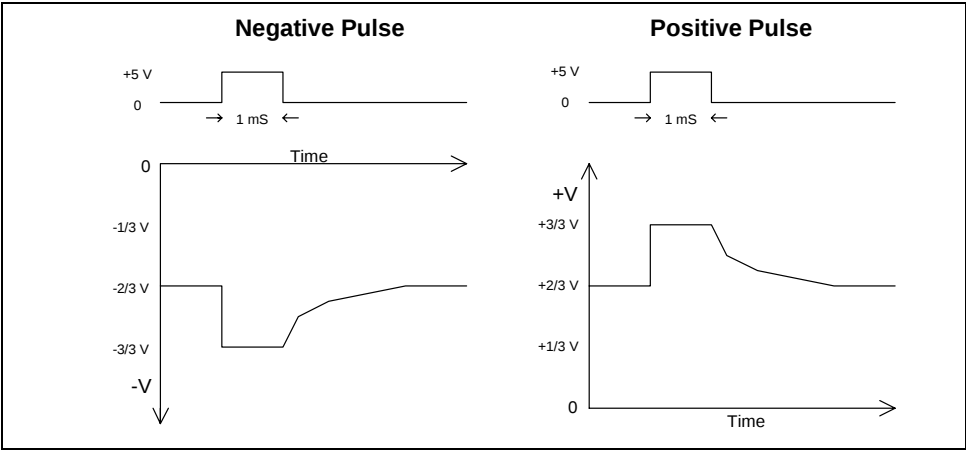


Figure 2-16 Low-Mass Gate Wave Forms

Applications

The following describes the applications for negative and positive pulse.

Detector Filter Bias Board (Negative Pulse)

The Detector Filter Bias board provides a method of tapping-off 1/11 of the full negative voltage to make the Anode slightly positive relative to the dual microchannel plate detector. When the ions strike the microchannel plate, electrons are liberated and attracted to the Anode by the positive bias. The resulting signal is applied to the digitizer input.

High Current Detector (Positive Pulse)

The positive version of the LMG is used to polarize a single microchannel plate that converts ion collisions to free electrons. The electrons are attracted to a scintillator by a 15 kV bias voltage. The scintillator converts electron collisions to light (photons). The photons strike a photomultiplier unit that converts the information back to an electrical signal that is applied to the digitizer input.

Specifications

Power

Power is +12 V dc at approximately 37 mA idle and 45 mA switching.

Input

The TTL gate pulse input impedance is 10 Mohm resistive.

Output

The external programmable power supplies provide either zero to +3 kV or zero to -3 kV. When the input signal is low, two-thirds of the programmed voltage appears on the J2 pulse output. When the input is high, the full-programmed voltage appears on the J2 output.

Connectors

The following table describes the connectors.

Name	Function	Connector Type
J1 PCB HV Input	HV = 0 to ± 3000 V dc	PCB internal MHV external
J2 PCB HB Pulse Output	2/3 HV to full HV	PCB internal MHV external
J3-1 PCB (J1-1 external) J3-2 PCB (J1-2 external) J3-3 PCB (J1-3 external) J3-4 PCB (J1-4 external) J3-5 PCB (J1-5 external)	Ground TTL Enable Input TTL Signal Input Ground +12 V dc Power Input	PCB internal DB15 Male external
J4 PCB HV Bias Output	HV = 0 to ± 3000 V dc	PCB internal MHV external

2.2.6 Timed Ion Selector (TIS) Assembly (V700471)

Overview

The Timed Ion Selector (TIS) assembly provides a differential voltage pulse of ± 950 V for the selection of ions within a specified mass range. When the positive and negative voltages are present on gate elements in the flight (drift) tube, all charged ions are deflected from the normal flight path. During the time that the TIS voltages are switched to ground potential, all ions pass unimpeded down the flight tube.

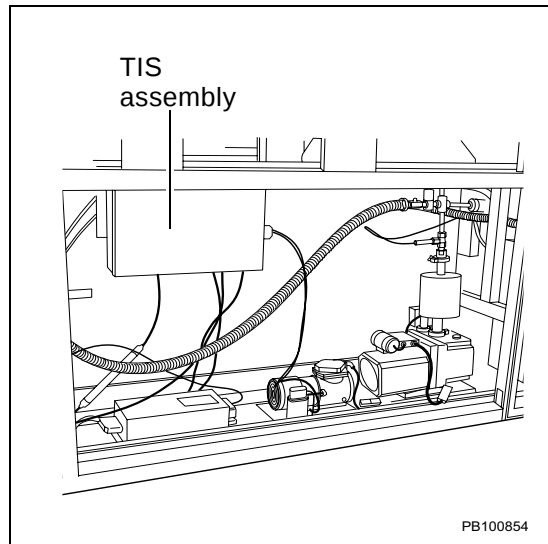


Figure 2-17 TIS Assembly Location (Voyager-DE STR Center Rear View)

Theory

WARNING

ELECTRICAL SHOCK HAZARD. Potentials in the order of 1000 V dc are present on this assembly. Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury. More than 0.02 joules of stored energy are present at outputs J3 and J4.

The TIS assembly (V700471 TIS ASSY) is a replaceable unit that contains an OEM (original equipment manufacturer) PCA, V109032 HV Pulse Module ± 1000 V. The block diagram ([Figure 2-18](#) on page 2-27) provides an overview of the theory of operation. The PCA Assembly diagram ([Figure 2-19](#) on page 2-28) illustrates the location of the I/O connectors and other important components.

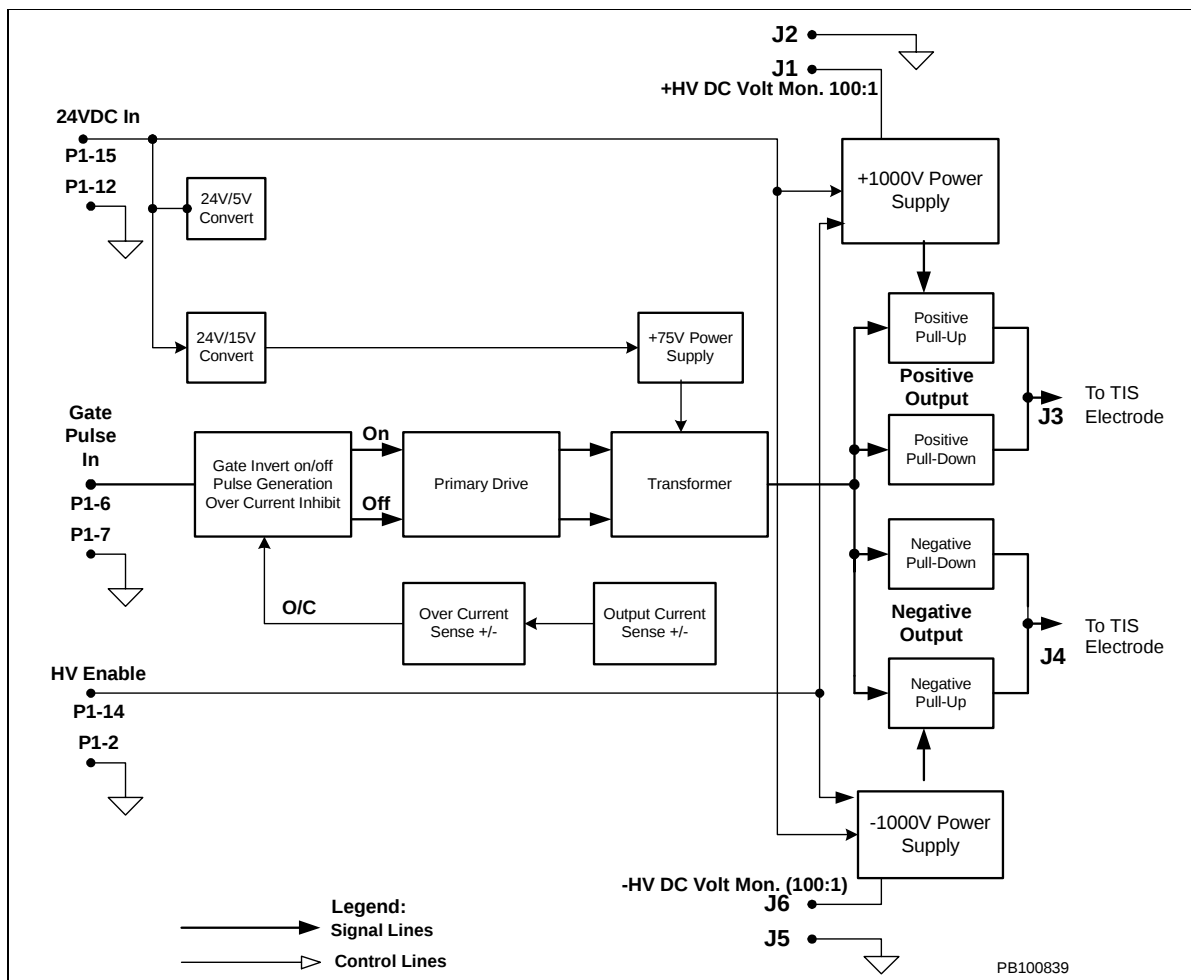


Figure 2-18 TIS Module Block Diagram

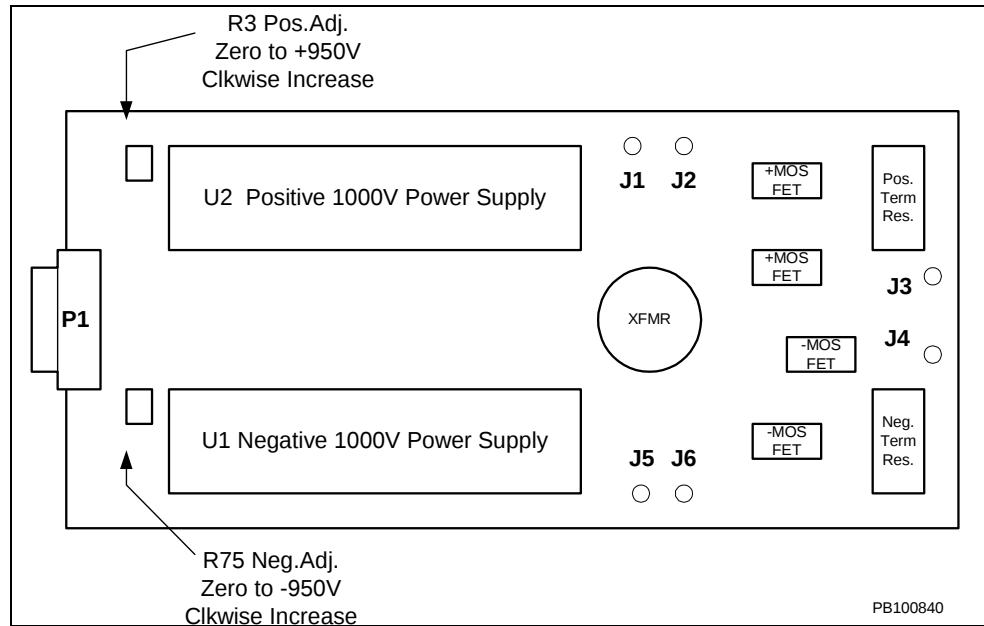


Figure 2-19 TIS PCA Assembly Diagram

All the power requirements for this assembly are provided by the +24 V dc input.

Power for the TTL logic and other low-voltage electronics is provided by DC/DC converters. The two high-voltage power modules have +24 V inputs and zero-to-1000 V outputs. The output voltage for each of the two modules can be measured with a voltmeter (VOM) at the 100:1 test point J1/J2 or J5/J6. Adjustment of their output to ± 950 V is controlled by potentiometers R3 and R75. Dynamic operation can be observed using Tektronix P5100, 2500 V oscilloscope probes.

When 24 V dc is applied to the power input and HV Enable Input is pulled high (or allowed to float high), +950 V dc and -950 V dc appear at outputs J3 and J4, respectively. High voltage is enabled at the same time and as a result of the same conditions as all other Voyager workstation high-voltage sources.

To completely disable the high voltage, see “Disabling High Voltage” on page 5-42.

The TTL gate control signal input has an on-board 50-ohm termination. When the TTL input gate signal is high, the positive and negative 950 V outputs are both switched to ground (zero volts). The gate input logic is coupled by a toroidal transformer to totem-pole FET output switches. Each polarity has:

- A FET for rapid pull-down to ground
- A FET for rapid pull-up to voltage
- Series termination resistors that serve as convenient points for attaching an oscilloscope probe to observe dynamic operation

Specifications

Specifications are summarized in the following table:

Item	Comment
Input power	+24 V dc at approximately 200 mA
Gate Pulse	TTL gate pulse input impedance, 50 ohms resistive
Output	
J3	0 to +1000 V dc
J4	0 to -1000 V dc

Normal operation is at ± 950 V dc. The TIS gates draw no current other than the instantaneous current required to switch a capacitive load. Output short-circuit protection is provided on the PCA.

Connectors

Table 2-6 Connectors on the TIS Board

Name	Function	Type
P1-02	5 V dc return (ground)	DB15 male
P1-03	+5 V dc (Not used)	DB15 male
P1-06	TTL gate pulse in (50 ohm)	DB15 male
P1-07	Pulse in return (ground)	DB15 male
P1-12	24 V dc return (ground)	DB15 male
P1-14	HV enable (TTL Hi)	DB15 male
P1-15	+24 V dc power in	DB15 male
J1	0 to +1000 V (100:1 divider)	Test point
J2	Ground return	Test point
J6	0 to –1000 V (100:1 divider)	Test point
J5	Ground return	Test point
J3	0 to +1000 V	Coax output
J4	0 to –1000 V	Coax output

See Section 5.5, Flight Tube and Mirror Chamber for how to adjust the TIS voltage.

2.2.7 TTL Output Opto-Trigger Board (V750065)

Overview

The TTL Output Opto-Trigger board has two parts: a laser pulse detection circuit and an “At Limit” feedback circuit.

Theory

The primary function of the Opto-Trigger PCA is to detect when the laser fires. This feedback is required because a variable delay exists between when the laser is triggered electronically and when the laser actually fires. The detected laser pulse is then synchronized with the 100-MHz clock. All time-based measurements are then based on this time.

The secondary function of the Opto-Trigger PCA is to feed back the “At Limit/Home” position of the stepper-motor-driven neutral-density attenuator to the Autosampler Control PCA. The “At Limit/Home” position is the position where the attenuation strength is maximum.

Laser Pulse Detection Circuit

The beam splitter directs a part of the laser beam onto the photodiode (CR1). The photodiode turns On when the beam hits it. When CR1 turns ON, Q1 and Q2 also turn On. This produces a positive signal at the input of the buffers U1 and U2. The signal is buffered by these chips and output to J4/J5, then sent to the pulse generator. The signal stays high until the laser stops firing.

“AT Limit” Feedback Circuit

The attenuator wheel has reflective tape at the position where the attenuation strength is maximum (the position where minimum laser energy passes). The limit switch consists of an LED and a phototransistor. When the attenuator wheel is in the Home position, the light from the LED is reflected off the reflector tape onto the phototransistor. This causes the phototransistor to turn on and subsequently turns on Q3. This signal is then sent to the Autosampler Control PCA.

Connectors

Table 2-7 Connectors on the TTL Output Opto-Trigger PCA

Name	Function	Type
J1	Power input +5 V, +15 V, and –15 V	4-pin Mini-Fit
J2	“At Limit” sensor power and read-back	4-pin Mini-Fit
J3	“At Limit” read-back to stepper motor control board	2-pin Mini-Fit
J4	Laser-detected pulse to control board	SMA
J5	Laser-detected pulse (spare)	SMA

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2.3 Electronics Only in Newer Model Instruments

Instruments with serial numbers 4154 and later have the following electronics:

- Beam-steering V750091
- DE switch box V725115 (3 Hz)/V725125 (~15 Hz)
- Einzel lens (voltage divider box) 4317251
- 48-bit I/O board V750033
- MALDI control board V750082 and V750102-001(STR), V750102-002(DE-PRO), V750102-003 (Voyager-DE)

[Figure 2-20](#) shows the housing of these electronics.

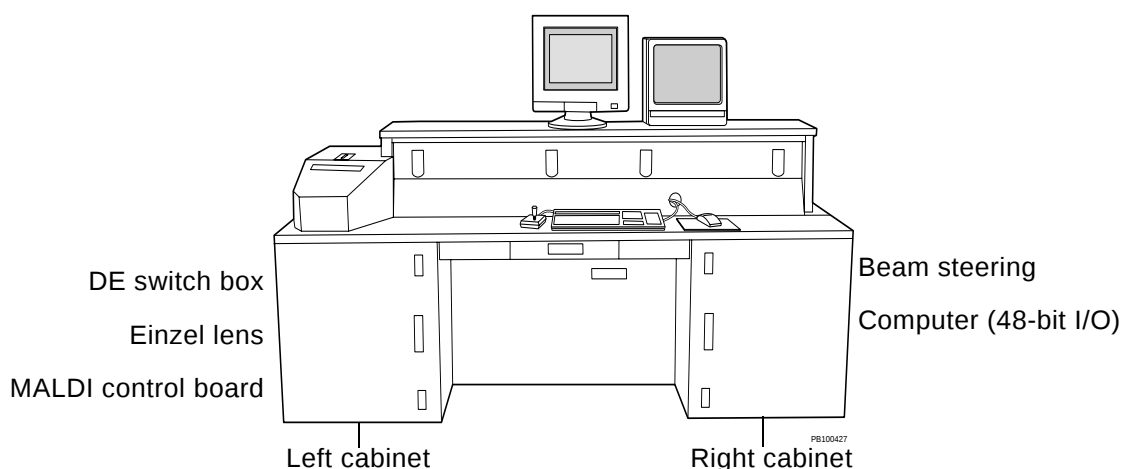


Figure 2-20 Housing of Electronics Only in Earlier Model Instruments

2.3.1 Beam-Steering Board (V750091)

Overview

Instruments with serial numbers 4154 and later have beam-steering plates and an einzel lens to focus and direct the beam of ions. There are two horizontal and two vertical beam-steering plates. This combination of X-Y deflection plates and an adjustable 500 V power supply allows fine-tuning of the ion trajectory. Earlier instruments (serial numbers 4153 and earlier) had a guide wire and flight-tube (drift-tube) power supply.

Before shipment, the beam-steering circuit assembly is optimized for system performance. If the instrument is disassembled or components are shifted out of factory alignment, the optimization procedure can be repeated by a trained field service engineer. For a description of this procedure, see Chapter 5, Troubleshooting by Components.

The Beam-Steering board assembly is installed where the V750061 Flight-Tube (Drift Tube) Power assembly was located in earlier instruments (Figure 2-21 on page 2-34). The Beam-Steering board assembly uses the same power and control connections as the former Drift Tube Power assembly.

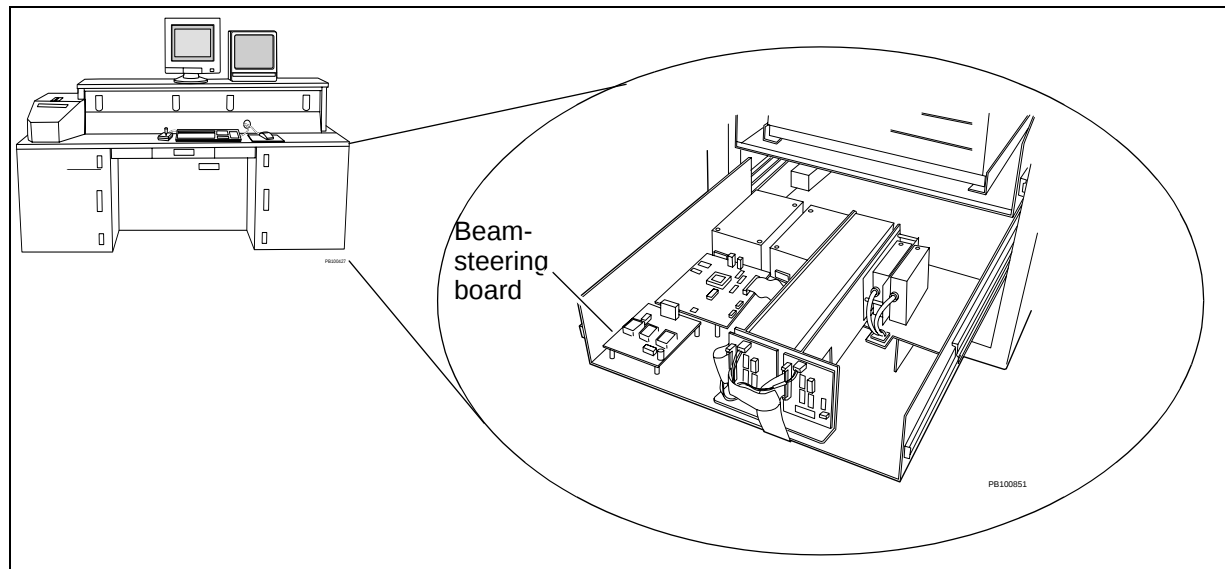


Figure 2-21 Beam Steering Board Location

Operation of the beam-steering voltage is transparent to the user. When acceleration voltage is changed, beam-steering voltage tracks in a linear fashion.

Theory

The beam-steering assembly consists of X-Y deflection plates and an adjustable/programmable dual power supply board ([Figure 2-22](#)).

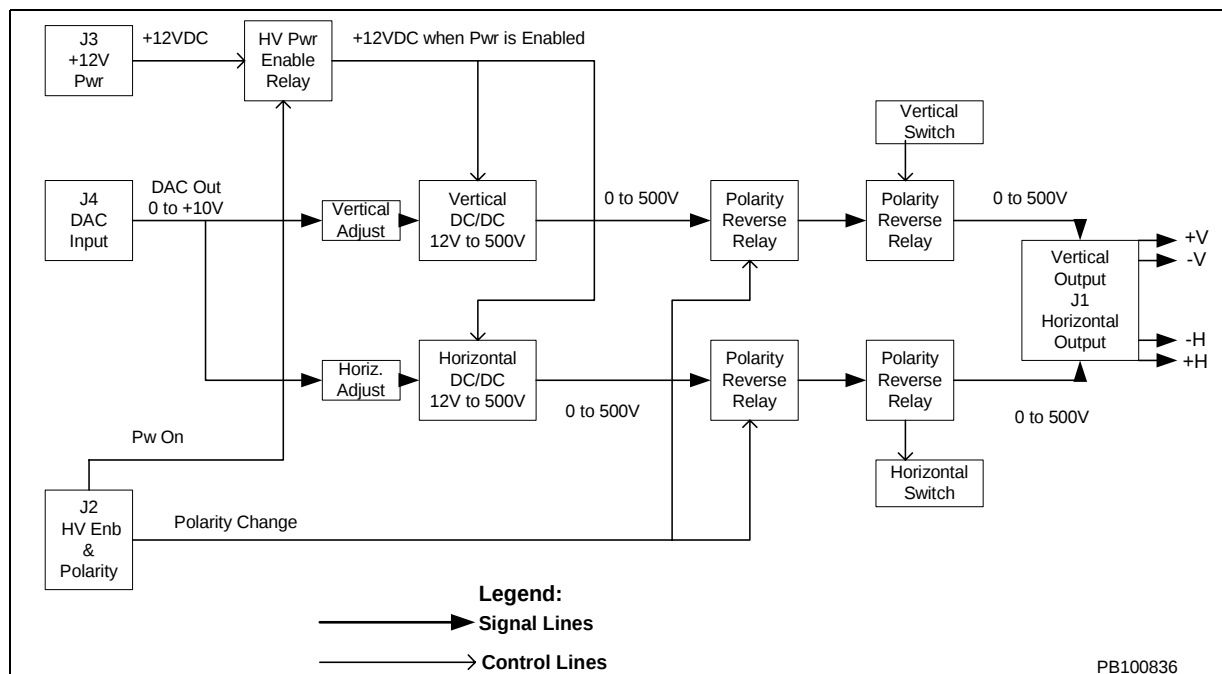


Figure 2-22 Beam-Steering Board Block Diagram

The X-Y plates are positioned early in the ion flight path. They interface to the outside via a 4-wire high-voltage vacuum feedthrough. Two twisted pair of 600 V wire connect the feedthrough to the board assembly.

The voltage applied to each plate is proportional to the ion acceleration voltage. A polarity switch and a trim pot (trimmer potentiometer) tailor each beam axis control to the individual instrument.

The deflection voltages are automatically reversed when the instrument is reconfigured from positive ion mode to negative ion mode. The deflection voltages are also automatically enabled and disabled along with the other system high voltages.

The Beam-Steering DAC address is at the same address as the Source Power Supply DAC address (address 7, 3-bit mode; address 31, 5-bit mode). Therefore, changing the source power voltage makes the same change to the beam-steering board voltage. In earlier instruments containing a guide wire, when the source voltage changed, the guide wire voltage tracked the source voltage, based on a percentage.

Before shipment, the system is optimized for performance. During final test, the optimum polarity is selected by actuating the slide switches, and the optimum voltage scaling for each axis is determined by adjusting the potentiometers while running a prescribed sequence of test samples. The values are documented on a label adhered to the right drawer base, next to the beam steering board. The values are based on an acceleration/source voltage of 25 kV.

Specifications

Power

Power to the five relays is supplied by +24 V dc at approximately 30 mA. Power to the two 12 V-to-500 V programmable DC/DC converters is supplied by +12 V dc at approximately 40 mA from the DVDT PCA. The converters specify a no-load to full 2 mA load current requirement of 16 mA to 150 mA. The deflector plates are essentially no-load devices.

Input

Input impedance load presented to the DAC is 3.6 K resistive. An input divider scales the DAC output of 0 to 10 V to match the DC/DC converter requirement of 0 to 5 V.

Output

Each axis has available 0 to 500 V dc. For the deflector plates, however, the output is current limited to 400 μ A, so no damage results from a continuous short circuit. The DC/DC converters specify a no-load ripple of less than 0.002% or 20 ppm. Load regulation for 0 to 100% current is 0.01%, and line regulation from 11.5 V to 16.0 V input is 0.1%.

Connectors, Switches, and Test Points

Table 2-8 Connectors, Switches, and Test Points on the Beam-Steering Board

Item	Name	Function	Type
Connectors	J1	Power output: Horizontal 0 to 500 V and Return Vertical 0 to 500 V and Return	14-pin Mini-Fit™
	J2	HV Enable, Post/Leg Ion Polarity, +24 V Relay Power	8-pin MTA™ locking header, 0.1-inch spacing
	J3	+12 V power for dual DC/DC 500 V converters	2-pin MTA locking header, 0.1-inch spacing

2-35

Table 2-8 Connectors, Switches, and Test Points on the Beam-Steering Board (Continued)

Item	Name	Function	Type
	J4	DC/DC program input from DAC	4-pin MTA locking header, 0.1-inch spacing
Switches	SW1 VERTICAL (+ and –)	Vertical deflection polarity switch	SPDT
	SW2 HORIZONTAL (+ and –)	Horizontal deflection polarity switch	SPDT
Test Points	HPOS1, HNEG1	Positive and negative test points for digital voltmeter	Test point
	VPOS1, VNEG1	Positive and negative test points for digital voltmeter	Test point

2.3.2 DE Switch Box V725115/V725125

The DE switch box ([Figure 2-23](#)) provides a very fast and stable high-voltage pulse to accelerate the sample ions after they are desorbed by a laser pulse.

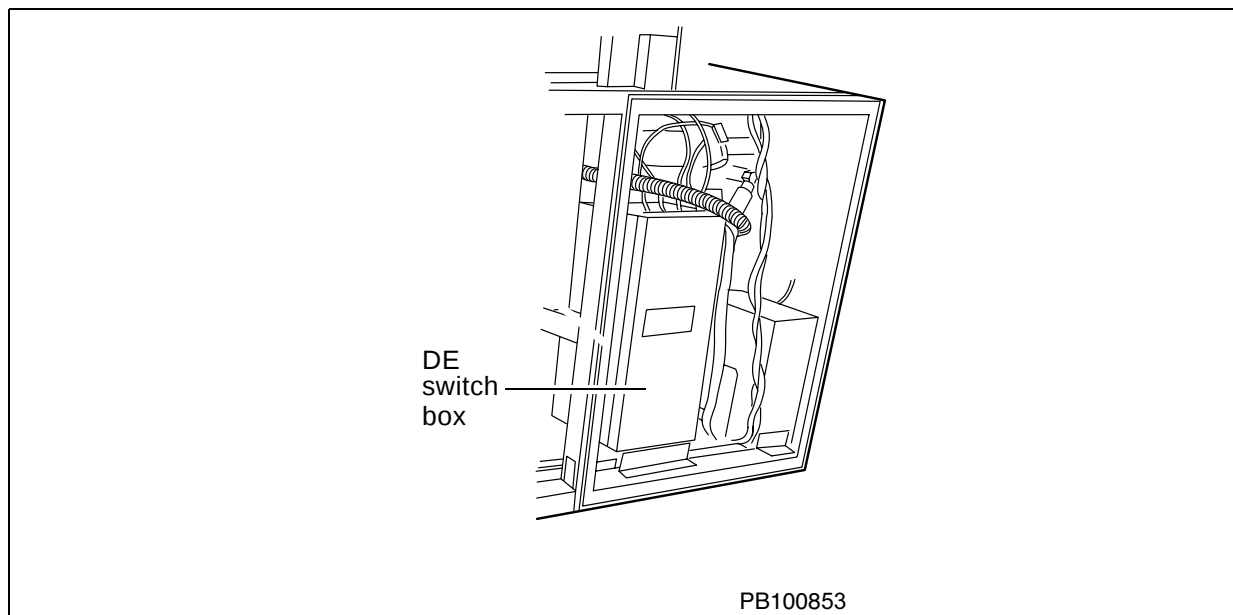
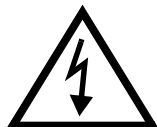


Figure 2-23 DE Switch Box Location

The DE switch box operates in conjunction with two programmable HV (high voltage) power supplies. When the laser pulse fires, one supply is providing a fixed “grid” rest value so that the ions do not see a voltage gradient until the DE switch box fires. The other supply is providing a higher “source”, so when the switch box fires, the ion group accelerates past the grid and down the flight tube.

Theory

WARNING



ELECTRICAL SHOCK HAZARD. Potentials up to 30,000 V dc are present in this assembly. Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury. In excess of 4 joules of stored energy may be present inside the enclosure and at the external terminals. This energy may remain stored in the capacitors for some time after all external connectors have been removed.

The DE switch box is comprised of:

- A 6.25 in. × 6.25 in. × 12.5 in Lexan® enclosure
- An HV solid-state switch
- Associated components necessary to provide the sample plate with voltage pulses to accelerate ions

Three HV relays are included, which, in conjunction with reversible power supplies, permit operation in either positive ion or negative ion mode.

Figure 2-24 shows two basic versions of the DE switch.

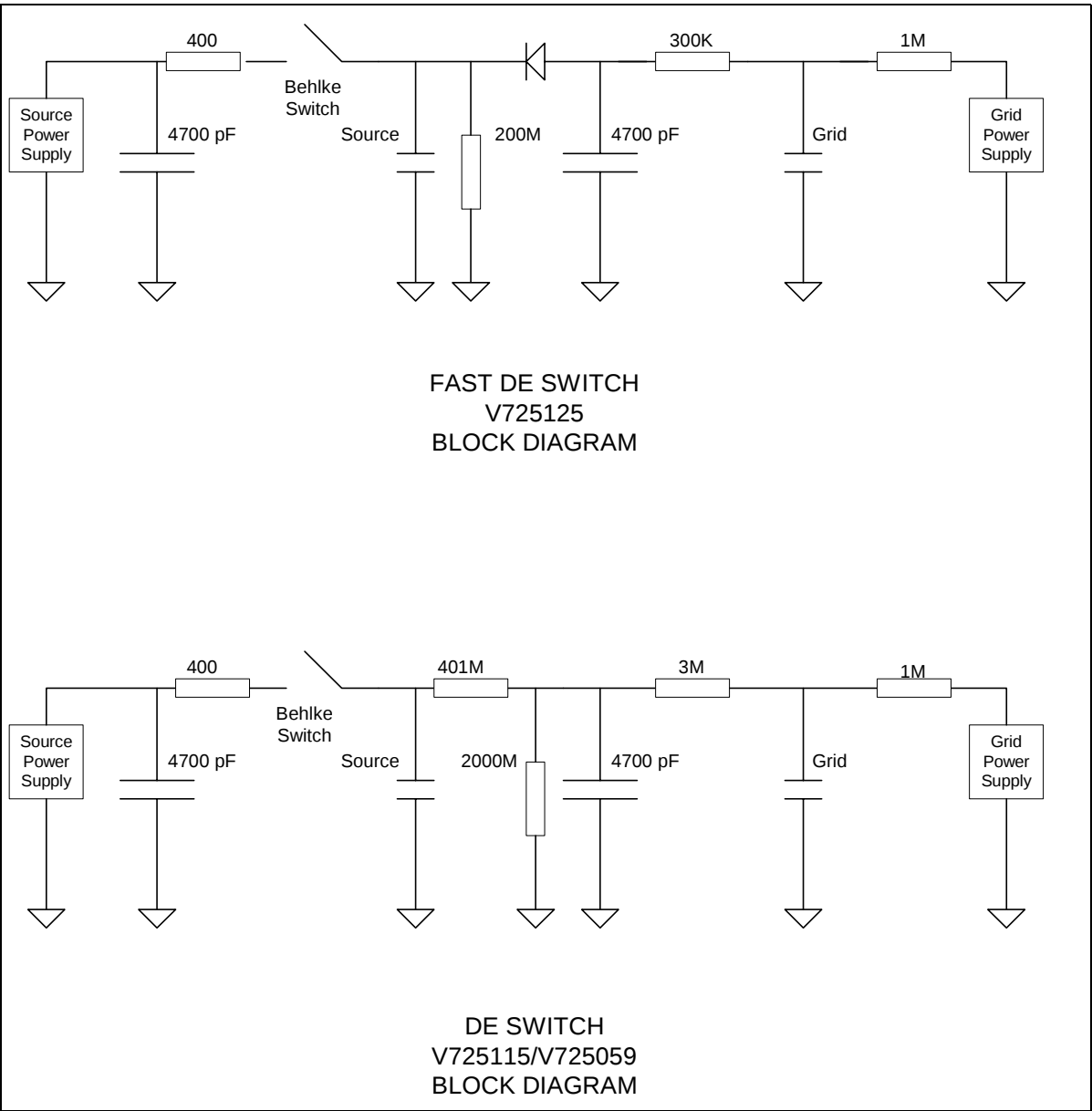


Figure 2-24 DE Switch Box Block Diagrams

Component	Comment
Source power	The source power supply is always set higher than the grid power supply. The source voltage appears across the adjacent 4700 pF capacitor.
Behlke switch	The Behlke switch is an extremely fast HV electronic switch.
Grid power supply	The grid power supply provides a potential to the grid. The forward-biased diode also provides the same grid rest potential to the source.
Source (the sample plate)	The source and the control grid are both represented as small capacitances of approximately 40 pF.

The series of events are as follows:

1. Immediately after the laser ionizes the sample, the Behlke input receives a 2 μ S TTL-level pulse, then the output closes for 10 μ S. 10 μ S is enough time to launch all the ions generated by the laser pulse.
2. The 4700 pF capacitance is briefly placed in parallel with the source capacitance.
The voltage across the source quickly jumps to a value only slightly less than the initial value across the 4700 pF capacitor.
3. The diode is reversed-biased to disconnect the source from the grid power supply.
4. The Behlke switch opens. The elevated source voltage exponentially decays through the parallel 200 Mohm resistor.
5. When it decays to the original grid rest voltage level, the diode again conducts and the grid power supply again maintains the source at the grid rest voltage.

[Table 2-9](#) describes the characteristics of each DE switch box model.

Table 2-9 Characteristics of the Three DE Switch Box Models

Feature/Condition	V725059	V725115	V725125
Serial numbers of Voyager on which installed	NA	STR 4142-4160 ¹ DE-Pro 6056-6130 Voyager-DE 1143-1170	STR 4161 and later DE-Pro 6131 and later Voyager-DE 1171 and later
Laser pulse rate	3 Hz	3 Hz	3 to 100 Hz (with grid voltage to source voltage ratio of 67% or greater)
Source pulse voltage isolation from the grid rest voltage	401 Mohm resistor network	401 Mohm resistor network	Diode
HV terminals	3	4	4
Damping resistors in the grid cables	This resistance is required	This resistance is included in the 3 Mohm and 1 Mohm resistors.	This resistance is included in the 3 Mohm and 1 Mohm resistors.
Small wire harness	Bottom of the box	Bottom of the box	Replaced by green V750074 printed circuit relay control board. ²
Power required	24 V and 5 V	24 V and 5 V	24 V dc only

¹Instruments S/N 4154 through 4160 may have been upgraded from V725115 to V725125.

²This circuit board also includes a 24 V-to-5 V dc/dc converter to supply the 5 V dc required by the Behlke switch.

The new model, V725125, can be used only on newer Voyager workstations that contain a MALDI Consolidated Control Board. This board provides switch-selectable firmware for compatibility with the old and new DE switches. In these systems, the laser pulse rate is further limited by the digitizer speed and the maximum pulse rate of the laser itself.

[Figure 2-25](#) illustrates operation on the V725125 operating at a pulse rate of 100 Hz.

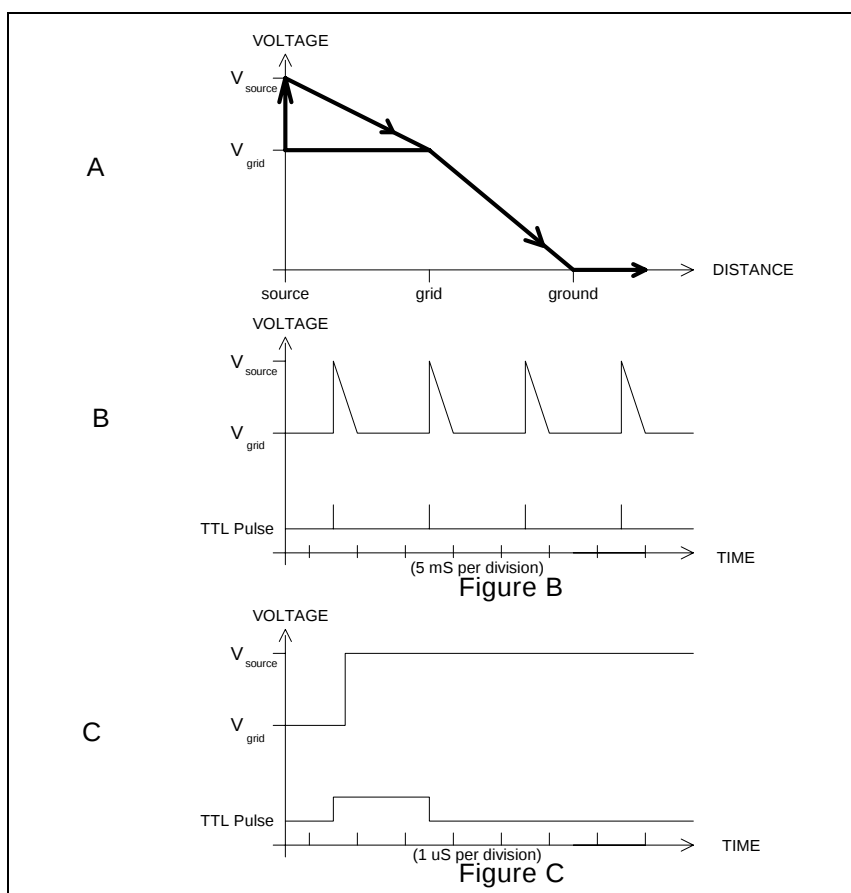


Figure 2-25 DE Switch Waveforms

[Figure 2-25](#) A illustrates voltage vs. distance. Note that the grid potential remains fixed while the source or sample potential is pulsed above the grid potential to launch the ions.

[Figure 2-25](#) B illustrates source voltage vs. time. Each time the Behlke switch receives a TTL level pulse, the source voltage pulses to the higher level, then exponentially decays to the grid rest voltage level.

[Figure 2-25](#) C is an expanded voltage vs. time diagram showing the leading edge of a single source pulse. Approximately 120 ns after the leading edge of the TTL level control pulse, the source voltage pulses from the rest grid level to the source pulse level. The rise time of the HV pulse is typically 50 ns.

A Tektronix P6015A HV probe connected to a special HV “Y” adapter cable is required to view these waveforms.

Specifications**Power****Table 2-10 Low-Voltage Power Requirements**

Switch Assembly	+5 V dc Requirements	+24 V dc Requirements
V725125	None	100 mA to 700 mA
V725115	400 mA	0 mA to 600 mA
V725059	400 mA	0 mA to 600 mA

Table 2-11 High-Voltage Power Requirements

Supply	Voltage	Current
Source power supply	0 to +30 kV or 0 to –30 kV	0 to 400 μ A
Grid power supply	0 to +30 kV or 0 to –30 kV	0 to 400 μ A

Input

Input impedance expects TTL level pulse generator capable of driving a 50 ohms load.

Output

Maximum source pulse level of 30 kV. Grid rest level must be at least 67% of source level.

Connectors**Table 2-12 Connectors on the V750074 Board Within the DE Switch Box**

Name	Function	Type
J1	Low-voltage power input, relay control input, and TTL pulse input	Amphenol 206486-1
J2	Source HV power supply input	Alden B102
J3	Grid feedthrough (Grid HV potential)	Alden B102
J4	Source feedthrough (Source HV pulse output)	Alden B102
J6	Grid HV power supply input	Alden B102

Firmware Configuration (MALDI Consolidated Control Board)**Table 2-13 Firmware Configuration**

Switch Box Assembly	Schematic	MALDI Consolidated Control Board Switch S1, Position 3 ^A
V725125	V750095	On 3 Hz to 100 Hz
V725115	V750075	Off 3 Hz
V725059	V725059	Off 3Hz

^AThe four positions are numbered 0 through 3. Therefore, the fourth dipswitch position is named Position 3.

LEDs

LED indicators on the bottom of the DE box high-voltage relays indicate relay actuation. [Table 2-14](#) illustrates the LED pattern for each Voyager workstation operation mode. Note that the green PCB on the bottom of the V725125 box assembly also has an orange LED to indicate that the 24 V to 5 V dc/dc converter is operating correctly. Voyager workstation mode indication is also provided on the V750082 MALDI Control Board at location D3 by LEDs labeled RLY1, RLY2, and RLY3.

Table 2-14 DE Switch Box LED Displays

Switch Assembly	Voyager Workstation Mode	5 V dc Orange	Relay-1 Yellow	Relay-2 Green	Relay-3 Red
V725125	DE Positive	On	Off	Off	Off
	DE Negative	On	On	On	On
	Continuous Positive	On	On	Off	Off
	Continuous Negative	On	On	Off	On
V725115	DE Positive	N/A	Off	Off	Off
	DE Negative	N/A	On	On	Off
	Continuous Positive	N/A	On	Off	On
	Continuous Negative	N/A	On	Off	On
V725059	DE Positive	N/A	Off	Off	Off
	DE Negative	N/A	On	On	Off
	Continuous Positive	N/A	On	Off	On
	Continuous Negative	N/A	On	Off	On

2.3.3 Einzel Lens Electronics (Voltage Divider Box, 4317251)

Overview

This assembly is a resistive tap off the source power supply that provides 50% of the source voltage to the einzel lens. The Voltage Divider box is mounted on the side of the DE switch box enclosure ([Figure 2-26](#)).

