



HP 5971A
Mass Selective Detector
Hardware Manual

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Printing History

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contain corrections or additional information.

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Manual Conventions

Notes, Cautions, and Warnings

In this manual, the following conventions are used for notes, cautions, and warnings.

Note Notes contain information which may be helpful or necessary.

Caution Cautions call attention to procedures which, if not correctly performed or adhered to, could result in damage to the instrument.

WARNING Warnings call attention to procedures which, if not correctly performed or adhered to, could result in personal injury.

Part Numbers

In this manual, Hewlett-Packard part numbers are generally listed in parentheses after the name of the part or in tables in the *Parts* chapters. Most Hewlett-Packard part numbers are either four-digit-by-four-digit (1234-1234) numbers or five-digit-by-five-digit (12345-12345) numbers. A few tools and supplies listed have no part numbers and are not available from Hewlett-Packard. Most of these can be obtained from laboratory supply companies.

Safety Information

Safety Class The HP 5971A Mass Selective Detector is a Safety Class I instrument and has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus.

WARNING Connecting the HP 5971A Mass Selective Detector to a power source which is not equipped with a protective earth contact creates a shock hazard for the operator and can damage the instrument. Likewise, interrupting the protective conductor inside or outside the HP 5971A or disconnecting the protective earth terminal creates a shock hazard for the operator and can damage the instrument.

WARNING Make sure that only fuses with the required current rating and of the specified type are used for replacement. The use of incorrect or makeshift fuses or the short-circuiting of fuse holders creates a shock hazard for the operator and can damage the instrument.

WARNING Any adjustment, maintenance or repair of the opened instrument while it is connected to a power source should be avoided if possible and, if required, should be carried out only by trained persons who are aware of the hazards involved.

Noise Declaration

English

LpA < 70 dB
operator position
normal operation
per ISO 7779

Deutsch

LpA < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19

Regulatory Information

Funkentstörung Deutschland

Herstellerbescheinigung

Hiermit wird bescheinigt, daß dieses Gerät in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist. Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Electromagnetic Interference Regulations Germany

Manufacturer Declaration

This is to certify that this equipment is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation; the right to check the series for compliance with the requirements was granted.

Table of Contents

Chapter 1	
General Information	
Introduction	1-2
Instrument Description	1-3
Performance Specifications	1-6
Dynamic range	1-6
Ionization energy	1-6
Mass axis stability	1-6
Mass range	1-6
Mass resolution	1-6
Scan speed	1-6
Sensitivity	1-6
SIM mode	1-7
Temperature control	1-7
Total ion mode	1-7
Vacuum system	1-7
Physical Specifications	1-8
Environment	1-8
Heat dissipation	1-8
Power requirements	1-8
Size	1-8
Weight	1-8
Manuals	1-9
Organization of this Manual	1-10
Instrument Identification	1-12
Warranty	1-13
Warranty Claims	1-15
Service Agreements	1-16

Introduction	2-2
Vacuum System	2-4
Vacuum manifold	2-6
Vacuum seals	2-8
Top plate	2-10
Foreline pump and trap	2-12
Foreline vacuum gauge	2-14
Diffusion pump and fan	2-16
Calibration valve	2-18
Ionization gauge tube	2-18
GC/MSD Interface	2-20
Analyzer	2-22
Radiator	2-24
Ion source	2-25
Mass filter	2-28
Detector	2-30
Electronics	2-32
Top board	2-34
Main board	2-36
HP-IB/MS control card	2-38
APG remote control card	2-38
Parallel/remote board	2-38
Power distribution board	2-40
Power supply	2-40
Connectors and Controls	2-42
APG remote control connector	2-42
I/O connector	2-42
Accessory connector	2-42
Ac power cord	2-44
On/off switch	2-44
Foreline pump cord receptacle	2-44

Chapter 3 Installation

Introduction	3-2
Site Preparation	3-3
Initial Installation	3-4
Conversions	3-5

Chapter 4 Operation

Introduction	4-2
Pre-Operation Checklist	4-3
GC Columns	4-4
Types of columns	4-4
Installing columns	4-5
Conditioning a capillary column	4-5
Installing a capillary direct column	4-6
Installing a column and splitter	4-10
Flow Rates	4-18
Heated Zones	4-20
Startup and Pumpdown	4-23
Monitoring Pressures	4-25
Tuning	4-26
Parts affected by tuning	4-27
Repeller	4-30
Filament	4-31
Ion focus lens	4-32
Entrance lens	4-32
Mass filter	4-33
X-ray lens	4-34
Electron multiplier	4-34
Tuning programs	4-35
Autotune	4-36
Quicktune	4-36
Midmass tune	4-36
Target tune	4-37
Usertune	4-38
Manual tune	4-38
CI autotune	4-39
CI quicktune	4-39
Accessory Control	4-40
Shutdown and Venting	4-42
Moving and Storage	4-44

Chapter 5
Troubleshooting

Introduction	5-2
Symptoms	5-3
General symptoms	5-4
Performance symptoms	5-9
Pressure symptoms	5-27
Temperature symptoms	5-28
Error messages	5-34
Troubleshooting Procedures	5-64
Leaks	5-65
Isolating the leak	5-66
GC leaks	5-66
MSD leaks	5-67
Contamination	5-71
GC contamination sources	5-72
MSD contamination sources	5-73

Introduction	6-2
General Maintenance Considerations	6-3
Maintenance schedule	6-4
Tools and supplies	6-6
Safety	6-8
High voltages	6-9
High temperatures	6-10
Chemical residue	6-11
Safety glasses	6-11
Electrostatic discharge	6-12
Vacuum System Maintenance	6-13
Checking the foreline pump fluid level	6-14
Adding foreline pump fluid	6-16
Replacing the foreline pump fluid	6-18
Replacing the foreline trap pellets	6-20
Checking and replacing the diffusion pump fluid	6-22
Removing the diffusion pump	6-22
Checking the diffusion pump fluid	6-26
Reinstalling the diffusion pump	6-29
Refilling the calibration vial	6-30
Replacing the foreline vacuum gauge	6-33
Analyzer Maintenance	6-35
Removing the analyzer	6-36
Reinstalling the analyzer	6-38
Cleaning the ion source	6-41
Removing the ion source	6-42
Disassembling the ion source	6-44
Cleaning	6-46
Reassembling the ion source	6-50
Reinstalling the ion source	6-52
Replacing a filament	6-54
Removing a filament:	6-55
Installing a filament	6-58
Replacing the detector	6-59
Removing the detector	6-60
Installing a detector	6-62
Replacing the analyzer	6-63

GC/MSD Interface Maintenance	6-64
Replacing the heater/sensor assembly	6-65
Removing the heater/sensor assembly	6-66
Installing a heater/sensor assembly	6-68
Electronics Maintenance	6-69

Chapter 7

Parts

Introduction	7-2
Ordering Information	7-3
Electronics	7-4
Vacuum System	7-6
Analyzer	7-8
GC/MSD Interface	7-12
Consumables	7-13
Miscellaneous	7-15

Appendix A Gauge Controller

General Information	A-1
Introduction	A-2
General Description	A-3
Specifications	A-5
Dimensions	A-5
Electrical	A-5
Manuals	A-6
Warranty / Warranty Claims / Service Agreements	A-7
 System Overview	 A-9
Introduction	A-10
Theory of Operation	A-11
Hardware Description	A-13
Ionization gauge tube	A-14
Gauge controller	A-16
 Installation	 A-19
Introduction	A-20
Initial Installation	A-21
 Operation	 A-27
Introduction	A-28
Operating the Gauge Controller	A-29
 Troubleshooting	 A-31
Introduction	A-32
Symptoms	A-33
 Maintenance	 A-39
Introduction	A-40
Degassing the Ion Gauge Tube	A-41
Replacing the Ion Gauge Tube	A-42
Changing the Voltage Setting	A-45
Replacing the Fuse	A-48
 Parts	 A-49
Introduction	A-50
Ordering Information	A-50
Parts	A-51

Appendix B	
Technical Reference	
General Information	B-1
Introduction	B-2
Organization	B-3
Top Board	B-5
Theory of Operation	B-6
RF amplifier	B-10
DC amplifiers	B-12
High voltage supply	B-13
Thermocouple amplifier	B-13
Alternate filament relay	B-14
Feedthrough connections	B-14
Testing the Filaments	B-15
Replacing the Top Board	B-18
Adjusting the RF coils	B-22
Main Board	B-25
Theory of Operation	B-26
Accessory Control	B-33
Input lines	B-34
Output lines	B-36
Other lines	B-37
Replacing the Main Board	B-38
HP-IB/MS Control Card	B-41
Theory of Operation	B-42
68000 CPU	B-44
68440 DMA	B-44
1-Mbyte RAM	B-44
64-Kbyte EPROM	B-44
HP-IB interface	B-46
Remote control expansion port	B-46
Mass spectrometer interface	B-46
Timer	B-46
Troubleshooting the HP-IB/MS Control Card	B-48
Initial checklist	B-48
HP-IB/MS control card test	B-52
Data test	B-53
GC/ALS test	B-54
Replacing the HP-IB/MS Control Card	B-55

APG Remote Control Card	B-59
Theory of Operation	B-60
Interface buffer	B-62
APG processor	B-62
APG bus interface	B-62
Power-on relay and driver	B-62
Interfacing to External Devices	B-64
System ready	B-64
Start run input	B-66
Parallel/Remote Board	B-67
Replacing the APG Remote Control Card	B-68
Power Distribution Board	B-71
Theory of Operation	B-72
Replacing the Power Distribution Board	B-76
Removing the electronics panel	B-76
Removing the power distribution board	B-80
Installing a power distribution board	B-82
Reinstalling the electronics panel	B-83
Power Supply	B-85
Theory of Operation	B-86
Testing the Power Supply	B-88
Replacing the Power Supply Fuse	B-92
Replacing the Power Supply Board	B-94
Calibration Valve	B-99
Testing the Calibration Valve	B-100
Replacing the Calibration Valve	B-102
Fuses	B-105
Circuit Breaker	B-106
Diffusion Pump Fuses	B-106
Power Supply Fuse	B-106
Diffusion Pump	B-109
Replacing the Diffusion Pump Fuses	B-110
Replacing the Diffusion Pump	B-112

**Appendix C
GC/IRD/MSD
Interface**

**Appendix D
CI Accessory**

Index

List of Figures

Figure 1-1. HP 5971A MSD and HP 5890A GC	1-5
Figure 2-1. Organization of the MSD system hardware	2-3
Figure 2-2. Locations of vacuum system components	2-5
Figure 2-3. Vacuum manifold	2-7
Figure 2-4. O-ring assemblies	2-9
Figure 2-5. Top plate	2-11
Figure 2-6. Foreline pump and trap	2-13
Figure 2-7. Foreline vacuum gauge	2-15
Figure 2-8. Diffusion pump and fan	2-17
Figure 2-9. Calibration valve and ionization gauge	2-19
Figure 2-10. GC/MSD interface	2-21
Figure 2-11. Analyzer	2-23
Figure 2-12. Ion source cross section	2-27
Figure 2-13. Quadrupole mass filter	2-29
Figure 2-14. Detector	2-31
Figure 2-15. Organization of the MSD electronics	2-33
Figure 2-16. Top board	2-35
Figure 2-17. Main board	2-37
Figure 2-18. HP-IB/MS & APG remote control cards	2-39
Figure 2-19. Power distribution board and power supply	2-41
Figure 2-20. Connectors and controls on the MSD	2-43
Figure 4-1. GC column installed capillary direct	4-7
Figure 4-2. Threading the nut and ferrule	4-9
Figure 4-3. GC column with splitter	4-11
Figure 4-4. Installing the vent tube	4-13
Figure 4-5. Splitter and wide-bore column	4-15
Figure 4-6. Splitter and megabore column	4-15
Figure 4-7. Threading the nut and ferrule	4-17
Figure 4-8. MS temperature vs GC/MSD interface temperature	4-21
Figure 4-9. Component temperatures vs. MS temperature	4-22
Figure 4-10. Parts affected by tuning	4-29
Figure 4-11. Accessory connector	4-41

Figure 5-1. Fan power wiring connector	5-7
Figure 5-2. Contact surface on GC/MSD interface	5-31
Figure 5-3. Interface socket	5-31
Figure 5-4. GC/MSD interface without insulation	5-33
Figure 5-5. Detector high voltage lead	5-38
Figure 5-6. Too cold troubleshooting tree	5-41
Figure 5-7. Diffusion pump cable connector	5-43
Figure 5-8. Diffusion pump wiring	5-46
Figure 6-1. Foreline pump fluid-level window	6-15
Figure 6-2. Adding foreline pump fluid	6-17
Figure 6-3. Replacing the foreline pump fluid	6-19
Figure 6-4. Replacing the foreline trap pellets	6-21
Figure 6-5. Disconnecting the foreline vacuum gauge	6-23
Figure 6-6. Disconnecting the diffusion pump wiring	6-25
Figure 6-7. Disassembling the diffusion pump stack	6-27
Figure 6-8. Calibration valve and vial	6-31
Figure 6-9. Foreline vacuum gauge tube	6-34
Figure 6-10. Removing the analyzer	6-37
Figure 6-11. Reinstalling the analyzer	6-39
Figure 6-12. Removing the ion source	6-43
Figure 6-13. Disassembling the ion source	6-45
Figure 6-14. Reassembling the ion source	6-51
Figure 6-15. Reinstalling the ion source	6-53
Figure 6-16. Removing the ion source	6-56
Figure 6-17. Filament retaining screws	6-57
Figure 6-18. Removing the detector	6-61
Figure 6-19. Removing the heater/sensor assembly	6-67
Figure 7-1. Analyzer	7-9
Figure 7-2. Ion source - exploded view	7-11
Figure A-1. Gauge controller	A-4
Figure A-2. Ionization gauge tube	A-12
Figure A-3. Gauge tube location	A-15
Figure A-4. Gauge controller front panel	A-17
Figure A-5. Ion gauge tube connections	A-23
Figure A-6. Gauge controller back panel	A-25
Figure A-7. Replacing the ion gauge tube	A-43
Figure A-8. Voltage selector card and fuse	A-47

Figure B-1. Top board	B-7
Figure B-2. Top board block diagram (1 of 2)	B-8
Figure B-2. Top board block diagram (2 of 2)	B-9
Figure B-3. Filament test points	B-17
Figure B-4. Top board connections and shipping clamps	B-19
Figure B-5. Removing the top board	B-21
Figure B-6. RF coil adjustment	B-23
Figure B-7. Main board	B-27
Figure B-8. Main board block diagram (1 of 5)	B-28
Figure B-8. Main board block diagram (2 of 5)	B-29
Figure B-8. Main board block diagram (3 of 5)	B-30
Figure B-8. Main board block diagram (4 of 5)	B-31
Figure B-8. Main board block diagram (5 of 5)	B-32
Figure B-9. Accessory control connector	B-35
Figure B-10. Removing the main board	B-39
Figure B-11. HP-IB/MS control card	B-43
Figure B-12. HP-IB/MS control card block diagram	B-45
Figure B-13. HP-IB/MS address switch	B-47
Figure B-14. HP-IB/MS control card switch settings	B-49
Figure B-15. HP-IB/RS 232 interface switch settings	B-50
Figure B-16. ALS controller switch settings	B-51
Figure B-17. Replacing the HP-IB/MS control card	B-57
Figure B-18. APG remote control card	B-61
Figure B-19. APG remote control card block diagram	B-63
Figure B-20. APG remote control cabling	B-65
Figure B-21. Parallel/remote board cabling	B-67
Figure B-22. Replacing the APG remote control card	B-69
Figure B-23. Power distribution board	B-73
Figure B-24. Power distribution board block diagram	B-75
Figure B-25. Electronics panel - main board side	B-77
Figure B-26. Electronics panel - power supply side	B-79
Figure B-27. Power distribution board connectors	B-81
Figure B-28. Power supply	B-87
Figure B-29. Dc voltage test points	B-89
Figure B-30. Power supply fuse	B-93
Figure B-31. Power supply terminal strip	B-95
Figure B-32. Power supply mounting screws	B-97
Figure B-33. Diode CR18	B-101
Figure B-34. Calibration valve	B-103
Figure B-35. Diffusion pump fuses	B-107
Figure B-36. Replacing the diffusion pump fuses	B-111
Figure B-37. Diffusion pump wiring connector	B-113
Figure B-38. Removing the diffusion pump stack	B-115

List of Tables

Table 4-1. Column flow rates	4-19
Table 4-2. Tuning parameters	4-28
Table 5-1. Contaminants	5-71
Table 6-1. Maintenance schedule	6-5
Table 6-2. Tools	6-6
Table 6-3. Cleaning supplies and consumables	6-7
Table B-1. Dc voltages	B-89
Table B-2. Power supply wiring	B-96

Introduction 1-2

Instrument Description 1-3

Performance Specifications 1-6

Physical Specifications 1-8

Manuals 1-9

Organization of This Manual 1-10

Instrument Identification 1-12

Warranty 1-13

Warranty Claims 1-13

Service Agreements 1-16

Introduction

Thank you for purchasing the HP 5971A Mass Selective Detector (MSD). We at Hewlett-Packard think you will be pleased with your choice, and will do our best to ensure your satisfaction. If you have any questions, please contact your local Hewlett-Packard office.

Instrument Description

The HP 5971A Mass Selective Detector (see Figure 1-1) is a stand-alone, capillary GC detector designed for use with the HP 5890A Gas Chromatograph (GC). The base model MSD includes the following:

- Cast-aluminum vacuum manifold
- Vapor diffusion high vacuum pump
- Mechanical foreline (roughing) pump
- Electron impact ion source
- Hyperbolic quadrupole mass filter
- Electron multiplier (detector)
- Instrument control electronics
- Power supplies
- GC/MSD interface

For additional information about the base model MSD hardware, refer to the *System Overview* chapter.

Major options available for the MS Engine include:

- Gauge controller for measuring vacuum manifold pressure
- GC/IRD/MSD interface for interfacing an HP 5890 GC, an HP 5965 Infrared Detector (IRD), and an HP 5971A MSD

For information about these options refer to the appropriate appendixes.

The HP G1072 CI Accessory is also available for use with the HP 5971A MSD. The CI accessory enables the MSD to perform chemical ionization analyses. Information about the CI accessory can be found in the *HP G1072A CI Accessory Hardware Manual*.

Real-time control of the MSD is provided by the MSD electronics according to setpoints and instructions from the data system. The data system sends operating parameters to the MSD and receive status information and data from the MSD.

The data system software includes programs to calibrate (tune) the MSD, acquire data, and process data. It also includes utilities for file management and editing. Tuning programs can adjust voltages in the ion source, calibrate mass assignments, and control the scanning of the mass analyzer. Data acquisition programs allow you to monitor the total ion current, automatically storing the mass spectra of GC peaks as they elute (scanning mode) or, alternatively, to monitor the concentrations of particular ions (selected ion monitoring mode).

Figure Not Available

Performance Specifications

The following specifications are subject to change without notice. A copy of the most recent specifications, in the form of a specifications sheet, can be obtained from your local Hewlett-Packard office.

Dynamic range	A logarithmic preamplifier provides more than six decades of dynamic range.
Ionization energy	70 eV from either filament.
Mass axis stability	± 0.15 amu per 12 hours assuming recent calibration (tuning), adequate ion statistics, and thermal equilibrium of the electronics.
Mass range	1.2 - 650 amu.
Mass resolution	0.5 ± 0.05 amu throughout the mass range (established automatically under computer control).
Scan speed	Eight user-selected scan rates with a maximum of 2000 amu/sec with 0.1 amu mass resolution.
Sensitivity	Sensitivities listed are for injections onto a 12-meter, Hewlett-Packard narrow-bore capillary checkout column that is installed capillary-direct through the GC/MSD interface. Scan mode — 1 ng of methyl stearate yields a signal-to-noise ratio of 20:1 at m/z 298.3 when scanned at 380 amu/sec between m/z 290 and m/z 310. SIM mode — 10 pg of methyl stearate yields a signal-to-noise ratio of 10:1 when monitoring m/z 298.3 in SIM mode with a dwell time of 50 msec.

SIM mode	In the selected ion monitoring (SIM) mode, the MSD monitors up to 20 individually selected masses at one time. Up to 200 groups of 20 masses can be selected for each run. Dwell time for each mass is user-selectable from 10 msec to 32767 msec.
Temperature control	The GC/MSD interface temperature is user-settable from 250° to 320°C. The end of the GC/MSD interface conductively heats the ion source and mass filter. The vacuum manifold is not otherwise heated.
Total ion mode	AC voltage-only mode, with adjustable low-mass cut-off, allows the HP 5971A to operate as a non-specific, high-sensitivity detector.
Vacuum system	Vacuum is maintained by an vapor diffusion pump backed by a two-stage, direct-drive mechanical pump. Overall system pumping speed is approximately 60 liters/sec for helium. The vacuum system can accommodate capillary flow rates up to 1 ml/minute (atmosphere) of helium.

Physical Specifications

The following specifications are subject to change without notice. A copy of the most recent specifications, in the form of a specifications sheet, can be obtained from your local Hewlett-Packard office.

Environment

Operating — The MSD will operate within specifications in a thermal environment of 15° to 35°C and a relative humidity of 25% to 90% (non-condensing).

Storage — The MSD can be stored in a thermal environment of -35° to 65°C at 5% to 95% relative humidity (non-condensing).

Heat dissipation

Approximately 3000 Btu/hour including the GC/MSD interface.

Power requirements

99-127 V ac or 198-254 V ac (factory installed options), 700 W. Line frequency 47-63 Hz.

Size

Height — 34 cm (13.4 in)

Width — 17 cm (6.7 in)

Depth — 65 cm (25.6 in)

Weight

21 kg (46 lb), excluding the external mechanical pump.

Manuals

Manuals following manuals are supplied with each HP 5971A MSD:

- *HP 5971A Mass Selective Detector Hardware Manual*
- *HP 5971A Mass Selective Detector Installation Manual*

Each data system is supplied with its own documentation. Additional copies of these and other Hewlett-Packard publications can be ordered through your local Hewlett-Packard office.

Organization of this Manual

This manual is a guide to the operation, troubleshooting, and maintenance of your HP 5971A Mass Selective Detector. It is a companion to the manuals supplied with your gas chromatograph and with your data system.

The chapters of this manual are as follows:

1. General Information — Describes the MSD, its specifications, associated manuals, and accessories. Outlines the instrument warranty and related topics.
2. System Overview — Provides an overview of the vacuum system, GC/MSD interface, analyzer, and electronic systems in the standard instrument. Each of the major options is discussed in its own appendix.
3. Installation — Briefly discusses site preparation and initial installation. Also discusses conversions between operating modes.
4. Operation — Explains how to install a capillary column, turn the MSD on, establish proper vacuum and flow rates, and tune (calibrate) the instrument.
5. Troubleshooting — Discusses common problems and their probable causes. Explains how to interpret error messages, as well as symptoms that appear in the results of analyses.
6. Maintenance — Explains the necessary routine maintenance procedures. Describes how to remove and replace some of the more commonly replaced parts and assemblies.
7. Parts — Provides information about the parts available for MSD operation and maintenance.

Appendix A — This appendix describes the optional gauge controller. The gauge controller allows you to use the ionization gauge tube in the MSD to monitor the high vacuum pressure in the vacuum manifold. Appendix A is organized in the same manner as the main body of the manual with seven chapters.

Appendix B — Appendix B is a technical reference. It contains information and procedures that are seldom needed or that are not appropriate for the average instrument operator. This appendix will be of interest primarily to Hewlett-Packard Customer Engineers and instrument technicians.

Appendix C — An appendix C tab is provided for the GC/IRD/MSD interface. The interface actually has a separate manual but behind the appendix C tab is a good place to keep that manual so that it will not get lost.

Appendix D — An appendix D tab is provided for the HP G1072A CI Accessory. The CI accessory has a separate manual but behind the appendix D tab is a good place to keep that manual so that it will not get lost.

Index — The index is the last part of the manual. It includes entries for both chapters 1-7 and the appendixes. It does not include entries for the GC/IRD/MSD manual, the CI accessory manual, the installation manual, or the data system manuals.

Instrument Identification

The HP 5971A Mass Selective Detector is identified with a 10-character serial number on a label on the rear of the instrument. The first four characters are the serial prefix. The fifth character is the country of origin — "A" represents the USA, "G" represents Germany. The last five characters are an identification number unique to each instrument.

When corresponding with Hewlett-Packard about your MSD, be sure to include the model number and the full 10-character serial number.

Write the serial number of your HP 5971A MSD here for future reference:

Serial # _____

Warranty

Hewlett-Packard (HP) warrants its Analytical products against defects in materials and workmanship for the warranty period. During the warranty period, HP will, at its option, repair or replace products which prove to be defective. Products that are installed by HP are warranted from the installation date, all others from the date of delivery.

If Buyer schedules or delays installation more than 30 days after delivery, then warranty period starts on 31st day from date of shipment. For international orders, the grace period is 60 days and the warranty period starts on the 61st day from the date of shipment.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in materials and workmanship. If HP receives notice of such defects during the warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

Within HP service travel areas, warranty and installation services for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge. For installation and warranty services outside of HP's service travel area, HP will provide a quotation for the applicable additional services.

The foregoing warranty shall not apply to defects resulting from:

1. Improper or inadequate maintenance, adjustment, calibration or operation by Buyer.
2. Buyer-supplied software, hardware, interfacing or consumables.

- 3. Unauthorized modifications or misuse.**
- 4. Operation outside of the environmental and electrical specifications for the product.**
- 5. Improper site preparation and maintenance.**
- 6. Customer-induced contamination or leaks.**

This warranty may be modified in accordance with the laws of your country. Please consult your local HP office for the period of the warranty, for shipping instructions and for the applicable wording of the local warranty.

Warranty Claims

If physical damage is found or if operation is not as specified when the instrument is first received, notify the carrier and the nearest Hewlett-Packard office immediately. The HP office will arrange for repair or replacement of the instrument without waiting for settlement of a claim with the carrier. For other than initial inspection warranty claims, contact your local HP office.

Service Agreements

Several service agreements are available, each designed to meet a specific need. In addition to a preventive maintenance agreement, others cover specific repair/maintenance services for the HP 5971A, and can provide for the extension of warranty beyond the initial warranty period.

Details of these agreements, together with prices applicable to the particular installation, can be obtained from your local Hewlett-Packard office.

Introduction 2-2

Vacuum System 2-4

GC/MSD Interface 2-20

Analyzer 2-22

Electronics 2-32

Introduction

This chapter describes the structure and function of the HP 5971A Mass Selective Detector (MSD). For purposes of description, the MSD can be divided into four systems (see Figure 2-1):

- Vacuum system
- GC/MSD interface
- Analyzer
- Electronics

The vacuum system establishes and maintains the vacuum required for the analyzer to operate.

The GC/MSD interface transports the sample from the gas chromatography (GC) to the ion source in the analyzer. The interface keeps the sample warm.

The analyzer ionizes the sample, filters the ions according to their mass-to-charge ratio (m/z), and generates a signal proportional to the number of ions reaching the detector.

The electronics control the vacuum system and the analyzer according to instructions from the data system. They also process data before it is sent to the data system.

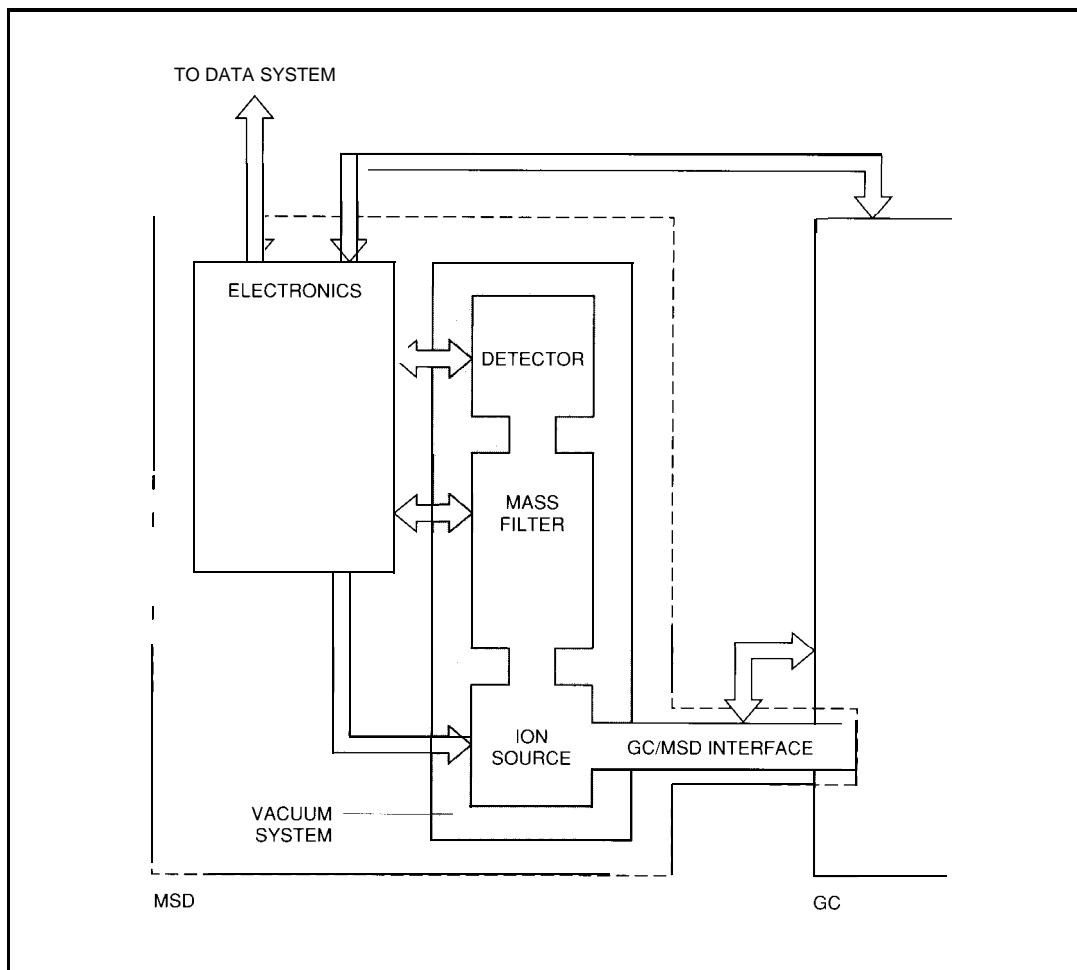


Figure 2-1. Organization of the MSD system hardware

Vacuum System

The vacuum system creates the high vacuum (low pressure) required for the analyzer to operate. Without this vacuum, the molecular mean free path is too short and ions can not travel through the analyzer. The major components of the vacuum system are:

- Vacuum manifold 2-6
- Vacuum seals 2-8
- Top plate 2-10
- Foreline pump and trap 2-12
- Foreline vacuum gauge 2-14
- Diffusion pump and fan 2-16
- Calibration valve 2-18
- Ionization gauge tube 2-18

Figure 2-2 shows the locations of the vacuum system components.

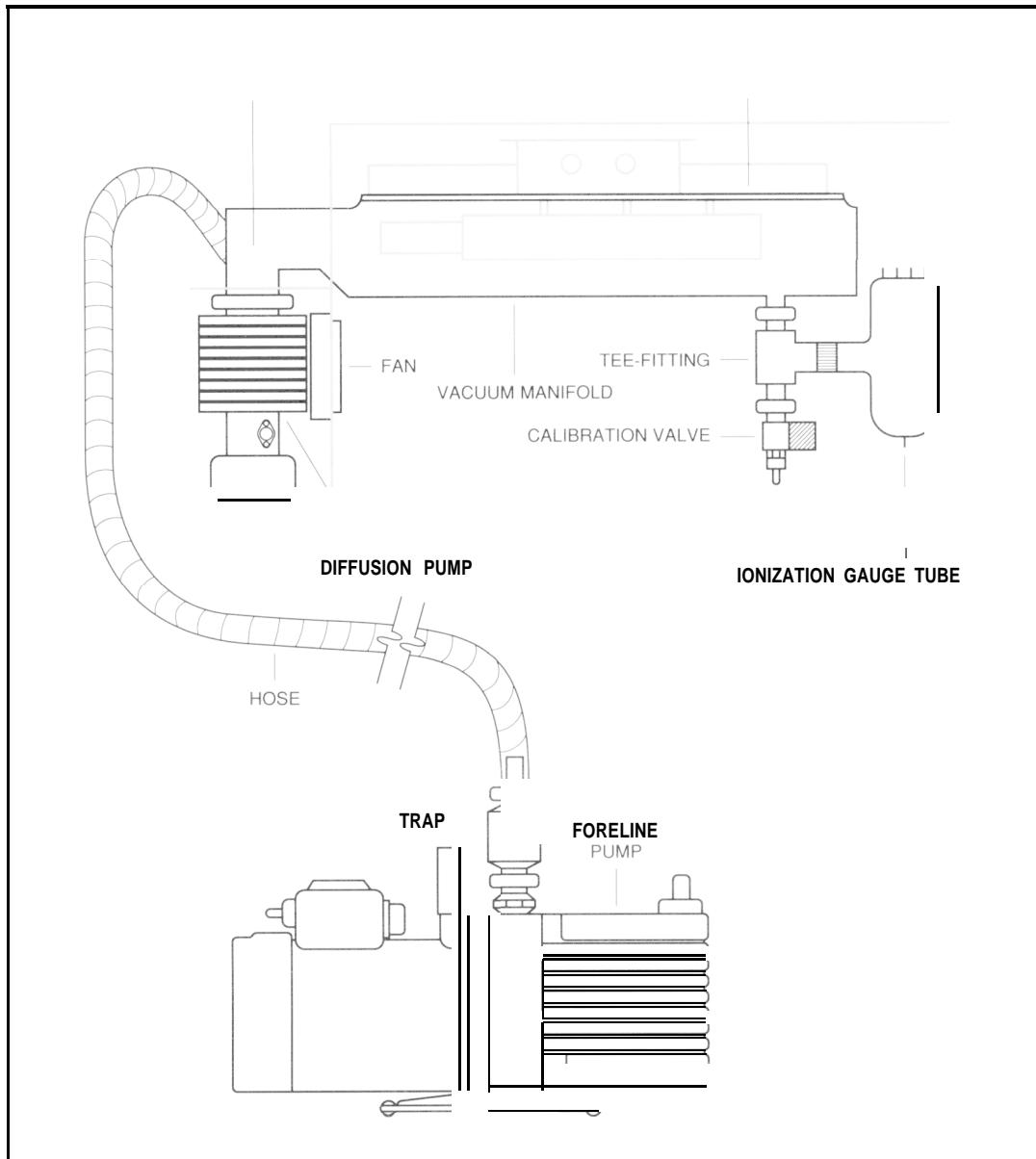


Figure 2-2. Locations of vacuum system components

Vacuum manifold The vacuum manifold is an aluminum casting fabricated especially for high vacuum service. It is shaped as shown in Figure 2-3,

On top of the vacuum manifold is an oval opening which accommodates an elastomer seal and the top plate. There are three additional vacuum fittings on the vacuum manifold:

- A KF25 flange for the GC/MSD interface
- A KF25 flange for the calibration valve and the ionization gauge tube
- A KF50 flange for the diffusion pump

Above the diffusion pump flange is an internal baffle, which helps prevent pump fluid vapor from migrating toward the sensitive analyzer elements. A return path is provided for any fluid that condenses on the baffle.

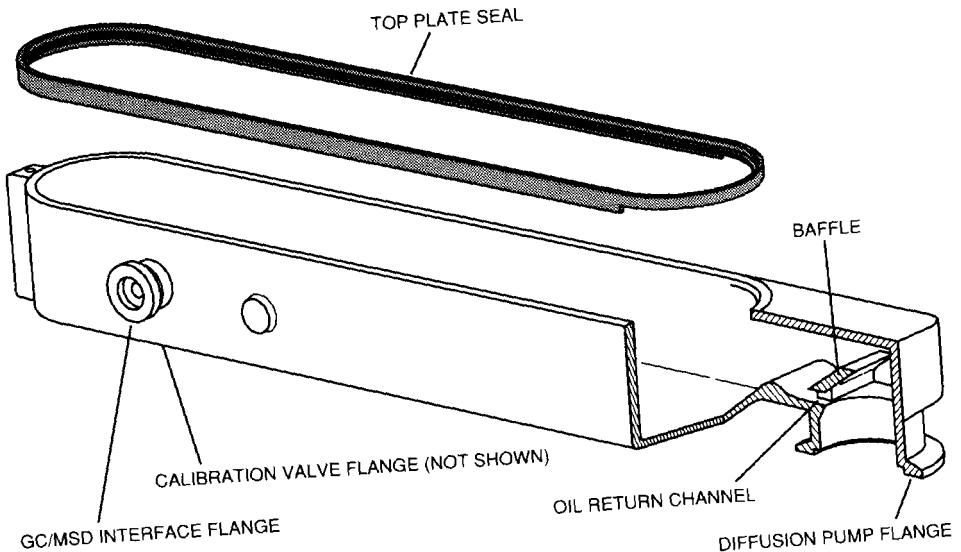


Figure 2-3. Vacuum manifold

Vacuum seals The top plate seal is a custom-molded elastomer seal which fits over the edge of the top opening in the vacuum manifold. It positions the top plate (and hence the analyzer assembly), and protects the sealing surfaces of the vacuum manifold during maintenance and repair.

Although this seal is fairly rugged, care should be taken to keep it free of dust and particles, and to avoid nicking or scratching it. The seal can be easily replaced. Avoid nicking or scratching the vacuum manifold and top plate surfaces that contact the seal.

The remaining vacuum seals are KF and NW seals. Both types are used with the KF flanges (see Figure 2-4). Both types consist of an elastomer O-ring and a centering ring that makes sure the seal is positioned correctly. Some seals have centering rings that are inside the elastomer O-ring and others have centering rings around the outside of the O-ring. The NW25 seals are vented to prevent air from being trapped between the elastomer O-ring and the centering ring. When the KF flanges are clamped together, the O-ring is compressed between the flange surfaces. KF clamps require no tools for assembly or disassembly.

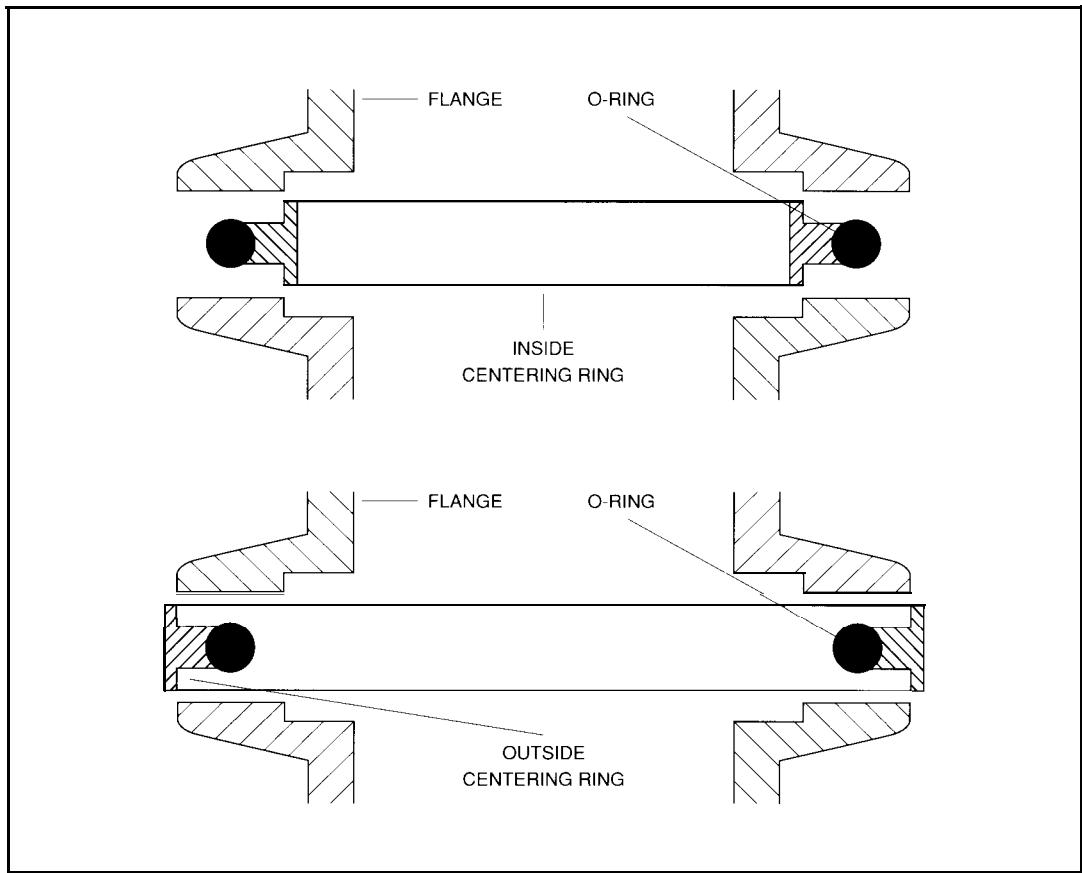


Figure 2-4. O-ring assemblies

Top plate The top plate (see Figure 2-5) is a flat, stainless steel plate that covers the large opening in the top of the vacuum manifold. The analyzer assembly is suspended from top plate inside the vacuum manifold. A nine-pin electrical feedthrough and several high-voltage feedthroughs are welded into this plate. Leads connect the internal pins to the various analyzer elements on the vacuum side of the plate.

The top board is mounted on the atmospheric side of the top plate. The proximity of these electronic circuits to the analyzer provides clean signals and reliable operation.

A shipping clamp is located at each end of the top plate. These clamps should not be tightened for normal MSD operation.

Note Having the shipping clamps tight during normal operation can result in vacuum leaks.

Tighten the shipping clamps only when you are moving the instrument.

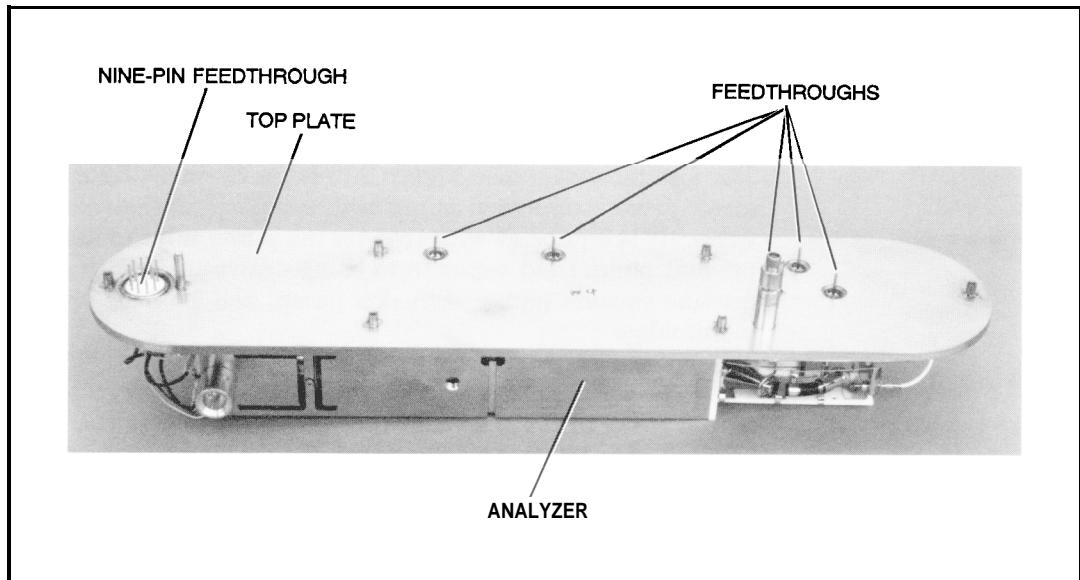


Figure 2-5. Top plate

Foreline pump and trap

The foreline pump lowers the pressure in the vacuum manifold so that the diffusion pump can be switched on. Once the diffusion pump is on, the foreline pump continues to pump away the material exiting the diffusion pump.

The foreline pump (see Figure 2-6) is an Edwards E2M2 direct-drive mechanical pump with a built-in anti-suckback valve. It is equipped with trap on the pump inlet to help prevent pump fluid vapor from being drawn up into the foreline vacuum gauge, diffusion pump, and vacuum manifold

The foreline pump can be located anywhere near the MSD, within reach of the hose that connects the pump to the foreline vacuum gauge. Typically, the foreline pump site on the floor below the MSD.

Figure Not Available

Foreline vacuum gauge The foreline vacuum gauge (shown in Figure 2-7) monitors the vacuum produced by the foreline pump. The primary function of the foreline vacuum gauge is diffusion pump control.

When the foreline pump has reduced the pressure in the vacuum manifold to below 0,3 Torr (300 mTorr), the diffusion pump is automatically switched on.

If the foreline pressure rises above 0.4 Tom (400 mTorr), the power distribution board automatically switches off the diffusion pump heater and the analyzer electronics.

The foreline pressure can be monitored from your data system, See the *Operation* chapter for more information.

The MSD also includes an ionization (ion) gauge tube. With the optional gauge controller, the ion gauge tube can measure the high vacuum in the vacuum manifold, See *Ionization gauge tube* later in this section for more information.

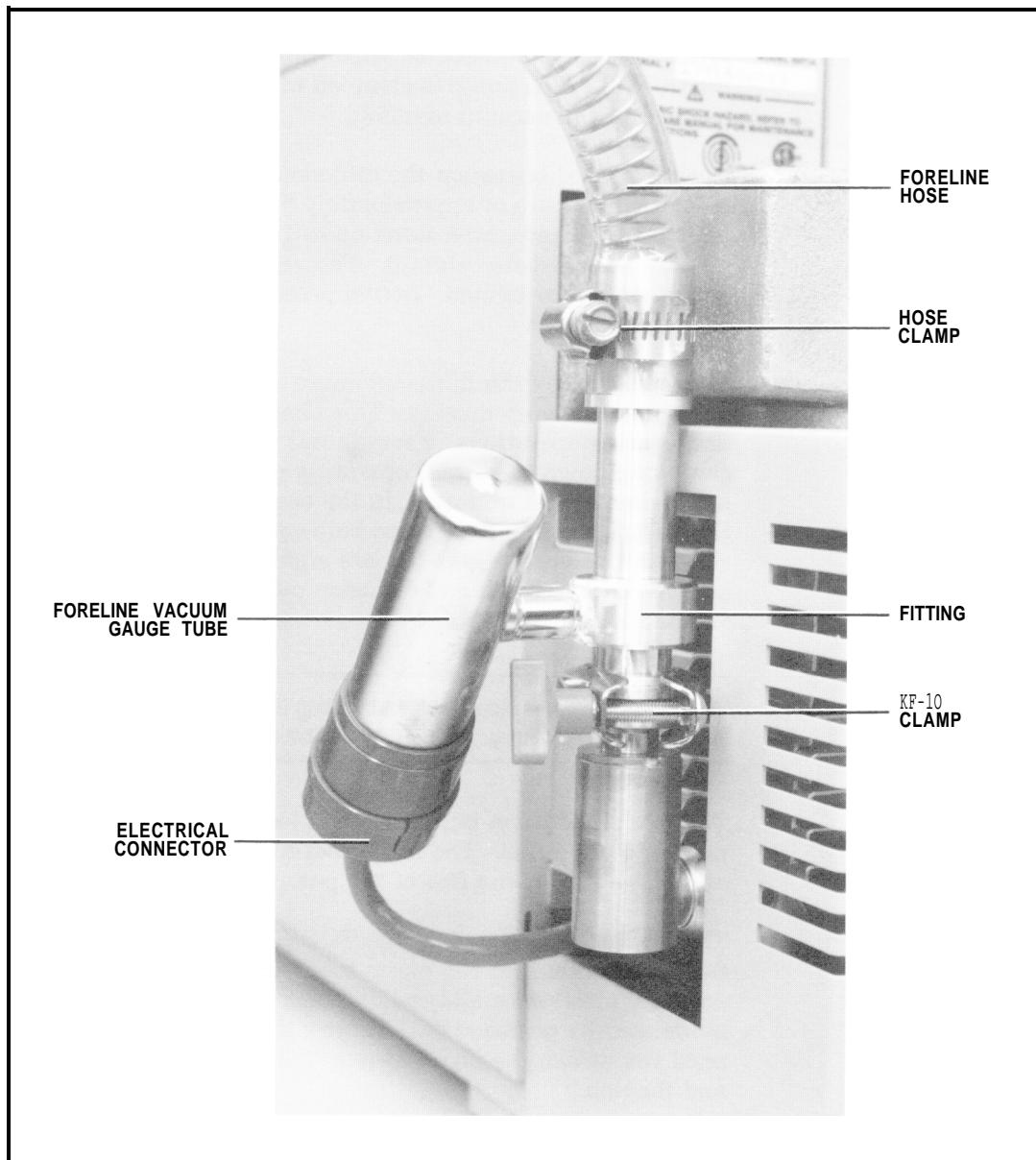


Figure 2-7. Foreline vacuum gauge

Diffusion pump and fan

The high vacuum in the vacuum manifold is created by an Edwards E050/60 air-cooled vapor diffusion pump (see Figure 2-8). This pump is clamped to the KF50 flange at the rear of the vacuum manifold.

During normal operation the diffusion pump maintains an indicated pressure of approximately 5×10^{-5} Torr (or lower) with gas chromatography flows up to 1 ml/min (typical for a 0.2-mm narrow-bore column). This indicated pressure is not corrected for helium. Actual pressure is approximately six times greater.

The small size of the diffusion pump allows it to heat up and cool down very quickly. This simplified pump down and venting operations. From initial power-on, the system can pump down to normal operating pressure (vacuum) in approximately 15 minutes. In the event of a power failure, the diffusion pump fluid stops boiling before the vacuum chamber pressure begins to rises significantly. This helps prevent backstreaming of diffusion pump fluid into the vacuum manifold.

Note

Your data system has Pumpdown and venting programs to guide you through these procedures. Follow their instructions carefully.

To cool the diffusion pump, a fan is located next to the pump's cooling fins. The fan draws air through the MSD and blows it over the fins of the pump.

There is a thermal switch (the TOO HOT switch) on the fins of the pump. If the pump temperature is too high, the analyzer electronics and the diffusion pump heater are automatically switched off. They will not switch on again until you switch the on/off switch (main circuit breaker) off and then on.

Another thermal switch (the TOO COLD switch) monitors the temperature below the cooling fins on the diffusion pump. This switch keeps the analyzer electronics off until the diffusion pump reaches its normal operating temperature.

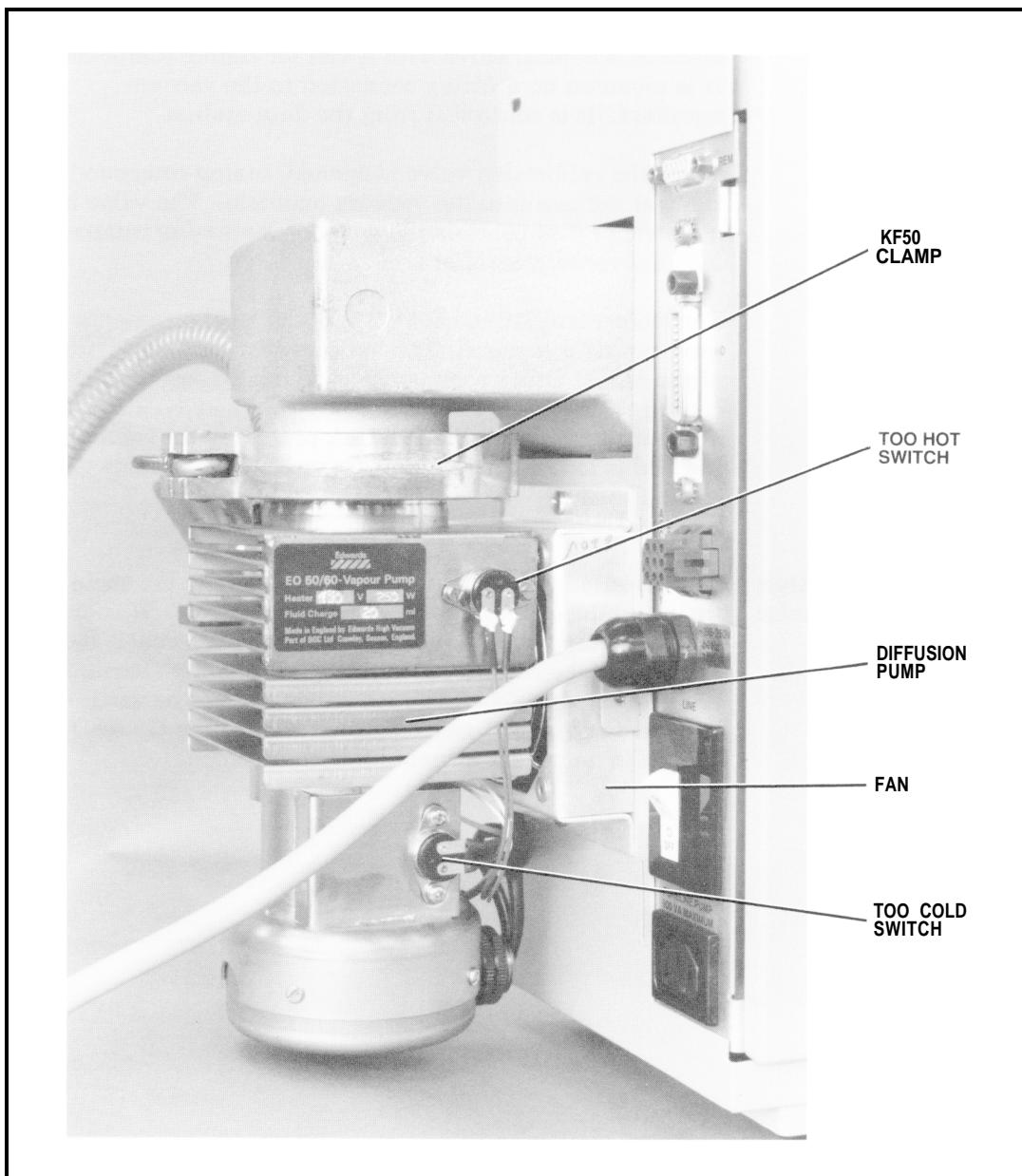


Figure 2-8. Diffusion pump and fan

Calibration valve The calibration valve (see Figure 2-9) is an electromechanical valve with a vial for tuning compounds. It is mounted on a fitting connected to the vacuum manifold. It is controlled from the data system.

When the calibration valve is opened, tuning compound in the vial diffuses into the vacuum manifold. The valve has a restrictor that controls the entry of the tuning compound into the vacuum manifold.

Perfluorotributylamine (PFTBA) is the most commonly used tuning compound. It is required for automatic tuning of the MSD. Other compounds can be used for manual tuning of the MSD. A tuning compound maybe a liquid or a volatile or semi volatile solid. A procedure for refilling the vial is located in the *Maintenance* chapter of this manual.

**Ionization
gauge tube**

An ionization (ion) gauge tube is connected to the same fitting as the calibration valve (see Figure 2-9). If your MSD is equipped with the optional gauge controller, the ion gauge tube can be used to measure the high vacuum in the vacuum manifold. The ion gauge can not be used without the optional gauge controller. See the *Gauge Controller* appendix for more information.

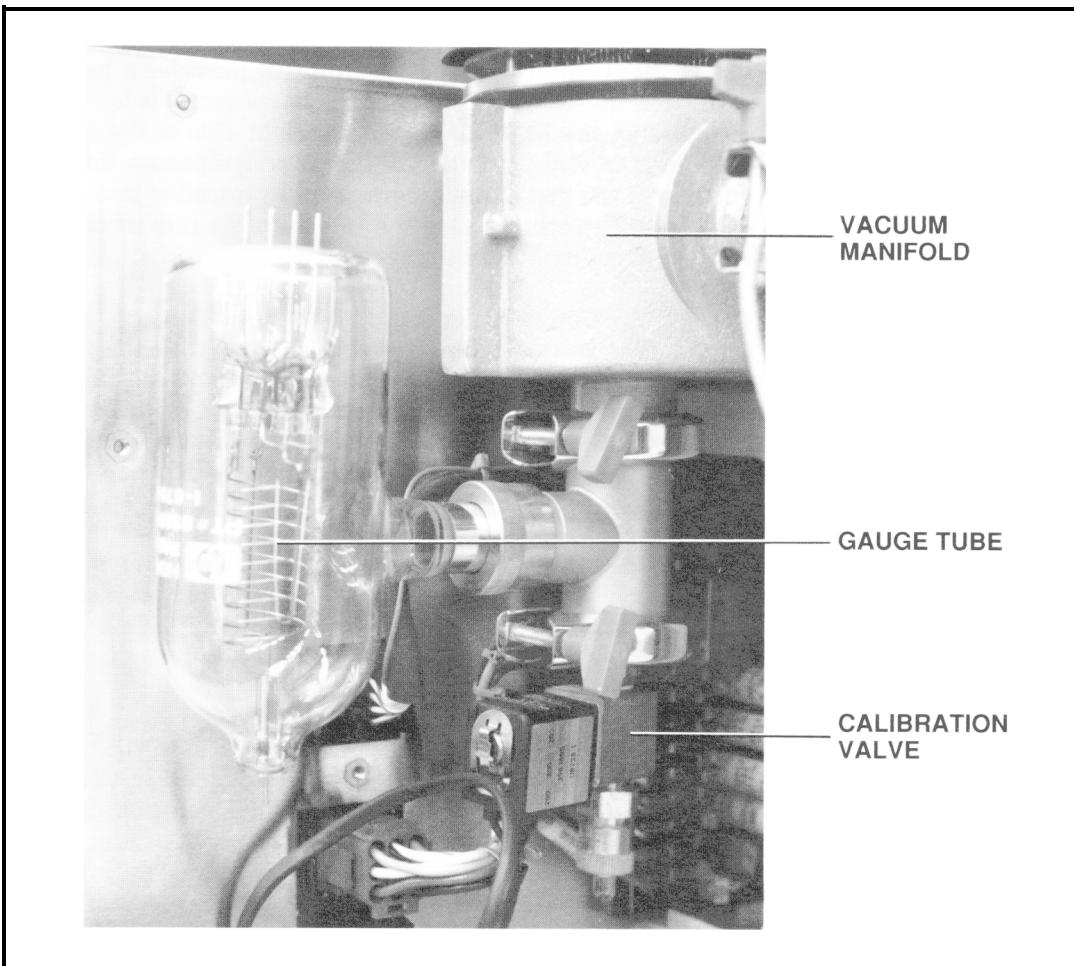


Figure 2-9, Calibration valve and ionization gauge

GC/MSD Interface

The GC/MSD interface (see Figure 2-10) provides a heated path from the GC oven to the MSD ion source. It is mounted on the KF25 flange on the right side of the vacuum manifold. One end of the interface passes through the side of the gas chromatography and protrudes into the GC oven. The other end of the interface fits into a socket on the ion source in the analyzer.

The GC/MSD interface is heated by an electric cartridge heater. The heater is powered and controlled by the detector B heated zone of the gas chromatography. The temperature can be set from the data system or from the keypad of the gas chromatography. A thermocouple in the GC/MSD interface allows you to monitor the temperature of the interface.

The analyzer (ion source, mass filter, and detector) is conductively heated by the end of the GC/MSD interface. The bellows on the interface provides a high thermal impedance path, so that the elastomer top plate seal and aluminum vacuum manifold stay relatively cool.

To establish proper analyzer thermal conditions, the GC/MSD interface assembly should be operated in the 250° to 320°C range. See *Heated Zones* in the *Operation* chapter for more information.

A fused-silica transfer line runs through the center of the GC/MSD interface. The GC effluent flows through the transfer line. If the GC column is a narrow-bore (0.20 mm id) or wide-bore (0.32 mm id) capillary column, the last 20 cm of the column maybe inserted into the GC/MSD interface to serve as the transfer line. If a megabore or packed column is installed in the GC, a splitter or jet separator must be used. In those cases, a separate piece of capillary column is installed as the transfer line. See *GC Columns* in the *Operation* chapter for details.