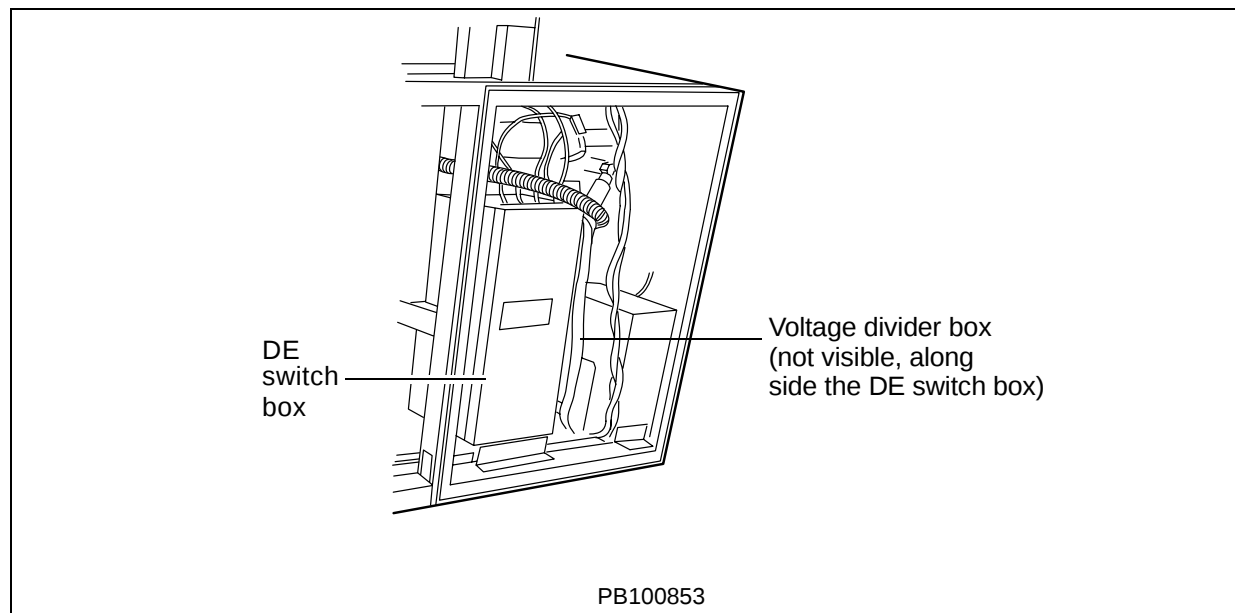


Figure 2-26 Voltage Divider Box Location (Voyager-DE STR Left Cabinet Rear View)

Theory

The Voltage Divider box consists of an epoxy-potted plastic or metal box with two series-500 Mohm resistors. The one end (top) of the resistors is connected to two HVPS (high voltage power supply)-type Alden connectors. The other end (bottom) of the resistors is tied to the Voltage Divider Box ground lug. The Voltage Divider Box ground is tied to the instrument frame ground through a braided cable.

WARNING

ELECTRICAL SHOCK HAZARD. Severe electrical shock can occur if the Voltage Divider box ground lug is not grounded to the instrument frame. The ground lug carries high voltage unless grounded. Failure to properly ground the ground lug can also damage the einzel lens.

The middle (50%) of the resistors is brought out to another HVPS-type Alden connector.

The two connectors at the top of the Voltage Divider Box (Figure 2-27 on page 2-45) allow you to connect the source HVPS to the Voltage Divider Box and also to the DE switch box. The connector on the bottom of the box provides a connection to the einzel lens.

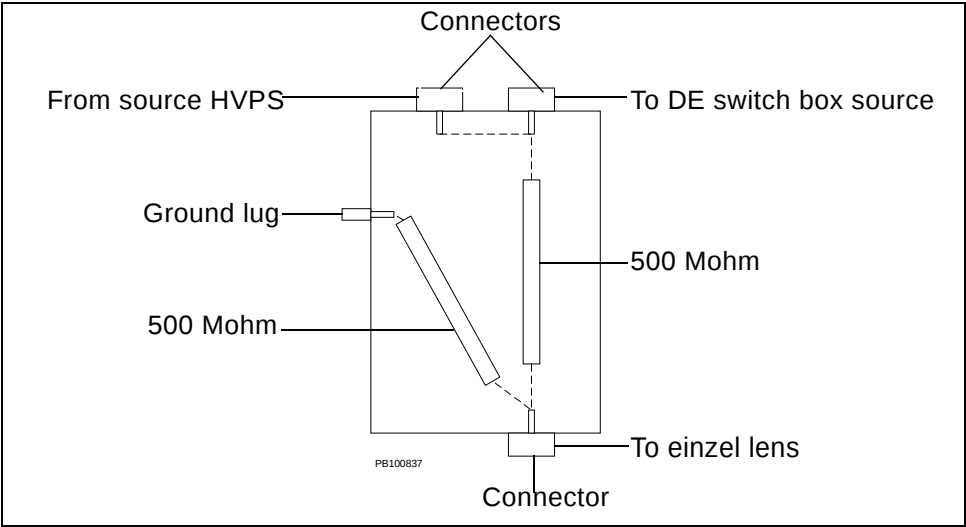


Figure 2-27 Voltage Divider Box Connectors

Connectors

Function	Type
Source HVPS	Alden HV 40 kV
DE switchbox source PS	Alden HV 40 kV
Einzel lens	Alden HV 40 kV
Ground lug	10-32 and hardware

2.3.4 48-Bit I/O Board with Game Port (V750033)

Overview

This I/O board has a dual function:

- It interfaces the input and output control signals between the computer and the other system components
- It interfaces, processes, and controls Game Port functions.

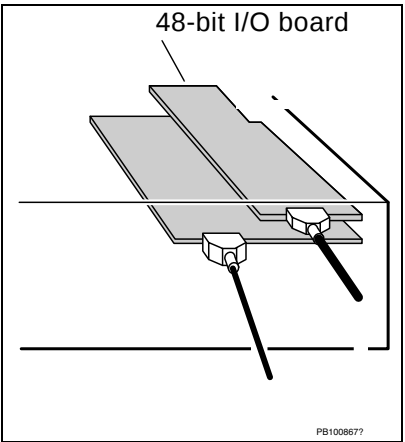


Figure 2-28 48-bit I/O Board in the Computer (Rear view)

Theory

The I/O board has three 8255 parallel interface adapter (PIA) chips. Each chip has an 8-bit data bus, 2-bit addressing, a chip select, and a read/write line, all of which are connected to the computer data bus. In addition each chip has three 8-bit I/O ports. Only two of the three chips are used; U38 is a spare.

All inputs and outputs to the 8255 chips are optically isolated through an HCPL-2630 chip. The isolators prevent noise on the computer bus and offer protection from high-voltage arcs in the system.

NOTE: +5 V (5 B on older schematics) was supplied from the Voyager workstation system (DC Distribution PCA) in older systems. In newer systems, this +5 V cable is not connected to the card, nor required, and the buffered 5 V and grounds are jumped to obtain power from the computer. Adding jumpers JP2 2-4, 6-8 and JP3 2-4 and 6-8 enables this.

Connectors

Table 2-15 Connectors on the 48-Bit I/O Board

Connector	Function	Type
J0	Enable, address, and I/O	26-pin ribbon
J1	Data and I/O	26-pin ribbon
J3	+5 V (5 B on older schematics) power	Plug

Table 2-15 Connectors on the 48-Bit I/O Board (Continued)

Connector	Function	Type
J4	(Not used)	NA
J5	(Not used)	NA
J6	Game port	16-pin ribbon

LEDs

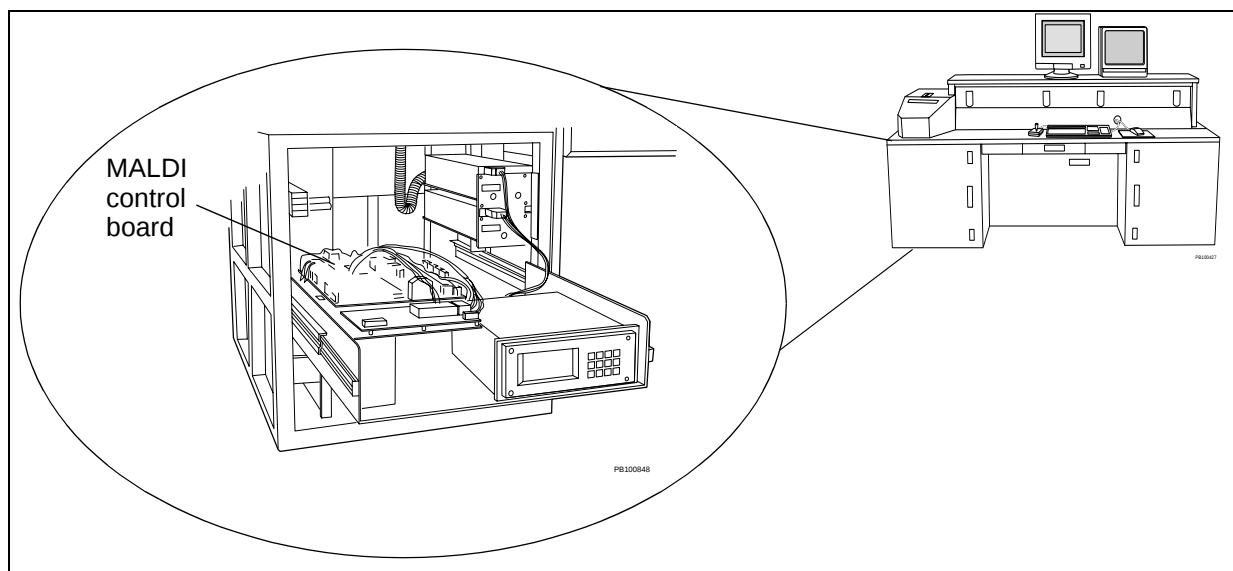
The I/O Board has one LED, the +5 V LED. The function is Buffered 5 V.

2.3.5 MALDI Control Board (V750082 and V750102-001, V750102-002, V7502-003)

Overview

The MALDI consolidated control board consolidates discrete logic functions previously found on the:

- Pulse Generator (Timed Ion Selector) Board
- DAC (source, grid, reflector and Beam Guide) Boards
- Old-style TTL MALDI Control and Distribution Boards

**Figure 2-29 MALDI Control Board Location**

[Table 2-17 on page 2-52](#) and Figure 2-30 on page 2-58 present the highlights of the MALDI control board.

Systems controlled by this board include the pumps, voltages, and vacuum system. MALDI consolidated control board functions to controls the:

- DE switch box
- High-voltage power supply (DAC control and enable, polarity)
- Timed-Ion Selector
- Delayed pulse generator
- Laser trigger
- Interlock sensor

Functions not controlled by the MALDI Control Board are listed in [Table 2-16](#).

Table 2-16 Functions Excluded from the MALDI Control Board

Functions Excluded from MALDI Control Board	
Voyager STR	Voyager-DE or DE-Pro
Stepper control ^A	Stepper control ^a
DVDT (Low-Mass Gate timer) functions	DVDT (low-mass gate timer) functions
Reflector DAC	
Beam guide (or beam steering) DAC	

^aTo provide use of an external laser, the MALDI Control Board is connected directly to the 48-bit IO PCA in the system computer, and the stepper motor signals for the laser attenuator are switched through the Control Board.

Theory

All the MALDI Control Board logic functions are in Altera complex programmable logic devices (CPLDs). All signals to and from the CPLDs are isolated by buffers or drivers.

The buffer section receives 40 bits of control from the computer 48-bit I/O card and supplies 8 bits back. All 48-bits to and from the 48-bit I/O card are immediately buffered (U1, U2, U3, U13, U14, U17).

The 40 bits designated as inputs to the control board are further divided into the Voyager Bus and Discrete IO.

Voyager Bus

The unidirectional Voyager Bus consists of:

- A 16-bit data bus
- Either a 3 or 5-bit address bus
- Two control bits (Load and Latch)

The bus is capable only of receiving data from the computer; it cannot be read from the computer. The Voyager Bus is used in three places:

- Internally to the CPLDs (for trigger generation and DE/TIS pulse generators),
- On the control board itself (for 16-bit DACs)
- As a buffered output from the Control Board to drive external DAC PCAs (reflector and Beam Guide in a STR) and the DVDT PCA (Detector Voltage Delay Timer or Low-Mass Gate delay timer).

DAC/HVPS control

The MALDI consolidated board contains up to four 16-bit DACs (U16, U22, U27, U44) and associated control signals to control high-voltage power supplies (HVPSs). The DACs, which are controlled via the Voyager bus, output a 0 to 10 V signal to control the HVPSs.

The V750102-001 configuration (STR configuration) has two populated DACs, U16 (source control DAC) and U22 (grid control DAC). The other two DACs are unpopulated because beam steering and mirror HVPSs are controlled by discrete DAC PCAs. See [Section 2.2.2. DAC \(Digital-to-Analog Converter\) Board \(V750025\)](#).

In addition to the DACs, two discrete outputs are associated with HVPS control: Enable and Polarity. U19, a precision voltage source, generates a 5 V reference for the 16-bit DACs.

Laser trigger generation

Laser trigger is generated from one of two sources:

- **Legacy discrete IC/trigger generator**—A 555-based oscillator controlled by pot R 46. To select this circuit, set dipswitch S1 to LASTRGOLD. This circuit can be set from 1 Hz to 200 Hz, but is not programmable by the software.

Output from this circuit runs through the Altera firmware, to line driver U6, and out SMA connector J6 (TP26).

If an external laser is present and selected, the corresponding laser trigger line driver is U5 (TP25).

- **CPLD-based digital divider trigger generator**—Available with 5-bit addressing and can be programmed to an optimal setting by the software.

To generate a trigger, two programmable down-counters are preloaded via the Voyager bus. When the laser trigger is enabled (by software):

1. The first counter is enabled, driven by a 63-kHz clock.
2. The first counter counts down from the preloaded value to zero.
3. When the first counter reaches zero, an output is generated, triggering the second counter.
4. The first counter reloads and starts again.
5. The second counter generates the laser trigger leading edge and starts counting down from the preloaded value.
6. When the second counter counts down to zero, it generates the laser trigger trailing edge.
7. The second counter then reloads.

The first counter generates a laser trigger frequency calculated by the following equation.

$$F = 63\text{kHz} / [N + X]$$

Where:

N = preloaded 16-bit number

X = overhead clock ticks = 1

For example, if N is 63 k, then F equals approximately 1 Hz.

As in the legacy trigger generator, output from this circuit runs through the Altera firmware to line driver U6, and out SMA connector J6 (TP26).

DE and Timed Ion pulse generators

The 15-bit pulse generators are firmware based and are functionally identical to the stand alone pulse generator described in Section 2.4.4, Pulse Generator PCA V750063.

The DE pulse generator provides triggers to the:

- DE switch box
- Digitizer
- Low-Mass Gate delay timer
- Timed-Ion selector
- Pulse generator

The Timed-Ion pulse generator provides a trigger to the Timed Ion Selector (TIS) Assembly V700471.

Discrete I/O

Input

Input for the consolidated control board from the instrument consists of 8 bits that reflect the state of the linear actuators, flap valves, and load position of the sample stage.

Inputs specify the following conditions:

- Linear 1 actuator extended
- Linear 1 actuator retracted
- Linear 2 actuator retracted
- Flap Door 1 open
- Flap Door 1 closed
- Flap Door 2 closed
- Load Position
- Interlock Status

You can view the state of these signals using the MALDI consolidated control board LEDs D6 and D11.

Output

Discrete outputs from the computer via the MALDI consolidated control board are interlocked through the firmware, buffered, and then sent to drivers that drive the relays and solenoids.

Output are to the:

- Foreline Solenoids 1 and 2
- Vent Solenoid
- Linear Actuators
- Polarity and High-Voltage Enable
- Linear Detector Enable
- Mirror HVPS Enable
- Turbo Pump Delay/Enable
- Camera and Camera lamp
- Timed-Ion Selector control (from Voyager bus)
- DE Switch Box Control (from Voyager bus)
- Laser Interlock

Linear Actuators and Flap Doors

The linear actuators and flap door switches are magnetic reed switches that complete the 5 V interlock circuit.

Interlock Status (System Interlock)

The system interlock consists of a series chain of panel switches. The panel switches, when made, provide a ground to relay K9. When K9 is activated, 24 V switched is available for HVPS and the laser interlock relay, and a signal is sent to the computer via U13-18

Load Position

The Load Position consists of two limit switches, one on the X-axis and one on the Y-axis. The switches are wired in series to ground and when made, present this ground to the computer via U13-3 to signify the sample stage is in the load position.

Turbo 2-Minute Delay

IC U40 provides a 2-minute inhibit signal to the turbo controllers. This delay allows time to generate a rough vacuum.

Polarity, High-Voltage Enable, Linear Detector Enable, Mirror HVPS Enable

The Polarity bit is applied to the source, grid, and mirror HVPSSs. The High-Voltage Enable bit is applied to the source and grid power supplies, but not the mirror power supply. The Linear Detector Enable bit enables the linear detector power supply and the Mirror HVPS bit enables the mirror HVPS and the mirror detector power supply.

Connectors, Resistors, and Test Points**Table 2-17 MALDI Control Board Connectors, Resistors, and Test Points**

Item	Name	Function	Type
Connectors	J0, J1	Workstation 48-bit I/O	26-position ribbon cable
	J2	Power ground	1/4" quick disconnect
	J3	From opto trigger board (detected pulse)	SMA female
	J4	Output from YAG Q-switch (firing pulse)	SMA female
	J5	External laser trigger	SMA female
	J6	Internal laser trigger	SMA female
	J7	DE switchbox control (24V+relay)	8-position Mini-Fit™
	J8	DE Switchbox trigger	SMA female
	J9	Digitizer trigger	SMA female
	J10	DVDT trigger	SMA female
	J11	TIS trigger	SMA female
	J12	TIS control	4-position Mini-Fit
	J14	DAC control, monitors, HVPS enables	DB25 Receptacle
	J15	Vacuum gauge serial connection (to multigauge controller)	DB9 plug
	J17	Voyager bus to right-hand drawer electronics: mirror, beam steering, low-mass gate	DB37 plug
	J18	Voyager bus expansion	34-position ribbon cable
	J22	Camera, grabber, vent solenoid, foreline solenoid control	12-position Mini-Fit
	J23	Linear and flap actuator solenoid control	8-position Mini-Fit
	J25	Detector 24 V, switched 24 V, polarity switching, LMG enable, vacuum gauge (to workstation)(right-hand drawer electronic controls)	DB25 Receptacle
	J26	Linear, flap, load position sensors	16-position Mini-Fit
	J27	Turbo controllers	DB15 Receptacle

Table 2-17 MALDI Control Board Connectors, Resistors, and Test Points (Continued)

Item	Name	Function	Type
Connectors (continued)	J28	Laser control from stepper motor PCBA	8-position Mini-Fit
	J29	To I/O Internal laser attenuator	8-position Mini-Fit
	J30	To external laser attenuator	12-position Mini-Fit
	J31	Internal laser interlock	2-position Mini-Fit
	J32	Interlock switches	2-position Mini-Fit
	J34	Power in +5, +24, +15, –15 V	12-position Mini-Fit
	JU1	Analog-Digital ground (normally open)	2-position 0.1-inch header
	JU2	Legacy trigger frequency (normally jumped)	2-position 0.1-inch header
	JU3	Auto-Manual laser type select (normally 1-2)	3-position Mini-Fit
	JU4	Stepper PCB 5 V select (normally 1-2)	3-position Mini-Fit
	JU5	Stepper PCB ground select (normally 1-2)	3-position Mini-Fit
	JU6	3.3-5.0 V select U46 (normally 2-3)	3-position Mini-Fit
	JU7-10	Open (not used)	2-position Mini-Fit
Pots	R24	DAC 5 V reference monitor at TP9	Potentiometer
	R46	3 Hz adjust “old laser trigger” (direct monitor at pin 3, U39)	Potentiometer
Test Points	TP1	External laser in	NA
	TP2	DE box trigger	NA
	TP3	TIS trigger	NA
	TP4	Internal laser in	NA
	TP5	Internal laser in, Comparator Signal	NA
	TP6	External laser in, Comparator Signal	NA
	TP7	Source DAC command	NA
	TP8	Source DAC monitor	Test point
	TP9	5 V reference	Test point

Table 2-17 MALDI Control Board Connectors, Resistors, and Test Points (Continued)

Item	Name	Function	Type
Test Points (continued)	TP10	Source DAC Return	Test point
	TP11	Spare DAC monitor	Test point
	TP12	Grid DAC command	Test point
	TP13	Grid DAC monitor	Test point
	TP14	Grid DAC Return	Test point
	TP15	Spare DAC command	Test point
	TP16	Spare DAC Return	Test point
	TP17	+15 V	Test point
	TP18	–15 V	Test point
	TP19	+24 V	Test point
	TP20	+5 V	Test point
	TP21	Ground, DC return	Test point
	TP22	+12 V	Test point
	TP23	Spare 2 DAC command	Test point
	TP24	Spare 2 DAC return,	Test point
	TP25	External laser trigger	Test point
	TP26	N ₂ laser trigger	Test point
	TP27	+3.3 V	Test point
	TP28	Mirror DAC monitor (DE + DE-Pro only)	Test point

MALDI Consolidated Control Board LEDs and Switches**Table 2-18 MALDI Consolidated Control Board LEDs and Switches**

LED/Switch Name	Position	Function
LED D3	1	Laser opto-trigger In
	2	Timed-Ion Selector enable
	3	TIS pulse Out
	4	DE pulse Out
	5	DE switch box Relay 1 On
	6	DE switch box Relay 2 On
	7	DE switch box Relay 3 On
	8	DE switch box Relay 4 (not used)
	9	Linear detector On
	10	Internal (N2) laser selected
LED D6	1	+12 V
	2	+24 V
	3	+15 V
	4	–15 V
	5	+5 V
	6	Cover removed (interlock open)
	7	Computer enabled
	8	Negative ion mode
	9	Mirror On
	10	Low-mass gate enable

Table 2-18 MALDI Consolidated Control Board LEDs and Switches (Continued)

LED/Switch Name	Position	Function
LED D11	1	Linear 1 actuator extended
	2	Linear 1 actuator retracted
	3	Linear 2 actuator retracted
	4	Flap Door 1 open
	5	Flap Door 1 closed
	6	Flap Door 2 open
	7	Flap Door 2 closed
	8	Sample stage at load position
	9	3.3 V
	10	Mirror detector On
LED D18	1	Linear 1 solenoid On
	2	Linear 2 solenoid On
	3	Flap Door 1 solenoid On
	4	Flap Door 2 solenoid On
	5	Foreline 1 solenoid On
	6	Foreline 2 solenoid On
	7	Vent solenoid
	8	Camera power On
	9	Grabber solenoid On
	10	5 V stepper

Table 2-18 MALDI Consolidated Control Board LEDs and Switches (Continued)

LED/Switch Name	Position	Function
Switch 1	1	Source turbo On (normally On)
	2	Mirror turbo On (normally On)
	3	Not used (spare turbo)
	4	old "3 Hz" DE box: Off, new: On
	5	not used
	6	Laser trigger select (old/new)
	7	3-5 bit addressing (3-bit, 5-bit)
	8	Internal/External laser manual select (normally "IntLas")

2

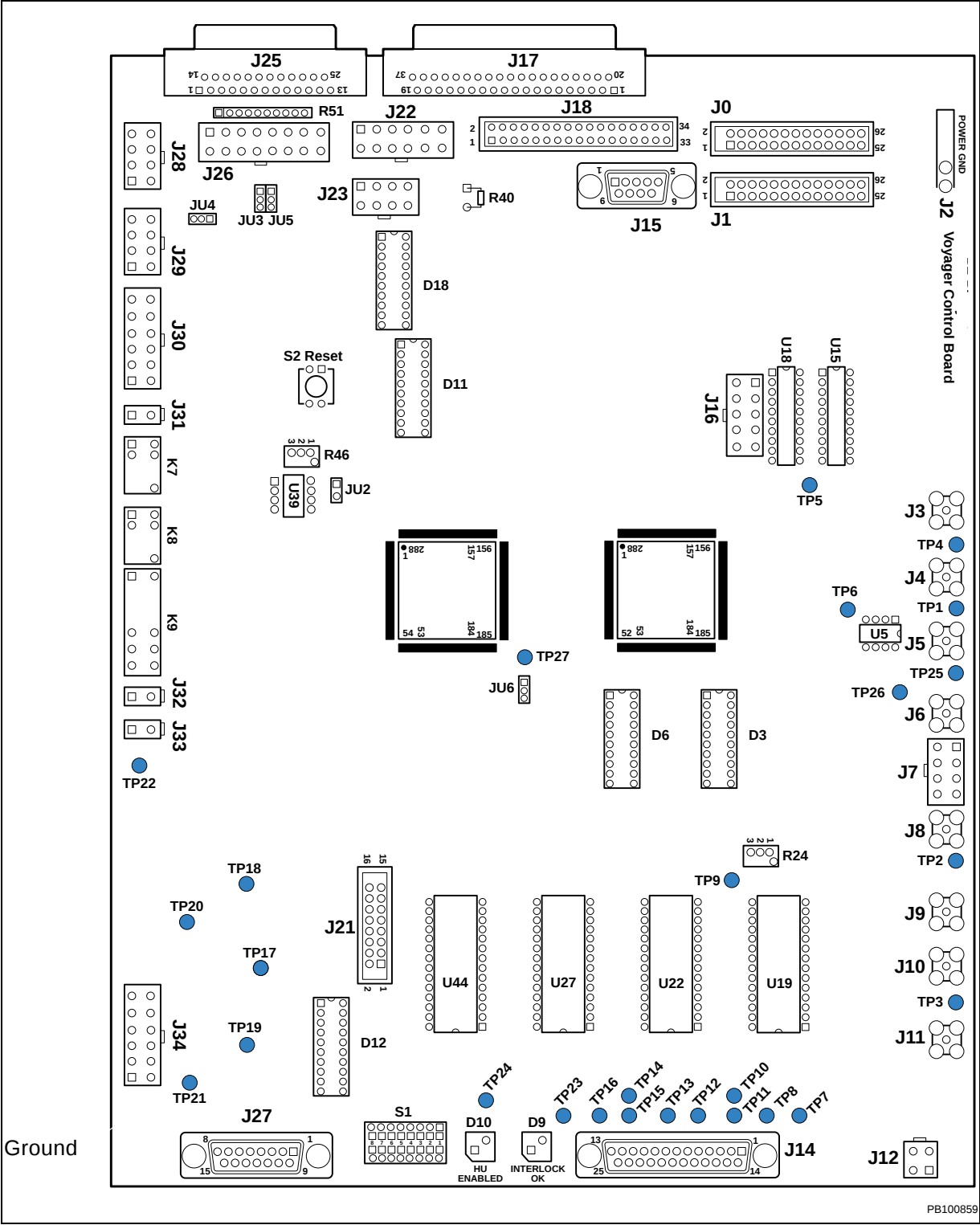


Figure 2-30 MALDI Control Board

2.4 Electronics Only in Earlier Instruments

Overview

The electronics only in instruments with serial numbers 4153 and earlier described in this section are:

- Flight-tube (drift-tube) power supply V750061
- Pulse Generator board V750063

In addition, the earlier instruments have the following electronics:

- Cable Distribution V750003
- Control board V750015
- DC power supplies (+12 V, +24 V; Quad +5 V, ± 15 V, -5.2 V)
- Laser switch board

[Figure 2-31](#) shows the housing of these electronics.

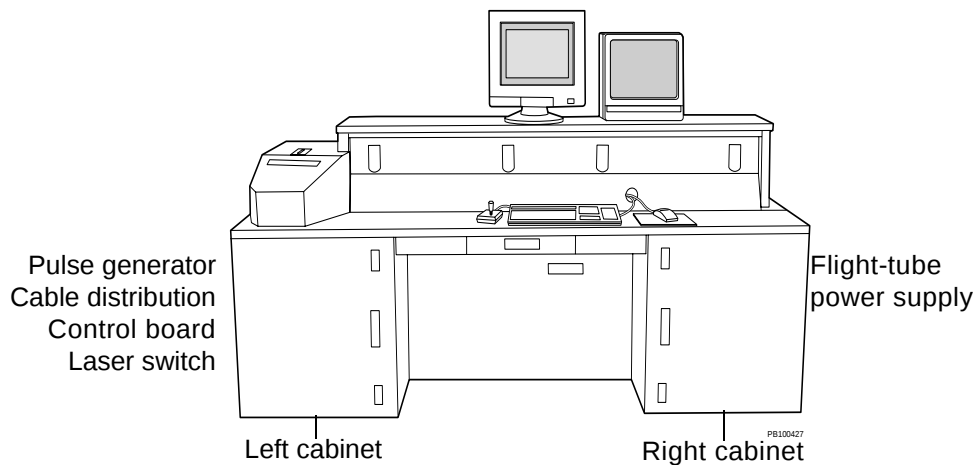


Figure 2-31 Housing of Electronics Only in Instruments with SN 4153 and Earlier

2.4.1 Flight-Tube (Drift-Tube) Power Supply (V750061)

Overview

Voyager-DE STR instruments with serial numbers 4153 and earlier have a guide wire strung along the center axis of the flight tube to organize the stream of ions into a narrow, straight beam.

The V750061 Flight Tube Power Supply is a programmable dual-polarity power supply board (Figure 2-32) that provides a programmable potential to the wire.

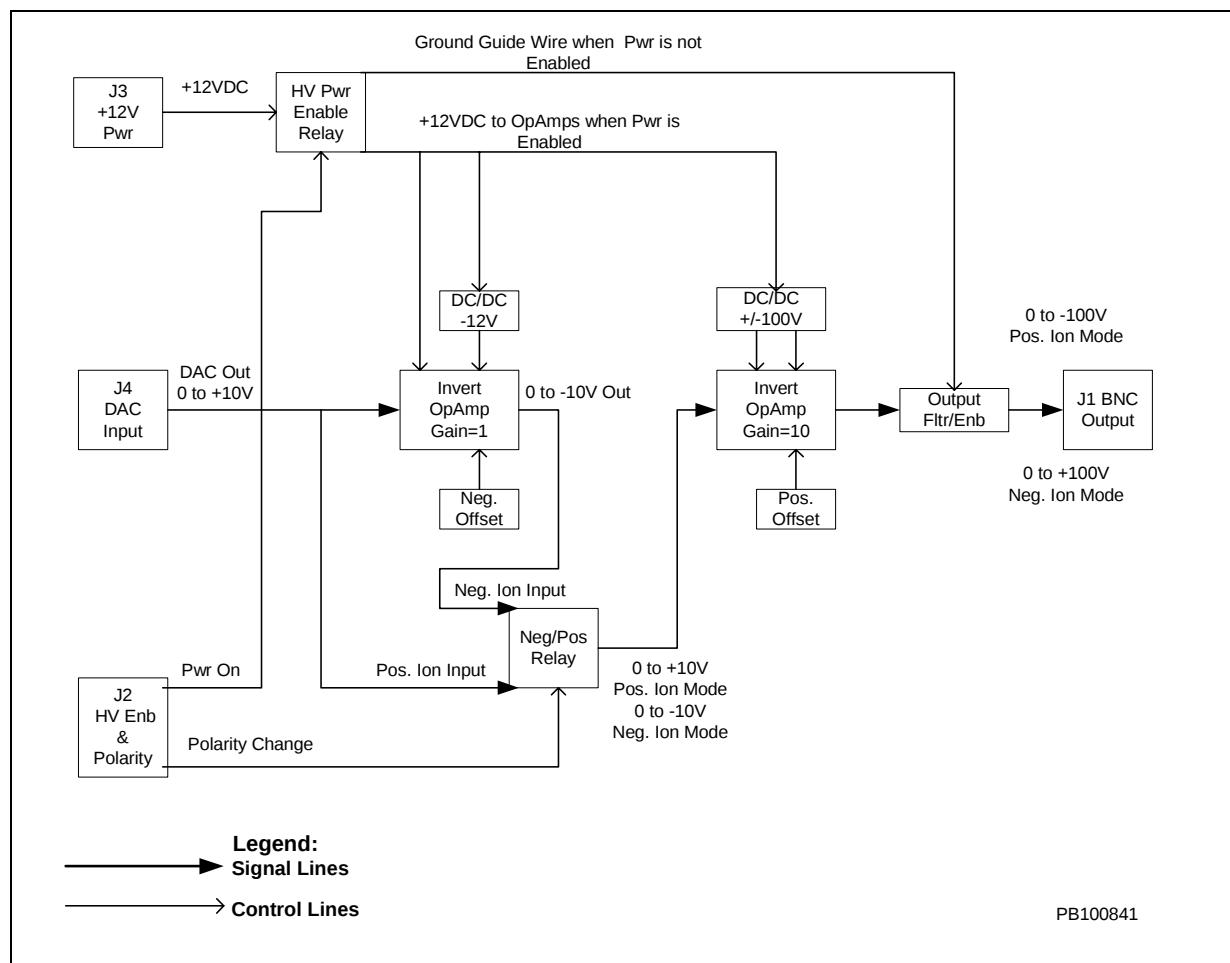


Figure 2-32 Flight (Drift)-Tube Power Supply Block Diagram

Theory

Ions of polarity opposite to the wire potential are drawn to the center of the flight tube by their attraction to the wire. Polarity applications are summarized in the following table.

Mode/Ions Attracted to Wire	Wire Potential
Positive ion	Negative
Negative ion	Positive

2

The Neg/Pos relay (controlled by J2) directs the 0 to 10 V signal from the guide wire DAC output to the power amplifier. The power amplifier amplifies the signal by a factor of 10, providing 0 to +100 V.

Connector J2 also provides a signal to activate the HV Power Enable relay. This relay has two outputs:

- **High Voltage disabled output**—Connects the guide wire to ground when high voltage is not enabled.
- **High Voltage enabled output**—Provides +12 V dc power to the two operational amplifiers when high voltage is enabled. The gain = 1 OpAmp receives +12 V directly from the relay and receives -12 V from a small DC/DC converter. The gain = 10 OpAmp receives +100 V and -100 V from a DC/DC converter powered by the same +12 V line.

The High Voltage Enable function operates with the “High Voltage Enable” on the Voyager software menu and is disabled by the Voyager hardware interlock.

See Section 5.5, Flight Tube and Mirror Chamber, for the steps to set the output to zero.

An earlier version of the Flight-Tube Power board has the same functionality and cable connections as the V750061 PCA. The earlier board has two relays and two programmable 100 V DC/DC power supplies. One relay provides High Voltage Enable and the other relay selects the output from either the Positive 100 V converter or the Negative 100 V converter. This PCA also has a potentiometer to adjust scale and can be replaced by the newer V750061 PCA.

Specifications

Power

Power specifications are:

- +24 V dc at approximately 20 mA to power the two relays
- +12 V dc at approximately 250 mA to power the two DC/DC converters and associated operational amplifiers

The guide wire is essentially a no-load device.

Input

Input impedance load presented to the DAC is approximately 10 K resistive.

Output

The guide wire receives 0.0 to -100 V dc in positive ion mode, and 0.0 to +100 V dc in negative ion mode. The output OpAmp is protected by an 100 ohm series resistor and by an internal thermal shutdown circuit. Ripple consists of approximately 5 mV peak-to-peak switching noise that can be measured with a coax cable directly connected to an oscilloscope.

Connectors and Trim Pots**Table 2-19 Connectors, Adjustments, and Tests on the Flight-Tube PCA**

Item	Name	Function	Type
Connectors	J1	Power Output: Horizontal 0 to –100 V Positive Ion mode and 0 to +100 V Negative Ion mode	BNC
	J2	HV Enable, Pos/Neg Ion Polarity, +24 V relay power	8-pin MTA locking header, 0.1-inch spacing
	J3	+12 V power for dual DC/DC converters and OpAmps	2-pin MTA locking header, 0.1-inch spacing
	J4	Program input from DAC	4-pin MTA locking header, 0.1-inch spacing
Trim Pots	RP9	Zero DC offset U2 (gain = 100) OpAmp, measure with digital voltmeter on output	Potentiometer
	RP8	Zero DC offset U1 (gain = 10) OpAmp, measure with digital voltmeter on output	Potentiometer
	Ripple	Approximately 5 mV peak-to-peak switching noise, measure with a coax cable directly connected to an oscilloscope	BNC Output Connector

2.4.2 Pulse Generator Board (V750063)

Overview

The Pulse Generator PCA can be configured for:

- Delayed-Extraction timing
- Timed Ion Selector timing

See [Table 2-20](#), for configurations.

In both functions, the board:

- Captures an input trigger
- Waits and counts off a pre-programmed delay
- Outputs a pulse of pre-programmed width

The circuit has 10-ns resolution and a 15-bit maximum delay (327 μ s).

Theory

The circuit can be divided into the following blocks ([Figure 2-33](#)):

- 100-MHz clock
- Trigger buffer and sync
- Latches
- Counters
- Address decoder
- Drivers

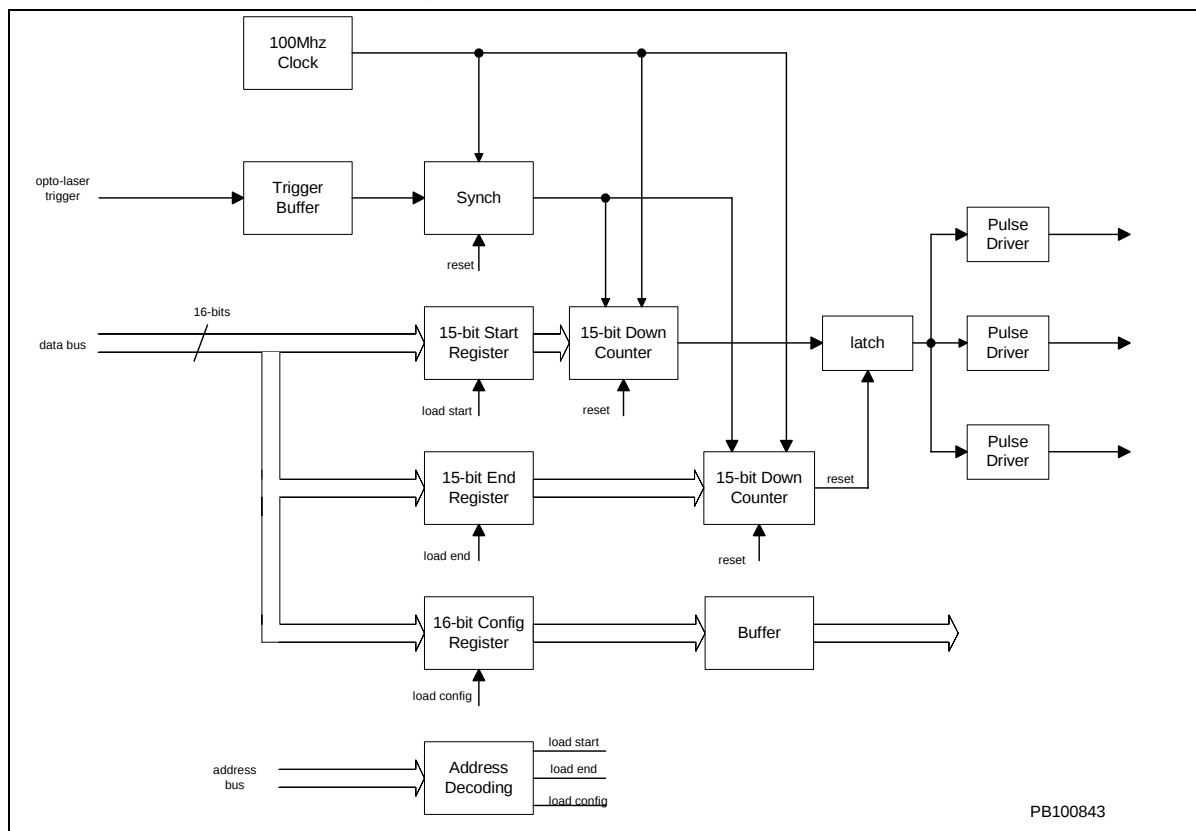


Figure 2-33 Pulse Generator Board Block Diagram

100-MHz Clock

The clock generates a 10-ns time base used by the counters, synchronizer, and address decoder.

Trigger Buffer

The trigger buffer takes a 3 to 12 V asynchronous pulse event, buffers it to 5 V, synchronizes it to the 100 MHz clock, then presents it as an enable signal to the two 15-bit counters.

Registers

There are three registers in the circuit:

- **Start-pulse register**—Loaded off the data bus with a 15-bit value that determines the start of the delayed output pulse. Along with the end-pulse register, this register determines the pulse delay and the pulse width.
- **End-pulse register**—Loaded off the data bus with a 15-bit value that determines the end of the delayed output pulse. Along with the start-pulse register, this register determines the pulse delay and the pulse width.
- **Configuration register**—Loaded off the data bus with a 16-bit value whose bits control logic functions and relays, such as Timed-Ion-Selector high voltage enable and control, DE box relays, and pulse generator enables.

Counters

There are two 15-bit down-counters loaded from the start- and end-count registers. These counters are pre-loaded at the same time the start- and end-count registers are loaded. When an enable signal is received from the Trigger buffer, the counters start counting down from their preset values.

When the start and end counters reach zero, the following occurs.

- **Start counter**—A latch is set high as the start of the delayed pulse.
- **End counter**—The latch is reset low as the end of the delayed pulse. The rest of the circuit is also reset and waits for the next input trigger.

Address Decoder

The address decoder decodes the address lines and the load control line, then loads the correct register, and presets the corresponding counter with the value on the data bus.

Drivers

The line drivers take the delayed pulse from the programmable logic circuit and provide enough current to drive the cabling to devices.

Types of Signals

The input signals to the pulse generator are:

- A trigger event
- Data and address lines from the Voyager bus
- Power

The output signals to the pulse generator are:

- A delayed pulse
- Configuration and control lines for relays and devices

Connectors, Headers, Jumpers, Test Points, and DIP Switches

Table 2-20 Functions of Pulse Generator Connectors, Headers, Jumpers, Test Points, and DIP Switches

Item	Name	Generic Function	DE Function	TIS Function	Type
Connectors	J0	Trigger in	Laser opto	Laser opto	2-position 0.1-inch header
	J1	Voyager bus	Voyager bus	Voyager bus	34-position ribbon
	J2	Auxiliary power out	Auxiliary power out	Auxiliary power out	10-position 0.1-inch header
	J3	+24 V in	+24 V in	+24 V in	3-position 0.1-inch header
	J4	Power in (+5 V, +15 V, –15 V)	Power in (+5 V, +15 V, –15 V)	Power in (+5 V, +15 V, –15 V)	9-position 0.1-inch header
	J5	TIS control	(Not used)	TIS control	4-position 0.1-inch header
	J6	Control I/O	Control I/O	Control I/O	Control I/O
	J7	Pulse out/ Control lines	DE Pulse	TIS pulse	7-position 0.1-inch header
	J8	Trigger in	Laser opto	Laser opto	BNC
	J9	Pulse out	DE Pulse	TIS pulse	BNC
	J10	Control lines	DE box control	TIS control/ power	8-position Mini-Fit
	J11/JP1	Pulse out	Digitizer trigger	(Not used)	BNC
	J12/JP2	Pulse out (spare)	Spare	Spare	BNC
	J13	+24 V out (can supply the fan)	(Not used)	(Not used)	2-position Mini-Fit
	J14	Not populated	Not populated	Not populated	Not populated
	J15	+24 V in	+24 V in	+24 V in	4-position Mini-Fit
	J16	Power in (+5 V, +15 V, –15 V)	Power in (+5 V, +15 V, –15 V)	Power in (+5 V, +15 V, –15 V)	10-position Mini-Fit

(continued)

**Table 2-20 Functions of Pulse Generator Connectors,
Headers, Jumpers, Test Points, and DIP Switches (Continued)**

Item	Name	Generic Function	DE Function	TIS Function	Type
Connectors (continued)	J17	Programming header	(Not used)	(Not used)	10-position ribbon
	JU1*	Addressing options	Jumped 5 - 6	Jumped 5 - 6	3 × 2 0.1-inch header
	JU2*	Board function DE/TIS	Shorted	Open	2 × 1 0.1-inch header
Switches	SW1*	Begin-pulse address	b0 off; b1,2,3 on	b0, 1, 2, 3 on	4-position DIP switch
	SW2*	End-pulse address	b0,3 off; b1,2 on	b0,1,2 on;b3 off	4-position DIP switch
	SW3*	Configuration address (=3)	b0,1 off; b2,3 on	b0,1 off; b2,3 on	4-position DIP switch
Test Points	TP1	−15 V dc	(Not used)	(Not used)	(Not used)
	TP2	−5.2 V dc	(Not used)	(Not used)	(Not used)
	TP3	+24 V dc	(Not used)	(Not used)	(Not used)
	TP4	+15 V dc	(Not used)	(Not used)	(Not used)
	TP5	+5 V dc	(Not used)	(Not used)	(Not used)
	TP6	Ground	(Not used)	(Not used)	(Not used)
	TP7	Delayed pulse out	DE trigger	TIS trigger	TTL
	TP8	Trigger input	Laser opto-trigger	Laser opto-trigger	TTL
Diodes	D2	−15 V dc LED	−15 V dc LED	−15 V dc LED	−15 V dc LED
	D4	−5.2 V dc LED	−5.2 V dc LED	−5.2 V dc LED	−5.2 V dc LED
	D5	+5 V dc LED	+5 V dc LED	+5 V dc LED	+5 V dc LED
	D7	+15 V dc LED	+15 V dc LED	+15 V dc LED	+15 V dc LED
	D9	+24 V dc LED	+24 V dc LED	+24 V dc LED	+24 V dc LED
	D11	Pulse out LED	Pulse out LED	Pulse out LED	Pulse out LED

* Configurable address and board function DE/TIS settings.

3 Before Servicing the Workstation

This chapter contains the following sections:

3.1	Voyager Laser Safety.....	3-2
3.1.1	Overview of Laser Safety	3-2
3.1.2	Required Customer-Provided YAG Laser Safety Measures	3-3
3.2	Venting the Voyager DE-STR Workstation	3-4
3.2.1	Preparing to Vent	3-4
3.2.2	Venting to Air	3-5
3.2.3	Purging the System to N2	3-5
3.3	Powering Up After Venting.....	3-6

3.1 Voyager Laser Safety

3.1.1 Overview of Laser Safety

Laser Classification

The Voyager-DE™ Biospectrometry™ Workstation uses a standard nitrogen laser and an optional Nd:YAG laser. Under normal operating conditions, the instrument laser is categorized as a Class I laser. Under certain conditions during servicing, when interlocks have been circumvented, the lasers fall into the following categories and can cause permanent eye damage:

- Nitrogen—Class IIIb
- Nd:YAG—Class IV

The Voyager-DE Biospectrometry Workstation complies with Title 21, U.S. Government DHEW/BRH Performance Standards, Chapter 1, Subchapter J, Section 1040, as applicable.

Laser Safety Features

The following safety features are included on the Voyager-DE Biospectrometry Workstation:

- Cabinet is designed to prevent access to collateral laser radiation exceeding the accessible emission limits in Performance Standards for Laser Products, 21 CFR 1040.10.
- Top, front, back, and side panels have interlock switches that disable the laser when panels are opened or removed.
- Safety labels for Class I standards are affixed to the unit.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. In External Trigger mode, the nitrogen laser energy storage capacitors are charged, and the laser is ready to fire at any time. When you perform service on the laser in External Trigger mode, remove jewelry and other items that can reflect the beam into your eyes or the eyes of others. Wear laser safety goggles and protect others from exposure to the beam. Post a laser warning sign.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. When instrument covers are removed, high voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles and post a laser warning sign at the entrance to the laboratory when you remove covers for service.

WARNING

LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing service.

Laser Safety Requirements

To ensure safe laser operation, note the following:

- The system must be installed and maintained by an Applied Biosystems Technical Representative.
- Top, front, back, and side panels must be installed during operation. When front and side panels are installed, there should be no detectable radiation present. If front or side panels are removed when the laser is operational, you may be exposed to laser emissions in excess of Class 1 rating.
- Do not remove labels or disable safety interlocks.

Additional Safety Information

Refer to the user manual provided with the laser for additional information on government and industry safety regulations.

3.1.2 Required Customer-Provided YAG Laser Safety Measures

Before servicing a system using the YAG laser, the customer is required to provide safety precautions. The YAG accessory supplied with the Voyager-DE STR is a class I laser, which is considered not capable of producing damaging radiation levels during operation. When maintenance requires an Applied Biosystems field service engineer to defeat the interlocks protection system for the instrument, the YAG laser is classified as a class IV laser. A class IV laser poses hazards to the eye and skin not only from the direct beam but in some cases also from the diffuse reflection. These lasers can be considered a fire hazard and may also produce laser-generated air contaminants and hazardous plasma radiation.

Therefore before you can perform maintenance or service on the YAG Laser while at the customer facility, the customer must:

- Provide the appropriate Laser Warning Signs. These signs shall be conspicuously displayed in a location where they will best serve to warn any and all onlookers.
- Provide the appropriate safety glasses/goggles to their employees if they are in the area while the laser is being serviced. The safety glasses/goggles must be rated for a YAG laser with a wavelength of 355 nm.
- Provide and document laser safety training to their employees on the hazards associated with a YAG laser.
- Remove all employees from the area where maintenance to the YAG laser is being performed.

In addition, all customers must be in compliance with the ANSI standard Z136.1-1993, American National Standard for the Safe Use of Lasers.

3.2 Venting the Voyager DE-STR Workstation

3.2.1 Preparing to Vent

To prepare the Voyager workstation for venting:

1. Close the Voyager software and other applications in the computer.

Newer Systems	Older Systems
Voyager Instrument Control Panel	Voyager control window
Voyager Data Explorer	GRAMS (Voyager software Version 4.51 and earlier)
Voyager Sequence Control Panel	NA
Instrument Hardware Controller (access from Windows Control Panel/Services)	NA (Only available with Voyager software Version 5.0 and later)

2. Turn off both BA1 and BA2 ion gauges from the multigauge controller.
3. On the rear panel of the instrument, turn off the Voyager STR workstation main power switch.
4. On the AC distribution board ([Figure 3-1](#)), disconnect (unplug) AC power to the following components:
 - Source turbo controller (J14)
 - Mirror (reflector) turbo controller (J13)
 - Fore (roughing) pump power (J1)

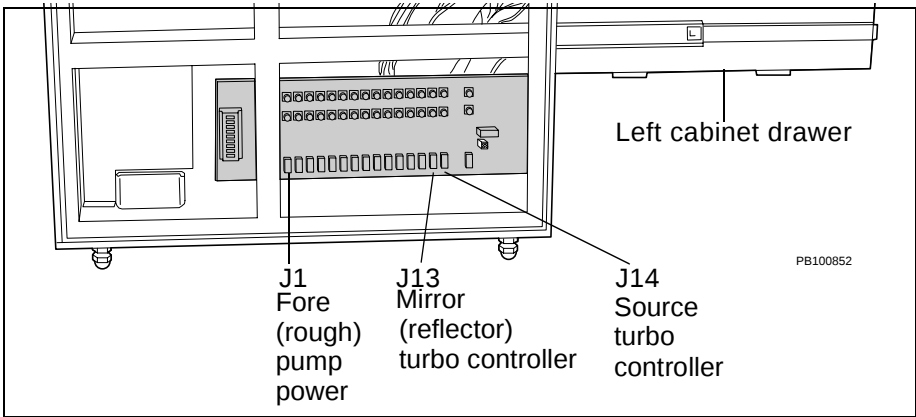


Figure 3-1 AC Power Connectors.

5. To prevent possible damage to the turbo pump balanced blades, allow the turbos to spin down for 5 to 10 minutes.

3.2.2 Venting to Air

Allow air to flow into the chamber slowly as described in the following table. As air flows into the vacuum chamber, you hear a slight hissing indicating atmosphere is seeping into the vacuum chamber.

Step	Newer Systems	Older Systems
1	Locate the filter mounted on the vent valve of the source turbo and mirror turbo.	Locate the small knurled vent screw on the side of the turbo.
2	Lift up the lever attached to the turbo vent valve to open the valve.	Loosen the vent screw slowly. CAUTION. <i>DO NOT</i> loosen the vent screw completely. The small knob may become lost and the vent screw O-ring may become detached.
3	When the sound of flowing air has stopped completely, close the turbo vent valve lever.	When the sound of flowing air has stopped completely, re-tighten the knurled vent screw by hand. CAUTION. <i>When tightening the knurled vent screw, DO NOT</i> over tighten it.

When the system is vented, the ion detector is exposed to the atmosphere. If the detector is exposed for more than 24 hours, the following problems may occur:

- A film of water and other molecules may form on the surface of the detector. The film can cause arcs across the surface of the detector when full voltages are applied.
- The detector may absorb moisture and may swell and crack.

For systems that will be at atmosphere for more than 24 hours, purge the system to N₂. Purging to N₂ protects detector integrity as well as minimizes pump down time. Pump down time is the time needed to return the system to vacuum after venting. The length of time the system was at atmosphere determines the pump down time. To estimate pump down time, multiply the time the system was at atmosphere by three.

3.2.3 Purging the System with N₂

To purge newer systems with N₂ gas:

1. Connect the N₂ gas tank to the filter on the source turbo venting valve. Connect one end of the regulator to the vent filter using a 3/8" O.D. clear PVC tubing and connect the other end of the regulator to the nitrogen drop line.
2. Preset pressure on the regulator to 5 psig.
3. Open the valve on the N₂ gas tank.
4. Lift up the lever attached to the turbo vent valve, allowing N₂ to flow into the chamber slowly.
5. Close the turbo vent valve when the sound of flowing N₂ has stopped completely.
6. Close the gas valve on the N₂ tank.
7. Disconnect the clear PVC tubing from the filter on the turbo venting valve.

3.3 Powering Up After Venting

Before powering up the Voyager workstation after venting:

1. Close all open vent valves.
2. Reconnect and secure all vacuum connections.
3. Switch on the Voyager workstation main power.

Once the valves are closed, vacuum connectors are secure, and the Voyager workstation main power is on:

1. On the AC distribution board, connect (plug in) the fore pump to the J1 connector ([Figure 3-1 on page 3-4](#)).
2. Monitor the TC2 vacuum reading on the multigauge controller. (For information, see [Section 5.7.2, Multigauge Controller](#).)
3. When the reading reaches below 3×10^{-1} torr, reconnect the following cables to the AC distribution board ([Figure 3-1 on page 3-4](#)):
 - The source turbo controller (J14)
 - The mirror turbo controller (J13)
4. Observe the turbo status indicator lights on the Voyager workstation top panel LED display or the D12 LEDs on the MALDI control board. Both of the status indicator lights on the turbos should display the following sequence of colors:
 - Yellow for about 1 minute—Indicating initial startup
 - Yellow and green briefly—Indicating turbo reached 80% of full speed
 - Green only—Indicating the turbo is at normal operating condition (56 krpm)

Red indicates a fault.

5. Wait an additional 10 to 30 minutes.

After the turbo has stabilized:

1. Using the multigauge controller, turn on the BA1 and BA2 gauges. (For information, see [Section 5.7.2, Multigauge Controller](#).)

Both vacuum readings should be below 8×10^{-5} torr, or you should see indications that the system is pumping down to a lower level.

2. Allow the system to pump down further to reach system operational pressures. Normally, BA1 should be below 9×10^{-7} torr. BA2, the mirror, is typically 10 times lower, 9×10^{-8} torr.

NOTE: To achieve a pressure below 9×10^{-7} torr may take the system a day or more.

3. When the system pressure readings are 9×10^{-6} torr or less, reboot the computer and launch the Voyager control panel.

4 Voyager Diagnostics Software

This chapter contains the following sections:

- 4.1 Overview 4-2
- 4.2 Voyager Software Compatibility 4-2
- 4.3 Accessing the Diagnostics Software 4-3
- 4.4 Diagnostics Software Features 4-5
 - 4.4.1 Control Pages4-5
 - 4.4.2 Status Bar4-11

4.1 Overview

The Voyager 32-Bit Diagnostics software for NT platform interface ([Figure 4-3](#)) allows you to:

- Troubleshoot or isolate electrical, mechanical, and vacuum problems
- Test the system after repairing or replacing parts
- Control the hardware components when the Instrument Hardware Controller (IHC) and Instrument Control Panel (ICP) are shut down.

You can run the diagnostics software whether the instrument is operating under vacuum or at atmosphere (ATM).

4.2 Voyager Software Compatibility

[Table 4-1](#) shows the compatibility between the various Diagnostics and Voyager Software versions and platforms.

Table 4-1 *Diagnostics and Voyager Software Version Compatibility*

Diagnostic Software	Platform	Compatible Voyager Software
<i>Voyager 32-bit</i>	<i>NT</i>	<i>Voyager Version 5.1 and later</i>
<i>Voyager 16-bit</i>	<i>NT</i>	<i>Voyager Version 4.51 through Version 5.01</i>
<i>Voyager 16-bit</i>	<i>Windows</i>	<i>Voyager Version 4.04 and earlier</i>

4.3 Accessing the Diagnostics Software

Before Accessing

Before accessing the diagnostics software, close the ICP and shut down the IHC as follows.

1. From the Start menu, select **Settings, Control Panel**.

2. In Control Panel, double-click  .
Services

The Services dialog box appears ([Figure 4-3](#)).

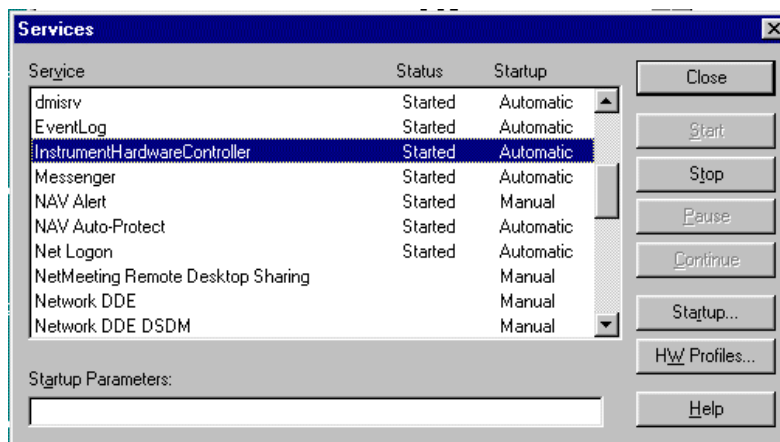


Figure 4-1 Services Dialog Box

3. Highlight the Instrument Hardware Controller program and click **Stop**.

Once the IHC has stopped, close this dialog box.

Accessing

To access the diagnostics software:

1. From the **Start** menu, select **Programs, Voyager**, and the appropriate Voyager diagnostics option. The Voyager Diagnostics software for NT platform option is highlighted in [Figure 4-2](#).



Figure 4-2 Start/Programs/Voyager Options

2. Use the View menu or click individual tabs to access the component control pages

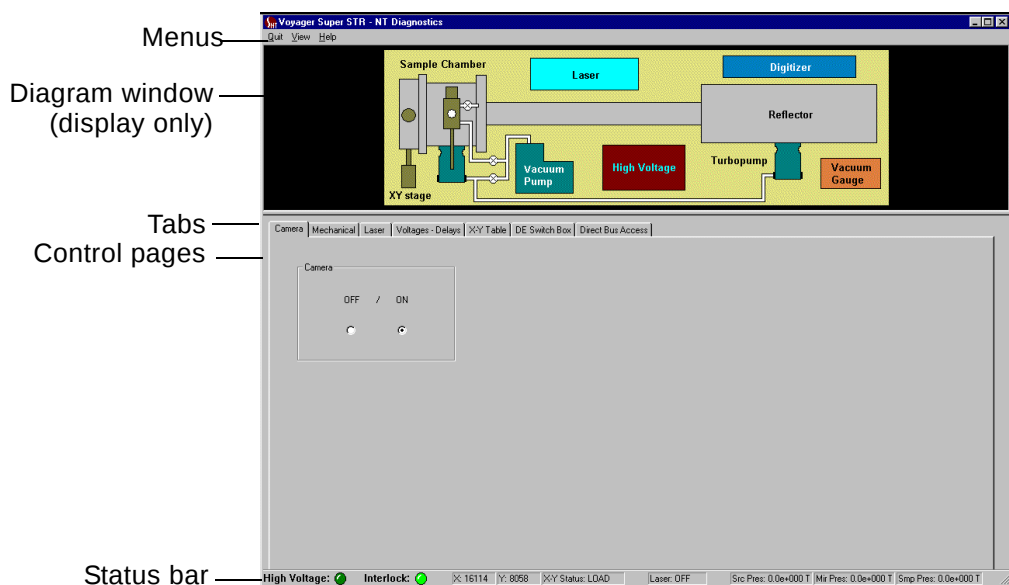


Figure 4-3 Voyager 32-Bit Diagnostics Software for NT Platform Window

3. To restart the IHC, you can do one of the following:

- Manually restart through the Services dialog box
- Reboot the computer system
- Launch the Instrument Control Panel

4.4 Diagnostics Software Features

4.4.1 Control Pages

Control pages ([Figure 4-3](#)) provide control over the instrument components. Using control pages for specific tasks is detailed in various sections in Chapter 5, Troubleshooting by Components, and in [Appendix A, Isolating Components Using Direct Bus Access](#). Where to find information about each control page is summarized in [Table 4-2](#).

Table 4-2 Matching Control Page with Figure and Specific Task Information

Control Page	Figure	Section Describing Tasks
Camera	Figure 5-28	Section 5.6, Computer and Video Systems
Mechanical	Figure 5-3	Section 5.2.4, Grabber, Linear Actuators, and Valves
Laser	Figure 5-25	Section 5.4.1, Laser Firing, Repetition Rate, and Reinitialization
Voltages-Delays	Figure 5-19	Section 5.3.8, Source, Grid, and Mirror Voltages
X-Y Table	Figure 5-7	Section 5.3, Main Source Chamber
DE Switch Box	Figure 5-21	Section 5.3.10, DE Switch Box Control
Direct Bus Access	Figure D-1	Appendix D, Isolating Components Using Direct Bus Access

[Table 4-3](#) summarizes the functions of each control page. To find the control page and troubleshooting sections applicable to a specific workstation component, refer to [Table 5-1. Matching Components with Control Page and Troubleshooting Information](#).

Table 4-3 Summary of Diagnostics Software Control Pages

Fields and Actions	Status Indicators	Comment
Camera Control Page —Powers-on and powers-off the camera		
Camera Off/On	None	By default, the Camera control page appears and powers on the camera and video lamps when you start the Voyager diagnostics software for NT platform.
Mechanical Control Page —Opens and closes the valves, extends and retracts the linear actuators, turns the grabber on and off, runs single or multiple load/eject cycles, and restarts faulted vacuum gauges		
Valves Close/Open: Flap Door #1, 2 Foreline Valve #1, 2 Vent valve Actuators Retract/ Extend: Linear #1 Linear #2	Flap Door #1 Closed/Open Flap Door #2 Open Linear #1 Retracted/Extended Linear #2 Retracted	Allows you to manually open and close the doors and valves to remove a stuck sample plate. Note: You can activate the flap doors and linear actuators only when the air compressor is running. The air compressor runs only when the sample stage is in the load region.
Grabber Off/On		Under normal operating conditions, the grabber powers on just before the Linear 1 actuator starts to extend or retract (if ejecting), and it powers off just after the Linear 1 actuator has fully retracted.

(continued)

Table 4-3 Summary of Diagnostics Software Control Pages (Continued)

Fields and Actions	Status Indicators	Comment
Mechanical Control Page (continued)		
Load Eject Cycle: Single iteration Multiple iterations Ignore vacuum faults Restart faulted vacuum gauges	Load Eject Cycle current operation	You can abort load/eject operations while they are executing, but doing so could place the system in an unsafe state. You can return the system to a safe state by clicking the appropriate radio buttons to open or close the affected components—flap doors, foreline valves, and linear actuators. When the instrument is operating at atmosphere, you can force the diagnostics software to ignore all vacuum gauge faults and finish load/eject operations. CAUTION: <i>Using this option to ignore and override vacuum gauge faults when the system is operating under vacuum could damage the ion gauges, O-ring seals, and vacuum pumps.</i>
Laser Control Page —Sets the laser repetition rate, re initializes the internal and external (if installed) laser, and adjusts the attenuator		
Fire laser		
Desired repetition rate	NA	You can adjust the laser repetition rate only if the system contains these optimization components: • Voyager V5.1 and later software • Consolidated control board (V750082 and V750102-001, V750102-002, V750102-003) with firmware (V960005rD and D/V960006rD) installed • Fast DE switch box (V725125) • 48-bit I/O control board (V750033) configured for 5-bit addressing NOTE: <i>Currently, regardless of the laser optimization components, the Voyager laser does not support repetition rates greater than 20 Hz. Setting the repetition rate to a value ≥ 20 Hz causes the laser to cease firing after it emits the first pulse.</i>
Laser type, re-initialize	NA	NA

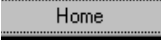
(continued)

Table 4-3 Summary of Diagnostics Software Control Pages (Continued)

Fields and Actions	Status Indicators	Comment
Laser Control Page (continued)		
Beam attenuation	Current beam attenuation	NA
Home beam attenuator	Limit switch at home	NA
Voltages and Delays Control Page —Sets all voltages and delay times in linear and reflector modes <i>NOTE: After changing any of the settings on this control page, you must apply them before they can take effect. To do so, click . If you leave the Voltage and Delays control page without applying the changes, you lose the changes. The values revert to the last applied settings.</i>		
Modes of operation: Linear, Reflector	NA	NA
Desired Voltages: Source Grid Mirror Guide Wire Ramp voltages Reset all	Actual voltages: Source Grid Mirror Guide Wire Ramping status	If you set and apply voltage for the source, grid, mirror, or guide wire without enabling high voltage, the diagnostics software programs only the corresponding DACs. You can verify these output voltages with a voltmeter. (DAC voltages are shown in Table D-2 on page D-8 .) To detect output voltages at the test points of the corresponding components, you must also enable and apply high-voltage.
Delays: <u>Delayed Extraction</u> Enable, Start delay time <u>Low Mass Gate</u> Enable, Start delay time <u>Timed Ion Selector</u> Enable, Start delay time, End delay time Set delays Reset all	NA	By pressing  , you set the delays specified for Delayed Extraction, Low Mass Gate, and Timed Ion Selector only when you have also enabled them. (It does not affect delays associated with ramping component voltages.)

(continued)

Table 4-3 Summary of Diagnostics Software Control Pages (Continued)

Fields and Actions	Status Indicators	Comment
X-Y Table Control Page —Moves the sample stage, resets home and load positions Before you can access the functions on this control page, you must click  to move the sample stage to its home position (0,0). This initializes the diagnostics software controls, enabling the software to calculate all other positions, including load position.		
Sample stage X, Y position: scroll bar desired position (counts or microns)	Current position	One step equals 3.175 μm . You can use either unit and switch back and forth between them. The diagnostics software performs the necessary conversions automatically. The micron is used in the NT Registry editor.
Move to: desired home load	Limit switches: home load	NA
Set load position	NA	NOTE: The SET Load Position button on the X-Y Table control page initiates a data write to the Registry file. The next time it is accessed, the Voyager Instrument Control Panel reads the new X,Y coordinates from the Registry file to determine the sample stage load position. Record the old coordinates in case you need to revert to them.
DE Switch Box Control —Checks the control wiring on the DE switch box		
Check control wiring test	Check Control Wiring test steps through expected voltage readings and instructions	Before you begin, assemble your voltmeter and meter probes, and access the DE switch box. This test checks the operative states of the three high-voltage kilovac relays by looking at resistance between J2 and J4 and the admittance between J3 and J2/Gnd.
DE Switch Box type	NA	V725059 Three-connector, high-voltage switch box in Voyager-DE STR workstation with serial numbers 4147 and earlier V725115 Four-connector, high-voltage switch box in systems with serial numbers 4148 through 4160 V725125 Four-connector fast DE switch box in systems with serial numbers 4161 and later

(continued)

Table 4-3 Summary of Diagnostics Software Control Pages (Continued)

Fields and Actions	Status Indicators	Comment
4 Direct Bus Access Control Page— Writes data directly to the various DACs, pulse generators, and ion source pulsar control register. For information, see Appendix D. Isolating Components Using Direct Bus Access. You cannot enable high-voltage or the Low Mass Gate using direct bus access. With direct bus access, you can only set the output voltage at the DACs and the Low Mass Gate value. Before you write data to any component, make sure you have appropriately connected or disconnected the high-voltage lines and connected meter probes or voltmeters to the appropriate DACs. <i>WARNING. ELECTRICAL SHOCK HAZARD.</i> Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury.		
Write address directly to the data bus for the: Source DAC Mirror DAC Grid DAC Beam guide DAC Control register LMG delay DE delay TIS delay	NA	Set value as decimal, hexadecimal, or binary

4.4.2 Status Bar

Use the Diagnostics Software window status bar (expanded drawing shown in [Figure 4-4](#)) to check the items described in [Table 4-4](#).



Figure 4-4 System Status Bar (Shown in Two Parts for Clarity)

Table 4-4 Diagnostics Software Status Bar Indicators

Component	Status
High Voltage	Indicates whether the high voltage is ON or OFF
Interlock	Indicates if the Voyager workstation covers (top, front, side, and rear panels) are locked in place. When the covers are securely in place, the interlock LED remains lit. If the interlocks are breached during normal operation, the system automatically disables the lasers and high-voltage supplies. For example, if the panels are off or ajar, the lasers, high-voltages, and the interlock and high-voltage LEDs remain off until the panels are secured. To operate the system with the panels removed during servicing, you can bypass the interlocks.
X	Displays the current X coordinate position of the sample stage
Y	Displays the current Y coordinate position of the sample stage
XY Status	Indicates whether the sample stage is currently in the load, home, or other (None) position
Laser	Indicates whether the laser is ON or OFF
Src Pres	(BA1) Displays the current pressure (in torr) in the main source chamber
Mir Pres	(BA2) Displays the current pressure (in torr) in the reflector mirror chamber
Smp Pres	(TC2) Displays the current pressure (in torr) in the sample-loading chamber

5 Troubleshooting by Components

This chapter contains the following sections:

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5.1 Troubleshooting Overview

This manual describes troubleshooting using:

- The Voyager Diagnostic software, introduced in [Section 4.4.1, Control Pages](#), and detailed in various sections in Chapter 5, Troubleshooting by Components
- The procedures in Chapter 5, Troubleshooting by Components
- The tables in Chapter 6, Troubleshooting by Symptoms

These methods are complimentary. For example, you may view the Diagnostic software control pages to determine which component is experiencing a problem, then turn to the appropriate section in Chapter 5, Troubleshooting by Components. In other cases, you may look up a symptom in Chapter 6, Troubleshooting by Symptoms, and use the diagnostics software to verify or correct the problem, referring to Chapter 5, Troubleshooting by Components for information on the appropriate control pages for servicing a specific component.

To find the control page and troubleshooting sections applicable to a specific workstation component, refer to [Table 5-1](#).

Table 5-1 Matching Components with Control Page and Troubleshooting Information

Component or Parameter	<u>Task</u> : Control Page	Troubleshooting Section
BA1, BA2, TC2	<u>Observe status</u> : Diagnostics Software Window Status bar: BA1, Srce Pres BA2, Mir Pres TC2, Smp Pres	Section 5.2.6, Vacuum Faults Section 5.7.1, Vacuum Gauges and Pumps Section 5.7.2, Multigauge Controller Section 6.1.5, Vacuum System Section 6.2, Multigauge Controller Common Error Codes
Beam attenuation	<u>Set laser attenuation</u> : Laser	Section 5.4.1, Laser Firing, Repetition Rate, and Reinitialization Section 5.4.2, Laser Attenuation Section 6.1.1, Spectral Problems
Beam guide wire DAC	<u>Set output voltage</u> : Direct Bus Access (Appendix D,)	NA
Beam-steering plates and voltage connections	<u>Set/observe values</u> : Voltages-Delays (source)	Section 5.3.8, Source, Grid, and Mirror Voltages
Camera	<u>Turn camera off/on</u> : Camera	Section 5.6, Computer and Video Systems

Table 5-1 Matching Components with Control Page and Troubleshooting Information

Component or Parameter	<u>Task</u>: Control Page	Troubleshooting Section
Control Register (high-frequency counter and ion source pulsar)	<u>Set values</u> : Direct Bus Access (Appendix D,)	NA
Delayed-extraction	<u>Enable</u> : Voltages-Delays <u>Set start delay</u> : Voltages-Delays, Direct Bus Access	Section 5.3.7, Delayed-Extraction Ion Source Section 5.3.10, DE Switch Box Control Section 6.1.1, Spectral Problems
DE switch box	<u>Test voltages</u> : DE Switch Box	Section 5.3.7, Delayed-Extraction Ion Source Section 6.1.1, Spectral Problems
Einzel lens assembly and voltage connection	<u>Set/observe values</u> : Voltages-Delays (source)	Section 5.3.8, Source, Grid, and Mirror Voltages Section 6.1.1, Spectral Problems
Feedthroughs	<u>Observe coordinates/status</u> : Window Status bar X; Y; X-Y Status	Section 5.3.3, Stepper Motor Feedthroughs Section 6.1.2, Sample Loading and Main Source Chamber
Flap Doors #1 and #2	<u>Close/open, observe status</u> : Mechanical	Section 5.1, Troubleshooting Overview Section 5.7.1, Vacuum Gauges and Pumps Section 6.1.2, Sample Loading and Main Source Chamber Section 6.1.5, Vacuum System
Foreline Valve #1 and #2	<u>Close/open</u> : Mechanical	Section 5.2.2, Internal Interlocks Operation Section 5.2.5, Load/Eject Cycles Section 5.2.7, Mechanical Control Page Errors and Warnings Section 6.1.5, Vacuum System
Grabber	<u>Turn grabber off/on</u> : Mechanical	Section 5.2.2, Internal Interlocks Operation Section 5.2.4, Grabber, Linear Actuators, and Valves Section 5.2.5, Load/Eject Cycles Section 5.3.2, Source Pedestal Section 5.3.5, Internal High-Voltage Cable Section 6.1.2, Sample Loading and Main Source Chamber

Table 5-1 Matching Components with Control Page and Troubleshooting Information

Component or Parameter	<u>Task</u> : Control Page	Troubleshooting Section
Grid DAC	<u>Set output voltage</u> : Direct Bus Access	Section 5.3.8, Source, Grid, and Mirror Voltages Section 5.3.10, DE Switch Box Control
Grid Voltage	<u>Set values</u> : Voltages-Delays <u>Test high voltages</u> : DE Switch Box	Section 5.3.8, Source, Grid, and Mirror Voltages Section 5.3.10, DE Switch Box Control
Guide wire voltage	<u>Set values</u> : Voltages-Delays Test high voltages: DE Switch Box	NA
High voltages	<u>Observe status</u> Diagnostics Software Window Status bar: High Voltage <u>Enable</u> : Voltages-Delays <u>Test</u> : DE Switch Box	Section 5.3.4 Section 5.3.5 Section 5.3.7 Section 5.3.8 Section 5.3.10 Section 5.5.1 Section 6.1.1 Section 6.1.4
Home position	<u>Home sample stage</u> : X-Y Table	see X and Y feedthroughs
Laser	<u>Observe status</u> Diagnostics Software Window Status bar: Laser <u>Fire, set repetition rate, attenuation, and laser type</u> : Laser	Section 5.4 Section 6.1.1 Section 6.1.3
Limit switches, microswitches	<u>Observe status</u> : Mechanical	Section 5.2.4 Section 5.3 Section 5.3.3 Section 6.1.2 Section 6.1.3
Linear actuators	<u>Retract/extend</u> : Mechanical	Section 5.2 Section 5.2.1 Section 5.2.4 Section 5.3 Section 5.3.2 Section 6.1.2 Section 6.1.5
Linear mode	<u>Set mode</u> : Voltages-Delays	Section 5.3.7 Section 5.3.8 Section 6.1.1

Table 5-1 Matching Components with Control Page and Troubleshooting Information

Component or Parameter	<u>Task</u>: Control Page	Troubleshooting Section
Load position	<u>Set coordinates</u> ; move sample stage: X-Y Table	see X and Y feedthroughs
Low-Mass Gate	<u>Enable</u> : Voltages-Delays <u>Set start delay</u> : Voltages-Delays, Direct Bus Access	Section 5.3.8 Section 5.3.9
Mirror DAC, voltage	DAC <u>Set output voltage</u> : Direct Bus Access Voltage <u>Set values</u> : Voltages-Delays <u>Test high voltages</u> : DE Switch Box	Section 5.3.6 Section 5.3.8
Polarity (Positive, negative)	<u>Set</u> : Voltages-Delays	Section 5.3.8 Section 6.1.1
Reflector mode	<u>Set mode</u> : Voltages-Delays	Section 5.3.6 Section 6.1.1
Sample loading and ejecting single or multiple iteration cycles	<u>Initiate load/eject cycles</u> : Mechanical	Section 5.2.4 Section 5.2.5
Source DAC, voltage	DAC. <u>Set output voltage</u> : Direct Bus Access Voltage. <u>Set values</u> : Voltages-Delays <u>Test high voltages</u> : DE Switch Box	Section 5.3.7 Section 5.3.8 Section 6.1.1
Sample Stage X, Y table	<u>Set Load position</u> : X-Y Table <u>Initiate load/eject cycles</u> : Mechanical	Section 5.2.4 Section 5.2.5 See also X and Y feedthroughs
Timed Ion Selector	<u>Enable</u> : Voltages-Delays <u>Set start and end delay</u> : Voltages-Delays, Direct Bus Access	Section 5.3.8 Section 5.3.9 Section 5.5.1
Variable grid		Section 5.3.4 Section 5.3.5 Section 5.3.8 Section 5.3.10

Table 5-1 Matching Components with Control Page and Troubleshooting Information

Component or Parameter	<u>Task</u> : Control Page	Troubleshooting Section
Vent valve	<u>Close/open</u> : Mechanical	Section 5.2.2 Section 5.2.4 Section 5.2.7
X and Y feedthroughs; Home and Load positions	<u>Set load position</u> : X-Y Table	Section 5.3 Section 5.3.3 Section 6.1.2 Section 6.1.3

¹The multigauge controller in the Voyager system monitors the vacuum system thermocouple (TC2) and Bayard-Alpert gauges (BA1 and BA2).

Additional Resources

In addition to this manual and the Voyager Diagnostics Software, you can access information in two databases:

- **The Voyager (MALDI) Product Support web site**—Provides standard information such as Service Bulletins, Service Notes, and support contact information.
- **The Voyager (MALDI) knowledge database**—Allows an exchange information with other service engineers.

You can review the web site and the knowledge database 24 hours/day, 7 days a week. Each database is fully text searchable and is individually replicated on Lotus Notes. You can also call on the Regional Specialist, the Field Service Technical Specialist, and the Product Support Specialist. For information, see [Appendix A, Technical Support and Training](#).

5.2 Sample Loading Chamber

When loading a sample plate, the sample plate is transported from the outside holder, into the sample loading chamber, then into the main source chamber through vacuum chambers at various pressures. The sample loading chamber ([Figure 5-1](#)) transports the sample plate between these areas using linear actuators, flap door actuators, and stepper motors.

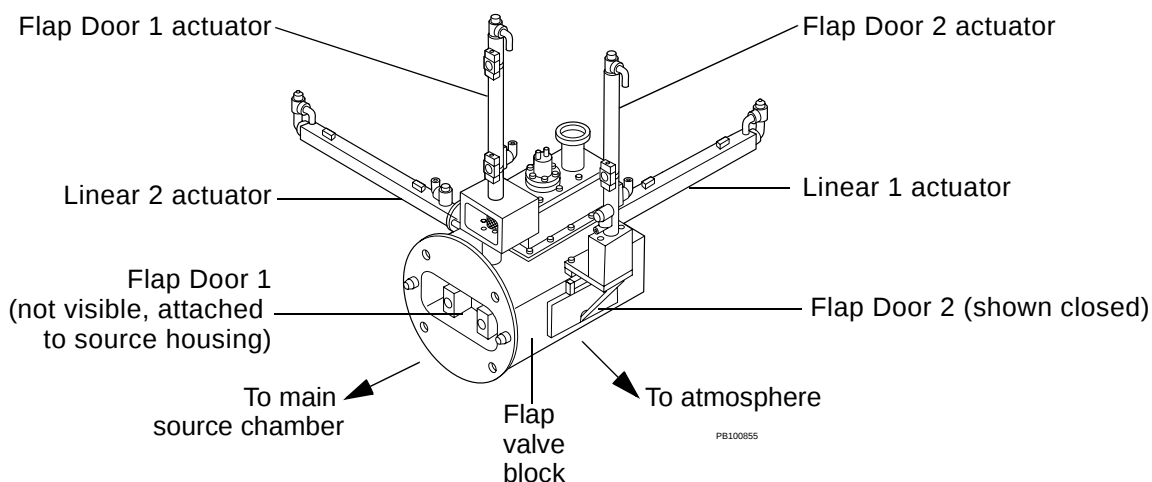


Figure 5-1 Voyager-DE STR Workstation Sample Loading Chamber

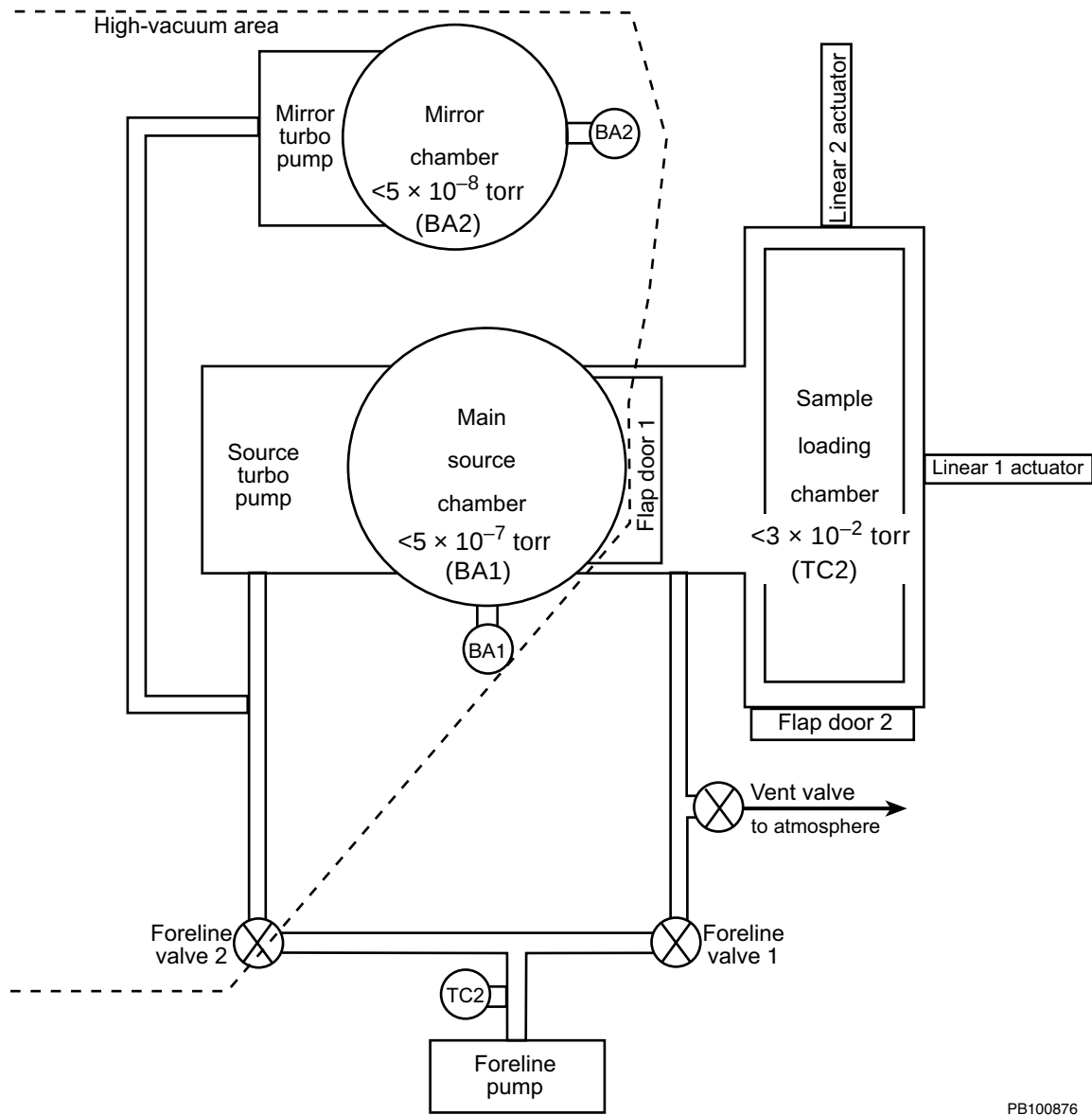
5.2.1 Vacuum System Interaction

The actuators operate with a minimum of 15 PSI (1.03 bar). An integrated compressor supplies pneumatic energy to:

- Open and close the flap doors
- Extend and retract the linear actuators

NOTE: You can activate the flap doors and linear actuators only when the air compressor is running. The air compressor runs only when the sample stage is in the load region.

Because the linear and flap door actuators are pneumatically controlled, the performance of the sample loading chamber may be affected by problems in the vacuum system ([Figure 5-2](#) on page 5-8).



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Figure 5-2 Sample Loading System and Typical Vacuum Pressures

5.2.2 Internal Interlocks Operation

Under normal operating conditions, procedures that require you to open and close any of the various valves, move the actuators, or power off the grabber can compromise the system's internal interlocks and damage the instrument, unless prerequisites specific to the operation are first met. Before performing such operations, know their prerequisites and the possible consequences of noncompliance. [Table 5-2](#), "Internal Interlock Hazard Control," on page 3-9 lists these operations and their prerequisites. When using the diagnostics software to control the component, failure to meet the prerequisites generates an error or a warning. An error is the result of a severe hazard and forces the operation to abort. A warning allows the option of continuing the operation with risk of damaging the instrument.

Table 5-2 Internal Interlock Hazard Control

To perform this operation ...	Do this first ...	Otherwise this occurs ...
Flap Door 1		
Open Flap Door 1	When under vacuum: • Close Flap Door 2. • Close the vent valve.	Warning
Close Flap Door 1	Retract Linear 1 actuator.	Error
Flap Door 2		
Open Flap Door 2	When under vacuum: • Close Flap Door 1. • Close Foreline valve 1. • Open the vent valve.	Warning
Close Flap Door 2	Retract Linear 2 actuator.	Error
Foreline 1		
Open Foreline 1	When under vacuum: • Close Flap Door 2. • Close the vent valve.	Error

Table 5-2 Internal Interlock Hazard Control (Continued)

To perform this operation ...	Do this first ...	Otherwise this occurs ...
Foreline 2		
Open Foreline 2	When under vacuum, close Foreline valve 1. OR 1. Close the vent value and Flap Door 2 2. Open Foreline valve 1 3. Wait until TC2 reads less than 8×10^{-2} torr*.	Warning
 *CAUTION: After you vent the sample-loading chamber, close the vent valve. Open Foreline valve 1. Wait to open Foreline valve 2 until TC2 reads less than 8×10^{-2} torr. If you open Foreline valve 2 before the foreline pump has reestablished a vacuum in the sample-loading chamber, you create a pressure burst that impacts the back of the turbo pumps. The burst may shut down the ion gauges (BA1 and BA2). You can restart the ion gauges after approximately 10 seconds. However, the vacuum system takes some time to stabilize.		
Vent valve		
Open the vent valve	Close Flap Door 1. Close Foreline Valve 1.	Error
Close the vent valve	Close Flap Door 2.	Warning
Linear 1 actuator		
Extend Linear 1 actuator	When under vacuum: - Open Flap Door 1. - Retract Linear 2 actuator. - Have the sample stage in Load position. In addition: - Close Flap Door 2. - Close the vent valve.	Error No error message occurs if these conditions are not meet, but controls are disabled.