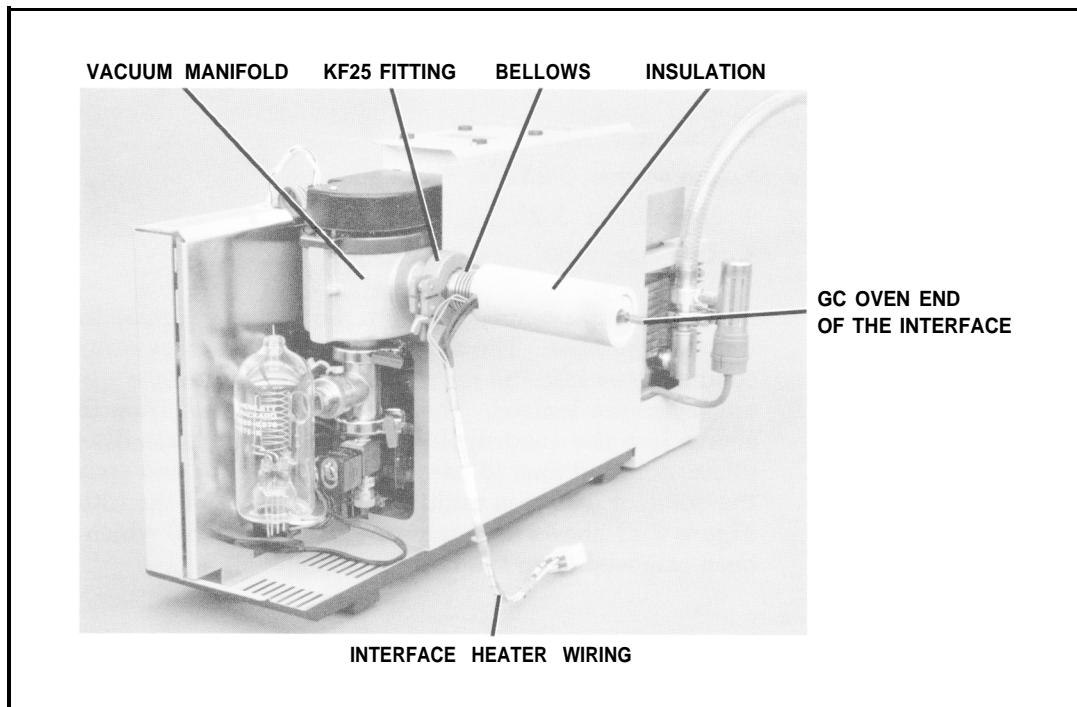


Figure 2-10. GC/MSD interface

Analyzer

The analyzer consists of the following component

- Radiator 2-24
- Ion source 2-25
- Mass filter 2-28
- Detector 2-30

The analyzer is suspended from the top plate inside the vacuum chamber. The eluent from the gas chromatography column flows into the ion source where the sample molecules are ionized. Three ions are expelled from the ion source into the Quadrupole mass filter. The mass filter allows selected ions to pass through the filter and strike the detector (electron multiplier) at the exit of the filter. Figure 2-11 shows an analyzer (with top board) which has been removed from the vacuum manifold.

Figure Not Available

Radiator The ion source and Quadrupole mass filter are contained within an aluminum radiator. This aluminum radiator is conductively heated by the GC/MSD interface. The radiator geometry determines the relative heating of the analyzer components.

A typical GC/MSD interface temperature is 280°C. Corresponding temperatures for the various parts of the analyzer are approximately

Radiator near the ion source (MS temperature) — 185°C
Ion source — 175°C
Mass filter — 150°C
Detector — 75°C

There is a thermocouple on the surface of the radiator near the ion source. The reading from this thermocouple is displayed by the data system software where it is labeled MS temperature. It takes at least 4 hours for the analyzer to reach thermal equilibrium. See *Heated Zones* in the *Operation* chapter for more information.

Ion source The standard ion source is a 70 eV electron impact ion source. It has a cylindrical geometry, which makes it easy to clean. The cylindrical design also ensures proper concentric alignment of the ion source elements. A cross section of the ion source is shown in Figure 2-12.

Electrons are emitted from one of two filaments. Only one filament is operative at any given time. The active filament can be chosen using the data system software. In addition to the ac power that heats it, the filament carries a -70 V dc bias voltage.

Each filament is outside, and immediately adjacent to, a hole in the ion source chamber. Electrons are emitted by the filament and enter the ion source chamber, which is at ground potential. A small permanent magnet focuses the electron beam.

The sample enters the ion source through the GC/MSD interface. The electrons from the filament ionize and fragment the sample molecules.

The ion source contains these lens elements

- Repeller
- Drawout (cylinder and plate)
- Ion focus
- Entrance lens

The repeller voltage can be varied from 0 to +19.8 V dc. A typical repeller voltage is +15 V dc. The electrical field created by the repeller pushes the positively charged fragments and parent ions toward the hole in the drawout plate.

The drawout plate and drawout cylinder are both at ground potential. The beam passes through the hole in the drawout plate, and is focused by the ion focus lens and the entrance lens.

The voltage on the ion focus lens can be varied from 0 to -127 V dc. A typical voltage is in the -60 to -100 V dc range.

The entrance lens voltage ramps with ion mass. It can be varied from 0 to -128 mV/amu. A typical range is -30 to -60 mV/amu. A constant, offset voltage of 0 to -64 V dc can also be applied to the entrance lens. Its voltage is combined with the ramped voltage to give a total entrance lens voltage.

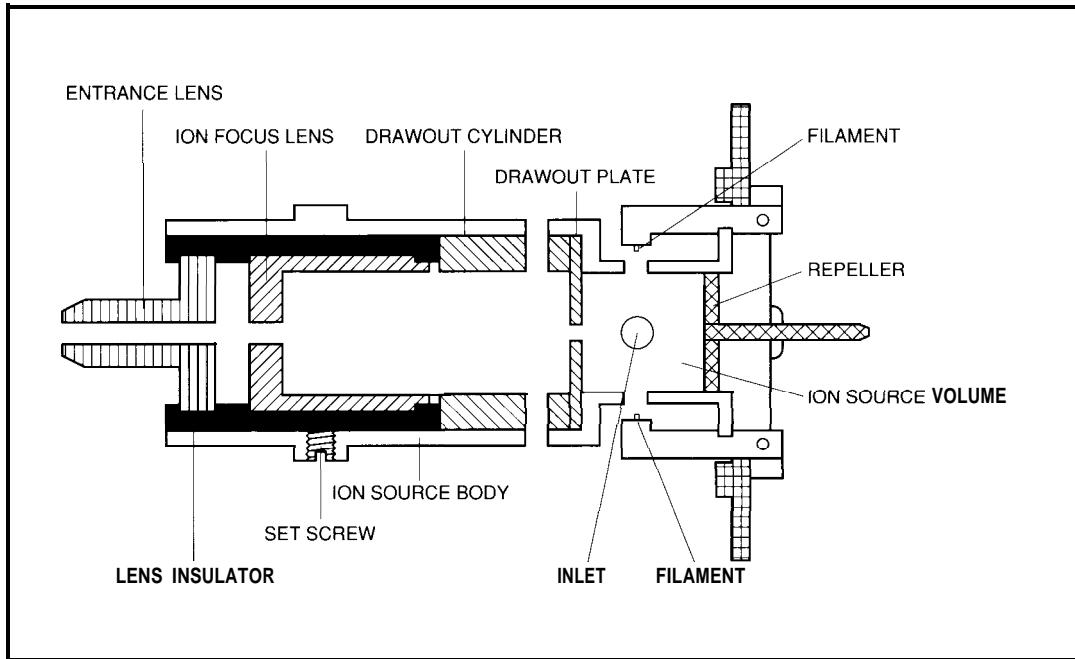


Figure 2-12. Ion source cross section

Mass filter The mass filter sorts ions according to their mass-to-charge ratio (m/z) and, at a given time, only allows ions of a selected m/z to pass through the filter,

The mass filter is a fused-silica tube with a hyperbolic geometry as shown in Figure 2-13. The four hyperbolic segments are coated on the inside with a conductive material. Opposite segments are connected together.

A combined dc and RF signal is applied to the two pairs of segments. The magnitude of the RF voltage applied to the mass filter determines the mass-to-charge ratio of the ions that pass through the entire length of the mass filter and reach the detector. The ratio of de-to-RF voltage determines the resolution.

The inside dimensions of the mass filter are such that it fits accurately over the end of the entrance lens, so that the entrance lens centers the quadrupole. The exit end of the Quadrupole is held in place by a ceramic insulator.

The mass filter requires no periodic maintenance. If maintenance is performed around the mass filter, care should be taken; the mass filter can be damaged by some solvents. Acetone, hexane, and freon can be used safely around the mass filter.

Caution Never use water or solvents with free chloride anywhere near the mass filter. These can ruin the mass filter.

Care should also be taken, when working with or around the mass filter, to not change its physical orientation.

Figure Not Available

Detector The detector is a continuous dynode electron multiplier. It is located at the exit end of the Quadrupole mass filter (see Figure 2-14). The detector receives the ions that have passed through the mass filter and generates an electronic signal proportional to the number of ions that strike it.

The x-ray lens is part of the detector. It directs the ion beam into the horn of the electron multiplier. Ions entering the horn strike the sides of the horn and liberate secondary electrons. These cascade through the horn, liberating more electrons as they go.

The voltage applied to the horn determines the gain. It is adjustable from 0 to -3000 V dc. The overall gain of the electron multiplier is adjusted to about 10^5 by the data system. A shielded cable carries the detector output to a logarithmic amplifier on the main board.

Figure Not Available

Electronics

The following assemblies make up the MSD electronics

- Top board 2-34
- Main board 2-36
- HP-IB/MS control card 2-38
- APG remote control card 2-38
- Parallel/remote card 2-38
- Power distribution board 2-40
- Power supply 2-40
- Connectors and controls 2-42

Figure 2-15 shows how these assemblies interconnect.

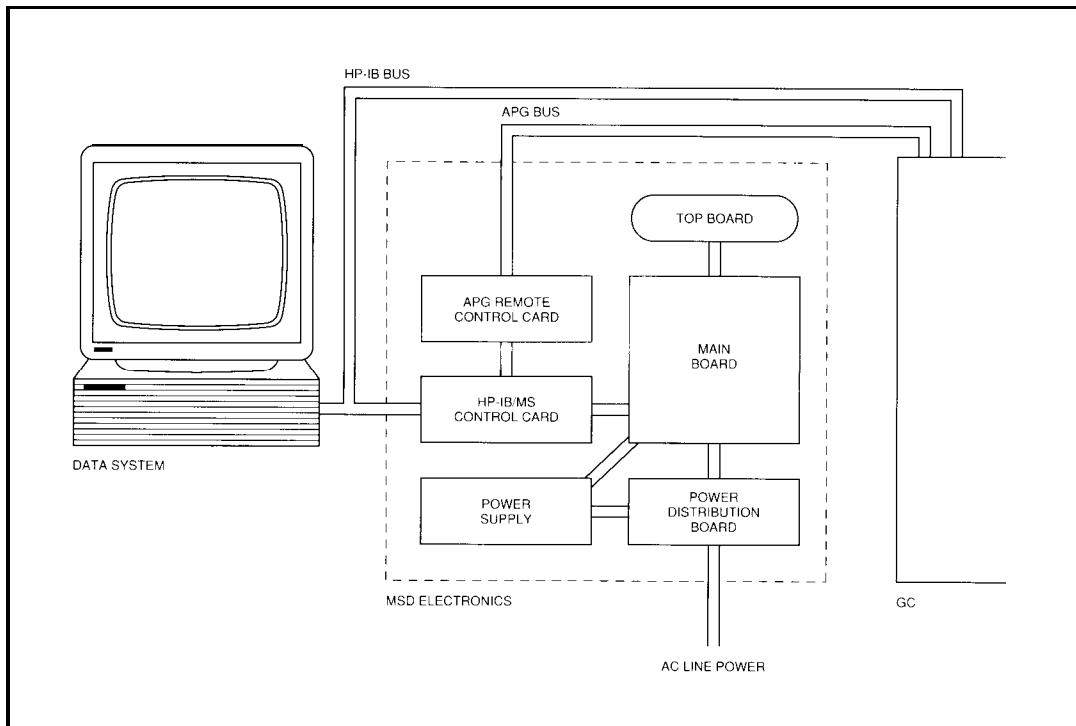


Figure 2-15. Organization of the MSD electronics

Top board The top board is mounted on the top plate, as shown in Figure 2-16. The top board performs the following functions:

- Generates the RF component of the voltage applied to the Quadrupole mass filter according to a signal from the main board
- Generates the dc component of the voltage applied to the Quadrupole mass filter. The magnitude of this voltage is proportional to the RF voltage
- Generates the 0 to -3000 V dc output that is applied to the detector (continuous dynode electron multiplier)
- Amplifies the signal from the thermocouple near the ion source and send the signal to the main board
- Passes voltages generated on the main board to elements in the ion source and the detector
- Switches the filament power from one filament to the other when commanded by the data system

Caution Never switch between filaments while the MSD electronics are on (MS on in the data system). Doing so will damage the filaments and decrease their life-span.

For more information about the top board, refer to the *Technical Reference* appendix.

Figure Not Available

Main board The main board (see Figure 2-17) is mounted on a vertical piece of sheet metal called the electronics panel. The main board performs the following functions:

- Receives and decodes digital information from the HP-IB/MS control card
- Sends digital information to the HP-IB/MS control card
- Generates voltages applied to the ion source filaments, repeller, ion focus lens, entrance lens, x-ray lens, detector, quadrupole RF voltage control, and de/RF ratio adjustment
- Generates control signals for alternate filament selection, quadrupole dc polarity, and true total ion mode selection
- Amplifies the electron multiplier output
- Converts the log amp output, coil dip signal, source temperature signal, and foreline pressure signal from analog to digital
- Turns off the analyzer electronics (top board) when conditions such as excess pressure or excess signal make it necessary
- Controls the calibration valve
- Provides optional accessory control (see the *Operation* chapter for more information about accessory control)
- Generates a 1-MHz clock signal for the top board,
- Generates ± 250 V dc (nominal) power for dc amplifiers and lens power supplies on the top board.

For more information about the main board, refer to the *Technical Reference* appendix.

Figure Not Available

HP-IB/MS control card The HP-IB/MS control card is located to the left of the main board on the electronics panel (see Figure 2-17). The HP-IB/MS control card has two main functions:

- The HP-IB portion of the card provides a communication interface between the MSD and the data system
- The MS control portion of the card provides real-time control of the MSD, freeing the data system for other tasks

For more information about the HP-IB/MS control card, refer to the *Technical Reference* appendix.

APG remote control card The APG remote control card is a small printed circuit board located on top of the HP-IB/MS control card (see Figure 2-17). The APG remote control card makes it possible for a remote start signal to start the MSD. It also ensures accurate run-start synchronization.

For more information about the APG remote control card, refer to the *Technical Reference* appendix.

Parallel/remote board The parallel/remote board is a small printed circuit board that allows up to three devices (instead of 1) to be connected to the APG remote connector on the GC (see Figure 2-18). A short cable connects the parallel/remote board to the APG remote connector on the GC.

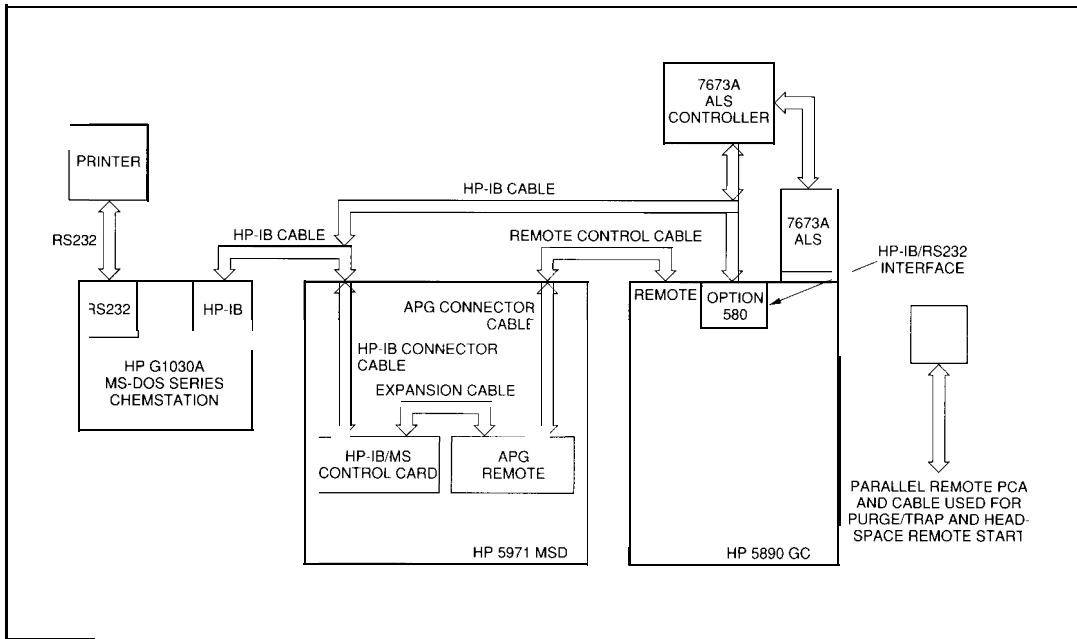


Figure 2-18. HP-IB/MS and APG cabling

Power distribution board The power distribution board (see Figure 2-19) is mounted next to the power supply on the electronics panel below the vacuum manifold,

The power distribution board performs the following functions:

- Distributes ac line power to the dc power supply and to the cooling fan
- Turns on the diffusion pump once the foreline pressure is low enough
- Regulates the ac power to the diffusion pump heater
- Disables the diffusion pump if the foreline pressure is too high or if the diffusion pump is too hot or too cold
- Passes the foreline pressure from the foreline gauge to the main board

For more information about the power distribution board, refer to the *Technical Reference* appendix.

Power supply The power supply (see Figure 2-19) is mounted next to the power distribution board on the electronics panel below the vacuum chamber. It converts ac line power into the dc voltages used by the rest of the electronics. The power supply generates the following dc voltages:

- +24 V (nominal) with a maximum of 0.5 A
- +15 V (nominal) with a maximum of 1.0 A
- 15 V (nominal) with a maximum of 0.2 A
- +5 V (nominal) with a maximum of 1.5 A

For more information about the power supply, refer to the *Technical Reference* appendix.

Figure Not Available

Connectors and Controls All connectors and controls are located on the back panel of the MSD (see Figure 2-20). These include

- APG remote control connector
- I/O connector
- Accessory connector
- Ac power cord
- On/off switch
- Foreline pump cord receptacle

The following material describes the functions of these connectors and controls.

APG remote control connector

The APG (Analytical Products Group) remote control connector is the external connector for the APG remote control card in the MSD. It receives remote start signals from the GC.

I/O connector

The cable from the data system is connected to the I/O connector.

Accessory connector

The accessory connector provides an interface through which external devices such as LEDs and solenoids can be powered and controlled. In addition, it provides a path for inputs such as a remote start signal. Additional information about the accessory connector can be found in *Accessory Control* in the *Operation* chapter of this manual and especially in the *Technical Reference* appendix.

Figure Not Available

Ac power cord

The ac power cord brings in all electrical power for the MSD.

On/off switch

The on/off switch is actually a circuit breaker. It turns the MSD on and off.

Foreline pump cord receptacle

The foreline pump cord receptacle provides ac power for the foreline pump. If the on/off switch is off, no power is supplied to the foreline pump.

Introduction 3-2

Site Preparation 3-3

Initial Installation 3-4

Conversions 3-5

Introduction

This chapter provides an overview of site preparation, initial installation, and subsequent conversion between operating modes.

The majority of the site preparation and initial installation information for the HP 5971A MSD is located in the *HP 5971A Mass Selective Detector Installation Manual*. Additional installation information is included in the installation manual supplied with your data system.

Conversion between operating modes applies primarily to MSDs that are equipped with the HP G1072A CI Accessory. Information about conversion between EI and CI operation can be found in the *HP G1072A CI Accessory Hardware Manual*.

Site Preparation

Installation of the MSD by your Hewlett-Packard Customer Engineer normally does not include site preparation. Unless prior arrangements are made with the Hewlett-Packard Customer Service Organization, site preparation is your responsibility.

Site preparation requirements include, but are not limited to, the following

- Space
- Power
- Air conditioning
- Gases
- Other operating supplies

Site requirements for the MSD are listed in the *HP 5971A Mass Selective Detector Installation Manual*. Your site must be properly prepared before the MSD can be installed.

Initial Installation

Initial installation of the HP 5971A Mass Selective Detector is normally the responsibility of your Hewlett-Packard Customer Engineer. Initial installation typically includes the following:

- Unpacking the MSD
- Attaching it to the gas chromatography
- Making necessary electrical, helium, and exhaust venting connections
- Starting up the MSD
- Verifying proper performance of the MSD
- Familiarizing the operator with the MSD and data system

Note Familiarization is not the same as a full training course. Training is not included with the installation of the MSD.

Note The CE will not test your system against your standards or samples. Further, the CE will not setup your laboratory procedures or develop methods for you. Assistance with laboratory procedures and methods can be obtained from your local Hewlett-Packard Applications Engineer (AE) on a consulting basis at additional cost.

For more information about installation of the MSD can be found in the *HP 5971A Mass Selective Detector Installation Manual*.

Conversions

After initial installation, converting from one mode of operation to another is your responsibility. For the MSD, the only significant conversions are between the EI and CI ionization modes on those MSDs equipped with the HP G1072A CI Accessory. These conversions are described in detail in the *HP G1072A CI Accessory Hardware Manual*.

Introduction	4-2
Pre-Operation Checklist	4-3
GC Columns	4-4
Flow Rates	4-18
Heated Zones	4-20
Startup and Pumpdown	4-23
Monitoring Pressures	4-25
Tuning	4-26
Accessory Control	4-40
Shutdown and Venting	4-42
Moving and Storage	4-44

Introduction

This chapter describes how to operate the MSD. It covers the following topics:

- What to check before turning on the MSD
- How to install a column
- How start up and pump down the MSD
- How to establish flows, temperatures, and pressures
- How to tune the MSD
- How to shut down, vent, and store the MSD

The sections in this chapter are:

- Pre-Operation Checklist
- G-C Columns
- Flow Rates
- Heated Zones
- Startup and Pumpdown
- Monitoring Pressures
- Tuning
- Accessory Control
- Shutdown and Venting
- Moving and Storage

Pre-Operation Checklist

This section assumes that your MSD has been previously installed and tested, but is not currently on. Verify the following before switching on the MSD:

- The MSD is connected to a grounded power source

WARNING Connecting the MSD to an ungrounded power source creates a shock hazard for the operator and can damage the instrument.

- The GC/MSD interface assembly is attached to the MSD and extends into the GC oven
- There is a GC column installed in the GC oven (see *GC Columns*, later in this chapter)
- The GC is on. If it is not, switch on the GC (see your GC manual), but do not turn on the GC/MSD interface heater (detector B temperature zone)
- The flow rate of carrier gas through the column is correct. If it is not, adjust the flow rate (see *Flow Rates*, later in this chapter)
- The foreline pump is attached to the MSD and its power cord is plugged into the receptacle on the MSD
- The foreline pump exhaust is properly vented

WARNING The exhaust from the foreline pump will contain trace amounts of whatever chemicals you are analyzing. Do not vent the pump exhaust into your laboratory.

GC Columns

Many GC columns are available. Some of them are directly compatible with the HP 5971A MSD and its capillary direct GC/MSD interface. Others, because of their physical size or high volumetric flow rate, are only compatible if a splitter or jet separator is used. The material in this section discusses various types of GC columns, their compatibility with the MSD, and how to install them.

Types of columns	<p>The following types of columns can be used in the HP 5890 GC with the HP 5971A MSD:</p> <ul style="list-style-type: none">• Narrow-bore columns (0.20 mm id, 0.30 mm od)• Wide-bore columns (0.32 mm id, 0.44 mm od) that are 25 meters long or longer (at reduced flows)• Wide-bore columns (0.32 mm id, 0.44 mm od) of any length if a splitter is used ahead of the GC/MSD interface• Megabore columns (0.53 mm id, 0.70 mm od) if a splitter or jet separator is used ahead of the GC/MSD interface• Packed columns if the HP 59913A Jet Separator is used
------------------	---

The narrow-bore and wide-bore columns can be inserted directly into the GC/MSD interface. When a splitter is used, the column is connected to the splitter and a restrictor (a special ultra-narrow 0.115 mm id capillary column) connects the splitter to the GC/MSD interface.

The HP 59913A Jet Separator is more efficient than a splitter. It preferentially sends heavier molecules into the MSD, so that an enrichment occurs (more sample enters the MSD relative to the amount of carrier gas). The jet separator comes with its own manual, which describes installation and operation.

Installing columns

As described previously, some columns can be inserted directly into the GC/MSD interface. Other columns must be used with a splitter, and a separate piece of capillary column connects the splitter to the GC/MSD interface. The following material describes how to install various types of columns.

- Conditioning a capillary column 4-5
- Installing a capillary direct column 4-6
- Installing a column and splitter 4-10

For information about installing a column with the jet separator, refer to the *HP 59913A Jet Separator Assembly Hardware Manual (59913-90007)*.

Conditioning a capillary column

Columns that have not been conditioned will sometimes "bleed". This can contaminate the MSD ion source and interfere with your analyses. Columns should be conditioned before they are installed in, or connected to, the GC/MSD interface. To condition a column, follow these steps:

- 1 Install one end of the column in the injection port.

Caution Do not install the other end of the column in the GC/MSD interface.

- 2 Start the carrier gas flow,

- 3 Ramp the GC oven temperature to about 10°C above the highest temperature you expect to use for analyses.

Caution Do not exceed the maximum temperature rating of the column.

- 4 Allow the carrier gas to flow through the column for several hours, longer for new columns.

Installing a capillary direct column

Use this procedure if you are installing a narrow-bore capillary column or a wide-bore capillary column without a splitter (see Figure 4-1). If another column is already installed, vent the instrument and remove the column before proceeding.

Caution The instrument must be vented before a column is installed. See *Shutdown and Venting* later in this chapter for more details.

Materials needed:

Ferrule

0.30-mm id, for narrow-bore columns (0100-1295)

0.50-mm id, for wide-bore columns (0100-0636)

Gloves, clean (large (8650-0300) or small (8650-0029))

Nut (05988-20066)

Wrench, open-end, 1/4-inch x 5/16-inch (8710-0510)

Procedure:

- 1 Install the new column in the injection port and G-C oven as described in the HP 5890A GC documentation but do not connect the MSD end of the column.

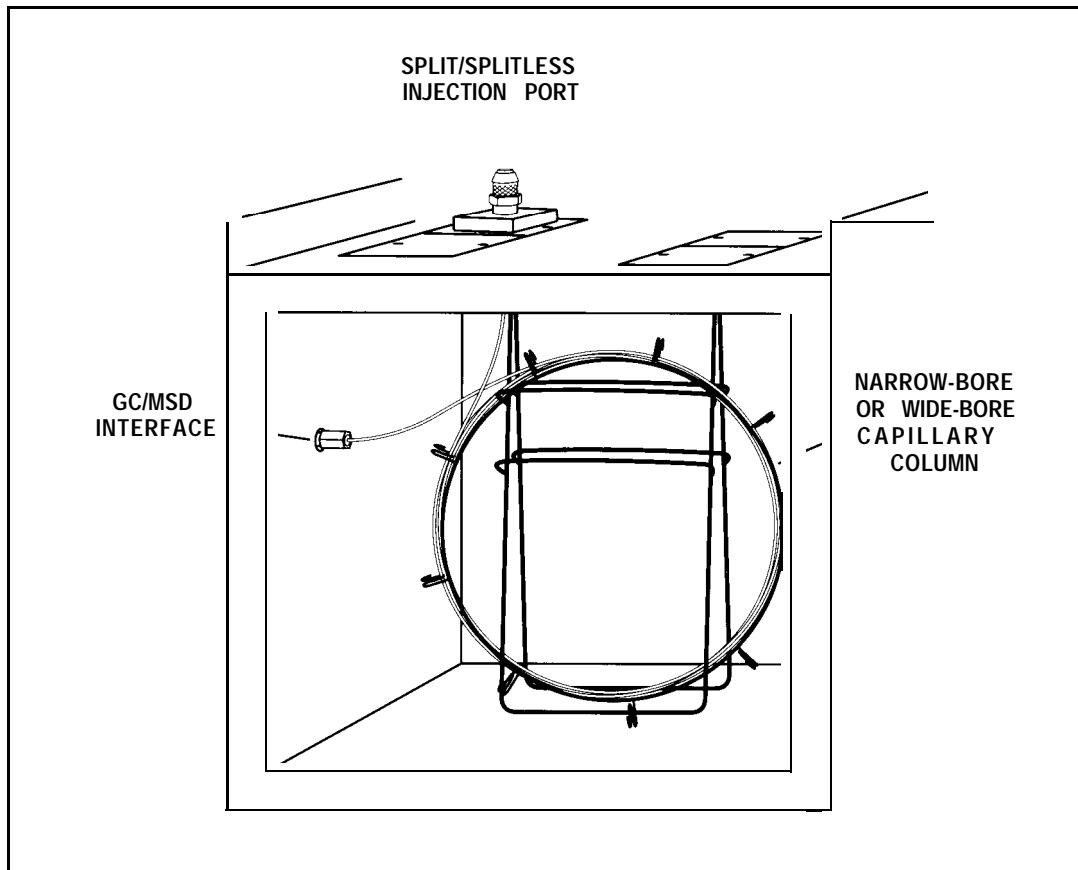


Figure 4-1, GC column installed capillary direct

- 2 Thread the free end of the capillary column through a nut and then through a ferrule as shown in Figure 4-2. Be sure that the ferrule slides easily along the column.
- 3 Score the tip of the column with a sharp knife and break off the first few centimeters of the column. Use a magnifying glass to examine the break. If the break is not clean, try again.
- 4 Gently slide the column into the GC/MSD interface until you feel some resistance as the column reaches the MSD end of the interface (about 20 cm). Then withdraw the column 1 mm.
- 5 Tighten the nut finger tight. Then, using the 1/4-inch wrench supplied with your instrument, finish tightening the nut. If the ferrule is new, you may have to turn the nut 1/4 to 1/2 turn with the wrench. If the ferrule has previously been compressed, you will probably have to turn the nut less than 1/4 turn,

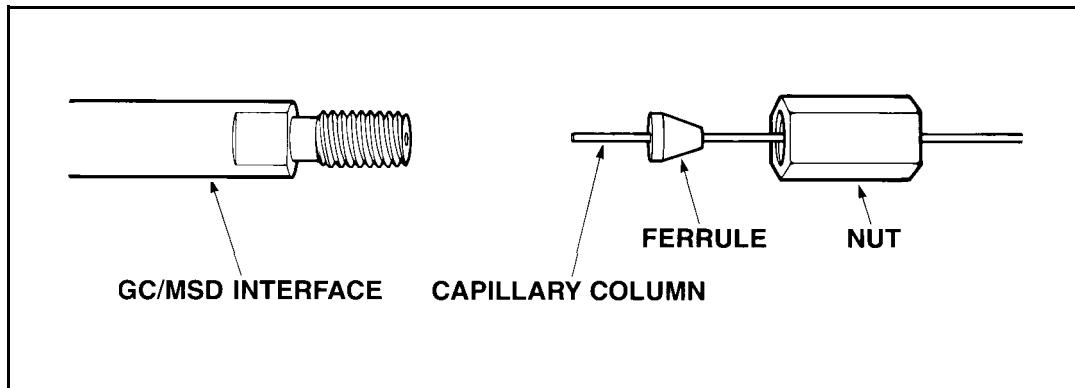


Figure 4-2. Threading the nut and ferrule

Installing a column and splitter

Use this procedure if you are installing a wide-bore or megabore capillary column with a splitter (see Figure 4-3). If another column is already installed, vent the instrument and remove that column before proceeding. In any case, the instrument must be vented before a column is installed. See *Venting* later in this chapter for more details.

Materials needed:

Ferrule

0.3-mm id (0100-0698)
0.5-mm id (0100-0636)
0.8-mm id ferrule (0100-1186)

Gloves, clean (large (8650-0300) or small (8650-0029))

Nut

long (05988-20066)
short (2740-0015)

Restrictor column, 0.115 mm id, 0.26 mm od, (05971-20590)

Sealing ring (0905-0938)

Split tube (05988-20224)

Tee connector (05995-20174)

Vent tube (1530-2163)

Wrench, open-end, 1/4-inch x 5/16-inch (8710-0510)

Procedure:

- 1 Install the new column in the injection port and GC oven as described in the HP 5890A GC documentation but do not connect the MSD end of the column.

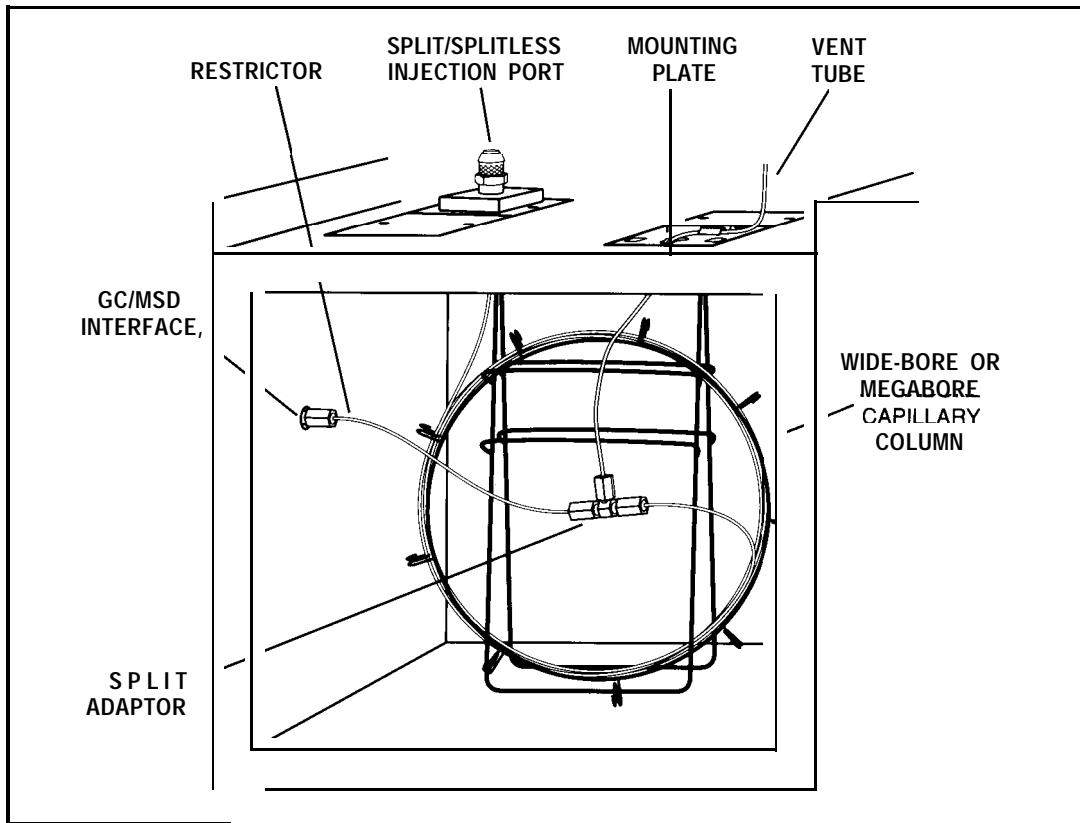


Figure 4-3. GC column with splitter

- 2 Lift the hinged cover on top of the GC. Remove a blank panel from one of the detector positions on the right.
- 3 Install the mounting plate supplied with the splitter.
- 4 Use a small piece of aluminum foil to cover the ferruled end of the stainless steel vent tube supplied with the splitter. This prevents GC oven insulation from contaminating the vent tube. From inside the GC oven, push the covered end of the vent tube up through the hole in the top of the GC oven and through the hole in the mounting plate.
- 5 Bend the vent tube as necessary (See Figure 4-4) and fasten it in place using the supplied clamp and screw.

WARNING Part of the eluent from your GC will be vented out this tube. Do not allow the eluent to vent directly into your laboratory. Use appropriate tubing and route the eluent to a fume hood or other appropriate place.

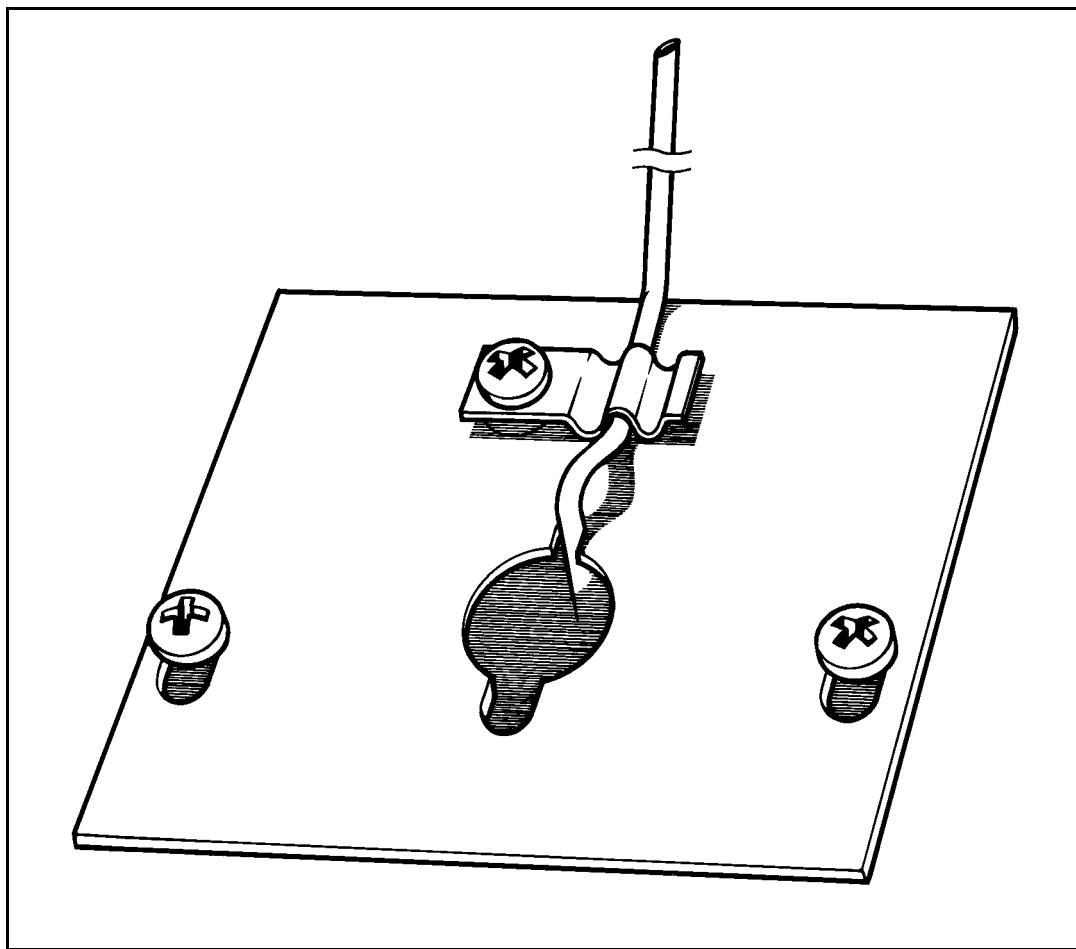


Figure 4-4. Installing the vent tube

Note Wear clean gloves for the following steps.

- 6 If you are installing a wide-bore column, slide the split tube into the tee connector (see Figure 4-5). If you are installing a megabore column, skip to step 7.
- 7 Slide a short nut and then a sealing ring onto the GC oven end of the vent tube. Insert the tube about 10 mm into the tee and thread the nut onto the tee. Tighten with the supplied 1/4-inch wrench.
- 8 Slide a long nut and a 0.5-mm id or 0.8-mm id ferrule (as appropriate) onto the end of the column. The tapered end of the ferrule should face the nut.
- 9 Score the tip of the column with a sharp knife and break off the first few centimeters of the column. Use a magnifying glass to examine the break. If the break is not clean, try again.
- 10 Insert the column into the right side of the tee until the end of the column is approximately in the center of the tee.
- 11 Thread the nut onto the tee and tighten, first by hand and then using the 1/4-inch wrench supplied with your MSD.
- 12 Cut about 50 cm of the restrictor capillary column (O. 115 mm id, 0.26 mm od) from the length provided with your MSD. The restrictor will serve as the transfer line through the GC/MSD interface.
- 13 Slide a long nut and a 0.3-mm id ferrule over one end of the restrictor. The tapered end of the ferrule should face the nut. Score and break the tip of the restrictor as described in step 9.

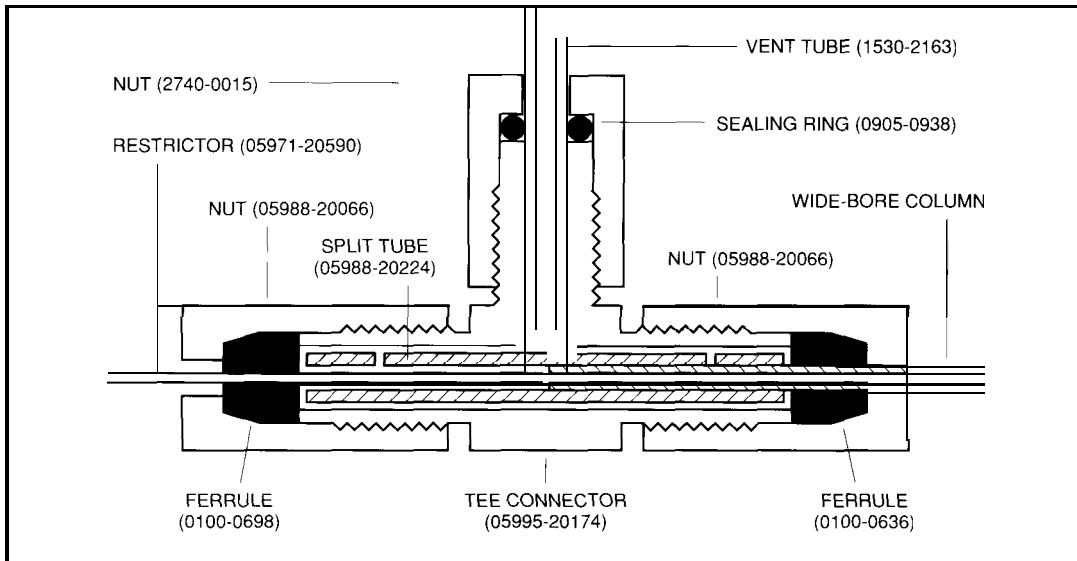


Figure 4-5. Splitter and wide-bore column

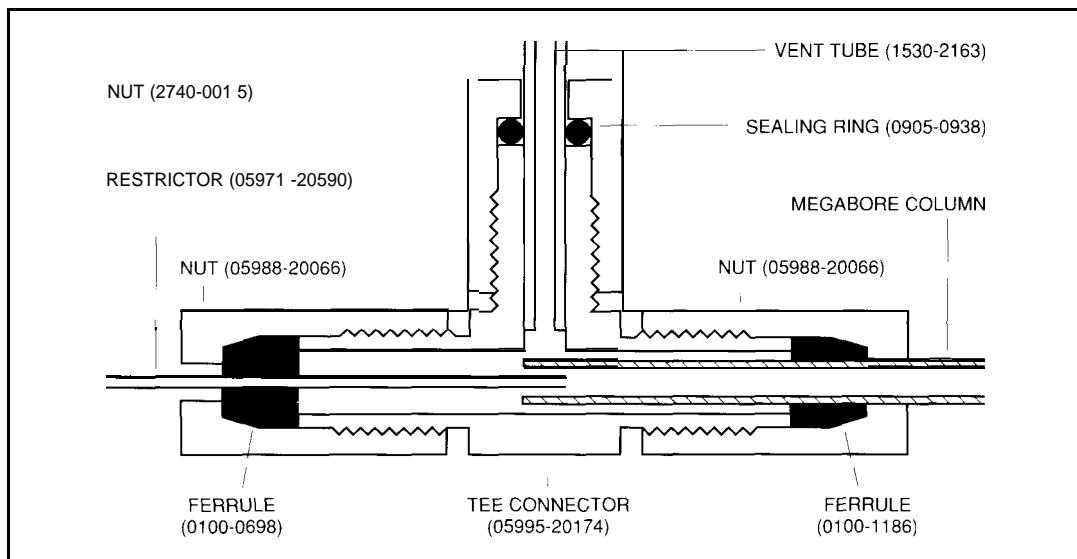


Figure 4-6. Splitter and megabore column

- 14 If you are installing a wide-bore column, insert the nutted end of the restrictor into the tee until it meets the end of the wide-bore column. Then, pull the restrictor back 1 mm. See Figure 4-5. Thread the nut onto the tee and tighten; first by hand and then using the 1/4-inch wrench supplied with your MSD.

If you are installing a megabore column, insert the nutted end of the restrictor into the tee until its end is a few millimeters inside the megabore column. See Figure 4-6. Once the restrictor is in place, thread the nut onto the tee. Tighten the nut, first by hand and then using the 1/4-inch wrench supplied with your MSD.

- 15 Slide a long nut and a 0.3-mm id ferrule over the free end of the restrictor. The tapered end of the ferrule should face the nut (see Figure 4-7). Score and break the column as described in step 9.
- 16 Gently slide the free end of the restrictor into the GC/MSD interface as far as it will go (about 20 cm). Then withdraw the column 1 mm and thread the nut onto the end of the GC/MSD interface. Tighten the nut, first by hand and then using the 1/4-inch wrench supplied with your MSD.

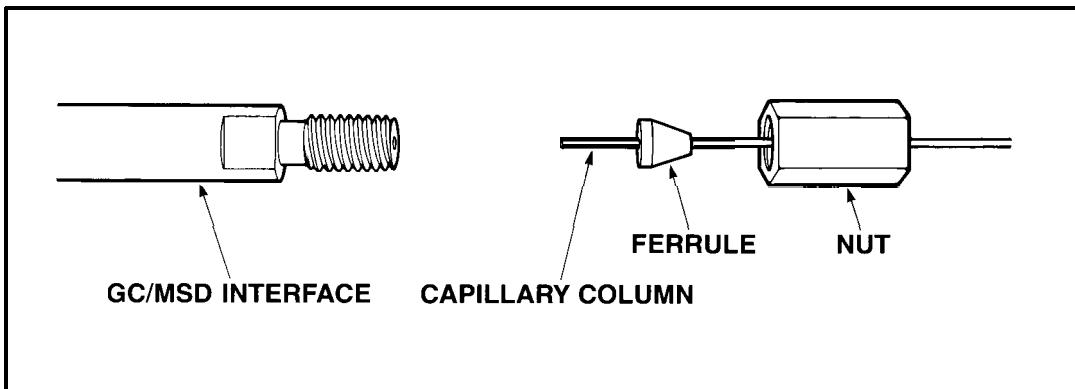


Figure 4-7. Threading the nut and ferrule

Flow Rates

The flow rate through a given column is regulated by the pressure of the carrier gas at the GC end (head) of the column. Table 4-1 shows the rough relationship between column head pressure and flow rates for various types of columns. The flow rates in the Table 4-1 are average rates within the column. The corresponding flow rates at atmospheric pressure are about half those shown in the table.

Caution The absolute maximum flow rate into the MSD must not exceed 1.5 ml/min. The maximum flow rate into the MSD during data acquisition must not exceed 1.0 ml/min.

You can make a direct measurement of the flow rate by injecting a small amount (less than 1 μ l) of air into the septum at the head of the column, and noting the retention time for a peak with a mass of 28 amu. The average linear velocity in the column is then:

$$\text{Linear Velocity (v)} = 100L/t$$

where v is the average linear velocity in centimeters per second, L is the column length in meters, and t is the retention time in seconds.

The corresponding volumetric flow rate is given by

$$\text{Flow rate} = v \times 60(\pi)D^2/400$$

where the flow rate is in milliliters per minute and D is the internal column diameter in millimeters.

Table 4-1. Column flow rates

Column Diameter (mm)	Length (m)	Injection Port Type	Interface Type	Head Pressure (psi)	Linear Velocity (cm/sec)	Column Flow (ml/min)
0.100	10	C	CD	38	30	0.13
0.200	12	C	CD	3	30	0.50
	25	C	CD	12	30	0.50
	50	C	CD	30	30	0.50
0.250	30	C	CD	8	30	0.90
0.320 (wide-bore)	25	C	ES	11	30	1.35
	50	C	CD	5	23	1.00
	50	C	ES	25	30	1.35
0.530 (megabore)	10	C	ES	2	50	7
	10	C, P	ES	8	152	20
	50	C, P	JET	24	227	30
1/8" (packed)	2	C	JET	48	—	40

C = split/splitless injection port

CD = capillary direct

ES = effluent splitter

JET = HP 59913A Jet Separator

P = packed column injection port

All values are approximate and are for a helium flow of less than 1 ml/minute into the HP 5971A MSD.

Heated Zones

The HP 5971A has only one actively heated zone: the GC/MSD interface. The radiator conducts and radiates heat from the GC/MSD interface to the analyzer (ion source, quadrupole mass filter, and detector). The temperatures of the analyzer components vary directly with the temperature of the GC/MSD interface. Because the analyzer is heated indirectly, it responds slowly to changes in the GC/MSD interface temperature. Analyses run before the analyzer is at thermal equilibrium produce unreliable data.

The HP 5971A has two temperature sensors. One sensor is in the GC/MSD interface. Its temperature can be read from the data system or from the GC, where it is known as the detector B temperature. The other sensor is in the radiator near the ion source. Its temperature can be read from the data system, where it is called the MS temperature.

Figure 4-8 is a graph of MS temperature as a function of GC/MSD interface temperature. The relationship is shown as a band rather than a line because for a given GC/MSD interface temperature, the MS temperature varies with the GC flow rate. In general, the higher the flow rate, the lower the MS temperature. Also, the exact relationship of these temperatures varies slightly from instrument to instrument.

Ion source temperature is an important factor in obtaining optimum mass spectrometric results. Figure 4-9 is a graph which shows how the ion source temperature, and the temperatures of other analyzer components, relates to the measured MS temperature. In general, the actual ion source temperature is 10°C lower than the measured MS temperature.

The GC/MSD interface should be operated in the 250°-320°C range. Subject to that restriction, the GC/MSD interface temperature should be slightly higher than the maximum GC oven temperature.

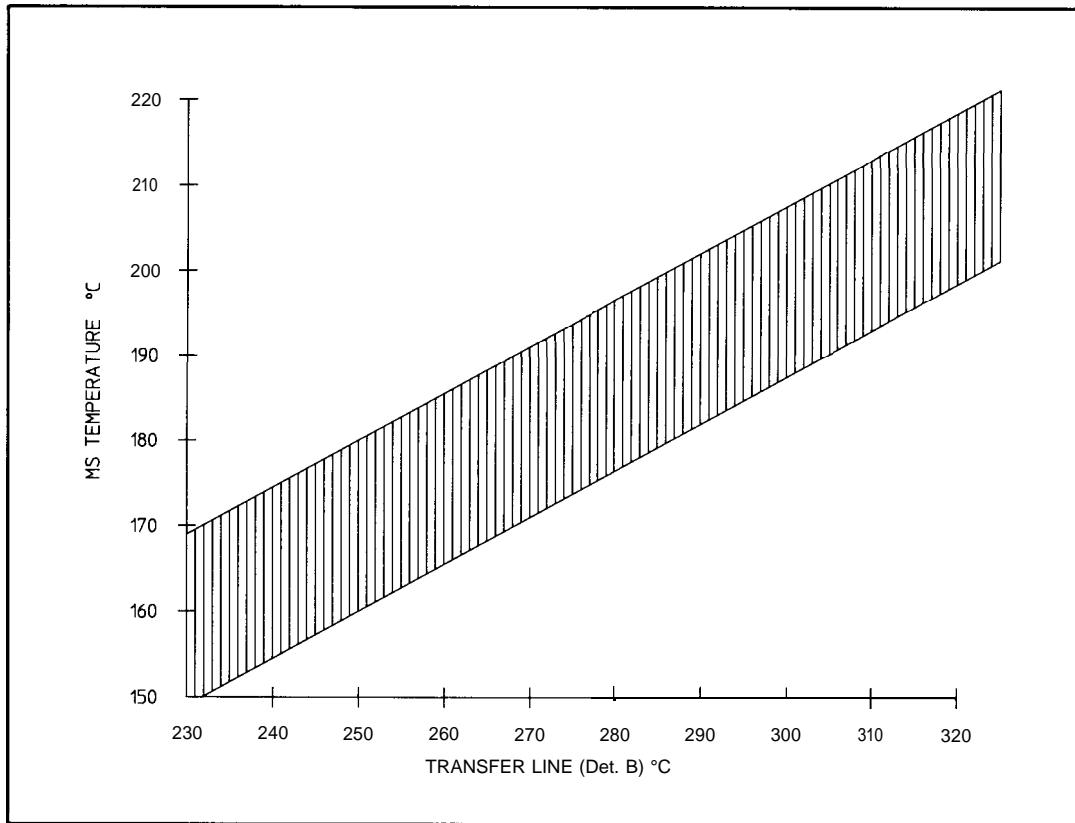


Figure 4-8. MS temperature vs GC/MSD interface temperature

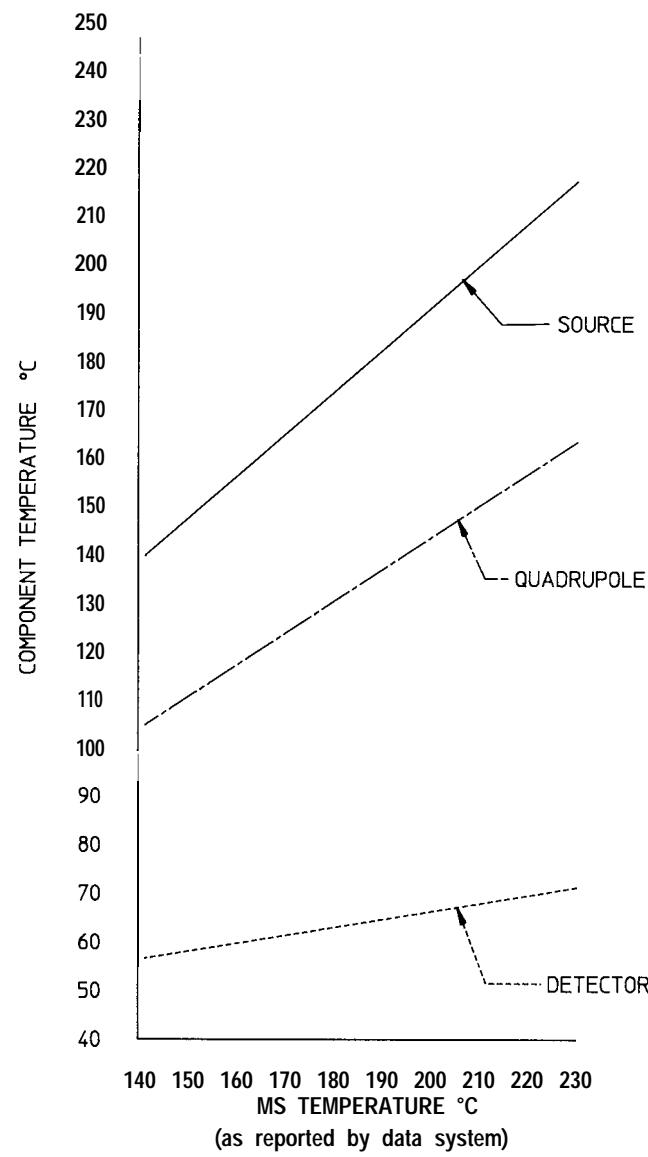


Figure 4-9. Component temperatures vs. MS temperature

Startup and Pumpdown

The startup and pumpdown procedure is mostly automated. Switching on the MSDS on/off switch (main circuit breaker) starts the foreline pump. As soon as the pressure in the vacuum manifold is below 300 mTorr, the diffusion pump turns on automatically.

The pumpdown program in your data system allows you to monitor the pumpdown process. It displays diffusion pump status, MS (analyzer) temperature, and foreline pressure. It also tells you when to turn on the GC/MSD interface heater and when the MSD is ready,

Under normal conditions, it will take the diffusion pump about 20 minutes to reach its normal operating temperature. It will, however, take the MSD at least 4 hours to reach thermal equilibrium.

Materials needed:

None

Procedure:

- 1 Make sure your system meets all of the conditions in the *Pre-Operation Checklist* earlier in this chapter.
- 2 Switch on the on/off switch (main circuit breaker) on the back panel of your MSD. This will turn on the foreline pump which you should be able to hear gurgling. The gurgling should become quieter and stop within 1 minute,

Note If the foreline pump does not stop gurgling it indicates a major air leak. Switch off the MSD and find and correct the leak.

- 3 On your data system, call up the vacuum control program. Refer to the documentation supplied with your data system for more information.

- 4 Select the pumpdown option. This displays the diffusion pump status, MS (analyzer) temperature, and foreline pressure. It also displays a time estimate of how long it will take the diffusion pump to reach its normal operating temperature.

Note The foreline pressure should fall below 300 mTorr within a few minutes. If it does not, then either there is an air leak or the foreline pump is not functioning correctly. Stop the pumpdown procedure and correct the problem before continuing.

- 5 When the diffusion pump reaches its normal operating temperature, you will be prompted to turn on the GC/MSD interface heater and the GC oven heater. If you know what temperatures you will be using for your analyses, set the heaters to those temperatures. Otherwise, set the GC/MSD interface temperature to 280°C and the GC oven temperature to 100°C.
- 6 Use the manual tune program to run a profile scan. Data acquired at this point will not be reliable because the analyzer is not at thermal equilibrium but you should be able to see some of the main PFTBA peaks such as m/z 69 and m/z 219.
- 7 Wait at least 4 hours for the MSD to reach thermal equilibrium. Then, autotune the MSD or tune it manually.

Note Tuning or acquiring data before the analyzer components have reached thermal equilibrium will result in unreliable tune values or unreliable data.

Note You can exit the pumpdown program before it is completed. Exiting the program will not stop the pumpdown process.

Monitoring Pressures

Maintaining correct pressures is critical to obtaining good results from your analyses. In addition, much information about the condition of your instrument can be gained by monitoring pressures. The HP 5971A MSD has two vacuum gauges for monitoring pressure:

- Foreline gauge
- Ionization gauge

The foreline gauge, a low-vacuum, thermal conductivity gauge, is located at the exit of the diffusion pump. It measures the foreline pressure. The instrument electronics monitor the foreline pressure at all times. When the foreline pressure falls below 300 mTorr, the diffusion pump is automatically switched on. When the foreline pressure rises above 400 mTorr, the diffusion pump is automatically switched off.

You can monitor the foreline pressure through the data system. Typical pressures will vary significantly depending on column flow and the condition of the diffusion and foreline pumps. You should watch for sudden changes in foreline pressure for a given column flow. A sudden change can indicate a leak or a malfunction of one of the vacuum system components.

The other vacuum gauge is a high-vacuum ionization (ion) gauge tube. It is located below the front of the vacuum manifold next to the calibration valve. The ion gauge tube can only be used if your instrument is equipped with the optional gauge controller. Refer to the *Gauge Controller* appendix for more information about the ion gauge and gauge controller.

Tuning

Tuning is the process of adjusting the MSD to improve performance. This is accomplished by introducing a chemical with well understood properties into the MSD. Various MSD parameters (voltages, currents, gain values, etc.) are adjusted until predetermined performance criteria are met.

Tuning can be general or specific. That is, the MSD can be tuned for good performance over its entire mass range or for optimum performance over a limited mass range (or at a specific mass). The MSD can be tuned to perform well on a wide range of chemicals or optimized for a single chemical. The data system software has several tuning programs for general and specific needs.

The tuning process can be automated to various degrees. Some tuning programs require no operator interaction, some require you to select initial parameters, and some require extensive operator interaction.

This section contains the following tuning information:

- Parts affected by tuning 4-27
- Tuning programs 4-35

Parts affected by tuning Tuning involves adjusting a number of MSD parameters. Some parameters are purely electronic and affect only the way the electronics process signals. Other parameters affect voltages or currents applied to parts in the MSD's ion source, mass filter, and detector. These parts are shown in Figure 4-8.

Table 4-2 contains a summary of the tuning parameters. The range and step size listed for a given parameter are the maximum range and minimum step size allowed. These are available in manual tune. In some cases, other tuning programs use a smaller range or a larger step size. In a few cases, tuning programs use a fixed value for a parameter.

The material following Table 4-2 describes the parts affected by tuning and the consequences of various adjustments. Because the effects of the various parts interact, the consequences listed are highly generalized

Table 4-2. Tuning parameter

Parameter	Minimum	Maximum	Default	Step size
Repeller				
repeller voltage	0V dc	+19.8 V dc	+15Vdc	0.08 V dc
Filament				
filament selection'	1	2	1	none
emission current	0 (off)	1 (on)	none	none
electron energy	-70 eV	-70 eV	-70 eV	none
Ion focus lens				
ion focus voltage	0V dc	-100 V dc	40 V dc	0.5 v dc
Entrance lens				
gain	0 mV/amu	-128 mV/amu	-40 mV/amu	0.5 mV/amu
offset	0V dc	-64 V dc	-4Vdc	0.25 V dc
Mass filter				
dc polarity	negative	positive	determined at factory	none
amu gain	0	1023	350	1
amu offset	0	255	50 ²	1
219 width	-0.15	+0.15	0	.0012
X-ray lens				
x-ray voltage	0 V dc	218 V dc	0 V dc ²	0.8 V dc
Electron multiplier				
EM voltage	-0 V dc	-3000 V dc	-1400 V dc	12 V dc

¹Selection of filament 1 or filament 2, see text for more information

²Default value is not recommended for actual use, see text for more information

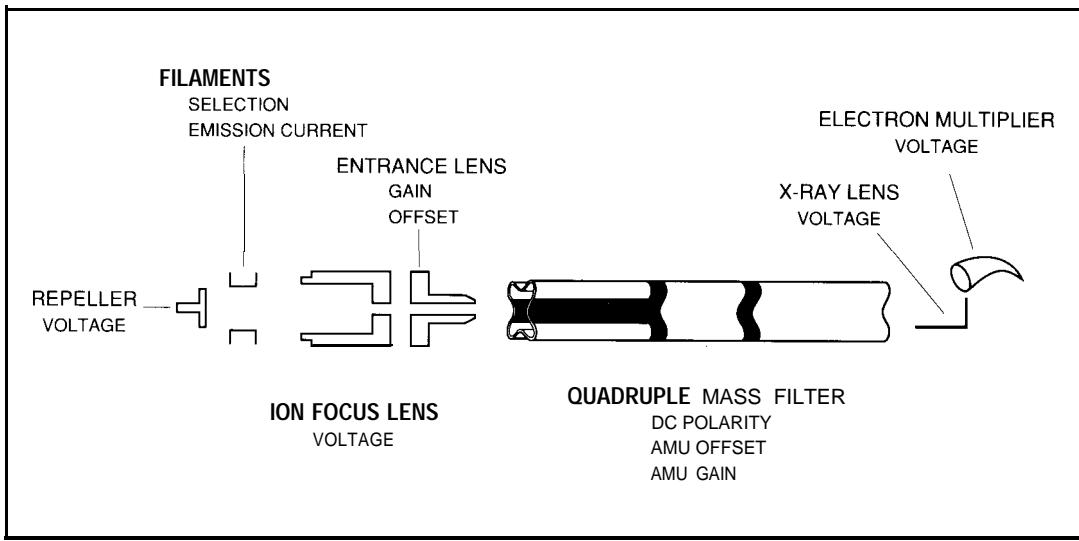


Figure 4-10. Parts affected by tuning

Repeller

A positive voltage is applied to the repeller. This repels positive sample ions, pushing them out of the ion source. The repeller voltage is also known as the ion energy, although in practice the ions only receive a fraction of the repeller energy. A fixed repeller voltage of +15 V is used by the autotune program.