Table 5-2 Internal Interlock Hazard Control (Continued)

To perform this operation ...	Do this first ...	Otherwise this occurs ...
Retract Linear 1 actuator	When vented, open Flap Door 1. When under vacuum: • Open Flap Door 1. • Close Flap Door 2. • Close the vent valve.	Error
Linear 2 actuator		
Extend Linear 2 actuator	Retract Linear 1 actuator. Open Flap Door 2.	Error
Retract Linear 2 actuator	Open Flap Door 2.	Error
Grabber		
Grabber off	Move the sample stage to Load position AND retract the Linear 1 actuator.	Warning

5.2.3 Camera

The camera enables you to see on the external monitor the sample spot and location where the laser is striking. The Diagnostics Software Camera control page ([Section 5.6, Computer and Video Systems](#)) shows the status of the camera.

5.2.4 Grabber, Linear Actuators, and Valves

Use the Diagnostics Software Mechanical control page ([Figure 5-3](#)) to manually control the valves, linear actuators, grabber, and load/eject cycles.

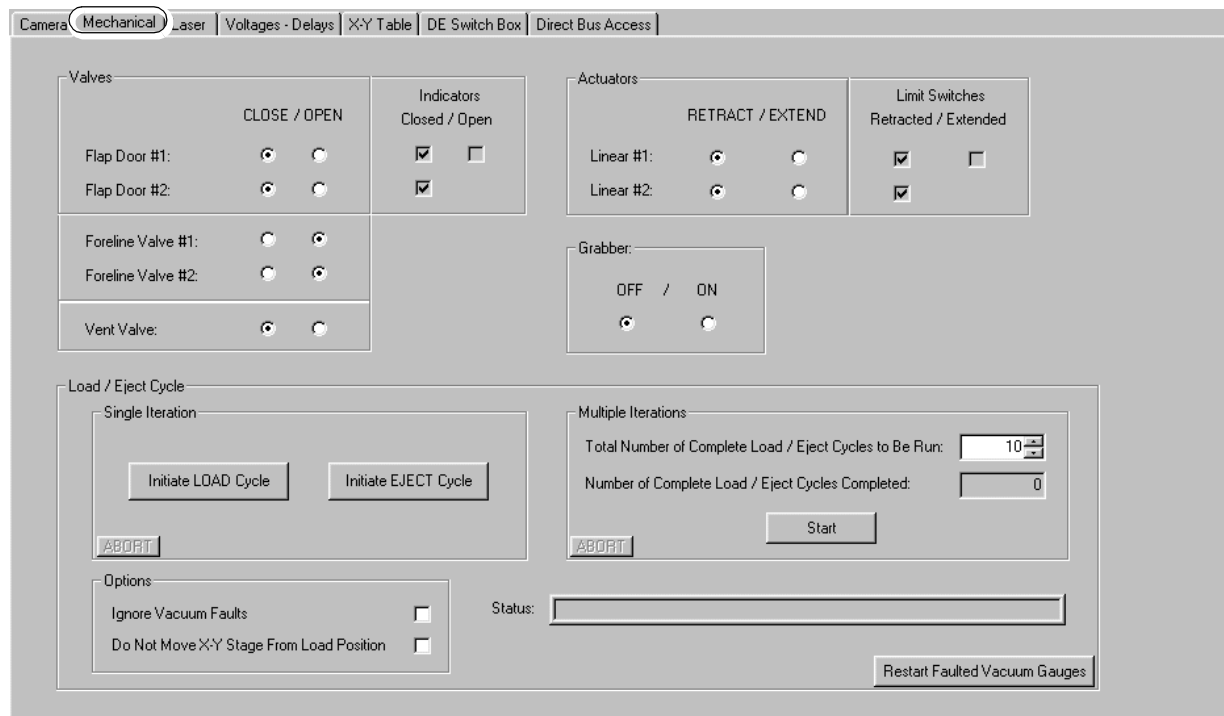


Figure 5-3 Mechanical Control Page

Opening and Closing Doors and Valves

You may need to manually open and close the doors and valves (in conjunction with the actuators and grabber) to remove a sample plate lodged in the main source chamber. To do so, click the **Open** or **Close** radio button of the respective valve. Observe the “Do This First” conditions in [Table 5-2](#), “Internal Interlock Hazard Control,” on page 3-9.

Extending and Retracting Linear Actuators

To extend or retract a linear actuator, click the **Retract** or **Extend** radio button of the particular actuator. Observe the prerequisites listed in [Table 5-2](#), “Internal Interlock Hazard Control,” on page 5-9.

The check boxes under Limit Switches indicate when the linear actuators have fully retracted or extended.

Powering the Grabber On and Off

To turn the magnetic grabber ([Figure 5-4](#)) on or off, click the **ON** or **OFF** radio button. Remember that:

- The magnetic grabber is connected to the end of the Linear 1 actuator. The grabber attaches to the handle end of the sample plate to transport it into and out of the main source chamber. (If the sample plate is inserted backward, the grabber has no suitable surface to magnetize and cannot eject the plate.)
- Under normal operating conditions, the grabber powers on just before the Linear 1 actuator starts to extend or retract (if ejecting), and it powers off just after the Linear 1 actuator has fully retracted.
- If the Linear 1 actuator is extended, the grabber remains powered on and the sample stage is in any position other than Load.

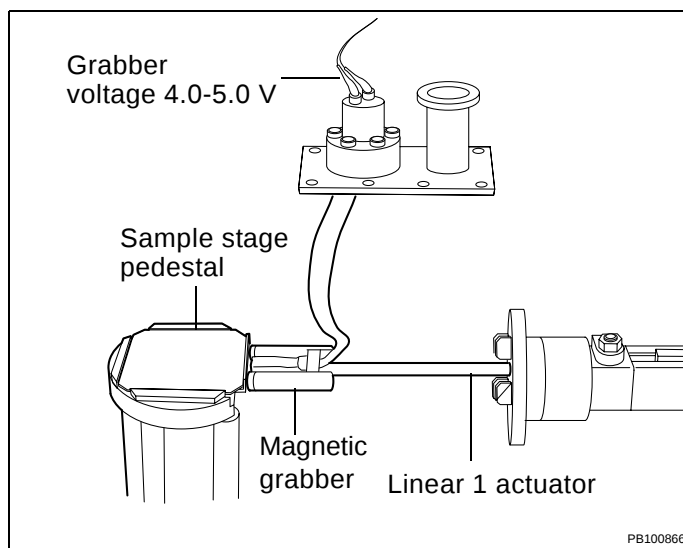


Figure 5-4 Grabber and Extended Linear 1 Actuator (Rotated View)

5.2.5 Load/Eject Cycles

After you replace or repair parts in the main source chamber and while the main source chamber is dismantled, you may need to verify that all mechanical parts involved in loading and ejecting sample plates are aligned and operating properly.

Using the Diagnostics Software Mechanical Control page, you can perform single load and single eject cycles to fine tune alignment. To test the alignment under simulated working conditions, you can set up multiple, dual load/eject cycles that run automatically and consecutively.

For both single cycles and multiple dual-cycles, you can:

- Monitor the progress of operations as they execute
- Abort operations at any point during execution
- Force the diagnostics software to ignore vacuum faults when the system is operating at atmosphere
- Run load/eject cycles without moving the sample stage

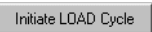
Keeping the Sample Stage Stationary During Load/Eject Cycles

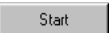
You can override the normal sequence of load/eject cycles and keep the sample stage stationary when you need to test the pneumatics of the linear actuators and flap doors or to test the grabber. To do so:

1. If you haven't already done so, open the X-Y Table control page and move the sample stage to Load position.
2. Return to the Mechanical control page, and check **Do Not Move X-Y Stage From Load Position**.
3. Start a single- or multiple-iteration load/eject cycle.

The diagnostics software performs the usual sequence of steps for the specified operation, but without moving the sample stage.

Initiating Load/Eject Cycles

To start a single load cycle, click . To start a single eject cycle, click .

To set up multiple load/eject cycles, set the number of load/eject cycles you want to run in Total Number of Complete Load/Eject Cycles to Run, then click .

[Table 5-3](#) lists the order of operations in load and eject cycles.

Table 5-3 Order of Operations in Single Load and Eject Cycles

Eject Cycle		Load Cycle	
Step	Operation	Step	Operation
1	Open Flap Door 1	1	Retract Linear 2 actuator
2	Extend Linear 1 actuator	2	Close Flap Door 2
3	Turn grabber on	3	Close foreline valve 2
4	Retract Linear 1 actuator	4	Close vent valve
5	Turn grabber off	5	Open foreline valve 1
6	Close Flap Door 1	6	Wait 10-15 seconds
7	Close foreline valve 1	7	Check sample loading chamber pressure (TC2 reads $<8 \times 10^{-2}$ torr)
8	Open vent valve	8	After verifying TC2 reads $<8 \times 10^{-2}$ torr, open foreline valve 2
9	Wait 5 seconds	9	Open Flap Door 1
10	Check sample loading chamber pressure	10	Turn grabber on
11	Open Flap Door 2	11	Extend Linear 1 actuator
12	Extend Linear 2 actuator	12	Turn grabber off
		13	Retract Linear 1 actuator
		14	Close Flap Door 1
		15	Check source chamber pressure
		16	Move sample stage to default position

Monitoring the Progress of Load/Eject Cycles

The status field ([Figure 5-5](#)) displays which operation in the load or eject cycle is currently executing.



Figure 5-5 Load or Eject Cycle Status Display

Aborting Load/Eject Cycles.

You can abort load/eject operations while they are executing, but doing so could place the system in an unsafe state. You can return the system to a safe state by clicking the appropriate radio buttons to open or close the affected components—flap doors, foreline valves, and linear actuators.

To abort the currently executing load/eject operation, click .

5.2.6 Vacuum Faults

When testing the system using the Diagnostics Software Mechanical control page, you develop a vacuum fault. Options for responding to vacuum faults depend on whether the system is in a load/eject cycle. If not in a load/eject cycle, and the ion gauges shut down due to a stability fault, a message is displayed that allows you to choose to restart the gauges or not.

If the system is in a load/eject cycle, during most cycle steps no message is displayed. Faults are displayed in the status bar.

However, in some cycle steps the cycle cannot progress until the vacuum pressures are below a safe threshold pressure. Under these conditions, an error condition may occur where the ion gauges shut down and a message is displayed that allows you to choose to restart the gauges or not.

If an error condition continues and the safe threshold is not attained before a Registry-specified timeout period expires, the load or eject cycle will stop. A message is displayed indicating you can recover from the error by backtracking the cycle steps. You backtrack until the instrument is back to a safe initial state.

Overriding Vacuum Faults

Checking the IGNORE VACUUM FAULTS check box allows the system to ignore all vacuum gauge faults and continue the load/eject cycle even if gauge errors or high pressures present. The system continues on to the next step once the safe threshold pressure is attained or the Registry-specified timeout period expires.

You should ignore vacuum faults only when the system is vented (operating at atmosphere). When vented, ion gauge (and BA2) values are irrelevant. After you've started to bring the system back up under vacuum, you can restart the gauges when TC2 (Smp. Pres: in the system status bar) reaches $<8 \times 10^{-2}$ torr.

Under normal operation, when vacuum gauges TC2, BA1, or BA2 reports a fault during a load or an eject cycle, the diagnostics software:

- Turns off the ion vacuum gauges.
- Stops the operation.
- Displays a message describing the fault, and asks whether you want to restart the gauges if they are off.
- Pauses, waiting for the timeout period specified in the Registry to expire.
- Depending on your input, the software either aborts or completes the operation.

A vacuum fault occurs when the sensors detect pressure greater than the pressure specified for operation:

- Over pressure Pressures $>8 \times 10^{-2}$ (sample loading chamber); $>9 \times 10^{-6}$ (main source chamber).
- Persistent
 - Over pressure Over pressure that persists longer than a Registry-specified timeout period (typically 120 seconds). Shuts down the ion gauges.
- Stability fault Over pressure that far exceeds the limit. Shuts down the ion gauges.

- COMM fault Failure by the diagnostics software to communicate with the ion gauges. Generates a warning you can override.
- Init fault Failure by the diagnostics software to initialize the ion gauges. Generates a warning you can override.

Faulty valves and gauges and leaky seals and pumps are potential sources of vacuum faults.

When the instrument is operating at atmosphere, you can force the diagnostics software to ignore all vacuum gauge faults and finish load/eject operations.

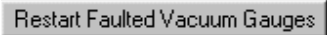
To force the diagnostics software to ignore vacuum faults and finish load/eject operations, check the **Ignore Vacuum Faults** check box. With this option enabled, all vacuum faults are ignored, and load/eject operations automatically continue after the diagnostics software waits for the specified timeout period to expire.

CAUTION

Using this option to ignore and override vacuum gauge faults when the system is operating under vacuum could damage the ion gauges, O-ring seals, and vacuum pumps.

Resetting Faulted Vacuum Gauges

After a vacuum fault occurs, the diagnostics software turns off the vacuum gauges to protect them from damage caused by over pressurization. You can restart the BA1 and BA2 ion gauges when TC2 registers $< 8 \times 10^{-2}$ torr.

To restart the vacuum gauges, click .

5.2.7 Mechanical Control Page Errors and Warnings

To determine the conditions generating display of an error or warning message, review [Table 5-4](#). An error is the result of a severe hazard and forces the operation to abort. A warning allows the option of continuing the operation with risk of damaging the instrument.

**Table 5-4 Diagnostics Software Mechanical Control Page
Warning and Error Conditions**

Action Selected in the Mechanical Control Page	Message Type	Condition Causing the Message
Open Flap Door 1	Warning	Vent valve is Open OR Flap Door 2 is Open
Close Flap Door 1	Error	Linear 1 actuator is Extended
Open Flap Door 2	Warning Warning Warning	Flap Valve 1 is Open Foreline Valve 1 is Open Vent valve is Closed
Close Flap Door 2	Error	Linear 2 actuator is Extended

**Table 5-4 Diagnostics Software Mechanical Control Page
Warning and Error Conditions (Continued)**

Action Selected in the Mechanical Control Page	Message Type	Condition Causing the Message
Extend Linear 1 actuator	Error Error	Flap Door 1 is Closed OR Linear 2 actuator is Extended Sample Stage is NOT at the Load Position
Retract Linear 1 actuator	Error	Flap Door 1 is Closed
Extend Linear 2 actuator	Error	Flap Valve 2 is Closed OR Linear 1 actuator is Extended
Retract Linear 2 actuator	Error	Flap Door 2 is Closed
Open Vent Valve	Error	Flap Door 1 OR Foreline Valve 1 is Open
Close Vent Valve	Warning	Flap Door 2 is Open
Open Foreline 1	Error	Flap Door 2 OR Vent Valve is Open
Open Foreline 2	Warning Warning	Vent valve AND Foreline Valve 1 are Open Flap Door 2 AND Foreline Valve 1 are Open
Close Foreline 2	Warning Warning	Flap Door 1 AND Vent Valve are Open Flap Door 1 AND Flap Door 2 are Open
Grabber OFF	Warning	Linear 1 actuator is Extended AND the X-Y Stage is NOT at the Load Position

5.3 Main Source Chamber

The main source chamber (Figure 5-6) has the:

- Sample stage (source pedestal and X-Y table)
- Variable-voltage grid
- Delayed-Extraction (DE) switch box
- Two 30 kV high-voltage power supplies (located in the left cabinet) and associated high-voltage cables

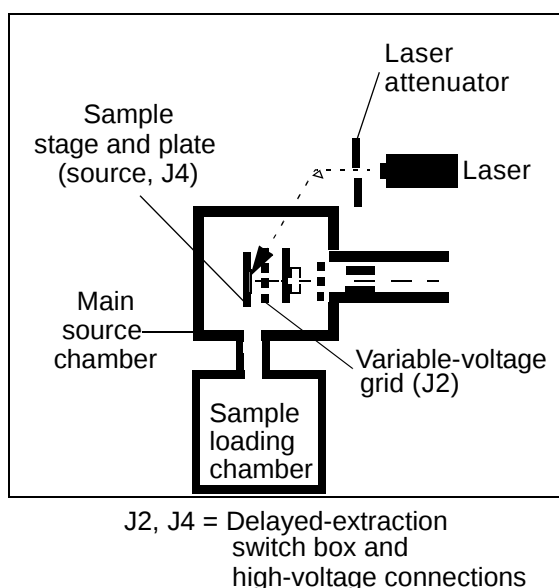


Figure 5-6 Voyager-DE STR Ion Source Components

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The source pedestal receives the sample plate from the sample loading chamber and is attached to the X-Y table. The X-Y table moves the source pedestal to the desired spot location and between the Home and Load positions. Microswitches on the X-Y table feedthroughs provides the status of the source pedestal Home and Load position.

Sample Stage (Load Position)

Use the X-Y Table control page (Figure 5-7) to recalibrate the load position of the sample stage and to move the sample stage to the load position before you open the Mechanical control page (see ["Keeping the Sample Stage Stationary During Load/Eject Cycles" on page -13](#)).

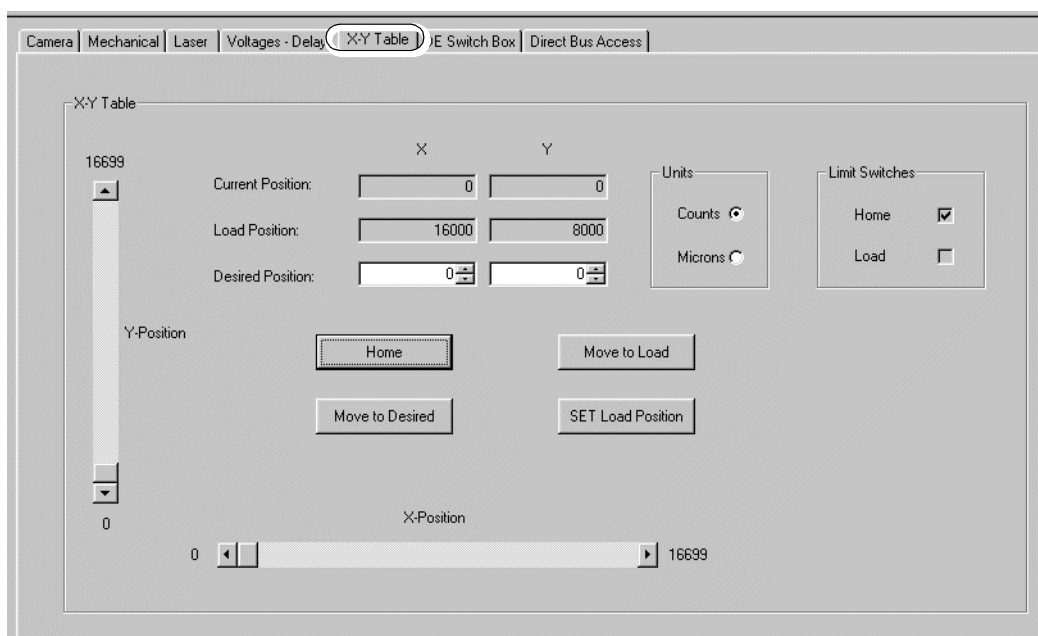


Figure 5-7 X-Y Table Control Page

Homing the Sample Stage

Before you can access the functions on this control page, you must click **Home** to move the sample stage to its Home position (0,0). This initializes the diagnostics software controls, enabling the software to calculate all other positions, including load position.

The limit switches are microswitches located on each feedthrough ([Figure 5-8](#) on page 5-20) at the Home position. These microswitches are position-sensitive and detect when the feedthroughs are Home or are within the load region. The Home microswitches detect the 0,0 position. The Load microswitches, because of their orientation on the feedthrough arms, sense position within a range of points. This range of points is referred to as the load region. The load switch for both the X and Y position must be enabled (closed) before the air compressor will run. If only one load switch is enabled (closed), the air compressor remains off.

The limit switches ([Figure 5-8](#)) are:

- Home Indicates the sample stage has reached the Home position at 0,0.
- Load Indicates the sample stage has reached the load region (approximately 16000 counts for the X position, 8000 counts for the Y position, plus or minus 300 to 500 counts).

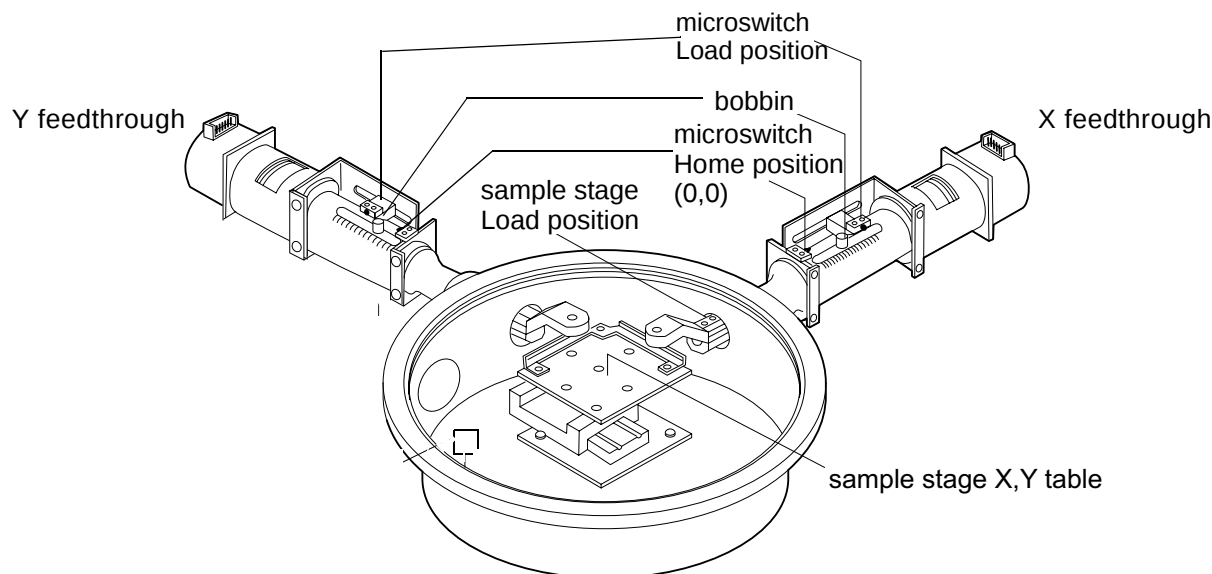


Figure 5-8 Sample Stage and Feedthroughs

You use the sample stage X and Y coordinate fields to adjust and reset the load position of the sample stage:

- **Current** Indicates the current location, in x, y coordinates, of the sample stage.
- **Load** Indicates the current location, in x, y coordinates, of load position.
- **Desired** Specifies the desired location, in x, y coordinates, to which to move the sample plate.
- **Units** Although the stepper motors operate in step units, Voyager software Version 5.0 and later use micron (μm) units. One step equals $3.175 \mu\text{m}$. You can use either unit and switch back and forth between them. The diagnostics software performs the necessary conversions automatically. The micron unit of measure is used in the NT Registry editor.

NOTE: The **SET Load Position** button on the X-Y Table control page initiates a data write to the Registry file. The next time it is accessed, the Voyager Instrument Control Panel reads the new X,Y coordinates from the Registry file to determine the sample stage load position.

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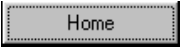
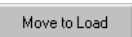
Resetting the Sample Stage Load Position

You may need to reset the load position to:

- Properly align the sample stage with the linear actuators. When the sample stage is misaligned with the linear actuator in the load position, the sample plate misses the sample stage during loading. The sample plate may jam or fall inside the main source chamber.
To verify proper positioning of the sample stage, vent the system to atmosphere and open the main source chamber. For details, see [Section 3.2, Venting the Voyager DE-STR Workstation](#).
- Ensure that the sensor bobbins trip the Load position microswitches to turn on the air compressor. Failure to trip these microswitches deprives the linear actuators and flap doors of adequate operating pressure (15 psi).

NOTE: Record the old coordinates in case you need to revert to them. When you click **SET Load Position**, the diagnostics software overwrites the coordinates of the Load position in the system Registry file.

To reset the Load position:

1. Click  to move the sample stage to the Home position at 0,0 and initialize the diagnostics software.
2. Click  to move the sample stage to the current Load position.
3. Use the scroll bars or the Desired Position spin controls to set the x, y coordinates of the new Load position.
4. Click  to move the sample stage to the new Load position specified in **Desired Position**.

The value in Current Position changes to match the value in Desired Position.

5. Repeat step [3](#) and step [4](#) until moving the sample stage to Desired Position trips the microswitches and turns on the air compressor.

If you are unable to set a Load position that trips the microswitches, you may need to adjust and reset the microswitches. For details, see [“Adjusting the Microswitches” on page -28](#).

6. Click  to reset the Load position of the sample stage to the location specified in **Current Position**.

The new values display in the Load Position field.

Viewing the Troubleshooting Flowchart

The flowchart in [Figure 5-9 on page 5-22](#) outlines a preliminary troubleshooting routine to use if you do not see peaks when acquiring a standard sample. Review the following warnings before performing troubleshooting.

WARNING

ELECTRICAL SHOCK HAZARD. Potentials in the order of 30,000 V dc are present. Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing the alignment.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. When instrument panels are removed, high voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles when you remove panels for service.

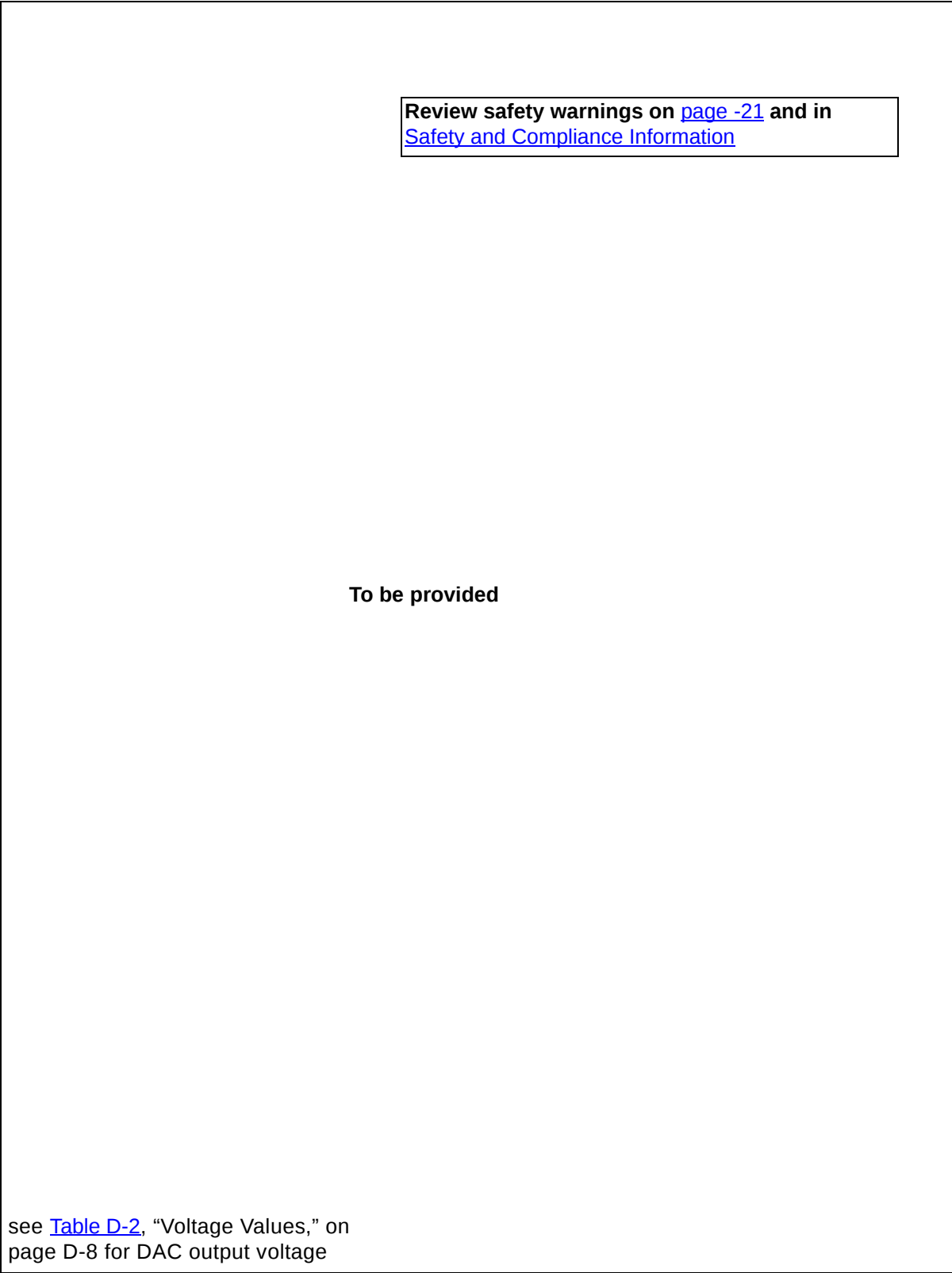


Figure 5-9 Source Troubleshooting Flowchart

Useful Materials

- Small flat file
- Small flat-blade screwdriver
- Long T-handle Allen wrench
- MicroFinish cloth
- Teflon-based spray lubricant with a sprayer extension tube
- 40 kV high-voltage probe
- Multimeter
- Feeler gauge
- High-voltage Y adapter (to be available in the future)
- Safety interlock tag jumper

5.3.1 Source Clips

Source clips guide the sample plate onto the sample stage. Source side clips should be smooth all the way out to their leading ends, with no burrs, bends, or dimples. If the clips are damaged, either replace them or smooth them with a small flat file and MicroFinish cloth.

If a new source clip is not available, you may be able to switch the two side clips. Switching the clips side to side allows the good, trailing edge of one clip to become the leading edge on the other side of the source. To switch clips side to side, replace Clip 1 with Clip 3. Then replace Clip 3 with Clip 1([Figure 5-10](#)).

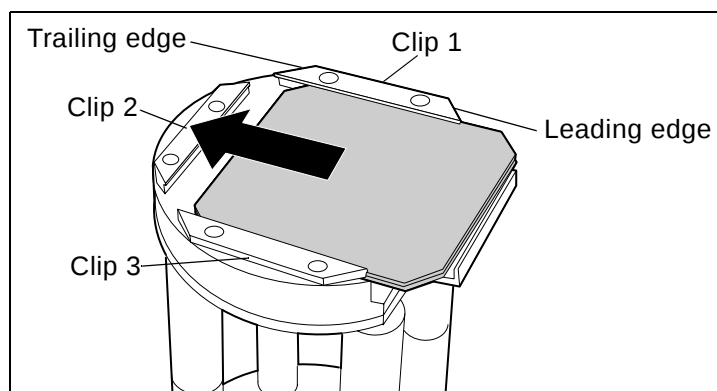


Figure 5-10 Switching Source Clips

After replacing the clips, inspect all sample plates used in the system. Sample plates that have either been dropped, damaged during loading, or otherwise mishandled may develop "dimples" or dents on their edges that cause the plates to bind in the source. Repair or replace any sample plates with damaged edges.

5.3.2 Source Pedestal

Aligning the Source Pedestal

Materials: T-handle allen wrench

To align the source pedestal:

NOTE: Before aligning the pedestal, be certain that both poles of the grabber are of equal length. If not, replace the grabber.

1. With a 7/64-inch T-handle allen wrench, loosen the four 6/32 inch screws ([Figure 5-11](#)) that mount the pedestal to the XY table.

CAUTION

When servicing the pedestal, avoid contacting the grid. The grid is delicate and may be damaged.

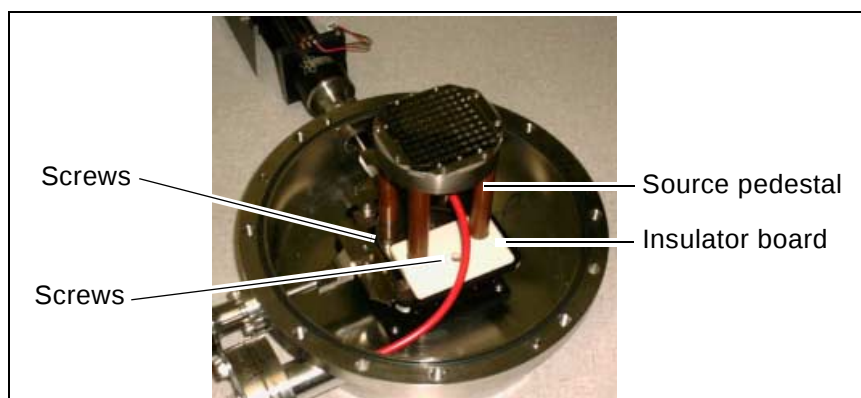


Figure 5-11 Sample Stage X-Y Table

2. On the Linear 1 actuator, use the extend orifice valve (the bleed screw closest to the source housing) to slow the extension of the grabber ([Figure 5-12](#) on page 4-25).

The Linear actuators shown in [Figure 5-12](#) on page 4-25 are the newer rectangular shaped actuators. Linear actuators in older systems are cylindrical.

3. Stop the magnetic grabber just 1 mm short of contacting the plate.

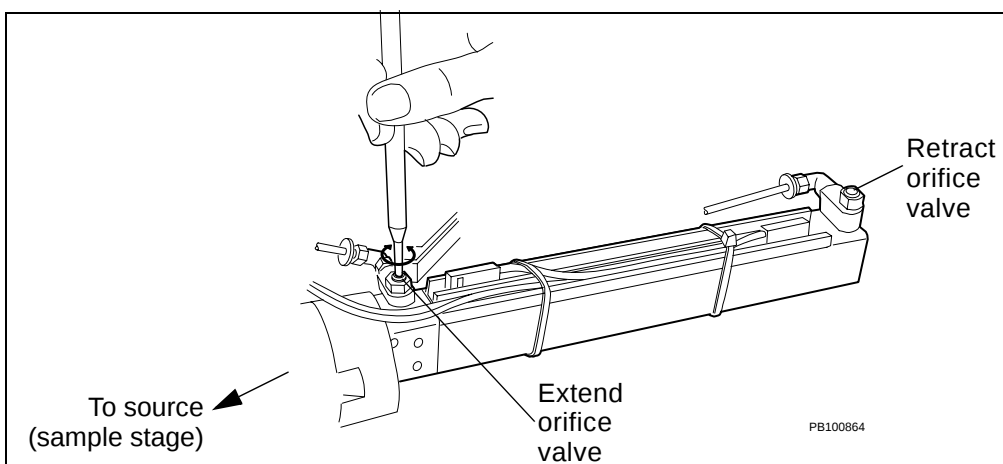


Figure 5-12 Linear Actuator 1 Extend and Retract Valves

4. Rotate the pedestal so that the edge of the plate is the same distance from both poles of the grabber.
5. Retighten the mounting screws while verifying the source and the grabber assembly remain properly aligned.

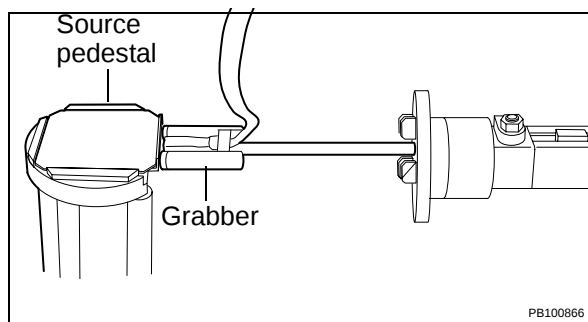


Figure 5-13 Aligning the Source with the Grabber

6. Reset the X- and Y-load coordinates as necessary. See [“Resetting the Sample Stage Load Position” on page -20.](#)
7. Reset the Extend Orifice valve to allow for the proper extension speed of the grabber. The usual adjustment range is 1½ to 2½ turns counterclockwise from fully closed (fully clockwise) position.

5.3.3 Stepper Motor Feedthroughs

The stepper motor feedthroughs provide detection of the Home and load positions ([Figure 5-14](#)). [Figure 5-15 on page 4-27](#) shows the feedthrough interconnects.

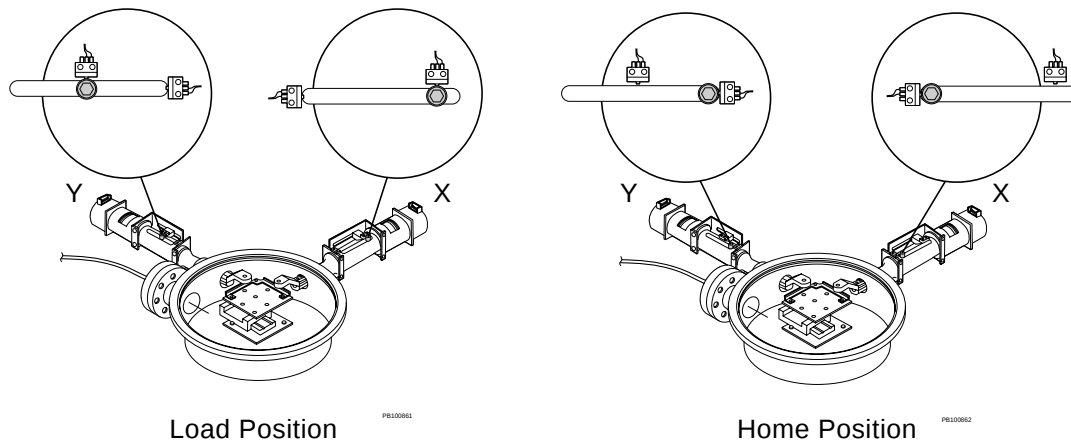


Figure 5-14 Stepper Motor Feedthroughs in Load and Home Positions

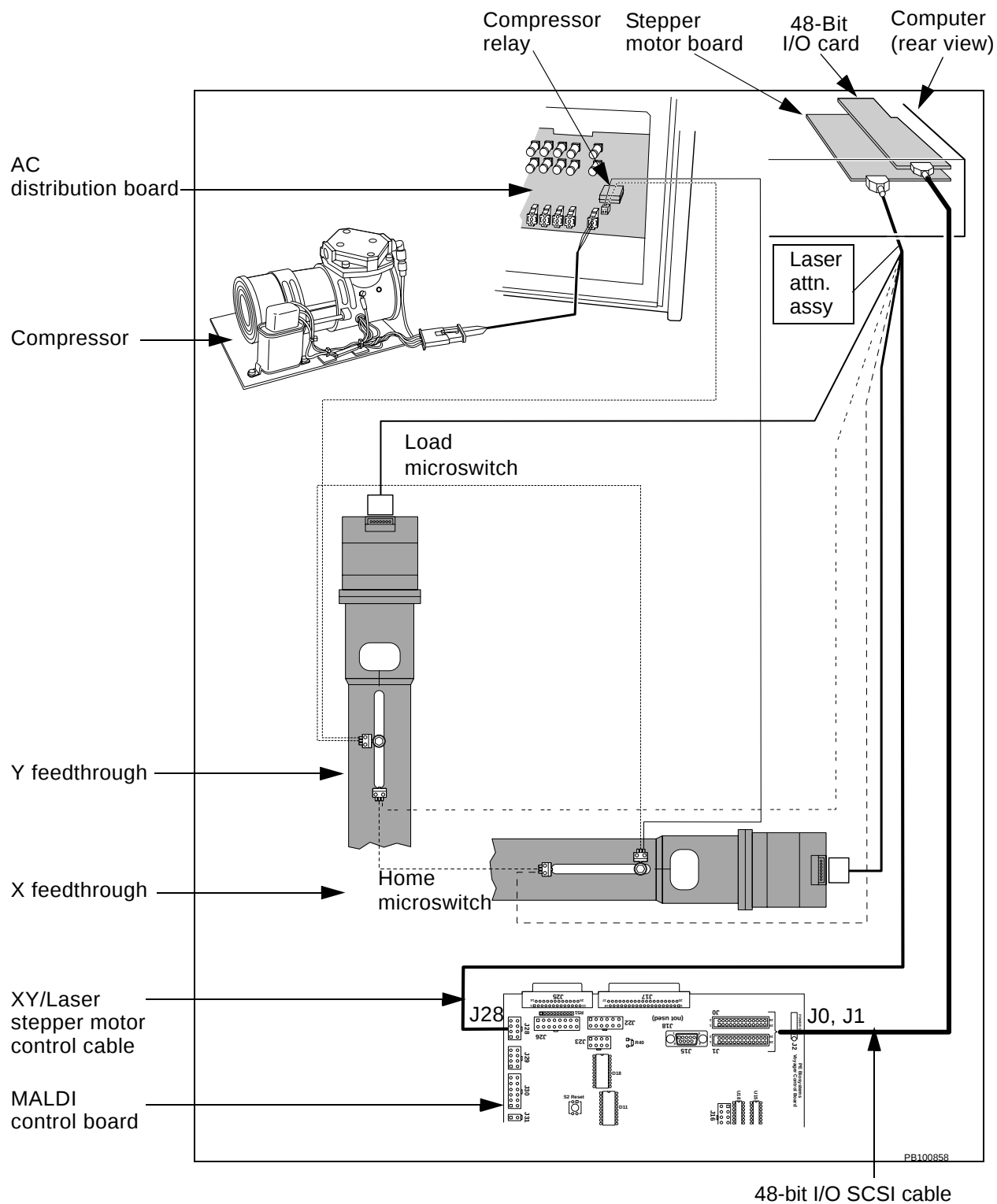


Figure 5-15 Feedthrough Interconnects

Lubricating the X and Y Feedthroughs

Useful Materials

- Silicon-or PTFE-based spray lubricant
- Lubricant extension tube with a 90° bend. The bend allows perpendicular access to the feedthrough worm gear.

A grinding noise or erratic binding when the bobbin is moving indicates the feedthroughs need lubrication. To lubricate the X and Y feedthroughs:

1. Expose the worm gear (drive screw) by moving both feedthroughs to their Home positions (fully extended). See [“Homing the Sample Stage” on page 5-19](#).
2. With the lubricant sprayer extension tube inserted into the feedthrough worm gear slot, lubricate the worm gear along its entire length.

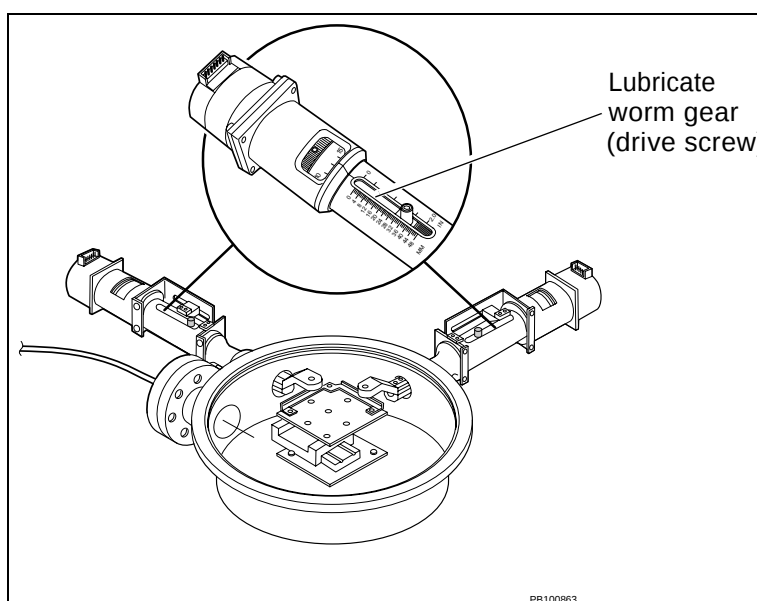


Figure 5-16 Lubricating the Feedthrough Worm Gear

3. Repeatedly move the source between sample plate spot position 91 and position 10 until the grinding noise or erratic binding subsides. Also cycle repeatedly from Home to Load Position.
4. If the grinding noise or erratic binding continues, repeat lubrication or replace the feedthrough, if necessary.