- If the repeller voltage is set too low, too few ions will leave the source, resulting in poor sensitivity and poor high mass response.
- If the repeller voltage is set too high, too many ions at too high a velocity will leave the ion source. This results in a “precursor” (poor mass filtering) and poor low mass resolution.
- If the ion current between the repeller and ground is too high, it indicates there are too many ions in the ion source. This causes an excess source pressure message to be generated.

Filament

The ion source contains two filaments. Only one of these filaments is used at time. There are two parameters that affect the filaments: filament selection and filament emission,

Filament selection — This parameter allows you to select which filament in the ion source is active.

- Filament 1 is also referred to as filament B, and the up filament.
- Filament 2 is also referred to as filament A, and the down filament.

Frequently, one filament will give better performance than the other. The better of the two filaments is noted on the final-test sheet accompanying your MSD.

Note No MSD is shipped until it passes all tests using each filament.

After replacing filaments, it is necessary to determine which filament gives better performance. To do this, run two autotunes, one with each filament. Use the filament that gives the best results.

Caution Use your data system to turn off the MSD electronics (MS off) before you switch filaments. Otherwise, the filament to which you are switching can be damaged by the voltage surge.

Filament emission — The filament emission current is fixed at 200 μ A. The filament emission parameter allows you to turn the filament on or off. Turning the filament off when it is not in use prolongs filament life. Turning the filament off for large solvent peaks can also prevent filament damage. The filament is shut off automatically if there is a general instrument “shutdown” due to excess pressure, excess signal, an RF fault, etc.

Ion focus lens

The ion focus lens focuses the stream of ions exiting the ion source,

- In general, increasing the ion focus voltage improves sensitivity at lower masses. Decreasing the ion focus voltage improves sensitivity at higher masses.
- Poor ion focus adjustment results in poor high mass response.

Entrance lens

The entrance lens is located at the entrance to the quadrupole mass filter. This lens minimizes the fringing fields of the quadrupole which discriminate against high mass ions. Two voltages are applied to the entrance lens. One voltage is fixed, the other voltage varies according to the ion mass currently being passed through the mass filter. In addition, -4.4 V is permanently applied to the entrance lens. This voltage cannot be altered by the operator.

Entrance lens gain — Entrance lens gain controls the variable voltage applied to the entrance lens. It determines how many volts are applied for each amu.

Entrance lens offset — The entrance lens offset controls the fixed voltage applied to the entrance lens.

- Increasing the entrance lens offset generally increases the abundance of ions at low masses without substantially decreasing the abundance of high mass ions.

Mass filter

Typically, the quadrupole mass filter has both an RF-frequency voltage and dc voltage applied to it. There are several parameters that affect the mass filter: dc polarity, amu gain, amu offset, and 219 width.

DC polarity — DC polarity selects the orientation of the direct current applied to the quadrupole mass filter. The value can be positive or negative. The dc polarity that works best for your MSD is determined at the factory and is listed on the final-test sheet accompanying your MSD.

Caution Do not change the physical orientation of the quadrupole mass filter.

AMU gain — AMU gain affects the ratio of dc voltage to RF frequency on the mass filter. This controls the widths of the mass peaks.

- A higher gain yields narrower peaks,
- Amu gain affects peaks at high masses more than peaks at low masses.

AMU offset — AMU offset also affects the ratio of dc voltage to RF frequency on the mass filter.

- A higher offset yields narrower peaks.
- Amu offset generally affects peak widths equally at all masses

219 width — M/z 219 is a prominent mass in PFTBA, the chemical used for autotune. This parameter makes small corrections to the m/z 219 peak width. The correction is electronic this parameter does not apply a voltage to any of the parts in the analyzer. Amu gain and amu offset must be readjusted after the 219 width is changed.

If you are tuning manually with a tuning compound other than PFTBA, there may not be an ion at m/z 219. In that case, set the 219 width to the last value found for it by autotune or set it to 0.

X-ray lens

The x-ray lens is a part of the detector. It directs ions into the electron multiplier horn which is located off-axis from the trajectory of photons, hot neutrals, and electrons coming from the ion source. The optimum x-ray voltage is affected by the electron multiplier setting. For that reason, the electron multiplier voltage is usually set first. Then, the x-ray is ramped to determine the setting that provides the greatest abundance.

Electron multiplier

The electron multiplier is also part of the detector. It usually carries a high negative potential (voltage) which attracts the positive sample ions. The electron multiplier voltage found in autotune should be used as a baseline for the voltage setting.

- To increase sensitivity, increase the electron multiplier voltage.
- For concentrated samples where less sensitivity is needed, decrease the electron multiplier voltage.

The voltage required by the electron multiplier generally increases over time. If the electron multiplier must always be set at 3000 V dc to achieve adequate sensitivity, it may need to be replaced. See the *Troubleshooting* chapter in this manual for more information.

Tuning programs The following tuning programs for the MSD are included in your data system software¹:

- Autotune 4-36
- Quicktune 4-36
- Midmass tune 4-36
- Target tune (DFTPP tune, BFB tune, and target tune) 4-37
- Usertune 4-38
- Manual tune 4-38
- CI autotune 4-39
- CI quicktune 4-39

The manuals supplied with your data system software describe these programs in detail. They also describe how to start the tuning programs, what the tuning programs do, and how to interpret the resulting reports.

The autotune, quicktune, midmass tune, target tune, and CI tune all require perfluorotributylarnine (PFTBA, (C₄F₉)₃N) as the tuning compound. It is a stable chemical that produces fragments throughout the MSD's entire mass range. Once a tune program is initiated, the calibration valve (sometimes known as the PFTBA valve) opens automatically to allow PFTBA to diffuse into the vacuum manifold. The mass spectrum of the PFTBA is then analyzed and used to guide the adjustment of the MSD.

In addition, CI tune requires methane as a reagent gas.

The usertune and manual tune programs provide more flexibility in the choice of tuning compounds. In these programs, the tuning masses are user-selectable so masses can be chosen to correspond to a wide variety of tuning compounds. PFTBA can, and frequently is, used with these programs but other tuning compounds can also be used.

Autotune

Autotune is an automated tuning program for general purpose MSD operation. The autotune program uses the PFTBA ions at m/z 69, 219, and 502. The purpose of the autotune program is to provide acceptable

- Ion abundances
- Peak widths
- Mass assignments
- Relative ion abundances

over the MSD's entire mass range.

Quicktune

Quicktune is a subset of the autotune program. Its operation is identical to the autotune program except that it does not adjust the relative abundances of the tune ions. Quicktune is faster than autotune and is useful in situations where you are not concerned with relative ion abundances or where you are confident that the relative abundances are already correct.

Midmass tune

Midmass tune is another variation of autotune. Midmass tune uses the PFTBA ions at m/z 69, 219, and 264. The purpose of the mid mass tune program is to optimize MSD performance over the low-to-mid mass range. It is especially useful if you are performing selected ion monitoring (SIM) analyses in the low-to-mid mass range.

Target tune

Target tuning is a way to optimize instrument parameters in order to approach the relative abundances between tune ions required for certain environmental methods. There are actually three tuning programs under target tune:

- DFTPP tune
- BFB tune
- Target tune

Each of these uses PFTBA as the tuning compound,

DFTPP tune — Adjusts the abundance ratios of m/z 131, 219, and 502 to meet target values. The goal is to meet the tuning requirements in EPA method 625.

BFB tune — Adjusts the ratio of m/z 131 and 219 to meet target values. The goal is to meet the tuning requirements in EPA method 624.

Target tune — Adjusts the abundance ratios of ions selected by the user to meet target values selected by the user. This program give you the flexibility to tune for other EPA methods.

Note Meeting the EPA requirements for these methods depends on the condition of the ion source and the condition of the GC column and inlet. Hewlett-Packard does not guarantee that these tunes will meet EPA requirements.

Usertune

Usertune is a tuning program which is similar to the autotune program. In usertune, however, you can select some of the initial tuning parameters. These parameters include:

- **Masses**
 - Repeller voltage
 - Entrance lens offset
- **Averages**
 - Tuning compound

This allows you a certain flexibility in customizing a tune for a particular application. Like autotune, however, the usertune program operates without user interaction once it is started.

Manual tune

The manual tune program is normally used when automated tuning programs fail or in situations where none of the other tune programs provide enough flexibility. These situations include tuning for operation over limited parts of the MSD's mass range, tuning for specific chemicals, and tuning for trace-level analysis. Manual tune is much more flexible than autotune but requires more operator expertise.

The manual tune program allows you to select one tuning parameter at a time, alter the value of that parameter, and observe the resulting affect on instrument performance. You can also instruct the instrument to ramp some parameters over a range of values. You can then select the value that provides the best instrument response.

The choice of tuning compound, the tuning ions, the parameters that are adjusted, and the order in which they are adjusted are all up to you.

CI autotune

CI autotune is a special tuning program for MSDs equipped with the HP G1072A Chemical Ionization Accessory.

Note CI autotune and CI quicktune are available only in the DOS-series MS ChemStation software,

The CI autotune requires PFTBA as the tuning compound and methane as the reagent gas. A number of manual adjustments to the methane flow are required before the CI autotune programs can be started. Once it is started, CI autotune program operates like the standard autotune. It uses the PFTBA ions at m/z 69, 219, and 414.

Note Reagent ions at m/z 70 interfere with accurate quantitation of the isotope abundance at that mass. This is normal.

See your data system documentation and the *HP G1072A CI Accessory Hardware Manual* for additional information.

CI quicktune

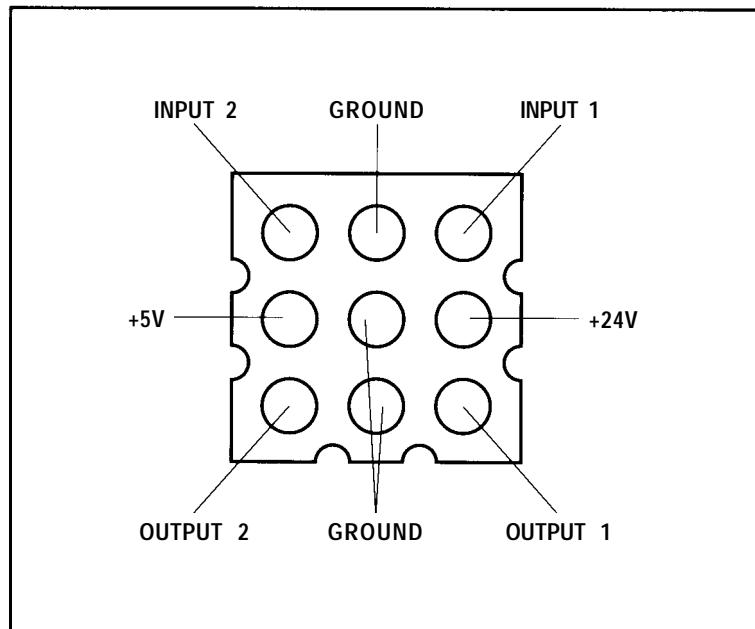
The CI quicktune program is also supplied with the CI accessory. The CI quicktune program has the same relationship to the CI autotune program that the standard quicktune program has to the standard autotune program. The CI quicktune program adjusts ion abundances, peak widths, and mass accuracy but does not adjust relative ion ratios.

Accessory Control

An accessory connector is located immediately above the power cord on the back panel of the MSD. The accessory connector provides an interface through which external devices such as LEDs and solenoids can be powered and controlled. In addition, it provides a path for inputs such as a remote start signal.

Note The APG remote connector (labeled REM) at the top of the MSD back panel is normally used for receiving remote start signals. The accessory connector is can be used for special applications such as GC/iRD/MSD systems or for coordination with instruments that can not communicate on the APG bus.

The accessory connector pin receptacles and their functions are shown in Figure 4-11. For additional information about the accessory connector and its use, refer to the *Technical Reference* appendix.



4-11. Accessory connector

Shutdown and Venting

The MSD must be vented in order to install or replace a capillary column. It must also be vented to perform many maintenance tasks.

The data systems include vent programs which help you shut down the MSD in a safe and orderly manner. You should always use a vent program when shutting down and venting your MSD.

- 1 On your data system, select the vacuum control program. See your data system documentation for more information.
- 2 Select the vent option. This initiates the venting program.
- 3 The data system will display a message instructing you to turn off the GC/MSD heater and GC oven heater. Turn off the GC/MSD heater and turn off the GC oven temperature or reduce the oven temperature setpoint to 30°C.
- 4 After you have turned off the heated zones, the data system will display the diffusion pump status, MS (analyzer) temperature, and foreline pressure. It will also display an estimate of the time it will take the diffusion pump and analyzer to cool.
- 5 When the time remaining reaches 0, or when the program prompts you to do so, switch off the on/off switch on the back of the MSD.

Note You can exit the vent program before it is completed. Exiting the program will not stop the cooling process.

Note We recommend that you wait until the program is completed. If necessary, however, you can safely switch off the instrument and vent as soon as the diffusion pump is cool and the MS temperature is below 100°C.

- 6 Unplug the MSD power cord from its electrical outlet.

- 7 Loosen the nut at the input end of the GC/MSD interface, and withdraw the transfer line (capillary column).

WARNING The nut may still be dangerously hot.

Caution Always vent the system through the GC/MSD interface. Never vent it at the foreline gauge tube or foreline pump. Doffisopm pump fluid or vapor could be carried toward the sensitive analyzer components by the sudden inrush of air. Also, the diffusion pump stack could be misaligned by the inrush of air.

Moving and Storage

If you plan to move your MSD or to not use it for an extended period of time, it is best to take the precautions described in this section.

- 1 Vent the system according to the procedure outlined earlier in this chapter.
- 2 Remove the transfer line (capillary column) from the GC/MSD interface.
- 3 Reinstall the nut and a blank ferrule (0100-0691) on the end of the GC/MSD interface.
- 4 Unplug the GC/MSD interface cable from the G-C and slide the MSD away from the GC.
- 5 Remove the MSD cover and tighten or reinstall the front and rear shipping clamps which hold the top plate in place. Then reinstall the cover.

The MSD is now ready to be moved. If you are going to store the MSD or if more than 24 hours will elapse before you operate it again, follow steps 6 and 7 before moving and storing the instrument. Read the caution below before moving the instrument.

- 6 Turn the MSD back on for 1 minute to re-establish a rough vacuum.
- 7 Turn the MSD off.

The instrument can now be stored or moved. If the instrument is moved, the foreline pump must be moved with the MSD; they can not be disconnected. In any case, take measures to make sure the MSD is never placed on its side or inverted.

Caution Extreme tipping or inverting of the MSD will result in contamination of the vacuum manifold and analyzer by diffusion pump fluid.

Introduction 5-2

Symptoms 5-3

Troubleshooting Procedures 5-64

Introduction

This chapter will help you diagnose problems in the operation of your HP 5971A Mass Selective Detector (MSD). It is divided into two sections:

- Symptoms
- Troubleshooting Procedures

The *Symptoms* section lists symptoms of instrument malfunction. For each symptom are listed many possible causes and the action you should take to further diagnose or correct the cause. Related symptoms are grouped together to make it easier to find the symptom you observe.

The other section, *Troubleshooting Procedures*, includes more in-depth procedure for diagnosing some specific problems such as leaks and contamination.

If the material in this chapter proves insufficient to help you diagnose a problem, contact your Hewlett-Packard Customer Engineer,

Symptoms

This section lists most of the commonly seen symptoms of problems in an HP 5971A MSD. Related symptoms are grouped together in the following categories:

- General symptoms 5-4
- Performance symptoms 5-9
- Pressure symptoms 5-27
- Temperature symptoms 5-28
- Error messages 5-34

General symptoms This section describes symptoms that you may observe during start up and pump down of the MSD. Some of the symptoms may also occur at other times.

- The MSD does not turn on 5-5
- The MSD is on but the fan is not operating 5-6
- The MSD is on but the foreline pump is not operating 5-8

Symptom: The MSD does not turn on

Possible Cause: The MSD on/off switch (circuit breaker) is not on.

Action: Check the MSD on/off switch and make sure it is in the ON (1) position. If not, switch it on. If the on/off switch repeatedly returns to a neutral position (not off or on), it indicates a more serious problem.

Possible Cause: The MSD power cord is not connected to an appropriate electrical outlet.

Action: Check the MSD power cord and make sure it is securely plugged into an appropriate electrical outlet.

Possible Cause: No ac power at the outlet you are using.

Action: Check the outlet, either with a voltmeter or by connecting another device to the outlet and observing whether that device works.

WARNING Only a trained electrician should check the ac power outlet.

Symptom: The MSD is on but the fan is not operating

This refers to a condition where the MSD is on (at least the foreline pump is operating) but the diffusion pump fan is not blowing air out the rear of the instrument.

Possible Cause: There is a bad connection between the fan wiring connector and the power distribution board to which it connects.

Action: Shut down and vent the MSD. Remove the diffusion pump and the fan. Make sure the fan wiring connector is securely connected to the power distribution board (see Figure 5-1).

Possible Cause: The fan is not working correctly.

Action: Shut down and vent the MSD. Remove diffusion pump and then remove the fan. Make sure the fan blades rotate freely. Bad bearings will be noisy or feel rough as the fan turns. Occasionally the fan wires can interfere with the rotation of the fan. Use an ohmmeter to check the resistance of the fan. It should be about 300 ohms in the 110/120 V ac fan or about 900 ohms in the 220/240 V ac fan. The fan must be held still while this measurement is taken; otherwise the resistance value varies as the fan turns. If the fan is bad, replace it.

Possible Cause: The power distribution board is not working properly (this cause is not very likely).

Action: Contact your Hewlett-Packard Customer Engineer.

Figure Not Available

Symptom: The MSD is on but the foreline pump is not operating

This symptom refers to a condition where you can tell the MSD is operating (at least the diffusion pump fan is operating) but the foreline pump is not operating.

Possible Cause: The foreline pump power cord is not plugged into the MSD.

Action: Make sure the foreline pump power cord is securely plugged into the socket on the back of the MSD.

Possible Cause: The foreline pump is malfunctioning.

Action: Replace the foreline pump.

Performance symptoms

Performance symptoms are symptoms that can be observed in the chromatograms and mass spectra generated by tuning or by actual analyses. The following performance symptoms are described in this section.

- Excessive noise 5-10
- High background 5-11
- Improper isotope ratios 5-13
- Inadequate abundance at high masses 5-14
- Inconsistent peak width (narrow or wide peak at m/z 219) 5-16
- Low abundance of m/z 502 5-17
- Low sensitivity 5-19
- Mass assignments incorrect (not m/z 69, 219, 502) 5-22
- Missing isotopes or incorrect isotope abundances 5-23
- Peak widths less than 0.4 amu or greater than 0.6 amu 5-24
- Peaks at m/z 18, 28, and 32 5-25
- Poor repeatability 5-26

Symptom: Excessive noise

This refers specifically to noise that is periodic (although the period may vary) and is approximately equal at all masses.

Possible Cause: The MSD and GC are connected to different power sources whose grounds are not at the same potential. This creates a current path (ground-fault loop) through the GC/MSD interface and analyzer, resulting in excessive noise.

Action: If possible, connect the MSD and GC to the same power source. If this is not possible (for example, because the MSD and GC are set to operate on different voltages), make sure the grounds for the separate power sources are at the same potential.

Possible Cause: One of the detector output cable connections is loose.

Action: Shut down and vent the MSD. Remove the safety cover. Check the connections at both ends of the detector output cable. Tighten the connections if necessary.

Possible Cause: The detector (electron multiplier) electrical connections are loose.

Action: Gain access to the detector (see *Replacing the detector* in the *Maintenance* chapter of this manual for more information). Check and, if necessary, tighten the electrical connections to the detector.

Possible Cause: The detector (electron multiplier) is loose.

Action: Gain access to the detector (see *Replacing the detector* in the *Maintenance* chapter of this manual for more information). Make sure the detector is securely fastened to the ceramic quadruple support at the end of the radiator. Make sure the detector support is securely fastened to the top plate.

Symptom: High background

“Background” is the mass spectrum of all the residual substances that are present in the MSD in the absence of a sample. When a sample is injected, the mass spectrum becomes that of the background plus the sample.

A new system, or one that has been recently vented, is typically rich with background peaks. This type of background tends to decrease with time, eventually reaching acceptable equilibrium values.

The list of possible causes below refers to high background that exists after more than one day under vacuum.

Possible Cause: Air leaks.

Action: See the *Leaks* section later in this chapter,

Possible Cause: Improper cleaning. There are many ways that poor cleaning practices can lead to contamination. Metal parts that are not dried properly will carry solvent into the instrument. Non-metal parts that are accidentally exposed to solvents can continue to release contaminants for a long time. Parts that are handled improperly after cleaning can be recontaminated by fingerprints and other substances.

Action: Be very careful when cleaning the ion source and related component. Make sure metal parts are dried thoroughly before the ion source is reassembled. Never allow the non-metallic parts to come in contact with cleaning solvents. Replace or bake out non-metallic parts that are dirty or are accidentally exposed to solvents. Wear clean gloves when you reassemble the ion source. If you suspect that the ion source was incorrectly cleaned, repeat the process. If necessary, replace the non-metallic parts.

Symptom: High background — continued

Possible Cause: Other contamination.

Action: See the *Contamination* section later in this chapter.

Symptom: Improper isotope ratios

Possible Cause: High background.

Action: Examine the results of your analyses for high background. If you see evidence of high background, see the material on the symptom *High background* earlier in this section.

Possible Cause: The resolution of adjacent peaks is set improperly. Wide peaks sometimes give higher than normal ratios. Narrow peaks sometimes give lower than normal ratios.

Action: Retune your MSD to correct the peak resolution. If this fails to correct the problem with isotope ratios, contact your Hewlett-Packard Customer Engineer.

Symptom: Inadequate abundances at high masses

Possible Cause: Potentials on some of the ion source elements are at the wrong levels. This could be because the instrument was not tuned properly or because there is an open circuit, short, or wrong connection in the ion source.

Action: First try retuning the instrument. If that doesn't help, shut down and vent the MSD, Remove the analyzer and examine the ion source wiring. Make sure there are no loose connections. Make sure no wires are shorted to grounded surfaces. Make sure all wires are connected to the proper terminals,

Possible Cause: The GC oven temperature is too low. This increases the column flow which in turn increases the MSD vacuum pressure.

Action: Increase the GC oven temperature and see if abundances at high masses improve. This is not always an acceptable solution since many GC separations are very temperature-sensitive.

Possible Cause: Excessive column flow.

Action: Check the column flow. The flow into the MSD should not exceed 1.0 ml/min during data acquisition and should never exceed 1.5 ml/min. See *Flow Rates* in the *Operation* chapter for more information.

Possible Cause: The vacuum manifold pressure is too high (greater than 10^4 Torr). This can only be checked if your MSD is equipped with the optional gauge controller.

Action: See the material on the error message *Excessive source pressure* for more information. Refer to the *Gauge Controller* appendix if your MSD is equipped with the optional high vacuum gauge.

Symptom: Inadequate abundances at high masses — continued

Possible Cause: The electron multiplier voltage is too low.

Action: Increase the electron multiplier voltage and see if the sensitivity improves. If it doesn't, or if the electron multiplier voltage is already near its limit, check some of the other possible causes.

Possible Cause: Poor filament alignment.

Action: Use the data system software to select the other filament and retune the MSD. If sensitivity improves, continue to use the new filament.

Caution Use your data system to turn off the MSD electronics (MS off) before you switch filaments. Otherwise, the filament to which you are switching can be damaged by the voltage surge.

Possible Cause: Dirty ion source or electron multiplier.

Action: Shut down and vent the MSD. Remove the analyzer and inspect the ion source. If the ion source is dirty, clean it according to the procedure listed in the *Maintenance* chapter. The electron multiplier seldom looks "dirty". However, if the electron multiplier voltage set by autotune has been at or near the upper limit of 3000 V, it maybe necessary to replace the electron multiplier. See the procedure in the *Maintenance* chapter for more information.

Possible Cause: The quadrupole mass filter is not working correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Inconsistent peak width (narrow or wide peak at m/z 219)

Possible Cause: The width of the peak at m/z 219 is inappropriately set.

Action: Adjust the mid-mass width. GC to the Edit MS Parameters form in the manual tune program. Adjust the 219 width and then readjust the amu gain and amu offset to get peaks which are 0.5 ± 0.03 amu wide. Before leaving manual tune, save the new settings to your autotune file. See your data system documentation for more information.

Possible Cause: The MSD and gas chromatography grounds are at different potentials, resulting in a ground fault loop.

Action: Have a qualified electrician check the grounds and make sure they are at the same potential or contact your Hewlett-Packard Customer Engineer.

Possible Cause: The quadrupole mass filter is not operating correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: Either the top board or main board is not working correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Low abundance of m/z 502

This material also applies to autotune results which show adequate m/z 502 abundance but a noisy baseline in the m/z 502 profile.

Possible Cause: Less than 8 hours have elapsed since the MSD was turned on. Contaminants which interfere with high mass sensitivity are still present in the instrument.

Action: Wait until at least 8 hours have elapsed since the instrument was turned on and then try autotune again.

Possible Cause: Poor vacuum (possibly air or water present).

Action: After you turn on the MSD, allow at least 8 hours with the GC/MSD interface heater on and set to at least 250°C to bake out contaminants. If the problem persists, check for small air leaks in the vacuum system. See Leaks later in this chapter for more information.

Possible Cause: Too much column flow.

Action: Make sure the column flow rate is not more than 1.0 ml/min. As a further test, obstruct the GC column at the injection port end, and observe whether the condition changes. A simple way to obstruct the column is to stick the injection port end of the column into a septum. When you have finished this test, be sure to score and break off the end of the column before reinstalling it in the injection port. This will ensure that the column is not blocked with septum material.

Symptom: Low abundance of m/z 502 — continued

Possible Cause: The filament is not working properly.

Action: Use the data system software to switch to the other filament.

Caution Use your data system to turn off the MSD electronics (MS off) before you switch filaments. Otherwise, the filament to which you are switching can be damaged by the voltage surge.

If the new filament works, delay replacing the old filament until the next time you vent the MSD. It will be necessary to retune the MSD with the new filament before acquiring data.

Possible Cause: The less effective of the two dc polarities has been selected.

Action: Use the data system software to reverse the dc polarity on the quadruple mass filter.

Possible Cause: The ion source is dirty.

Action: Clean the ion source according to the procedure in the *Maintenance* chapter.

Possible Cause: Your instrument's quadruple mass filter is defective.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Low sensitivity

Possible Cause: The gas chromatography is not performing correctly.

Action: Consult the documentation supplied with your G-C.

Possible Cause: The GC injection type (split or splitless) specified in the data acquisition program does not match the injection being used.

Action: Check your data system's data acquisition and make sure the correct type of GC injection is specified.

Possible Cause: An air leak.

Action: See the *Leaks* section later in this chapter.

Possible Cause: The last autotune was not successful.

Action: Repeat autotune. Data acquisition should never be attempted if the instrument is not operating well enough to pass autotune or allow a satisfactory manual tune.

Possible Cause: A valid tune file was not specified when the data acquisition parameters were established.

Action: Make sure the tune file (autotune or manual tune) specified in the data acquisition software is a valid file.

Possible Cause: The electron multiplier voltage is too low.

Action: Increase the electron multiplier voltage and see if the sensitivity improves. If it doesn't, or if the electron multiplier voltage is already near its limit, check some of the other possible causes.

Symptom: Low sensitivity — continued

Possible Cause: Dirty ion source or detector.

Action: Shut down and vent the MSD. Remove the analyzer and inspect the ion source. If the ion source is dirty, clean it according to the procedure listed in the *Maintenance* chapter. The detector seldom looks “dirty”. However, if the electron multiplier voltage set by autotune has been at or near the upper limit of 3000 V, it may be necessary to replace the detector. See the procedure in the *Maintenance* chapter for more information.

Possible Cause: Poor filament alignment.

Action: Use the data system software to select the other filament and retune the MSD. If sensitivity improves, continue to use the new filament.

Caution Use your data system to turn off the MSD electronics (MS off) before you switch filaments. Otherwise, the filament to which you are switching can be damaged by the voltage surge.

Possible Cause: Wrong dc polarity on the quadruple mass filter.

Action: Use the data system software to reverse the polarity on the quadruple. If sensitivity improves, continue to use the new quadruple polarity.

Possible Cause: The column in the GC/MSD interface is not installed correctly.

Action: Check the GC column connections and make sure it is installed correctly. See the *Operation* chapter for more information about installing a GC column.

Symptom: Low sensitivity — continued

Possible Cause: The instrument temperature is too low.

Action: Use the data system software to check the GC/MSD interface and ion source temperatures. The GC/MSD interface temperature should be between 250° and 320°C. The MS temperature should be at least 150°C. See the *Heated Zones* section in the *Operation* chapter of this manual for more information.

Possible Cause: The vacuum manifold pressure is too high (greater than 10^{-4} Torr). This can only be checked if your MSD is equipped with the optional high vacuum gauge.

Action: See the material on the error message *Excessive source pressure* for more information. Refer to the *Gauge Controller* appendix if your MSD is equipped with the optional high vacuum gauge.

Symptom: Mass assignments incorrect (not m/z 69,216, 502)

Small (acceptable) shoulders in the mass peaks can cause ± 0.1 amu shifts in mass assignments. Shifts greater than ± 0.2 amu indicate a serious problem.

Possible Cause: The instrument electronics are not working properly.

Action: Contact your Hewlett-Packard Customer Engineer or replace (one at a time) the top board and main board and see if the problem disappears.

Possible Cause: The quadrupole mass filter is not working correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Missing isotopes or incorrect isotope abundances

Possible Cause: The MSD is not tuned correctly.

Action: Try retuning the MSD.

Possible Cause: High background (m/z 70 is very sensitive to high background). High background is most common when the MSD is first pumped down after it has been open to the atmosphere.

Action: Give the instrument plenty of time to pump down with the GC/MSD interface heater on after it has been open to the atmosphere. This is especially true if parts such as the ion source were cleaned.

Possible Cause: The ion source is dirty.

Action: Clean the ion source according to the instructions in the *Maintenance* chapter.

Possible Cause: Your instrument's detector is not working properly.

Action: Contact your Hewlett-Packard Customer Engineer or replace the detector and see if the problem disappears.

Possible Cause: Your instrument's quadrupole mass filter is not working properly,

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Peak widths less than 0.4 amu or greater than 0.6 amu

Possible Cause: The amu gain or amu offset is inappropriately set.

Action: Rerun autotune. If that doesn't help, go to the Edit MS Parameters form in the manual tune program. Adjust the amu gain and amu offset to get peak widths of 0.5 ± 0.03 amu.

Possible Cause: The instrument electronics are not working correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: Your instrument's quadruple mass filter is not working properly.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: Peaks at m/z 18,28, and 32

Possible Cause: Air leak. These are the classic peaks seen when an MSD has an air leak.

Action: See the *Leaks* section later in this chapter.

Symptom: Poor repeatability

Possible Cause: Variations in temperature, flow rate, and pressure.

Action: Make sure the MSD is located in an environment where the temperature is stable. Keep it out of drafts and direct sunlight. Make sure you have a steady, well-regulated supply of carrier gas. Keep the foreline pump and diffusion pump well serviced.

Possible Cause: Loose connections within the analyzer.

Action: Shut down and vent the MSD. Check the external analyzer wiring connections. Then, remove the analyzer and check all of the internal analyzer wiring connections. Make sure they are all secure.

Possible Cause: The MSD and gas chromatography grounds are at different potentials, resulting in a ground-fault loop.

Action: Have a qualified electrician check the grounds and make sure they are at the same potential or contact your Hewlett-Packard Customer Engineer.

Possible Cause: Intermittent failure in the electronics.

Action: Contact your Hewlett-Packard Customer Engineer.

Pressure symptoms

Abnormal pressure in the vacuum system is sometimes an indication of a problem with the MSD. In the standard MSD, pressure is monitored by the foreline vacuum gauge. It is also monitored indirectly by monitoring the ion current between the repeller and ground. This is proportional to the ion source pressure. In both cases, an abnormal pressure reading will generate an error message. For more information about pressure symptoms, refer to the *Error message* section later in this chapter.

If your MSD is equipped with the optional ionization gauge controller, you can directly monitor the pressure in the vacuum manifold. For information about pressure symptoms that can be observed with the ion gauge controller, refer to the *Gauge Controller* appendix.

Temperature symptoms The MSD has several temperatures that are monitored.

The GC/MSD interface temperature is monitored and controlled by the GC (GC detector B). You can check this temperature through the data system or from the keypad on the front of the GC.

The analyzer temperature in the MSD is monitored by the data system where it is called the MS temperature. You can check this temperature through the data system.

In addition, there are thermal switches on the diffusion pump that cause the pump to be switched off if it gets too hot or too cold. The diffusion pump temperature can not be monitored by the operator.

Some temperature problems will cause an error message to be generated. Others can be observed by the operator. The following symptoms are described in this section:

“ The analyzer (MS) temperature is too low 5-29

For additional temperature-related symptoms, refer to the *Error messages* section later in this chapter.

Symptom: The analyzer temperature is too low

The analyzer is conductively heated by the GC/MSD interface. Figure 4-8 in the *Operation* chapter of this appendix shows the relationship between GC/MSD temperature and analyzer (MS) temperature. If the analyzer temperature is outside the range listed in Figure 4-8 for a given GC/MSD interface temperature, one of the following may be the cause:

Possible Cause: It has been less than 4 hours since the GC/MSD interface heater was turned on. The analyzer is heated indirectly by the GC/MSD interface. It requires at least 4 hours to reach thermal equilibrium after the GC/MSD interface is turned on.

Act Wait until at least 4 hours have passed since the GC/MSD interface heated was turned on before tuning or acquiring data. It is better if even more time has passed; overnight is ideal.

Possible Cause: A fault in the GC has caused the detector B heated zone (the one that powers the GC/MSD interface heater) to be turned off.

Action: Check your GC and make sure the detector B heated zone is still operating correctly.

Possible Cause: Poor thermal contact between the GC/MSD interface and the interface socket on the analyzer. This can be caused by dirty or damaged contact surfaces. It can also be caused by poor alignment of the contact surfaces or by an interface socket that is not fully threaded into the radiator.

Action: Shut down and vent the MSD. Move the MSD away from the GC and give the GC/MSD interface time to cool.

WARNING The GC/MSD interface maybe extremely hot. Do not touch it until it has had time to cool.

Symptom: The analyzer temperature is too low — continued

Loosen the KF clamp and remove the GC/MSD interface from the MSD. Inspect the GC/MSD interface surface that contacts the interface socket (see Figure 5-2). It should be clean and smooth with no dents or scratches (the interface shown in Figure 5-2 is damaged). If the interface is dirty, it should be cleaned and if it is damaged it should be replaced.

Next, remove the analyzer assembly from the vacuum manifold. Inspect the interface socket (see Figure 5-3). It should be firmly threaded into the radiator. The inner surface of the socket should be clean and have no dents or scratches.

Figure Not Available

Symptom: Analyzer temperature too low — continued

Possible Cause The GC/MSD interface heater sleeve is not tightly clamped to the interface assembly.

Action: Shut down the and vent MSD, Move the MSD away from the GC. Remove the insulation from around the GC/MSD interface (see Figure 5-4).

WARNING The GC/MSD interface may be extremely hot. Do not touch it until it has had time to cool.

Under the insulation is the interface heater sleeve, a two-part aluminum sleeve held together by four screws. Make sure the sleeve is tight; you should not be able to rotate or move it. If the sleeve is not tight, tighten it. Try to apply the same torque to each screw.

Figure Not Available

Error messages The error messages listed are messages that your data system generates based on hardware status codes from the MSD. Some messages will appear only when your data system is in the tuning mode. Other messages will appear in tune and data acquisition.

Note The exact wording of error messages may vary from one data system to another.

Some error messages are “latched” error messages which remain active in your data system even if the condition that generated the message has corrected itself. If the underlying cause is removed, these messages can be cleared by checking instrument status through the data system. See the documentation supplied with your data system for information about checking instrument status. The following error messages are covered in this section.

- Can not achieve constant peak widths 5-35
- Difficulty in the mass filter electronics 5-36
- Difficulty with the detector HV supply 5-37
- The diffusion pump is or was too hot 5-39
- The diffusion pump is too cold 5-41
- Excessive source pressure 5-47
- The foreline pressure has exceeded 300 mTorr 5-49
- Gain and offset = 0 and peaks are too wide 5-52
- Mass spectrometer 1/0 check failure 5-53
- MS does not respond 5-54
- No peaks found 5-56
- Serious error occurred during data acquisition 5-57
- There is no emission current 5-58
- There is not enough signal to begin tune 5-60
- There was an excessive signal level 5-62

Error message: Can not achieve constant peak widths

Possible Cause The initial tuning parameter settings are too far from the correct settings,

Action: Use the manual tune program to find initial settings which are closer to being correct. Then, either finish tuning manually or use the values as a starting point for autotune.

Possible Cause There is no PFTBA in the calibration vial.

Action: Check the calibration vial and, if necessary, add PFTBA, See *Filling the calibration vial* in the *Maintenance* chapter.

Possible Cause One of the detector cable connections is loose.

Action: Make sure the detector cable connections are secure.

Possible Cause The calibration valve is defective.

Action: Listen for a click when the valve is supposed to operate. If you don't hear the click either the valve or the electronics controlling it are not working properly,

This is a latched message.

Possible Cause: The RF coils **are** not properly tuned (dipped).

Action: Contact your Hewlett-Packard Customer Engineer or refer to the *Top Board* chapter in the *Technical Reference* appendix.

Possible Cause: A mass filter lead is open or grounded.

Action: Shut down and vent the MSD. Remove the analyzer. Inspect the mass filter leads. Make sure the leads are all connected and they are not touching the top plate or another grounded surface. Reconnect or reposition the leads as necessary.

Possible Cause: Defective quadruple mass filter. If the mass filter is physically broken, the RF fault will probably be persistent for all amu settings above 100. Otherwise, the fault will probably occur at the upper end of the mass range.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: Defective circuits in the main board or top board.

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: Difficulty with the detector HV supply

This message is generated when the voltage supplied to the electron multiplier is less than that specified by the data system. HV fault does not occur if the voltage supplied is greater than that specified by the data system. However, the error message *There was an excessive signal level* will tend to occur in that case.

Possible Cause: A defective or shorted detector (electron multiplier).

Action: Shut down and vent the MSD. Remove the analyzer. Look at the detector connections. Verify that the high voltage lead is connected to the proper pin (see Figure 5-5) and that it is not shorted to the vacuum chamber wall, top plate, or the electron multiplier frame.

Possible Cause: Defective electronics.

Action: Set the electron multiplier voltage to 0, and read the MS status. If the fault persists, the problem is probably on the main board. Set the high voltage to greater than 1000 V. If the fault returns, the problem is probably in the top board or in the wiring in the vacuum manifold. See your data system manual for more information.

Figure Not Available

Error message: The diffusion pump is or was too hot

This is a latched error message.

Possible Cause: The environment in which the MSD is operating is too hot.

Action: Do not operate the MSD in an environment in which the temperature is above 35°C. See *Physical Specifications* in the *General Information* chapter.

Possible Cause: The air intakes to the MSD are blocked.

Action: Inspect your MSD and make sure the vent slots on the side and bottom of the instrument are not covered or blocked.

Possible Cause: The fan is not operating correctly.

Action: Check for air flow behind the instrument. If there is no air flow or if the air flow is very weak, the fan is not operating correctly. See the symptom *The MSD is on but the fan is not operating* earlier in this chapter.

Possible Cause: The diffusion pump fluid level is too low.

Action: See *Checking and replacing the diffusion pump fluid* in the *Maintenance* chapter.

Possible Cause: The diffusion pump cable is not firmly connected to the power distribution board.

Action: Shut down and vent the MSD. Remove the diffusion pump and fan. Make sure the diffusion pump cable connector is securely connected to the power distribution board.

Error message: The diffusion pump is or was too hot — continued

Possible Cause: The too hot (upper) thermal switch is defective.

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: The diffusion pump is too cold

This message means that the diffusion pump temperature is below its minimum operating temperature. There are many possible causes for this error message. The troubleshooting tree in Figure 5-6 helps to narrow and categorize the possible causes. Refer to the troubleshooting tree and the list of possible causes when diagnosing this error message.

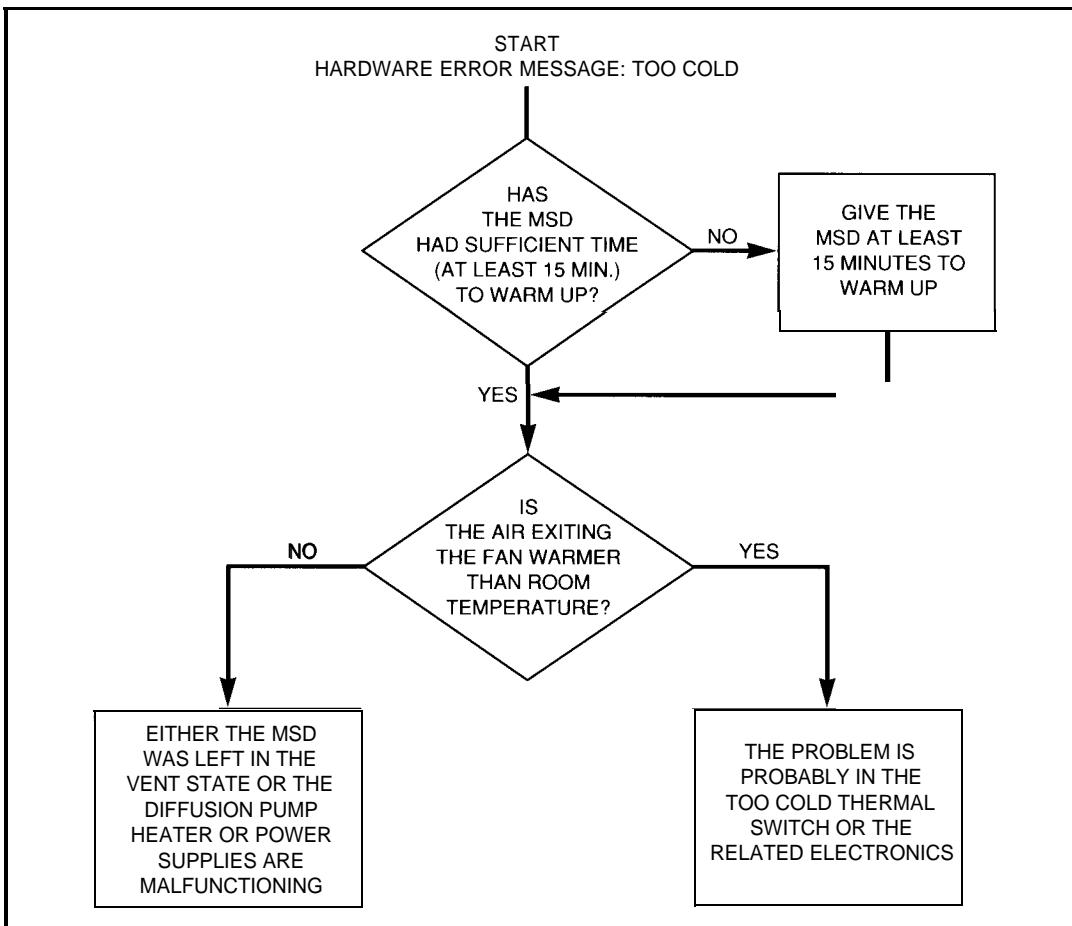


Figure 5-6. Too cold troubleshooting tree

Error message: The diffusion pump is too cold — continued

Possible Cause: The diffusion pump has not yet had time to reach operating temperature.

Action: At a room temperature of 25°C, the diffusion pump takes 10-15 minutes to reach operating temperature. If the room is cooler, it takes a little longer. Be sure to give the diffusion pump enough time to warm up.

Possible causes related to the thermal switch

Possible Cause: The thermal switch is not making solid contact with the diffusion pump.

Action: Shut down and vent the MSD. Allow the diffusion pump to cool. Make sure the screws which hold the thermal switch in place are tight. A commercial heat sink compound should be used between the thermal switch and the diffusion pump.

Possible Cause: The thermal switch is defective (open).

Action: Use a screwdriver or short piece of wire to connect the two terminals of the thermal switch. If the pump is hot and the message disappears, then the switch is bad and it should be replaced. Contact your Hewlett-Packard Customer Engineer.

Possible Cause: The diffusion pump cable (which includes the thermal switch wires and the diffusion pump heater wires) is not firmly connected to the power distribution board.

Action: Shut down and vent the MSD. Remove the diffusion pump and the fan. Check the connector (see Figure 5-7). Make sure the connector is firmly seated.

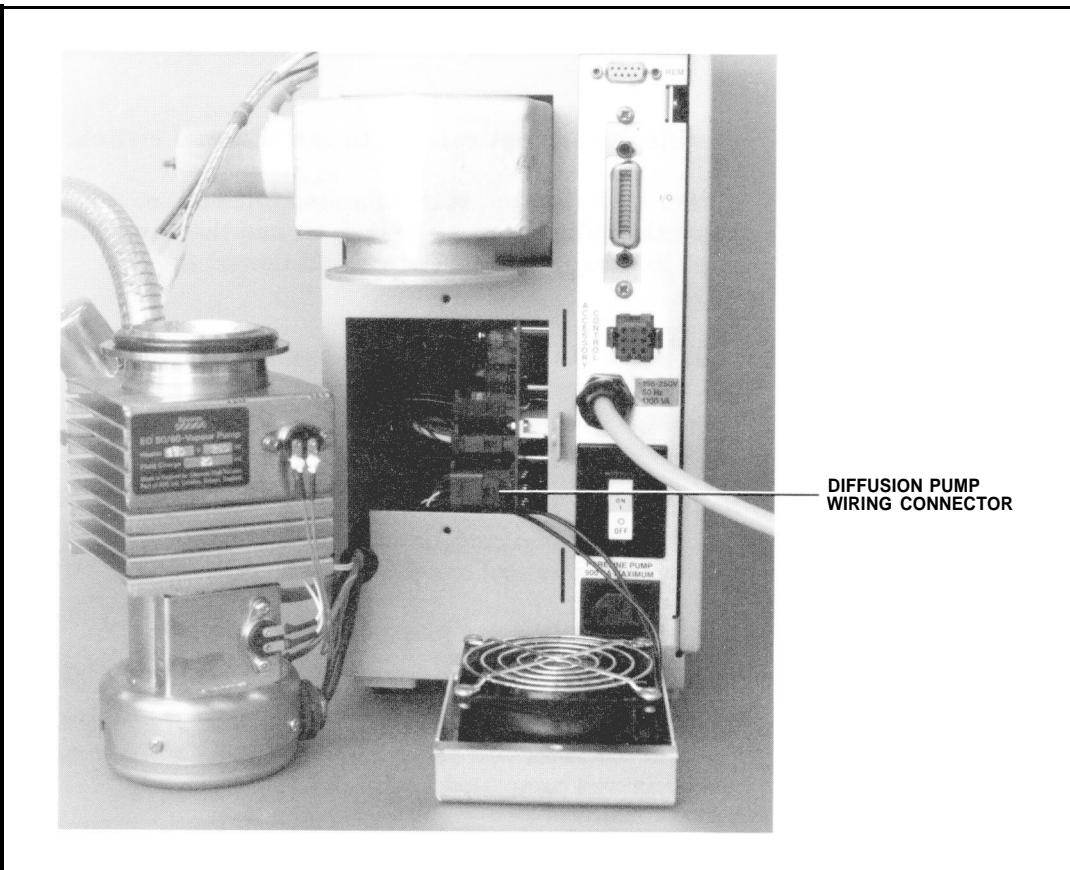


Figure 5-7. Diffusion pump cable connector

Possible Cause: The electronic which sense the thermal switch are not working properly (this cause is not very likely).

Action: Contact your Hewlett-Packard Customer Engineer.

Possible causes not related to the thermal switch

Possible Cause: Another fault (too hot, excess foreline pressure, etc.) has caused the diffusion pump to turn off and the pump has cooled to enough to close the too cold (lower) thermal switch,

Action: If this is the cause, another error message (too hot, excess foreline pressure) should appear along with the too cold message. Look up the other message in this chapter and correct the causes of that message.

Possible Cause: The diffusion pump cover is off. This can allow the diffusion pump to cool too efficiently.

Action: Make sure the diffusion pump cover is installed.

Possible Cause: Data system software is still in the vent mode because the last time the MSD was vented, it was turned off before the vent cycle was completed.

Action: Enter the pumpdown mode. See *Startup and Pumpdown* in the *Operation* chapter for more information.

Possible Cause: The voltage of the ac line power dropped below the minimum allowed voltage for more than 4 seconds. This caused the diffusion pump heater circuitry to turn off and stay off.

Action: Turn the MSD on/off switch (circuit breaker) off and, after a few seconds, back on. This should reset the diffusion pump heater circuitry. If this happens repeatedly, check your ac power source.

Error message: The diffusion pump is too cold — continued

possible Cause: The diffusion pump cable is not firmly connected to the power distribution board.

Action: Shut down and vent the MSD. Remove the diffusion pump and fan. Make sure the diffusion pump cable connector is securely connected to the power distribution board (see Figure 5-7).

Possible Cause One or both of the fuses for the diffusion pump heater circuitry have blown.

Action: Refer to the *Diffusion Pump* chapter in the *Technical Reference* appendix for information on checking and replacing the diffusion pump fuses.

Possible Cause: The diffusion pump heater has failed.

Action: Shut down and vent the MSD. Remove the diffusion pump and the fan. Unplug the diffusion pump cable connector from the power distribution board. Use an ohmmeter to measure the resistance of the diffusion pump heater (see Figure 5-8). Heater resistance should be about 32 ohms for a 110/120 V ac heater or 130 ohms for a 220/240 V ac heater. If the heater is shorted or open, replace the diffusion pump or contact your Hewlett-Packard Customer Engineer.

Possible Cause: The power distribution board or some other electronic board is not working correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

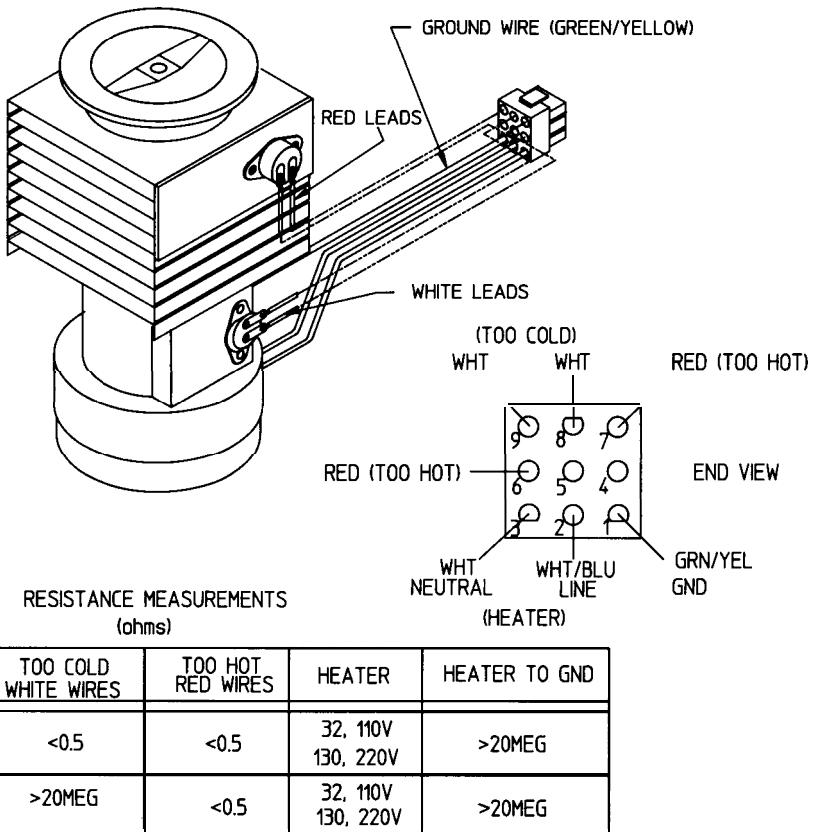


Figure 5-8, Diffusion pump wiring

Error message: Excessive source pressure

This message means the ion source pressure is too high. It is determined indirectly by measuring the ion current between the repeller and ground. A current greater than 2 microamps indicates excess ion source pressure. This is a latched error message.

Possible Cause: Air leak.

Action: See the *Leaks* section later in this chapter.

Possible Cause: A large solvent peak.

Action: Program the MSD electronics to stay off during the solvent peak. Check your data system manuals for more information.

Possible Cause: The calibration vial was recently refilled. It is normal to see this message the first few times the valve is used after the vial is refilled.

Action: The message should not appear after the first few of tunes. If the message continues to appear, check the other possible causes.

Possible Cause: The calibration vial is overfilled or defective.

Action: Check the calibration vial and make sure it is not overfilled. There should always be at least 1/4 inch between the fluid level and the top of the vial. See *Filling the calibration vial* in the *Maintenance* chapter for more information. Also make sure that the O-ring around the vial is in good condition and that the knurled nut is tight.

Error message: Excessive source pressure — continued

Possible Cause: The diffusion pump is not operating.

Action: Look for other signs that the diffusion pump is not operating (e.g., the air exiting the instrument is cool). See the error message *Too cold* earlier in this section for possible reason the diffusion pump is not operating.

Possible Cause: The repeller is shorted to ground. This is most common immediately after the vacuum chamber has been open for maintenance. During reassembly or reinstallation, the repeller wire is accidentally placed in contact with a grounded surface.

Action: Shut down and vent the MSD. Remove the analyzer. Inspect the repeller wire. Carefully position the repeller wire so that it doesn't make contact with anything except its normal contacts. A short can also be caused by a "sliver" of metal in the ion source, probably between the repeller and the repeller mounting plate.

Possible Cause: The ion source is dirty.

Action: Clean the ion source as described in *Cleaning the ion source* in the *Analyzer Maintenance* section of the *Maintenance* chapter in this appendix. Pay particular attention to the ion source body.

Possible Cause: A malfunction somewhere in your instrument's electronics

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: The foreline pressure has exceeded 300 mTorr

Possible Cause: The foreline pump is not on.

Action: Make sure the foreline pump is securely plugged into the outlet on the MSD. If the foreline pump is plugged in but still not operating, refer to the symptom *The MSD is on but the foreline pump is not operating* earlier in this chapter. If the foreline pump has failed, it maybe necessary to replace it.

Possible Cause: The foreline vacuum gauge is unplugged.

Action: Check the blue plastic connector on the bottom of the foreline gauge tube. Make sure it is firmly connected to the foreline gauge tube.

Possible Cause: The GC column is broken.

Action: Examine the GC column and replace it if necessary.

Possible Cause: A substantial leak in the vacuum system (foreline pump exhaust flow greater than 1 ml/min).

Action: Turn off the instrument. Visually inspect the foreline hose, foreline trap, GC/MSD interface nut, KF fittings, and top plate seal. See the *Leaks* section later in this chapter for more information.

Possible Cause: The hose between the diffusion pump and the foreline pump has collapsed.

Action: Check the hose. If it has collapsed, shutdown and vent the MSD. Replace the hose.

Error message: The foreline pressure has exceeded 300 mTorr — continued

Possible Cause: The adsorbent pellets in the foreline trap are saturated with water or pump fluid.

Action: Shut down and vent the instrument as described in the *Operation* chapter.

Caution The MSD must be vented before the foreline trap is opened. Otherwise, diffusion pump oil will be back-streamed into the vacuum manifold and contaminate the analyzer.

Open the foreline trap and replace the pellets with new ones that have been baked out. See *Replacing the foreline trap pellets* in the *Maintenance* chapter for more information.

Possible Cause: The foreline vacuum gauge is defective.

Action: If you have access to another foreline pump which you know works properly, substitute it for the current foreline pump (the MSD must be shut down and vented before the substitution can be made). If the message returns, the foreline vacuum gauge is defective and should be replaced. If you do not have access to another foreline pump, replace the foreline vacuum gauge and see if the message reappears. See *Replacing the foreline vacuum gauge* in the *Maintenance* chapter for more information.

Error message: The foreline pressure has exceeded 300 mTorr — continued

Possible Cause: The foreline pump is working but not providing enough vacuum.

Action: Shut down and vent the MSD. Disconnect the foreline vacuum gauge fitting from the diffusion pump. Do not disconnect the gauge tube. Use a rubber stopper to plug the fitting. Turn on the MSD. The foreline vacuum gauge will still work, so you can measure the vacuum capability of the foreline pump and foreline hose alone. If the vacuum fails to fall below 0.3 Torr (300 mTorr), then the foreline pump is defective and should be repaired or replaced.

Error message: Gain and offset .0 and peaks are too wide

Possible Cause: There is no PFTBA in the calibration vial.

Action: Check the calibration vial and, if necessary, add PFTBA. See *Filling the calibration vial* in the *Maintenance* chapter for more information.

Possible Cause: The calibration valve is defective.

Action: Listen for a click when the valve is supposed to operate. If you don't hear the click, either the valve or the electronics controlling it are not working properly. Contact your Hewlett-Packard Customer Engineer or refer to the *Calibration Valve* chapter in the *Technical Reference* appendix for more information.

Possible Cause: The MSD and gas chromatography grounds are at different potentials, resulting in a ground-fault loop.

Action: Have a qualified electrician check the grounds and make sure they are at the same potential or contact your Hewlett-Packard Customer Engineer.

Possible Cause: A failure somewhere in your instrument electronics.

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: Mass spectrometer 1/0 check failure

Possible Cause: The cable between the MSD and data system has a bad or loose connection at one or both ends.

Action: Check both cable connectors. If necessary, clean the connector contacts or tighten the connector screws.

Possible Cause: Defective cable between MSD and data system.

Action: Replace the cable and see if the message returns.

Possible Cause: No connection or an improper connection between the HP-IB/MS control card and the HP-IB connector on the back panel of the MSD.

Action: Shut down and vent the MSD. Remove the cover of the MSD and remove the safety cover. Make sure the cable between the HP-IB/MS control card and the HP-IB connector is securely connected at both ends.

Possible Cause: The HP-IB/MS control card in the MSD is defective.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: An electronic board in the MSD (besides the HP-IB/MS control card) is defective.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: The communication interface board in the data system is not functioning correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: MS does not respond

Possible Cause: The MSD is not powered up.

Action: Make sure the MSD is powered up.

Possible Cause: The cable between the MSD and the data system is missing.

Action: Make sure the appropriate cable is connected between the MSD and the data system.

Possible Cause: One of the cable connections between the MSD and the data system is loose or bad.

Action: Check both cable connectors; clean the connector contacts or tighten the connector screws if necessary.

Possible Cause: No connection or an improper connection between the HP-IB/MS control card and the HP-IB connector on the back panel of the MSD.

Action: Shut down and vent the MSD. Remove the cover of the MSD and remove the safety cover. Make sure the cable between the HP-IB/MS control card and the HP-IB connector is securely connected at both ends.

Possible Cause: Defective cable between the MSD and the data system.

Action: Replace the cable and see if the message returns.

Possible Cause: The +5 V dc power supply is defective.

Action: Contact your Hewlett-Packard Customer Engineer or refer to the *Power Supply* chapter in the *Technical Reference* appendix for more information.

Error message MS does not respond — continued

Possible Cause: The HP-IB/MS control card in the MSD is not functioning correctly.

Action: Contact your Hewlett-Packard Customer Engineer.

Possible Cause: The communication interface in your data system is defective.

Action: Contact your Hewlett-Packard Customer Engineer.