Adjusting the Microswitches

The stepper motor feedthroughs ([Figure 5-17](#) on page 4-29) have two switches:

- **Home**—Triggering the Home Position switch occurs when the linear actuators are fully extended. Due to its mounting configuration, the Home switch has very little wear and rarely needs replacement. However, if you replace a Home switch, the respective X or Y load coordinate will need to be adjusted ([“Resetting the Sample Stage Load Position” on page 5-20](#)).
- **Load**—Triggering the Load Position switch retracts the linear actuator. Check the Load Position switch as part of the preventative maintenance schedule and replace if necessary.

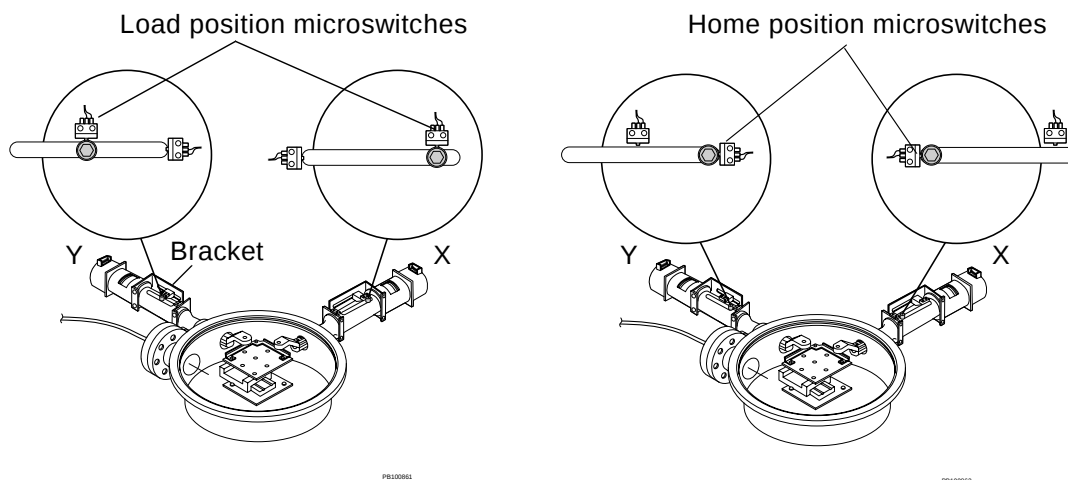


Figure 5-17 Stepper Motor Feedthrough Load and Home Position Switches

Occasionally, an error message is displayed during plate loading or ejection indicating that the source is not in the load position, even though the compressor is energized.

Both the 5 V logic for the load position sensing and the 24 V for the compressor relay use the same load position microswitches on the sides of the linear feedthroughs. If the switches are not adjusted to provide sufficient pressure on the switch button, a resistance (usually about 10 to 20 ohms) will occur in the switch contacts. This resistance is sufficient to drop the 5 V logic signal low enough to cause the 5 V load logic to fail, but not enough to cause the 24 V compressor control to fail. As such, the compressor runs, but the logic faults.

To adjust the load position microswitch:

1. Move the Load Switch bracket ([Figure 5-17](#)) closer to the feedthrough sensor bobbin.

CAUTION

Moving the switch too close to the bobbin may cause excessive wear and premature switch failure.

2. Adjust the Load Switch bracket such that the switch and the bobbin are centered (Figure 5-18 on page 5-29) and close enough that the switch is activated by contact with the bobbin.

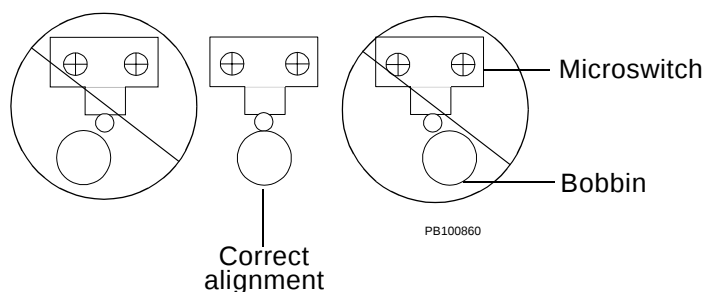


Figure 5-18 Adjusting the Load Position Microswitch (Top View)

If the problem persists, replace the switch.

5.3.4 Sample Plate and Grid Voltage

The ion source can be relatively easy to troubleshoot if high voltage is present at the sample plate and the grid assembly. However, measuring and verifying these voltages can be difficult because the power supplies are safety interlocked and isolated to prevent accidental exposure to potentially lethal high voltages.

You can measure source and grid voltages directly or indirectly:

- **Directly**—Vent the instrument and disable the vacuum system. Use a high-voltage probe to measure the voltages.
- **Indirectly**—Use a high-voltage Y adapter

Before optimizing the variable-voltage grid setting (Grid Voltage%), adjust laser intensity until you obtain a signal-to-noise ratio of approximately 50:1.

5.3.5 Internal High-Voltage Cable

You can test the integrity of the high-voltage (HV) cable with the system under vacuum. This process takes advantage of the Linear Actuator 1 being grounded.

In this test, you determine if the internal high-voltage cable feedthrough is maintained from the sample plate to the high-voltage connectors.

Using the 16-bit Diagnostic Software

To test the HV cable using the 16-bit diagnostics software:

1. Load the sample plate into the sample plate holder.
2. Exit Voyager Control software and manually turn off the ion gauge tubes.
3. Start the service mode software.
4. Initialize the autosampler, then move the sample plate to the load position.
5. Close Foreline Valve 1.
6. Open Flap Door 1 and extend the Linear 1 actuator. This completes the circuit.

As you extend the Linear 1 actuator, watch the video monitor. If you see movement of the plate, the grabber assembly is touching the plate.

7. Connect a small feeler gauge to the shaft of the Linear 1 actuator and the high-voltage feedthrough.
8. With the multimeter set for Ohms, measure resistance from the high-voltage feedthrough to the shaft of the Linear 1 actuator.
9. If open (infinite resistance is observed), the internal high-voltage connection cable is defective or dislodged. Vent the system, then replace or reconnect the cable.

Using the 32-Bit Diagnostic Software

To test the HV cable using the 32-bit diagnostics software:

1. Load the sample plate into the sample plate holder.
2. Exit Voyager Control software and manually turn off the ion gauge tubes.

3. Shut down the Instrument Hardware Controller and start the 32-bit diagnostics software. For information see [Chapter 4, Voyager Diagnostics Software](#).
4. Select the **XY** tab. Initialize the autosampler by clicking Home.
5. Click **Move to Load**.
6. Select the **Mechanical** tab.
7. Close Foreline Valve 1.
8. Open Flap Door 1 and extend the Linear 1 actuator. This completes the circuit.

As you extend the Linear 1 actuator, watch the video monitor. If you see movement of the plate, the grabber assembly is touching the plate.

9. Connect a small feeler gauge to the shaft of the Linear 1 actuator and the high-voltage feedthrough. Measure resistance (Ohm) flows from the high-voltage feedthrough to the shaft of the Linear 1 actuator.
10. If open (infinite resistance is observed), the internal high-voltage connection cable is defective or dislodged. Vent the system, then replace or reconnect the cable.

5.3.6 Operation Mode

The Voyager-DE STR workstation offers two flight path modes of operation, Linear and Reflector. When set to Linear and Reflector mode:

- Linear The mirror voltage is inoperative, and the Timed Ion Selector delay time ignored.
- Reflector All voltages and delay times apply.

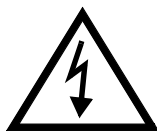
To set the instrument mode using the Diagnostics Software Voltage and Delays control page,

1. click the **Linear** or **Reflector** radio button next to Mode of Operation and apply.
2. Click APPLY ALL (Ramp Voltages / Set Delays). If you leave the Voltage and Delays control page without applying the changes, you will lose the changes. The values revert to the last applied settings.

5.3.7 Delayed-Extraction Ion Source

To troubleshoot the ion source in Delayed-Extraction mode, do the following:

1. When the laser is not firing:
 - Verify source voltage is less than the grid voltage.
 - Verify all switch box relay LEDs are off when the system is in positive ion mode. See the schematic for appropriate LED states for other modes.
2. Fire the laser.
3. Observe the source voltage and the DE Timer switch box for pulses. If pulses are present or the source voltage is not pulsing, replace the switch box.

**WARNING**

ELECTRICAL SHOCK HAZARD. High-voltage contacts are exposed with front or side panels removed. Because the DE switch box uses 30 kV, disable the high voltages before servicing the DE switch box. Servicing the DE switch box when the high voltages on, severe electrical shock can result. Wear proper eye protection.

Set the system to Continuous Linear Mode and acquire a standard sample. If you still do not see peaks when acquiring a standard sample, check the following:

- **Source DAC output**—Source DAC output voltage is at expected value. Calculate the expected value by dividing the accelerating voltage by 3,000. For example, a 15,000 V accelerating voltage equals a 5 V expected reading; A 20,000 V accelerating voltage equals a 6.66 V expected reading.
- **Grid DAC output**—Grid voltage for Continuous Extraction is at expected value, 75% of DAC output. For example, for a 20,000 V accelerating voltage, 75% of the 6.66 V DAC outputs equals a trim pot 5.0 V reading.
- **30 kV High-Voltage power supply**—Current “I” trumpet is set at 3 turns counterclockwise or counterclockwise from the x stop point. Check that the polarity is correct. If the current “I” pot and polarity are set correctly and no voltage is present, replace the power supply.
- **High-voltage cable**—Connection to source pedestal is secure
- **Laser**—Laser is delivering adequate power and is positioned correctly
- **Delayed-Extraction switch box**—Switch Box is functioning properly in Delayed-Extraction and Continuous Linear mode
- **Delayed-Extraction Timer circuit board**—Output for older systems with the ECL logic board is -5.2 V. (Newer systems with TTL boards and the MALDI consolidated control board do not use -5.2 V.)

5.3.8 Source, Grid, and Mirror Voltages

Use the Diagnostics Software Voltages-Delays control page ([Figure 5-19](#)) to set system voltage parameters and timing delays.

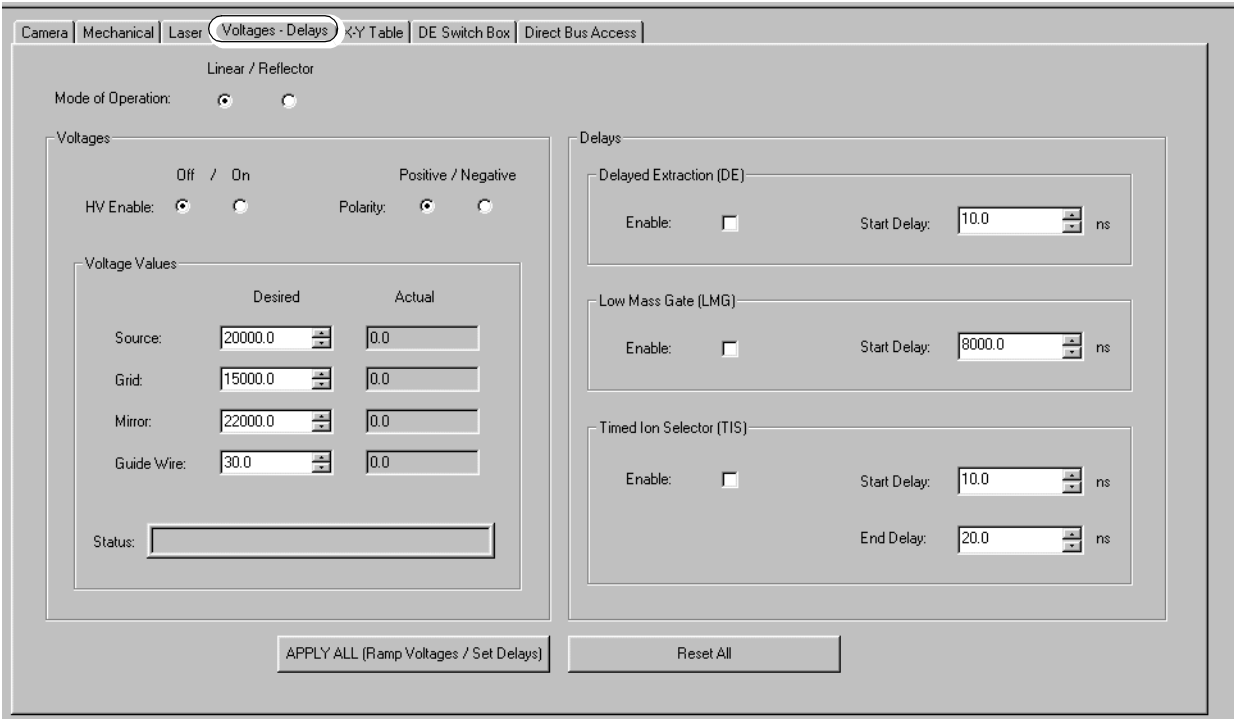


Figure 5-19 Voltage-Delays Control Page

Applying the Settings

After changing any of the settings on this control page, you must apply them before they can take effect. To do so, click **APPLY ALL (Ramp Voltages / Set Delays)**. If you leave the Voltage and Delays control page without applying the changes, you will lose the changes. The values revert to the last applied settings.

If you set and apply voltage for the source, grid, mirror, or guide wire without enabling high-voltage, the diagnostics software programs only the corresponding DACs. You can verify these output voltages with a voltmeter. (DAC voltages are shown in [Table D-2](#), “Voltage Values,” on page D-8.) To detect output voltages at the test points of the corresponding components, you must also enable and apply high-voltage.

By pressing **APPLY ALL (Ramp Voltages / Set Delays)**, you set the delays specified for Delayed Extraction, Low-Mass Gate, and Timed Ion Selector only when you have also enabled them. (It does not affect delays associated with ramping component voltages.)

The status field ([Figure 5-20](#)) tracks the state of the voltages.

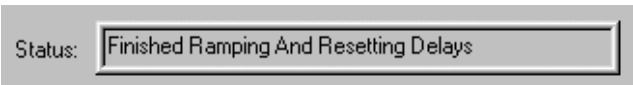


Figure 5-20 Voltages Status Display

Setting the Voltages

The voltage options provide complete control of the high-voltage components. You can:

- Enable/disable high-voltage for all components the DACs control
- Set the voltage polarity
- Ramp each DAC to a specified voltage
- Enable and set specific delays for voltages applied to Delayed Extraction, the Low-Mass Gate, and the Timed Ion Selector

Turning the High-Voltages On and Off

To power the high-voltages on or off, click the **Off** or **On** radio button next to HV Enable and click apply.

- If you set DAC voltages without enabling HV, only the corresponding DACs output voltages are detectable with a voltmeter (DAC voltages are shown in [Table D-2](#), “Voltage Values,” on page D-8).
- Enabling/disabling HV turns high-voltage on and off for all HV components (source, grid, mirror, and guide wire).

Setting the Voltage Polarity

To set the voltage polarity, click the **Positive** or **Negative** radio button next to Polarity, and click apply.

- Positive polarity is the instrument default setting.
- The polarity setting determines which ions (+ or –) are repelled from the sample plate and accelerated down the flight tube.

Ramping the DAC Voltages

To set DAC voltages, under Desired, increase or decrease the appropriate spin button, or enter a value in the appropriate field.

- **Source** 0 to 20 kV range. For the STR, usually set to 20,000.0 V. The source voltage defaults to 20000.0 when the Voltage and Delays control page opens.
Changing this voltage automatically changes the voltage of the beam-steering plates and the Einzel lens, which receives approximately 50% of the source voltage.
- **Grid** 0 to 20 kV range. Set as a percentage of the source voltage, it must be within 10 kV of the source voltage; typically about 65% to 95% of source voltage. The grid voltage defaults to 15000.0 when the Voltage and Delays control page opens.
You must set and apply the source and grid voltages at the same time.
- **Mirror** 0 to 30 kV range. Reflector mode only (ignored in linear mode). The mirror voltage defaults to 22000.0 when the Voltage and Delays control page opens.
When changing from reflector to linear mode, diagnostics software waits 5 seconds for the mirror high-voltage supply to fully discharge.
- **Guide Wire** Ignored in Voyager-DE STR workstation with serial numbers 4154 and later.

Resetting All Voltages and Delay Times

Click  to disable all high-voltages, reset all DAC voltage values to 0.0 V, and disable all delay timing options.

5.3.9 Delayed Extraction, Low-Mass Gate and Timed Ion Selector Delay Times

Use the Diagnostics Software Voltages-Delays control page ([Figure 5-19](#)) timing delays.

To enable DE, the LMG, or the TIS, click the radio button of the function you want to enable. To set delay times (defined in [Table 5-5](#)), increase or decrease the counter (start and end delay times) to set the delay.

Table 5-5 DE, LMG, and TIS Delay Times

Parameter	Clock cycle	Start Delay	End Delay
DE	10 ns	How long accelerating voltage is withheld after the laser fires. Values range from 10 to 32,768 ns.	NA
LMG	222-ns steps	How long the detector is deactivated, reducing its sensitivity to low-mass ions. Values range from 8,000 to 65,000 ns.	NA
TIS	10 ns	Determines when the TIS is deactivated (voltage turned off) to pass the ions of interest. Values range from 10 to 327,670 ns.	Determines when the TIS is reactivated (voltage applied) to deflect unwanted ions.

Resetting All Voltages and Delay Times

To disable all high-voltages, reset all DAC voltage values to 0.0 V, and disable all delay timing options, Click  ([Figure 5-19](#)).

5.3.10 DE Switch Box Control

Use the DE Switch Box control page ([Figure 5-21](#)) to test the high voltages supplied to the source, grid, mirror, and guide wire through the DE switch box.

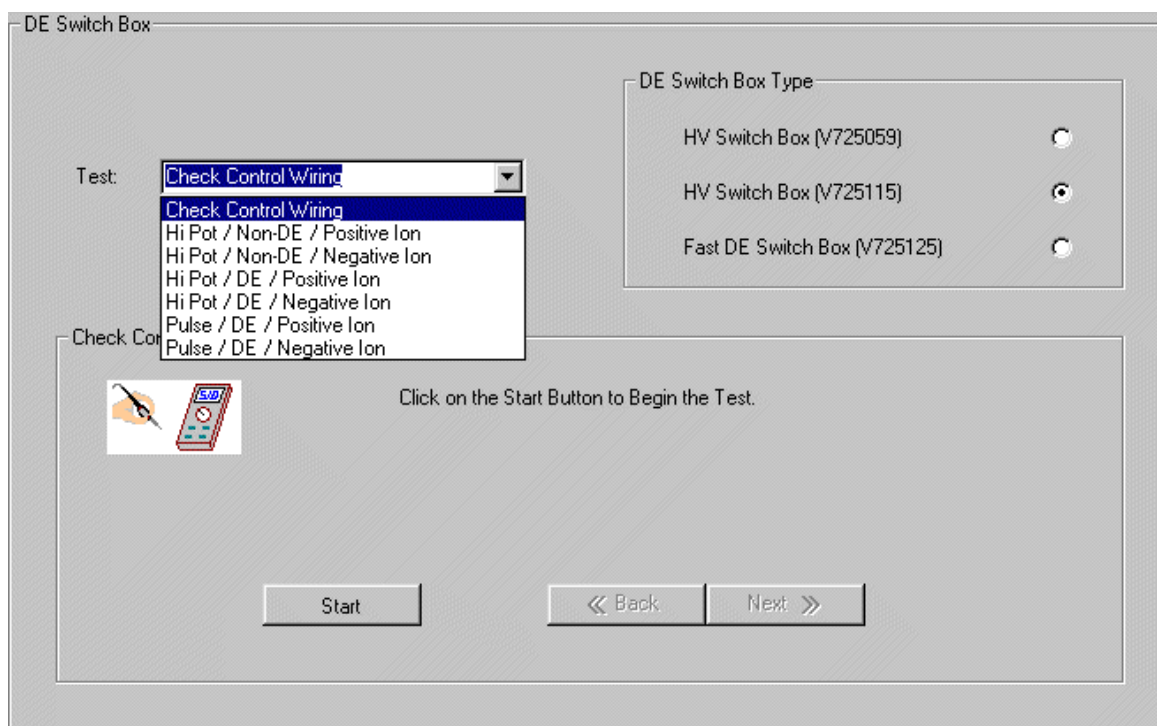


Figure 5-21 DE Switch Box Control Page

NOTE: Of the seven tests listed in the Test drop-down menu, you can run **only** the Check Control Wiring test at the field site. The remaining six tests are performed only at the factory.

Checking the Control Wiring

This test checks the operative states of the three high-voltage kilovac relays by looking at resistance between J2 and J4 and the admittance between J3 and J2/Gnd.

Before you begin, assemble your voltmeter and meter probes, and access the DE switch box. Next, in the diagnostics software DE Switch Box control page, select the type of DE switch box that the system contains:

- V725059 Three-connector, high-voltage switch box in Voyager-DE STR workstation with serial numbers 4147 and earlier
- V725115 Four-connector, high-voltage switch box in systems with serial numbers 4148 through 4160
- V725125 Four-connector fast DE switch box in systems with serial numbers 4161 and later

Before running the Check Control Wiring Test:

1. Select Check Wiring Test from the **Test** dropdown menu.
2. Make sure you have selected the correct DE switch box type.

To run the Check Control Wiring Test:

1. As prompted ([Figure 5-22](#)), disconnect all high-voltage connections (input and output) from the DE switch box.

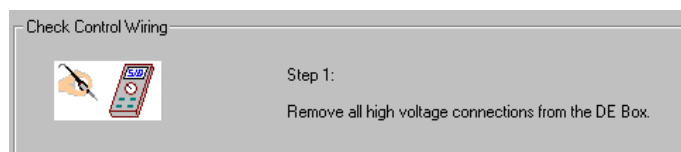
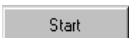


Figure 5-22 Check Wiring Test Step 1 Status Message

2. Click  .
3. As prompted ([Figure 5-23](#)), check the diagnostics software test status area for instructions regarding connections or expected results.

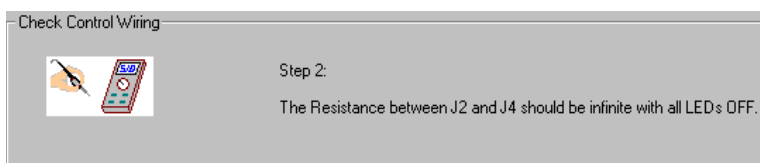
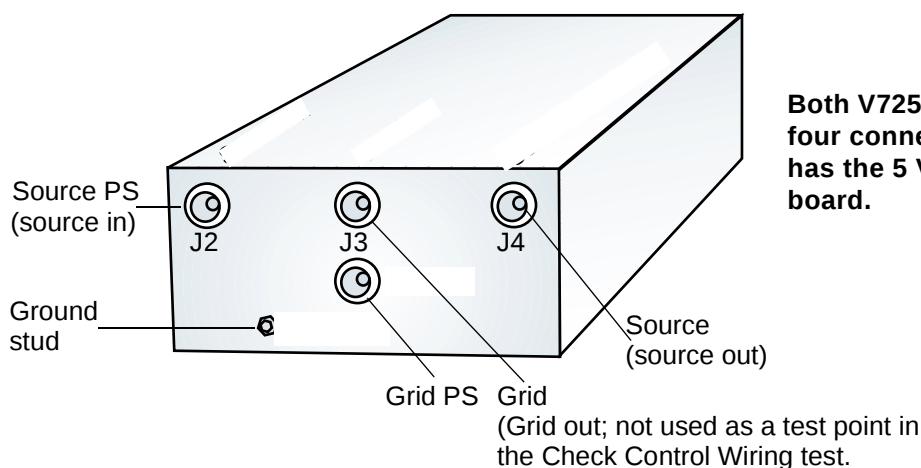


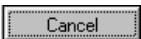
Figure 5-23 Check Wiring Test Step 2 Status Message

4. Connect your meter probes to the appropriate connectors ([Figure 5-24](#)).



Both V725115 and V725125 have four connectors. Only V725125 has the 5 V pull-up control board.

Figure 5-24 DE Switch Box Connections

You can click  at any time to cancel the test or start over.

5. Click  when you are ready to continue.
6. Continue to check the test status area for expected voltage readings and instructions each time you click  .
7. If the test results in mismatched values, run the test again.

5.4 Laser System

The nitrogen laser is replaced as a unit. You cannot replace the plasma cartridge because it must be aligned by the manufacturer.

The beam steering plates work in conjunction with the laser position. After adjusting the laser position, beam steering plates often require re-optimization.

5.4.1 Laser Firing, Repetition Rate, and Reinitialization

Use the Diagnostics Software Laser control page ([Figure 5-25](#)) to fire the internal or external (if present) laser, set its repetition rate, re-initialize it, and adjust its attenuator (intensity). You cannot use the joystick to control either the internal or the external laser. Instead, you must use the  button on the control page.

WARNING

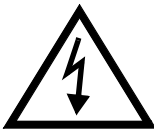
ELECTRICAL SHOCK AND LASER HAZARD. In External Trigger mode, the nitrogen laser energy storage capacitors are charged, and the laser is ready to fire at any time. When you perform service on the laser in External Trigger mode, remove jewelry and other items that can reflect the beam into your eyes or the eyes of others. Wear laser safety goggles and protect others from exposure to the beam. Post a laser warning sign.

WARNING

ELECTRICAL SHOCK AND LASER HAZARD. When instrument covers are removed, high voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles and post a laser warning sign at the entrance to the laboratory when you remove covers for service.

WARNING

LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing service.



5

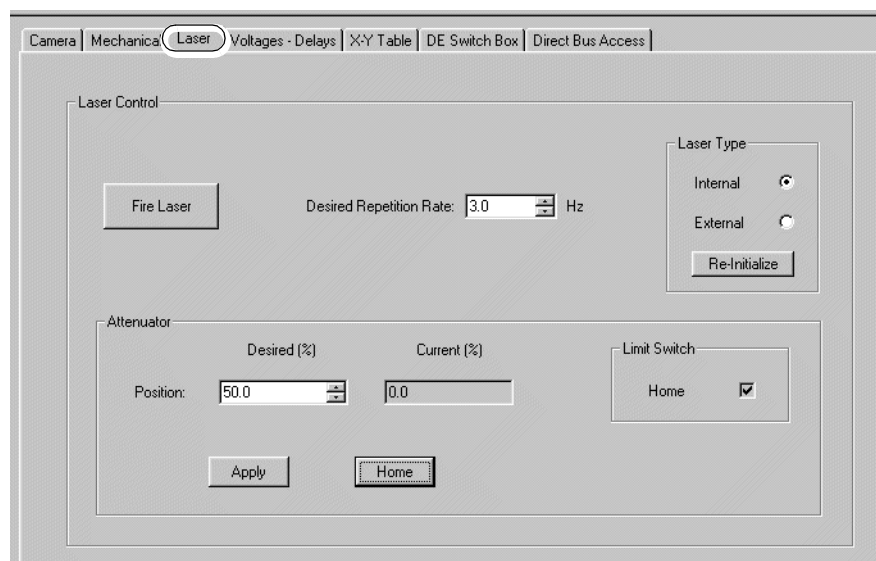
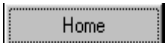


Figure 5-25 Laser Control Page

Firing the Laser

To fire the laser:

1. Select Laser Type by clicking the appropriate radio button.
2. If you switched lasers in [step 1](#), click  (for details, see [“Re-initializing the Laser” on page -40](#)).
3. Click  to set the attenuator at minimum intensity (0%) and initialize the diagnostics software.
4. Set the laser repetition rate and attenuator (%) as needed (for details, see [“Adjusting the Attenuator Position” on page -41](#)).

You can adjust the laser repetition rate only if the system contains laser optimization components (for details, see [“Setting the Laser Repetition Rate” on page -39](#)).

5. Click .

The laser pulses continuously.

6. To stop the laser pulsing, click  again.

Setting the Laser Repetition Rate

You can adjust the laser repetition rate only if the system contains these optimization components:

- Voyager Version 5.1 and later software
- Consolidated control board (V750082 and V750102-001, V750102-002, V750102-003) with firmware (V960005rD and D/V960006rD) installed
- Fast DE switch box (V725125)
- 48-bit I/O control board (V750033) configured for 5-bit addressing

To set the laser repetition rate:

1. If necessary, select the laser and re-initialize it. For details, see [Re-initializing the Laser](#).
2. Set the repetition rate by increasing or decreasing the value in **Desired Repetition Rate**.

NOTE: Currently, regardless of the laser optimization components, the Voyager laser does not support repetition rates greater than 20 Hz. Setting the repetition rate to a value ≥ 20 Hz causes the laser to cease firing after it emits the first pulse.

Re-initializing the Laser

After switching lasers, you need to re-initialize the newly-selected laser before use. This procedure resets the transmission path for control signaling to the newly-selected laser.

Reinitialization stops the laser from firing, homes the laser attenuator, and resets the attenuator minimum and maximum values to those stored in the Registry file.

Under Laser Type, select the laser you are switching to (**Internal** or **External**) and then click

A rectangular button with a light gray background and a thin black border. The text "Re-Initialize" is centered on the button in a black, sans-serif font.

5.4.2 Laser Attenuation

The attenuator of the internal laser is an optical disk with a 360° gradient of optical density ([Figure 5-26 on page -41](#)) positioned between the laser and the prism. The laser attenuator decreases or increases the intensity of the laser beam. As the laser is triggering, you adjust the attenuation by pressing the Control+Page Up and Control+Page Down keys with the Voyager Software Instrument Control Panel window active. This rotates the laser attenuator to set the degree of optical density at the point the laser beam enters the attenuator. The optical density determines the amount of energy that is delivered to the sample spot.

Attenuation is controlled by a stepper motor and is adjustable using the Voyager Control Panel laser step controls. For information on setting the step size, see the *Voyager User Guide*, Digitizer/Laser Parameters.

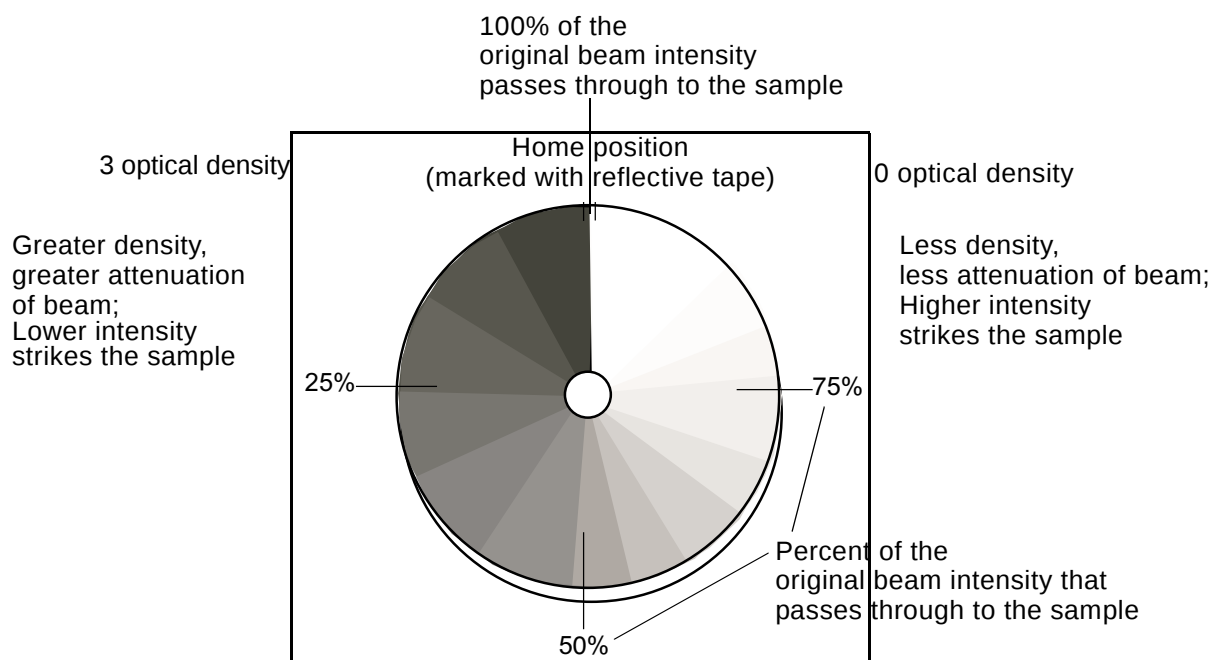


Figure 5-26 Internal Laser Attenuator

When the laser pulse passes through an area of greater optical density, the intensity of the laser beam is proportionally blocked and lower intensity reaches the sample. When the laser pulse passes through an area of less optical density, a smaller proportion of the laser beam is blocked. Therefore, the laser beam reaching the sample is of higher intensity (more energy) when the attenuator is set at a low density than when set to a greater density.

Adjusting the Attenuator Position

To set the attenuation using the Diagnostics Software Laser Control page:

1. Select or enter a value in the Attenuator Desired (%) **Position** spin box.

Values range from 0% to 100%. A value of 0% (Home position) allows the minimum intensity laser beam to strike the sample; a value of 100% allows the maximum intensity to strike the sample.

2. Click to rotate the attenuator to the new position, or click to rotate the attenuator to its Home position (0.0).

When the attenuator reaches its new position, the value in **Current (%)** changes to match the value in **Desired (%)**. When the attenuator reaches Home position, the value in **Current (%)** changes to 0.0, and a check appears in the **Home** check box under Limit Switch.

NOTE: Home position is marked on the attenuator wheel by a piece of reflective tape. The attenuator assembly has an opto-couple device that senses the reflective tape. If the system does not detect Home position properly, check the condition of the reflective tape.

5.5 Flight Tube and Mirror Chamber

5.5.1 Timed Ion Selector

The flight tube contains a timed ion selector (TIS). The TIS is a Bradbury-Nielson gate. When the TIS is turned on, voltage (± 950 V) is applied to the selector to deflect unwanted ions. At the time that corresponds to the ions of interest, voltage is turned off (Start Delay), and the ions of interest pass to the detector ([Figure 1-11](#) on page 1-16). After the ions pass through the selector, voltage is turned on again (End Delay), to deflect ions of non-interest.

Disabling High Voltage

High voltage for the TIS is enabled at the same time and as a result of the same conditions as all other Voyager workstation high-voltage sources.

To completely disable the high voltage:

1. Turn off the High Voltage in the Voyager Instrument Control Panel (see the *Voyager User Guide*)
2. Remove the DB15-type input connector at P1
3. Remove the two output cables at J3 and J4

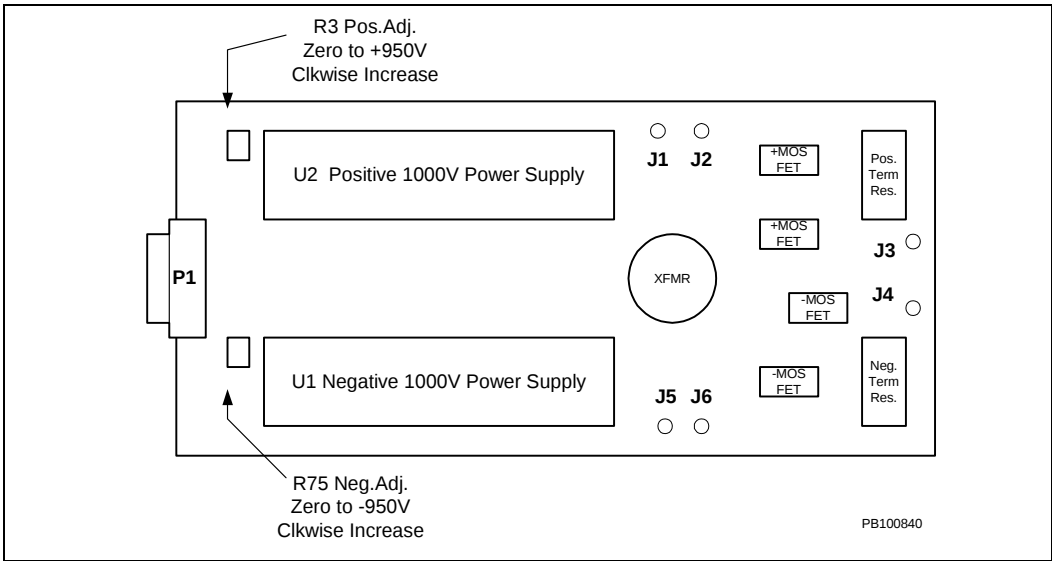


Figure 5-27 TIS PCA Assembly Diagram

Adjusting TIS voltage

The following table shows how to adjust the TIS voltage (± 950 V dc is normal) using two potentiometers ([Figure 5-27](#)).

Potentiometer	Function
R3	0 to +1000 V dc, adjustable (clockwise to increase)
R75	0 to –1000 V dc, adjustable (clockwise to increase)

5.5.2 Flight-Tube (Drift-tube) Power Supply

The DC offset adjustments requires two steps.

1. With the system in positive ion mode and with a digital voltmeter on the output, the RP9 offset potentiometer for the OpAmp with a gain of 10 is adjusted for zero volts.
2. With the system in negative ion mode, the RP8 offset potentiometer for the OpAmp with a gain of one is adjusted for zero volts.

Diagnostics Software Voltages-Delays Control Page

Use the Voltages-Delays control page ([“Voltage-Delays Control Page” on page -33](#)) to set:

- Mode of operation (Linear/Reflector). See [Section 5.3.6](#)
- High-Voltage (On/Off). See [“Turning the High-Voltages On and Off” on page -34](#)
- Mirror voltage (Desired; observe Actual). See [“Setting the Voltages” on page -34](#)
- Timing delays: Low-Mass Gate (Start Delay) and Timed Ion Selector (Start and End Delays). See [Section 5.3.9](#)

5.6 Computer and Video Systems

The camera allows you to see on the external monitor the sample spot and location where the laser is striking. The Camera control page ([Figure 5-28](#)) shows the status of the camera.

By default, the Camera control page appears and powers on the camera and video lamps when you start the Voyager diagnostics software for NT platform.

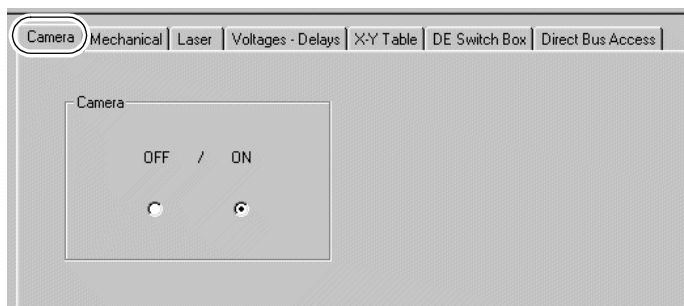


Figure 5-28 Camera Control Page

5.7 Vacuum System

This section includes a description of the vacuum gauges and multigauge controller

Additional information is provided in [Section 3, Before Servicing the Workstation](#):

- A procedure for venting the system to air
- A procedure for purging the system to N₂
- A procedure for powering up the workstation after venting

5.7.1 Vacuum Gauges and Pumps

The vacuum system ([Figure 5-2](#) on page 5-8) uses multiple pumps to create and maintain a sealed high-vacuum environment for unobstructed ion drift.

The Voyager-DE STR has three vacuum chambers and three pumps, as described in the following table:

Vacuum Chamber	Vacuum Range	Typical Pressure	Vacuum Pump
Sample loading chamber	Lower-than-atmospheric-pressure	$<3 \times 10^{-2}$ torr (TC2)	Fore pump
Main source chamber	High vacuum	$<5 \times 10^{-7}$ torr (BA1)	Turbo pump 1
Mirror chamber (analyzer)	High vacuum	$<5 \times 10^{-8}$ torr (BA2)	Turbo pump 2

The fore pump, or roughing pump, creates a lower-than-atmospheric-pressure condition before the turbo pumps start, and provides backing pressure to the turbo pumps. The fore pump can reduce pressures down to the 10^{-3} torr range.

Valves and Flap Doors

Vacuum is maintained in the main source chamber and sample loading chamber by valves and flap doors that isolate the chambers. Vacuum differential between the main source and mirror chambers is maintained by a differential pumping baffle.

Gauges

Two types of gauges monitor vacuum pressures, one thermocouple (TC2) gauge and two ion gauges (Bayard-Alpert gauges, BA1 and BA2). To monitor these gauges, you use a multigauge controller. See [Section 5.7.2, Multigauge Controller](#).

The following table summarizes the gauges and corresponding measurement ranges:

Gauge Type	Gauge Range	Gauge Name	Comment
Thermocouple Gauge	Atmospheric pressure ($7.6 \times 10^{+2}$ torr) to 1×10^{-3} torr	TC2	On initial pumpdown, the turbo pumps start 2 minutes after AC power is supplied to the instrument.
Ion Gauge (Bayard-Alpert Gauge)	9.9×10^{-4} torr to 1.0×10^{-8} torr	BA1, BA2	You can enable high-voltage power only when BA1 reads 9.0×10^{-6} torr or less.

5.7.2 Multigauge Controller

The multigauge controller in the Voyager system monitors the vacuum system thermocouple (TC2) and Bayard-Alpert gauges (BA1 and BA2). The multigauge controller is located in the left cabinet ([Figure 5-29](#)).

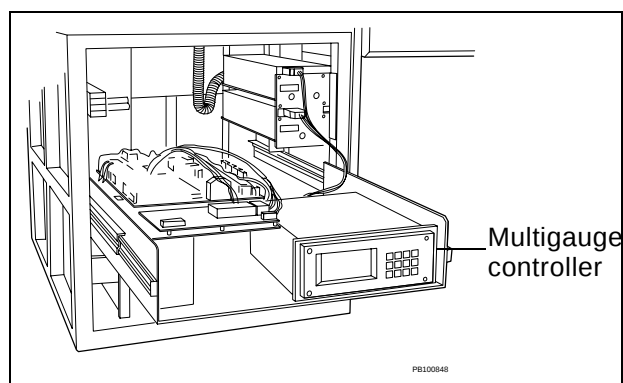


Figure 5-29 Location of the Multigauge Controller in Left Cabinet (Front View)

Use the multigauge controller to:

- Verify the status of the BA1 and BA2 gauges
- Verify the status of the TC2 gauge
- Degas the BA1 and BA2 gauges
- Verify the baud rate

You access the multigauge controller functions and parameters through the front panel keyboard ([Figure 5-30](#)). The readings, prompts, and error messages are displayed on the liquid crystal display (LCD). Pressing the F(unction) key before pressing another key accesses the second function of the next key you press.

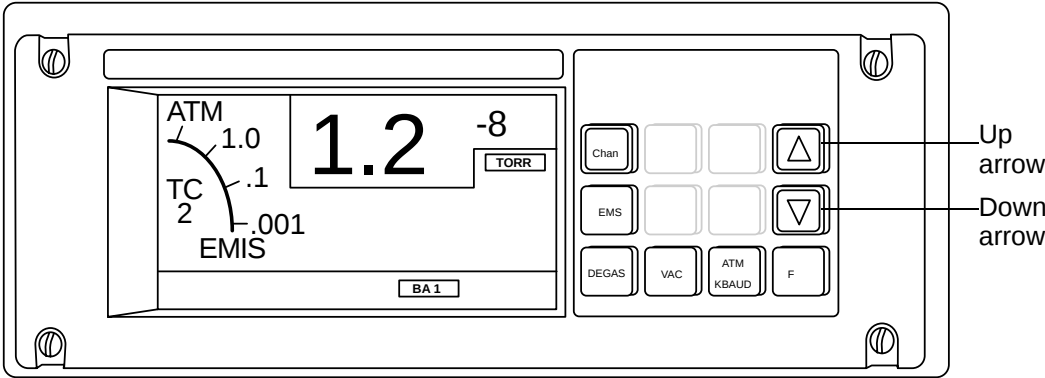


Figure 5-30 Multigauge Controller Screen and Keyboard

The multigauge controller key functions are:

- **CHAN**—Toggles through readings as described in the following table.