Error message: No peaks found

*See the error message: **There is not enough signal to begin the tune.***

Error message: Serious error occurred during data acquisition

Possible Cause: This message indicates that something has caused the MSD to generate a fault signal. Almost anything which can cause the MSD to generate a fault could be the cause of this message.

Action: Run autotune or manual tune. If the problem is with the MSD hardware, a more specific error message should appear during tuning or the tuning results themselves should be unusual. If everything is fine during tuning, refer to the other possible causes listed below.

Possible Cause: Too much sample was injected. This will cause the ion source pressure to be too high, the vacuum manifold pressure to be too high, or it will overload the electron multiplier.

Action: Reduce the amount of sample injected into the GC.

Possible Cause: The solvent delay is set incorrectly and the solvent peak is overloading the vacuum system or the electron multiplier.

Action: Check your data acquisition results and the solvent delay setting in your data system software. Make sure data acquisition starts after the solvent peak elutes. Refer to the *There was an excessive signal level* and *Excessive source pressure* error messages for more information.

Error message: There is no emission current

This message indicates that power is being sent to a filament, but there are no electrons being emitted from that filament.

If the filament has just been turned on, the fault circuitry allows enough time for the filament to warm up before testing whether there is sufficient emission. Therefore, this message should not be caused by the instrument not having enough time to warm up.

Possible Cause: The filament cable is not connected.

Action: Remove the cover of the MSD. Make sure the filament cable is firmly connected at both ends. The filament cable is the twisted pair of thick white wires near the front of the MSD.

Possible Cause: The selected filament is burnt out or the filament lead is not connected inside the vacuum chamber.

Action: Use your data system software to select the other filament.

Caution Use your data system to turn off the MSD electronics (MS off) before you switch filaments. Otherwise, the filament to which you are switching can be damaged by the voltage surge.

If the new filament works, delay replacing the bad filament (or connecting the lead) until the next time you vent the MSD. Retune the MSD with the new filament before acquiring data.

Error message: There is no emission current — continued

Possible Cause: The filament is shorted to ground.

Action: Contact your Hewlett-Packard Customer Engineer or refer to the *Top Board* chapter in the *Technical Reference* appendix for more information.

Possible Cause: Defective filament drive circuit on main board, defective filament cable or defective K3 relay on top board.

Action: Contact your Hewlett-Packard Customer Engineer or refer to the appropriate chapters in the *Technical Reference* appendix for more information.

Possible Cause: Defective error reporting circuitry.

Action: Contact your local Hewlett-Packard Customer Engineer.

Error message: There is not enough signal to begin the tune

Possible Cause: The amu (mass) calibration is so poor that the actual mass peak does not fall within the window assigned to that mass.

Action: Use the manual tune program to widen the window. See your data system manual for more information.

Possible Cause: There is no PFTBA in the calibration vial.

Action: Check the vial on the calibration valve. If it is empty, fill it according to the procedure listed in the Maintenance chapter.

Possible Cause: The detector cable is either not connected or not connected correctly.

Action: Shut down and vent the MSD. Remove the main cover and then remove the safety cover. Check both ends of the detector cable and make sure the connections **are secure**. A 5/16-inch wrench maybe required to tighten the top board end of the cable.

Possible Cause: The detector is not connected or not properly connected.

Action: Shut down and vent the MSD. Remove the analyzer from the vacuum manifold. Make sure all the leads to the detector are properly connected.

Possible Cause: The ion source is not connected or not connected properly.

Action: Shutdown and vent the MSD. Remove the analyzer from the vacuum manifold. Make sure all the leads to the ion source are properly connected.

Error message: There is not enough signal to begin the tune — continued

Possible Cause: The threshold command is ineffective.

Action: Set the defaults and repeat autotune.

Possible Cause: Increased vacuum manifold pressure can interfere with high mass signals before the pressure becomes high enough to generate its own error message.

Action: Look for peaks characteristic of air in your mass spectra. See *Leaks* later in this chapter for more information. If the pressure is too high, there maybe no peaks at all.

Possible Cause: The calibration valve is not working properly.

Action: Listen for a click when the valve is supposed to operate. If you don't hear a click either the valve or the electronics controlling it is not working properly. Contact your Hewlett-Packard Customer Engineer or refer to the *Calibration Valve* chapter in the *Technical Reference* appendix for more information.

Possible Cause: The detector is not working correctly.

Action: Increase the electron multiplier voltage to 3000 V by 100-V increments. If the message persists, and you have ruled out the other possible causes, it may be necessary to replace the detector.

Error message: There was an excessive signal level

This error message is generated when the detector (electron multiplier) output is greater by a factor of 10 than the value the analog-to-digital converter (ADC) can convert. This is a latched error message.

Possible Cause: Excessive electron multiplier voltage.

Action: Reduce the electron multiplier voltage. If the fault goes away, continue to run the electron multiplier at a lower voltage.

Possible Cause: A large peak such as a solvent peak has eluted.

Action: Program the detector (electron multiplier) to turn off when a large peak such as a solvent peak is expected. See your data system documentation for more information.

Possible Cause: The calibration vial was recently filled or overfilled.

Action: Check the calibration vial and make sure the vial is not overfilled. Also make sure the valve fittings are tight. See *Refilling the calibration vial* in the *Maintenance* chapter for more information.

Possible Cause: A small leak. Typically, this will generate an excess pressure error message instead of an excess signal level message.

Action: See the material on leaks later in this chapter.

Possible Cause: The detector is defective.

Action: Replace the detector.

Error message: There was an excessive signal level — continued

Possible Cause: Defective error reporting circuitry,

Action: Contact your Hewlett-Packard Customer Engineer,

Troubleshooting Procedures

This section contains additional troubleshooting information on two topics:

- **Leaks** 5-65
- **Contamination** 5-71

The *Leaks* section describes how to isolate and detect leaks in the vacuum system.

The *Contamination* section provides information about identifying and removing sources of contamination.

Leaks Leaks are a potential source of problems for any instrument which requires a good vacuum in order to operate. Leaks are generally caused by vacuum seals that are damaged or not fastened properly. Signs of leaks include:

- Higher than normal vacuum pressure
- Higher than normal background (see *Contamination*)
- Peaks characteristic of air in the background (m/z 18, 28, 32, 40, and 44)
- Poor sensitivity

If you suspect a leak, the air and water check in the data system software can be used to help confirm your suspicion. The air and water check is a special version of autotune. It compares the abundances of ions at m/z 18 (water) and m/z 28 (nitrogen) to the abundance of m/z 69 in PFTBA. It also compares the abundances of m/z 18 and m/z 28 to each other. The abundances of m/z 18 and 28 should each be less than 5% of the abundance of m/z 69. The abundance of m/z 28 should be less than the abundance of m/z 18. See your data system documentation for more information about performing the air and water check.

Note If your MSD has been vented recently, it can take up to 4 hours for the abundance of m/z 28 (nitrogen) to reach an appropriate level and up to 24 hours for the abundance of m/z 18 (water) to reach an appropriate level.

Note If an air leak is present, the ratio of m/z 28 to m/z 32 will be about 5:1. If the abundance of m/z 28 is well over 5 times the abundance of m/z 32, then there may be another chemical present with an ion at m/z 28 such as CO or C₂H₄.

If the air and water check confirms that you have an air leak in your system, the first thing to do is to determine whether the leak is in the MSD or in the GC. Use the procedure *Isolating the leak* to determine which instrument has the leak.

Isolating the leak

Leaks originate in the GC or in the MSD. Troubleshooting is easier if you can isolate where the leak originates. The following procedure provides a way to determine where the leak is located.

- 1 Run an autotune and save the results.
- 2 Remove the GC column from the GC injection port and cap the end of the column with a septum.
- 3 Run a second autotune. Compare the results of the first autotune with the second autotune. If the results are essentially the same, the problem is in the MSD or GC/MSD interface. If the results are significantly different, the problem is in the GC.
- 4 Cut off the first 30 cm of the capillary column and reinstall the column in the injection port.

GC leaks

Most leaks in the GC occur at one of two places:

- Injection port
- Septum

Leaks in split/splitless injection ports can sometimes be confirmed by switching the injection port purge on and off and checking the abundance of the ions associated with air (primarily m/z 28 and m/z 32). If the abundance of air with the purge off is much greater (x 100) than the abundance of air with the purge on, this is confirmation of a leak in the injection port. Consult the documentation supplied with your GC for additional information.

MSD leaks

Leaks in the MSD generally occur in one of several places:

- Column nut (the nut on the end of the GC/MSD interface)
- Top plate seal
- KF flanges
- Calibration valve

The easiest way to find leaks in your MSD is using a small “lecture” bottle of an inert gas such as argon. Use the following procedure:

WARNING If your MSD is equipped with the optional ion gauge controller, turn off the ion gauge before proceeding. Otherwise, dangerous voltages may be present on the ion gauge tube.

Note If your GC is equipped with a split/splitless injection port, turn the injection port purge on during leak checking.

- 1 With the MSD still running, remove the diffusion pump cover and the main MSD cover.

WARNING Do not remove any of the safety covers, dangerous voltages are present under these covers. The diffusion pump will be dangerously hot and the ion gauge tube may be dangerously hot. Do not touch any part of the MSD.

- 2 Call up the manual tune program. Set the software to look for m/z 40, the main peak for argon (or for the main peak in whatever inert gas you are using), and select the repeat profile scan.

3 One point at a time, spray the argon at the following points:

- Column nut (on the end of the GC/MSD interface)
- GC/MSD interface KF25 fitting
- Top seal (all the way around)
- Calibration valve KF 10 fitting
- Ion gauge tube fitting
- Diffusion pump KF50 fitting

After spraying each of these points, pause for 10 to 20 seconds and observe the peak profile on the data system. A sudden peak at m/z 40 means that there is a leak where you just sprayed.

4 After you have located and repaired the leak, test that point again to make sure it is repaired. Also test each of the other points again to make sure there was not more than one leak.

Column nut — There are several causes of column nut (the nut on the end of the GC/MSD interface) leaks. The nut may not have been tightened enough the last time it was installed. Temperature cycling of the GC oven sometimes loosens a new nut/ferrule. Retightening a few times usually solves this problem. If the nut is already tight, the problem may be the ferrule. The ferrule maybe an old one which has already been fully compressed. If necessary, remove and replace the nut and ferrule (this will require venting the instrument),

Top seal — The top seal is the seal between the top plate and the vacuum manifold. It is very sensitive to dust, dirt, and damage to the surfaces with which it is in contact. If you detect a leak in the top seal, shut down and vent the MSD. Remove the analyzer and remove the seal. Inspect the seal for dust or damage. If the seal is damaged, it should be replaced. Inspect the top edge of the vacuum manifold and the bottom of the top plate for damage. If these surfaces are damaged, they can in turn damage the seal when it is installed.

KF fittings — KF fittings can leak either because the clamp is not tightened enough or because some of the parts are damaged. If you find a KF fitting that is leaking, first try tightening the clamp. If that doesn't solve the problem, shut down and vent the MSD. Disassemble the leaking clamp and inspect the parts for damage. Replace any parts which are scratched, dented, or damaged.

Ion gauge tube fitting — The ion gauge tube fitting is a threaded fitting with an O-ring seal. If you find a leak there, turn off the gauge controller and allow the ion gauge to cool. Shut down and vent the MSD. Then try gently tightening the fitting.

WARNING Do not overtighten this fitting, it is possible to break the ion gauge tube.

If tightening the fitting does not eliminate the leak, remove the ion gauge tube and replace the O-ring in the fitting.

Calibration valve — The calibration valve can have a leaky KF fitting. It is also possible, although unlikely, that the valve itself would leak: allowing the tuning compound or air to leak into the vacuum manifold. The standard test with Freon will not detect a leaking valve. A leaking valve can also be diagnosed by excessive background with peaks in the background matching peaks in the tuning compound. If the calibration valve KF fitting is leaking, treat it like any other KF fitting. If the valve itself is leaking, contact your Hewlett-Packard Customer Engineer or refer to the *Calibration Valve* chapter in the *Technical Reference* appendix.

Contamination Contamination is usually identified by the presence of excessive background in the results of data acquisition. It can come from the GC or from the MSD. The first thing to do when contamination becomes evident is to determine which instrument is responsible for the contamination. Use the procedure outlined under *Isolating the leak* in the *Leaks* section in this chapter.

The likely source of the contamination can also frequently be determined by identifying the contaminants. Some substances are much more likely to originate in one instrument than in the other. Table 5-1 lists the masses associated with some of the more common contaminants.

Table 5-1. Contaminants

Masses	Compound	Possible Source
18,28,32,40,44	H ₂ O, N ₂ , O ₂ , Ar, CO ₂	Air
31	Methanol	Cleaning solvent
43,58	Acetone	Cleaning solvent
77	Benzene or xylene	Cleaning solvent
91,92	Toluene or xylene	Cleaning solvent
105, 106	Xylene	Cleaning solvent
151, 153	Trichloroethane	Cleaning solvent
73, 147,207,221,281,295, 355,429	Dimethylpotysiloxane	Septum or methylsilicone column coating
170,262,354,446	Diffusion pump fluid	Diffusion pump fluid
149	Plasticizer (phthalates)	Vacuum seals damaged by high temperatures
Peaks space 14 amu apart	Hydrocarbons	Human fingerprints, foreline pump fluid

GC contamination sources

Contamination originating in the GC typically comes from one of these sources:

- Column bleed
- Septum bleed
- Dirty injection port
- Injection port liner
- Contaminated syringe
- Poor quality carrier gas

Column or septum bleed — These can frequently be identified by an intense peak at 207 amu (dimethyl-polysiloxane). Non cross-linked capillary columns are a major cause. High-bleed septums are also a common cause. For this reason, cross-linked capillary columns are recommended for almost all applications. Also recommended are low-bleed septa such as the “red” HP Septa (5181-1263).

A simple test to detect column bleed is to increase the GC oven temperature 20° or 30°C. A corresponding increase in background indicates column bleed.

With some columns, bleeding can be prevented by conditioning (“baking out”) the column before it is used. Refer to *Conditioning a capillary column* in the GC *Columns* section in the *Operation* chapter of this appendix for more information.

Dirty injection ports, injection port liners, syringes, and contaminated carrier gas — These are harder to diagnose because the background spectra you see will depend on the contaminants. If the contamination problem is coming from the GC, but it is not septum or column bleed, try cleaning the injection port and replacing the injection port liner. Clean or replace the syringe. Switch to a different source of carrier gas and replace the carrier gas tubing with new (clean) tubing.

MSD contamination sources

Contamination originating in the MSD typically comes from one of the following sources:

- Air leak
- Cleaning solvents
- Diffusion pump fluid
- Foreline pump oil
- Fingerprints

Air leaks — Air leaks can occur in many places as discussed previously in the *Leaks* section. Air leaks can be identified by characteristic peaks at m/z 18, 28, 32, 40, and 44, and especially by an abundance of m/z 28 (nitrogen) that is more than the abundance of m/z 18 (water). See the *Leaks* section earlier in this chapter for more information.

Cleaning solvents — It is common to see cleaning solvent peaks in the mass spectra shortly after the ion source or other parts are cleaned. The best way to avoid this is to dry all cleaned parts in an oven before reassembling and reinstalling them. Avoid contact between solvents and O-rings. Also, do not bake O-rings or parts that contain teflon.

Diffusion pump fluid — If the diffusion pump is allowed to pump with no carrier gas flow into the vacuum system, pump fluid vapor can drift up into the vacuum manifold.

More serious is fluid backstreamed into the vacuum manifold by sudden or improper venting of the vacuum system. If a diffusion pump has backstreamed, a prominent peak will often be seen at m/z 446 and the spectral baseline will exhibit small peaks at most masses. It may also be possible to see an fluid film on parts in the vacuum manifold.

Foreline pump fluid — Foreline pump fluid contamination is characterized by peaks spaced 14 amu apart (hydrocarbons). Contamination with mechanical pump is less common, but can occur if the foreline pump is allowed to operate for an extended time with the diffusion pump off and no carrier gas flow into the system.

Fingerprints — Fingerprints contain hydrocarbons that can appear in mass spectra. Fingerprint contamination is characterized by a series of mass peaks 14 amu apart. The abundances of these peaks decrease as peak masses increase. Fingerprint contamination is usually caused by the failure to wear clean gloves during ion source cleaning or other maintenance. Use special care to avoid recontaminating parts after you clean them.

The action required to remove contamination depends on the type of contamination and the level of contamination. Minor contamination by water or solvents can usually be removed by allowing the system to pump (with a low flow of clean carrier gas) overnight. Serious contamination by pump fluid or fingerprints is much more difficult to remove, it may require extensive cleaning. Contact your Hewlett-Packard Customer Engineer,

Introduction 6-2

General Maintenance Considerations 6-3

Vacuum System Maintenance 6-13

Analyzer Maintenance 6-35

GC/MSD Interface Maintenance 6-64

Electronics Maintenance 6-69

Introduction

This chapter describes how to maintain your HP 5971A Mass Selective Detector. The chapter is divided into five sections:

- General Maintenance Considerations
- Vacuum System Maintenance
- Analyzer Maintenance
- GC/MSD Interface Maintenance
- Electronics Maintenance

General Maintenance Considerations covers general maintenance information including a maintenance schedule, information about tools and supplies provided with your instrument, and safety considerations.

Vacuum System Maintenance describes maintenance procedures related to the vacuum system. Examples of procedures in this section include replacing the foreline pump fluid and refilling the calibration vial.

Analyzer Maintenance describes maintenance procedures related to the analyzer. Examples of procedures in this section include cleaning the ion source and replacing the detector (electron multiplier).

GC/MS Interface Maintenance describes maintenance tasks related to the GC/MSD interface. The most common of these is replacing the interface heater/sensor assembly.

Electronics Maintenance describes maintenance of the electronics in the MSD.

General Maintenance Considerations

This section contains background information related to the maintenance of your MSD. Of special importance is the section on safety, which you should read before performing any of the maintenance procedures listed in this chapter.

- Maintenance schedule 6-4
- Tools and supplies 6-6
- Safety 6-8
- Electrostatic discharge 6-12

Maintenance schedule

Common maintenance tasks are listed in Table 6-1. Performing these tasks on a regular basis can reduce operating problems, prolong system life, and reduce overall operating costs. Keep a record of system performance characteristics and maintenance operations performed. This makes it easier to identify variations from normal operation and to take corrective action.

Table 6-1. Maintenance schedule

	Every week	Every 3 months	Every 6 months	Every year	As needed
Tune the MSD	x				
Check foreline pump fluid level	x				
Check and, if necessary, refill the calibration valve		x			
Replace the foreline pump fluid			x		
Replace the foreline trap pellets			x		
Check and, if necessary, replace the diffusion pump fluid				x	
Clean the ion source					x
Check the carrier gas trap					x
Replace worn out parts such as filaments and the detector					x

Tools and supplies Table 6-2 lists tools needed to maintain the MSD. Table 6-3 lists cleaning supplies and other consumables needed to maintain the MSD. Some of the tools and supplies needed to service the HP 5971A MSD are included in the tool kit (05971-60561) supplied with the MSD.

Table 6-2. Tools

Description	HP Part Number
Ball driver	
1.5-mm	8710-1570
2.0-mm	8710-1804
Hex nut driver, 1/4-inch	8720-0002
Pliers, long-nose (1.5-inch nose)	8710-1094
Ruler, metal	
Screwdriver	
flat-blade, large	8730-0002
Pozidriv #1 (small)	8710-0899
Pozidriv #2 (large)	8710-0900
Tweezers, non-magnetic	8710-0907
Wrench, open-end, 1/4-inch x 5/16-inch	87104510

Table 6-3. Cleaning supplies and consumables

Description	HP Part Number
Abrasive paper	5061-5896
Alumina abrasive powder	86604791
Aluminum foil, clean	
Cloths, clean, lint-free	05980-60051
Cotton swabs	5080-5400
Detector	05971-80101
Diffusion pump fluid	6040-0723
Filament assembly	05971-60140
Foreline pump fluid	6040-0517
Foreline trap pellets	9301-1104
GC/MSD interface heater/sensor assembly	05971-60105
Glass beakers	
50 and 400 ml	
Gloves, clean	
chemical-resistant	
large	8650-0030
small	0650-0029
Hydrocarbon sample	05970-60045
PFTBA sample kit	05971-60571
Solvents	
acetone, reagent-grade	-----
methanol, reagent-grade	-----
methylene chloride, reagent-grade	-----
Ultrasonic bath	-----

Safety Some of the procedures in this chapter require access to the inside of the instrument while it is on or shortly after it is turned off. If not performed correctly, some of these procedures could involve exposure to potentially dangerous voltages or temperatures. The following material elaborates on these potential dangers; read it carefully.

WARNING The HP 5971A MSD must be disconnected from its power source before it is opened for any adjustment, replacement, maintenance, or repair.

WARNING Any adjustment, maintenance, or repair of the opened instrument shall be avoided as far as possible and, if unavoidable, shall be carried out only by a trained person who is aware of the hazards involved.

High voltages

Whenever the MSD is plugged in, even **if the on/off switch (circuit breaker) is off**, potentially dangerous voltage (110/120 V ac or 220/240 V ac) exists on:

- The wiring between where the power cord enters the instrument and the on/off switch

Whenever the on/off switch is on, potentially dangerous voltages exist on:

- Power supply
- Power distribution board
- Main board
- Top board
- Wires and cables between these boards
- Wires and cables between these boards and the connectors on the back panel of the MSD

Under normal circumstances, all of these parts are fully covered by safety covers. As long as these safety covers are in place, it should be difficult to accidentally make contact with dangerous voltages.

One or two procedures in this chapter which require access to the inside of the MSD while it is on. In each of those procedures, there is no reason to remove any safety cover and the danger of accidental shock should be extremely small as long as the procedures are followed carefully.

WARNING

Under no circumstances should any maintenance procedure which requires the removal of a safety cover be performed unless the MSD is turned off and its power cord disconnected.

If your instrument is equipped with the optional gauge controller, potentially dangerous voltage also exists where the cable from the gauge controller plugs into the gauge tube. Turn off the gauge controller if you are going to be working near the gauge tube. See the *Gauge Controller* appendix for more information.

High temperatures

Many parts in the MSD operate at or reach temperatures high enough to cause serious burns. These parts include but are not limited to:

- GC/MSD interface
- Ion gauge tube
- Radiator
- Ion source
- Quadrupole mass filter
- Diffusion pump
- Foreline pump

These parts should never be touched while the instrument is in operation. After the MSD is turned off, these parts should be given plenty of time to cool before they are handled. This is especially true of the GC/MSD interface.

WARNING	Because the temperature of the GC/MSD interface is controlled through the GC, the interface can be at a dangerously high temperature even though the MSD is off. Even after it is turned off, the GC/MSD interface cools very slowly. This is especially true if the GC oven is at an elevated temperature.
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Chemical residue

Not all of your sample is ionized by the ion source. The majority of any sample passes through the ion source without being ionized and is pumped away by the vacuum system. As a result, the exhaust from the foreline pump will contain traces of the chemicals present in your samples. Treat pump exhaust as toxic.

WARNING Exhaust from the foreline pump may contain toxic chemicals and should never be vented into the laboratory.

Use a hose to vent the foreline pump exhaust outside or into a fume hood. Be sure to comply with your local air quality regulations.

The fluid in the diffusion pump and foreline pump also collects traces of the samples being analyzed. All used pump fluid should be considered hazardous waste and handled accordingly. Dispose of used fluid correctly, as specified by your local regulations.

WARNING When replacing pump fluid, use chemical-resistant gloves and safety glasses. Avoid all contact with the fluid.

Safety glasses

Safety glasses should be worn during all maintenance procedures.

Electrostatic discharge

All of the printed circuit boards in the MSD contain components that can be damaged by electrostatic discharge (ESD). These boards should not be touched or handled unless absolutely necessary. When it is necessary to handle these boards, always use a grounded wrist strap and take other anti-static precautions. The grounded wrist strap should be connected to the main MSD ground point which is located near the main power wiring and is labeled with the international symbol for ground. Handle printed circuit boards by their edges and avoid touching components or traces.

Caution In order to be effective, an anti-static wrist strap must fit snugly (not tight). A loose strap provides little or no protection.

Caution Even anti-static precautions are not 100% effective. Handle electronic circuit boards as little as possible.

Vacuum System Maintenance

This section lists procedures for maintaining the vacuum system of your MSD. The procedures in this section should be performed according to the schedule listed under *Maintenance schedule* earlier in this chapter or as indicated by symptoms. If you doubt your ability to safely and correctly perform any of these procedures, contact your Hewlett-Packard Customer Engineer. Procedures included in this section are:

- Checking the foreline pump fluid level 6-14
- Adding foreline pump fluid 6-16
- Replacing the foreline pump fluid 6-18
- Replacing the foreline trap pellets 6-20
- Checking and replacing the diffusion pump fluid 6-22
- Refilling the calibration vial 6-30
- Replacing the foreline vacuum gauge 6-33

Checking the foreline pump Checking the foreline pump fluid level is a simple task which requires no tools. It can be done while the system is fluid level operating. The foreline pump fluid level should be checked at least once a week.

Materials needed:

None

Procedure:

- 1 Gain access to the foreline pump.
- 2 Look at the window in the end of the foreline pump (see Figure 6-1). The fluid level should be between the upper and lower marks next to the window. If the fluid level is near or below the lower mark, you should add fluid. If it is almost time for the regular fluid replacement, it may be easier just to drain and replace the fluid. Refer to *Adding foreline pump fluid* or *Replacing the foreline pump fluid* later in this section for more information.

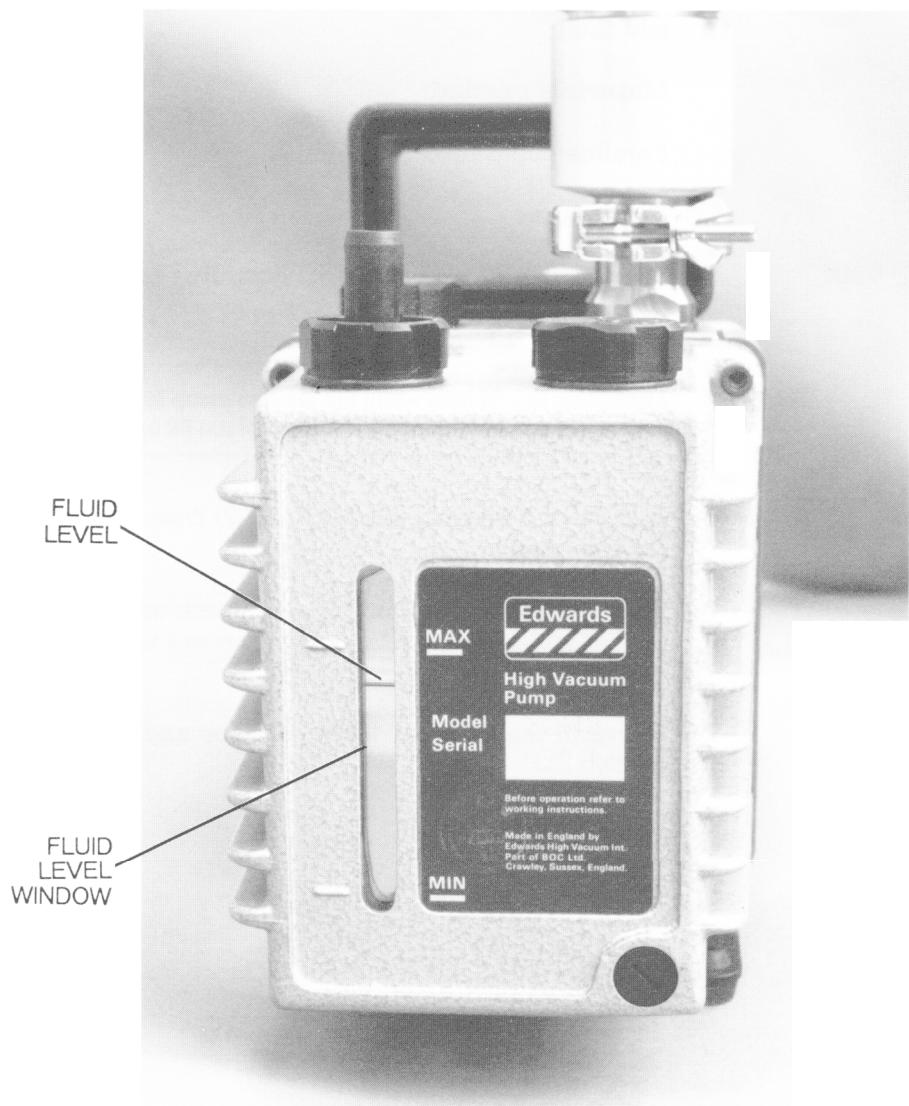


Figure 6-1. Foreline pump fluid level window

Adding foreline pump fluid

If the fluid level in the foreline pump gets low before the scheduled fluid replacement, use the following procedure to add fluid:

Materials needed

Foreline pump fluid (6040-0517)

Procedure:

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter..

WARNING Attempting to add fluid while the foreline pump is running could result in dangerously hot fluid splashing out of the fill opening.

2. Remove the fill plug (see Figure 6-2) from the top of the foreline pump.
3. Pour foreline pump fluid into the pump until the fluid level in the fluid-level window is near but not above the upper mark.
4. Reinstall the fill plug. Then, start up and pump down the MSD.



Figure 6-2. Adding foreline pump fluid

Replacing the foreline pump fluid

The fluid in the foreline pump should be replaced at least once every six months. When you replace the fluid, you should also replace the pellets in the foreline trap. Wear chemical-resistant gloves throughout this procedure.

Materials needed

Foreline pump fluid, 450 ml, (6040-0517, 1 liter)
Container for catching old pump fluid, at least 500 ml
Gloves, chemical-resistant
Screwdriver, flat-blade, large (8730-0002)

Procedure:

- 1 Shutdown and vent the MSD according to the procedure listed in the *Operation* chapter.
- 2 Place the container under the drain plug on the foreline pump.
- 3 Remove the fill plug from the top of the pump.
- 4 Remove the drain plug from the pump.

WARNING Wear chemical-resistant gloves and avoid contact with the pump fluid. The residue from some samples may be toxic. Dispose of used fluid properly.

- 5 Reconnect the MSD power cord to the electrical outlet. Switch on the MSD for 2 or 3 seconds, and then switch it off again. This displaces old fluid from the internal pump cavities. Disconnect the power cord again.

Caution Do not run the pump for more than a few seconds without fluid.

- 6 Reinstall the drain plug and pour 300 ml of fluid into the pump through the fill hole.

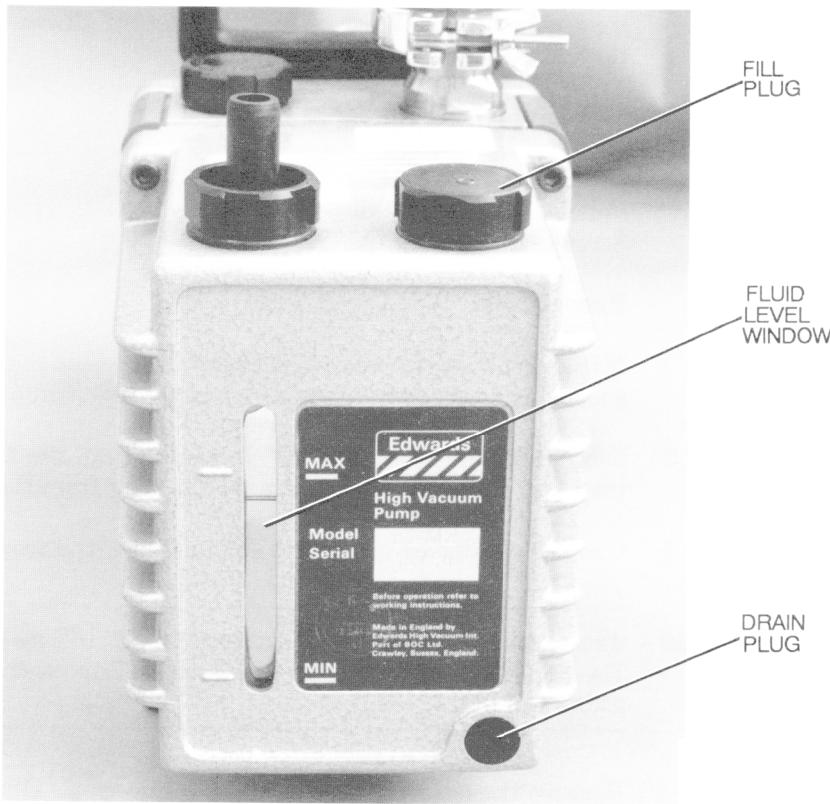


Figure 6-3. Replacing the foreline pump fluid

- 7 Watch the fluid level window. Add fluid until the fluid level is near but not above the upper mark next to the window.
- 8 Reinstall the fill plug.
- 9 Reconnect the MSD power cord,
- 10 Start up and pump down the MSD according to the procedure in the *Operation* chapter.

Replacing the foreline trap pellets

The adsorbent pellets in the trap on the foreline pump should be replaced at the same time the foreline pump fluid is replaced. Wear chemical-resistant gloves throughout this procedure.

Materials needed

Gloves, chemical-resistant
Pellets, adsorbent (9301-1 104)
Screwdriver, large, flat-bladed (8730-0002)

Procedure:

- 1 If it is not already vented, shutdown and vent the MSD according to the procedure listed in the *Operation* chapter.
- 2 Disconnect the KF40 and KF25 clamps from the foreline trap (see Figure 6-4) and remove the trap from the pump.
- 3 Use a screwdriver to pry the screen out of the trap.

WARNING Wear chemical-resistant gloves and avoid contact with the pellets. The residue from some samples may be toxic. Dispose of used pellets properly.

- 4 Remove the old pellets from the foreline trap. Dispose of the pellets properly.
- 5 **Open a new can of foreline trap pellets. Use your GC oven to bake the new pellets at 250°C for 2 hours. Let the pellets cool and then pour them into the foreline trap.**
- 6 Reinstall the screen by pressing it into place in the trap.
- 7 Reconnect the KF40 fitting between the foreline trap and the foreline hose, and the KF25 fitting between the foreline trap and the foreline pump.
- 8 Reconnect the MSD power cord.
- 9 Start up and pump down the MSD according to the procedure in the *Operation* chapter.

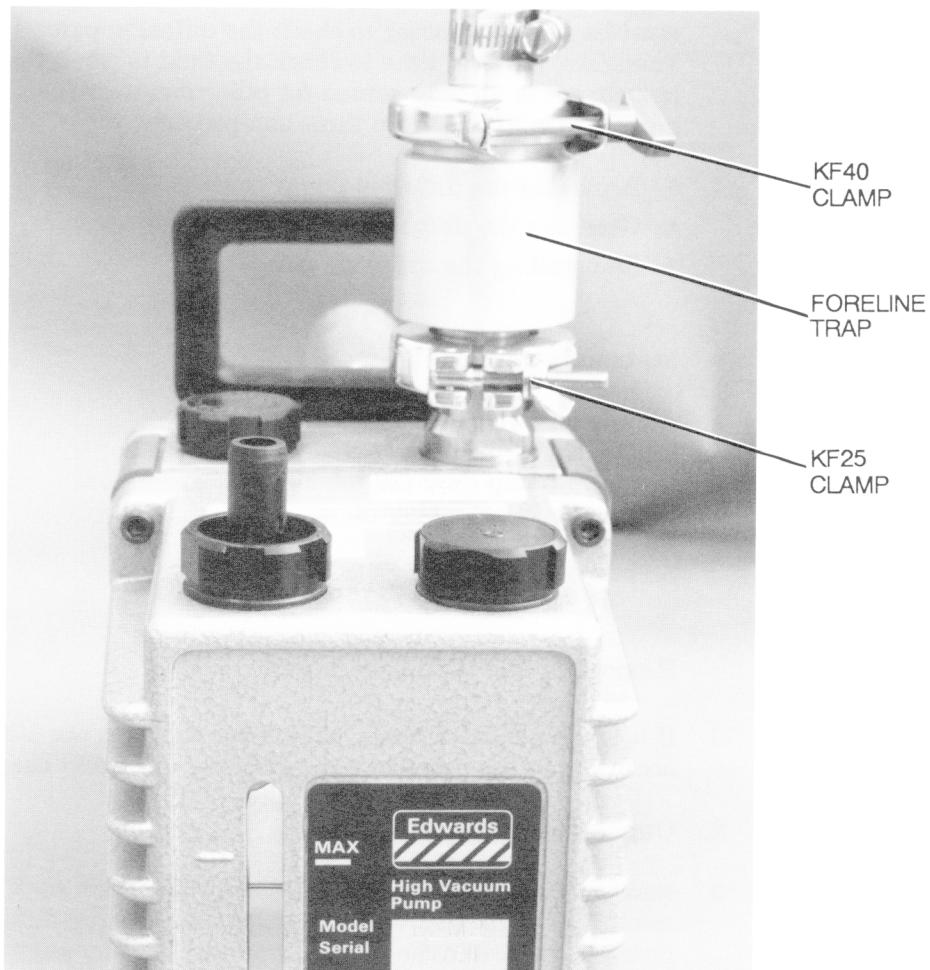


Figure 64. Replacing the foreline trap pellets

Checking and replacing the diffusion pump fluid

It is not necessary to check the diffusion pump fluid more than once a year, unless you observe symptoms that suggest a problem with the diffusion pump fluid. The MSD must be vented in order to check the diffusion pump fluid. Therefore, the best time to check the fluid is when the instrument is already vented for other maintenance. This procedure is divided into three sub-procedures

- Removing the diffusion pump
- Checking the diffusion pump fluid
- Reinstalling the diffusion pump

Materials needed

Aluminum foil, clean
Cloths, clean, lint-free (05980-60051)
Diffusion pump fluid (20 ml, 6040-0723)
Gloves, chemical-resistant
Ruler, metal
Screwdriver, Pozidriv #2 (8710-0900)

Removing the diffusion pump

- 1 If it is not vented already, shut down and vent the MSD according to the procedure listed in the *Operation* chapter.
- 2 Unplug the MSD power cord.
- 3 Remove the small (KF10) clamp (see Figure 6-5) that connects the foreline vacuum gauge fitting to the diffusion pump. Disconnect the fitting from the diffusion pump.
- 4 Remove the diffusion pump cover.
- 5 Hold the diffusion pump in one hand and with your other hand remove the large (KF50) clamp that connects the diffusion pump to the vacuum manifold.

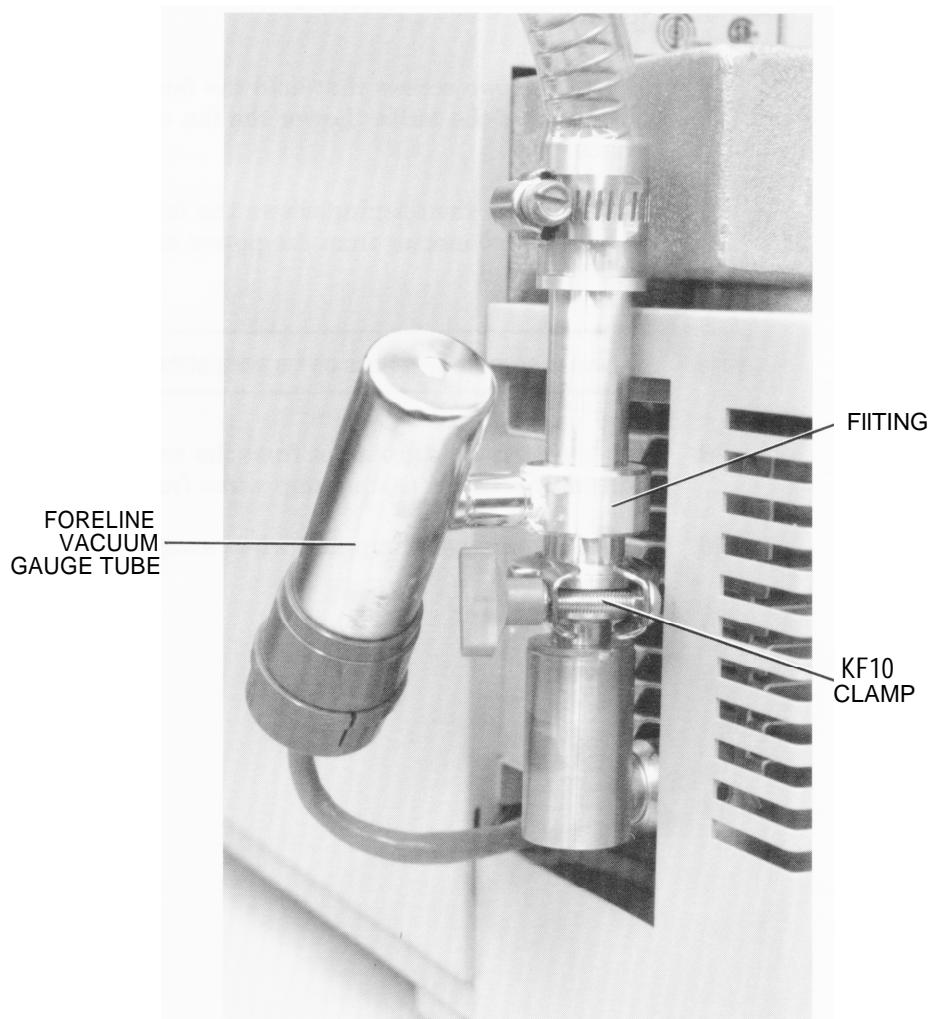


Figure 6-5. Disconnecting the foreline vacuum gauge

- 6 Lower the diffusion pump onto the work surface. The wires from the diffusion pump will still be connected to the MSD.
- 7 Remove the two screws that hold the fan assembly to the back panel of the MSD. Lower the fan onto the work surface.
- 8 Reach through the opening where the fan was and unplug the nine-pin connector from the power distribution board (see Figure 6-6).

Note You have to squeeze in the tabs on the sides of the connector to unplug it.

- 9 Withdraw the split grommet from the cutout in the cabinet and remove the diffusion pump wires from the grommet.
- 10 Move the diffusion pump and wires away from the MSD.



Figure 6-6. Disconnecting the diffusion pump wiring

Checking the diffusion pump fluid

- 1 Cover the top of the diffusion pump with clean aluminum foil.
- 2 Place the pump in the GC oven and heat it at 60% for 15 minutes.
- 3 Remove the diffusion pump from the oven and remove the aluminum foil.
- 4 Remove the stack retaining clip by pulling upon one side of the clip. Place the clip on a clean, lint-free cloth.

WARNING Use gloves to avoid contact with the diffusion pump fluid. It may contain residue from the samples you have been analyzing.

- 5 Remove the stack pieces one-at-a-time. Be careful to note the order in which you remove the pieces. Place the pieces on a clean, lint-free cloth.

Note Some diffusion pumps are equipped with one-piece stacks. If your diffusion pump is equipped with one of these, you can lift the entire stack out of the diffusion pump as a single part.

- 6 Examine the diffusion pump fluid (a small flashlight helps). It should be clear or have a slight yellow tint. If the fluid is dark or cloudy it should be replaced.
- 7 Use a metal ruler to measure the depth of the fluid in the diffusion pump. If your diffusion pump has been in operation, the fluid should be $9\text{ mm} \pm 1\text{ mm}$ deep. A newly filled diffusion pump will have a pool of fluid 12 mm deep.

If the fluid in your diffusion pump is clear and at the correct level, there is no need to replace it. Skip to step 10. If the fluid is discolored or too low, then it should be replaced. Refer to steps 8 and 9 for instructions.

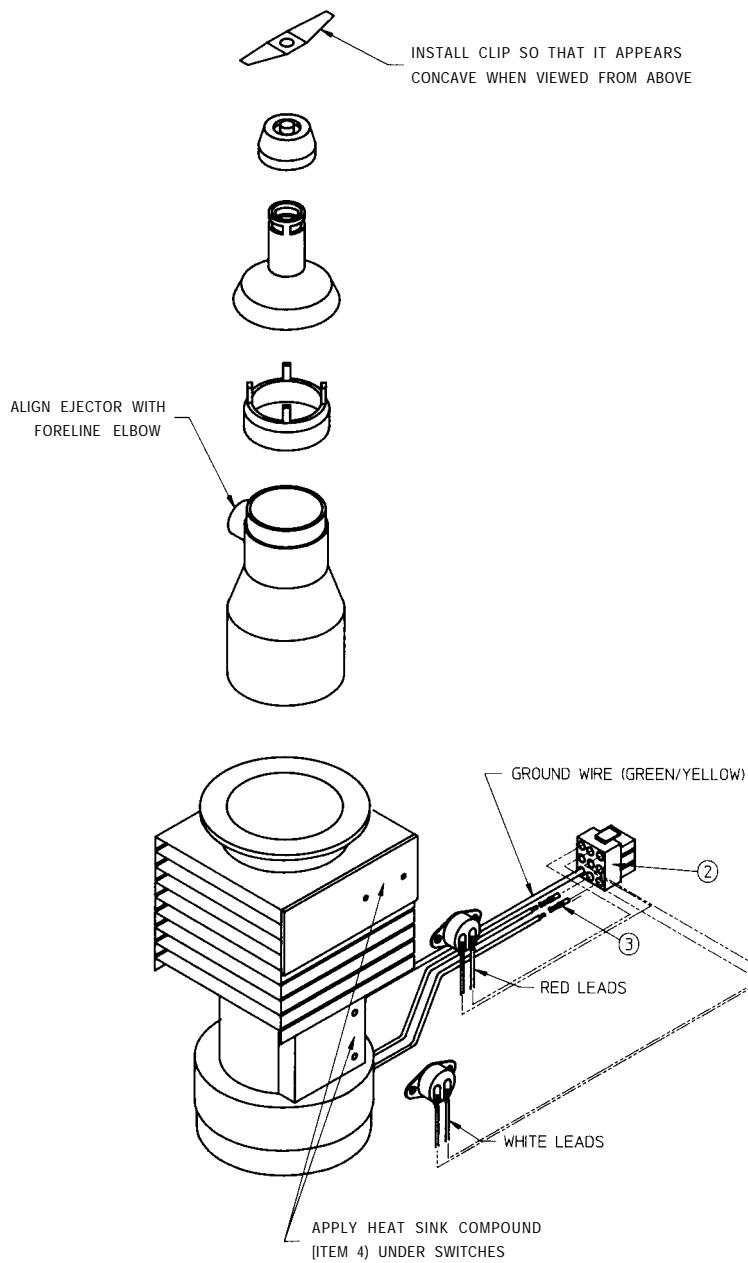


Figure 6-7. Disassembling the diffusion pump stack

- 8 Invert the pump and drain out all the fluid. Residual fluid can be wiped out with a clean, lint-free cloth (again, do not get any of the fluid on your skin).

Caution Never immerse the pump in any type of solvent or in water.

- 9 Pour one pre-measured 20-ml tube of diffusion pump fluid into the bottom of the diffusion pump. Use this exact amount and do not use any other type of fluid.
- 10 Reinstall the stack, one piece at a time. Install the bottom stack member so that the ejector tube is aligned with the foreline elbow (exhaust tube). If this piece is installed incorrectly, the pump will not function at all.
- 11 Carefully reinstall the stack retaining clip. The clip should be centered and should appear concave when viewed from the top of the diffusion pump.

Reinstalling the diffusion pump

- 1 Reconnect the diffusion pump wiring connector to the power distribution board, Slide the grommet into the cutout in the cabinet.
- 2 Vacuum the accumulated dust from the fan, Dust buildup can reduce the fan's effectiveness and shorten its service life. Vacuum both sides of the fan.
- 3 Reinstall the fan.
- 4 Make sure the NW50 seal (O-ring assembly) is in good condition and then lift the diffusion pump into position.
- 5 Reinstall the KF50 clamp that holds the pump to the vacuum manifold.
- 6 Reconnect the foreline vacuum gauge to the diffusion pump.
- 7 Reinstall the KF1O clamp.
- 8 Reinstall the diffusion pump cover.
- 9 Reconnect the MSD power CON.
- 10 Startup and pump down the MSD according to the procedure in the *Operation* chapter.

Refilling the calibration vial

You can refill the calibration vial without venting the system. To refill the vial, proceed as follows

Materials needed:

PFTBA or other tuning chemical
Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

- 1 Make sure that there is no tuning or data acquisition program currently running.
- 2 If your instrument is equipped with the optional ionization gauge controller, switch the ion gauge tube off. You can do this by first turning off the filament switch and then switching off the power switch on the gauge controller.

WARNING If the ion gauge controller is not off, dangerous voltages will be present around the gauge tube.

- 3 Remove the MSD cover.

WARNING There are hazardous voltages and possibly a hot high-vacuum gauge tube inside the MSD. Avoid contact with the gauge tube, and with the circuitry on the top board and main board.

- 4 Locate the calibration valve. It is under the vacuum manifold at the front of the MSD (see Figure 6-9).
- 5 Loosen the knurled nut that holds the calibration vial in place.
- 6 Pull the vial down out of the valve. There will probably be some resistance since the inside of the vial is still under vacuum.

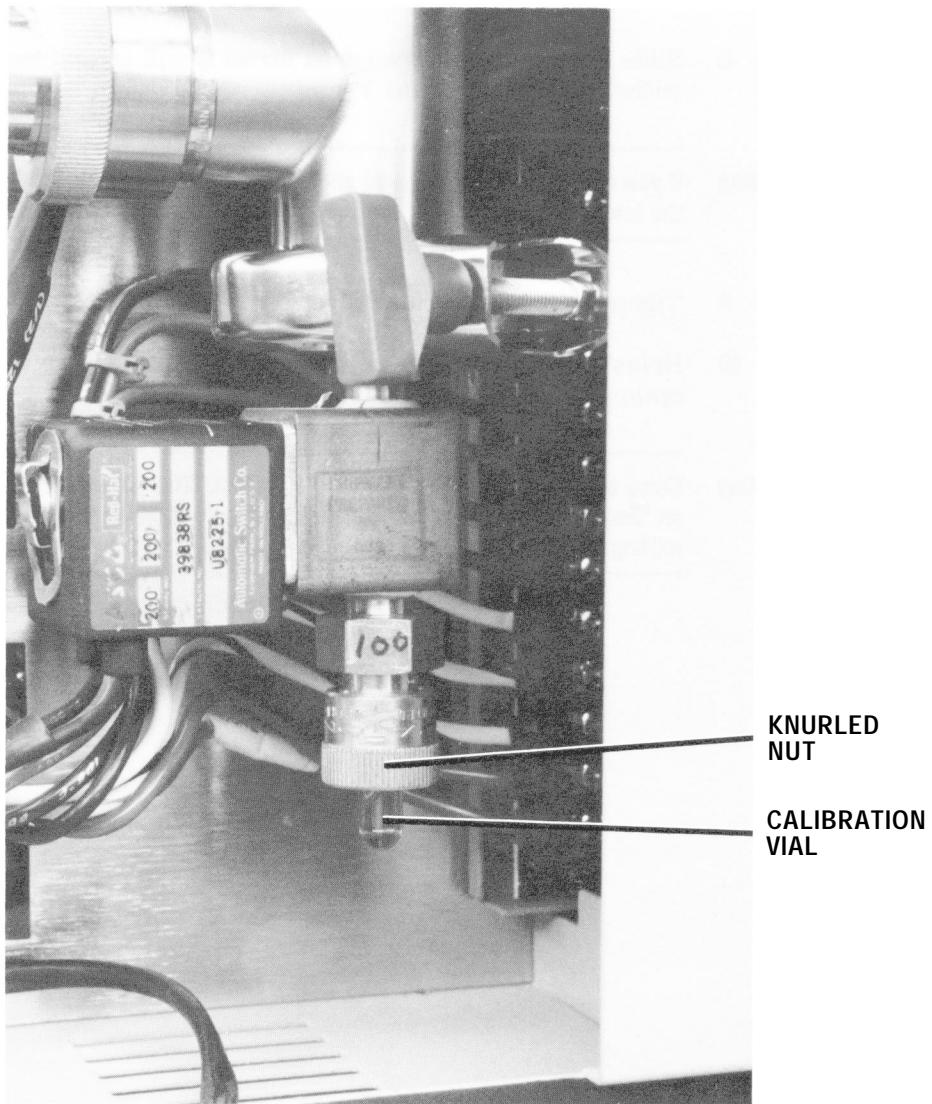


Figure 6-8. Calibration valve and vial

- 7 Refill the vial to no closer than 1/4 inch of the top with PFTBA or whatever chemical you want to use for tuning.
- 8 Slide the vial into the valve as far as it will go and then withdraw the vial about 1 mm.

Caution If you do not withdraw the vial slightly, it may break when you tighten the knurled nut.

- 9 Tighten the knurled nut finger tight,
- 10 Reinstall the MSD top cover and, if applicable, turn the optional high-vacuum gauge tube back on.

Note Some air is trapped in the vial when it is refilled. This sometimes causes an 'Excess source pressure' error message during the first tune after refilling. This is more likely if the vial is overfilled.

Replacing the foreline vacuum gauge

The foreline vacuum gauge is mounted on the output port of the diffusion pump (see Figure 6-9). Use the following procedure to replace the foreline vacuum gauge.

Materials needed

Foreline vacuum gauge tube (0960-0540)
Tape, Teflon (0460-0016)

Procedure:

- 1 Shut down and vent the MSD, as described in the *Operation* chapter.
- 2 Unplug the blue electrical connector from the bottom of the foreline vacuum gauge.
- 3 Remove the KF1O clamp that connects the foreline vacuum gauge fitting to the diffusion pump. Disconnect the fitting from the pump.
- 4 Remove the foreline vacuum gauge by carefully unscrewing it from the fitting.
- 5 Clean the remnants of the teflon tape from the threads in the fitting.
- 6 Unpack the new foreline vacuum gauge tube. Apply 1-1/2 turns of teflon tape to the threads of the gauge tube.

Note Do not wrap the tape all the way to the outer end of the threads.

- 7 Carefully screw the new gauge tube into the fitting. When installed, the gauge tube may not be exactly vertical. This is acceptable.
- 8 Reinstall the fitting and tighten the KF1O clamp. If the O-ring assembly appears worn or damaged, replace it.
- 9 Reconnect the blue electrical connector to the bottom of the foreline vacuum gauge tube.

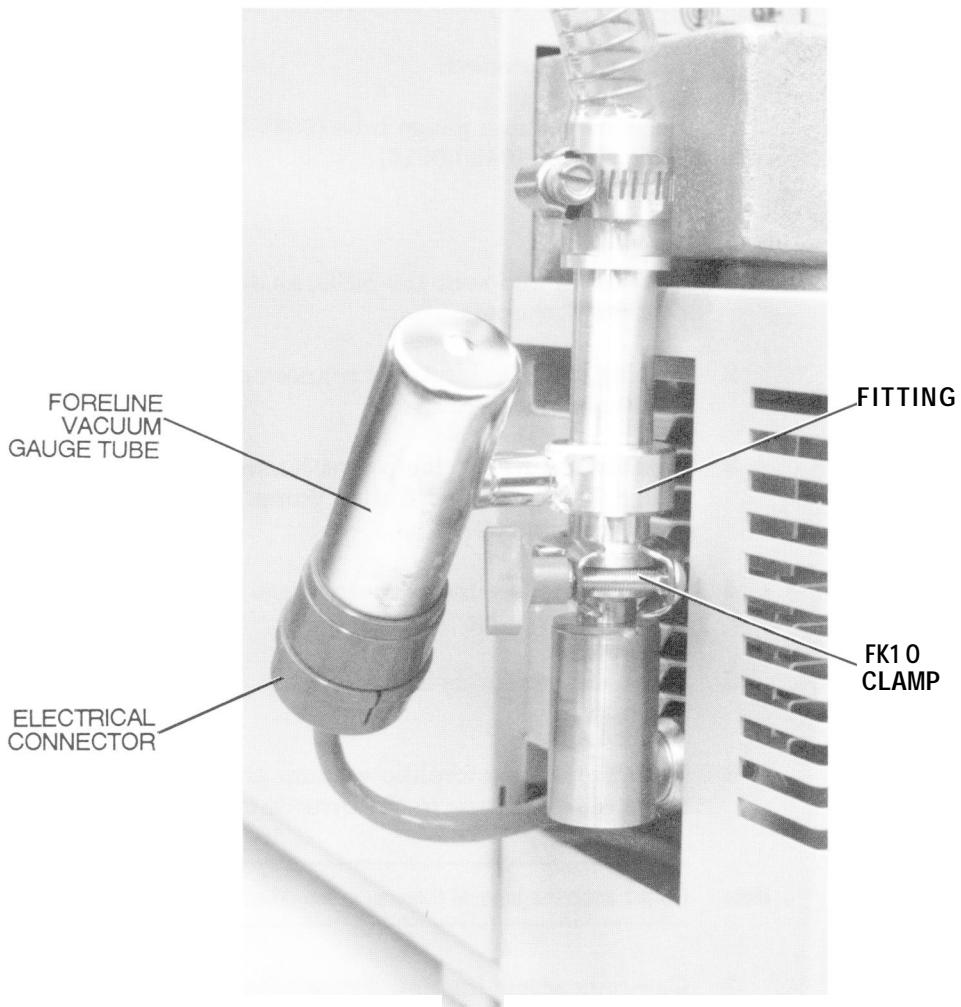


Figure 6-9. Foreline vacuum gauge tube

- 10 Startup and pump down the MSD as described in the *Operation* chapter of this manual.

Analyzer Maintenance

This section contains procedures for maintaining the analyzer, which consists of the ion source, mass filter, and detector. These procedures are not scheduled maintenance procedures and should be performed only when symptoms indicate they are necessary. See the *Troubleshooting* chapter for more information about indications of the need for analyzer maintenance. Procedures in this section include:

- Removing the analyzer 6-36
- Reinstalling the analyzer 6-38
- Cleaning the ion source 6-41
- Replacing a filament 6-54
- Replacing the detector 6-59

Removing the analyzer Several maintenance procedures require you to remove the analyzer from the MSD. Follow this procedure to remove the analyzer (including the top plate and top board) from the vacuum manifold,

Materials needed

Cloths, clean, lint-free (05980-60051)

Screwdriver, Pozidriv #2 (8710-0900)

Wrench, open end, 1/4-inch x 5/16-inch (8710-0510)

Procedure

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter. Disconnect the MSD power cord.
- 2 Carefully slide the MSD away from the gas chromatography.
- 3 Remove the screws that hold the MSD top cover in place. Then, remove the top cover.
- 4 Remove the clamp from the KF25 fitting which connects the GC/MSD interface to the MSD.
- 5 Carefully pull the GC/MSD interface out of the vacuum manifold. Set the GC/MSD interface on a clean, lint-free cloth and cover it with another clean cloth. Be careful to not touch the portions of the interface which are normally inside the vacuum manifold.
- 6 Disconnect the electrical connections between the top board and the main board (see Figure 6-10)
 - Unplug the ribbon cable from the top board
 - Unplug the filament supply cable from the top board
 - Unscrew the detector output cable from the top board
- 7 If the shipping clamps are still in place (they should not be used during normal operation), loosen the rear clamp and remove the front clamp.

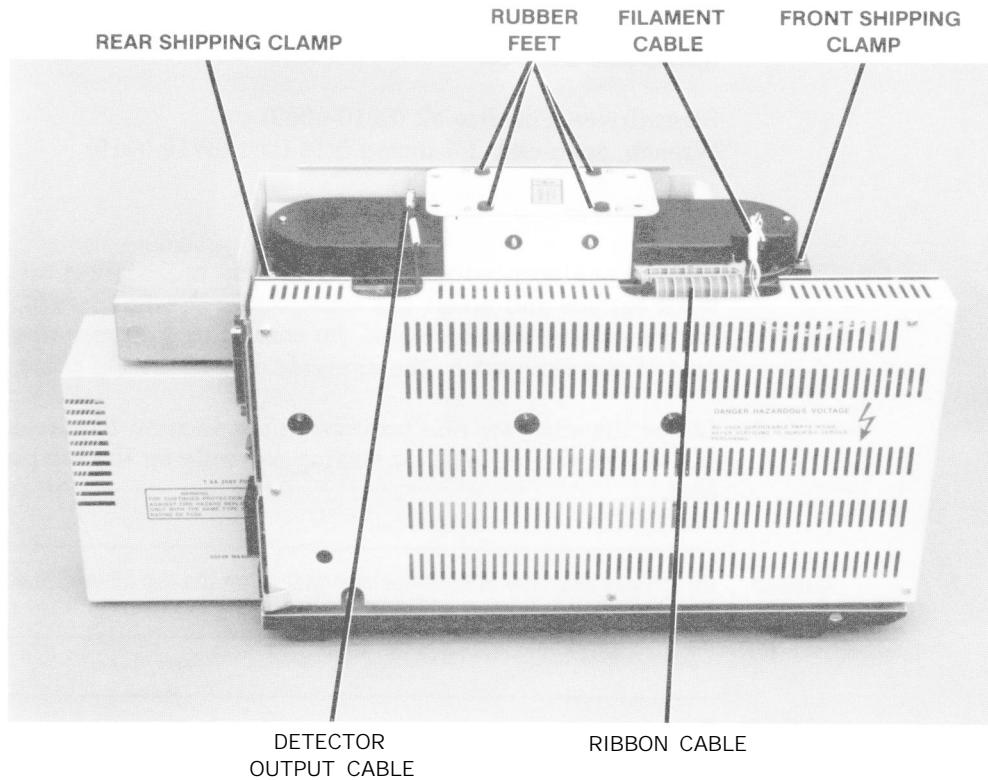


Figure 6-10. Removing the analyzer

- 8 Lift the analyzer/top plate/top board out of the vacuum manifold and place it upside down on a clean work surface. The top of the RF coil cover has four black feet for this purpose.

Reinstalling the analyzer When you are ready to reinstall the analyzer, use the following procedure,

Materials needed

Screwdriver, Pozidriv #2 (8710-0900)
Wrench, open-end, 1/4-inch x 5/16-inch (8710-0510)

Procedure:

- 1 Lift the analyzer (with top plate and top board) from the work surface and invert the assembly so the analyzer is hanging below the top plate. Be careful to not touch any part of the analyzer or the analyzer side of the top plate.
- 2 Lower the analyzer into position in the vacuum manifold. Make sure the top plate is resting correctly on the top plate seal.

Caution Do not use any type of high-vacuum grease on the top plate side of the seal. It attracts dust which interferes with a good seal.

Note The shipping clamps should not be tightened for normal operation. If you intend to transport or store the MSD then they should be installed and tightened at this time.

- 3 Reconnect the ribbon cable, filament supply cable, and detector output cable.
- 4 Reinstall the KF25 O-ring assembly on the GC/MSD interface. KF flange. If the O-ring assembly appears to be worn or damaged, replace it.
- 5 Gently insert the GC/MSD interface back into the vacuum manifold. Make sure the tip of the GC/MSD interface extends into the ion source and that the interface seats properly in the interface socket on the radiator.

If the GC/MSD interface can not be inserted far enough, check to see if the tip is bent.

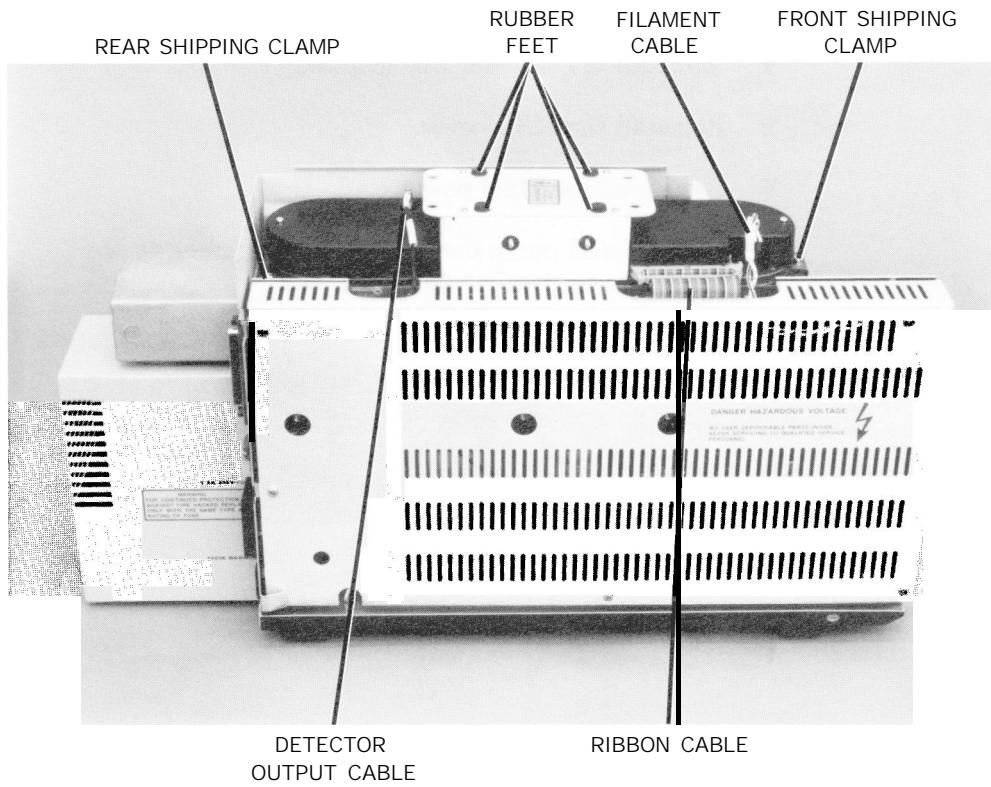


Figure 6-11. Reinstalling the analyzer

- 6 Slide the MSD back into position next to your gas chromatography.
- 7 Reinstall the transfer line (capillary column).
- 8 Reinstall the MSD cover.
- 9 Reconnect the MSD power cord.
- 10 Startup and pump down the MSD according to the procedure in the *Operations* chapter.

Cleaning the ion source

There is no regular interval for cleaning the ion source. The ion source should be cleaned whenever instrument symptoms indicate it is necessary. See the *Troubleshooting* chapter for more information about the symptoms of a dirty ion source. The ion source cleaning procedure is divided into the following sub-procedures

- Removing the ion source 6-42
- Disassembling the ion source 6-44
- Cleaning 6-46
- Reassembling the ion source 6-50
- Reinstalling the ion source 6-52

Note Clean gloves should be worn throughout this procedure.

Materials needed

Abrasive paper (5061-5896)

Alumina abrasive powder (8660-0791)

Aluminum foil, clean

Cloths, clean (05980-60051)

Cotton swabs (5080-5400)

Glass beakers, 50 and 400 ml

Gloves, clean (8650-0029 (small) or 8650-0030 (large))

Hex ball driver, 1.5 mm (8710-1570)

Pozidrive screwdriver, #2 (8710-0900)

Solvents

acetone, reagent-grade

methanol, reagent-grade

methylene chloride (dichloromethane) reagent-grade

Ultrasonic bath

Wrench, open end, 1/4-inch x 5/16-inch (8710-0510)

Removing the ion source

- 1 Remove the analyzer from the MSD. Refer to *Removing the analyzer* earlier in this section.
- 2 Examine the wires between the nine-pin feedthrough and the pins of the ion source (see Figure 6-12). Make notes about which wires connect to which pins on the ion source. These will help you reconnect them properly later.
- 3 Disconnect the wires from the pins on the ion source.
- 4 Unscrew and remove the GC/MS interface socket.
- 5 Remove the two small screws that hold the ion source into the radiator.
- 6 Pull out the ion source, taking care not to damage the filaments. Place the ion source on a clean, lint-free cloth.

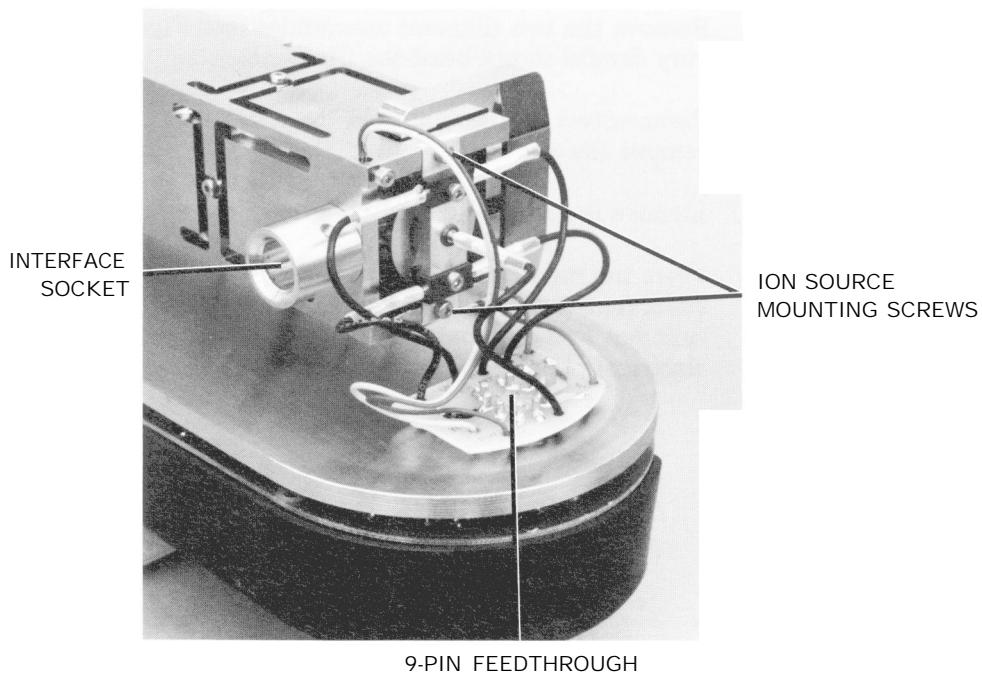


Figure 6-12. Removing the ion source

Disassembling the ion source

- 1 Remove the two filament assemblies (see Figure 6-13). Be very careful to not bend the filaments.
- 2 Remove two screws that hold the repeller in place and remove the repeller.
- 3 Remove the set screw that holds the lens stack in place.
- 4 From the repeller end of the ion source, push out the lens stack (entrance lens, ion focus lens, and insulator), drawout cylinder, and drawout plate. Do not apply force to the electrical pins on the entrance lens or ion focus lens.

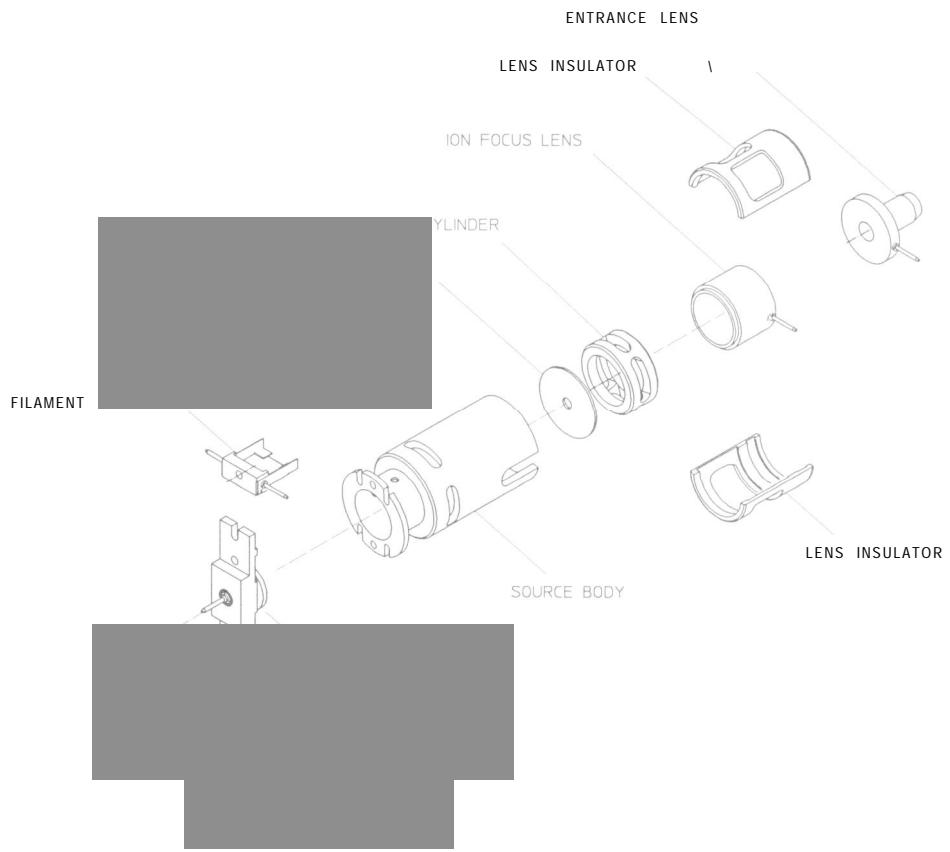


Figure 6-13. Disassembling the ion source

Cleaning

The objective of cleaning the ion source parts is to remove deposits that can interfere with instrument performance. The amount and type of cleaning required depends on the condition of the parts (how dirty they are) and the material the parts are made of (generally stainless steel or ceramic).

Cleaning steel parts — Almost all of the metal parts in the ion source are stainless steel. Stainless steel is relatively easy to clean because many solvents and mild abrasives can be used without damaging the parts. We recommend a three-step process for cleaning stainless steel parts:

1. Abrasive cleaning
2. Ultrasonic cleaning in a series of solvents
3. Drying

If steel parts show no visible discoloration, the abrasive cleaning step can be eliminated. Surfaces that do not come into contact with the sample or ion beam (such as the outside of the source body) generally do not require abrasive cleaning even if they are discolored.

Caution It is generally not necessary to clean the screws with abrasives. They should, however be cleaned ultrasonically.

Abrasive paper or an abrasive slurry of alumina powder and reagent-grade methanol can be used to clean steel parts. Generally the slurry is preferred because it is less abrasive. Also, a swab with slurry can reach corners that are difficult to clean with abrasive paper.

Use only enough force to remove the discolorations. It is not necessary to polish the parts. All residue from the abrasive cleaning should be rinsed away with reagent-grade methanol before you begin the ultrasonic cleaning.

All steel parts, abrasively cleaned or not, should be ultrasonically cleaned for 15 minutes in each of the following solvents

1. Methylene chloride
2. Acetone
3. Methanol

Each of these solvents removes different types of contaminants. The solvents should be used in the order listed.

WARNING All of these solvents are hazardous, work in a fume hood at all times and take appropriate precautions.

Note Parts that are cleaned abrasively should be ultrasonically cleaned separately from parts which are not abrasively cleaned.

Drying can be accomplished by baking the cleaned parts in the GC oven at 50°C for 30 minutes. Parts that are not thoroughly dried will carry solvent into the vacuum manifold resulting in contamination and slowing of the pumpdown procedure.

Note Take care to avoid recontaminating cleaned parts. Always wear clean gloves. Never set the parts down on dirty surfaces. When drying the parts in an oven, set the parts in a clean beaker. Loosely cover the top of the beaker with aluminum foil to prevent dust in the oven from contaminating the parts.

Cleaning other parts — A few parts in the MSD ion source are not stainless steel and require special cleaning procedures.

The filament assemblies should not be cleaned at all. They do not contact the sample path and their cleanliness is not essential. Attempting to clean the filament assemblies could easily result in damage to the assemblies.

The repeller is mostly stainless steel but has a vespel seal where the contact pin joins the repeller. The rest of the repeller can be cleaned like other stainless steel parts. The vespel area should not be abrasively cleaned but can safely be ultrasonically cleaned.

The lens insulators are also vespel. They should not be abrasively or ultrasonically cleaned. Abrasive cleaning will damage them. Sonic cleaning can cause the insulators to swell. If the insulators appear dirty, they can be cleaned with a cotton swab dampened with reagent-grade methanol. If that fails to clean the insulators, they should be replaced.

Cleaning procedure — Follow these steps to clean the parts of the ion source.

- 1) Clean and dry all of the metal parts of the ion source as described in *Cleaning steel parts*. Pay particular attention to areas that contact the ion beam. Those areas include
 - The round face of the repeller
 - The inside and vent slots of the ion source body
 - Both faces of the drawout plate and the hole in the plate
 - The inside and vent slots of the drawout cylinder
 - All surfaces of the ion focus lens
 - The flat side of the entrance lens and the hole in the lens

It is generally not necessary to abrasively clean the exterior of the ion source body.

- 2) Clean or replace the lens insulators as described under *Cleaning other parts*.

Caution Be very careful to not recontaminate the parts once you have cleaned them. It is a good idea to put on a new pair of clean gloves before handling the cleaned and dried parts.

Reassembling the ion source

- 1 Slide the drawout plate and then the drawout cylinder into the ion source body (see Figure 6-14).
- 2 Bring together the entrance lens, ion focus lens, and the two lens insulators. Together, these are the lens stack.
- 3 Slide the lens stack into the source body.
- 4 Reinstall the set screw that holds the lens stack in place.
- 5 Reinstall the repeller on the source body.
- 6 Reinstall the filament assemblies. Make sure that the filaments are still centered over the small holes in the source body.

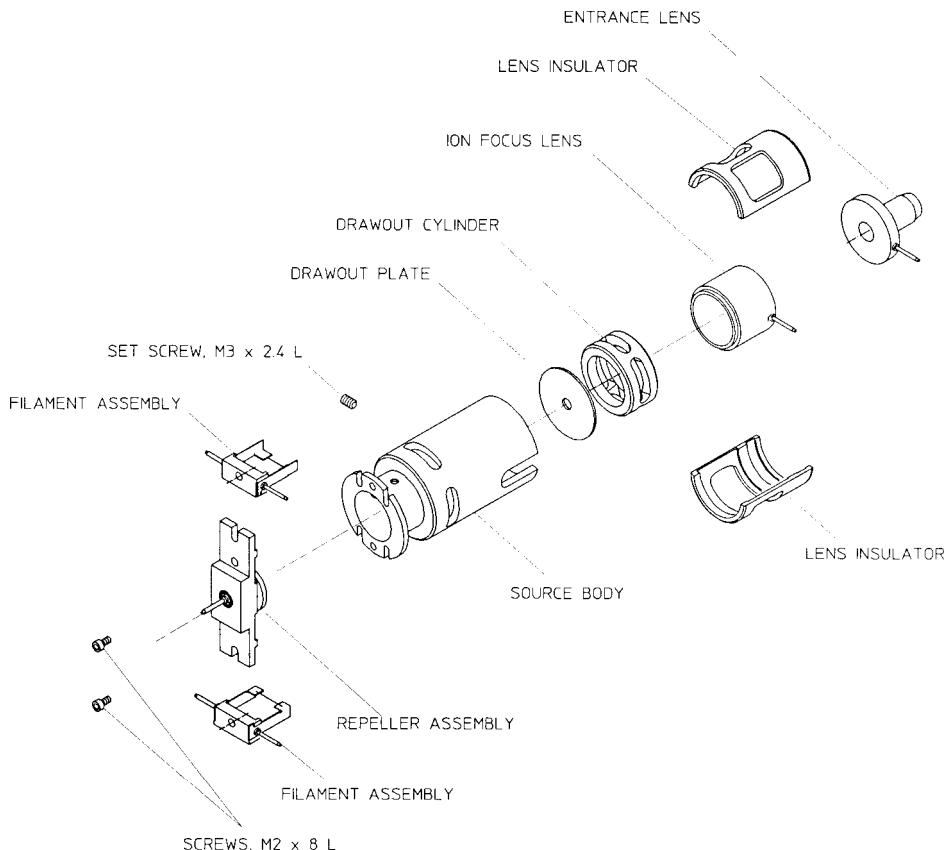


Figure 6-13. Disassembling the ion source

Reinstalling the ion source

- 1 Reinstall the ion source in the radiator (see Figure 6-15).
Be careful to not damage the filaments
- 2 Reinstall the GC/MSD interface socket.
- 3 Reconnect the wires from the feedthrough to the appropriate pins on the ion source. Refer back to the notes you took when you disconnected these wires.
- 4 Reinstall the analyzer in the MSD. Refer to *Reinstalling the analyzer* earlier in this section.

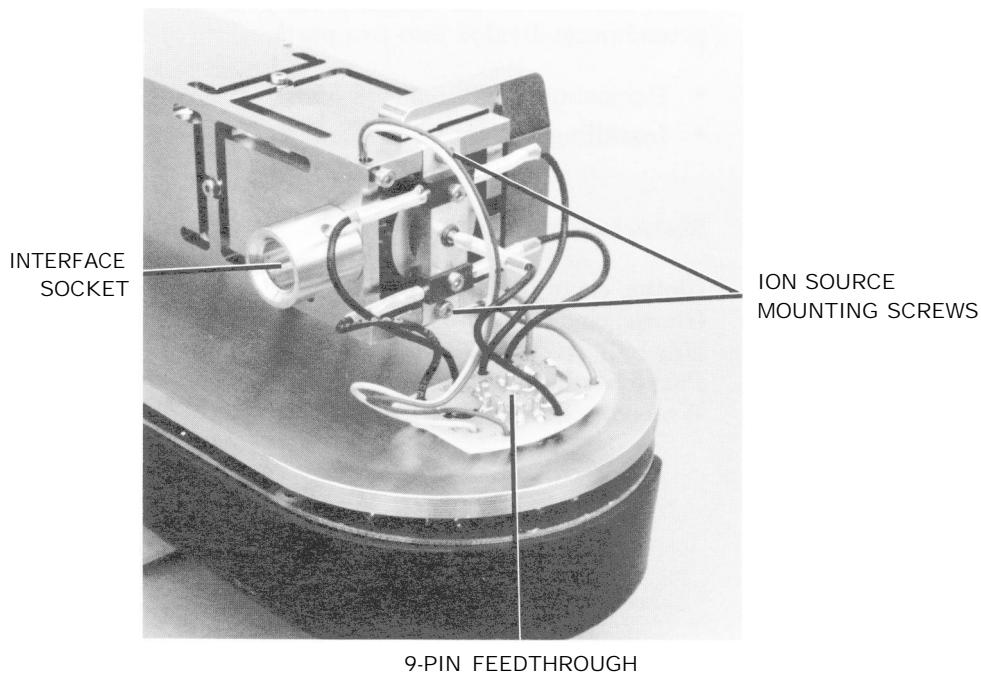


Figure 6-15. Reinstalling the ion source

Replacing a Before replacing an ion source filament, make sure the filament other filament is not adequate for your analyses. This procedure is divided into two parts:

- Removing the filament 6-55
- Installing a filament 6-58

Materials needed

Cloths, clean (05980-60051)

Gloves, clean (8650-0029 (small) or 8650-0030 (large))

Hex ball driver, 1.5 mm (8710-1570)

Pozidrive screwdriver, #2 (8710-0900)

Wrench, open end, 1/4-inch x 5/16-inch (8710-0510)

Removing a filament

Note Wear clean gloves throughout the procedure.

- 1 Note from your data system which filament (1 or 2) is not working correctly.
- 2 Remove the analyzer as described in *Removing the analyzer* earlier in this section.
- 3 Examine the wires between the nine-pin feedthrough and the pins of the ion source (see Figure 6-16). Make notes about which wires connect to which pins on the ion source. These will help you reconnect them properly later.
- 4 Disconnect the wires from the pins on the ion source.
- 5 Unscrew the GC/MSD interface socket and remove it from the radiator.
- 6 Remove the two small screws that hold the ion source in the radiator.
- 7 Pull out the ion source, taking care to not damage the filaments.
- 8 Remove the appropriate filament assembly (see Figure 6-17).

Note The ion source shown in Figure 6-17 is an older version without the vent slots. The filament orientation is the same for all versions of the ion source.

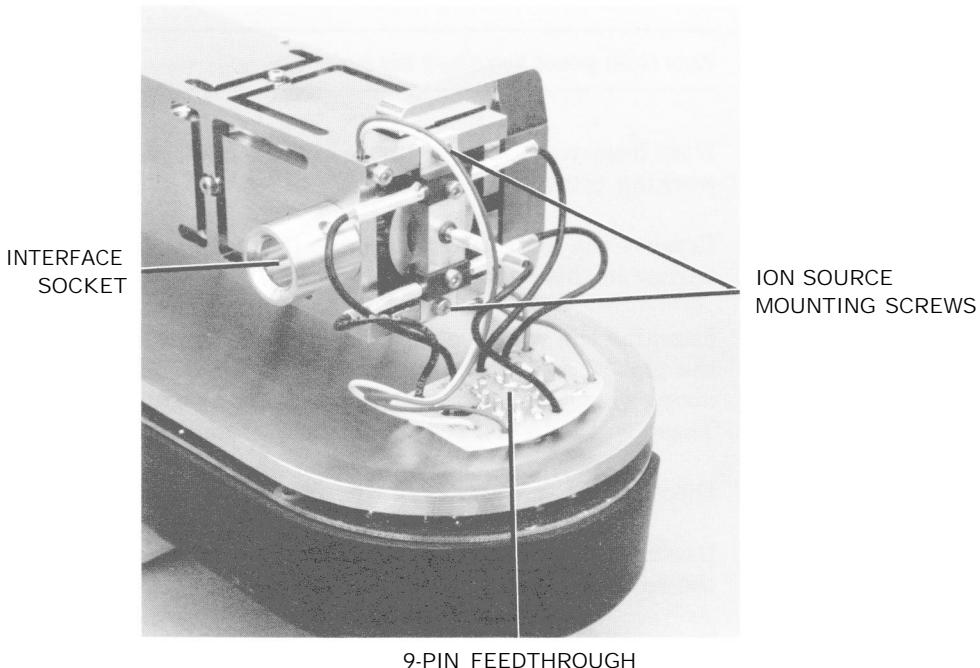


Figure 6-16. Removing the ion source

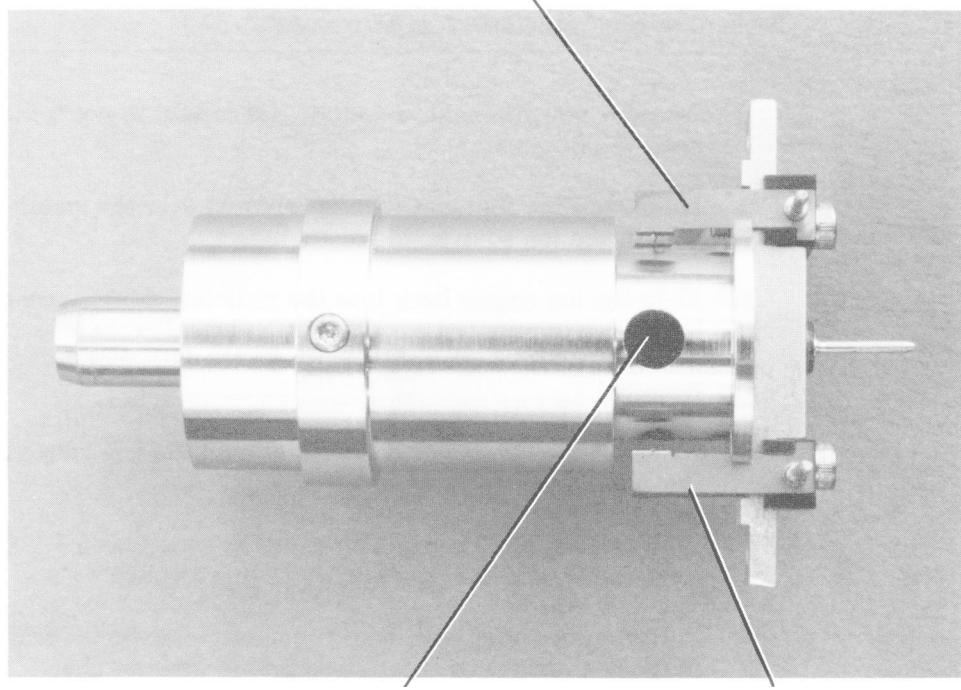


Figure 6-17. Filament retaining screws

Installing a filament

Note Wear clean gloves throughout this procedure,

- 1 Install a new filament assembly. Be careful to not touch or bend the filament.
- 2 Make sure the filament wire is centered over the small hole in the ion source.
- 3 Slide the ion source back into the radiator. Make sure the ion source is oriented correctly with the entrance hole facing the side of the radiator where the interface socket is installed.
- 4 Reinstall the two small screws that hold the ion source in the radiator.
- 5 Reinstall the analyzer by following the procedure *Reinstalling the analyzer* earlier in this chapter.
- 6 Perform autotunes with both filaments. Determine which filament provides the best performance and use that filament for analyses. See the *Tuning* section in the *Operation* chapter in this appendix and the tuning information in the manuals supplied with your data system for more information.

Replacing the detector The detector (electron multiplier) has a limited lifetime and will eventually need to be replaced. See the *Troubleshooting* chapter for more information about symptoms of a worn-out detector. Replacing the detector is divided into two procedures:

- Removing the detector 6-60
- Installing a detector 6-62

Materials needed:

Cloths, clean, lint-free (05980-60051)
Detector assembly (05971-80101)
Gloves, clean (8650-0029 (small) or 8650-0030 (large))
Hex ball driver, 1.5 mm (8710-1570)
Pozidrive screwdriver, #2 (8710-0900)

Removing the detector

Note Wear clean gloves throughout this procedure.

- 1 Remove the analyzer by following the procedure *Removing the analyzer* earlier in this section.
- 2 Disconnect the detector electrical leads (see Figure 6-18).
- 3 Disconnect the detector support from the top plate.
- 4 Disconnect the detector support from the detector.
- 5 Remove the two small screws that hold the detector onto the ceramic quadruple support at the end of the radiator.
- 6 Hold the ceramic quadruple support in place and remove the detector.

Caution If you accidentally pull out the ceramic quadruple support the quadruple will drop, losing alignment and possibly damaging the quadruple.

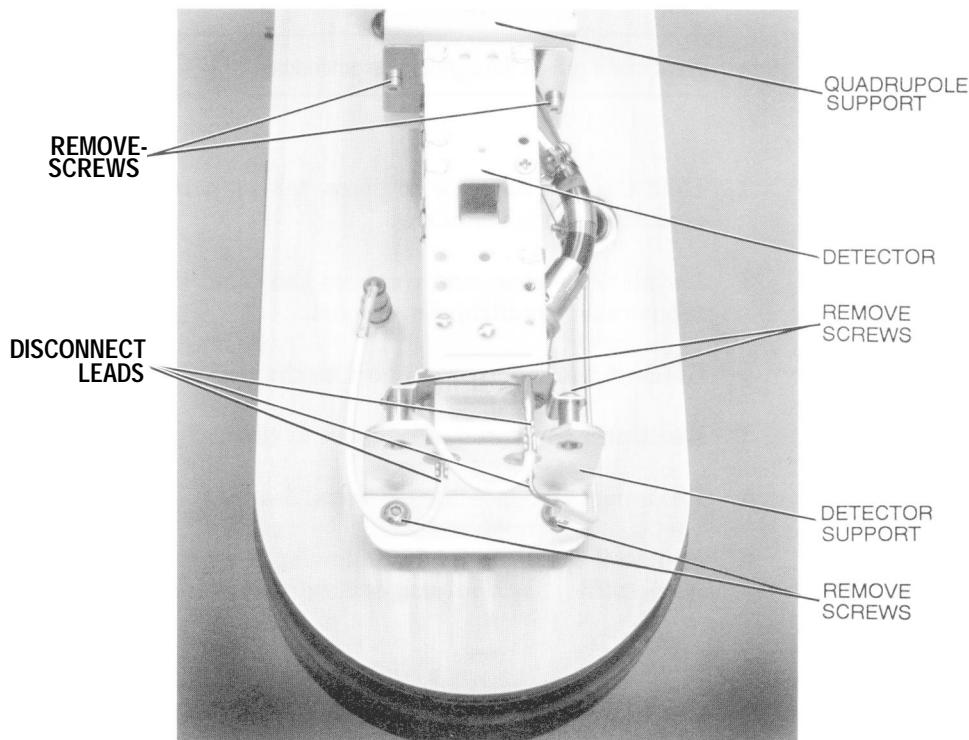


Figure 6-18. Removing the detector

Installing a detector

Note Wear clean gloves throughout this procedure.

- 1** Hold the new detector in place, taking care to not touch the electron multiplier horn.
- 2** Install the screws and washers that hold the detector to the ceramic quadruple support.
- 3** Connect the detector support to the end of the new detector.
- 4** Reconnect the detector support to the top plate.
- 5** Reconnect the detector electrical leads.
- 6** Reinstall the analyzer by following the procedure *Reinstalling the analyzer* earlier in this section.

Replacing the analyzer The entire analyzer (ion source, mass filter, and detector) plus the top plate and top board can be replaced as a unit. This is sometimes the fastest way to get your MSD back to work. To replace the analyzer, follow this procedure

Materials needed:

Analyzer assembly (05971-60101)
Screwdriver, Pozidriv #2 (8710-0900)
Wrench, 1/4-inch, open-end (8710-0510)

Procedure:

- 1 Remove the analyzer (with top plate and top board) according to the procedure *Removing the analyzer* earlier in this chapter.
- 2 Install a new analyzer (with top plate and top board) according to the procedure *Reinstalling the analyzer* earlier in this chapter.
- 3 In your data system software, reconfigure the filament selection and dc polarity on the quadruple to match the settings on the final test results sent with the new analyzer assembly,

Note If you fail to reset the filament selection or quadruple polarity, the sensitivity of the MSD can be seriously impaired.

GC/MSD Interface Maintenance

There are no regularly scheduled maintenance procedures for the GC/MSD interface. The procedures in this section should be performed as necessary. See the *Troubleshooting* chapter for more information about indications of the need for maintenance. If you have doubts about your ability to safely and correctly perform a maintenance procedure, contact your Hewlett-Packard Customer Engineer. Procedures in this section include:

- Replacing the heater/sensor assembly 6-65

**Replacing the
heater/sensor
assembly**

When symptoms indicate that is necessary, use the following procedures to replace the heater/sensor assembly in the GC/MSD interface. See the *Troubleshooting* chapter for more information about the symptoms of a burned out heater or failed sensor.

- Removing the heater/sensor assembly 6-66
- Installing a heater/sensor assembly 6-68

Materials needed:

Heater/sensor assembly (05971-60105)
Screwdriver, Pozidriv #1 (8710-0899)
Wrench, 1/4-inch, open-end (8710-0510)

Removing the heater/sensor assembly

- 1 Shut down and vent the MSD. Refer to the *Operation* chapter for more information.
- 2 Disconnect the cable that connects the GC/MSD interface to the GC. Move the MSD away from the GC.

WARNING Be sure to give the GC/MSD interface enough time to cool. Otherwise, it will be dangerously hot.

- 3 Remove the insulation from around the GC/MSD interface.
- 4 Loosen the four screws that hold the heater sleeve onto the GC/MSD interface (see Figure 6-19),
- 5 Slide the heater sleeve off of the GC/MSD interface.
- 6 Disconnect the ground wire from the rear half of the heater sleeve.
- 7 Loosen the set screw that holds the heater cartridge in the heater sleeve. Slide the heater cartridge and thermocouple out of their holes in the heater sleeve.

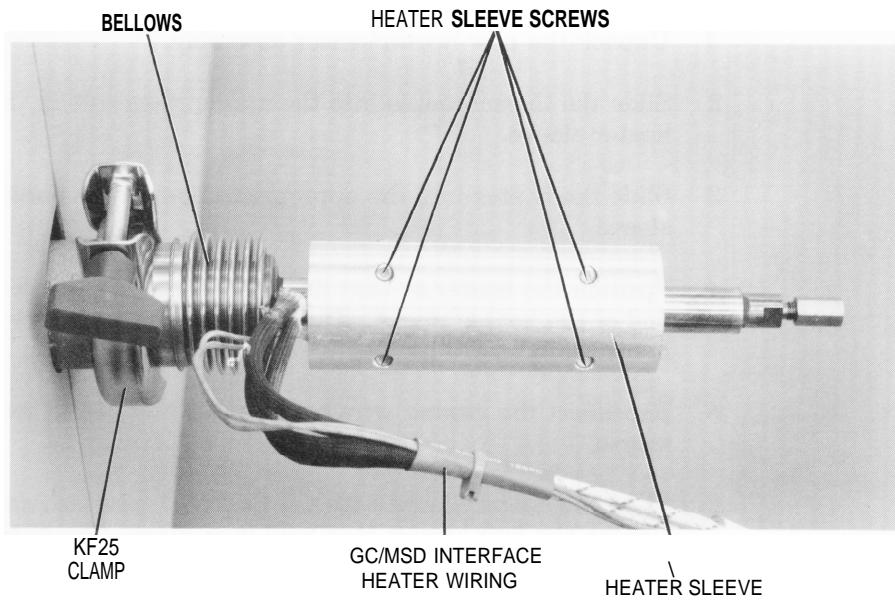


Figure 6-19. Removing the heater/sensor assembly

Installing a heater/sensor assembly

- 1 Unpack the new heater/sensor assembly.
- 2 Slide the thermocouple into the appropriate hole in the heater sleeve.
- 3 Slide the heater into the appropriate hole in the heater sleeve.
- 4 Position the heater so that its outer end is even with the end of the heater sleeve. Then, tighten the set screw that holds the heater in place.
- 5 Reconnect the ground wire to the other half of the heater sleeve.
- 6 Slide the heater sleeve onto the GC/MSD interface and tighten the four screws that hold it in place. Try to tighten the screws evenly.
- 7 Slide the insulation over the heater sleeve.
- 8 Move the MSD into its normal position next to the GC. Reconnect the heater/sensor cable to the GC.
- 9 Reinstall the capillary column. Then, startup and pump down the MSD.

Electronics Maintenance

There are no regularly scheduled maintenance procedures for the MSD electronics. Procedures for replacing fuses and printed circuit boards can be found in the *Technical Reference* appendix in this manual.



Introduction 7-2

Ordering Information 7-3

Electronics 7-4

Vacuum System 7-6

Analyzer 7-8

GC/MSD Interface 7-12

Consumables 7-13

Miscellaneous 7-15

Introduction

This chapter lists parts which can be ordered for use in the maintenance of your HP 5971A. It includes most of the parts or assemblies in the HP 5971A. It does not include individual electronic components; the electronic assemblies (printed circuit boards) are available only as complete assemblies.

Some parts are available as rebuilt assemblies. Rebuilt assemblies pass all the same tests and meet all the same specifications as new parts. Rebuilt assemblies can be identified by their part numbers; the first two digits of the last five digits of the part number are 69 (i.e., XXXXX-69XXX). Some rebuilt assemblies are available on an exchange-only basis. In those cases, you must return the equivalent part to Hewlett-Packard after you receive the rebuilt assembly.

This chapter is organized so that related parts are grouped together.

If a part you need is not listed in this chapter, check the *Hewlett-Packard Analytical Supplies Catalog*. If you still can not find it, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Ordering Information

To obtain parts for your HP 5971A MSD, address the order or inquiry to your local Hewlett-Packard office. Supply them with the following information:

- Model and serial number of your MSD**
- HP part number(s) of the part(s) needed**
- Quantity of each part needed**

Electronics

The printed circuit boards in the MSD are available only as complete assemblies. Individual electronic components are not available. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Description	HP Part Number
APG remote control interface card	05971-60009
Cables	
analyzer cable kit (wiring inside the vacuum manifold)	0597140130
APG connector cable (from APG remote Control card to APG connector)	05970-60151
ect	05971-60416
diffusion pump thermal switches and connector	05971-60424
expansion cable (from APG remote control card to HP-IB/MS control card)	05971-60426
filament twisted pair	05971-60412
foreline gauge	05971-60413
GC to GC/MSD interface (GC/MSD heater/sensor assembly)	05971-60105
HP-IB cable, 1-meter	8120-4654
HP-IB connector cable (from HP-IB/MS control card to HP-IB connector)	05971-60417
ion source	05971-60005
IRD external accessory control cable (used in GC/IRD/MSD systems)	05971-60429

continued

Description	HP Part Number
Cables – continued	
main board to top board (ribbon cable)	05971-60018
parallel/remote cable (GC)	05990-60119
power distribution board to main board	05971-60422
remote control cable (to GC)	35900-80700
Fuses	
diffusion pump	
2-amp (220/240 V ac)	2110-0002
4-amp (110/120 V ac)	21104055
power supply	
1-amp (220/240 V ac)	2110-0001
2-amp (110/120 V ac)	2110-0002
HP-IB/MS control card	05971-89006
Main board	05971-60118
Power distribution board	05971-60003
Power supply	0950-1882
Top board	05971-89001

Vacuum System

This table lists the replacement parts available for the vacuum system. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Description	HP Part Number
Blank flange, KF25	0100-1396
Calibration valve and vial	05971-60550
Clamp	
KF10/16, for foreline hose fitting	0100-1397
KF25 hinged, for GC/MSD interface	0100-1398
KF25 stamped, for calibration valve	0100-0549
KF40, for top of foreline trap	0100-1426
KF50 for diffusion pump	0100-1395
Diffusion pump, complete	
110/120 V ac	05971-60530
220/240 V ac	05971-60531
Fan	
110/120Vac	05971-60540
220/240 V ac	05971-60541
Foreline hose	05971-60119
Foreline pump, Edwards E2M2	
all 60 Hz and 100 V ac, 50 Hz MSDs	3162-0149
all other 50 Hz MSDs	05989-80024
Foreline trap	
body	05971-20562
body screen	05971-00560
cap	05971-20561
cap screen	05971-00561

continued

Description	HP Part Number
Foreline vacuum gauge	
fitting	05971-20530
gauge tube	09604540
O-rings and seals	
KF10 O-ring assembly	0100-1183
KF25 O-ring assembly	3162-0110
KF40 O-ring assembly	0100-1425
NW25 seal, vented	0100-1551
NW50 seal	05971-20177
top plate	05971-40100
Shipping clamp	
front	05971-00210
rear	05971-00211
Thermal switch, for diffusion pump	
too cold (bottom)	3103-0145
too hot (top)	3103-0146
Top plate (includes feed-throughs)	05971-60120
Vacuum manifold	05971-20550

Analyzer

This table lists the replacement parts related to the analyzer. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or contact your local Hewlett-Packard office.

Description	HP Part Number
Analyzer (ion source, mass filter, and detector) with top plate and top board, tested	05971-69100
Analyzer cable kit (wiring inside manifold)	05971-60130
Detector assembly	05971-80101
Interface (GC/MSD) socket	05971-20133
Ion source, complete	05971-60102
body	05971-20128
drawout cylinder	05971-20141
drawout plate	05971-20134
entrance lens (with pin)	05971-20126
filament assembly	05971-60140
ion focus lens (with pin)	05971-20127
lens insulator (pair)	05971-20130
repeller assembly	05971-60170
Magnet assembly	05971-60160
Quadruple contacts (1 pair)	05971-60132
Quadruple ring, detector end	05971-20136
Quadruple ring, source end	05971-20135
Radiator	05971-20120
Screws	
M2 x 5L ion source mounting screw	0515-1077
M2 x 6L detector mounting screw	0515-0221
M2 x 8L filament retaining screw	0515-1046
M3 x 2.4L lens stack set screw	0515-1446
M3 x 8L analyzer mounting screw	0515-0319
Top plate	05971-60120

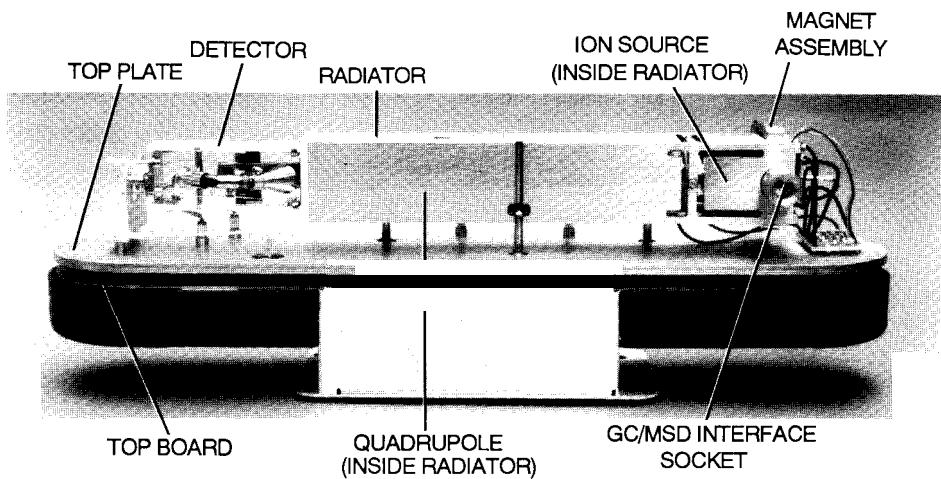


Figure 7-1. Analyzer

Description	HP Part Number
Ion source, complete	05971-80102
body	05971-20128
drawout cylinder	05971-20141
drawout plate	05971-20134
entrance lens (with pin)	05971-20128
filament assembly	05971-80140
ion focus lens (with pin)	05971-20127
lens insulator (pair)	05971-20130
repeller assembly	05971-80170

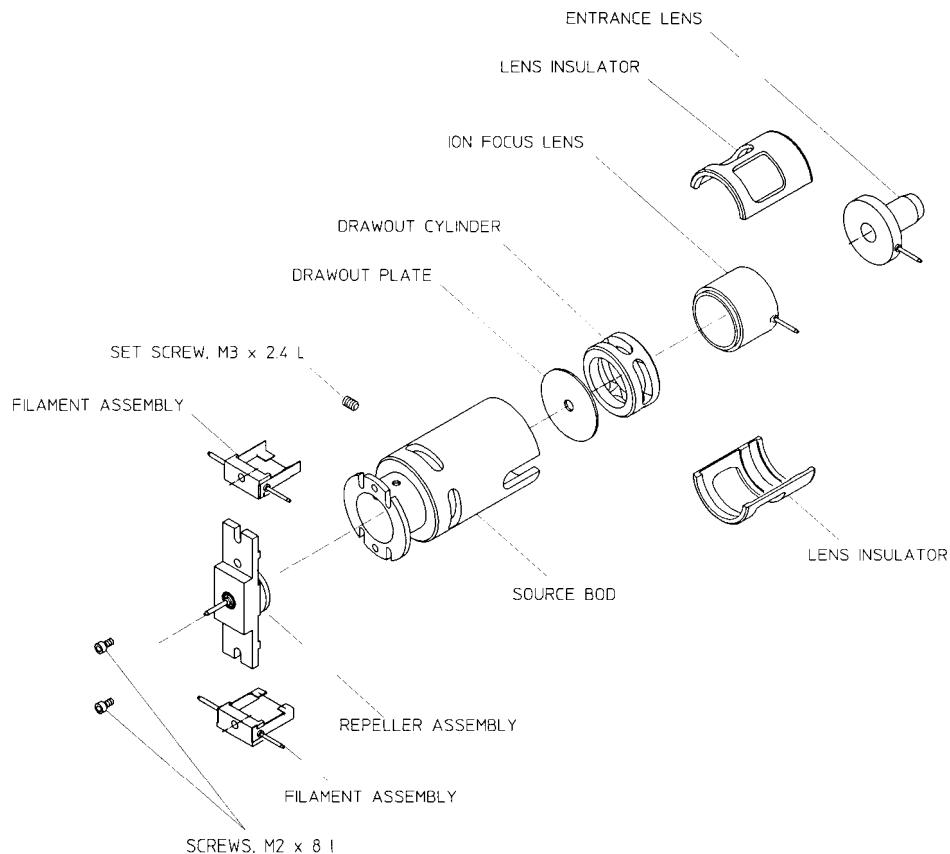


Figure 7-2. Ion source - exploded view

This table lists the replacement parts related to the GC/MSD interface. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Description	HP Part Number
Column nut	05988-20066
Effluent splitter	
ferrule	
for megabore (0.53-mm id) column	0100-1186
for restrictor column	0100-0698
for wide-bore column (0.32-mm id)	0100-0636
nut	
for capillary columns	05988-20066
for vent tube	2740-0015
restrictor column	05971-20590
sealing ring, for vent tube	0905-0938
split tube	05988-20224
tee connector	05995-20174
Guide tube	05971-20307
Heater sleeve	05988-20210
Heater/sensor assembly (includes cable)	05971-60105
Insulation	05971-20301
Screws, M4 x 16L for heater sleeve	0515-0071
Transfer tube	
tip (gold-plated)	05971-20305
welded assembly	05971-60300

Consumables

Consumables are supplies which are regularly used up during normal MSD operation or maintenance. This table lists consumables for the MSD. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Description	HP Part Number
Abrasive paper, 30 μ m	5061-5896
Alumina powder	8660-0791
Cable ties	1400-0482
Cloths, clean	05980-60051
Cotton swabs (package of 100)	5080-5400
Diffusion pump fluid (20 ml)	6040-0723
Ferrules	
blank, graphite-vespel	01004691
0.1 7-mm id, for restrictor column	0100-0698
0.301-mm id, for narrow-bore column	0100-1295
0.44-mm id, for wide-bore column	0100-0636
0.70-mm id, for megabore column	0100-1186
Filament assembly	05971-60140
Foreline pump fluid (1 liter)	6040-0517
Foreline trap pellets	9301-1104
Fuse	
diffusion pump	
2-amp (220/240 V ac)	21104002
4-amp (110/120 V ac)	2110-0055
power supply	
1-amp (220/240 V ac)	2110-0001
2-amp (110/120 V ac)	2110-0002

continued

Description	HP Part Number
Gloves, clean	
large	6650-0030
small	6650-0029
Hydrocarbon sample kit	05970-60045
O-rings and seals	
KF10 O-ring assembly	0100-1163
KF25 O-ring assembly	3162-0110
KF40 O-ring assembly	0100-1425
NW25 seal, vented	0100-1551
NW50 seal	05971-20177
top plate	0597140100
PFTBA sample kit	05971-60571
Teflon tape	0460-0016
Vacuum gauges	
ionization gauge tube	0960-0376
foreline gauge tube	0960-0540

Miscellaneous

This table lists parts that do not conveniently fit in any of the other categories in this chapter. If there is a part you need that is not listed in this chapter, contact your Hewlett-Packard Customer Engineer or contact your local Hewlett-Packard office.

Description	HP Part Number
Grommet, 0.875-inch id (for cutouts in sheet metal to mount the vacuum manifold)	0400-0268
Paint, touch-up, Dove gray	6010-1146
Tool kit	05971-60561
Video tape (cleaning the ion source)	
VHS-NTSC format	05971-90007
VHS-PAL format	05971-90008





Appendix A

Gauge Controller

Table of Contents

Appendix A

General Information	A-1
System Overview	A-9
Installation	A-19
Operation	A-27
Troubleshooting	A-31
Maintenance	A-39
Parts	A-49

General Information

Introduction A-2

General Description A-3

Specifications A-5

Manuals A-6

Warranty / Warranty Claims/ Service Agreements A-7

Introduction

This appendix describes the theory, operation, and maintenance of the gauge controller (option 400 of the HP 5971A Mass Selective Detector) and ionization gauge tube. The information in this appendix supersedes any corresponding information in the main body of this hardware manual. Information not superseded by this appendix can be assumed to still apply to instruments equipped with the gauge controller.

This appendix is organized as follows:

- Chapter 1. General Information
- Chapter 2. System Overview
- Chapter 3. Installation
- Chapter 4. Operation
- Chapter 5. Troubleshooting
- Chapter 6. Maintenance
- Chapter 7. Parts

General Description

Each HP 5971A MSD is equipped with an ionization (ion) gauge tube. The optional gauge controller allows you to use the ion gauge tube to monitor the pressure in the MSD vacuum manifold. This can aid both everyday operation and troubleshooting.

The gauge controller provides power for the ion gauge tube, measures the current flow in the ion gauge tube, and displays the pressure in the ion gauge tube. The gauge controller option includes the gauge controller, a power cord, and a cable for connecting the gauge controller to the ion gauge tube,

The gauge controller can be ordered and installed with a new HP 5971A MSD or retrofitted to an MSD that is already in service,

Note

HP 5971A MSDs with serial numbers below 3049A00000 were not equipped with ionization gauge tubes. An ion gauge tube and gauge controller can still be retrofitted to those instruments. Order HP 598226 option #071. This option includes the gauge controller, ion gauge tube, and necessary fittings.

GAUGE CONTROLLER POWER CORD GAUGE TUBE CONTROLLER CABLE

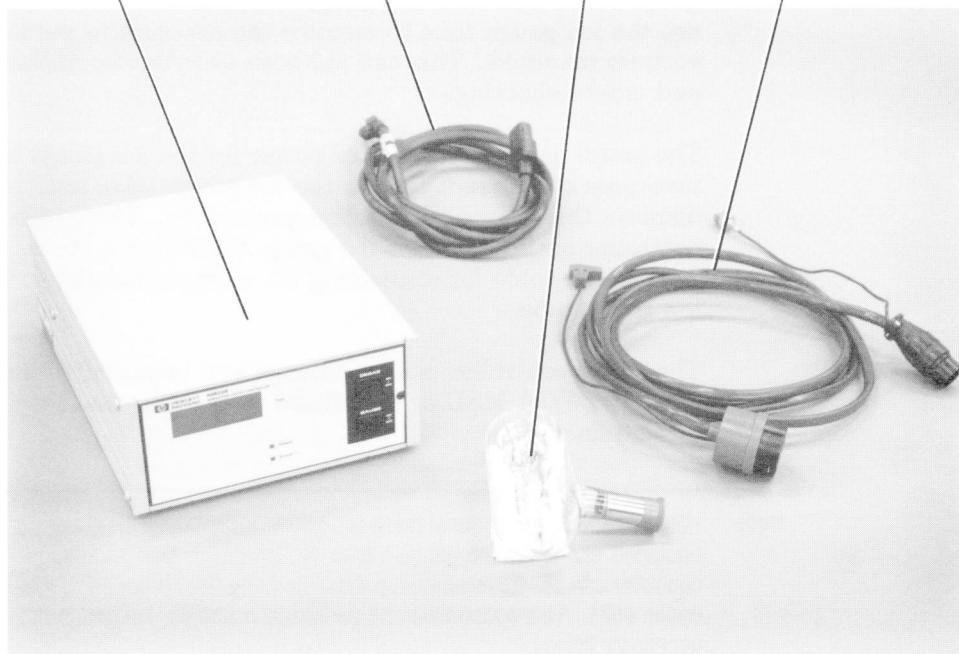


Figure A-1. Gauge controller

Specifications

The gauge controller does not change the specifications of the HP 5971A MSD. Some specifications of the gauge controller itself are as follows:

Dimensions

Height	3.5 inches (89 mm)
Width	9.5 inches (241 mm)
Depth	14.0 inches (358 mm) including connectors
Weight	10.5 lb (4.8 kg)

Electrical

Voltage	90-130 V ac; or 200-260 V ac
Frequency	50-80 Hz
Power	100 W, maximum
Fuse	90-130 V, 1.25A; 200-260 V, 0.80 A
Degas	8 V, 10 A, maximum
Emission current	0.01 mA-10 mA; factory at at 0.01 mA
Emission current/ pressure	0.01 to 0.1 mA 10^{-7} to 10^{-1} Torr 0.1 to 1.0 mA 10^{-8} to 10^{-2} Torr 1.0 to 10 mA 10^{-9} to 10^{-3} Torr
Accuracy ¹	Typically $\pm 3\%$ of reading at 20°C to 30°C

¹Not corrected for helium

Manuals

In addition to this appendix the gauge controller includes an instruction manual from its manufacturer. The instruction manual contains much valuable information about the installation and operation of the gauge controller.

WARNING

Be sure to read the information on grounding in the manufacturer's manual.

Warranty /

The gauge controller does not alter the MSD warranty.
The gauge controller is included in the MSD warranty.

**Warranty
Claims /**

The ionization gauge tube is considered a consumable part and is not included in the MSD warranty. For warranty, warranty claims, and service agreement information, see the *General Information* chapter in the main body of this manual.

**Service
Agreements**



Introduction A-10

Theory of Operation A-11

Hardware Description A-B

Introduction

This chapter contains two sections. The first, *Theory of Operation*, describes the theory of how an ionization gauge functions. The second, *Hardware Description*, describes the gauge controller and the parts supplied with it.

Theory of Operation

Ionization gauges rely on the ionization of gas molecules to establish a pressure-dependent current flow. In a typical ionization gauge (see Figure A-2), a heated filament emits electrons that are accelerated from the filament toward a coiled grid that is held at a high positive voltage relative to the filament. The rate of electron emission from the filament is regulated by a circuit that controls the current that heats the filament.

Emitted electrons may traverse the distance from the filament to the coiled grid several times, but most will eventually collide with and ionize the gas molecules that are in the tube. Some ions will be formed outside the coiled grid, but the positive ions formed inside the positive coiled grid are electrically trapped. They are then driven to a collector wire, from which they are fed to a measurement circuit. The number of ions formed is, of course, a function of the number of molecules present. Pressure is also a function of the number of molecules present so the pressure can be inferred from the current through the measurement circuit. The ionization gauge will not operate at pressures above approximately 1×10^{-3} Torr.

At the collector wire, the ions give up their charges and recombine to form neutral molecules. These neutral molecules can then return to the gas phase or stay adsorbed on the collector wire. In addition, some ions are formed outside the coiled grid and are, therefore, repelled by it. They, too, can recombine to form neutral molecules that can adhere to and contaminate the inner surfaces of the gauge tube. Because of this contamination of collector wire and tube inner surfaces, it is desirable to periodically degas the tube. Degassing is accomplished by passing a large current through the grid coil in order to briefly raise the gauge temperature.

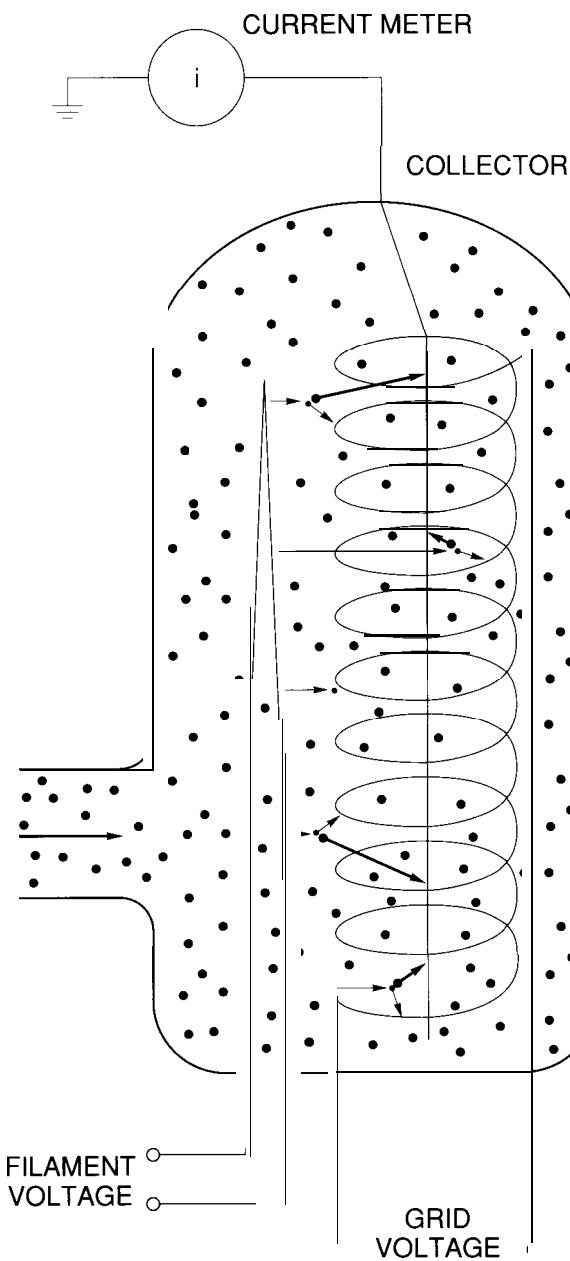


Figure A-2. Ionization gauge tube

Hardware Description

The gauge controller option includes of the following parts:

- Gauge controller
- Controller cable
- Power cable

Although they are supplied as standard parts of the MSD, the ionization gauge tube and its tee fitting are functionally a part of the gauge controller option.

Ionization The ionization (ion) gauge tube is mounted inside the MSD gauge tube just below the front of the vacuum manifold (see Figure A-3). The ion gauge tube is connected to a fitting that is connected to the vacuum manifold. The interior of the gauge tube is at the same pressure as the interior of the vacuum manifold.

WARNING The ion gauge tube operates at dangerously high temperature and voltages. Do not work near the gauge tube unless it is turned off and has had sufficient time to cool. Even when the gauge tube is off, there is a maximum voltage of 5.5 V present on the gauge tube pins.

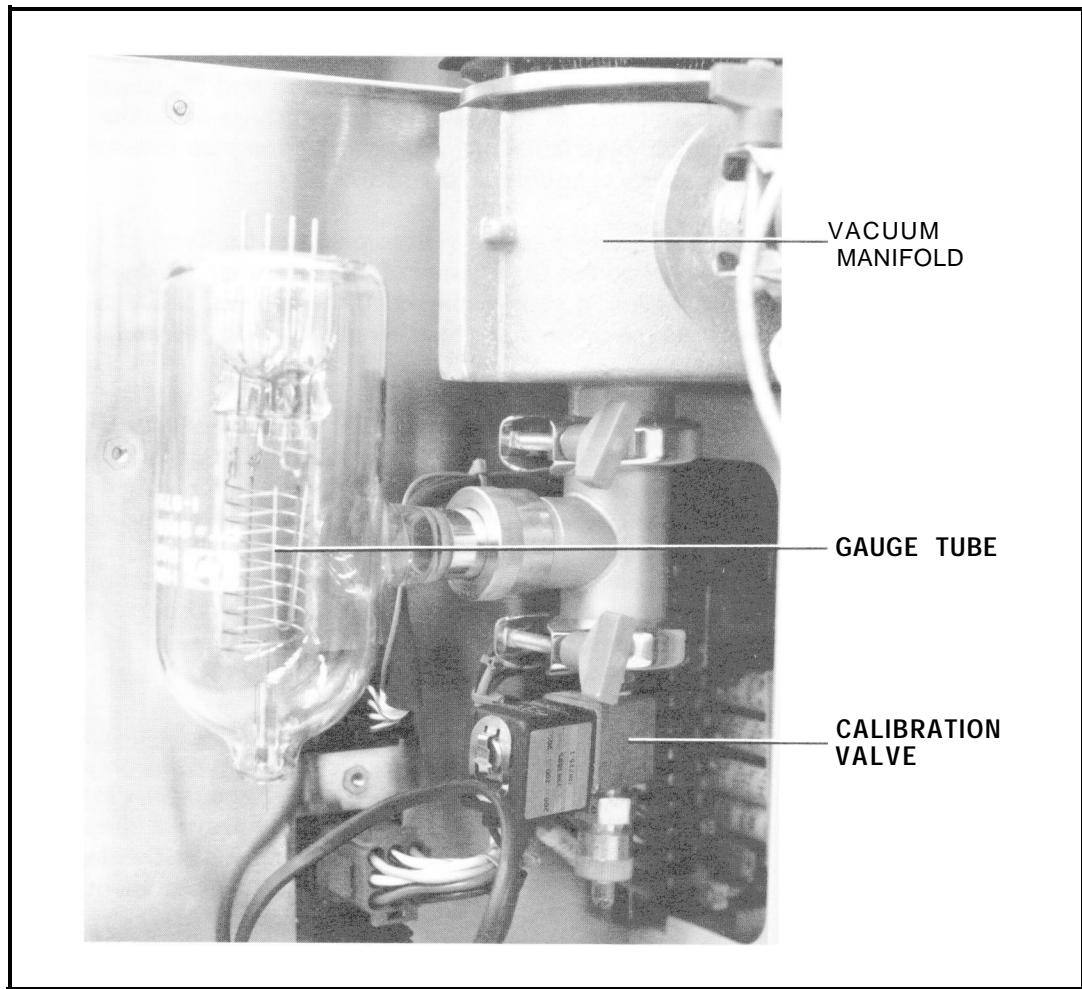


Figure A-3. Gauge tube location

Gauge controller

The gauge controller (1) regulates the current to the filament of the gauge tube, thus ensuring a constant emission of electrons from the filament and (2) measures the ion current to the collector. From these data, the controller calculates and displays the pressure present in the vacuum manifold of the MSD.