Table 5-6 Multigauge Controller CHAN Key Function

Gauge	Measures	Expected Pressure (torr)
BA1	Pressure in main source chamber	Less than 5×10^{-7}
BA2	Pressure in mirror chamber	Less than 5×10^{-8}
TC2	Pressure in sample loading chamber	Less than 5×10^{-2} during operation. Higher when loading or ejecting a sample plate.
TC1, TC3, TC4	Not used; displays E03, indicating gauge not connected	—

- **EMIS**—Turns Bayard-Alpert gauges, BA1 and BA2, on or off.
- **F, EMIS**—Pressing F, then EMIS, turns BA1 and BA2 on. Pressing EMIS turns the gauge off.
- **DEGAS**—Turns degassing of BA1 and BA2 on and off. When activated, the red DEGAS legend lights up.
- **VAC**—Allows calibration of the thermocouple gauge, TC2, vacuum reading.
- **ATM**—Displays TC2 atmosphere.
- **F, KBAUD**—Pressing F, then KBAUD, displays and allows programming of the RS232 baud rate and parity

- **Up arrow**—Increments digits when you enter parameters.
- **Down arrow**—Decrements digits when you enter parameters.
- **F**—The F key has several functions:
 - Accesses the second function of a subsequently pressed key when pressed.
 - Advances from one flashing digit to another when pressed when entering parameters.
 - Fast-forwards to the end of the procedure when pressed and held.

The multigauge controller requires:

- **Two fuses**—AC distribution board fuses F11A and F11B. The fuse OK indicator is DS11 ([Figure 5-31](#)).
- **110 V power**—From the AC distribution board connection J11. If the power does not turn on, check that the main power switch on the back of the multigauge controller is in the On position.

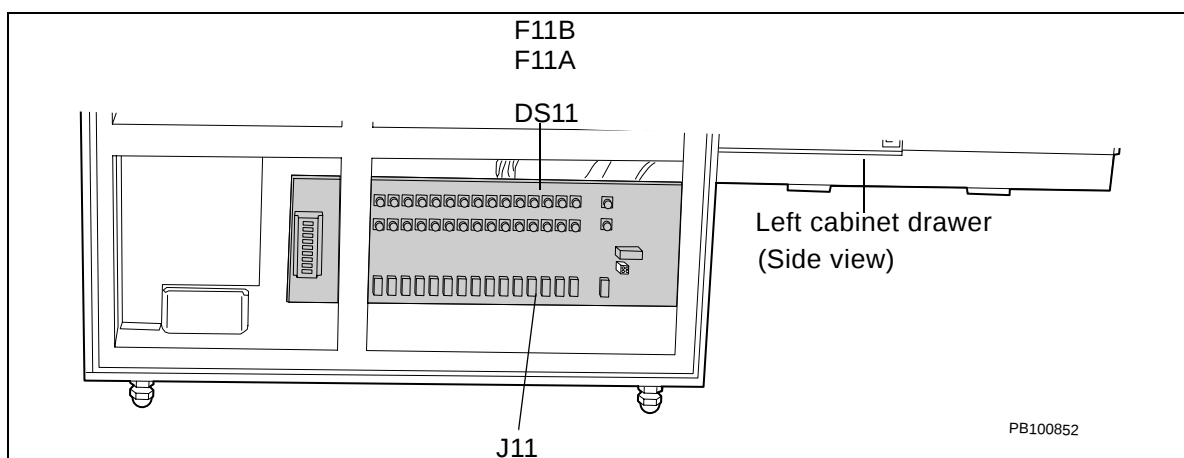


Figure 5-31 Multigauge Controller AC Distribution Board Connection and Fuses

See the *Varian Multigauge Controller Manual* shipped with each Voyager-DE STR system for detailed information about the functioning of this unit.

5.7.3 Multigauge Controller, Computer, and Workstation Interaction

Baud Rate

The multigauge controller-to-Voyager connection uses RS232 technology. The Voyager workstation, computer serial ports, and the multigauge controller communicate bidirectionally at 9600 baud (decimal).

The baud rate sets the number of bits per second that can be transmitted to the computer system. If the baud rate is set incorrectly, the multigauge controller can not communicate with the Voyager software, and the Voyager software will not initialize the vacuum system.

The Voyager baud rate is factory-set and is displayed on the multigauge controller as 9.6 kBaud.

Verifying and Resetting the Baud Rate

Occasionally the Voyager software displays a Vacuum Gauge Communication Failure error message upon initialization. This error can occur if the baud rate is set correctly in the multigauge controller, but is set incorrectly in the Voyager external computer registry.

Verify that the baud rate setting on the multigauge controller is 9.6 kBaud. If the multigauge controller baud rate is correct, verify the Voyager computer registry baud rate. To verify the baud rate on the multigauge controller, press Function-kBaud. A blinking number is displayed. If necessary, you can change the number to 9.6 by pressing the arrow keys. To enter and apply the number, press the Function key. Press the Function key again to return to the pressure display.

Accessing the Voyager Computer Registry Keys

You can verify and reset baud rate and other Voyager registry keys. To access the registry keys:

- On the Voyager computer desktop, select **Start**, then **Run**.
- In the run dialog box, type **regedt32** or select **regedt32** from the drop-down list.
- Click **OK**.
The Registry Editor is displayed.

Verifying and Resetting Baud Rate in the Voyager Registry

Verify the Voyager computer registry baud rate as follows:

1. Access the Voyager computer registry (Voyager vacuum monitor baud) as described in [Accessing the Voyager Computer Registry Keys](#) above.
2. Check the Voyager vacuum monitor baud rate setting in the registry by selecting the following path in the left panel of the Registry Editor window ([Figure 5-32](#) on page 4-49):

```
HKEY_LOCAL_MACHINE
SOFTWARE
    PerSeptiveBiosystems
        Maldi
            Server
                HiVolt
                    Vacuum Monitor
                        Vacuum Monitor Baud Rate
```

3. In the Registry Editor window right panel, double-click **default**.
The DWORD Editor box is displayed.
4. In the DWORD Editor box, select Decimal.
5. If the baud rate registry setting is other than 9600, type **9600** in the Data field.
6. Click **OK**.
7. Close the Registry Editor window.

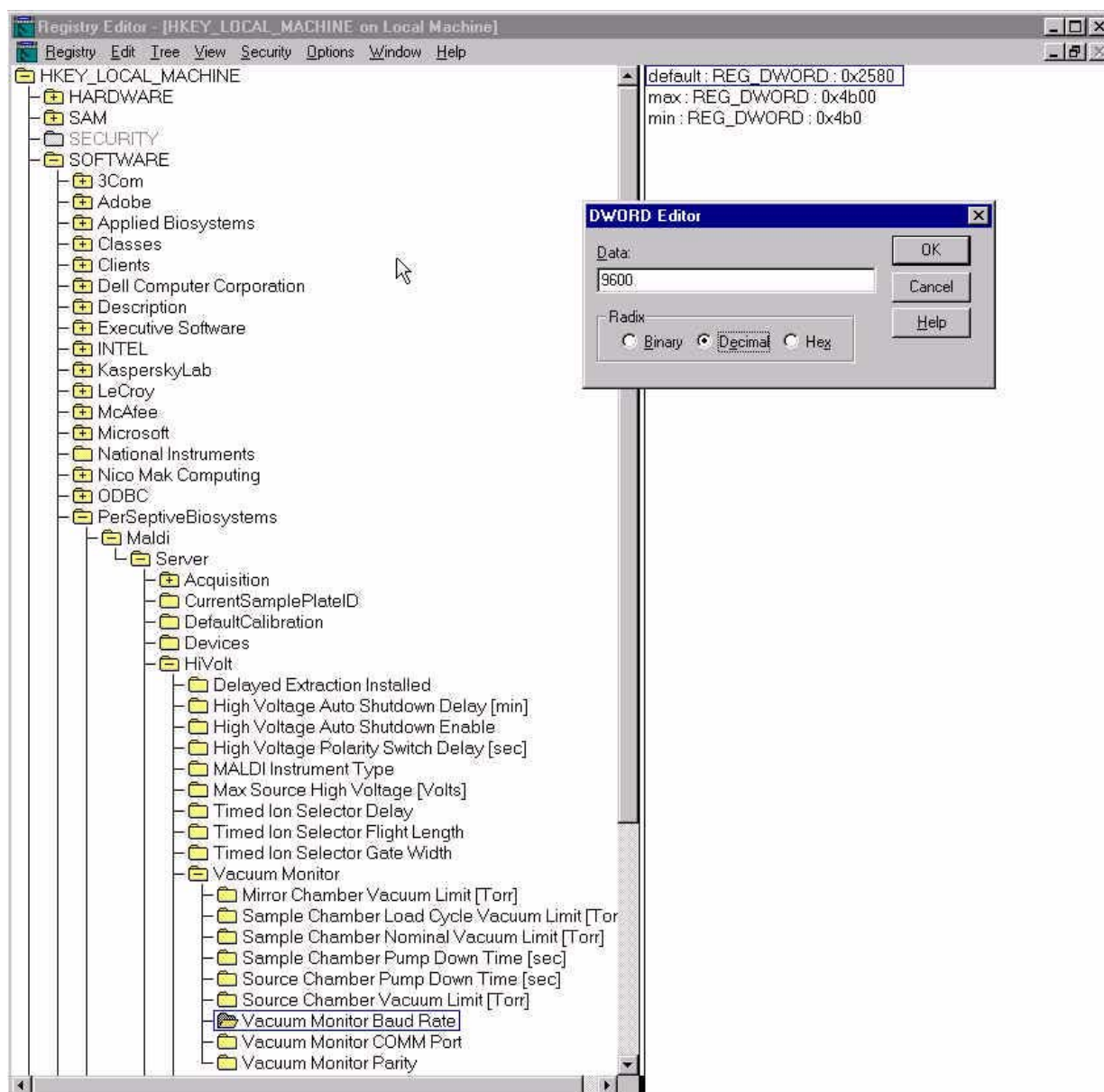


Figure 5-32 Path to the Vacuum Monitor Baud Registry Setting

Verifying and Resetting Com Port Settings

The multigauge controller communicates via the computer communications port 2. A Vacuum Gauge Communication Failure error occurs if the Voyager computer Com Port settings are incorrect. Verify the Voyager software Com Port settings by selecting the following on the Voyager computer desktop:

1. On the Voyager computer desktop, select **Start, Settings, Control Panel**
2. Double-click **Ports**, then **Com2**

Check that the settings displayed match those in [Table 5-7](#).

Table 5-7 Settings for COM2

Field	Value
Baud rate	9600
Data Bits	8
Parity	Odd
Stop Bits	1
Flow Control	None

3. If necessary, select **9600** from the drop-down list. Click **OK**.

To set the Vacuum monitor com port to COM2 in the registry settings:

1. Open the registry as described [“Accessing the Voyager Computer Registry Keys” on page 5-48](#)
2. Select the following path in the left panel of the Registry Editor window:

```
HKEY_LOCAL_MACHINE
SOFTWARE
  PerSeptiveBiosystems
    Maldi
      Server
        HiVolt
          Vacuum Monitor
            Vacuum Monitor COMM Port
```

3. In the Registry Editor window right panel, double-click **default**.
4. If necessary, in the string field, type **COM2**. Click **OK**.

Verifying and Resetting Vacuum Monitor Parity

Similarly, you can verify the parity setting. The Voyager registry key must be set to 1. The multigauge controller can be set to any value. The default parity setting in the Voyager computer registry is 1.

Parity codes are summarized in [Table 5-8](#).

Table 5-8 Parity Codes

System	Parity Code
Voyager computer	Default is Odd (1)
Voyager software	Must be set to 1
Multigauge controller	Can be different from the Voyager software setting. Can be set to any of the following: • O (odd) • E (even) • — (none)

Verifying Parity in the Voyager Registry

To verify parity in the Voyage registry setting:

1. Access the Voyager computer registry (Voyager vacuum monitor baud) as described in [“Accessing the Voyager Computer Registry Keys” on page -48.](#)
2. Check the Voyager vacuum monitor parity setting in the registry by selecting the following path in the Registry Editor window left panel:

```
HKEY_LOCAL_MACHINE
SOFTWARE
  PerSeptiveBiosystems
    Maldi
      Server
        HiVolt
          Vacuum Monitor
            Vacuum Monitor Parity
```

3. In the Registry Editor window right panel, select **default**.
The DWORD Editor box is displayed.
4. In the DWORD Editor box, select **Decimal**.
5. If the parity setting is a value other than 1, type **1** in the Data field.
6. Click **OK**.

Thermocouple Gauge

High pressures such as those found in the fore pumping of a vacuum system are generally measured with a thermocouple gauge. The thermocouple gauge ([Figure 5-33](#) on page 4-52) measures the heat transfer rate from a heated wire at approximately 350 °C. Heat transfer and pressure are directly proportional. As gas is removed from the system, less heat is removed. The changes in temperature are measured by a thermocouple junction and its output is displayed as changes in pressure.

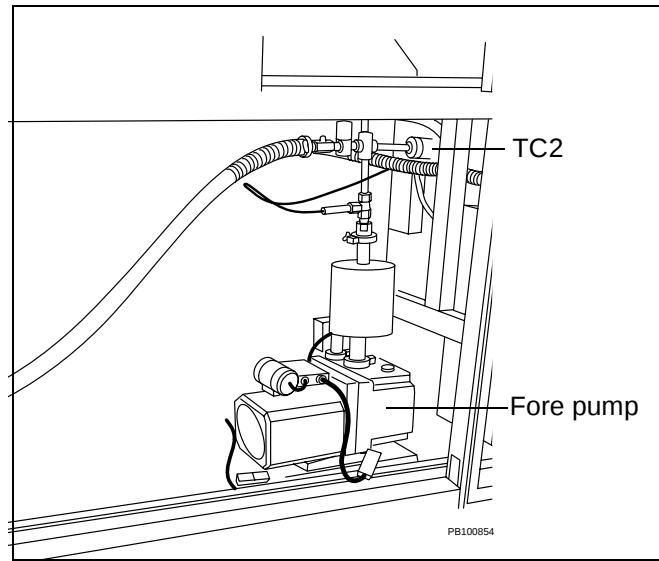


Figure 5-33 Thermocouple (TC2) Gauge (Voyager-STR Workstation Rear View)

Because factors other than pressure affect the thermocouple reading, the thermocouple gauge provides an indication of the vacuum pressure rather than an accurate measurement of it. In general, the true pressure is within approximately 30% of the measured value.

Inaccuracies in pressure readings result when the dissipation of heat occurs at a different rate than expected. Factors affecting the thermocouple accuracy are: I

- **Presence of a gas other than air**—The system is calibrated for air. If the residual gas in the vacuum system is a different gas, the dissipation of heat occurs at a different rate. For example, hydrogen or helium in the system causes the heat to be conducted away from the thermocouple more rapidly than air, resulting in a higher than actual pressure reading.
- **Contaminants on the surface of the thermocouple and heater**

Calibrating the Thermocouple Gauge

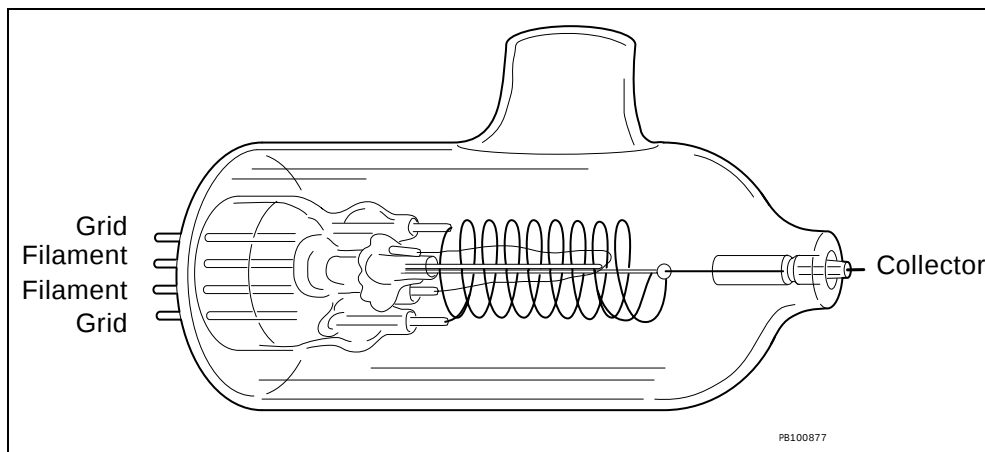
Before using the thermocouple, select TC2 using the CHAN key. Set the atmosphere and vacuum by using the ATM and VAC keys ([Table 5-9](#)).

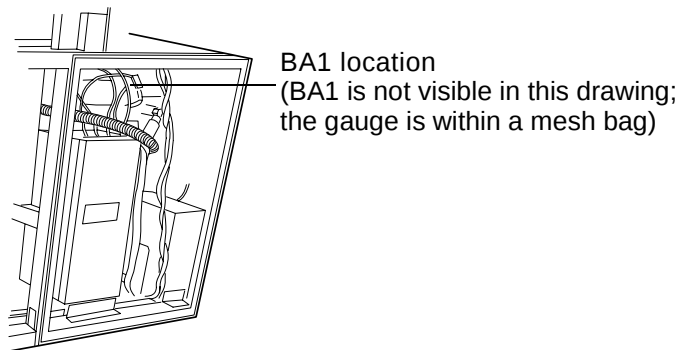
Table 5-9 Setting Atmosphere and Vacuum

To Set	Do This
Atmosphere	1. Expose TC2 to atmospheric pressure. 2. Press the ATM key. The main display reads 760 torr.
Vacuum	1. Expose TC2 to a known vacuum pressure (10^{-3} torr range). 2. Press the VAC key. The display shows the most recent vacuum setting with the most significant digit flashing. 3. Set the display to the vacuum level desired. TC2 is now calibrated.

Ion Gauge

The ion gauge ([Figure 5-34](#) on page 5-53) consists of a collector, grid, and filament. [Figure 5-35](#) on page 5-54 shows the location of BA1 within the Voyager-DE STR.

**Figure 5-34 Bayard-Alpert (BA1, BA2) Ion Gauge**



PB100853

Figure 5-35 BA1 Location (Voyager-STR Workstation Rear View)

An ionization gauge calculates pressure by simultaneously measuring emission current and ion current. The emission current results from the electrons emitted from the filament (I⁻). The positive ions that impact the collector (and pick up electrons from ground) account for the positive ion current (I⁺).

Pressure is directly proportional to the ratio of ion current to emission current and indirectly proportional to the sensitivity of the gauge.

Factors affecting ion gauge accuracy include:

- Contaminants
- Composition of gas used
- Outgassing of residual gases in the glass and metal parts
- X-ray limit

Degassing the Bayard-Alpert Gauges

If the vacuum does not come down, contaminants may be trapped within the gauge. The Degas function cleans the vacuum gauges of residual contaminants. Degassing occurs through a controlled high temperature baking of the gauge. Degas the gauge periodically and whenever the system has been open.

Before degassing can begin, the:

- Emission of the gauge must be on
- Pressure must be less than or equal to 1×10^{-5} torr

To begin degassing, press the multigauge controller **Degas** key. Observe the pressure readings. The pressure peaks asymmetrically, and then drops to a lower equilibrium pressure.

NOTE: If the Voyager system is On and the pressure rises above the vacuum setting, Voyager software displays an error. Reset the Voyager software after the pressure normalizes to below the vacuum setting.

You can shut off degassing manually. When the equilibrium pressure stabilizes, press the **Degas** key to end degassing. If you do not manually shut off degassing, degassing shuts off automatically after a preset time. For information, see the *Varian Multigauge Controller Manual*.

Multigauge Controller Error Codes

When an error occurs, the multigauge controller software displays an error code. Error messages may be displayed in the Voyager Instrument Control Panel ([Figure 5-36](#)). (Wording of error messages may vary, depending on the version of Voyager Software.)

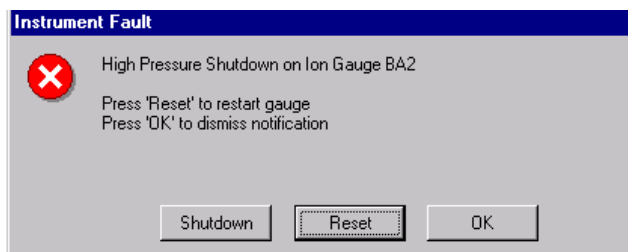


Figure 5-36 Voyager Software Error Message Corresponding to the Multigauge Controller E3 Error Code

Some of the most common error codes and corresponding troubleshooting hints are presented in [Section 6.2, Multigauge Controller Common Error Codes](#). See the *Varian Multigauge Controller Manual* for the complete list of codes.

6 Troubleshooting by Symptoms

This chapter contains the following sections:

- 6.1 Troubleshooting Tables..... 6-2
 - 6.1.1 Spectral Problems6-2
 - 6.1.2 Sample Loading and Main Source Chamber 6-4
 - 6.1.3 Computer System and Software 6-9
 - 6.1.4 Power Supplies and Circuit Boards 6-10
 - 6.1.5 Vacuum System 6-11
- 6.2 Multigauge Controller Common Error Codes 6-16
- 6.3 LED Indicators..... 6-18

6.1 Troubleshooting Tables

This section includes symptoms, possible causes, and actions to troubleshoot the:

- Spectral problems
- Sample Loading and Main Source Chamber
- Computer and software
- Power supply
- Vacuum system

For additional information, see the *Voyager User Guide*.

6.1.1 Spectral Problems

Table 6-1 Spectral Troubleshooting

Item	Symptom	Possible Cause	Action
Continuous Mode			
1	In linear mode, flat signal on oscilloscope or Monitor window for matrix and sample region when in positive ion mode. Same result when switched to reflector mode.	A Defective fuse or DAC board. B Einzel lens is wrong polarity or is shorted to ground. C High-voltage connection to the sample plate is broken or disconnected. D High-voltage power supply is defective. E Laser beam is not striking the sample with adequate intensity. F Linear detector is defective.	Check fuse. Replace if defective. Check that source and grid DAC output is correct. Replace if defective. Check einzel lens polarity. Check for shorts. Adjust or replace connection. Replace high-voltage power supply. Check the attenuator functioning. See “Adjusting the Attenuator Position” on page 5-41. For the Nitrogen laser, verify laser output is >200 μJ. Troubleshoot the linear detector.

6-2

Table 6-1 Spectral Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
1	In linear mode, flat signal on oscilloscope or Monitor window for matrix and sample region when in positive ion mode. Same result when switched to reflector mode. (continued)	G Reflector detector is defective.	Troubleshoot the reflector detector.
		H Digitizer or one of its channels is defective.	Troubleshoot the digitizer.
Delayed-Extraction Mode			
2	Flat signal on oscilloscope or monitor window for matrix and sample region when in linear or reflective mode. Peaks display when switched to continuous mode.	A Delayed-extraction switch box is defective.	Verify source voltage output is rising when the laser is firing. Verify all DE switch box LEDs are unlit. Check the +5 at connector on DE switch box. Adjust. Check control wiring. Replace DE switch box. Warning: Before servicing the DE switch box, disable high-voltages.
		B Delayed-extraction timer pulse generator board is defective.	Check for –5.2 V. Replace DE timer pulse generator board. Note: In one version of the Quad power supply, the –5.2 V is not present on the pulse generator board.

6.1.2 Sample Loading and Main Source Chamber

[Table 6-2](#) includes troubleshooting symptoms related to the sample load and eject mechanisms such as the following components:

- Flap doors
- Linear actuators
- Magnetic grabber
- Sample plate
- Source pedestal and clips
- XY feedthroughs
- XY microswitches

Error and warning messages displayed when using the Diagnostics Mechanical control page are explained in [Section 5.2.7](#). Also, because the linear and flap door actuators are pneumatically controlled, the performance of the sample loading chamber may be affected by problems in the vacuum system.

Table 6-2 Source and Sample Loading Chamber Troubleshooting

Item	Symptom	Possible Cause	Action
1	When the system covers are removed and the source is in motion, a loud grinding or squeaking noise can be heard in the source area; or the source sticks when trying to achieve desired location.	A X and/or Y feedthroughs need lubrication.	Lubricate feedthroughs. (See “Lubricating the X and Y Feedthroughs” on page 5-28.)
2	Sample plate either occasionally or consistently falls off the grabber during sample plate loading	A The magnetic grabber failed. B The Y-load coordinate is misaligned.	With the grabber attached to circuit, check that voltage to the grabber switches properly: From a low +5 V logic state when the grabber is off to a high +5 V logic state when energized. If the voltage is not switching properly, check for continuity through grabber coils. With the source open, adjust the alignment of the Y-coordinate by varying the Y-load coordinate value in the diagnostics software. Use a mirror and a small light to verify distance from edge of sample plate to inside edges of source, not to source clips.

Table 6-2 Source and Sample Loading Chamber Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
2	Sample plate either occasionally or consistently falls off the grabber during sample plate loading (continued)	C Source pedestal is not rotationally aligned with the grabber.	Place a known good plate in the source. When extending the grabber, check that both poles of the grabber touch the sample plate simultaneously. If not, adjust alignment. (For information, see "Aligning the Source Pedestal" on page 5-24.)
		D Source side clips have damaged leading ends. or Sample plate(s) have damaged edges.	Check the clip edges for denting, dimpling, and other damage. Smooth the edges with a small flat file and MicroFinish cloth. Replace if necessary. If no clip replacements are available, reverse the clips. (For information, see "Source Clips" on page 5-23.) Also check the sample plates. Smooth the edges with a small file and MicroFinish cloth or replace them as appropriate.
3	Sample plate cannot be pushed fully onto the stage	A Rear source clip is damaged.	Check the rear source clip for "dimples" or dents. Smooth the edges with a small file and MicroFinish cloth. If necessary, replace the clip. (For information, see "Source Clips" on page 5-23.) Also check the sample plates. Smooth the edges with a small file and MicroFinish cloth or replace them as appropriate.

(continued)

Table 6-2 Source and Sample Loading Chamber Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
4	During sample plate ejection, the sample plate either occasionally or consistently cannot be pulled off the stage by the grabber	A Grabber is not being energized.	With the grabber attached to circuit, check that voltage to the grabber switches properly: From a low +5 V logic state when the grabber is off to a high +5 V logic state when energized. If the voltage is not switching properly, check for continuity through grabber coils.
		B X-coordinate needs adjusting.	To adjust the X-load coordinate while the system is under vacuum: 1. Extend the magnetic grabber (attached to Linear 1 actuator; see the Voyager diagnostics software Mechanical Control page). 2. Observe the deflection of a sample plate when the grabber turned off. The stage deflects 1 to 2 mm when the grabber pushes on it. There is some play between the sample plate and source when the plate is mounted in the source. When the X-load coordinate is set correctly, the plate should deflect slightly more than the source.

(continued)

Table 6-2 Source and Sample Loading Chamber Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
4	During sample plate ejection, the sample plate either occasionally or consistently cannot be pulled off the stage by the grabber. (continued)	C Source pedestal is not rotationally aligned with the grabber.	Place a known good plate in the source. Verify the grabber poles are of equal length. If necessary, replace the grabber poles. When extending the grabber, check that both poles of the grabber touch the sample plate simultaneously. If not, adjust alignment. (For information, see “Aligning the Source Pedestal” on page 5-24.)
		D Linear 1 retract speed is too fast. The retract speed control valve (bleed screw) on the end of Linear actuator 1 (farthest away from the source housing) may be set improperly. The actuator may retract too quickly, breaking the magnetic connection between the sample plate and grabber.	Adjust the retraction rate to a slower speed by turning the retract speed control valve clockwise. (See Figure 5-12 on page 5-25.)
		E Detent balls on source are binding because sample contamination is getting into the holes where the balls are mounted.	If the detent balls provide too much resistance to compression, the grabber may have insufficient force to pull the plate from the source. To break the resistance, press down on the balls with an Allen wrench or similar tool. If necessary, disassemble and clean or replace the source.
		F Springs are too stiff.	Press down on the balls with an Allen wrench or similar tool.

(continued)

Table 6-2 Source and Sample Loading Chamber Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
4	During sample plate ejection, the sample plate either occasionally or consistently cannot be pulled off the stage by the grabber (continued)	G Defects on plate edges not allowing plate to release from detent balls or source edge clips.	Check the edges of all sample plates in use for damage. Smooth the edges with a small flat file and MicroFinish cloth. If necessary, replace the sample plate.
		H Contamination on sample plate.	Check the bottoms and edges of all sample plates in use for contamination. Clean. If necessary, replace the sample plate.
5	Grabber not contacting plate during loading or ejection	Insufficient X-load adjustment available to enable plate to be adequately contacted by the grabber during plate loading or ejection. Linear 1 actuator shaft is too short for system tolerances. (More often seen with older Bimba style actuators.)	Unscrew the grabber approximately 3/32" (roughly two turns) back on actuator shaft. Leave enough threads available on actuator shaft to securely attach the jam nut (cap) back onto shaft. To prevent the grabber and cap from loosening, place a small amount of thread sealant (such as LockTite) on the actuator shaft threads.
6	X or Y load coordinates require continual adjustment Or The X or Y home switches are moving	The X and Y home switch brackets are loose.	Tighten such that when the linear feedthroughs are fully extended to the home position, you see no movement of the home switches.

6.1.3 Computer System and Software

Table 6-3 Computer System and Software Troubleshooting

Item	Symptom	Possible Cause	Action
1	Error message displays: Waiting for laser trigger (4.5 Software)	A Laser is not firing.	Verify proper operation of laser. See laser warnings below.
		B Opto-trigger board is faulty.	Replace trigger PCB.
		C Digitizer trigger channel is defective.	Replace digitizer.
2	Acquisition Error (Version 5.0 software)	A Laser is not firing.	Verify proper operation of laser. See laser warnings below.
		B Opto-trigger board is faulty.	Replace opto-trigger PCB.
		C Digitizer trigger channel is defective.	Replace digitizer.
3	An error message appears during plate loading or ejection indicating that the source is not in the load position, even though the compressor is energized.	A load position microswitch needs adjusting or replacing.	Adjust the load switch bracket closer to the feedthrough post. Caution: Moving the switch too close to the post will cause premature failure of the switch. Replace the switch if necessary.

WARNING

LASER HAZARD. When instrument panels are removed, high-voltage contacts are exposed, and the laser emits ultraviolet radiation. Wear laser safety goggles when you remove panels for service.

WARNING

LASER HAZARD. Exposure to direct or reflected laser light can burn the retina and leave permanent blind spots. Never look directly into the laser beam. Remove jewelry and other items that can reflect the beam into your eyes. Wear laser safety goggles during laser alignment. Protect others from exposure to the beam. Post a laser warning sign while performing the alignment.

6.1.4 Power Supplies and Circuit Boards

Table 6-4 Power Supply and Circuit Board Troubleshooting

Item	Symptom	Possible Cause	Action
1	High-voltage interlock error	Cover is open (front, side, and rear panels).	Close and secure all Voyager workstation covers. Insert interlock service tag.
2	High-voltage interlock error occurs with covers and service interlock tag are in place.	A Fuse is blown.	Check the 5 V fuse. Replace.
		B Cable connection is faulty.	Verify the +5 V cable connection to the 48-bit I/O board is properly connected. Verify the cable connections between the control board and 48-bit I/O card are secure.
3	High voltage is off	DAC voltage is not present.	Replace DAC
4	After replacing the 30 kV power supply, voltage less than 30 kV is observed.	I pot needs adjusting.	Turn I pot counter clockwise three turns.
5	+5 V reference is less than or greater than 5 V	Reference pot needs adjusting.	Adjust the DAC reference pot.
6	Source or grid DAC voltage output incorrect	A High-voltage arc scrambled DAC and DAC output. +5 V reference is less than or greater than 5 V.	Reload DAC by changing a value or loading a different method.
		B ± 15 V fuse or power supply is faulty.	Check fuse or power supply. Replace.
		C DAC output is too low.	Replace DAC PCB.
		D DAC output is incorrect.	Check 5 V reference (test point 9) voltage on consolidated control board. If necessary, adjust to 5.00 V.
		E 48-bit I/O board is faulty.	Replace 48-bit I/O board.

6.1.5 Vacuum System

[“Multigauge Controller Common Error Codes” on page -16](#) lists the error codes displayed by the Multigauge controller, possible causes, and actions.

Table 6-5 Vacuum System Troubleshooting

Item	Symptom	Possible Cause	Action
1	TC2 reading shows higher than normal pressure (i.e. TC2 reading shows atmospheric pressure); It takes a long time to pump down after plate loading.	A Vent valve is stuck open after loading or ejecting the sample plate.	Close the vent valve. Check that 24 V is present to operate the vent valve. Clean or replace the vent valve if it is malfunctioning.
		B Flap Door 2 is not closing properly.	Check that Flap Door 2 actuator is operating properly. Close Flap Door 2.
			Check Flap Door 2 O-ring for any cracks or damages. If it is damaged, replace the O-ring.
		C A sample plate that was improperly loaded in the transporter and has jammed is interfering with Flap Door 2 closure.	If possible, eject the transporter out. Reseat the plate properly.
		D The fore pump is not pumping efficiently.	Check the pump oil level and color. Refill oil or replace the oil if the oil color is dark (ice tea color).
			Replace pump if it is malfunctioning.
		E Gas flows at vacuum hose connections.	Check the gasket on the clamps. Replace the gasket if it is damaged. Tighten the clamps.

(continued)

Table 6-5 Vacuum System Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
1	TC2 reading shows higher than normal pressure (i.e. TC2 reading shows atmospheric pressure); It takes a long time to pump down after plate loading. (continued).	F Flap Door 2 is not sealed properly.	Check that the Flap Door and the O-ring are free of dust and fibers. If necessary, clean up any dust or fibers using a laboratory wipe moistened with ethanol (100%). Replace the O-ring if it is damaged. Check that the Flap Valve presses evenly on the O-ring, with the face of the valve being parallel to the face of the Sample Loading Chamber when closed. If it is not parallel, adjust the Flap Valve hinge bar.
		G Leaking from the knurled nut on Linear 1 actuator.	Finger-tighten the nut. Do not over-tighten it.
		H Leaking from the knurled nut on Linear 2 actuator.	Finger-tighten the nut. Do not over-tighten it.
		I Leaking from the knurled nut on Flap Door 1.	Finger-tighten the nut. Do not over-tighten it.
		J Samples on the plate are not completely dry.	Dry the samples completely before loading sample plate.
! WARNING! CHEMICAL HAZARD. Ethanol is a flammable liquid and vapor. It may cause eye, skin, and upper respiratory tract irritation. Prolonged or repeated contact may dry skin. Exposure may cause central nervous system depression and liver damage. Please read the MSDS and follow the handling instructions. Wear appropriate protective eyewear, clothing, and gloves.			

(continued)

Table 6-5 Vacuum System Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
2	BA1 ion gauge shut down with E09 displayed on Multigauge controller display after plate loading/ejecting	A Flap Door 1 is improperly closing.	Check that the sample plate is not stuck at Flap Door 1. Make sure the Flap Door 1 actuator works properly.
		B Flap Door 1 is improperly sealing.	Align Flap Door 1 Replace damaged O-ring.
		C Samples on the plate are not completely dry.	Dry the samples completely before loading sample plate.
		D Foreline Valve 2 is improperly sealing.	Replace Foreline Valve 2 assembly.
		E Linear 1 actuator is leaking at its O-ring seal.	—The knurled nut may be slightly loose; try tightening. —The O-ring seal under the knurled nut may be binding and in need of lubrication. —The Linear actuator shaft may be scratched or nicked, allowing an air burst to enter the Sample Loading Chamber when the actuator is being extended during the plate loading/ejection process.

(continued)

Table 6-5 Vacuum System Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
3	BA1 (or BA2) ion gauge reading shows higher than normal pressure; BA1 (or BA2) ion gauges shut down with E09 on display but TC2 reading is normal.	A Source or reflector turbo is not pumping properly.	Check that when the source turbo or reflector turbo is running, the normal status light is on. If the turbo makes loud whining noise, replace the turbo.
		B Source or reflector turbo shuts down.	Check the source or reflector turbo fuse on the ac distribution circuit board. Replace if necessary. If the turbo controller is working properly but the turbo cannot be restarted to normal speed, replace the turbo. Check that the corresponding turbo controller is working properly. See the <i>Varian Turbocontroller Instruction Manual</i> .
		C Failure of Foreline Valve 1 or 2.	Check the functioning of Foreline Valves 1 and 2. Replace if faulty.
4	Fore pump is not running.	A Fuse is blown.	Replace the fuse on the Voyager AC distribution board.
		B Oil level too low or oil is too dirty.	Refill oil to appropriate level or replace oil completely. Use designated oil for each type of pump.
		C Pump is inoperable.	Replace the pump.
5	Multigauge controller displays E05 error on BA1 or BA2 gauges	A The ion gauge filament is open.	Check the continuity of the filament. If the filament is open, replace the gauge.
		B The connection from the ion gauge to the multi-gauge controller is loose or malfunctioning.	Reseat cable connections.

(continued)

Table 6-5 Vacuum System Troubleshooting (Continued)

Item	Symptom	Possible Cause	Action
6	“Ion Gauge Controller not responding” error occurs during vacuum initialization	A BA1 and/or BA2 are not on.	Turn on BA1 and BA2 before starting vacuum initialization.
		B Wrong Com port is selected.	In the computer use Com Port 2 for the vacuum gauge controller (see <i>Voyager User Guide</i>).
7	Vacuum initialization error	BA1 and/or BA2 pressure readings exceed the normal operational pressure limits.	Check vacuum system performance and ensure the pumps are pumping properly. When the system reaches appropriate pressures, re initialize the gauges, if necessary.
8	When system re-starts after a power outage, the Voyager control panel shows an instrument error when acquiring data.	System pressure has not been pumping down sufficiently before the computer boots up and IHC starts to initialize the system.	Check system pressure. Stop and restart the IHC if system is under normal operating pressures.

6.2 Multigauge Controller Common Error Codes

Table 6-6 Multigauge Controller Common Error Codes

Error Code	Possible Error Source	Possible Cause	Action
E02	Microburst	Wet sample plate.	Recalibrate microburst tolerance setting to the default by pressing: F, Vac, then A52.
E03	Ion gauge connection broken or disconnected. The Voyager Control panel displays an error message indicating a high pressure shut down on the ion gauge.	No current.	If resetting the Voyager software clears the error, the problem was between the software and the multigauge controller. If the error persists, the problem is between the Voyager hardware and multigauge controller.
		Collector cable connection is bad or dislodged.	Replace or reconnect the cable.
E04	Filament	BA gauge filament is over current or shorted. Commonly, filament is shorted to the grid.	Measure filament-to-grid with an ohm meter. If the reading is not open, replace the BA gauge. If reading is open, move the BA board to an open slot on the multigauge controller mother board. If the board fails in the new slot, replace the BA board.

(continued)

Table 6-6 Multigauge Controller Common Error Codes (Continued)

Error Code	Possible Error Source	Possible Cause	Action
E05	Gauge does not ignite	Power not plugged in to the ion gauge. Faulty BA Board. Faulty BA slot on the multigauge controller mother board.	Move the BA board to an open slot on the multigauge controller mother board. If the board fails in the new slot, replace the BA board.
		On reflector systems, bad cable or connection.	On the back of the multigauge controller, disconnect the BA1 and BA2 cables. Connect the BA2 cable to the BA1 gauge. Check the BA2 display to verify the BA1 status. If status is correct, the BA1 cable is defective and needs replacement.
E07	Over temperature	Temperature inside the multigauge controller is over 65 °C.	Verify that the fan is operational. Replace if necessary.
E08	Multigauge controller board	Board logic failure.	Power down then power up the mass spectrometer. Reset the multigauge controller unit by pressing: F, Vac, then A81. If necessary, replace the multigauge controller unit.
E09	Vacuum system	Catastrophic leak in the vacuum system.	Toggle through the channels to locate the gauge that is shut down. Check the integrity of the: Foreline hose connections Copper seals O-ring seals Feedthroughs Weldments
E14	Keypad	Keypad locked.	Unlock the keypad by pressing: F, Vac, then A33.

6.3 LED Indicators

LED indicators reflect the status of the system. [Table 6-7](#) describes LED states and any actions needed to correct the fault.

Table 6-7 LED Indicators

LED Location	LED State	System Status	Comment
Voyager workstation top panel or D12 on MALDI Consolidated Control Board	Yellow	Turbo initial start-up	Turbos initiated.
	Yellow and green	Turbo building up speed	Turbo is at 80% of full speed.
	Green	Turbo at full speed	Turbo is at normal operating conditions (56 krpm).
	Red	Turbo fault	Unplug the turbo pump and plug it in again. If the fault persists, check the: • Turbo pump for turbo failure • Turbo pump for turbo controller failure • Vacuum system for a severe vacuum leak

Technical Support and Training

A

This appendix contains the following:

Technical Service Resources	A-2
Contacting Technical Support	A-5
Obtaining Technical Documents	A-10
Obtaining Customer Training Information	A-11

Technical Service Resources

Overview [Figure A-1](#) shows the available chain of resources to obtain Voyager service and troubleshooting assistance.

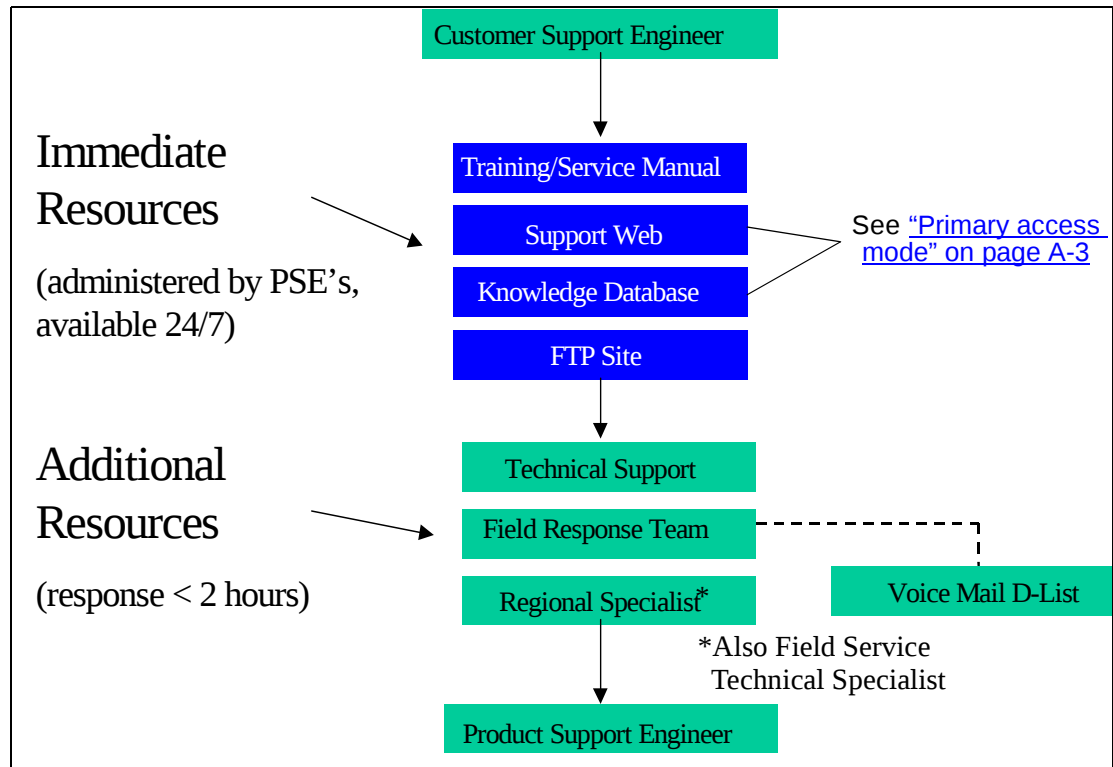


Figure A-1 Resource Chain

Voyager Support Database Field service engineers can review the Voyager (MALDI) Product Support web site and the Voyager (MALDI) Knowledge Database 24 hours/day, 7 days a week. Each database is a repository of information that is fully text searchable and is individually replicated on Notes.