A digital readout of the system pressure (in Torr) is displayed on the front panel of the controller. A degas on/off switch, a gauge-tube on/off switch, and LEDs that indicate power-on and degas-on are also located on the front panel (Figure A-4).

The gauge controller incorporates degas circuitry which makes it possible to periodically decontaminate the collector wire and the inner surfaces of the ion gauge tube. The degas circuit is turned on by means of the degas on/off switch on the front panel of the controller. The degas circuit passes a large current through the gauge-tube grid, thereby increasing the tube temperature and burning off adsorbed contaminants from the inner surfaces of the tube and from the collector wire,

An electrical interlock prevents actuating the degas circuit unless the ion gauge tube is on and the displayed pressure is below 5×10^{-5} Torr. This interlock prevents turning the degas on at system pressures that would prevent electron emission from the filament or that would make the degas current ineffective. There is no pressure measurement displayed during operation of the degas circuit.

The gauge controller can be operated at distances of up to 50 ft from the ion gauge tube by using a longer controller cable than that furnished with the controller. However, as the length of the cable is increased, the degas power delivered to the gauge tube is decreased.

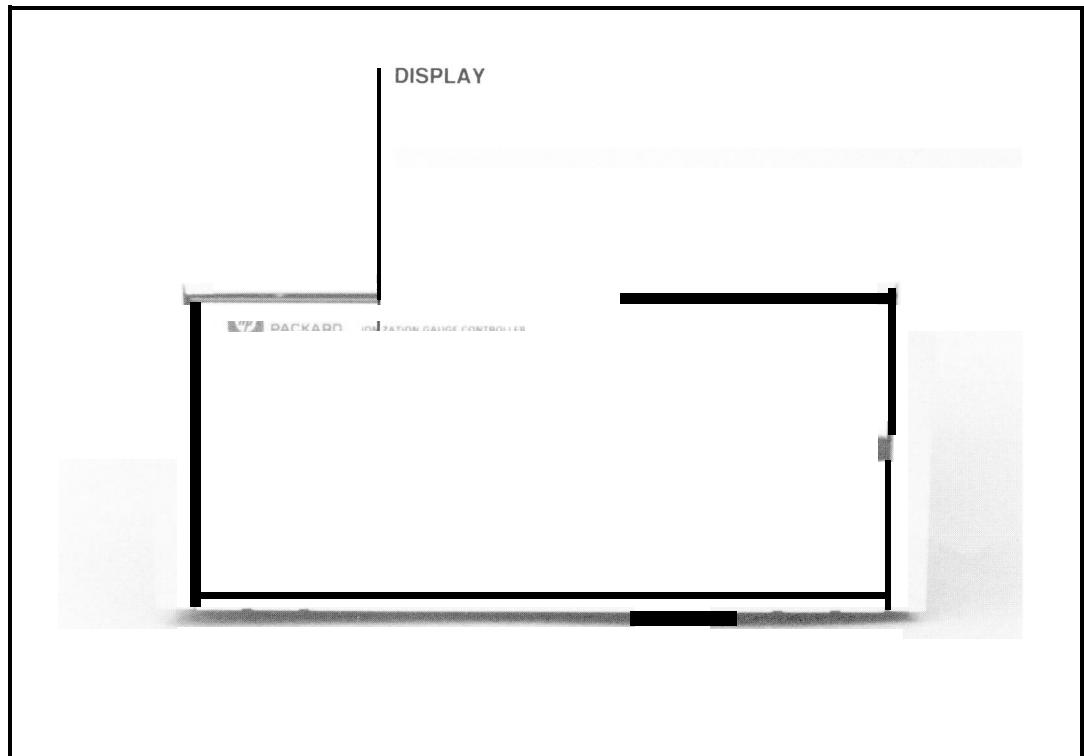


Figure A-4. Gauge controller front panel



Introduction A-20

Initial Installation A-21

Introduction

The ion gauge tube is supplied standard on the HP 5971A MSD. If you order the optional gauge controller with your MSD, your Hewlett-Packard Customer Engineer will connect the gauge controller to the ion gauge at the time of installation. If you are adding the gauge controller to an MSD that is already in service, you can connect the gauge controller to the ion gauge tube. Use the procedure, *Initial Installation*, in this chapter to connect the gauge controller and ion gauge tube.

Initial Installation

Use this procedure to connect the gauge controller to the ionization gauge tube in your HP 5971A MSD.

Materials needed

Controller cable (59822-60002)
Gauge controller (59822-60003)
Power cord (part of 59822-60003)
Screwdriver, Pozidriv #2 (8710-0900)

Procedure

- 1 Shut down and vent the MSD, using the procedure listed in the *Operation* chapter in the main body of this manual. Disconnect the MSD power cord.
- 2 Remove the MSD cover.
- 3 Connect the large blue connector on the controller cable to the four pin connectors on the top of the gauge tube (see Figure A-5).

WARNING Never attach the controller cable to an ion gauge tube that is under vacuum. If the tube pins are accidentally bent in making the connection, the tube can implode.

- 4 Connect the small blue connector on the controller cable to the single pin on the bottom of the gauge tube.
- 5 Route the cable so that it exits the MSD through the notch in the MSD cover below the GC/MSD interface. Then, reinstall the MSD cover.

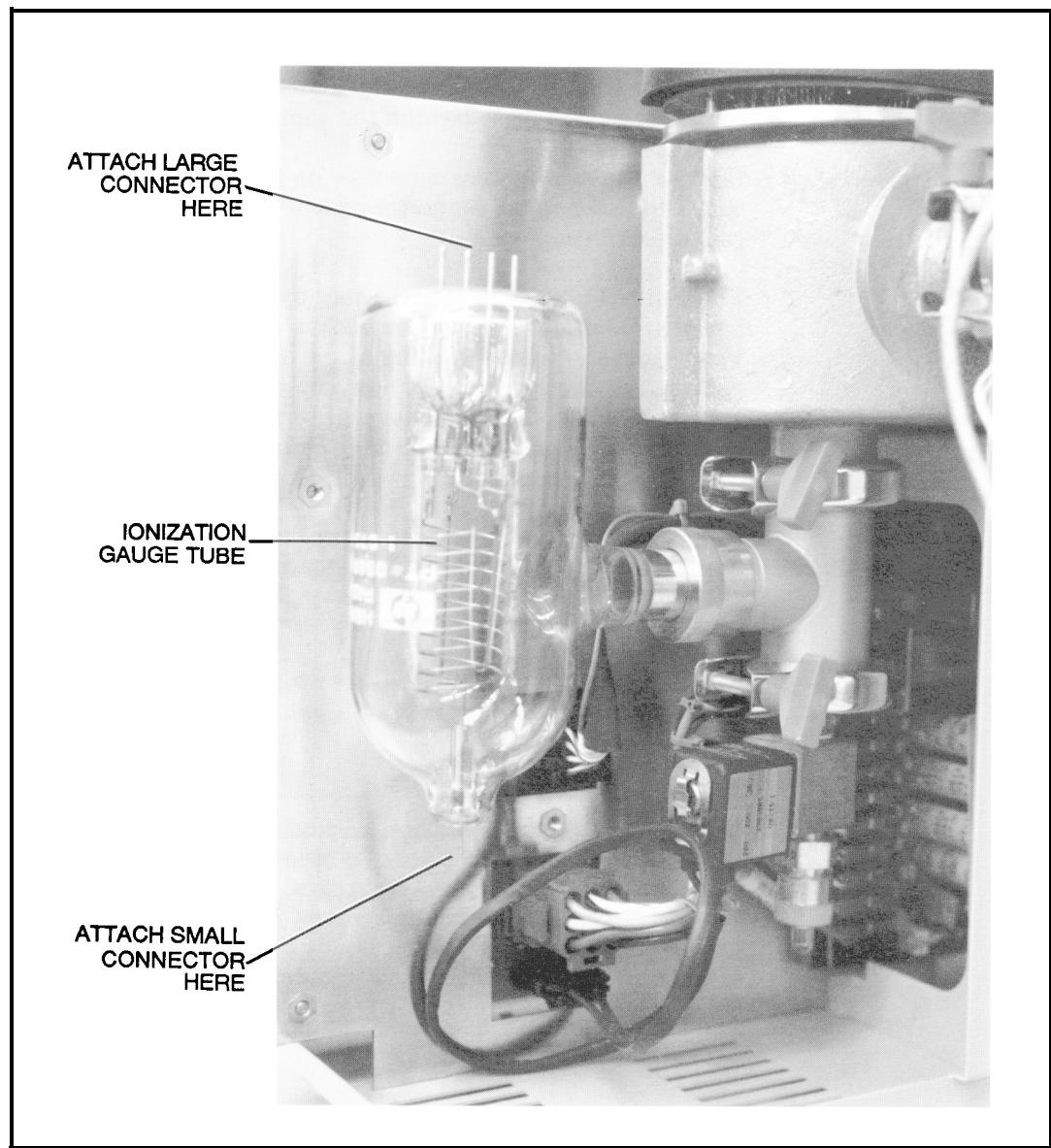


Figure A-5. Ion gauge tube connections

- 6 Press the large black connector on the controller cable to the gauge connector on the back panel of the gauge controller (Figure A-6). Turn the knurled ring on the black connector clockwise to tighten the connection.
- 7 Connect the small silver connector on the controller cable to the collector input connector on the back panel of the gauge controller.
- 8 Check the line-voltage selector card by looking through the transparent slide cover on the back of the controller. Verify that the voltage setting of the card (the readable voltage, not the inverted one) corresponds to the line voltage to which the controller will be connected. If it does not, refer to *Changing the Voltage Setting* in *Maintenance* chapter of this appendix.

WARNING Operating the gauge controller with an improperly set selector card can create a shock hazard and can damage the controller.

- 9 Connect the gauge controller power cord to the connector on the controller back panel (adjacent to the fuse) and then to the electrical outlet.

WARNING Under certain operating conditions, ion-producing devices and associated instruments can expose the operator to dangerously high voltages unless proper grounds are in place. For this reason, it is essential that the ion gauge controller and MSD are properly grounded. See the instruction manual supplied by the manufacturer of the gauge controller for more information about this important subject.

- 10 Once appropriate ground connections have been made, start up and pump down the MSD. Refer to the *Startup and Pumpdown* procedure in the *Operation* chapter in the main body of this manual.

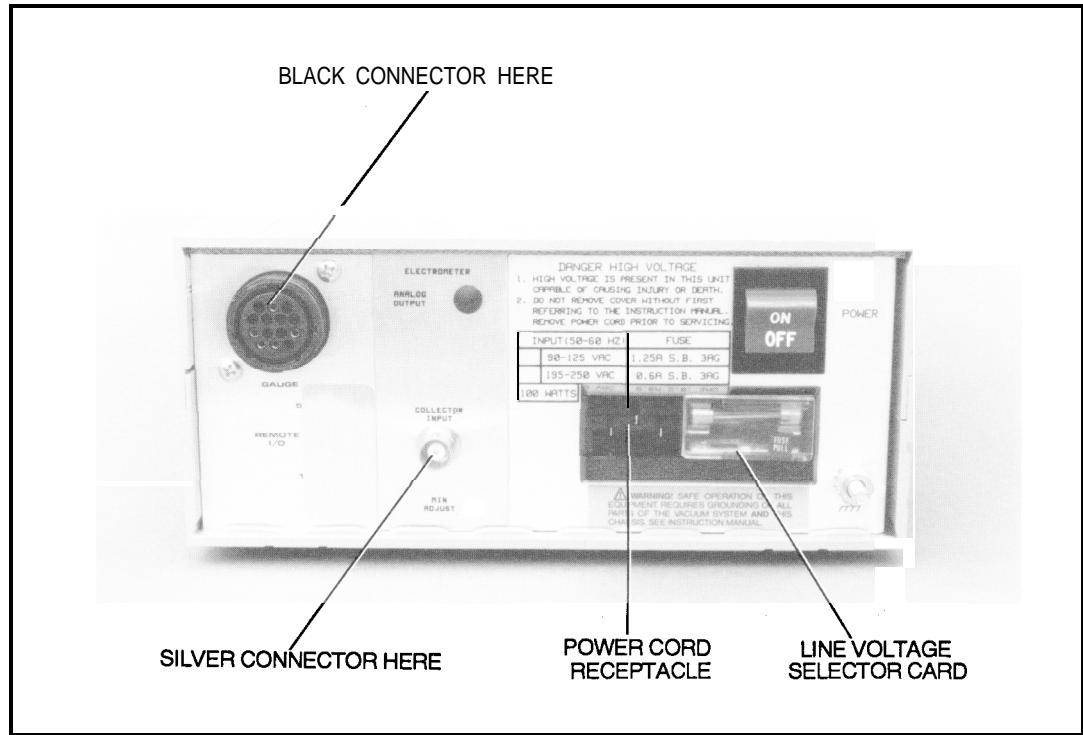


Figure A-6. Gauge controller back panel





Introduction A-28

Operating the Gauge Controller A-29

Introduction

The ion gauge tube and gauge controller enable you to monitor the pressure in the vacuum manifold of the MSD. To turn on the gauge controller and start monitoring pressure, refer to the following procedure:

- Operating the Gauge Controller

Operating the Gauge Controller

Follow these instructions to operate the gauge controller and ion gauge. Make sure the controller and MSD are properly grounded before starting operation. Refer back to Figure A-4 for clarification of switch locations,

WARNING

Under certain operating conditions, ion-producing devices and associated instruments can expose the operator to dangerously high voltages unless proper grounds are in place. For this reason, it is essential that the ion gauge controller and MSD are properly grounded. See the instruction manual supplied by the manufacturer of the gauge controller for more information about this important subject.

- 1 If it is not already on, start up and pump down the MSD **as** instructed in the *Operation* chapter in the main body of this manual.
- 2 Verify that the voltage selector on the gauge controller is set to the proper line voltage (see the *Installation* chapter in this appendix),
- 3 Verify that the gauge controller power cord is connected to a suitable source of ac power.
- 4 Turn on the gauge controller power switch (located on the back panel of the controller). The green power LED on the front of the gauge controller should light.
- 5 Once the MSD has completed the pumpdown procedure, press and release the gauge on/off switch on the front panel of the gauge controller. The pressure display should immediately indicate a reading of 9.9 + 9. After about 2 seconds, the actual pressure in the vacuum manifold will be displayed.

Note

If the pressure display on the gauge controller goes blank or continues to display 9.9 +9, refer to the *Troubleshooting* chapter later in this appendix.

With a normal carrier gas flow of less than 1 ml/min, pressure in the vacuum manifold should be less than 4×10^5 Torr as indicated on the gauge controller. Higher pressure can indicate a number of problems (vacuum leak, leftover solvents, etc.). See the *Troubleshooting* chapter in the main body of this manual for more information on causes of excessive pressure. If pressure in the vacuum manifold rises too high, the gauge controller will automatically turn off the ion gauge tube. Protective circuitry will also turn off the diffusion pump.

The ionization gauge is calibrated for air. If you are using a carrier gas such as helium, the pressure displayed by the gauge controller will not be absolutely accurate. Helium causes a pressure reading approximately 6 times lower than the actually pressure. For example, if the indicated pressure is 2.0×10^6 Torr, the actual pressure would be 1.2×10^5 Torr. All pressures listed in this manual are indicated pressures, so calculating the actual pressure is not very important.

As mentioned briefly in *Theory of Operation* earlier in this appendix the gauge tube must periodically be degassed. A step-by-step degas procedure is listed in the *Maintenance* chapter later in this appendix. The gauge controller will not execute the degas procedure if the pressure is above 5.5×10^5 Torr.

Introduction A-32

Symptoms A-33

Introduction

This chapter lists the symptoms and probable causes of the problems you are most likely to encounter while using the gauge controller to monitor the vacuum manifold pressure. These are problems related directly to the ion gauge or gauge controller. For general pressure symptoms, and other symptoms not covered in this chapter, refer to the *Troubleshooting* chapter in the main body of this manual or consult your Hewlett-Packard Customer Engineer.

Symptoms

This section lists most of the commonly seen symptoms of problems with the gauge controller. Symptoms described in this section include:

- The gauge controller power LED does not light when the power switch is turned on A-34
- The gauge controller fuse fails as soon as the power switch is turned on A-35
- The gauge controller display briefly shows 9.99 + 9 and then goes blank A-36
- With the degas switch on, the degas indicator does not light A-37

Symptom: The gauge controller power LED does not light when the power switch is turned on

Possible Cause: The gauge controller power cord is not connected to an electrical outlet.

Action: Connect the gauge controller power cord to an appropriate electrical outlet.

Possible Cause: There is no power at the electrical outlet to which the gauge controller is connected.

Action: Have a qualified electrician check the electrical outlet.

Possible Cause: The gauge controller fuse (F2) has failed.

Action: Check and, if necessary, replace the fuse. See the *Maintenance* chapter later in this appendix for more information.

Symptom: The gauge controller fuse fails as soon as the power switch is turned on

Possible Cause: The fuse and/or voltage setting in the gauge controller are not properly matched to the voltage of your power source.

Action: Make sure the voltage setting of the gauge controller matches the voltage of the power source. Replace the fuse with one of the correct rating. See the *Maintenance* chapter later in this appendix for more information.

Possible Cause: There is something else wrong with the gauge controller.

Action: Contact your Hewlett-Packard Customer Engineer.

Symptom: The gauge controller display briefly shows 9.99 + 9 and then goes blank

Possible Cause: Pressure in the vacuum manifold is too high to allow the ion gauge tube to turn on.

Action: Allow the system more time to pump down. If the vacuum system fails to reach a low-enough pressure, check for leaks or problems with the diffusion pump. See the *Troubleshooting* and *Maintenance* chapters in the main body of this manual for more information.

Possible Cause: The line voltage is low.

Action: Have a qualified electrician check the line voltage.

Possible Cause: The ion gauge tube is not connected to the gauge controller.

Action: Check all of the cable connections between the gauge tube and the gauge controller.

Possible Cause: The gauge tube filament is burned out.

Action: Inspect and, if necessary, replace the gauge tube. See the *Maintenance* chapter later in this appendix for more information.

Possible Cause: The controller cable is defective.

Action: Replace the controller cable.

Symptom: With the degas switch on, the degas indicator does not light

Possible Cause: The ion gauge tube is not on,

Action: The ion gauge tube must be on before it can be degassed.

Possible Cause: The vacuum manifold pressure is above 5×10^5 Torr.

Action: The gauge controller will not degas the ion gauge tube unless the pressure is below 5×10^5 Torr. Wait until the vacuum manifold pressure is lower.



Introduction A-40

Degassing the Ion Gauge Tube A-41

Replacing the Ion Gauge Tube A-42

Changing the Voltage Setting A-45

Replacing the Fuse A-48

Introduction

This section contains maintenance procedures unique to MSDs equipped with the optional gauge controller. Degassing of the gauge tube is a procedure which should be performed about once a week. All of the other procedures in this section should be performed only when indicated by instrument behavior. These procedure include replacing the ion gauge tube, changing the voltage setting of the gauge controller, and replacing the fuse in the gauge controller.

Degassing the Ion Gauge Tube

Inside surfaces of the ion gauge tube, as well as the collector, can become contaminated by neutral molecules that are formed in the tube as a result of the recombining of ions formed outside the coiled grid. This contamination can cause pressure readings to be erratic or false. These problems can be avoided by periodic (about once a week) degassing of the tube. Note that no pressure readings are available during degassing. Proceed as follows to degas the gauge tube.

Note The d as circuit cannot be actuated if the system pressure is greater than 5×10^5 Torr.

Materials needed:

None

Procedure:

- 1 Complete any analysis in progress.
- 2 With the system operating, press and release the degas switch (on the controller front panel). The degas LED should light.
- 3 A large current will be passed through the grid coil, increasing the temperature of the gauge tube. Allow the tube to operate at this high temperature for about 15 minutes. This will outgas the collector and the inner surfaces of the tube.
- 4 Press and release the degas switch again to stop the degas process.

Replacing the Ion Gauge Tube

When necessary, replace the gauge tube as follows. Refer to Figure A-7. The *Troubleshooting* chapter in this appendix contains more information about the symptoms of a failed ion gauge tube.

Materials needed:

Ion gauge tube (0960-0376)
Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

- 1 Complete or stop any analysis in progress.
- 2 Switch off the ion gauge tube (gauge on/off switch).
- 3 Switch off the gauge controller power switch and disconnect the gauge controller from its power source.
- 4 Shut down and vent the MSD as described in the *Operation* chapter in the main body of this manual. Disconnect the MSD power cord.
- 5 Remove the MSD cover.

WARNING The ion gauge tube may still be dangerously hot. Let it cool before removing it.

- 6 Disconnect the large blue connector from the top of the ion gauge tube. Disconnect the small blue connector from the bottom of the ion gauge tube.
- 7 Loosen the gauge tube by turning the knurled O-ring collar counterclockwise. Pull the gauge tube from the tee.
- 8 Install a new gauge tube in the tee and tighten the knurled O-ring collar by turning it clockwise.
- 9 Reconnect the large and small blue connectors to the appropriate ends of the gauge tube.

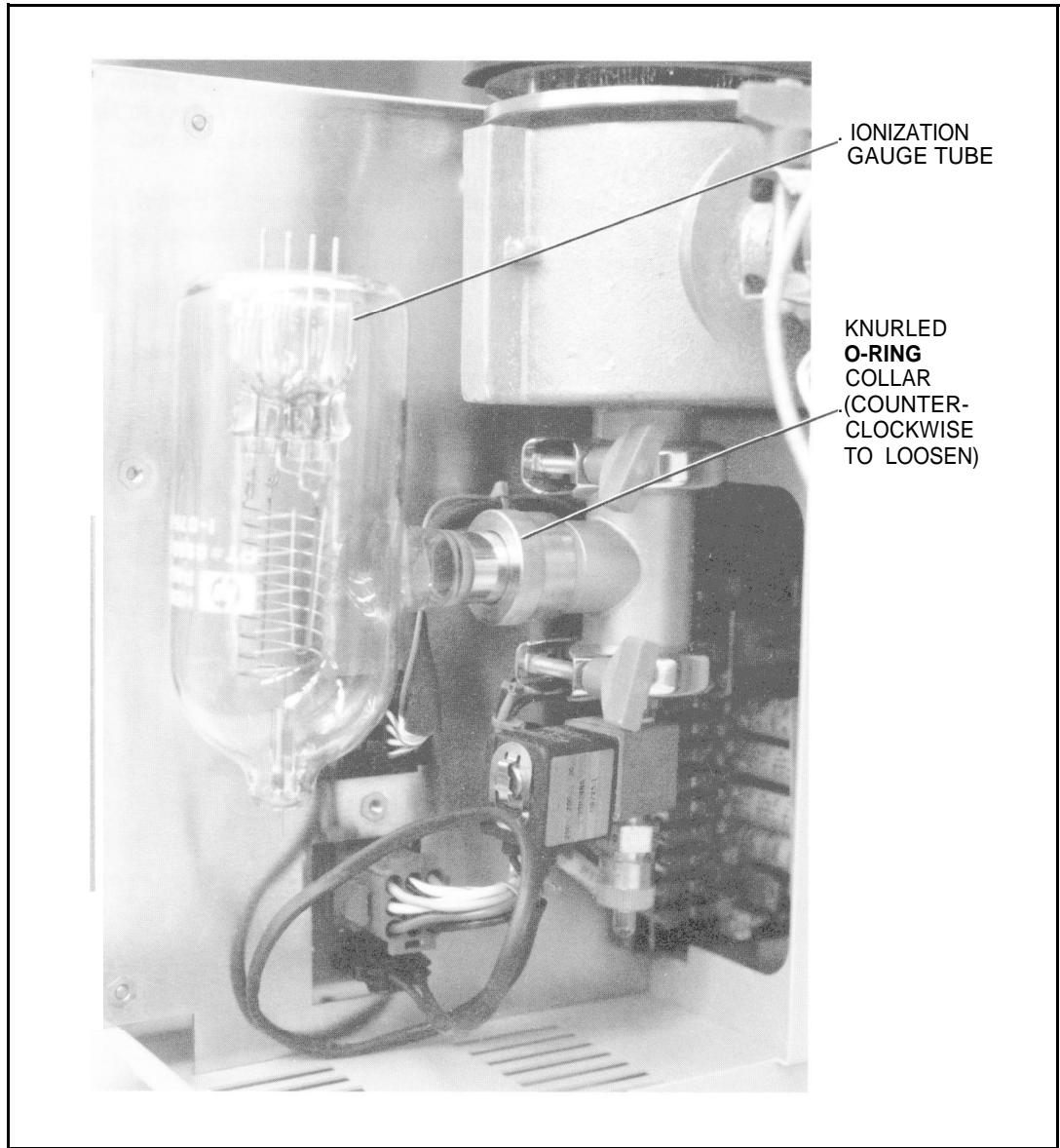


Figure A-7. Replacing the ion gauge tube

- 10 Reinstall the MSD cover,
- 11 Reconnect the MSD power cord. Start up and pump down the instrument according to the procedure listed in the *Operation* chapter in the main body of this manual.
- 12 Reconnect the gauge controller power cord. Switch on the new ion gauge tube according to the instructions provided in the *Operation* chapter in this appendix.

Changing the Voltage Setting

If the gauge controller is to be used with a line voltage that is different from the voltage visible on the voltage-selector card on the back of the gauge controller, proceed as follows to change the voltage setting.

Materials needed:

Fuse to match new voltage setting (if necessary)
Power cord to match new voltage setting (if necessary)

Procedure:

- 1 Use the gauge on/off switch to turn off the ion gauge tube.
- 2 Switch off the gauge controller power switch.
- 3 Disconnect the gauge controller power cord from the electrical outlet and then from the back panel of the gauge controller.
- 4 On the back panel of the gauge controller, slide the transparent fuse cover to the left (see Figure A-8).
- 5 Pull the fuse-extractor tab (labeled FUSE PULL) to the left and remove the fuse from the fuse holder.
- 6 Insert a sharp-pointed instrument into the small hole on the front edge of the voltage-selector card and pull the card out of the card holder. The card fits snugly in the card holder and considerable force may be required to remove it.
- 7 Reinsert the card so that the voltage setting required will be readable when the card is in place in the card holder.

Line Voltage	Card Setting	Fuse
90-110 V ac	100	1.25 A SB
105-130 V ac	120	1.25 A SB
195-235 V ac	220	0.60 A SB
210-260 V ac	240	0.60 A SB

- 8 Verify that the fuse is of the correct current rating. If necessary, insert a new fuse. Before inserting the fuse, move the fuse-extractor tab to the right.
- 9 Slide the transparent cover back over the fuse and connect the power cord to the new power source.

Caution A different power cord maybe required to match the new power source.

- 10 Switch on the gauge controller and then the ion gauge tube.

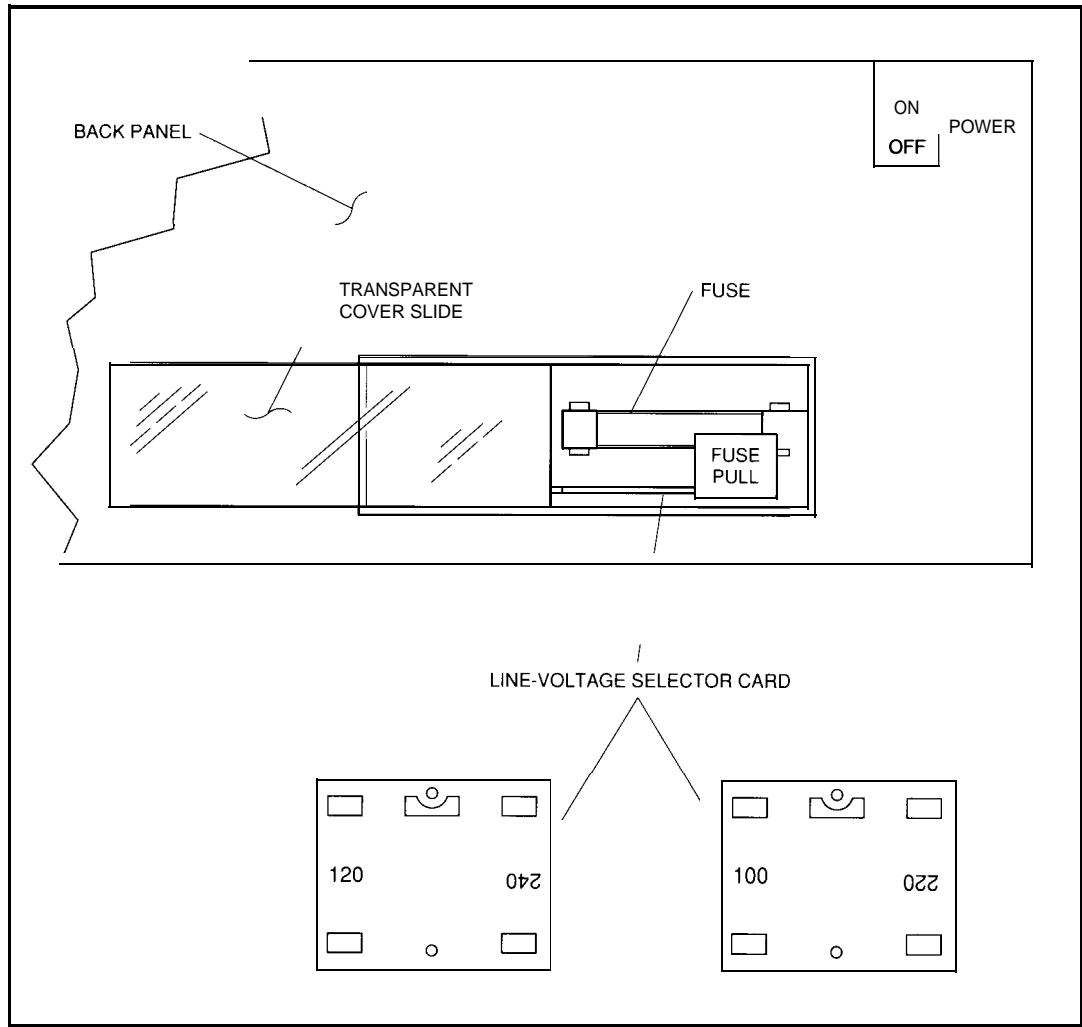


Figure A-8. Voltage selector card and fuse

Replacing the Fuse

To replace the gauge controller power fuse, follow the instructions for changing the gauge controller voltage setting but do not alter the voltage selector card setting. Also, it should not be necessary to replace the power cord.

Introduction A-50

Ordering Information A-50

Parts A-51

Introduction

This chapter lists parts which can be ordered for use in the maintenance of the gauge controller and related parts. If a part you need is not listed in this chapter, check the *Parts* chapter in the main body of this manual or check the *Hewlett-Packard Analytical Supplies Catalog*. If you still can not find it, contact your Hewlett-Packard Customer Engineer or your local Hewlett-Packard office.

Ordering Information

To obtain parts for the HP 5971A MSD, address the order or inquiry to your local Hewlett-Packard office. Supply them with the following information:

- Model and serial number of your MSD
- HP part number(s) of the part(s) needed
- Ž Quantity of each part needed

Parts

The following parts can be ordered for use in maintaining the optional high vacuum gauge. See the *Parts* chapter in the main body of this manual for additional parts.

Description	HP Part Number
Complete high vacuum system (includes gauge controller, ion gauge tube, controller cable, power cord, tee fitting, KF25 clamp and KF25 O-ring assembly)	HP 596226 #071
Controller cable (gauge controller to gauge tube)	59822-60002
Fuses	
0.60 A slow-blow	-----
1.25 A slow-blow	-----
Gauge controller	59822-60003
Ionization gauge tube	0960-0376
KF25 clamp	0100-0549
KF25 O-ring assembly	3162-0110
Tee fitting	05971-20580
Tube kit for HP 5971A (includes ion gauge tube, tee fitting, KF25 clamp and KF25 O-ring assembly)	59822-60071





Appendix B

Technical Reference

Table of Contents

Appendix B

General Information	B-1
Top Board	B-5
Main Board	B-25
HP-IB/MS Control Card	B-41
APG Remote Control Card	B-59
Power Distribution Board	B-71
Power Supply	B-85
Calibration Valve	B-99
Fuses	B-105
Diffusion Pump	B-109

General Information

Introduction B-2

Organization B-3

Introduction

This appendix contains information and procedures that are seldom needed by, or that are not appropriate for, the average operator of the HP 5971A Mass Selective Detector. It will be of interest primarily to Hewlett-Packard Customer Engineers and to instrument technicians. Information in this appendix includes:

- Theory of operation for the electronics in the MSD
- Procedures for replacing components that are expected to seldom fail
- Troubleshooting procedures and other adjustments that require exposure to dangerous voltages or temperatures

WARNING

A few of the procedures in this appendix involve a risk of exposure to hazardous voltages. Do not attempt these procedures unless you have been trained to work with hazardous voltages. If you are not absolutely positive of your ability to perform a procedure safely and correctly, wait and get assistance from your Hewlett-Packard Customer Engineer (CE).

Caution

Some of the procedures in this appendix can, if not performed correctly, result in damage to the MSD. Do not attempt these procedures unless you have been trained to service electronic equipment. In particular, you should be aware of the threat posed by electrostatic discharge and understand how to prevent electrostatic discharge.

Organization

This appendix contains the following chapters:

- Chapter 1. General Information
- Chapter 2. Top Board
- Chapter 3. Main Board
- Chapter 4. HP-IB/MS Control Card
- Chapter 5. APG Remote Control Card
- Chapter 6. Power Distribution Board
- Chapter 7. Power Supply
- Chapter 8. Calibration Valve
- Chapter 9. Fuses
- Chapter 10. Diffusion Pump

If the information you need is not in the main body of this manual, and is not in the appropriate chapter in this appendix or one of the other appendixes, contact your Hewlett-Packard Customer Engineer.



Theory of Operation B-6

Testing the Filaments B-15

Replacing the Top Board B-18

Adjusting the RF Coils B-22

Theory of Operation

The top board's primary functions are to generate the voltages applied to some elements of the analyzer and to pass signals back and forth between the analyzer and the main board. The top board contains the following functional elements:

- RF amplifier B-10
- DC amplifiers B-12
- High voltage supply B-13
- Thermocouple amplifier B-13
- Alternate filament relay B-14
- Feedthrough connections B-14

Figure B-1 shows the top board. Figure B-2 is a block diagram of the top board.

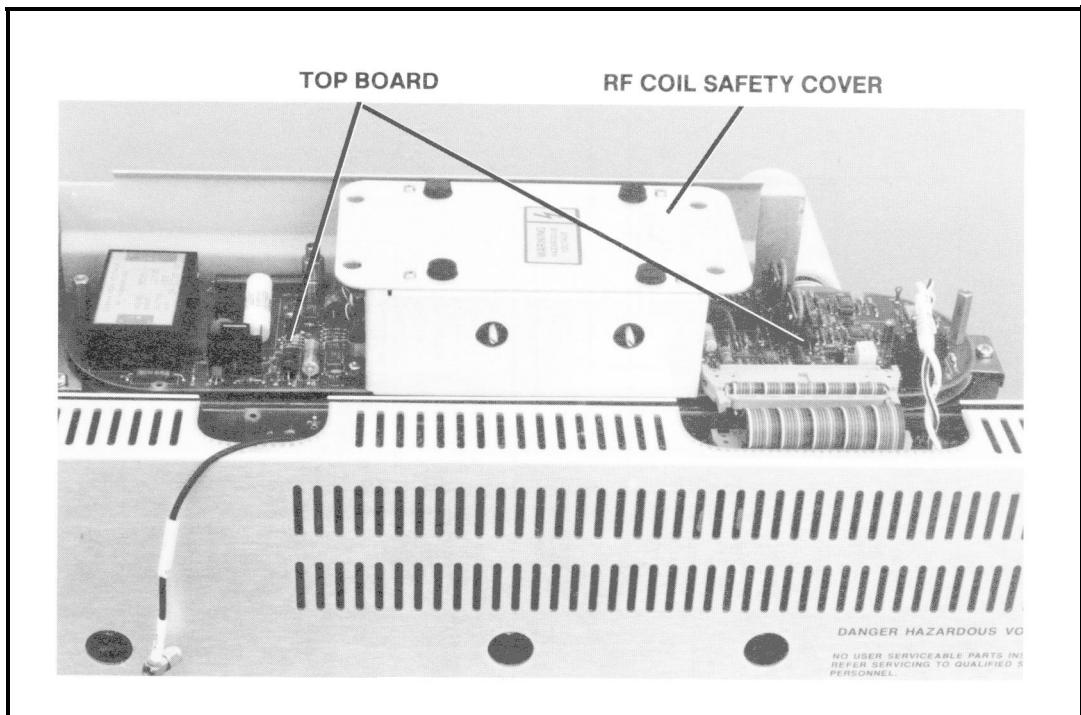


Figure B-1. Top board

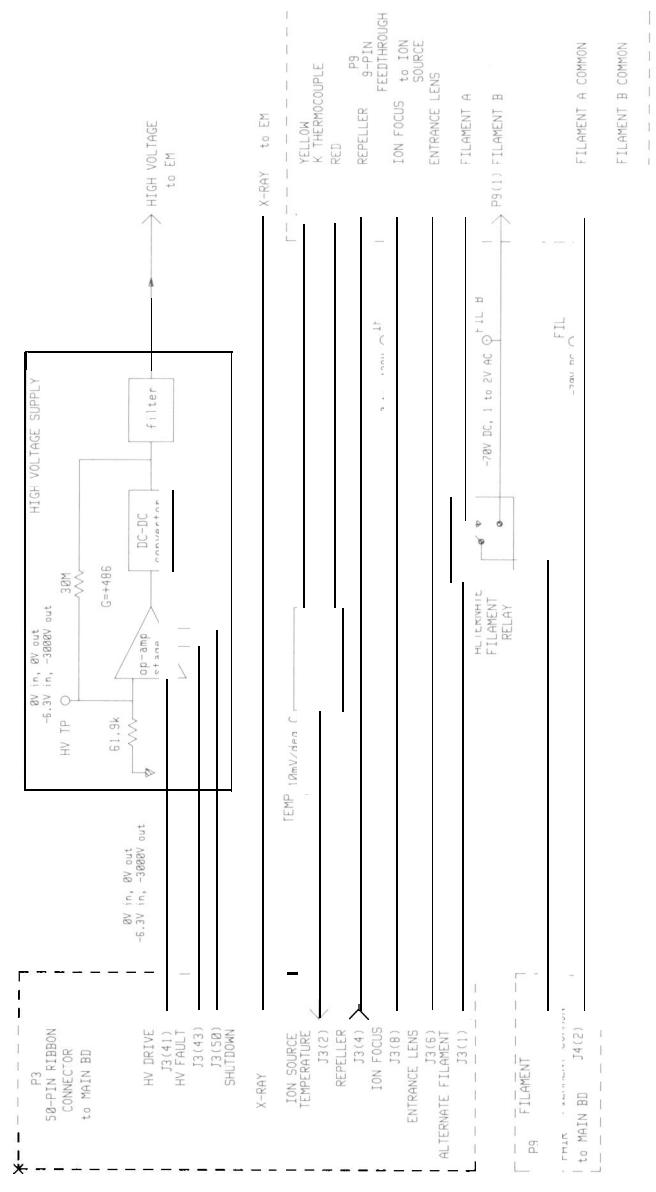


Figure B-2. Top board block diagram (2 of 2)

coils may need adjustment. The procedure for adjusting the coils is described later in this chapter.

The mass of the transmitted ions ranges from 1.2 to 650 amu, as the output of the tuned amplifier ranges from approximately 1.2 to 650 V rms.

RF detector

The RF detector samples the 1 MHz RF voltage across the quadrupole. Through full-wave rectification and filtering, the detector produces a dc level proportional to the magnitude of the RF. This voltage can be measured at the RF DET OUT test point.

The RF modulator, tuned amplifier, and RF detector are arranged in a closed loop, so that the RF output can be very accurately controlled. RF DET OUT is equal in magnitude and opposite in polarity to the MASS AXIS signal, with which it is summed at the input of the RF modulator.

The gain of the RF detector is approximately 1/100 (10 V dc output for about 1000 V RF input). The exact ratio is fixed by a set of three parallel resistors. Two of three are factory selected during the board test process, so that the RF detector gain (and hence the gain of the RF amplifier as a whole), will be sufficiently accurate to assure proper mass selection by the quadrupole.

If the feedback loop is not completed, the operational amplifier at the input of the RF modulator will be driven to its positive limit. This in turn activates the RF FAULT signal to the main board, indicating that there is a problem in the RF amplifier. When an RF fault occurs, a message such as "Difficulty with mass filter electronics" will be displayed at the data system. However, if the loop is incomplete for some reason other than an RF amplifier malfunction (as, for example, when another fault shuts down the RF amplifier), this message will not be displayed.

DC amplifiers The dc amplifiers supply the dc component of the voltage to the quadrupole mass filter. The magnitude of this dc voltage is proportional to the RF voltage (and hence proportional to the MASS AXIS signal from the main board). The ratio of the dc voltage to RF voltage determines the resolution of the mass filter.

There are two dc amplifiers (U- and U+ in Figure B-2). The U- amplifier has the output of the RF detector as its input, and has a gain of -19.159. This gain can be adjusted slightly by the RATIO ADJUST signal from the main board. The output of the U- amplifier varies from 0 to -154 V (-151 V plus the ratio adjust contribution) as the output of the RF detector varies from 0 to +7.9 V,

The U+ amplifier operates as an inverter (it has a gain of -1). The U- and U+ amplifier outputs can be measured at the U-TP and U+TP test points, respectively.

The U+ and U- amplifier outputs are summed with the RF voltage generated by the transformer coupled tuned amplifier, by a simple series circuit. RF filters keep the RF voltage from coupling back into the dc amplifiers.

The polarity of the dc voltage applied to the quadrupole mass filter can be reversed. This occurs when the U+/U-POLARITY line from the main board is held low, which activates the K1 relay. The performance of the quadrupole mass filter is optimized by choosing either positive (0) or negative (1) dc polarity. The correct polarity for a given quadrupole mass filter is selected at the factory and will not change unless the quadrupole is replaced. The polarity of the quadrupole mass filter in your MSD is listed on the final-test sheet accompanying the instrument.

When the TTI (true total ion) line is held low, the K2 relay is energized, which opens (interrupt) the input to the U- amplifier from the RF detector. This drives the U- and U+ outputs to zero. When there is no dc voltage on the quadrupole, the quadrupole acts as a high-pass mass filter, with a cutoff mass proportional to the amplitude of the RF voltage. The analyzer is said to be in true total ion mode when TTI is active.

High voltage supply

The high voltage supply generates a 0 to -3000 V output, which is applied to the continuous-dynode electron multiplier. The high voltage supply is a non-inverting amplifier with a gain of about 500. It is driven by the I-IV DRIVE signal from the main board. HV DRIVE varies from 0 to -6.3 V. An HV TP test point will have the same value as I-IV DRIVE, if the high voltage amplifier is working properly.

If the SHUTDOWN line is active, the high voltage supply shuts down. If there is a malfunction in the high voltage amplifier, the output voltage will not be fed back to the operational amplifier at the input, and therefore that amplifier will be driven to its positive limit. This in turn activates the HV FAULT signal to the main board, indicating that there is a problem in the HV amplifier. When an HV fault occurs, a message will be displayed at the data system. However, if the loop is incomplete for some reason other than an HV amplifier malfunction (as, for example, when another fault shuts down the HV amplifier), this message will not be displayed.

Thermocouple amplifier

A Type K (red/yellow or chromel/alumel) thermocouple is attached to the radiator near the ion source. Its leads are connected to the top board via two pins of the nine-pin feedthrough in the analyzer top plate. The signal between these leads is the input to a thermocouple amplifier on the top board. That amplifier's output can be measured at the SOURCE TEMP test point, or by monitoring the voltage on the TEMP line to the main board (this can be done from the data system). The TEMP signal measures 10 mV/°C. At room temperature this would be about 0.25 V. The temperature at the thermocouple is displayed by the data system as the MS temperature.

Alternate filament relay Filament power is supplied by the main board. However, this power can be muted to either of two filaments in the ion source. When the ALT FILAMENT signal from the main board is held low, the alternate filament relay (on the top board) is energized. This switches the filament power from filament 1 (B) to filament 2 (A). The filament switching can be controlled from the data system,

Caution **Never switch between filaments while the MSD electronics are on (MS on in the data system). Doing so will damage the filaments and decrease their life span.**

Feedthrough connections Four dc voltages are generated on the main board, and passed through the top board to the nine-pin feedthrough in the analyzer top plate. These are the REPELLER ION FOCUS, and ENTRANCE LENS voltages to the ion source, and the voltage to the X-RAY lens (part of the detector).

Testing the Filaments

The following material describes how to test the filaments and related circuits.

WARNING

This procedure involves exposure to dangerous voltages and should only be used by trained instrument technicians.

Note

This procedure requires a high-impedance voltmeter that draws less than 50 microamps at 70 V dc. It also requires a floating voltmeter capable of reading 30 kHz ac.

Materials needed:

Screwdriver, Pozidriv #2 (8710-0900)
Voltmeter, HP E2378A or equivalent

Procedure:

- 1 With the MSD still on, remove the instrument cover.
- 2 Remove the black plastic cover from the front of the top board.

WARNING

Dangerous voltages are present on the top board.

- 3 Disconnect the filament cable and the large ribbon cable between the top board and the main board.
- 4 Measure the resistance between the FIL A test point and the FIL test point (see Figure B-3). If filament A is good, the resistance will be less than 1 ohm. Repeat the measurement between the FIL B test point and the FIL test point. If filament B is good the resistance will be less than 1 ohm. If either measurement indicates an open circuit, the corresponding filament is either burned out or not connected.

- 5 Measure the resistance between the FIL A, FIL B, or FIL test point and ground. The resistance should be greater than 1 megohm. A lower resistance indicates that one of the filaments is shorted to ground.
- 6 Reconnect the filament cable and ribbon cable.
- 7 Measure the dc voltage between the FIL test point and ground. The voltage should be about -70 V dc. If this voltage is not present, try replacing, in order, the filament cable, main board, and top board.
- 8 Measure the ac voltage between the FIL test point and the test point corresponding to the active filament (filament 1, FIL B, filament 2 = FIL A). The ac component should be about 1 V. If this voltage is not present, try replacing, in order, the filament cable, main board, and top board.
- 9 Reinstall the electronics safety cover and the MSD cover. Do not forget to reconnect the wires from the EI/CI switch to the main board.

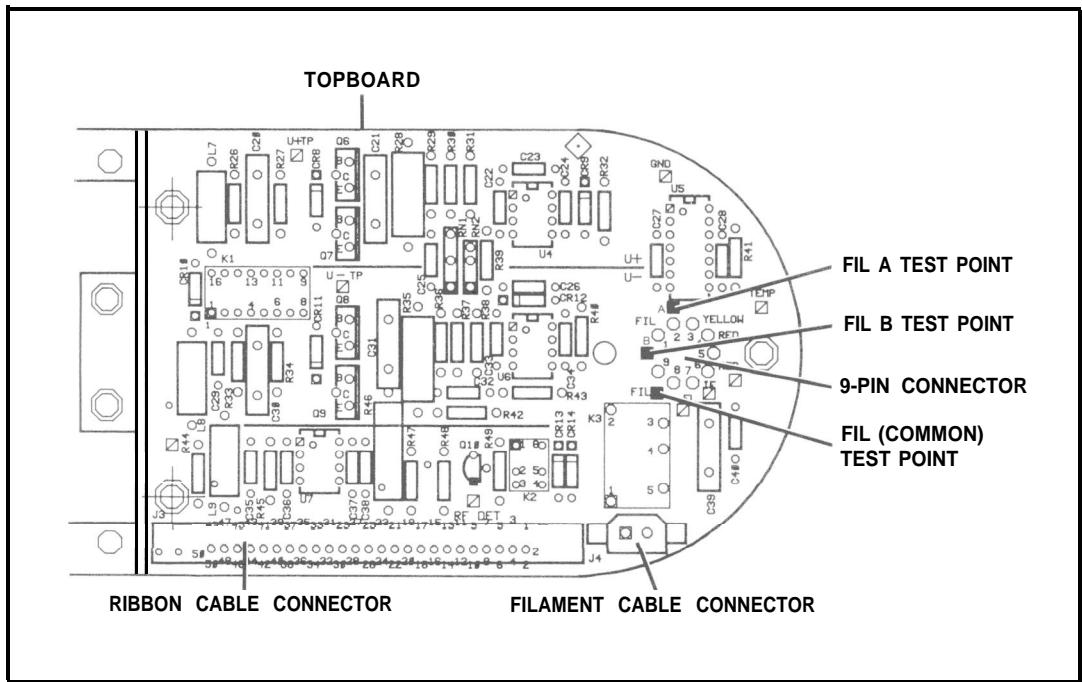


Figure B-3. Filament test points

Replacing the Top Board

If symptoms indicate that the top board should be replaced, refer to the following procedure. See the *Troubleshooting* chapter in the main body of this manual for more information about symptoms that indicate a bad top board.

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)

Screwdriver

 Pozidriv #1 (8710-0899)

 Pozidriv #2 (8710-0900)

Top board (05971-69001)

Procedure:

Caution

Be sure to take appropriate electrostatic discharge precautions before beginning this procedure. See *Electrostatic discharge* under **General Maintenance Considerations** in the **Maintenance** chapter in the main body of this manual.

- 1 Shut down the MSD, as described in the *Operation* chapter in the main body of this manual but do not vent the instrument (GC carrier gas will fill the vacuum manifold instead of air).
- 2 Remove the MSD cover.
- 3 If the shipping clamps that hold the top plate to the vacuum manifold were removed, reinstall them (see Figure B-4). If the clamps are still in place, make sure they are tight,
- 4 Remove the electrical connections between the top board and the main board
 - Unplug the ribbon cable at the top board
 - Unplug the filament cable at the top board
 - Unscrew the detector output cable at the top board

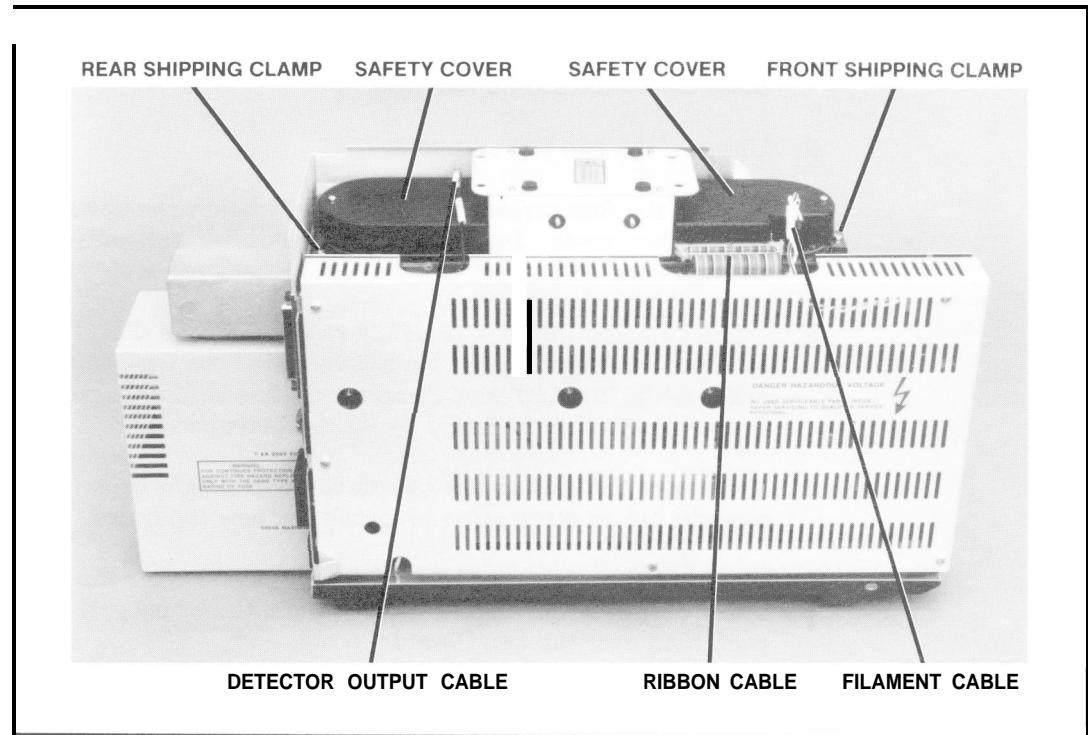


Figure B-4, Top toard connections and shipping clamps

- 5 Unscrew the two screws holding the plastic safety cover in place. Figure B-5 shows the top board as it appears after these covers have been removed.
- 6 Unscrew the two hex standoffs.
- 7 Remove the four screws that are directly below the holes in the DIP coil cover. Insert the smaller Pozidriv screwdriver through each hole to get at the screw beneath it.
- 8 Using two screwdrivers, carefully reach in beside the nine-pin connector (at the ion source end of the top board) and gently “rock up” the connector until it is disengaged. Then, remove the top board by lifting it straight up.
- 9 Make sure the pins on the top plate feedthroughs are straight before attempting to install the new top board.
- 10 Orient the new top board over the top plate. Lower the board first over the “signal” (electron multiplier output) post, then over the two “locator” posts.
- 11 Engage the nine-pin connector, and the four individual feedthroughs coming up through the top plate.
- 12 Reinstall the four screws removed in step 7.
- 13 Reinstall the two hex standoffs.
- 14 Reinstall the plastic safety covers.
- 15 Reconnect the ribbon cable, filament cable and detector output cable.
- 16 Adjust the RF coils (see *Adjusting the RF Coils* later in this chapter).

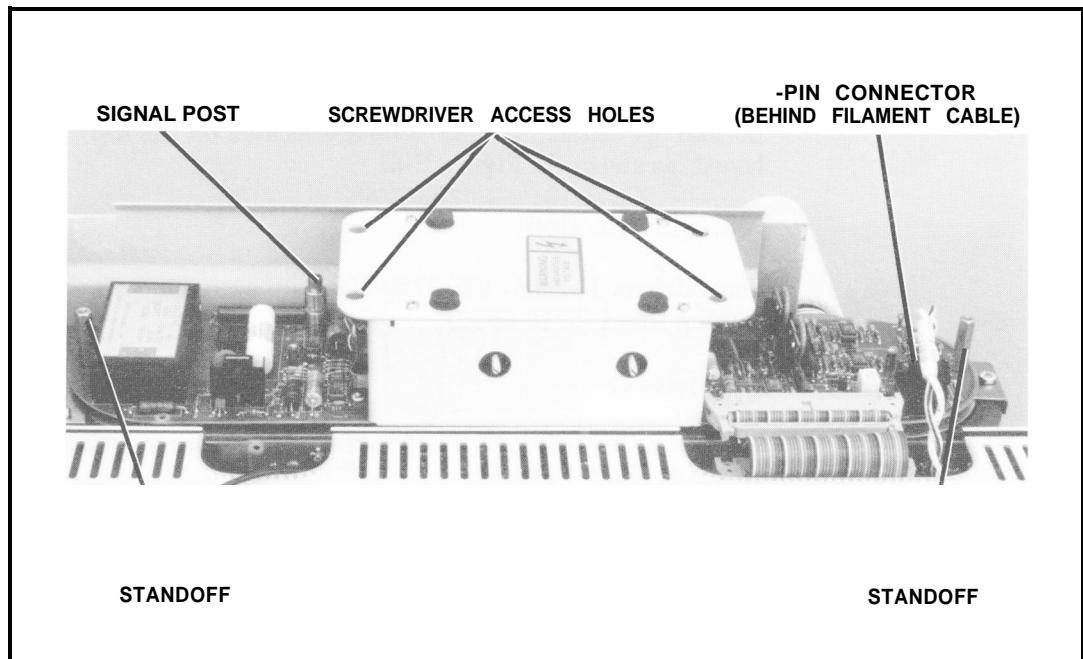


Figure B-5. Removing the top board

- 17 Reinstall the MSD top cover.
- 18 Startup and pump down the instrument according to the appropriate procedure from the *Operation* chapter in the main body of this manual.

Adjusting the RF Coils

The RF coils need to be adjusted when the analyzer or top board is replaced. They do not require adjustment during normal operation. The RF coils are located on the top board, as shown in Figure B-6.

Materials needed:

Screwdriver, Pozidriv #2 (8710-0900)
Tuning wand (8710-0933)

Procedure:

- 1 Have your MSD in a state of thermal equilibrium (turned on for at least 4 hours).
- 2 Remove the MSD cover.

WARNING

There are hazardous voltages and possibly a hot high-vacuum gauge tube inside the MSD. Avoid all contact with the gauge tube, and with the circuitry on the top board.

- 3 Make sure that the aluminum cover is in place over the RF coils,
- 4 Proceed to the Set RFPA program in your data system software. See the documentation supplied with your data system software for more information,
- 5 Once in the Set RFPA program, you will see a message such as "Enter AMU_VALUE" on your screen. Type in "100" and press the Enter or Return key (in rare cases, when the instrument is far out of adjustment, you may have to begin at 10 amu).

The screen will then display a label such as "DIP VOLTAGE", followed by a number representing a voltage.

RF COIL ADJUSTMENT SCREWS

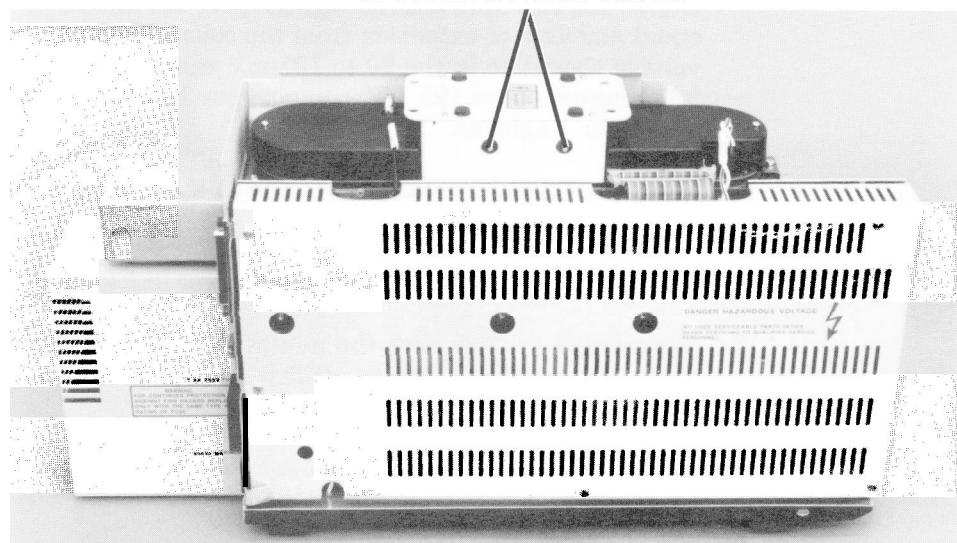


Figure B-6. RF coil adjustment

- 6 Using the non-metallic tuning wand, turn the adjustment screws on the RF coils so as to minimize this voltage. Adjust the two coils alternately, keeping the screws at equal amounts of extension from the coils. The minimum voltage should be in the 90 to 125-mV range. If the minimum is above 125 mV, contact Your Hewlett-Packard Customer Engineer.
- 7 When you have adjusted the voltage to the minimum value, press the "STOP" key.
- 8 Select SET RFPA again. This time, enter 650 amu.
- 9 Repeat step 5. This time the minimum voltage should be in the 500 to 800-mV range. If it is above 800 mV, contact your Hewlett-Packard Customer Engineer.
- 10 When you have adjusted the voltage to the minimum value, press the "STOP" key again.
- 11 Exit the SET RFPA program.
- 12 Reinstall the MSD cover.

Theory of Operation B-26

Accessory Control B-33

Replacing the Main Board B-38

Theory of Operation

The main board (see Figure B-7) performs the following functions

- Receives and decodes digital information from the HP-IB/MS control card
- Sends digital information to the HP-IB/MS control card
- Generates voltages for the ion source filaments, repeller, ion focus lens, entrance lens, x-ray lens, electron multiplier high voltage control, quadrupole RF voltage control, and de/RF ratio adjustment
- Generates control signals for alternate filament selection, quadrupole dc polarity, and true total ion mode selection
- Performs logarithmic amplification for the electron multiplier output
- Performs analog-to-digital conversion for the log amp output, coil DIP signal, ion source temperature signal, and foreline vacuum signal
- Monitors the TOO HOT, TOO COLD, and FORELINE PRESSURE signals from the vacuum system, monitors the HV FAULT and RF FAULT signals from the top board, and measures the repeller current (to monitor for excess source pressure); based on these signals, implements the safety interlocks
- Activates the SHUTDOWN line to the top board when the analyzer electronics should be disabled
- Controls the calibration valve
- Energizes the filaments (only one at a time)
- Provides accessory control

- Generates a 1-MHz clock signal for the top board.
- Generates ± 250 V dc (nominal) power for dc amps and lens power supplies on the top board.

Figure B-8 is a simplified block diagram of the main board,

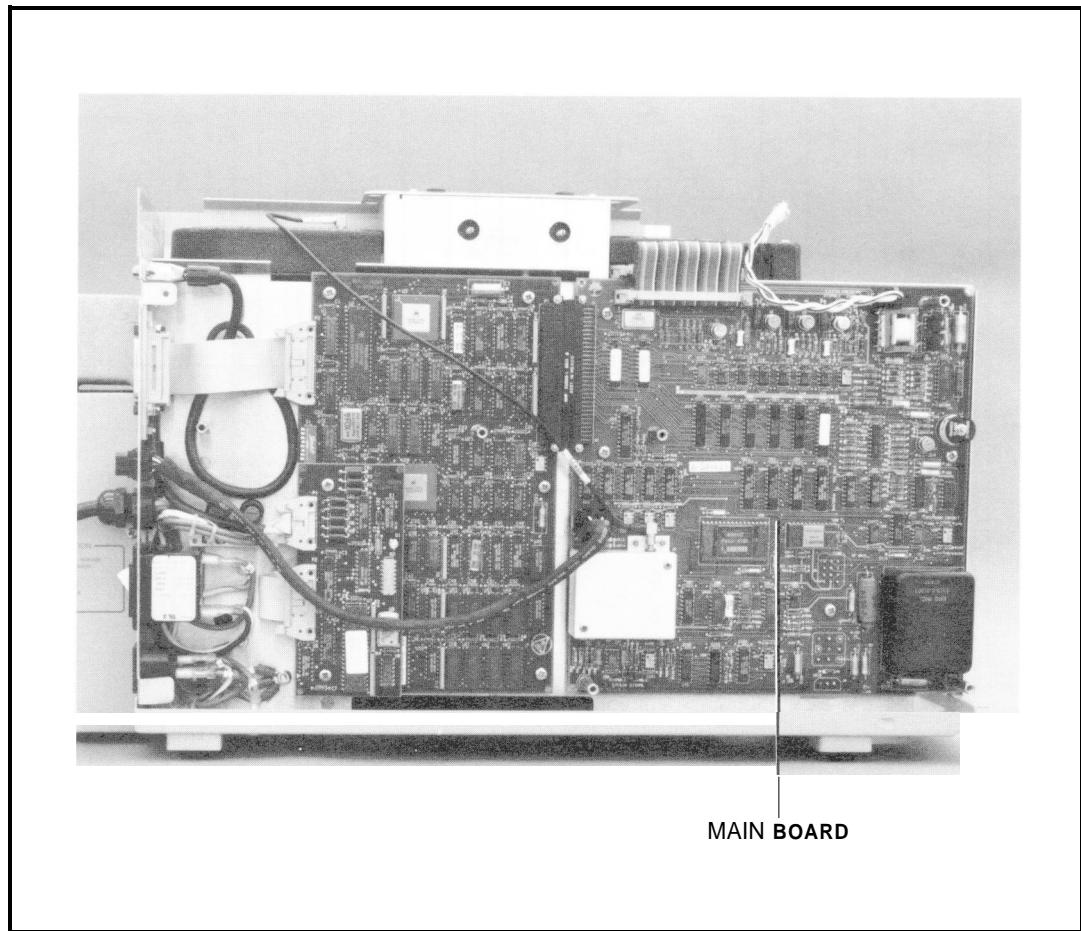


Figure B-7. Main board

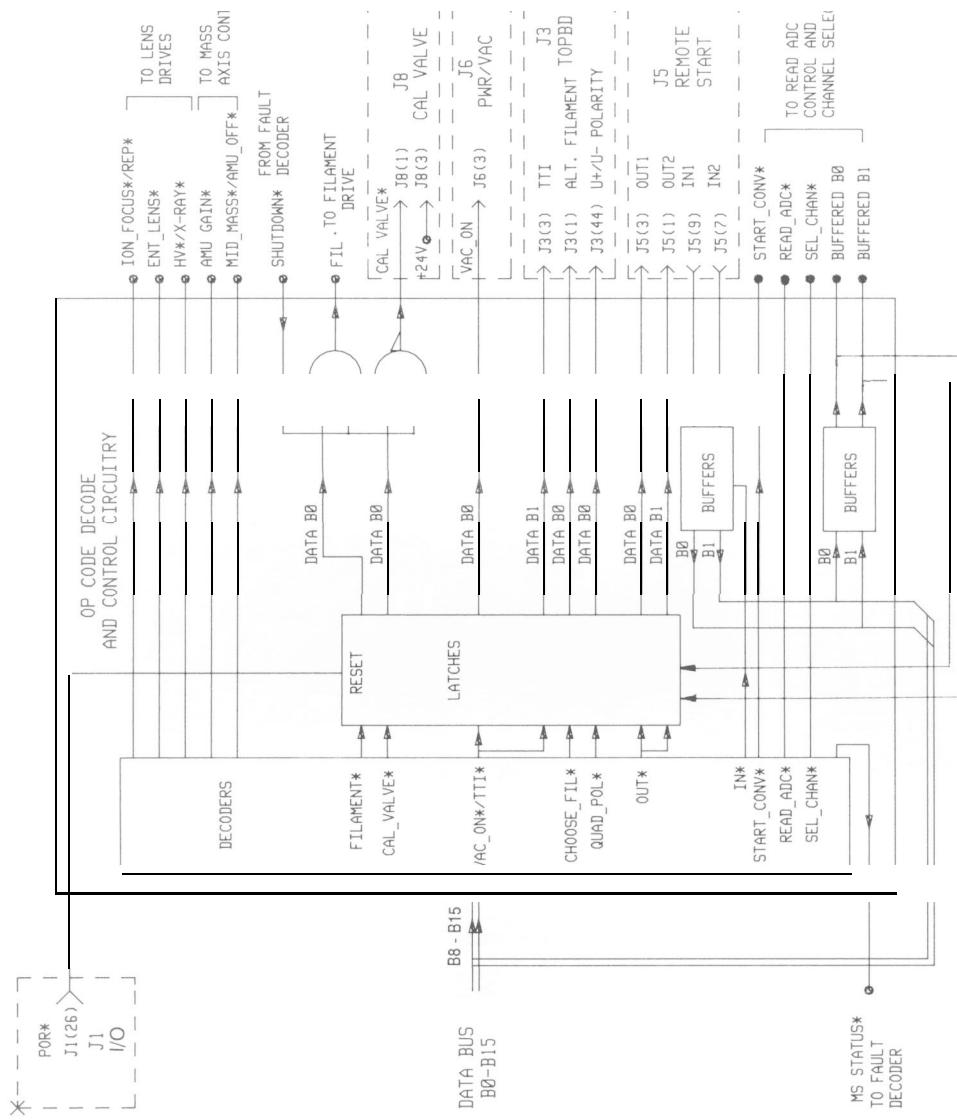
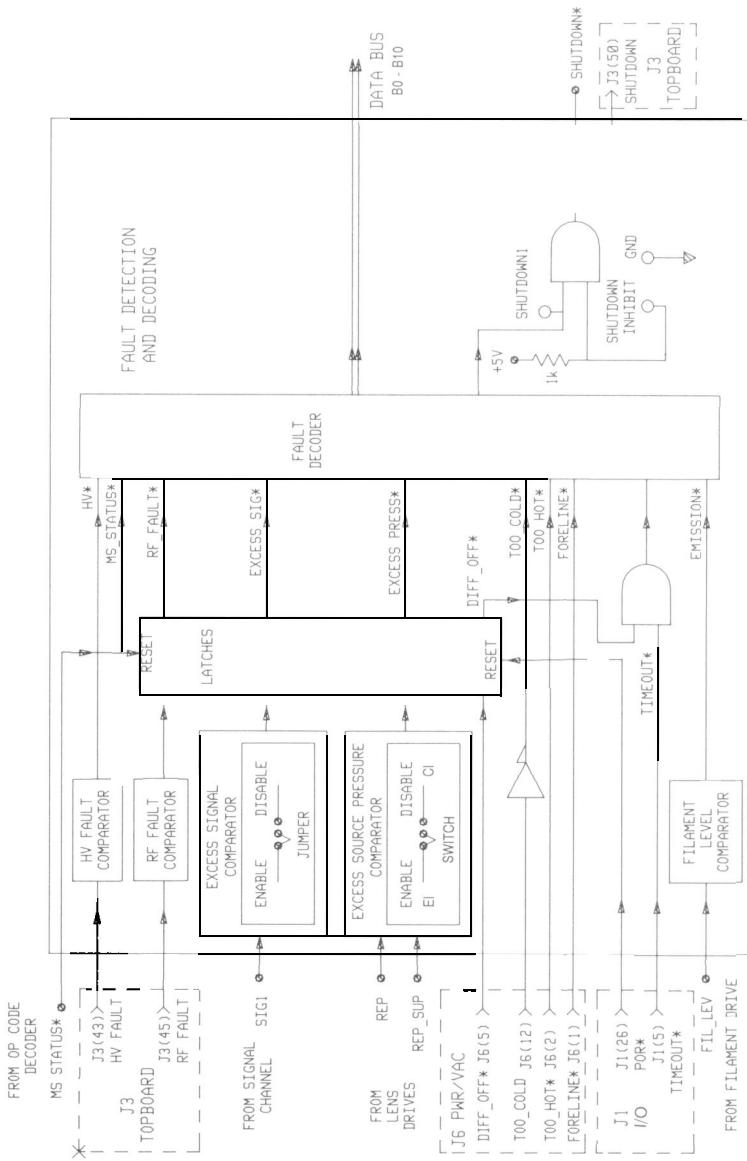


Figure B-8. Main board block diagram (1 of 5)



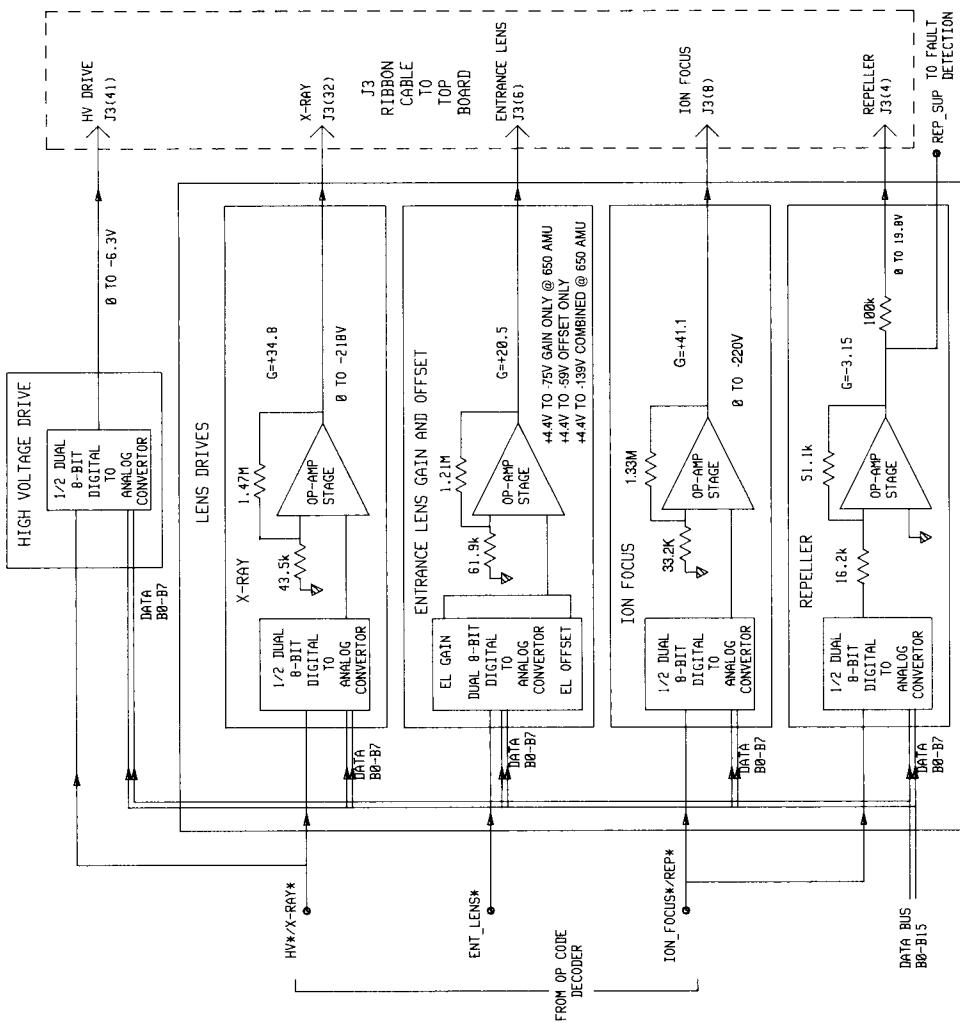


Figure B-8. Main board block diagram (3 of 5)

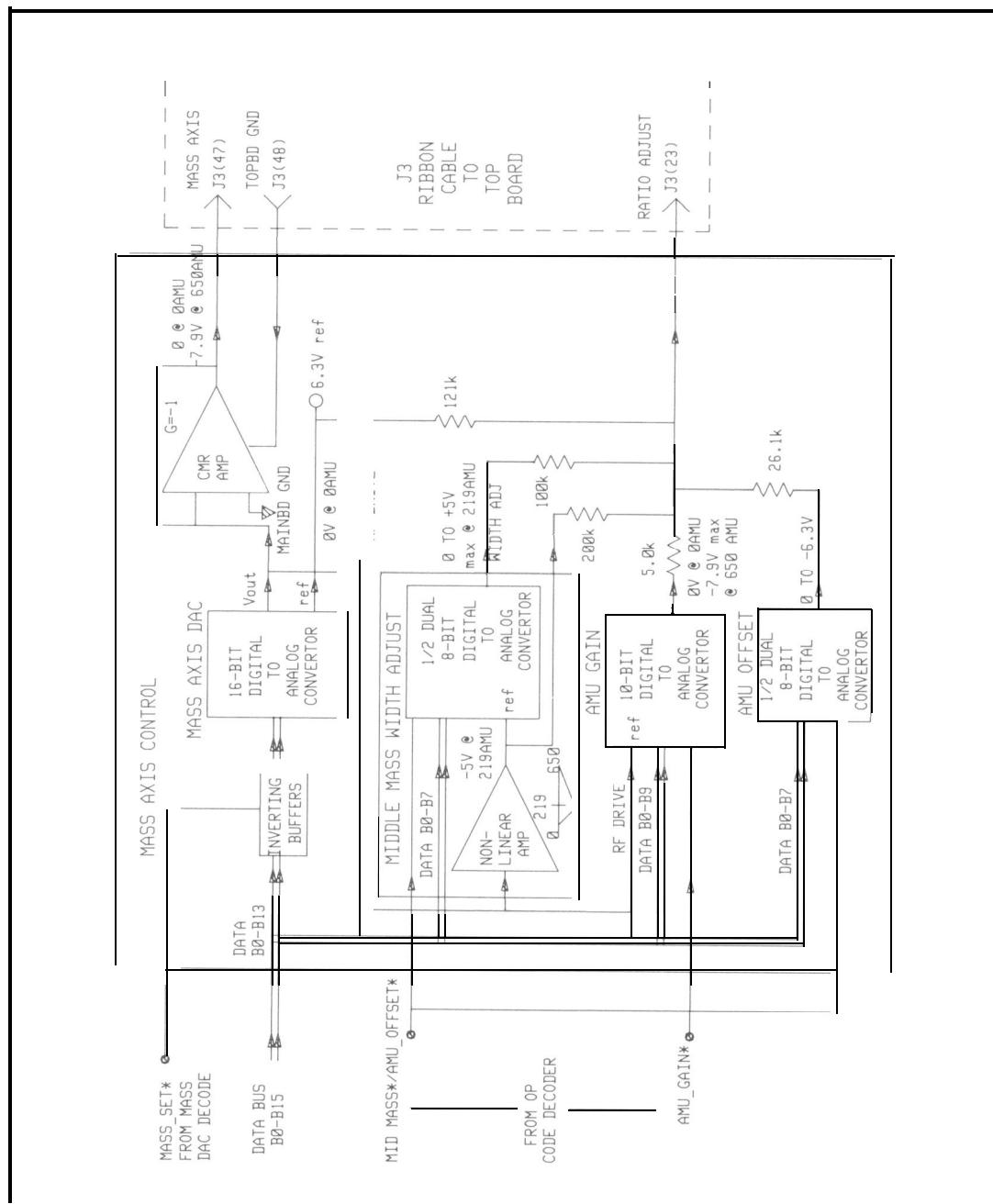


Figure B-8. Main board block diagram (4 of 5)

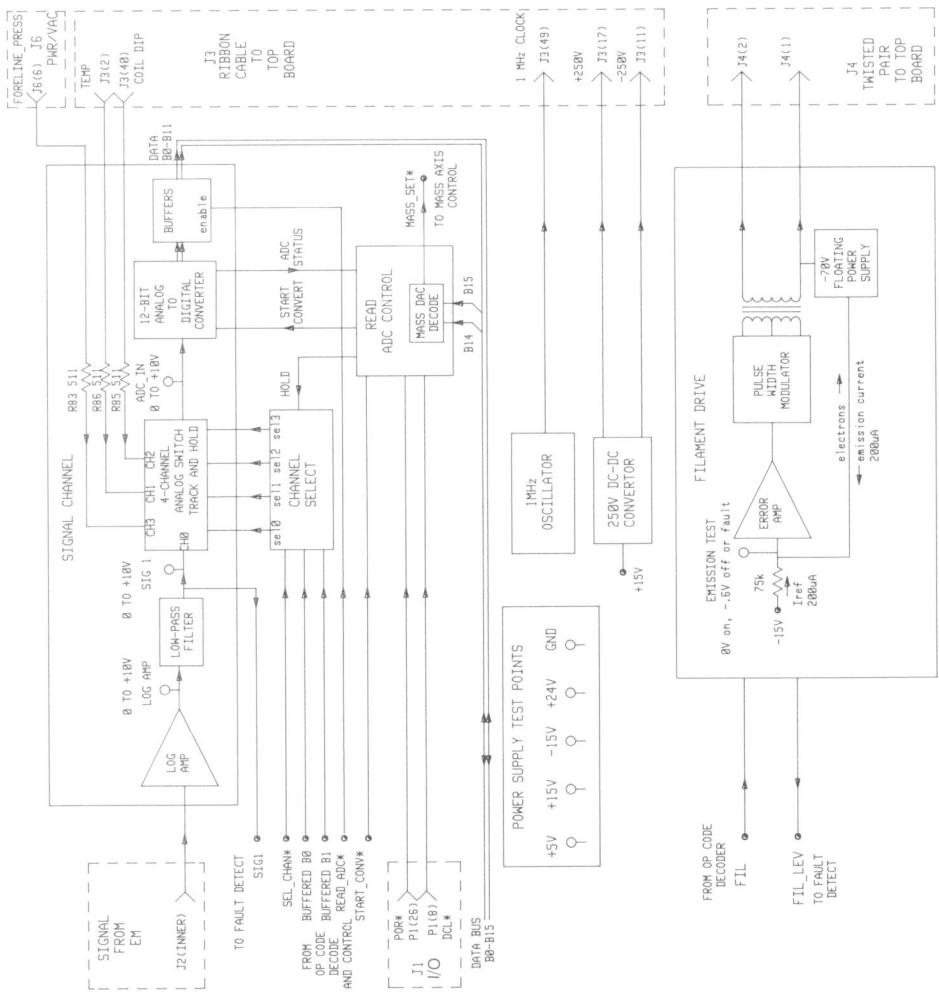


Figure B-8. Main board block diagram (5 of 5)

Accessory Control

An accessory control connector is located above the power cord on the back panel of the MSD. The connector is part of the accessory control cable (05971-60428). The accessory control cable attaches to connector J5 on the main board. It extends the functions of J5 to a more accessible location.

The accessory control connector provides an interface through which external devices such as LEDs and solenoids can be powered and controlled. In addition, it provides a path for inputs such as a remote start signal.

Note The APG remote connector (labeled REM) at the top of the MSD back panel is normally used to receive remote start signals. The accessory connector can be used for special applications such as GC/IRD/MSD systems or for coordination with instruments that can not communicate on the APG bus.

Input lines Input lines 1 and 2 (pins 9 and 7 respectively, see Figure B-9) are connected to a 74LS244N logic chip. The logic chip is inactive when the voltage on the lines is above +2.0 V. Line voltages between +2.0 V and +0.7 V produce indeterminate logic states.

When there is no input to the input lines, the voltages in the lines are pulled toward +5 V by 1 kilohm resistors between the input lines and the +5-V power supply. Under these conditions, the logic chip is inactive.

If an input line voltage is pulled down to less than +0.7 V, that input line is active. The input driver must sink 4.3 mA below +0.7 V to ensure that the input signal is recognized.

The logic chip does not latch inputs. As a result, an input line voltage must be low (the chip must be active) when the input is being read by the data system. Most software reads the input status three or four times in quick succession to avoid erroneous responses to a single noise transient.

The status of an input line can be read through the data system by using the XFER command. The response is a number that identifies the states of the two input lines.

Command:

XFER 20480 [Return]

Input1	Input 2	Respo
Inactive (high)	Inactive (high)	4095
Active (low)	Inactive (high)	4094
Inactive (high)	Active (low)	4093
Active (low)	Active (low)	4092

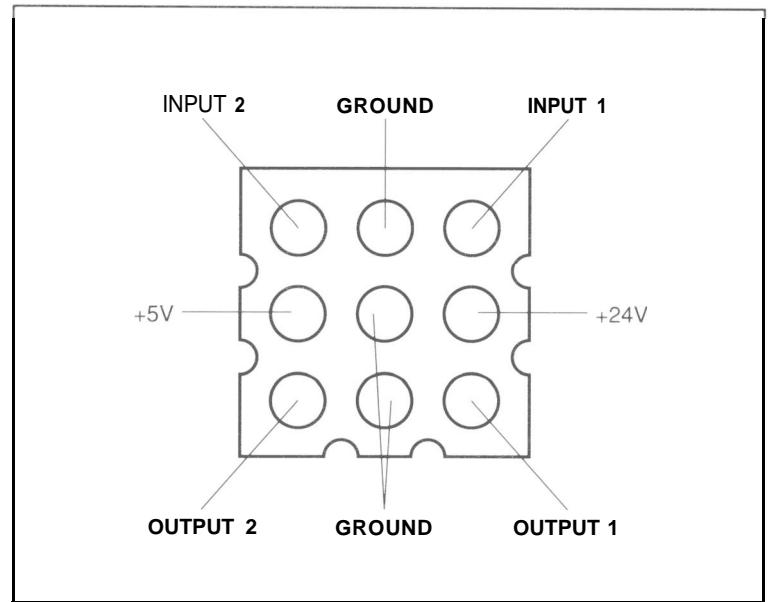


Figure B-9. Accessory control connector

Output lines

The output driver for the HP 5971A output lines is a 75462 dual, peripheral, positive NAND driver integrated circuit. When the output lines are inactive, their voltages can range from 0 to 24 V depending on the circuit to which they are connected (passive high). A diode in each output circuit limits the lines to a maximum of 24 V. When the output lines are active, they are pulled down to below 0.4 V (active low).

The output lines can be activated or deactivated through the data system by using the XFER command. The state of the lines — active or inactive — is determined by a number, n, appended to the command. The number, n, can be 0-3.

Command:

XFER 28416,n [Return]

Response:

n	Output 1	Output 2
0	Inactive (high)	Inactive (high)
1	Active (low)	Inactive (high)
2	Inactive (high)	Active (low)
3	Active (low)	Active (low)

Other lines There are five other lines on the accessory connector: three ground lines, one +5-V dc line, and one +24-V dc line (pin receptacles 2, 4, 5, 6, and 8, Figure B-9).

The three ground lines are tied directly to the main board ground plane, which is tied directly to the instrument ground plane.

The +24-V line allows the output lines to directly drive loads such as 24-V relays or solenoids. The +5-V line allows the output lines to drive loads such as LEDs or TTL logic devices.

Either the +5-V or +24-V lines can be used to power small interface circuits, which might be useful in achieving hardware compatibility between the MSD and external accessories. However, a Hewlett-Packard Customer Engineer should be consulted before attempting to draw more than 100 mA for this purpose.

Care must be exercised to ensure that voltage drops across resistances do not seriously affect the 0.7 -2.0 V margin on the input lines. For example, if a ground wire is too small and there is a 0.8-V drop on the ground owing to the external load, the input circuitry may not correctly read an active (low) input.

Replacing the Main Board

Use the following procedure if symptoms indicate that the main board should be replaced. See the *Troubleshooting* chapter in the main body of this manual for more information about symptoms of a malfunctioning main board.

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Main board (05971-60018)
Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

Caution Be sure to take appropriate electrostatic discharge precautions before beginning this procedure. See *Electrostatic discharge* under *General Maintenance Considerations* in the *Maintenance* chapter in the main body of this manual.

- 1 If your MSD is equipped with a gauge controller, switch off the filament switch and then the gauge controller power switch.
- 2 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of this manual. Disconnect the MSD power cord.
- 3 Remove the MSD cover.
- 4 Remove the electronics safety cover. When you do this, you will have to disconnect the EI/CI switch wires from the main board.
- 5 Disconnect the three connectors that connect to the back side of the main board near the calibration valve.
- 6 Unplug the ribbon cable, filament cable, detector output cable, and accessory control cable from the main board.
- 7 Remove the four hexagonal standoffs (see Figure B-10).

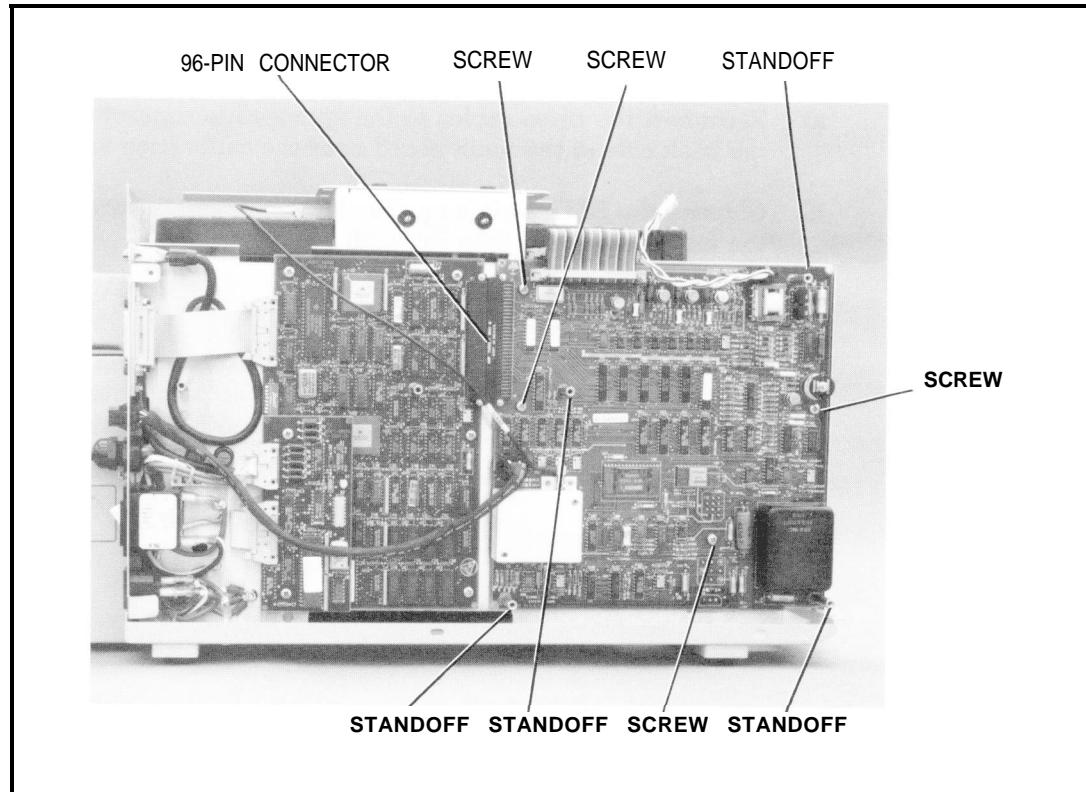


Figure B-10. Removing the main board

- 8** Remove the four main board mounting screws.
- 9** Slide the main board to the right to disengage the 96-pin connector from the HP-IB/MS control card.
- 10** Lift out the main board.
- 11** Put the new main board in position. Slide it to the left to engage the 96-pin connector to the HP-IB/MS control card.
- 12** Reinstall the screws that hold the main board in place.
- 13** Reinstall the four hexagonal standoffs.

- 14 Reconnect the ribbon cable, filament cable, detector output cable, and accessory control cable to the main board.
- 15 Reconnect the three cables to the appropriate connectors on the back side of the main board near the calibration valve.
- 16 Connect the EI/CI switch on the electronics safety cover to the main board and then reinstall the safety cover.
- 17 Reinstall the MSD cover.
- 18 Reconnect the MSD power cord and then startup and pump down the instrument according to the procedure listed in the *Operations* chapter in the main body of this manual.

Theory of Operation B-42

Troubleshooting the HP-IB/MS Control Card B-48

Replacing the HP-IB/MS Control Card B-55

Theory of Operation

The HP-IB/MS control card is located next to the main board in the MSD (see Figure B-11). The primary purposes of the HP-IB/MS control card are to provide a communication interface between the MSD and the data system and provide real-time control of the MSD; as a result, the card frees the data system for other activities.

The principal features and functions of the HP-IB/MS control card include the following:

- 10-MHZ system clock
- 1 Mbyte of RAM (for data buffering and code)
- 64 Kbytes of EPROM (for diagnostics and power-up initialization)
- Three 16-bit counters chained into one 48-bit counter for retention time
- Two-channel DMA controller
- 16-bit parallel interface for communication with MSD circuits
- Interface to the Analytical Product Group (APG) remote bus on the remote control interface card
- HP-IB interface for communication with data system

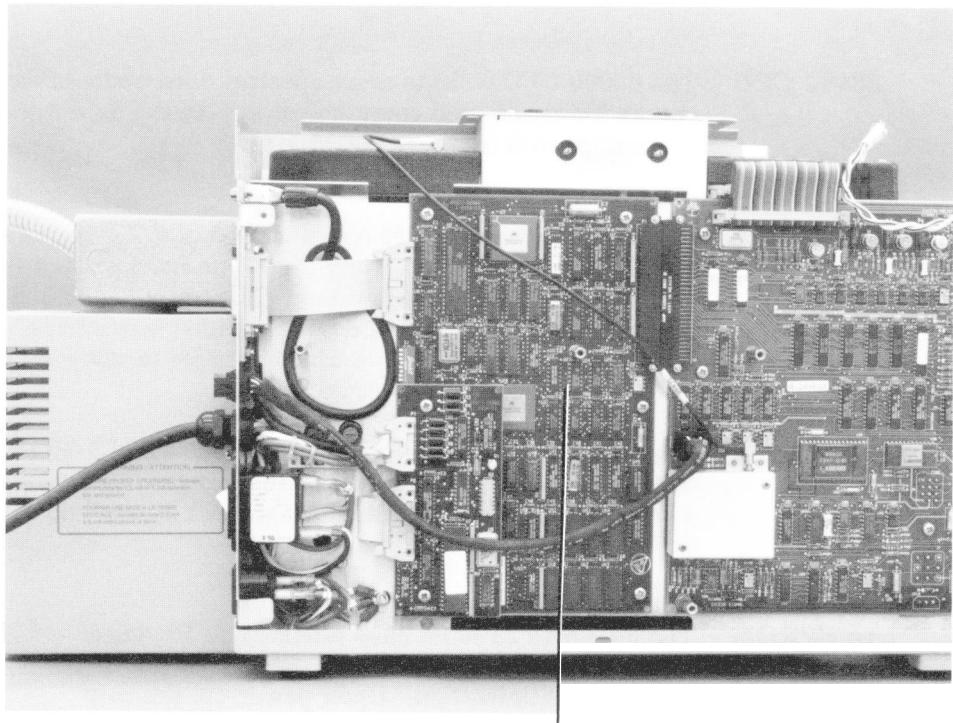


Figure B-11. HP-IB/MS control card

The functional areas of the HP-IB/MS control card are discussed in the following material and a block diagram of these areas is shown in Figure B-12.

68000 CPU The 68000 CPU collects mass spectral data, reduces data checks for errors, and communicates with the data system. It operates at a frequency of 10 MHz.

68440 DMA The 68440 direct memory access moves data by way of the HP-IB interface from the data system to memory and from memory back to the data system. The 68440 DMA is a dual-channel DMA controller, one channel of which is hard-wired to the HP-IB interface in order to allow efficient HP-III transfer.

1-Mbyte RAM The RAM on the 1-Mbyte RAM card consists of 1-Mbit dynamic RAMs (DRAMs). The card thus provides a total of 1 Mbyte of RAM for data buffering, stack space, and downloaded code.

64-Kbyte EPROM The 64-Kbyte EPROM card provides 64 Kbytes of nonvolatile memory for the HP-IB/MS control card power-up initialization. Upon power-up, the card initializes and performs an integrity test of its various subsystems, the results of which are available to the data system by way of serial poll.

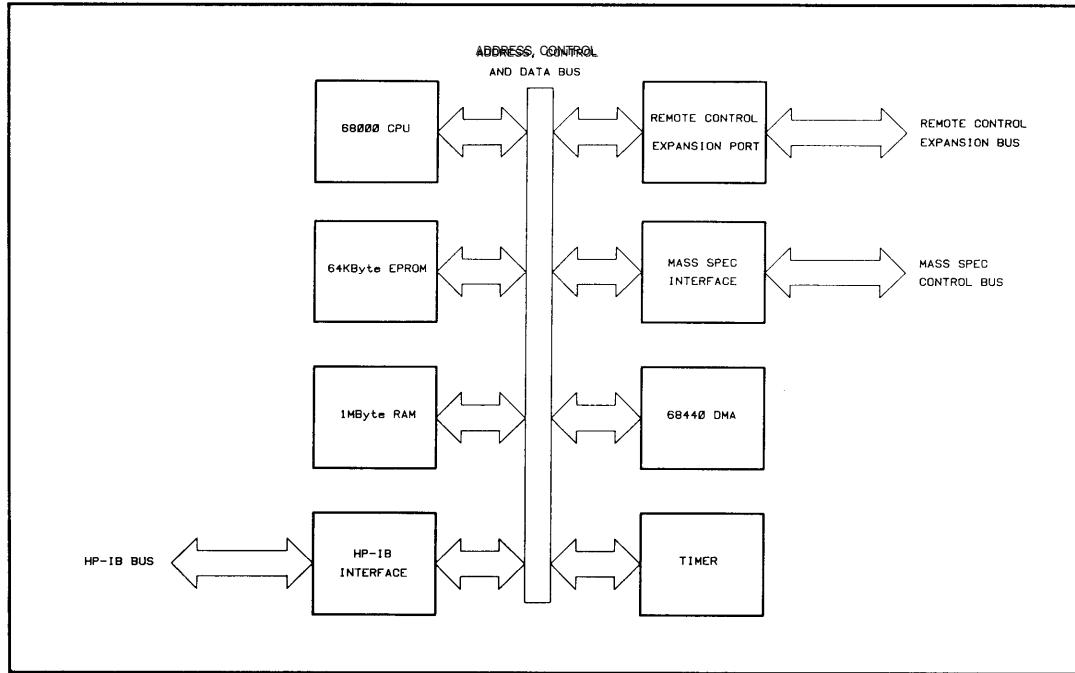


Figure B-12. HP-IB/MS control card block diagram

HP-IB interface The HP-IB interface is the interface to the data system. To provide efficient transfer of data the interface controller is hard-wired to the 68440 controller. HP-IB/MS address switch (see Figure B-13) must be set to a unique address. See the installation manual supplied with your system for more information.

Remote control expansion port The remote control expansion port on the HP-IB/MS control card provides access to the APG remote control interface located on the APG remote control card.

Mass spectrometer interface The mass spectrometer input-output (MSIO) is a 16-bit input latch clocked by the rising edge of DCL*, and a 16-bit output latch with open-collector drivers, DCL* is the device control line signal used to trigger reads and writes of data to and from the MSD.

Timer The MC6840 programmable timer is used to measure retention time, that is, the time from sample injection to the occurrence of a chromatographic peak. The timer can measure events up for up to 22.5 days with a resolution of 1 μ sec.

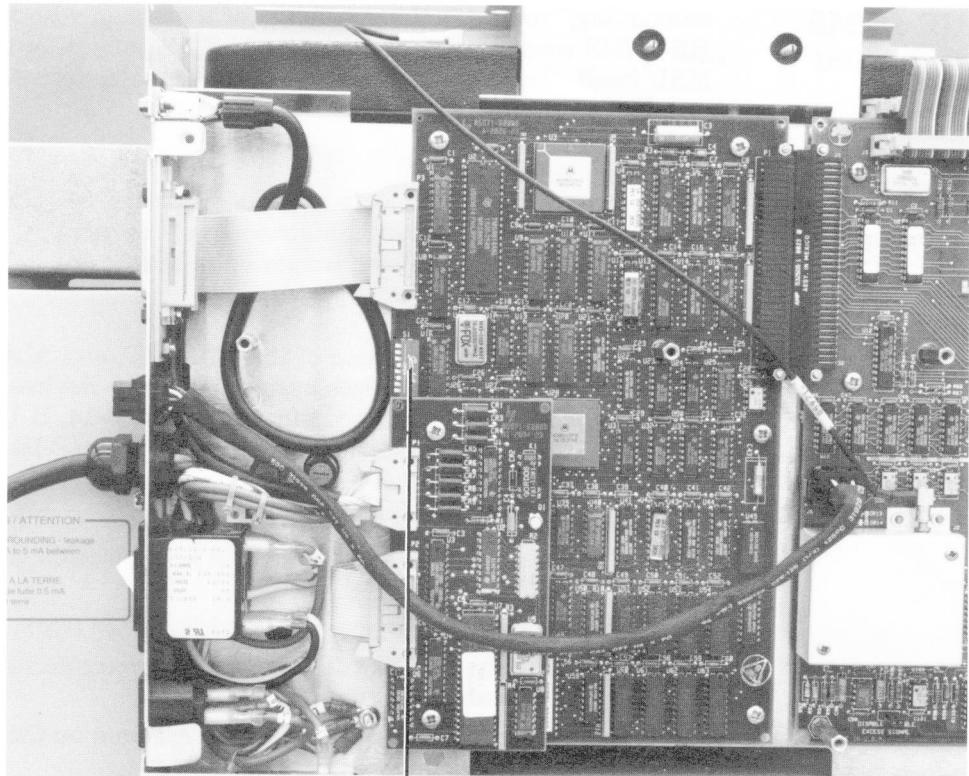


Figure B-13. HP-IB/MS address switch

Troubleshooting the HP-IB/MS Control Card

An error message such as "The MS interface is not responding," indicates the possibility of a problem with the HP-IB/MS control card, the GC, the ALS, the cables, or the MSD itself. To identify the source of the trouble, proceed as follows

Initial checklist

Before proceeding to the more specific diagnostic tests, use the following checklist to eliminate some of the more common and easily corrected causes of system communications problems.

- Verify the HP-IB addresses of the MSD, GC, and ALS correspond to the addresses assigned to those devices in the data system software. Refer to Figures B-14, B-15, and B-16, respectively, for the locations of the HP-IB address switches.
- Ensure that all HP-IB connections are tight.
- Verify that the HP-IB interface cable is in place on the GC.
- Verify that the GC has memory Revision G, or later.
- Check that only the GC, MSD, and ALS are connected to the HP-IB interface bus.
- If the problem persists, switch all instruments on the HP-IB bus off and then on.

Note Refer to the HP 19257A HP-IB/RS-232 Interface Kit Installation and Setup Manual for additional information about testing the HP-IB bus.

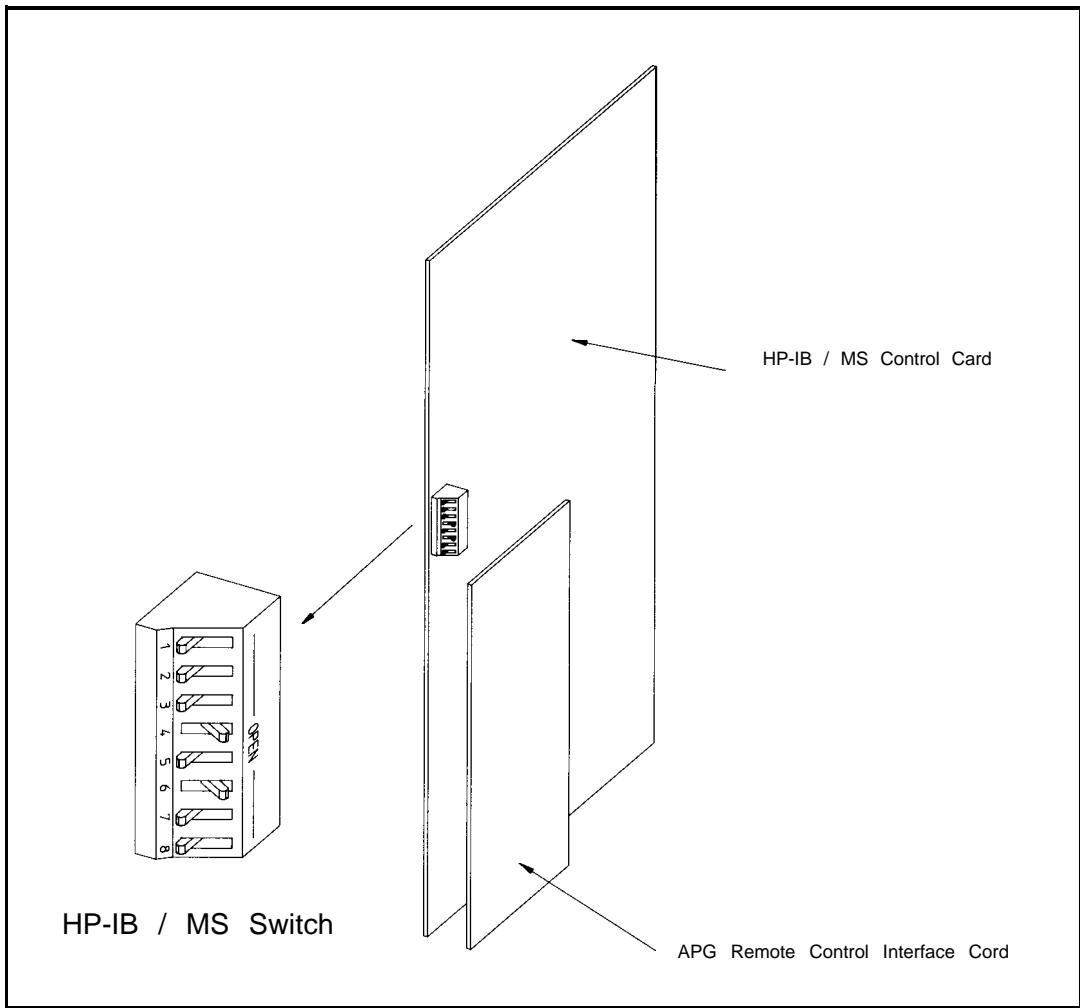


Figure B-1. HP-IB/MS control card switch settings

HP-IB / RS232 Interface Cord
(Located in HP 5890 GC)

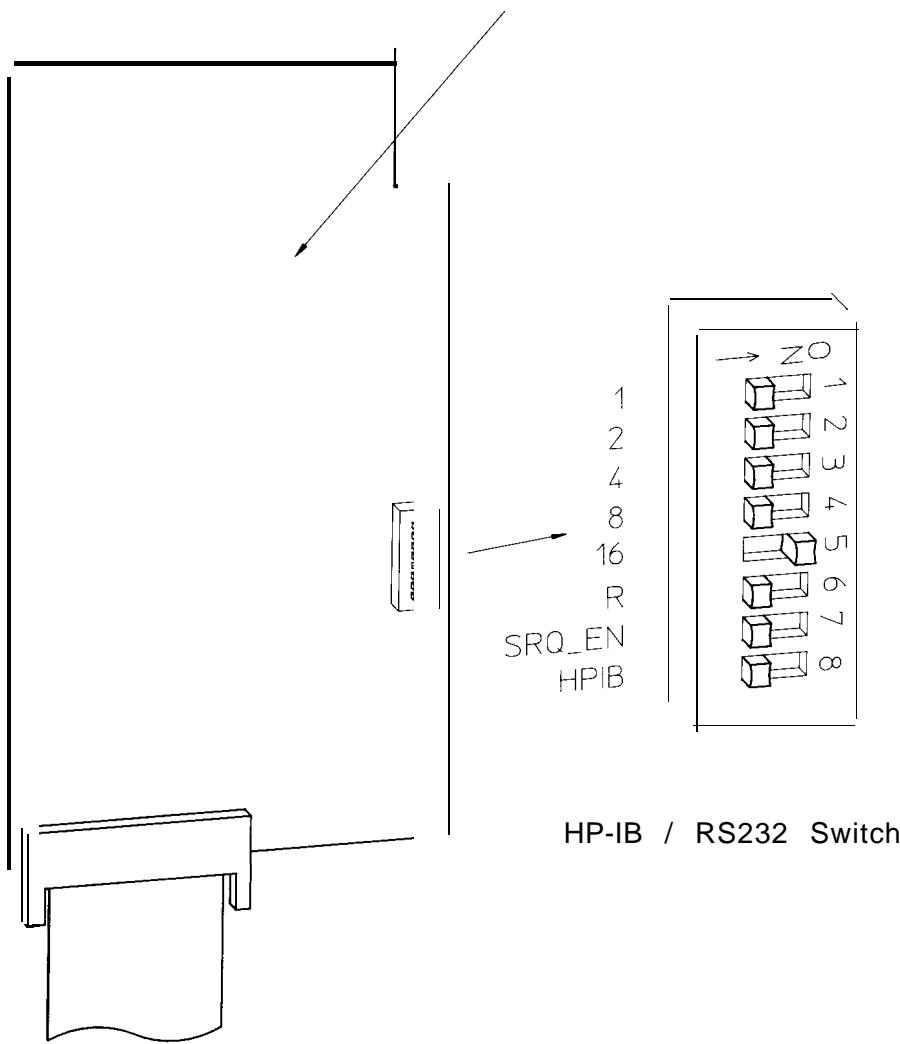


Figure B-15. HP-IB/RS 232 interface switch settings

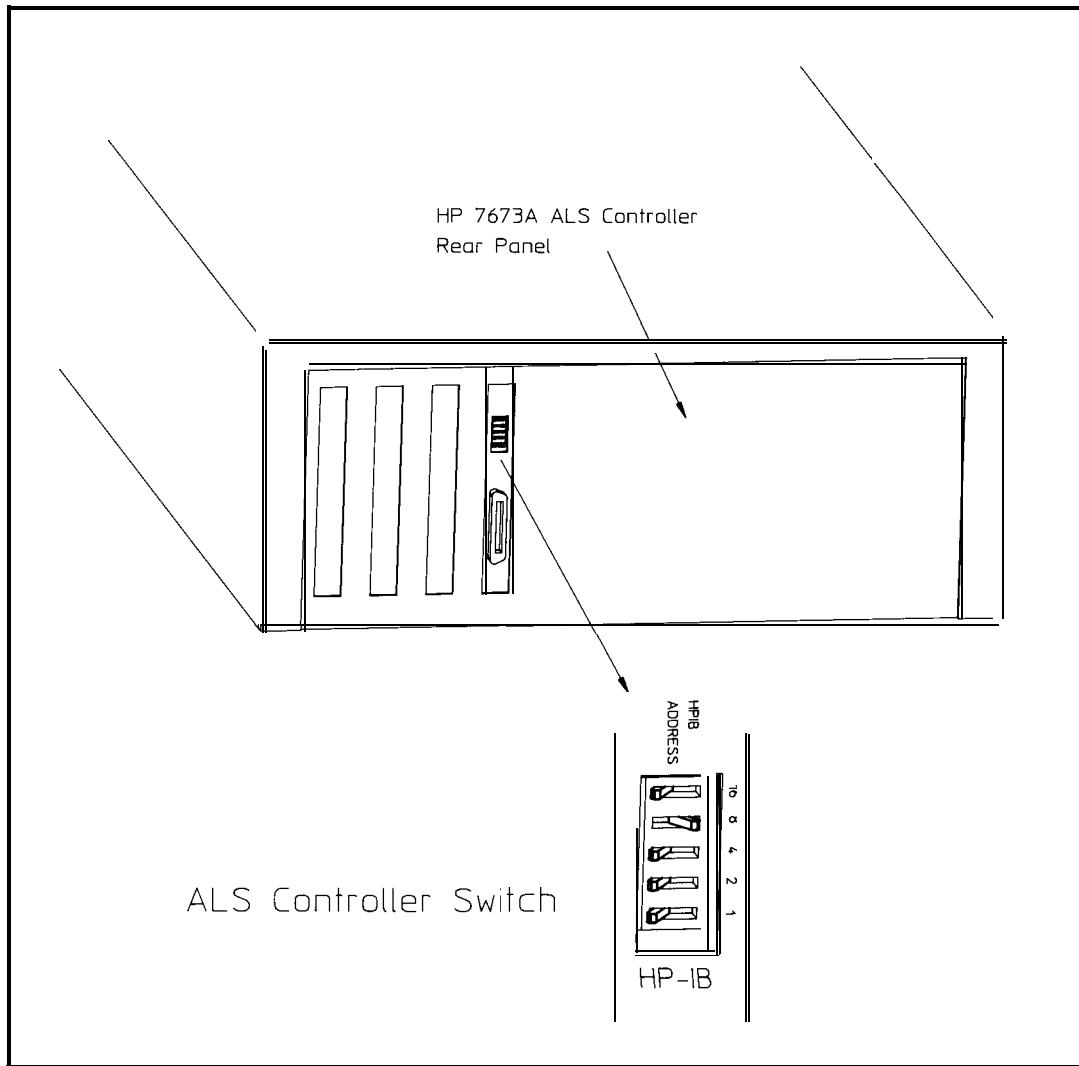


Figure B-16. ALS controller switch settings

HP-IB/MS control card test If the *Initial checklist* revealed no obvious causes for the error message, use the following test to verify that the HP-IB/MS control card is operating correctly.

- 1 Make sure the MSD has power, that it is plugged in, turned on, and that the +5 V test point on the main board reads between +4.75 and +5.15 V dc. Refer to the *Power Supply* chapter in this appendix for more information about checking this voltage.
- 2 Ensure that the HP-IB/MS control card is plugged in and cabled correctly. Check both the HP-IB connector cable and the external HP-IB cable.
- 3 Bring up the manual tune program. See your data system manuals for more information.
- 4 Switch the MSD off then on, using the on/off switch (circuit breaker) on the back panel of the MSD.

Caution The system should not be power-cycled if the diffusion pump is warm, that is, if the air venting from the rear of the MSD is warmer than ambient. If the pump is warm, disconnect the foreline gauge connector, wait 10 minutes, reconnect the connector, and then power-cycle the MSD.

- 5 Try to initialize the HP-IB/MS control card by typing the command scinit.
- 6 If the HP-IB/MS control card is still “not responding,” disconnect the GC and ALS HP-IB cables (if present). Be sure there are no HP-IB devices on the HP-IB loop except the data system and the MSD. Power-cycle the MSD and re-initialize with the scinit command.

- 7 If the message "MS interface initialized" appears (in 5-10 seconds), the HP-IB/MS control card is probably not the cause of the problem; proceed with the data test and GC/ALS test to determine if the problem is in the GC or ALS. If the HP-IB/MS control card still does not respond, proceed to the next step.
- 8 If the HP-IB/MS control card is still not responding replace the internal HP-IB connector cable (05971-60417), switch the MSD off then on, and re-initialize by using the scinit command.
- 9 If the HP-IB/MS control card still does not respond, replace the external HP-IB cable (8120-4654), power-cycle the MSD, and re-initialize by using the scinit command.
- 10 If the HP-IB/MS control card still fails to respond, replace it with a rebuilt HP-IB/MS control card (05971-69006).

Data test To verify that the HP-IB/MS control card and the MSD are providing data proceed as follows.

- 1 Bring up the manual tune program. See your data system manuals for more information.
- 2 Switch the MSD off then on, and re-initialize the HP-IB/MS control card with the scinit command. Repeat this power-cycle and initialization sequence several times, making sure that after each repetition the message "MS interface initialized" appears. Each reset and download requires about 5-10 seconds.

GC/ALS test Before proceeding with the following test, the first seven steps of the *HP-IB/MS control card test* must have been completed successfully. This establishes that the HP-IB/MS control card operates correctly when the GC and ALS are disconnected, but not when they are connected.

To determine if the problem is associated with the GC or the ALS, proceed as follows.

- 1 Reconnect the GC to the HP-IB bus but leave the ALS disconnected.
- 2 Bring up the manual tune program. See your data system manuals for more information.
- 3 Switch the MSD off then on, and use the scinit command to re-initialize the HP-IB/MS control card.
- 4) If the message “MS interface initialized” appears (in 5-10 see), it indicates that the HP-IB/MS control card and the GC are operating correctly and that the problem could be with the ALS.
- 5) To determine if the ALS is the cause of the problem, reconnect the ALS, power-cycle both the GC and the MSD, and use the scinit command to re-initialize. If the HP-IB/MS control card fails to initialize, it is likely that the problem is with the ALS

Replacing the HP-IB/MS Control Card

If the troubleshooting tests indicate that the HP-IB/MS control card should be replaced, refer to the following procedure

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
HP-IB/MS control card (05971-90006)
Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

Caution Be sure to take appropriate electrostatic discharge precautions before beginning this procedure. See *Electrostatic discharge* under *General Maintenance Considerations* in the *Maintenance chapter* in the main body of this manual.

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of this manual.
- 2 Remove the MSD cover.
- 3 Remove the electronics safety cover. To remove the safety cover, you will have to disconnect the EI/CI switch wires from the main board.
- 4 Disconnect the HP-IB connector cable from the HP-IB/MS control card. The HP-IB connector cable connects the HP-IB MS control card to the HP-IB connector on the instrument back panel (see Figure B-17).
- 5 Disconnect the expansion cable which connects the HP-IB MS control card to the APG remote control interface card.

- 6 Disconnect the APG connector cable from the APG remote control card. The APG connector cable connects the APG remote control card to the APG remote connector on the back panel of the instrument.
- 7 Disconnect the accessory connector cable which connects the main board to the accessory connector on the back panel of the instrument. This cable is not connected to the HP-IB/MS control card but its removal makes it easier to remove the HP-IB/MS control card.
- 8 Loosen the two screws that hold the APG remote control card to the HP-IB/MS control card. Carefully remove the APG remote control card.

Note

The spacers behavior the two cards will be loose; do not drop them into the bottom of the instrument.

- 9 Remove the hexagonal standoff that passes through the HP-IB/MS control card.
- 10 Remove the four other screws that hold the HP-IB/MS control card in place.
- 11 Slide the card to the left slightly to disconnect the 96-pin connector that connects it to the main board and then lift the HP-IB/MS control card out of the instrument.
- 12 Move the replacement HP-IB/MS control card into place. Slide it to the right to engage the 96-pin connector to the main board.
- 13 Reinstall the four screws that hold the top and right-hand edges of the HP-IB/MS control card in place.
- 14 Reinstall the hexagonal standoff.

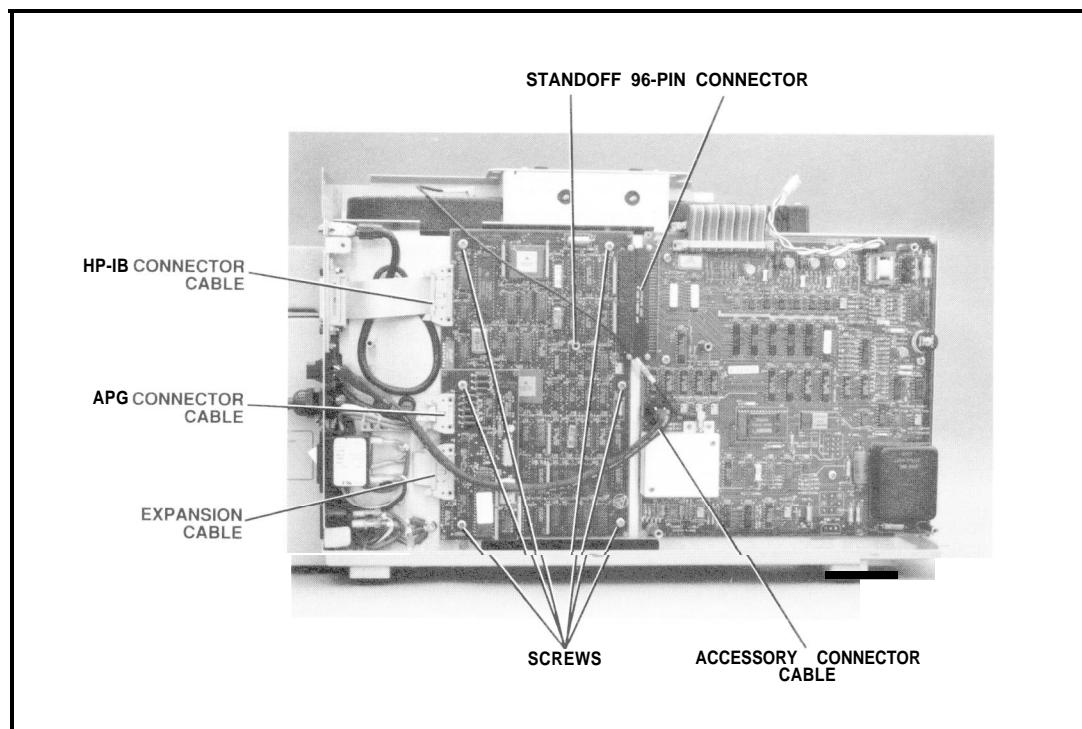


Figure B-17. Replacing the HP-IB/MS control card

- 15 Reinstall the APG remote control card using the two screws and two standoffs.
- 16 Reinstall the expansion cable which connects the APG remote control card to the HP-IB/MS control card.
- 17 Reinstall the APG connector cable.
- 18 Reinstall the HP-IB connector cable.
- 19 Reinstall the accessory connector cable.

- 20 Reinstall the electronics safety cover. Be sure to reconnect the EI/CI switch wires to the main board,
- 21 Reinstall the MSD top cover.
- 22 Reconnect the MSD power cord. Start up and pump down the MSD according to the procedure listed in the *Operations* chapter in the main body of this manual.

Theory of Operation B-60

Interfacing to External Devices B-64

Parallel/Remote Board B-67

Replacing the APG Remote Control Card B-68

Theory of Operation

The APG remote control card provides a means for a remote-start signal to be read by the HP-IB/MS control card. It also ensures accurate run-start synchronization. The APG remote control card is mounted on top of the HP-IB/MS control card (see Figure B-18) and is connected to the HP 5890 GC by the remote control cable. It is connected to the HP-IB/MS control card by the expansion cable.

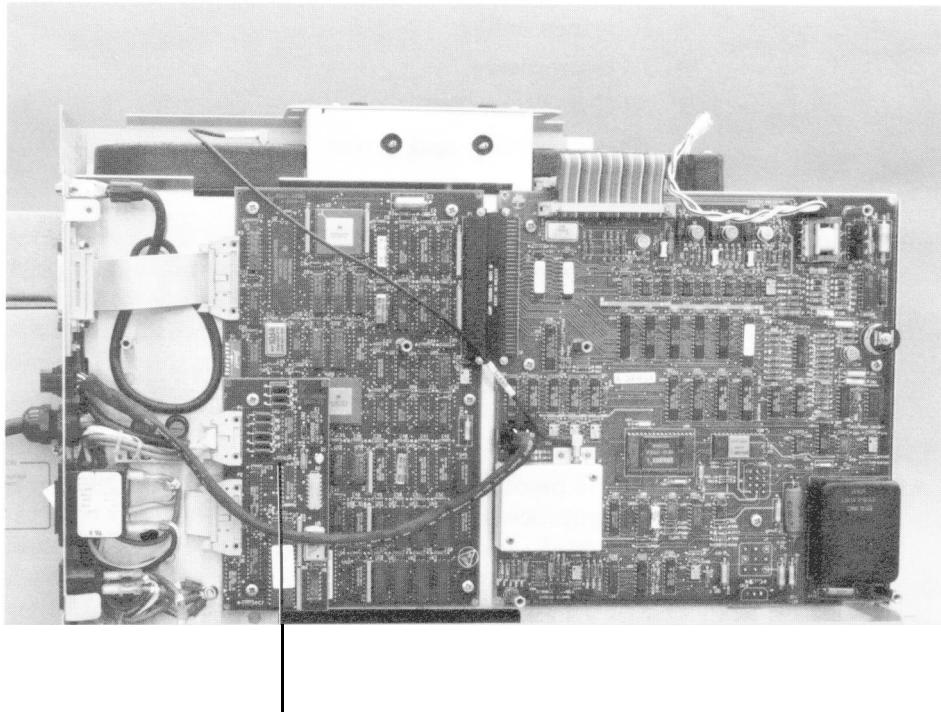


Figure B-18. APG remote control card

The APG remote control card contains four functional blocks (Figure B-19).