The following table describes the information available and how to access each database.

	Applied Biosystems Voyager (MALDI) Support Web Site	Voyager (MALDI) Knowledge Database
Purpose	To provide released documents from Houston	To provide communication tool for FSE to share facts, questions, and new technical information
Categories	Installation documents Parts list Service bulletins, service manual, service notes Shareware, software and software installation documents Support contact information Guides and related manuals Utility programs	Electronics General Installation and operation Mechanical Service bulletins and notes Software Spare parts
Primary access mode	Through the internet, go to: http://usfosdws03/intranet/pbiosupportweb.nsf/docs/4LFFAJRMIR?opendocument	Through Lotus Notes desktop, go to: File-Database-Open Server: USFOSDWS03/FOS/PEC Database: MSGBOARDS Folder: VOYAGER
Additional access modes	- Through the Applied Biosystems intranet, go to: https://gene.peintranet.net/ (login to the intranet is needed) Select: Departments, Product Support, Voyager Support - Through Lotus Notes desktop, go to: File-Database-Open Server: USFOSDWS03/FOS/PEC Database: INTRANET Folder: PBIOSUPPORT.NSF	- Through the internet, go to: http://167.116.75.148/msgboards/Voyager.nsf/all?OpenView - Through the Applied Biosystems intranet, go to: https://gene.peintranet.net/ (login to the intranet is needed) Select: Departments, Product Support, Link to the MALDI *****Knowledge Database*****

	Applied Biosystems Voyager (MALDI) Support Web Site	Voyager (MALDI) Knowledge Database
How to add content	E-mail a Voyager product engineer (specialist)	If you have access to Lotus Notes or the Applied Biosystems intranet, you can add content directly to the knowledge database. Otherwise, you can email contributions to: Voyager@appliedbiosystems.com.

Contacting Technical Support

Overview You can contact Applied Biosystems for technical support:

- By e-mail
- By telephone or fax
- Through the Applied Biosystems Technical Support web site

Note: For information on obtaining technical documents such as Applied Biosystems user documents, MSDSs, and certificates of analysis, see ["Obtaining Technical Documents" on page A-10](#).

By E-Mail You can contact technical support by e-mail for help in the product areas listed below.

Product/Product Area	E-Mail Address
Genetic Analysis (DNA Sequencing)	galab@appliedbiosystems.com
Sequence Detection Systems and PCR	pcrlab@appliedbiosystems.com
Protein Sequencing, Peptide, and DNA Synthesis	corelab@appliedbiosystems.com
• Biochromatography • PerSeptive DNA, PNA and Peptide Synthesis systems • FMAT™ 8100 HTS System • CytoFluor® 4000 Fluorescence Plate Reader • Mariner™ Mass Spectrometers • MassGenotyping Solution 1™ (MGS1) System • Voyager™ Mass Spectrometers	tsupport@appliedbiosystems.com
LC/MS (Applied Biosystems/MDS Sciex)	support@sciex.com
Chemiluminescence (Tropix)	tropix@appliedbiosystems.com

By Telephone or
Fax In North America

To contact Applied Biosystems Technical Support in North America, use the telephone or fax numbers in the table below.

Note: To schedule a service call for other support needs, or in case of an emergency, dial **1.800.831.6844**, then press **1**.

Product/Product Area	Telephone	Fax
ABI PRISM® 3700 DNA Analyzer	1.800.831.6844 , then press 8^a	1.650.638.5981
DNA Synthesis	1.800.831.6844 , press 2 , then press 1^a	1.650.638.5981

Product/Product Area	Telephone	Fax
Fluorescent DNA Sequencing	1.800.831.6844 , press 2 , then press 2^a	1.650.638.5981
Fluorescent Fragment Analysis (including GeneScan® applications)	1.800.831.6844 , press 2 , then press 3^a	1.650.638.5981
Integrated Thermal Cyclers (ABI PRISM® 877 and Catalyst 800 instruments)	1.800.831.6844 , press 2 , then press 4^a	1.650.638.5981
ABI PRISM® 3100 Genetic Analyzer	1.800.831.6844 , press 2 , then press 6^a	1.650.638.5981
Peptide Synthesis (433 and 43x Systems)	1.800.831.6844 , press 3 , then press 1^a	1.650.638.5981
Protein Sequencing (Procise® Protein Sequencing Systems)	1.800.831.6844 , press 3 , then press 2^a	1.650.638.5981
PCR and Sequence Detection	1.800.762.4001 , then press: 1 for PCR ^a 2 for TaqMan® applications and Sequence Detection Systems including ABI Prism® 7700, 7900, and 5700 ^a 6 for the 6700 Automated Sample Prep System ^a or 1.800.831.6844 , then press 5^a	1.240.453.4613
• Voyager™ MALDI-TOF Biospectrometry Workstations • Mariner™ ESI-TOF Mass Spectrometry Workstations • MassGenotyping Solution 1™ (MGS1) System	1.800.899.5858 , press 1 , then press 3^b	1.508.383.7855
Biochromatography (BioCAD®, SPRINT™, VISION™, and INTEGRAL® Workstations and POROS® Perfusion Chromatography Products)	1.800.899.5858 , press 1 , then press 4^b	1.508.383.7855
Expedite™ Nucleic Acid Synthesis Systems	1.800.899.5858 , press 1 , then press 5^b	1.508.383.7855
Peptide Synthesis (Pioneer™ and 9050 Plus Peptide Synthesizers)	1.800.899.5858 , press 1 , then press 5^b	1.508.383.7855

Product/Product Area	Telephone	Fax
PNA Custom and Synthesis	1.800.899.5858 , press 1 , then press 5^b	1.508.383.7855
• FMAT™ 8100 HTS System • CytoFluor® 4000 Fluorescence Plate Reader	1.800.899.5858 , press 1 , then press 6^b	1.508.383.7855
Chemiluminescence (Tropix)	1.800.542.2369 (U.S. only), or 1.781.271.0045^c	1.781.275.8581
LC/MS (Applied Biosystems/MDS Sciex)	1.800.952.4716	1.508.383.7899

a.5:30 A.M. to 5:00 P.M. Pacific time.

b.8:00 A.M. to 6:00 P.M. Eastern time.

c.9:00 A.M. to 5:00 P.M. Eastern time.

Outside North America

To contact Applied Biosystems Technical Support or Field Service outside North America, use the telephone or fax numbers below.

Region	Telephone	Fax
Eastern Asia, China, Oceania		
Australia (Scoresby, Victoria)	61 3 9730 8600	61 3 9730 8799
China (Beijing)	86 10 64106608 or 86 800 8100497	86 10 64106617
Hong Kong	852 2756 6928	852 2756 6968
Korea (Seoul)	82 2 5936470/6471	82 2 5936472
Malaysia (Petaling Jaya)	60 3 79588268	603 79549043
Singapore	65 896 2168	65 896 2147
Taiwan (Taipei Hsien)	886 2 2358 2838	886 2 2358 2839
Thailand (Bangkok)	66 2 719 6405	662 319 9788
Europe		
Austria (Wien)	43 (0)1 867 35 75 00	43 (0)1 867 35 75 11
Belgium	32 (0)2 532 4484	32 (0)2 582 1886
Denmark (Naerum)	45 45 58 60 00	45 45 58 60 01
Finland (Espoo)	358 (0)9 251 24 250	358 (0)9 251 24 243
France (Paris)	33 (0)1 69 59 85 85	33 (0)1 69 59 85 00

Region	Telephone	Fax
Germany (Weiterstadt)	49 (0) 6150 101 0	49 (0) 6150 101 101
Italy (Milano)	39 (0)39 83891	39 (0)39 838 9492
Norway (Oslo)	47 23 12 06 05	47 23 12 05 75
Portugal (Lisboa)	351.(0)22.605.33.14	351.(0)22.605.33.15
Spain (Tres Cantos)	34.(0)91.806.1210	34.(0)91.806.12.06
Sweden (Stockholm)	46 (0)8 619 4400	46 (0)8 619 4401
Switzerland (Rotkreuz)	41 (0)41 799 7777	41 (0)41 790 0676
The Netherlands (Nieuwerkerk a/d IJssel)	31 (0)180 392400	31 (0)180 392409 or 31 (0)180 392499
United Kingdom (Warrington, Cheshire)	44 (0)1925 825650	44 (0)1925 282502
European Managed Territories (EMT)		
Africa, English speaking (Johannesburg, South Africa)	27 11 478 0411	27 11 478 0349
Africa, French speaking (Paris, France)	33 1 69 59 85 11	33 1 69 59 85 00
India (New Delhi)	91 11 653 3743 91 11 653 3744	91 11 653 3138
Poland, Lithuania, Latvia, and Estonia (Warszawa)	48 22 866 4010	48 22 866 4020
For all other EMT countries not listed (Central and southeast Europe, CIS, Middle East, and West Asia	44 1925 282481	44 1925 282509
Japan		
Japan (Hacchobori, ChuoKu, Tokyo)	81 3 5566 6230	81 3 5566 6507
Latin America		
Caribbean countries, Mexico, and Central America	52 55 35 3610	52 55 66 2308
Brazil	0 800 704 9004 or 55 11 5070 9654	55 11 5070 9694/95
Argentina	800 666 0096	55 11 5070 9694/95
Chile	1230 020 9102	55 11 5070 9694/95
Uruguay	0004 055 654	55 11 5070 9694/95

Through the
Technical Support
Web Site

To contact Technical Support through the Applied Biosystems web site:

-
1. Access the Applied Biosystems Technical Support web site at **www.appliedbiosystems.com/techsupp**.
 2. Under the Troubleshooting heading, click **Support Request Forms**, then select the support region for the product area of interest.
 3. In the Personal Assistance form, enter the requested information and your question, then click **Ask Us RIGHT NOW**.
 4. In the Customer Information form, enter the requested information, then click **Ask Us RIGHT NOW**.
-

Within 24 to 48 hours, you will receive an e-mail reply to your question from an Applied Biosystems technical expert.

Obtaining Technical Documents

Overview You can obtain technical documents, such as Applied Biosystems user documents, MSDSs, certificates of analysis, and other related documents for free, 24 hours a day. You can obtain documents:

- By telephone
- Through the Applied Biosystems Technical Support web site

Ordering Documents by Telephone

To order documents by telephone:

-
1. From the U.S. or Canada, dial **1.800.487.6809**, or from outside the U.S. and Canada, dial **1.858.712.0317**.
-
2. Follow the voice instructions to order documents (for delivery by fax).

Note: There is a limit of five documents per fax request.

Obtaining Documents Through the Web Site

To view, download, or order documents through the Applied Biosystems Technical Support web site:

-
1. Access the Applied Biosystems Technical Support web site at **www.appliedbiosystems.com/techsupp**.
-
2. Under the Resource Libraries heading, select the type of technical document you want.
-
3. In the search form, enter or select search criteria, then click **Search**.
-
4. In the results screen, do any of the following:
 - Click  to view a PDF version of the document.
 - Right-click , then select **Save Target As** to download a copy of the PDF file.
 - Select the **Fax** check box, then click **Deliver Selected Documents Now** to have the document faxed to you.
 - Select the **Email** check box, then click **Deliver Selected Documents Now** to have the document (PDF format) e-mailed to you.

Note: There is a limit of five documents per fax request, but no limit on the number of documents per e-mail request.

Obtaining Customer Training Information

The Applied Biosystems Training web site at **www.appliedbiosystems.com/techsupp/training.html** provides course descriptions, schedules, and other training-related information.

Assembly Drawings

B

This appendix contains the following:

Finding Components B-2

Relative Assembly Locations B-3

Finding Components

[Table B-1](#) provides figure numbers showing the listed component.

Table B-1 Component Diagrams

Component	See Figure
Beam-steering plates and voltage connections	Figure B-5 , Figure B-6
Einzel lens assembly and voltage connection	Figure B-5 , Figure B-6 , Figure B-7
Feedthroughs	Figure B-8
Flap doors	Figure B-9
Flap valve block	Figure B-9
Ion exit aperture	Figure B-5
Linear actuators	Figure B-9
Sample loading chamber	Figure B-9
Stage X, Y table; load position	Figure B-8
Variable grid	Figure B-6
X and Y feedthroughs; home and load positions	Figure B-8

Relative Assembly Locations

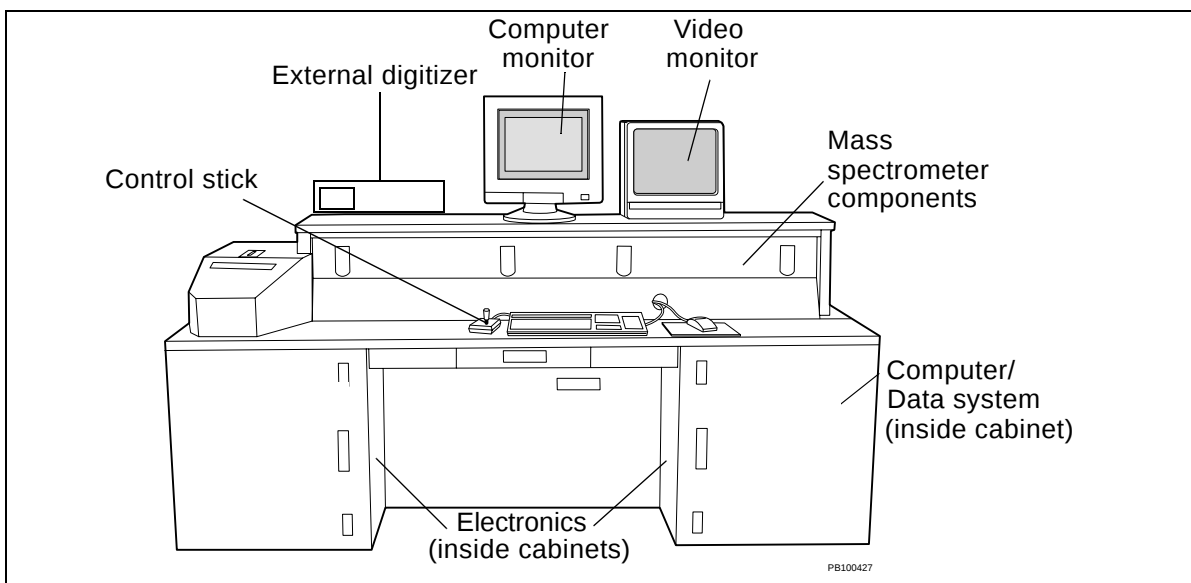


Figure B-1 Voyager-DE STR Biospectrometry Workstation

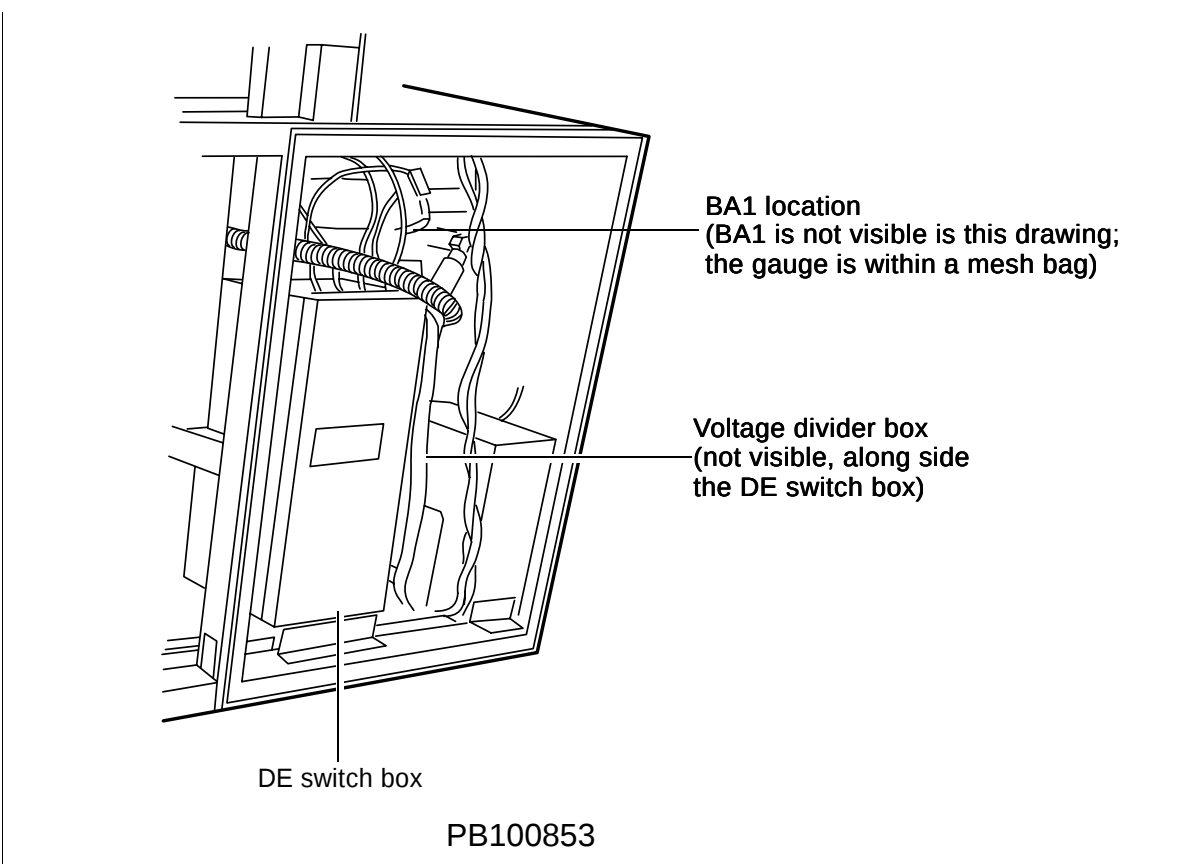


Figure B-2 Voyager-DE STR Left Cabinet Rear View

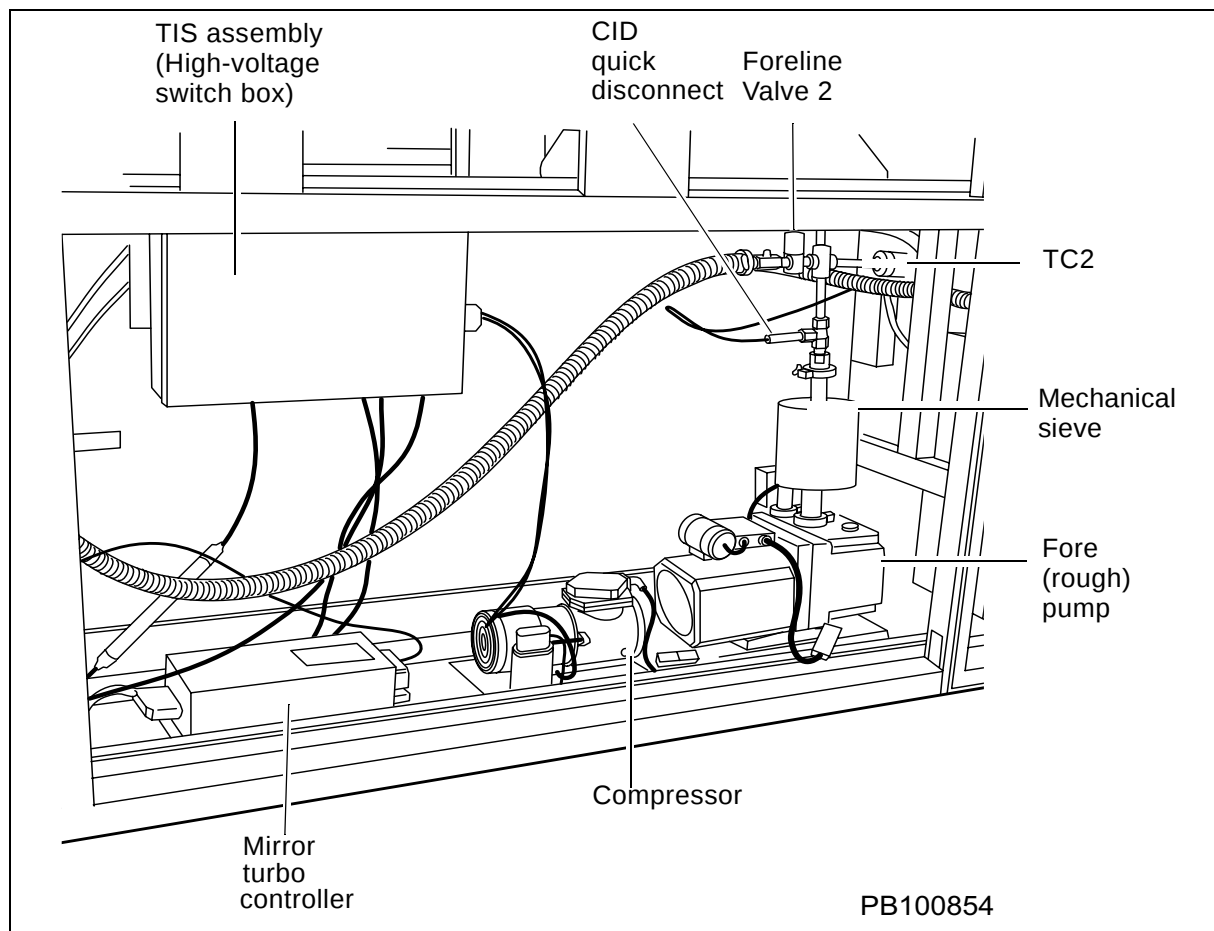


Figure B-3 Voyager-DE STR Center Rear View

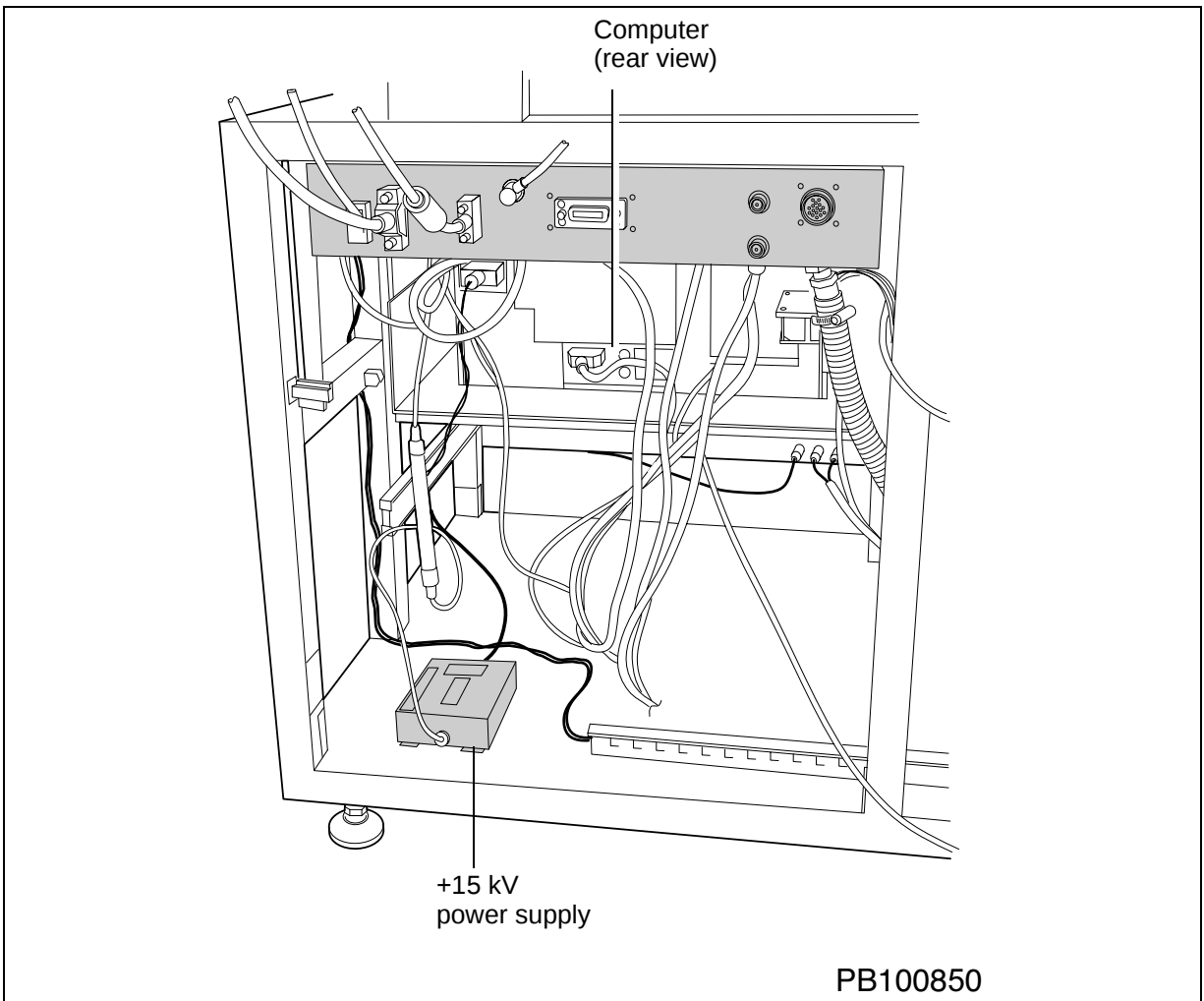


Figure B-4 Right Cabinet Rear View

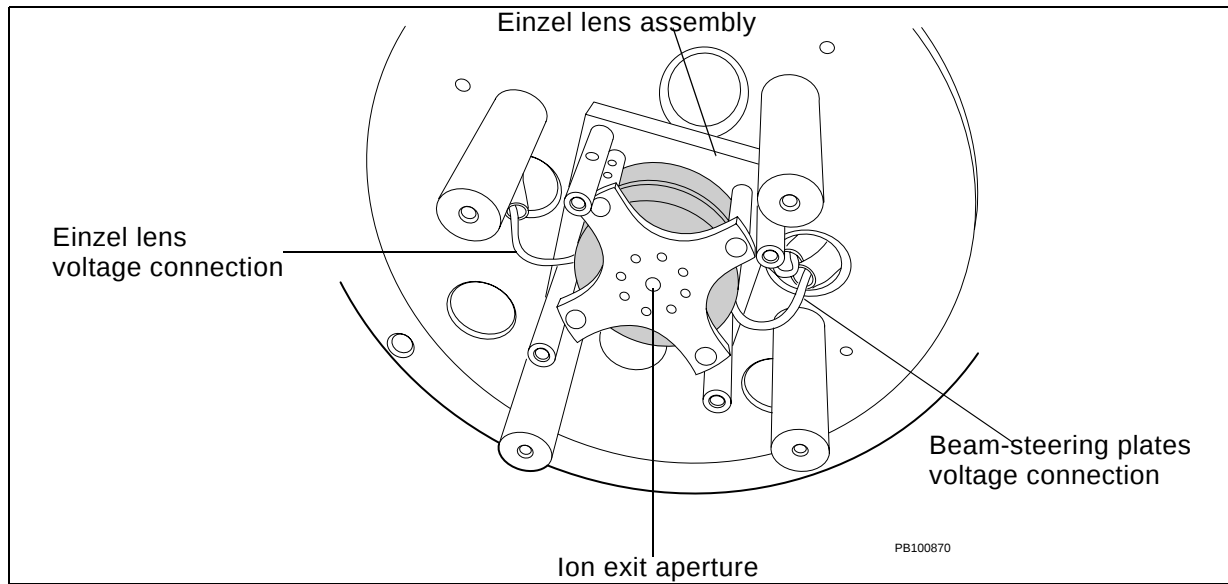


Figure B-5 Einzel Lens Assembly (with Variable Voltage and Ground Grids Removed)

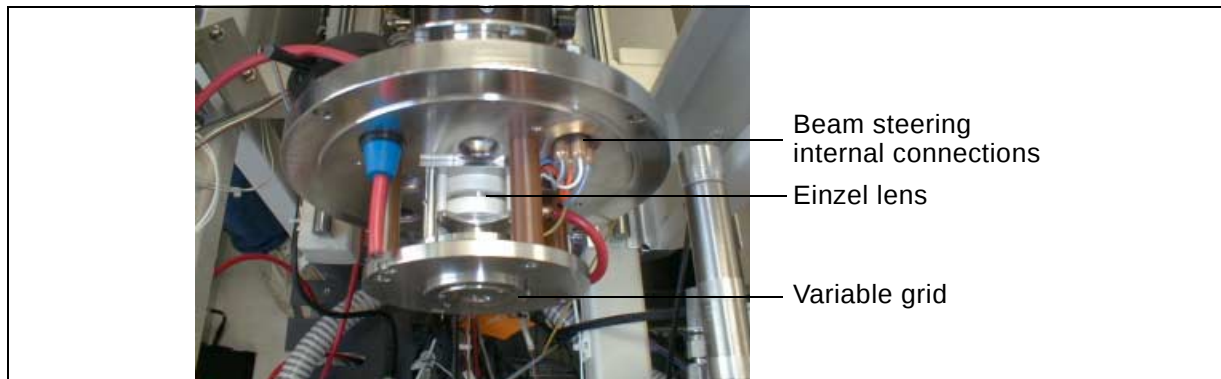


Figure B-6 Ion Exit Flange Showing the Einzel Lens Assembly

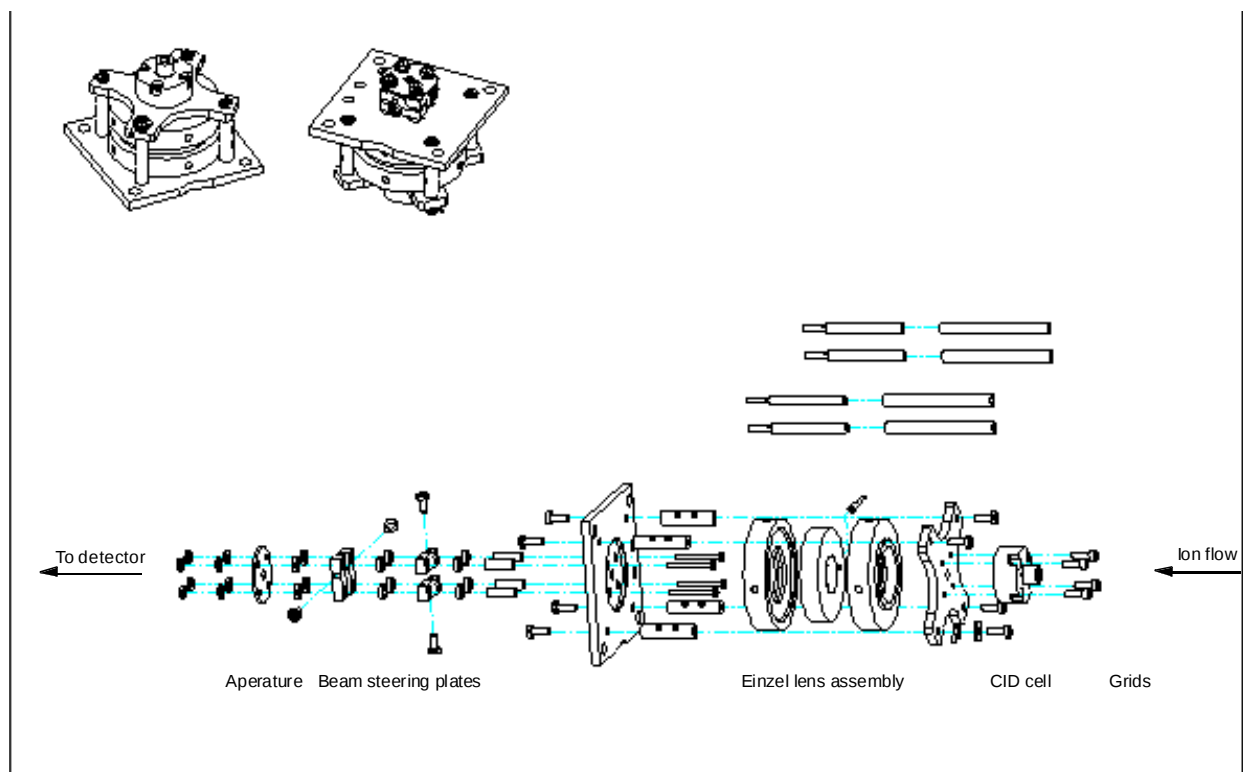


Figure B-7 Einzel Lens Assembly

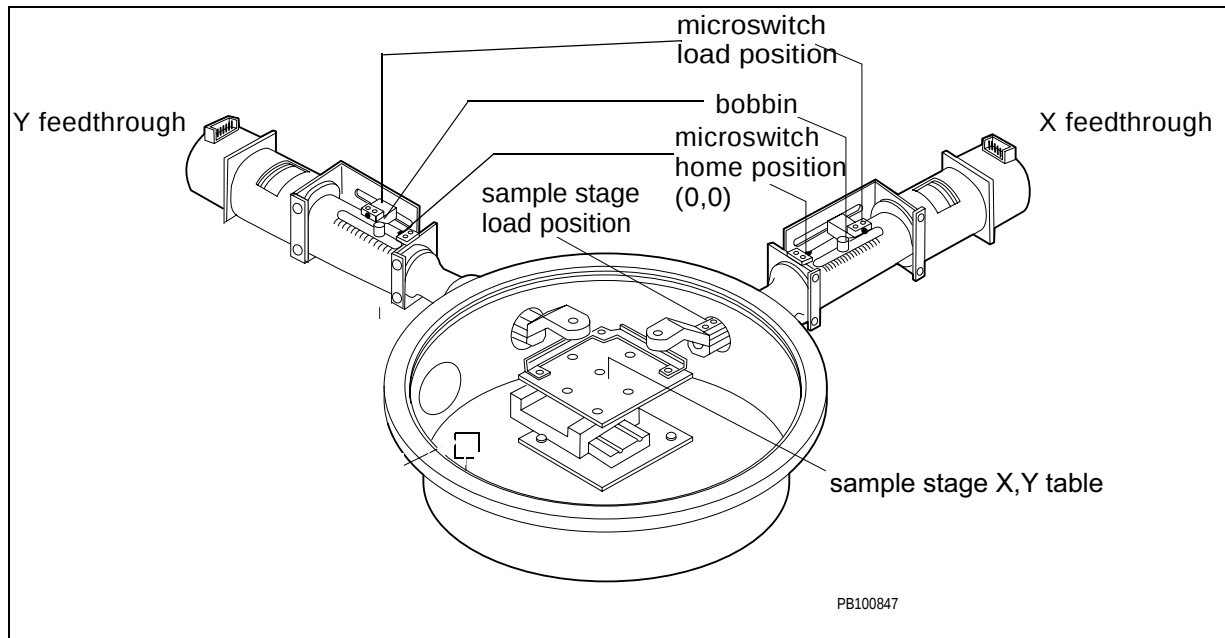


Figure B-8 Feedthroughs and Sample Stage

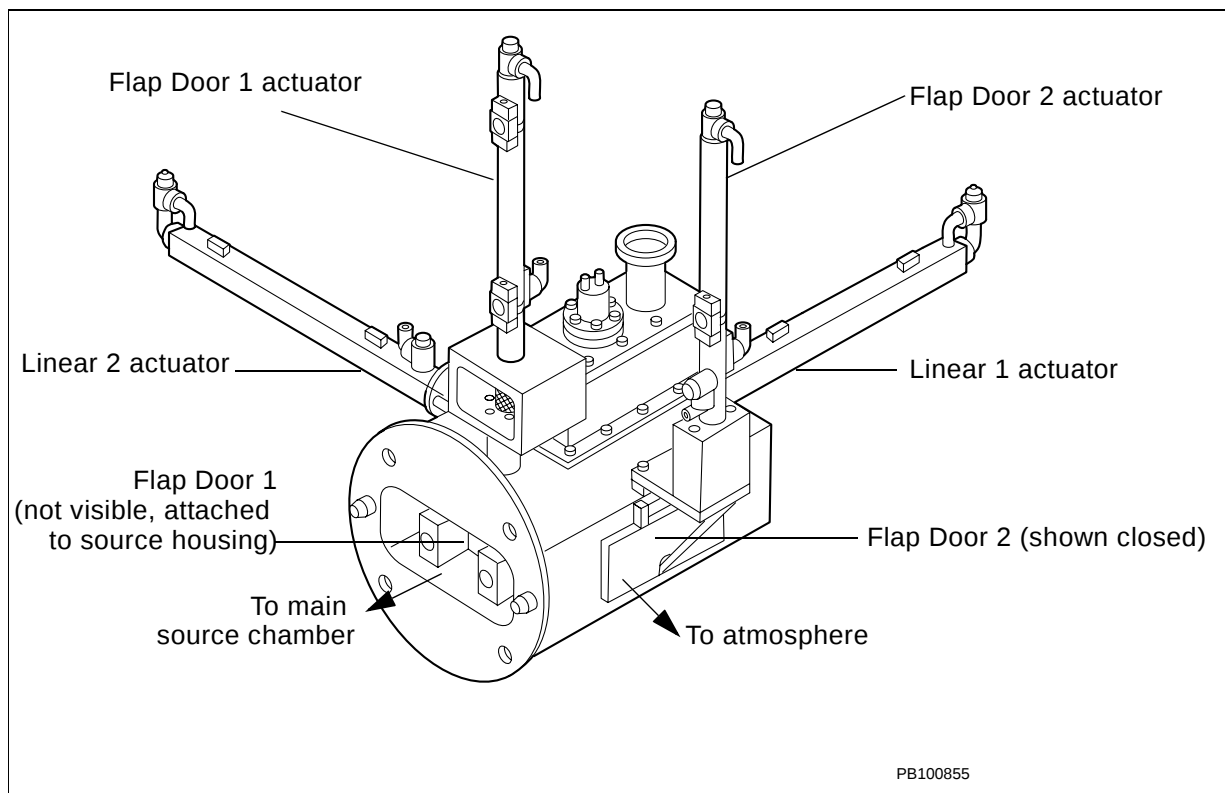


Figure B-9 Sample Loading Chamber

Electronic Drawings

C

This appendix contains the following:

Locations of Electronic Components	C-2
Pin 1 Connector Locations	C-4
Interconnects	C-5
MALDI Consolidated Control Board	C-7

Locations of Electronic Components

Use the following figures to locate electronic components. For more information about Voyager workstation electronics, see the circuit board schematics posted on the MALDI knowledge database and review [Chapter 2. Voyager-DE STR Workstation Electronics Theory](#) in this manual.

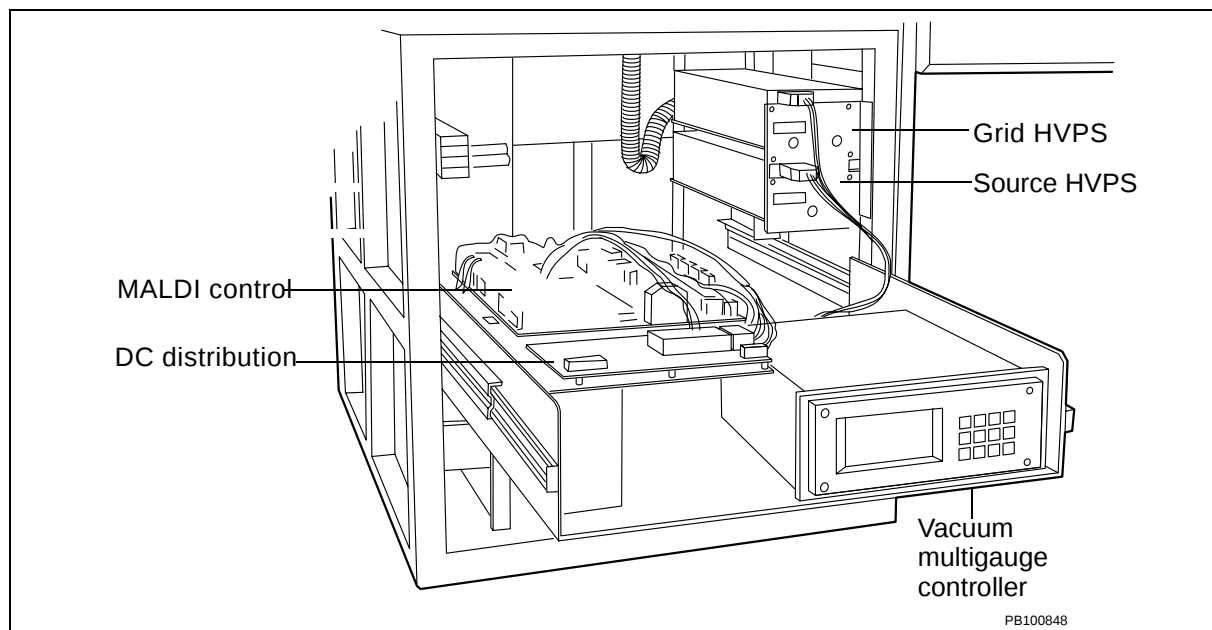


Figure C-1 Electronics in Left Cabinet (Front View)

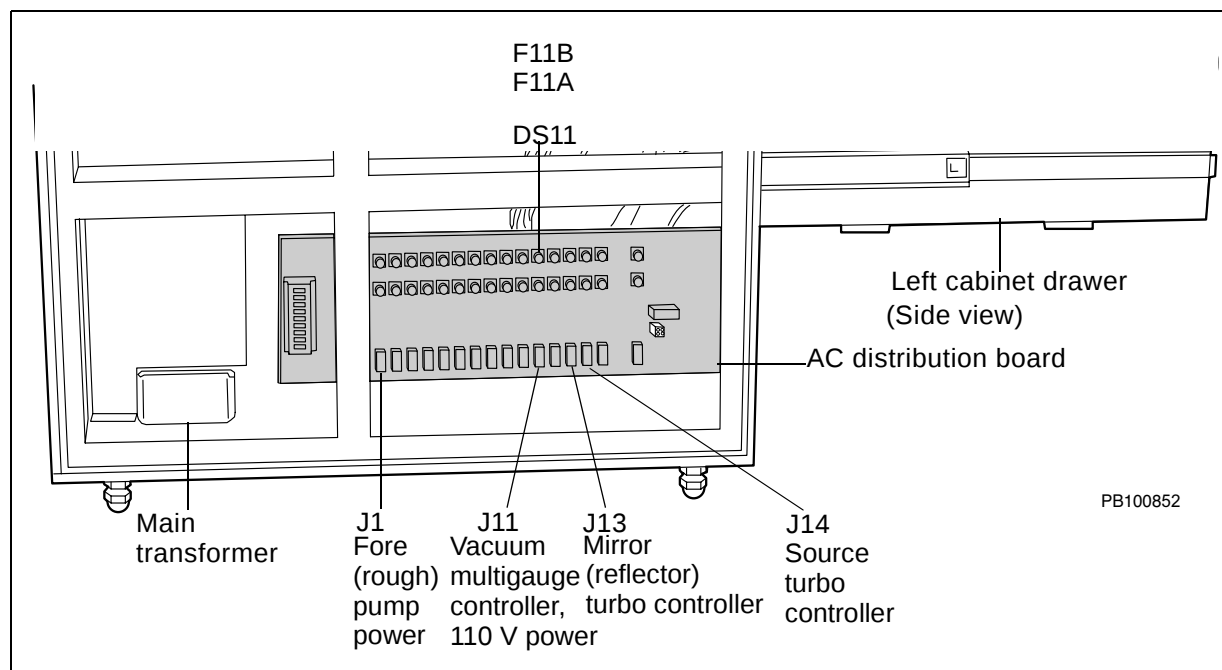


Figure C-2 Electronics in the Left Cabinet (Side View)

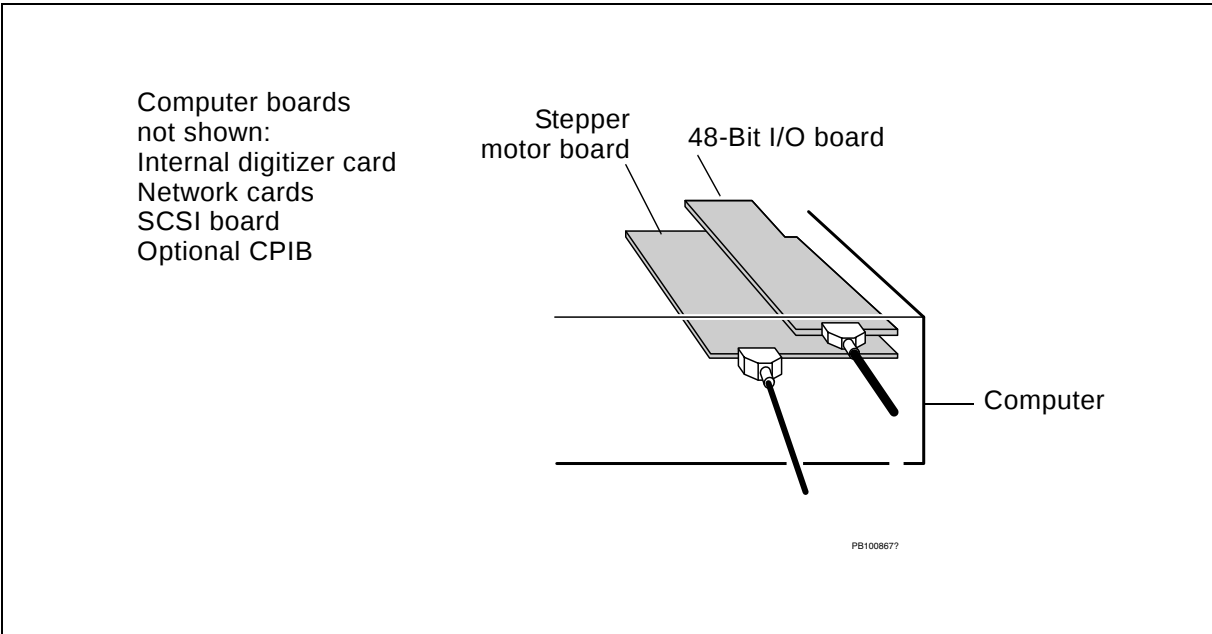


Figure C-3 Electronics in the Right Cabinet (Top Drawer, Rear View)

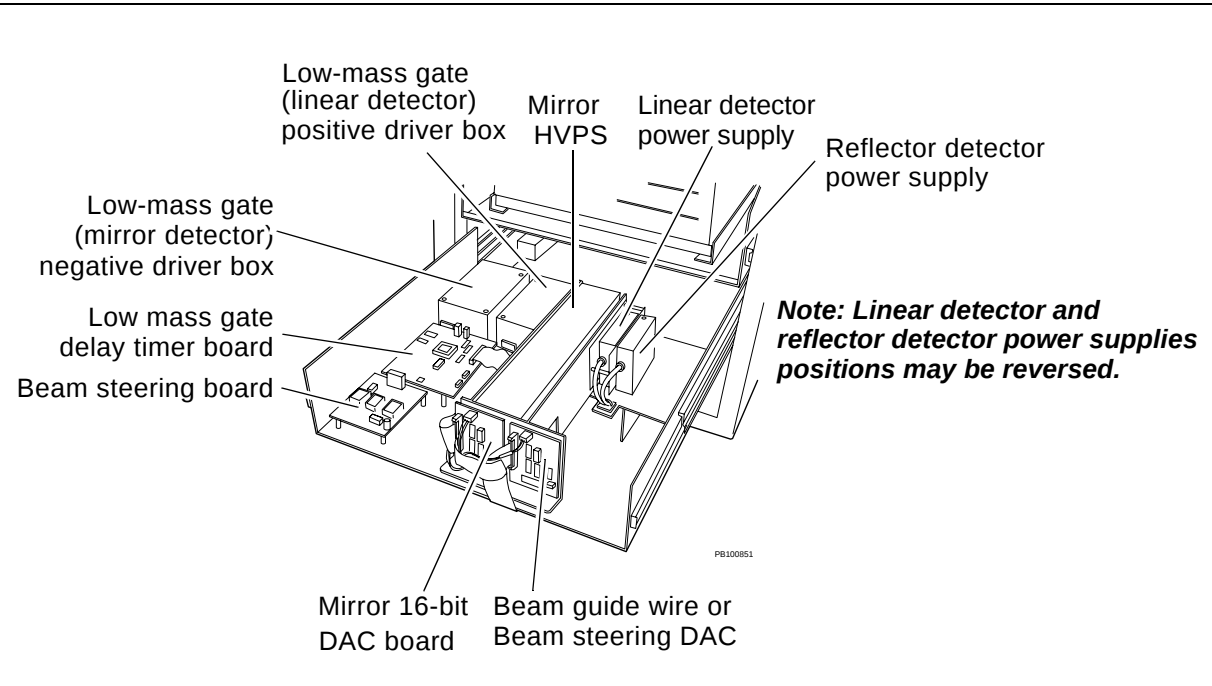


Figure C-4 Electronics in the Right Cabinet (Bottom Drawer, Front View)

Pin 1 Connector Locations

Use [Figure 5](#) to find the pin 1 positions for commonly used connectors.

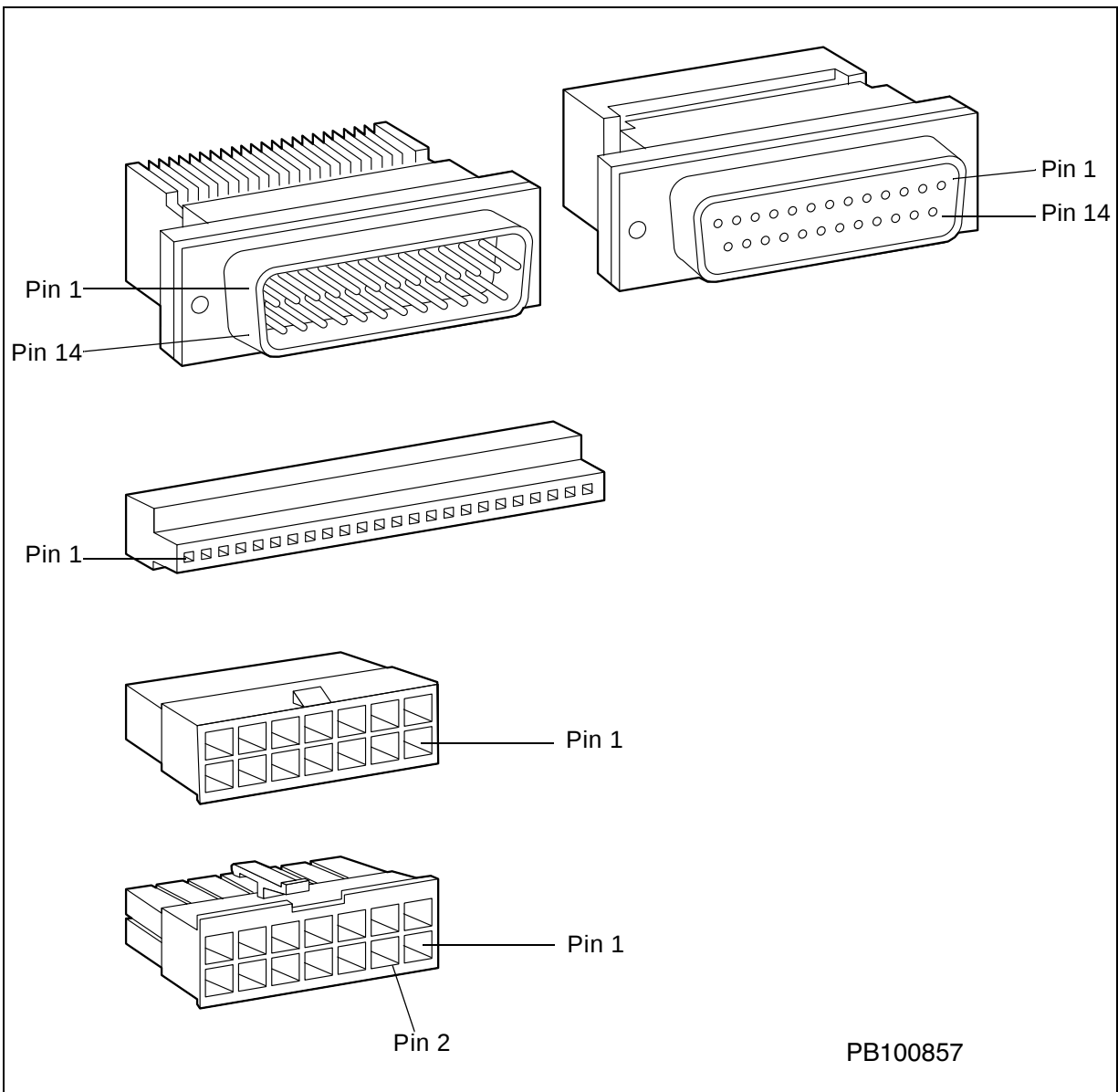


Figure C-5 Pin 1 Connector Locations

Interconnect

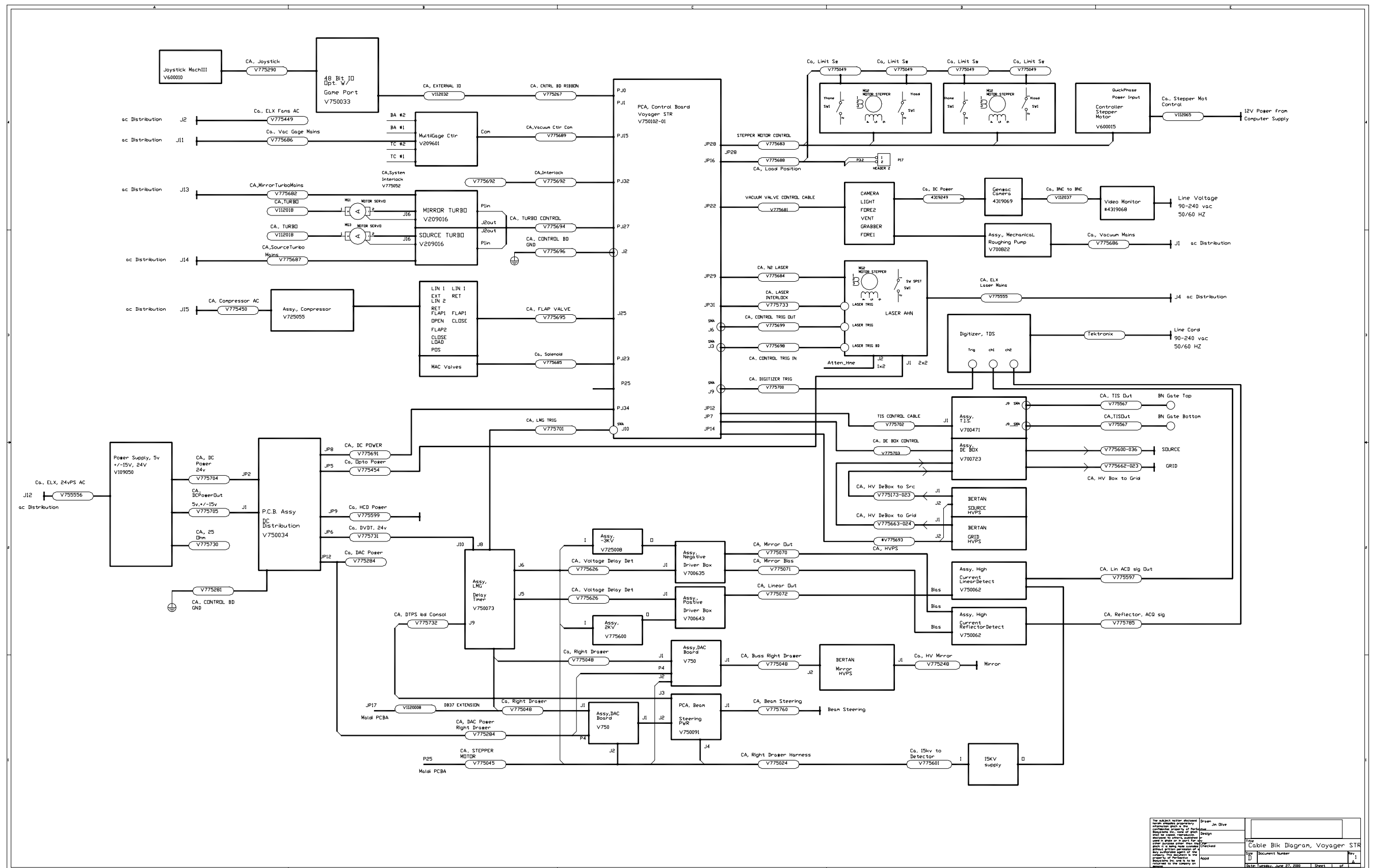
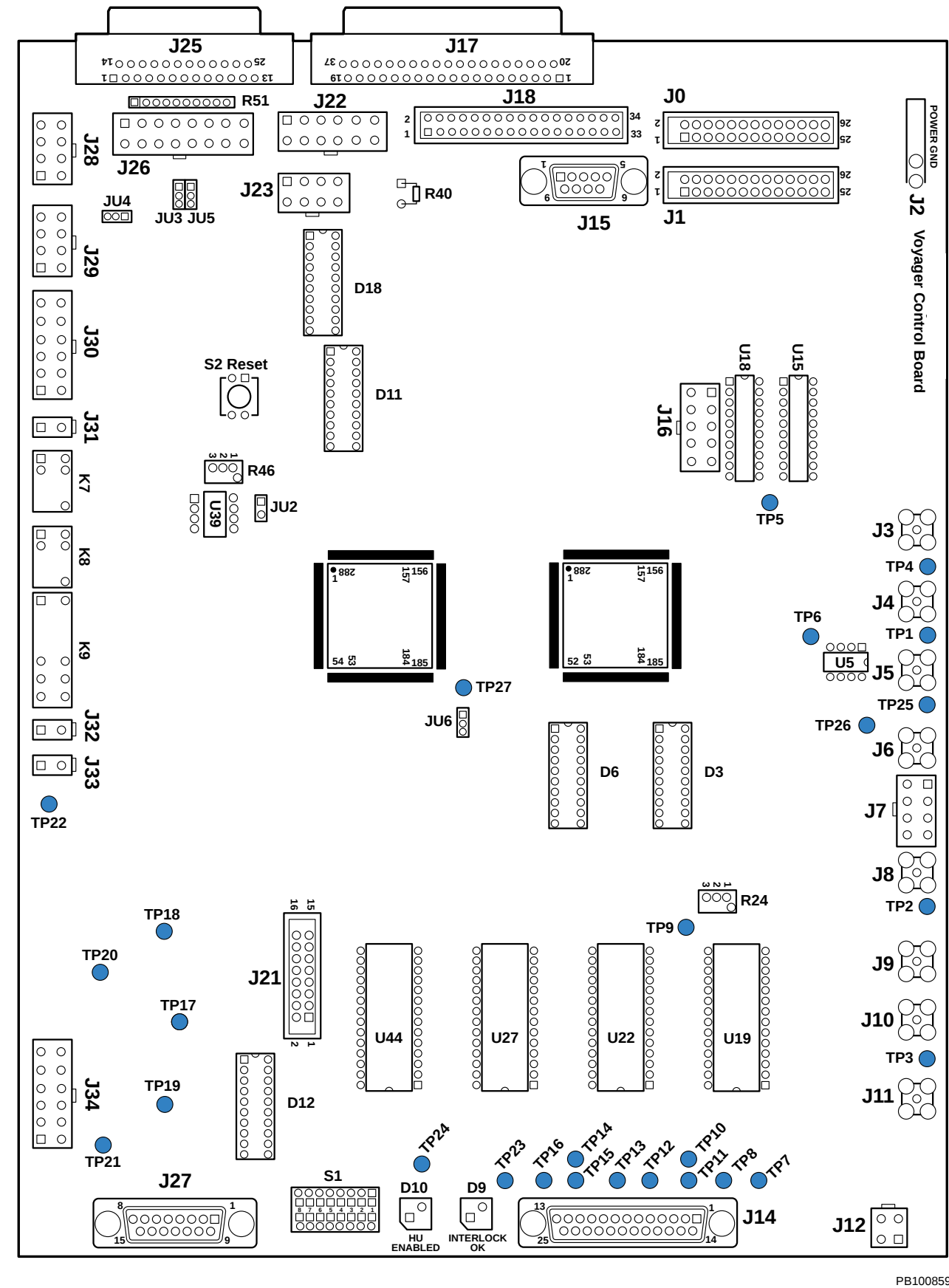


Figure C-1 Voyager-STR Interconnect

**MALDI
Consolidated
Control
Board**



PB100859

Figure C-2 Consolidated MALDI Control Board

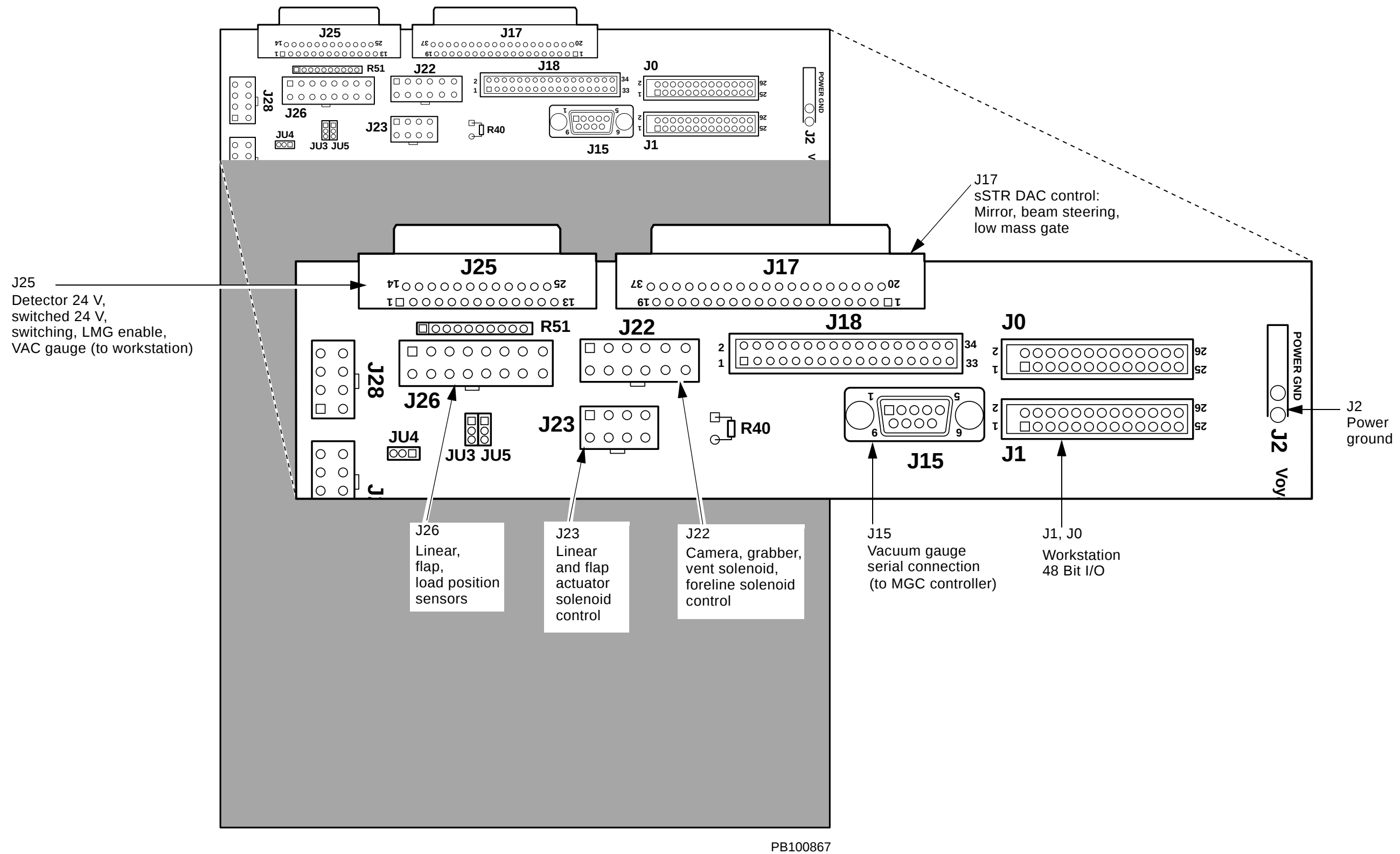


Figure C-3 Consolidated MALDI Control Board View A

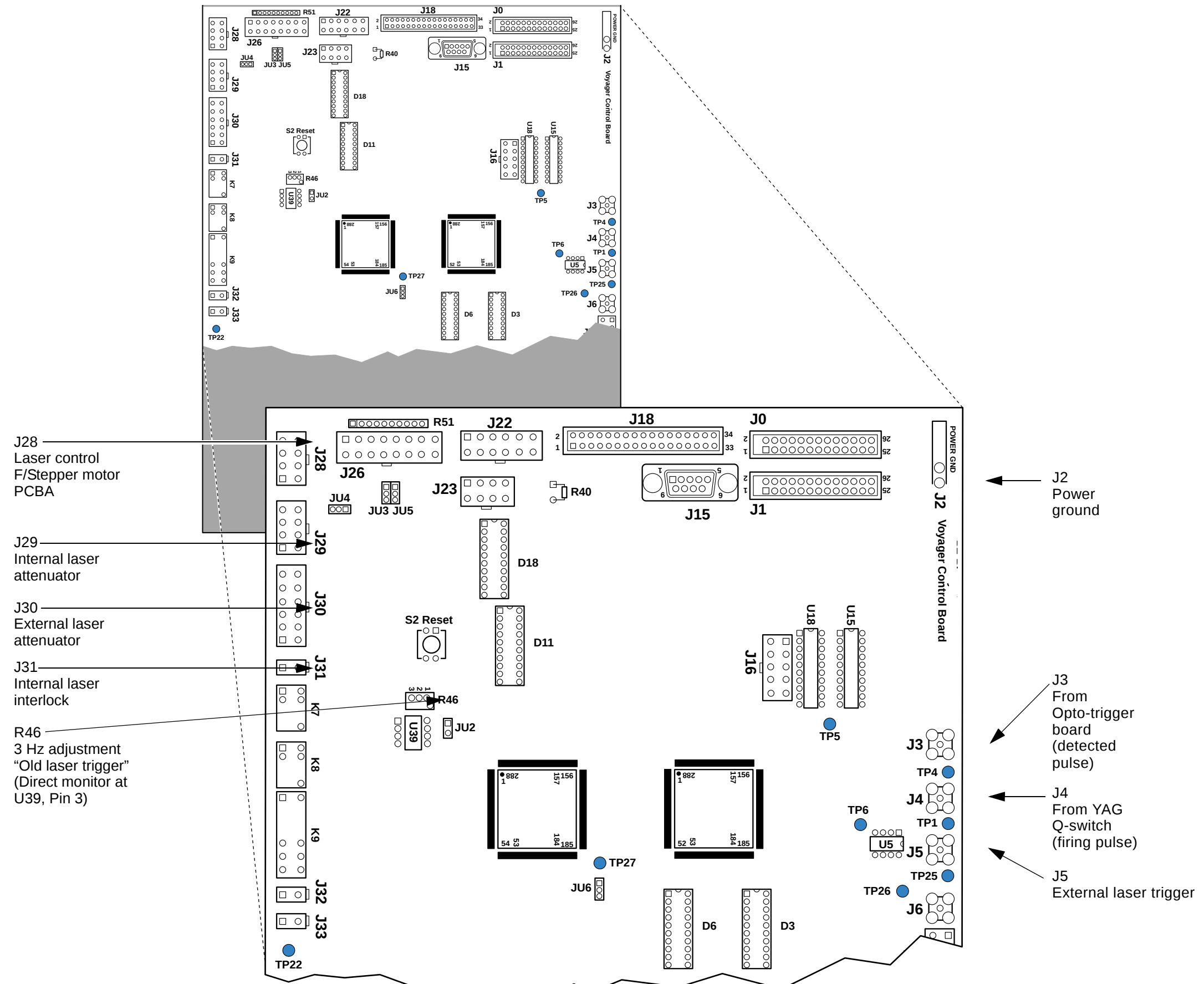


Figure C-4 Consolidated MALDI Control Board View B

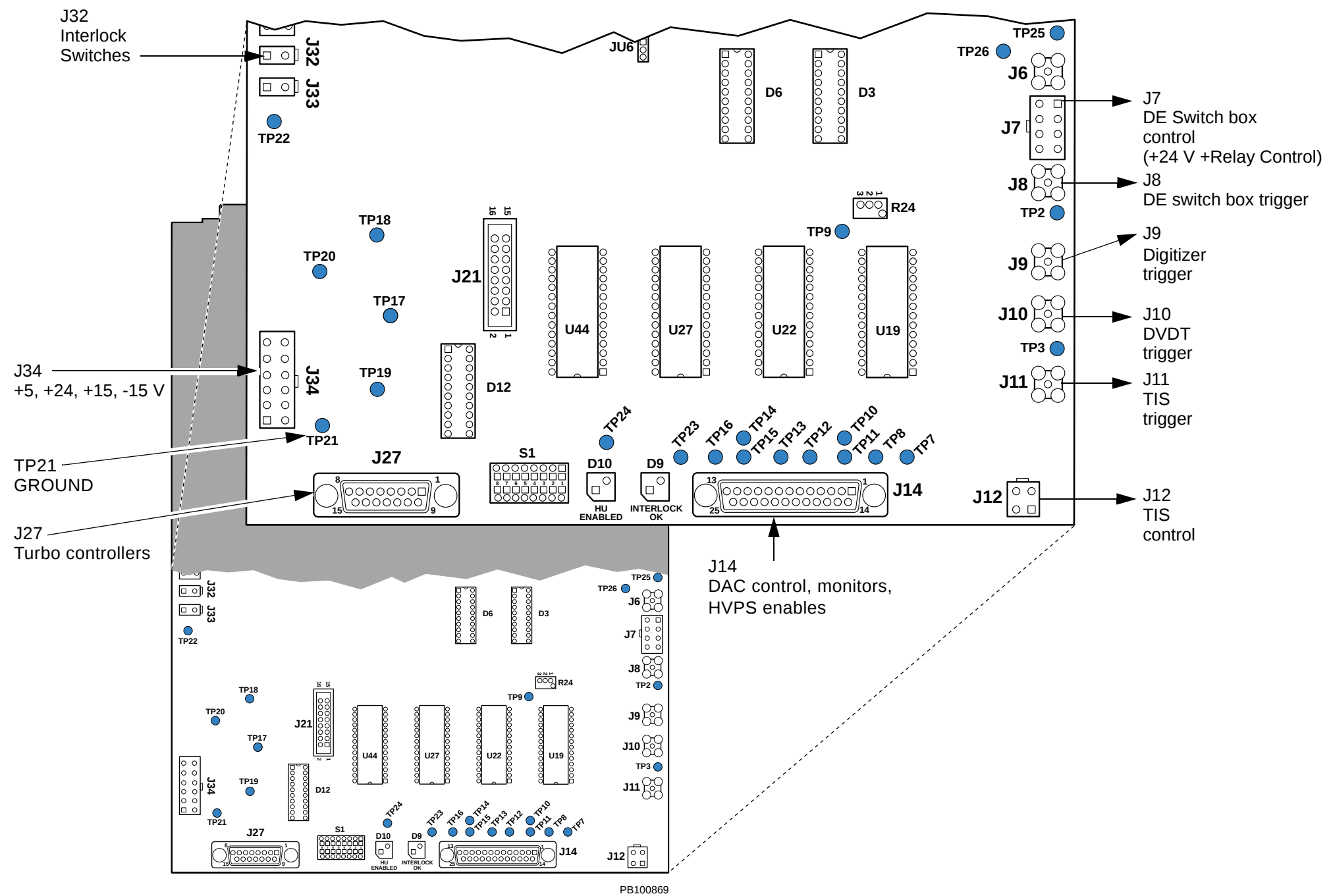


Figure C-5 Consolidated MALDI Control Board View C

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Isolating Components Using Direct Bus Access

D

This appendix contains the following:

Diagnostics Software Direct Bus Access Control Page	D-2
Writing Data Directly Over the Data Bus	D-3
Data Values for Direct Access	D-5
Setting the Low-Mass Gate Delay Time	D-9
Setting and Disabling Delayed Extraction	D-10
Setting the Timed Ion Selector	D-1

Diagnostics Software Direct Bus Access Control Page

Use the Direct Bus Access control page ([Figure D-1](#)) to write data directly to selected components over the data bus. Use this method if you do not want to use the individual component control page—Laser, Voltages and Delays, and DE Switch Box.

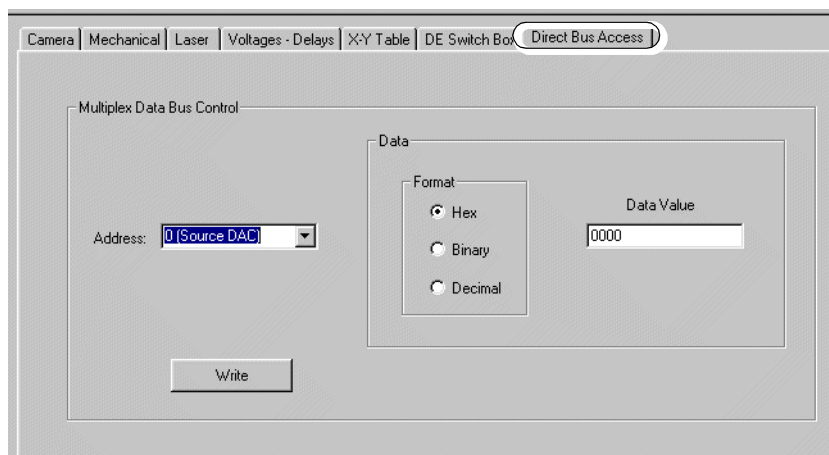
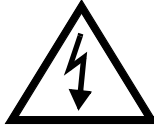


Figure D-1 Direct Bus Access Control Page

You cannot enable high-voltage or the Low Mass Gate using direct bus access. With direct bus access, you can only set the output voltage at the DACs and the Low Mass Gate value.

Writing Data Directly Over the Data Bus

Before you write data to any component, make sure you have appropriately connected or disconnected the high-voltage lines and connected meter probes or voltmeters to the appropriate DACs.



WARNING

ELECTRICAL SHOCK HAZARD. Safe operating procedures and proper use of equipment are the responsibility of the authorized and qualified service person. Precautions must be taken to protect against possible serious and/or fatal bodily injury.

To write data directly to a component:

1. Select the component you want to write to from the **Address** dropdown menu ([Figure D-2](#)).

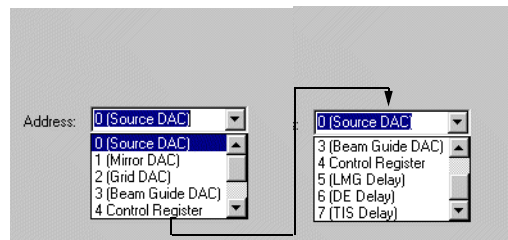


Figure D-2 Direct Bus Access Address Menu

2. Select the format of the data ([Figure D-3](#)) by clicking the appropriate button under **Format**.

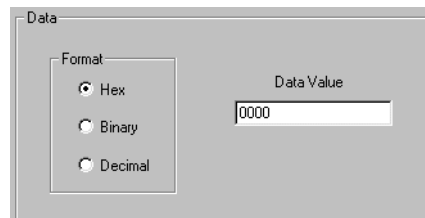


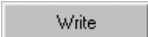
Figure D-3 Direct Bus Access Format Menu

Note: When writing to the Control Register, it's often easier to enter a decimal or hexadecimal value initially, then switch to binary format to set or clear specific bits.

3. Enter a 16-bit data value in the Data Value field. The value you enter depends on the component you are programming. For details, see [Table D-1 on page D-5](#).

When you write directly to the Control Register, you must write the entire sixteen data bits even if you want to change only some of the register bit values.

Only the corresponding DACs output voltages are detectable with a voltmeter when you set their voltages without enabling high-voltage. (DAC voltages are shown in [Table D-2 on page D-8](#).)

4. Click  to transmit the data over the data bus.

Data Values for Direct Access

[Table D-1](#) lists each of the components that you can write to directly and describes their corresponding sixteen data bits.

Table D-1 Direct Access Data Values

Component	Parameter	Bit values
0 (Source DAC)	Voltages from 0 to 30 kV.	Values written correspond to voltages 0 to 10 V at the DAC. For details, see Table D-2 on page D-8 .
1 (Mirror DAC)	Voltages from 0 to 30 kV.	Values written correspond to voltages 0 to 10 V at the DAC. For details, see Table D-2 on page D-8 .
2 (Grid DAC)	Voltages from 0 to 30 kV.	Values written correspond to voltages 0 to 10 V at the DAC. For details, see Table D-2 on page D-8 .
3 (Beam Guide DAC)	Voltages from 0 to 30 kV.	Ignored for Voyager-DE STR workstation with serial number 4154 and later.
4 (Control Register) (high-frequency counter and ion source pulser)	TIS frequency select	Bits 0-2. Value is: 000 = 10 ns (100 MHz)
	DE and TIS counter enable	Bit 3. Values are: 0 = disabled 1 = enabled
	TIS high-voltage enable	Bit 4. Values are: 0 = disabled 1 = enabled
	Power level	Bit 5. Ignored for Voyager-DE STR workstation. Values for other models are: 0 = low 1 = normal
	NA	Bit 6. Not used. Set to 0.
	DE mode enable	Bit 7. Values are: 0 = disabled 1 = enabled

Table D-1 Direct Access Data Values (continued)

Component	Parameter	Bit values
4 (Control Register, continued)	DE mode select	Bits 8-10. Each bit represents a relay: bit 8/relay 1, bit 9/relay 2, and bit 10/relay 3. Bit combinations set the DE switch box mode. Values are: 110 = DE negative ion mode 101 = Non-DE mode (positive and negative ion) 000 = DE positive ion mode
	NA	Bits 11-14. Not used. Set to 0.
	Low Mass Gate timer start/end	Bit 15. Determines whether the value is the timer start or end time: 0 = start 1 = end
5 (LMG delay)	Low Mass Gate delay time	Bits 0-7 represent 8,000 to 65,000 ns. Values entered represent the (target delay time ns) – 8 ns/222 ns. Values are: Dec = 0 to 255 Hex = 00 to FF Bin = xxxx xxxx 0000 0000 to xxxx xxxx 1111 1111 Where 0 = 8000 and 255 = 65000. You must interpolate all values between the min/max. Bits 8-15 are ignored.

Table D-1 Direct Access Data Values (continued)

Component	Parameter	Bit values
6 (DE delay)	Delayed Extraction delay time	Bits 0-14 represent 10 to 32,768 ns. Values entered represent the target time divided by the TIS clock frequency in ns—10 ns. Bit 15 selects start/end time: 0 = start 1 = end Valid start times (correspond to values ranging from 10 to 32,767) are: Dec = 0 to 32767 Hex = 0000 to 7FFF Bin = 0000 0000 0000 0000 to 0111 1111 1111 1111 Where 0 = 10 ns and 32767 = 327670 ns at the DAC. You must interpolate all values between the min/max. Valid end times (correspond to values ranging from 10 to 32,768) are: Dec = 32768 to 65535 Hex = 8000 to FFFF Bin = 1000 0000 0000 0000 to 1111 1111 1111 1111 Where 32768 = 10 ns and 65535 = 327680 ns at the DAC. You must interpolate all values between the min/max.
7 (TIS delay)	Timed Ion Selector delay time	Bits 0-14 represent 10 to 32,768 ns. Values entered represent the: (target time/ TIS clock frequency ns)—10 ns. Bit 15.Sets start/end time: 0 = start 1 = end Valid start times* (correspond to values from 10 to 32767) are: Dec = 0 to 32767 Hex = 0000 to 7FFF Bin = 0000 0000 0000 0000 to 0111 1111 1111 xxxx Where 0 = 10 ns and 32767 = 327670 ns at the DAC. You must interpolate all values between the min/max. Valid end times* (correspond to values ranging from 10 to 32768) are: Dec = 32768 to 65535 Hex = 8000 to FFFF Bin = 1000 0000 0000 0000 to 1111 1111 1111 xxxx Where 32768 = 10 ns and 65535 = 327680 ns at the DAC. You must interpolate all values between the * Not all values in the range are valid; do not write all 1s to the low four bits of the data value.

[Table D-2](#) lists the voltages and the data bits that program them.

Table D-2 Voltage Values

Component Voltage Output (kV)	DAC Output Voltage	Hex	Binary	Decimal
1	0.3333	0888	0000 1000 1000 1000	2184
2	0.6666	1111	0001 0001 0001 0001	4369
3	0.9999	1999	0001 1001 1001 1001	6553
4	1.332	2222	0010 0010 0010 0010	8738
5	1.665	2AAA	0010 1010 1010 1010	10922
6	1.998	3333	0011 0011 0011 0011	13107
7	2.331	3BBB	0011 1011 1011 1011	15291
8	2.664	4444	0100 0100 0100 0100	17476
9	2.997	4CCC	0100 1100 1100 1100	19660
10	3.33	5555	0101 0101 0101 0101	21845
11	3.663	5DDD	0101 1101 1101 1101	24029
12	3.994	6666	0110 0110 0110 0110	26214
13	4.329	6EEE	0110 1110 1110 1110	28398
14	4.662	7777	0111 0111 0111 0111	30583
15	4.995	7FFF	0111 1111 1111 1111	32767
16	5.328	8888	1000 1000 1000 1000	34952
17	5.661	9110	1001 0001 0001 0000	37136
18	5.994	9999	1001 1001 1001 1001	39321
19	6.327	A221	1010 0010 0010 0001	41505
20	6.66	AAAA	1010 1010 1010 1010	43690
21	6.993	B332	1011 0011 0011 0010	45874
22	7.326	BBBB	1011 1011 1011 1011	48059
23	7.659	C443	1100 0100 0100 0011	50243
24	7.992	CCCC	1100 1100 1100 1100	52428
25	8.325	D554	1101 0101 0101 0100	54612
26	8.658	DDDD	1101 1101 1101 1101	56797
27	8.991	E665	1110 0110 0110 0101	58981
28	9.324	EEEE	1110 1110 1110 1110	61166
29	9.657	F776	1111 0111 0111 0110	63350
30	10	FFFF	1111 1111 1111 1111	65535

Setting the Low-Mass Gate Delay Time

To set the low-mass gate delay time, you write a delay time. You then have the optional to write to the Control register to specify whether the value is the start or end delay time. To set delay times:

1. From the Address pulldown menu, select **5 (LMG delay)**.
2. Enter an 8-bit value in the Data Value text field for the start delay time.

Values range from 0 to 255 (decimal) and represent 8,000 to 65,000 ns.

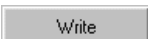
3. Click  .

The remaining steps are optional. Because you cannot enable the Low Mass Gate timers, it makes no difference whether the delay time you write is the start or end time.

4. From the Address pulldown menu, select **4 (Control Register)**.
5. Enter a 16-bit value in Data Value text field.

Clear bit 15 (LMG enable) to specify that the data value previously written is the start time for the delay. The remaining bits do not affect the Low Mass Gate circuitry.

Remember, you must write the entire sixteen bits of the control register, so enter a value that sets all components the control register configures (including TIS and DE parameters) appropriately.

6. Click  .
7. Repeat steps 1 through 6, but specify the end delay time in step 5 by setting bit 15 to 1.

Setting and Disabling Delayed Extraction

Setting Delayed Extraction

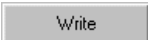
To set and invoke delayed extraction, you

- Set the start and end times for the delay
- Write to the control register to select and enable DE mode
- Write to the control register to enable the DE counter, which starts the DE timer counters

The procedure is as follows:

1. From the Address pulldown menu, select **6 (DE delay)**.
2. Enter a 16-bit value in the Data Value text field for the start delay time.

Values range from 0 to 32,767 (decimal) and represent 0 to 327,670 ns at the DAC.

3. Click  .

4. Enter a 16-bit value in the Data Value text field for the end delay time.

The most significant bit (MSB) is a select bit, defined in the table below:

Data Value MSB	Represents
0	Start
1	End

Values range from 32,768 to 65,535 (decimal) and represent 0 to 327,680 ns at the DAC.

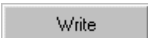
5. Click  .

6. From the Address pulldown menu, select **4 (Control Register)**.

7. Enter a 16-bit value in the Data Value text field.

- Set bit 3 (DE counter enable) to enable the counter
- Set bit 7 (DE mode enable) to enable DE mode
- Clear bits 8 through 10 (DE mode select) for positive ion mode, or set them to 110 for negative ion mode.

Remember, you must write the entire sixteen bits of the control register, so enter a value that sets all components the control register configures (including TIS and LMG parameters) appropriately.

8. Click  .

Disabling Delayed Extraction

To disable delayed extraction, you must disable the DE counter, select non-DE mode, and disable DE mode:

1. From the Address pulldown menu, select **4 (Control Register)**.
2. Enter a 16-bit value in the Data Value text field.
 - Clear bit 3 (DE counter enable) to disable the counter.
 - Clear bit 7 (DE mode enable) to disable DE mode.
 - Set bits 8 through 10 (DE mode select) to 101 for non-DE mode (positive or negative polarity).

Remember, you must write the entire sixteen bits of the control register, so enter a value that sets all components the control register configures (including TIS and LMG parameters) appropriately.

3. Click  .

Setting the Timed Ion Selector

To set up and invoke the Timed Ion Selector, you:

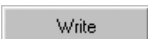
- Set the start and end times for the delay.
- Write to the Control register to set the TIS frequency.
- Enable TIS high-voltage. (For non-STR systems, you also set the TIS power level.)
- Enable the TIS counter.

To set the TIS counter:

1. From the Address pulldown menu, select **7 (TIS delay)**.
2. Enter a 16-bit value in the Data Value text field for the start delay time.

Values range from 0 to 32,767 (decimal) and represent 0 to 327,670 ns at the DAC.

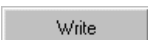
However, because of a limitation of the pulse generator, you cannot write all 1s to the low four bits of the data value.

3. Click  .

4. Enter a 16-bit value in the Data Value text field for the end delay time.

Values range from 32,768 to 65,535 (decimal) and represent 0 to 327,670 ns at the DAC.

Although values range from 32,768 to 65,535, a limitation of the pulse generator prevents you from writing all 1s to the low four bits of the data value.

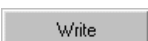
5. Click  .

6. From the Address pulldown menu, select **4 (Control Register)**.

7. Enter a 16-bit value in the Data Value text field.

- Clear bits 2-0 (TIS frequency select) to select a frequency of 100 MHz.
- Set bit 4 (TIS high-voltage enable) to enable high-voltage.
- Set bit 3 (TIS counter enable) to enable the counter, which starts the TIS timer counters and activates the Timed Ion Selector.

Remember, you must write the entire sixteen bits of the Control register, so enter a value that sets all components the Control register configures (including DE and LMG parameters) appropriately.

8. Click  .

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