- Interface buffer
- APG processor
- APG bus interface
- Power-on relay and driver

Interface buffer The interface buffer functions to buffer the connections between the APG remote control card and the HP-IB/MS control card. It also protects the microprocessor from electrostatic discharge. The buffer contains address decode and data bus drivers to move data from the APG remote control card to and from the HP-IB/MS control card.

APG processor The APG processor contains an HP 68701 microprocessor; the microprocessor forms the heart of the APG remote control card. It communicates with the HP-IB/MS control card by accepting commands and by providing data when asked. In addition, it debounces the remote control bus and provides the HP-IB/MS control card with an indication of important bus activity by way of the remote interrupt request (REM_IRQ*) line. Conditions that determine when interrupts occur, as well as other configuration information, are set up by the HP-IB/MS control card by means of commands to the HP 68701. The APG processor also contains the clock oscillator for the card.

APG bus interface The APG bus interface drives and monitors the state of the APG bus lines. The interface contains ESD protection diodes, an 8-bit bus driver, and an 8-bit receiver. It also provides all of the power-up, power-down, de-glitch, and loading requirements for the APG remote control bus.

Power-on relay and driver The power-on relay block contains the power-on relay and the power-boost transistor to drive it. The relay is normally closed and is connected to the POWER-ON signal on the APG remote control bus. As a result, the POWER-ON signal is pulled to ground when the APG remote control card is powered down.

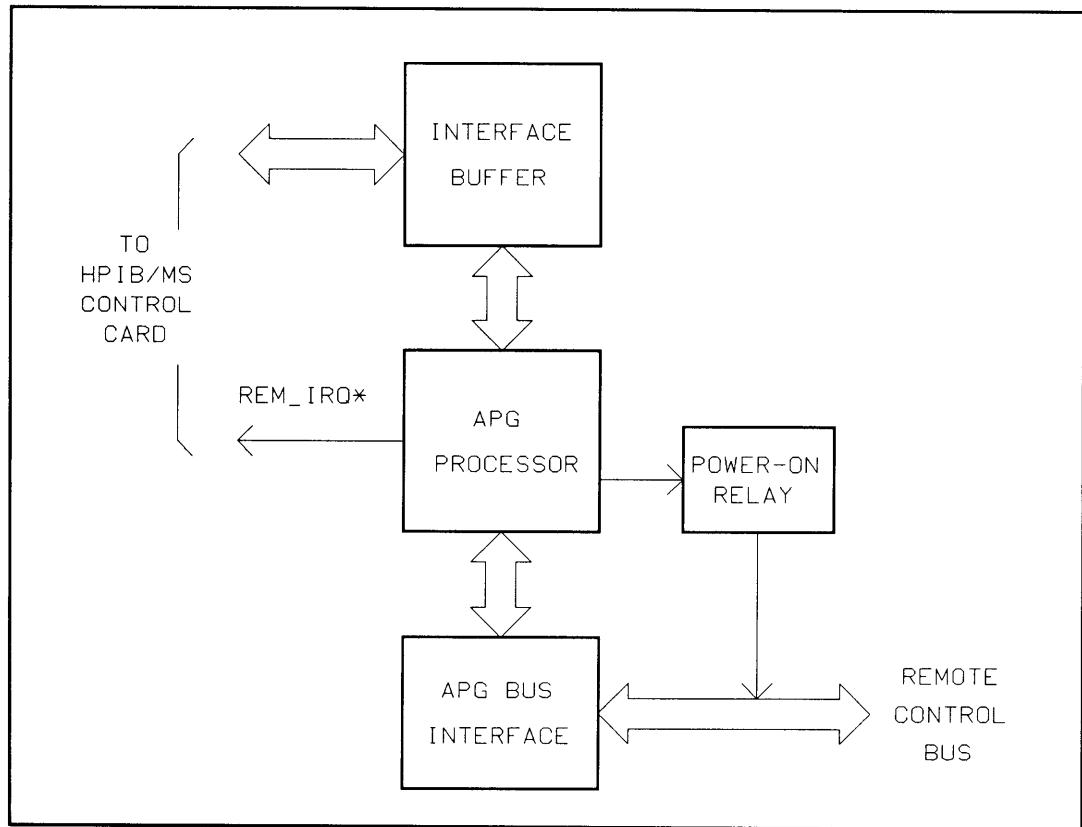


Figure B-19. APG remote control card block diagram

Interfacing to External Devices

It is often necessary to communicate with external devices (e.g., a purge-and-trap) during a run. Typically, these communications are requests to (1) send a System Ready signal, (2) receive a Start Run signal from an external device, or (3) program the timing of events during a run.

System ready

When interfacing to an external device such as a Tekmar purge and trap, it is desirable to communicate a System Ready signal to the device. In the case of a multisample Tekmar, each sample is purged onto a trap where it waits for a ready signal. On receipt of the ready signal, the desorb cycle begins and the Tekmar gives a contact closure to indicate a Start Run when a specific temperature has been reached. The problem is from where to get the System Ready signal. The most obvious choice is the GC but, unfortunately, the GC System Ready signal usually means that only the W—not the entire system—is ready.

The HP 5971A MSD and the HP 5890 GC follow the APG protocol for System Ready and Start Run signals. Thus, pin 5 on the APG remote connector on the HP 5890A GC main board is held low at all times except when the GC, MSD, and data system are ready for the next run. On System Ready, a logic high of 5 V dc is present between pin 5 and any ground (pins 2, 4, 5, 7, or 11). This same high can be detected between pins 7 and 1 on the APG remote connector on the rear panel of the MSD, if there is no HP 5890A GC present (see Figure B-20).

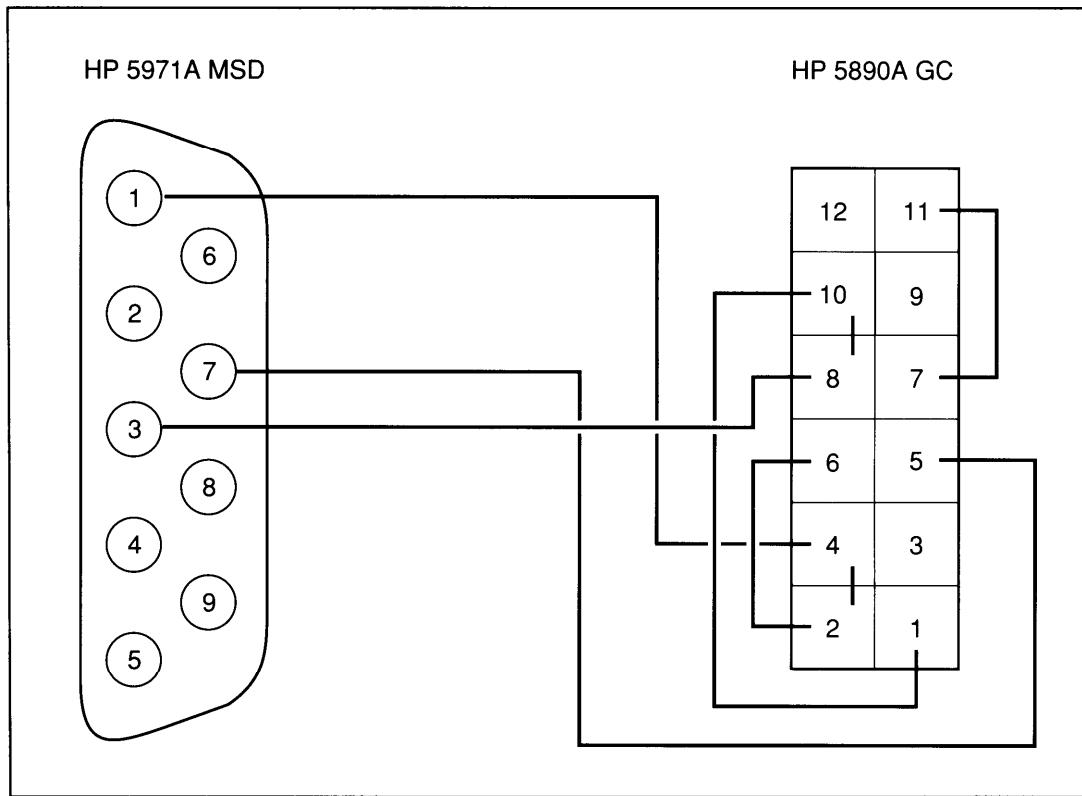


Figure B-20. APG remote control cabling

Start run input

The Start Run signal can be sent through the APG remote connector (pins 1 and 2) of the HP 5890A GC. Since remote cables are made for most common devices, this is often the simplest way. A general-purpose remote cable (05890-61080), which is also available, terminates in spade lugs. Care must be taken to ensure that the system is actually ready before the Start Run signal is sent.

The best way to generate a Start Run signal is to use the APG remote connector on the HP 5890 GC. It is, however, possible to use the APG remote connector on the back of the MSD. A contact closure between pins 3 and 1 will start the run (again presuming the system is ready).

Parallel/Remote Board

The parallel/remote board allows up to three devices (instead of one) to be connected to the APG remote connector of the HP 5890 GC. A short cable connects the board to the APG remote connector on the HP 5890 GC (Figure B-21).

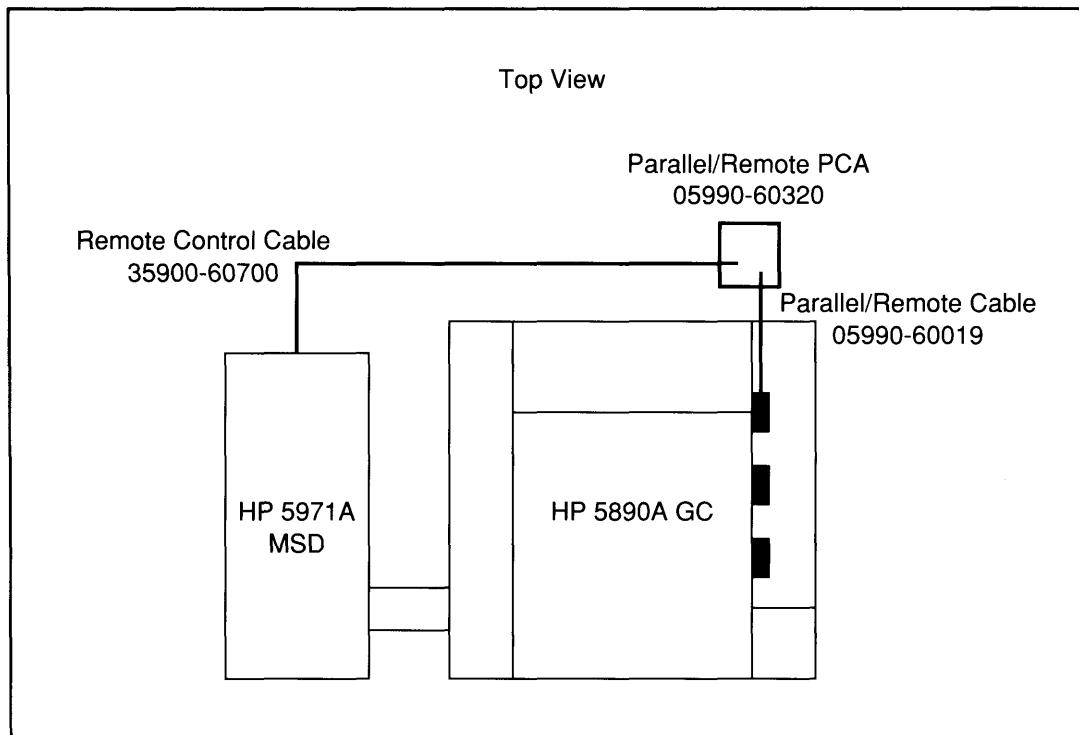


Figure B-21. Parallel/remote board cabling

Replacing the APG Remote Control Card

Use the following procedure if it becomes necessary to replace the APG remote control card.

Materials needed

APG remote control card (05971-60009)

Hex nut driver, 1/4-inch (8720-0002)

Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

Caution Be sure to take appropriate electrostatic discharge precautions before beginning this procedure. See *Electrostatic discharge* under *General Maintenance Considerations* in the *Maintenance* chapter in the main body of this manual.

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of the manual.
- 2 Remove the MSD cover.
- 3 Remove the electronics safety cover. To remove the safety cover, you will have to disconnect the EI/CI switch wires from the main board.
- 4 Disconnect the expansion cable (see Figure B-22) from the APG remote control card. The expansion cable connects the APG remote control card to the HP-IB/MS control card.
- 5 Disconnect the APG connector cable from the APG remote control card. The APG connector cable connects the APG control card to the APG connector on the back panel of the MSD.
- 6 Loosen the two screws that hold the APG remote control interface card to the HP-IB/MS control card. Carefully remove the APG remote interface control card.

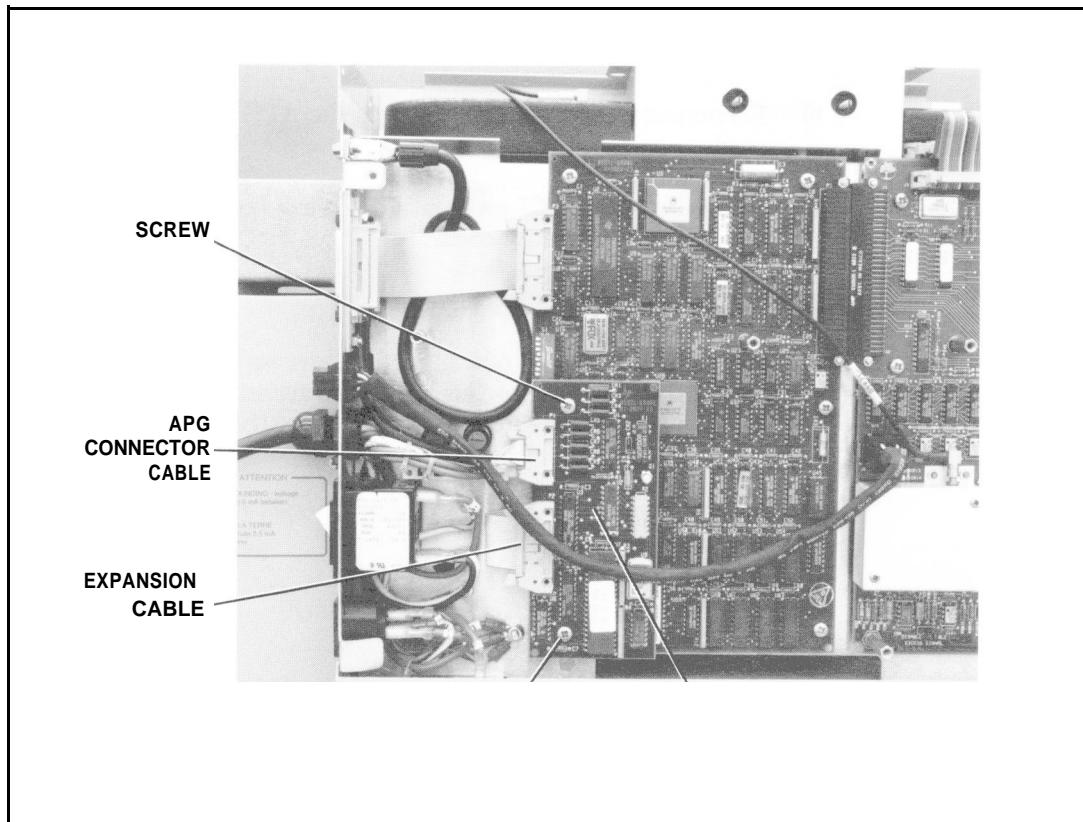


Figure B-22. Replacing the APG remote control card

Note The spacers between the two cards will be loose; do not drop them into the bottom of the instrument.

- 7 Unpack the new APG remote control card and position it on the HP-IB/MS control card.
- 8 Install and tighten the two screws that hold the APG remote control card in place,

- 9 Reconnect the APG connector cable to the APG remote control card.
- 10 Reconnect the expansion cable to the APG remote control card.
- 11 Reconnect the EI/CI-switch to the main board and reinstall the electronics safety cover.
- 12 Reinstall the MSD top cover.
- 13 Reconnect the MSD power cord. Start up and pump down the MSD according to the procedure listed in the *Operations* chapter in the main body of this manual.

Theory of Operation B-72

Replacing the Power Distribution Board B-76

Theory of Operation

The power distribution board (see Figure B-23) is mounted next to the power supply on the electronic panel below the vacuum manifold.

Circuitry on the power distribution board performs the following functions:

- Distributes ac line power to the dc power supply and the cooling fan
- Regulates the power to the diffusion pump heater
- Tests the foreline pressure for sufficient vacuum to allow activation of the diffusion pump
- Passes the foreline pressure signal and the safety interlock signals to the main board; the safety interlock signals are TOO HOT, TOO COLD, FORELINE, and DIFF OFF

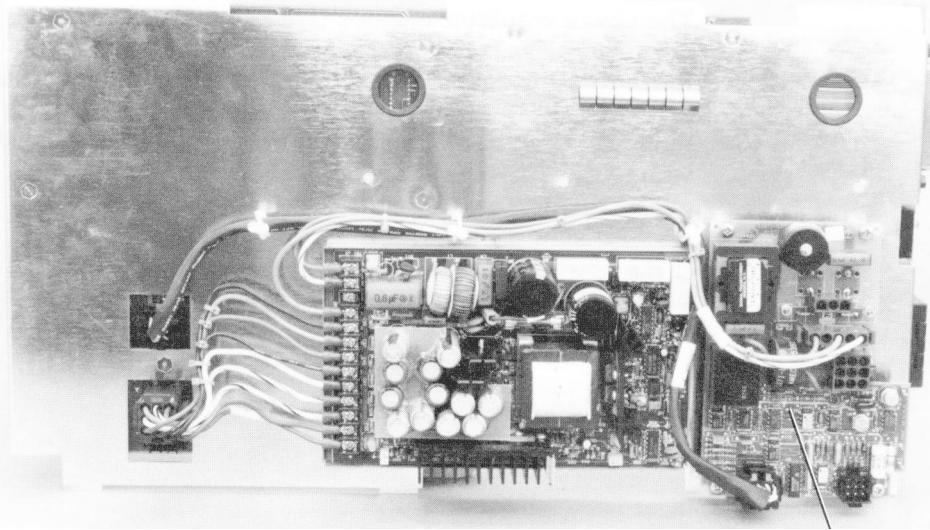
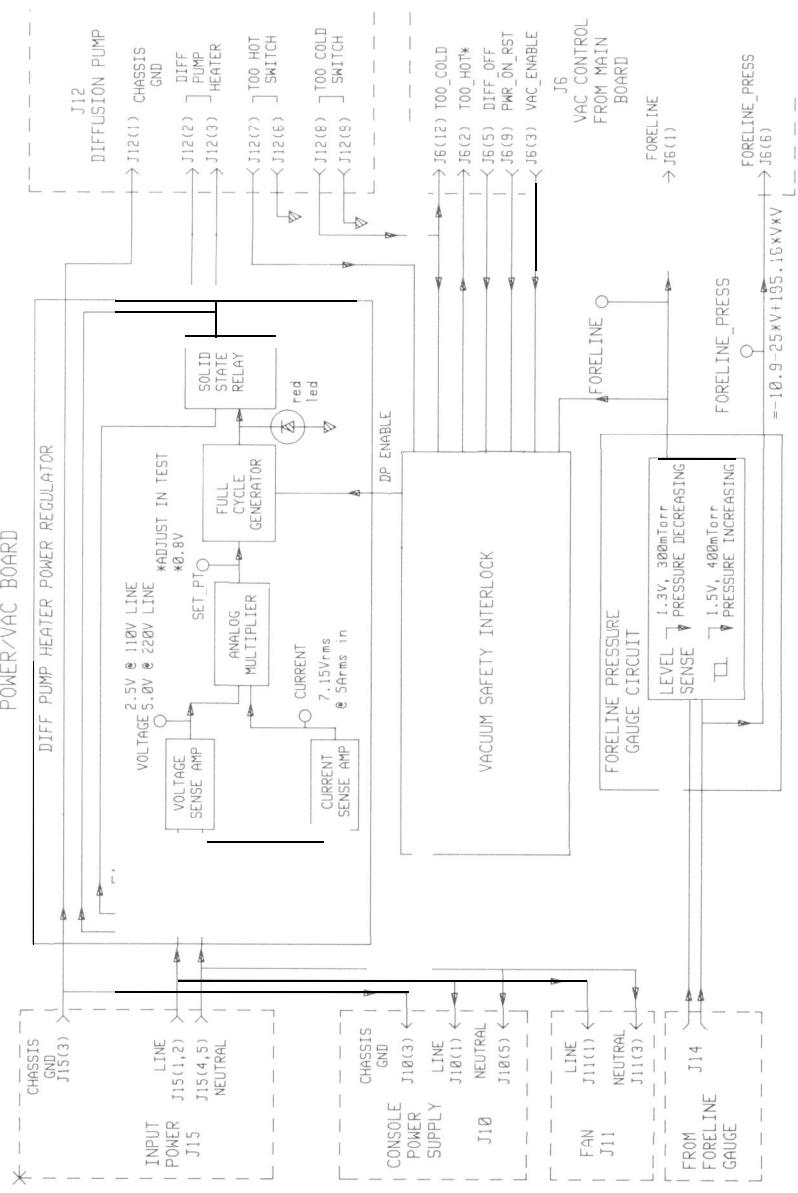


Figure B-23. Power distribution board

Figure B-24 is a simplified block diagram of the power distribution board.

The power regulator ensures that the diffusion pump heater receives constant power, even if there are fluctuations in the ac line voltage. It measures the voltage across the heater and the current through it, multiplies them together, and compares the result with a standard value. Any discrepancy is applied as an error signal to adjust the power.

If the power distribution board senses a malfunction in the diffusion pump power regulator, it shuts off power to the diffusion pump.



Replacing the Power Distribution Board

The power distribution board is mounted next to the power supply on the electronics panel. It is secured to the panel by five screws. The procedure for replacing the power distribution board is divided into four parts:

- Removing the electronics panel
- Removing the power distribution board
- Installing a power distribution board
- Reinstalling the electronic panel

Materials needed:

Hex nut driver, 1/4-inch (8720-0002)
Power distribution board (05971-60003)
Screwdriver, Pozidriv #2 (8710-0900)

Removing the electronics panel

Use this procedure to remove the electronics panel from the MSD.

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of this manual. Disconnect the MSD power cord.
- 2 Remove the MSD cover.
- 3 Remove the five screws that hold the electronics safety cover in place. Remove the safety cover. You will have to disconnect the EI/CI switch wires from the main board,
- 4 Disconnect the cables that connect the top board and the main board (see Figure B-25).
 - Disconnect the ribbon cable at the main board
 - Disconnect the filament cable at the main board
 - Disconnect the detector output cable at the main board

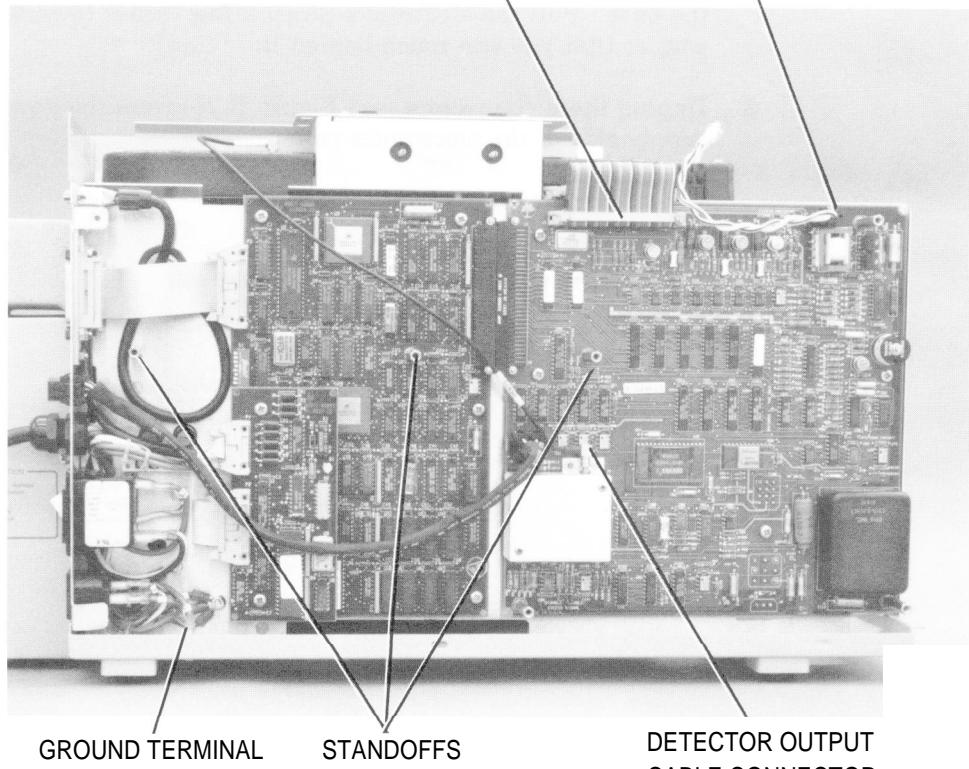


Figure B-25. Electronics panel -main board side

- 5 Disconnect the ground wire that connects the main ground terminal on the electronics panel to the base of the instrument.
- 6 Unscrew the three hexagonal standoffs that hold the electronics panel to the vacuum manifold.

- 7 Tilt the top of the electronics panel forward to disengage the two grommets from the bosses on the vacuum manifold.
- 8 Lift the electronics panel to disengage the three tangs at the base, Pull the electronics panel a few inches toward you, so that you can reach behind it.
- 9 Unplug these connectors (see Figure B-26) from the power supply side of the electronics panel:
 - Calibration valve (inline, three pins)
 - Fan (inline, three pins)
 - Diffusion pump (large square, nine pins)
 - Foreline vacuum gauge (small square, nine pins)
- 10 Lift the electronic panel out of the MSD.

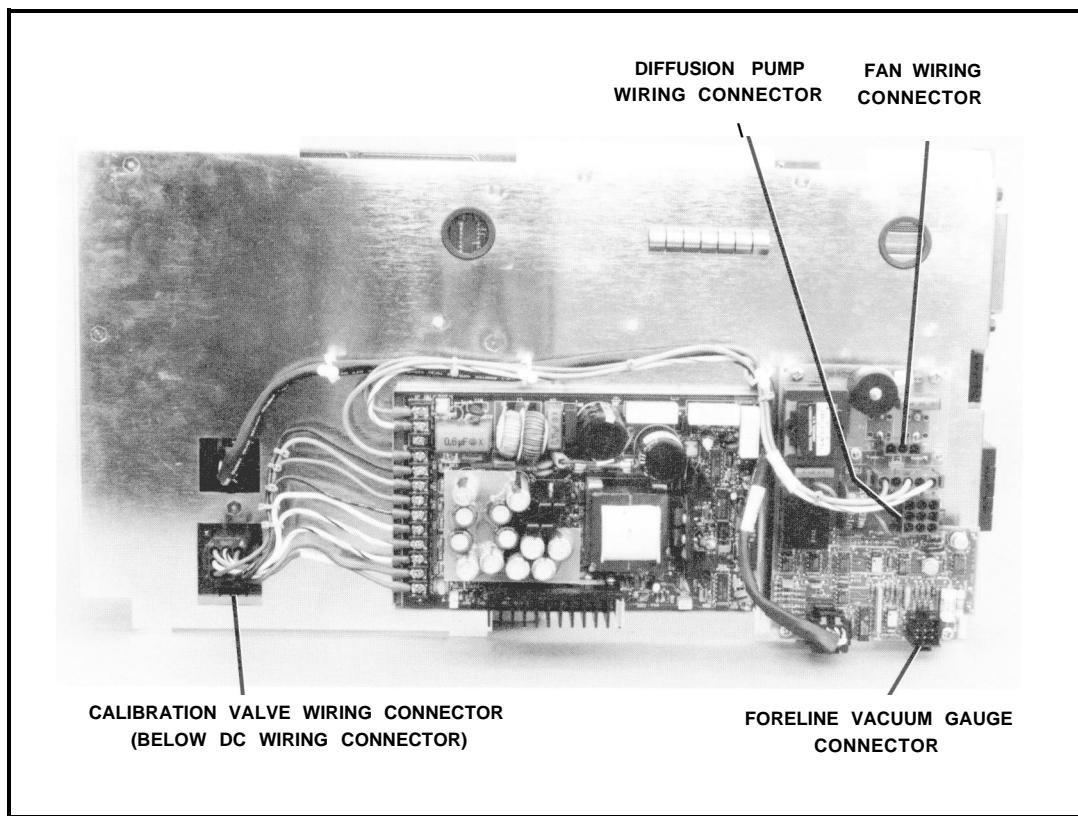


Figure B-26. Electronics panel-power supply side

Removing the power distribution board

Once you have removed the electronics panel from the MSD, use this procedure to remove the power distribution board. Refer to Figure B-27.

- 1 On the main board side of the electronics panel, disconnect the white, five-pin connector located just below the two round diffusion pump fuse holders.
- 2 Unplug the 5-pin and 12-pin connectors from the power distribution board.
- 3 Remove the five screws that hold the power distribution board to the electronics panel. Then, remove the power distribution board. Keep the five screws for installing the new power distribution board.

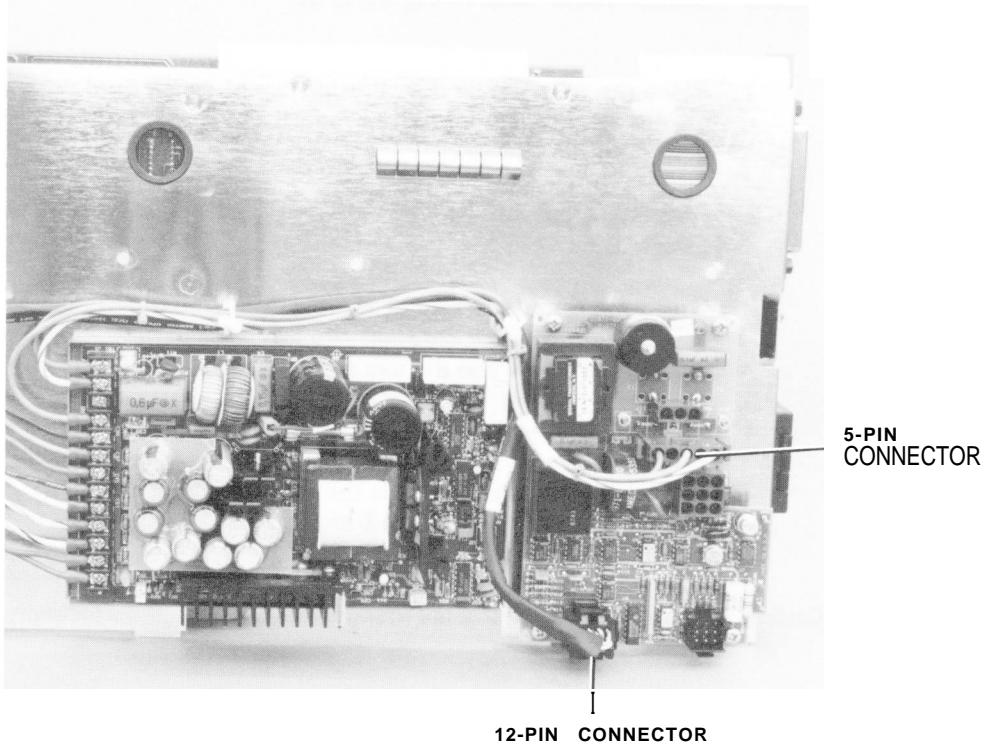


Figure B-27. Power distribution board connectors

Installing a power distribution board Use this procedure to install a new power distribution board. Refer back to Figure B-27.

- 1 Place the new power distribution board in its final position on the electronics panel and install the five screws that hold it in place.
- 2 Reconnect the 5-pin and 12-pin connectors to the power distribution board.
- 3 On the main board side of the electronics panel, reconnect the white connector through the hole in the electronics panel just below the diffusion pump fuses..
- 4 The new power distribution board will be fused for 110/120 V ac operation. If your instrument operates on 220/240 V ac power, you must replace the two standard 4-amp diffusion pump fuses with 2-amp fuses (21 10-0002).

Caution Operating the MSD with the wrong fuses can damage the instrument.

Reinstalling the electronics panel Once you have replaced the power distribution board, use the following procedure to reinstall the electronics panel. Refer back to Figures B-25 and B-26.

- 1 Place the electronics panel a few inches from its proper position at the side of the vacuum manifold,
- 2 Reach behind the electronics panel and plug in the four connectors that you disconnected when you removed the electronics panel. The four connectors are:
 - Calibration valve connector
 - Foreline vacuum gauge connector
 - Diffusion pump wiring connector
 - Fan wiring connectorMake sure the wires from these connectors are routed away from the fan.
- 3 Engage the three tangs along the bottom of the electronic panel into the slots in the base of the MSD. Tilt the electronics panel toward vertical.
- 4 Guide the rear grommet of the electronics panel over the rear boss of the vacuum manifold.
- 5 Reinstall the rear hexagonal standoff (nearest to this grommet).
- 6 Reinstall the middle hexagonal standoff. This one passes through the HP-IB/MS control card.
- 7 Reinstall the front hexagonal standoff. It passes through the main board,
- 8 Reconnect the ground wire to the ground terminal on the base of the MSD.

- 9 Reconnect the following cables to the main board
 - Ribbon cable
 - Filament cable
 - Detector output cable
- 10 Reinstall the MSD cover,
- 11 Reconnect the MSD power cord. Startup and pump down the MSD according to the appropriate procedure in the *Operation* chapter in the main body of this manual.

Theory of Operation B-86

Testing the Power Supply B-88

Replacing the Power Supply Fuse B-62

Replacing the Power Supply B-94

Theory of Operation

The power supply (see Figure B-28) is a switching power supply. It is mounted next to the power distribution board on the electronics panel below the vacuum chamber.

The power supply generates these dc voltages for use by the rest of the electronics:

- +24 V (nominal) with a maximum of 0.5A
- +15 V (nominal) with a maximum of 1.0 A
- 15 V (nominal) with a maximum of 0.2 A
- +5 V (nominal) with a maximum of 1.5 A

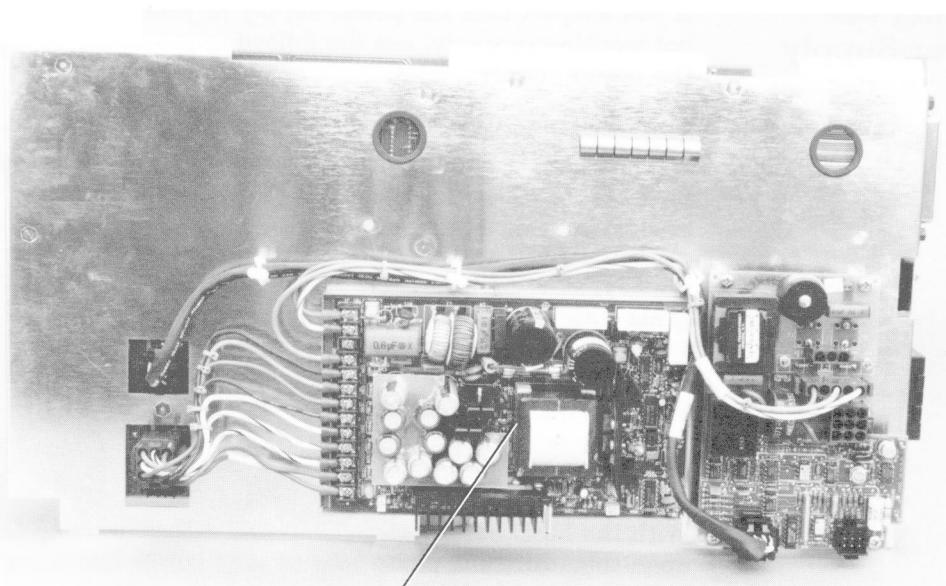


Figure B-28. Power supply

Testing the Power Supply

If you suspect that the power supply in your instrument is not working properly, use the following procedure to test the power supply.

WARNING This procedure involves exposure to 10 potentially hazardous voltages. Do not perform this procedure unless you have been trained to service electronic equipment and work with hazardous voltages.

Materials needed:

Screwdriver, Pozidriv #2 (8710-0900)
Voltmeter, HP E2378A or equivalent

Procedure:

- 1 With the MSD on (foreline pump and diffusion pump fan operating, diffusion pump may or may not be operating), remove the main MSD cover.
- 2 Remove the safety cover which covers the main board and the HP-IB/MS control card.

WARNING Dangerous voltages are present under this safety cover. Do not touch any wiring or components except with the voltmeter test probes.

- 3 Measure the voltages between each of the four voltage test points and the ground (GND) test point on the lower right corner of the main board. See Figure B-29 for the locations of the test points. Table B-1 lists the acceptable voltage range for each test point.

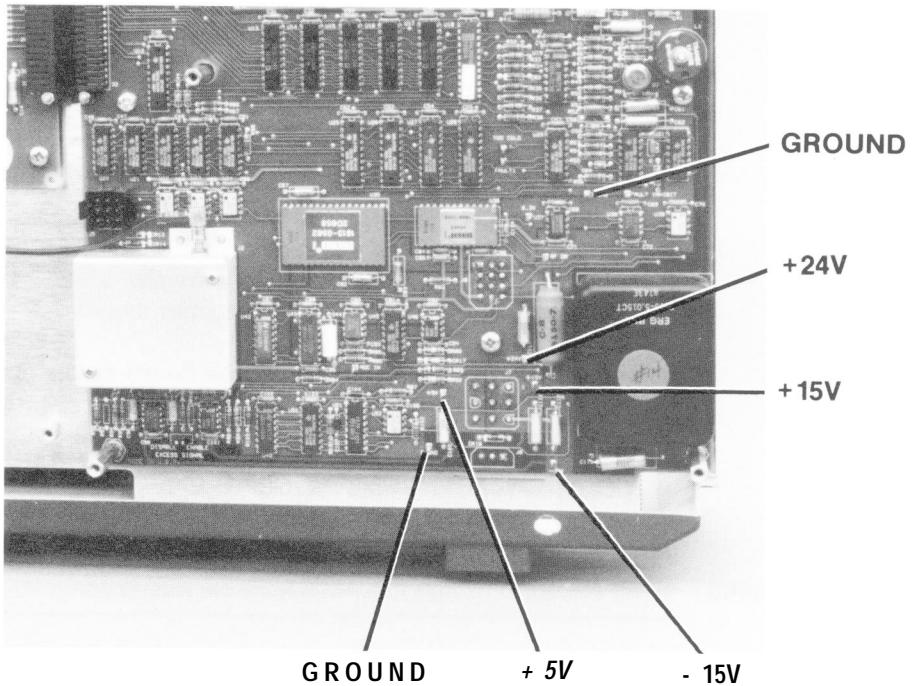


Figure B-29. Dc voltage test points

Table B-L Dc voltages

Test point	Voltage Range (V dc)
+24V	+23.92 to +28.08
+15V	+1425 to +15.75
-15V	-15.75 to -14.25
+5V	+4.75 to +5.15

If all the voltages are zero, there are several possible causes. The cable from the power supply to the main board may not be connected. The cable from the power distribution board to the power supply may not be connected. The “crowbar” circuit in the power supply may have been tripped by a short. The fuse on the power supply may have blown.

The cable from the power supply to the main board connects to the “back” of the main board near the calibration valve. Check and make sure the cable connector is securely fastened to the main board.

The cable from the power distribution board to the power supply is located in a hard-to-inspect area underneath the vacuum manifold. The only way to carefully inspect this cable is to remove the electronics panel (the metal panel that most of the electronic boards are mounted to).

WARNING Never attempt to remove this panel while the MSD is on.

The power supply contains a “crowbar” circuit which acts much like a manual circuit breaker. An internal instrument short can cause the crowbar circuit to trip, shutting down the entire power supply. If you suspect this has occurred, turn the MSD off for at least 1 minute and then turn it back on. If the short was an isolated event, the instrument should power up. If the short is permanent, the crowbar circuit will trip again and the MSD will not power up. In this case contact your Hewlett-Packard Customer Engineer.

A blown fuse on the power supply is very, very rare. The only way to gain access to the fuse is to remove the electronics panel. The fuse can then be visually inspected or tested.

Voltages maybe present at the test points but outside the ranges given in Table B-1. In that case, either the connection between the power supply cable and the main board is bad or the power supply is not functioning correctly. If the cable connections seems to be good, replace the power supply or contact your Hewlett-Packard Customer Engineer.

Replacing the Power Supply Fuse

If symptoms indicate that the power supply fuse has failed, use the following procedure to inspect and, if necessary, replace it. Refer to the *Troubleshooting* chapter in the main body of this manual for more information about symptoms of a failed power supply fuse.

Materials needed:

Fuse puller (8710-1 141)

Replacement fuse

 1-amp (2110-0001)

 2-amp (2110-0002)

Screwdriver, Pozidriv #2 (8710-0900)

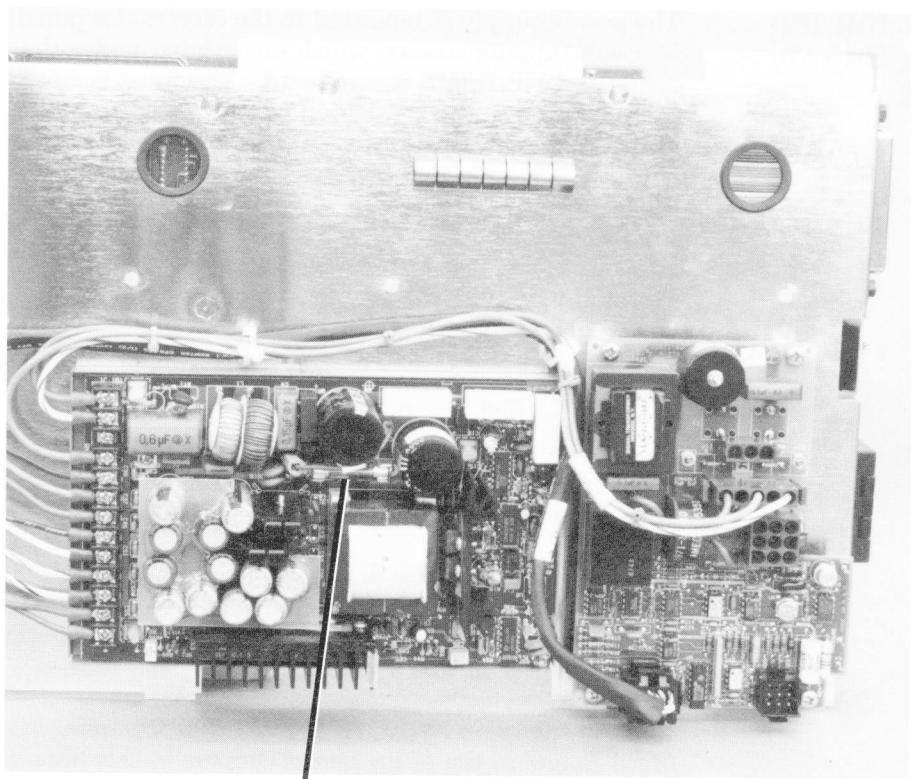
Procedure

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of this manual. Unplug the MSD power cord.
- 2 Remove the electronic panel according to the procedure *Removing the electronics panel* in the *Replacing the Power Distribution Board* procedure in the *Power Distribution Board* chapter in this appendix.
- 3 Inspect the power supply fuse (see Figure B-30). If the fuse has failed, replace it. The power supply fuse should be a 2-amp fuse if your MSD operates on 110/120 V ac power or a 1-amp fuse if your MSD operates on 220/240 V ac power.

Caution

The power supply fuse rarely fails. Its failure is usually a sign of a significant underlying problem. If the power supply fuse fails repeatedly, contact your Hewlett-Packard Customer Engineer.

- 4 Reinstall the electronics panel according to the instructions in *Reinstalling the electronics panel*.



POWER SUPPLY FUSE

Figure B-30. Power supply fuss

- 5 Reconnect the MSD power cord.
- 6 Startup and pump down your MSD according to the procedure listed in the *Operation* chapter in the main body of this manual.

Replacing the Power Supply Board

The power supply is mounted to the electronic panel by four self-tapping screws, which are located under the main board and HP-IB/MS control card. You must remove the main board and the HP-IB/MS control card in order to remove the power supply.

Materials Needed:

Hex nut driver, 1/4-inch (8720-0002)
Power supply (0950-1882)
Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

- 1 Shut down and vent the MSD according to the procedure listed in the *Operation* chapter in the main body of this manual and then unplug the MSD power cord.
- 2 Remove the electronics panel according to the procedure *Removing the electronics panel* in the *Replacing the Power Distribution Board* procedure in the *Power Distribution Board* chapter in this appendix.
- 3 Remove the main board, as described in *Replacing the Main Board* in the *Main Board* chapter in this appendix. There may be some overlap between this procedure and the one in the previous step.
- 4 Remove the HP-IB/MS control card as described in *Replacing the HP-IB/MS Control Card* in the *HP-IB/MS Control Card* chapter in this appendix. There maybe some overlap between this procedure and the ones in the previous two steps.
- 5 Remove the clear plastic safety cover from over the terminal strip on the left side of the power supply.
- 6 Remove the wires from lugs 13, 12, and 10 of the terminal strip (see Figure B-31). The terminals are numbered from the bottom. The bottom terminal is 1 and the top terminal is 13.

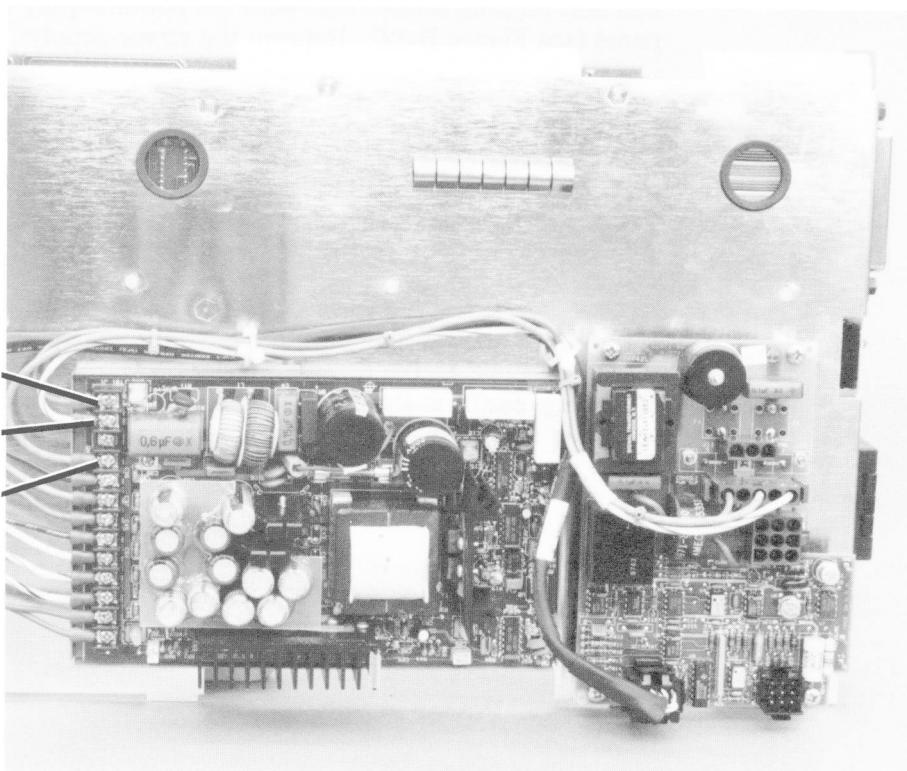


Figure B-31. Power supply terminal strip

- 5 On the main-board side of the electronics panel, remove the four self-tapping screws that hold the power supply to the panel (see Figure B-32). Remove the power supply.

Note figure B-32 shows an older communication interface card. In current MSDs, no printed circuit board will be present on this side of the electronics panel because the main board and HP-IB/MS control card should already have been removed.

- 6 If the new power supply does not have the nine-pin connector wired to the terminal strip, transfer the wires and connector from the old power supply. Note the color coding of the wires, or refer to Table B-2 when connecting them

Table B-2. Power supply wiring

Terminal	Wire Colors
13	Gray
12	White /red /gray
11	Not used
10	Green /yellow
9	Black
8	Orange
7	Violet
6	Black
5	White
4	White / black /gray
3	White /black /gray
2	Red
1	Red

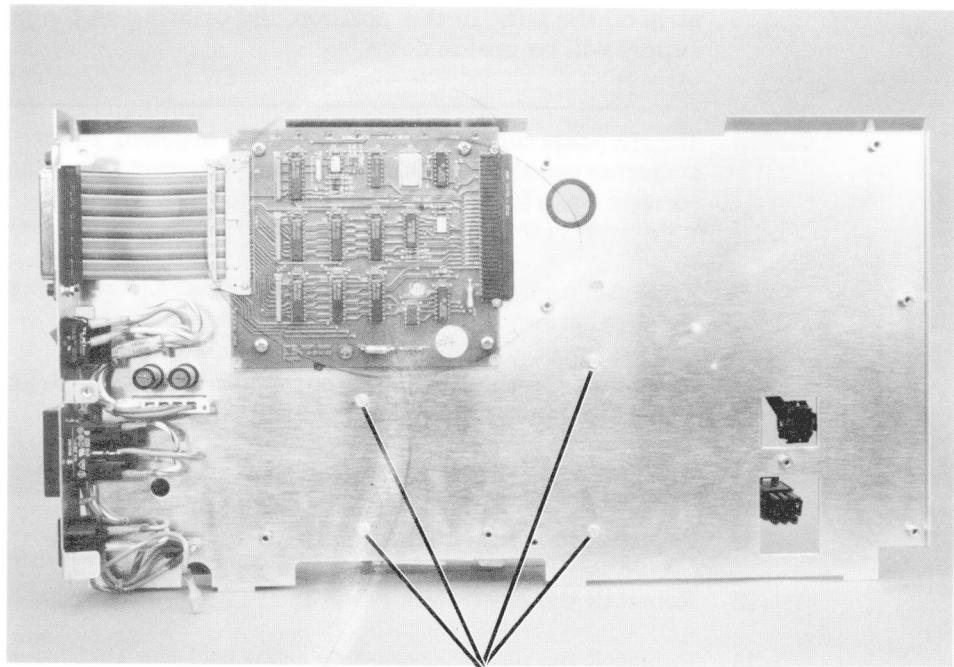


Figure B-32. Power supply mounting screws

- 7 Place the new power supply in position with the terminal strip on the left. In this position, the printing on the power supply will be upside down.

Caution The new power supply is fused for 110/120 V ac power. If your instrument operates on 220/240 V ac power, you must replace the standard 2-amp fuse with a 1-amp fuse (2110-0001).

- 8 From the main-board side of the electronics panel, reinstall the four screws that hold the power supply in place.
- 9 Reconnect the three wires disconnected in step 6. Refer to Table B-2 for the color codes.
- 10 Reinstall the HP-IB/MS control card.
- 11 Reinstall the main board.
- 12 Reinstall the electronics panel in the MSD.
- 13 Reinstall the electronics safety cover and the MSD cover. Do not forget to reconnect the EI/CI switch wires to the main board.
- 14 Start up and pump down the MSD as described in the *Operation* chapter in the main body of this manual.

Testing the Calibration Valve B-100

Replacing the Calibration Valve B-102

Testing the Calibration Valve

If symptoms indicate that the calibration valve in your MSD is not operating correctly, use the following procedure to test the calibration valve. See the *Troubleshooting* chapter in the main body of this manual for more information.

WARNING

This procedure involves exposure to potentially hazardous voltages. Do not perform this procedure unless you have been trained to service electronic equipment and work with hazardous voltages.

Materials needed:

Screwdriver, Pozidriv #2 (8710-0900)
Voltmeter, HP E2378A or equivalent

Procedure:

- 1 With the instrument still operating, remove the MSD cover and the electronics safety cover.

WARNING

Hazardous voltages (approximately 250 V dc) will be present on the main board. Do not attempt this procedure unless you have been trained in electronic instrument maintenance and are experienced at working with hazardous voltages.

- 2 Connect a voltmeter across diode CR18 along the lower edge of the main board (see Figure B-33).
- 3 Initiate an autotune. If the voltmeter registers in the 24 to 26 V dc range, then the electronics are working and the valve should be replaced. If zero voltage is registered or if the voltage measured is significantly outside the range listed, then the electronics are not working correctly. In that case, contact your Hewlett-Packard Customer Engineer.

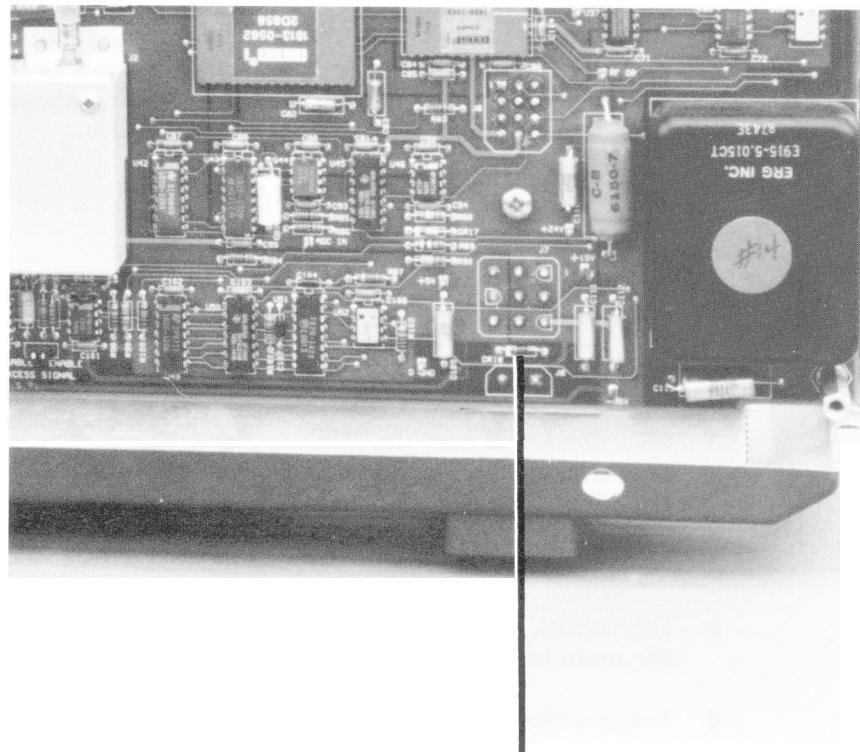


Figure B-33. Diode CR18

Replacing the Calibration Valve

If symptoms indicate that the calibration valve is leaking or malfunctioning and should be replaced, use the following procedure. Refer to the *Troubleshooting* chapter in the main body of this manual for more information about symptoms of a malfunctioning calibration valve.

Materials needed:

Calibration valve assembly (05971-60550)

PFTBA (05971-60571)

Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

- 1 Shut down and vent the MSD, as described in the *Operation* chapter in the main body of this manual. Unplug the MSD power cord.
- 2 Remove the MSD cover.
- 3 Disconnect the calibration valve wiring where it connects to the main board (see Figure B-34).
- 4 Remove the KF25 clamp that connects the calibration valve to the tee fitting.
- 5 Remove the calibration valve assembly.
- 6 Unpack the new calibration valve assembly. The new assembly should be assembled and complete except the calibration vial will be empty.
- 7 Set the KF25 O-ring assembly in place on top of the new calibration valve assembly. If the O-ring appears worn or damaged, replace it.
- 8 Lift the calibration valve assembly into place and reinstall the KF25 clamp.
- 9 Connect the calibration valve wiring to its connector.

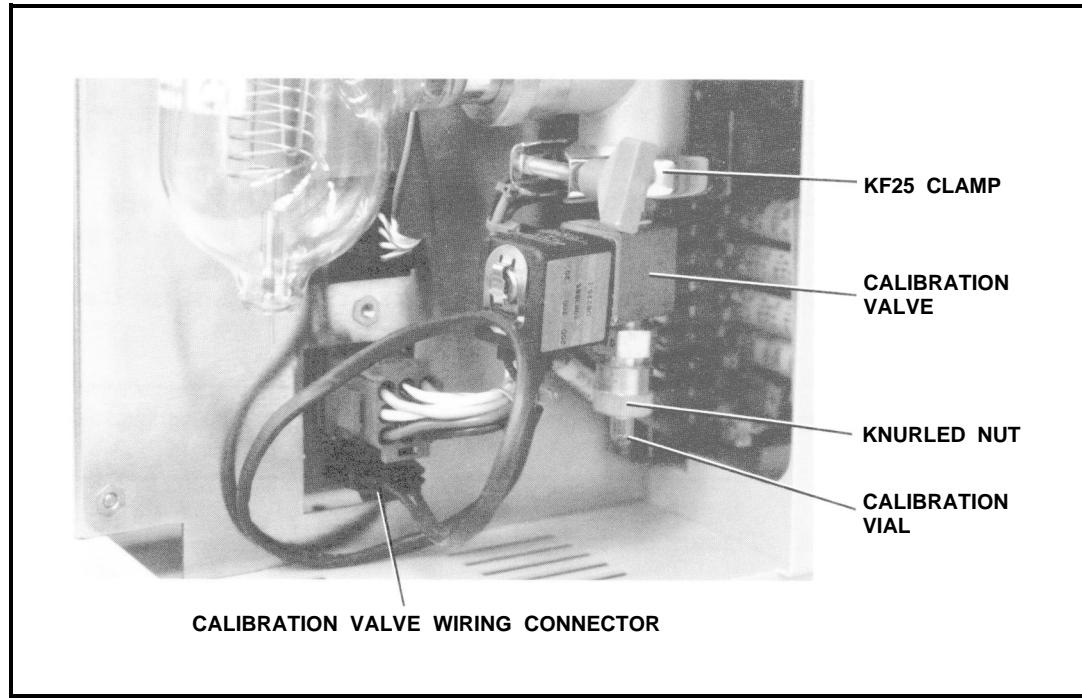


Figure B-34. Calibration valve

- 10 Loosen but do not remove the knurled nut that holds the calibration vial in place..
- 11 Pull the calibration vial down out of the calibration valve assembly.
- 12 Fill the vial to no closer than 1/4 inch of the top with PFTBA or whatever chemical you wish to use for tuning,
- 13 Slide the vial into the valve as far as it will go and then withdraw the vial about 1 mm.

Caution If you do not withdraw the vial slightly, it may break when you tighten the knurled nut.

- 14 Tighten the knurled nut finger tight.
- 15 Reinstall the MSD top cover.
- 16 Startup and pump down the MSD according to the procedure in the *Operation* chapter in the main body of this manual.

Note Some air is initially trapped in the valve and vial. This sometimes causes an 'Excess source pressure' error message during the first tune after installation. This is more likely if the vial is overfilled.

Circuit Breaker B-106

Diffusion Pump Fuses B-106

Power Supply Fuse B-106

Circuit Breaker

The circuit breaker, which serves as an on/off switch, is located on the back panel of the instrument. The breaker automatically opens (switches itself to a neutral position) if there is a power surge. It can be reset by switching it to the OFF position and then back to the ON position. Repeated opening of the circuit breaker indicates an underlying problem with either the line power or the MSD itself.

Diffusion Pump Fuses

The diffusion pump fuses are located on the power distribution board. The cylindrical fuse holders protrude through the electronics panel so they can be reached from the main-board side of the electronics panel (see Figure B-35). If one of the diffusion pump fuses fails, the diffusion pump will not heat up even though the foreline pump and diffusion pump fan are operating.

The diffusion pump fuses should be 4-amp fuses (21 10-0055) if your MSD operates on 110/120 V ac power or 2-amp fuses (21 10-0002) if your MSD operates on 220/240 V ac power. See the *Diffusion Pump* chapter in this appendix for information about replacing these fuses.

Power Supply Fuse

The power supply fuse is located in a fuse holder mounted on the power supply board. If the power supply fuse fails, the power supply stops producing all dc power. The power supply fuse rarely fails. When it does, it is generally a sign of a larger problem. See the *Power Supply* chapter in this appendix for information about replacing the power supply fuse.

The power supply fuse should be a 2-amp fuse (2110-0002) if your instrument operates on 110/120 V ac power or a 1-amp fuse (21 10-0001) if your instrument operates on 220/240 V ac power.

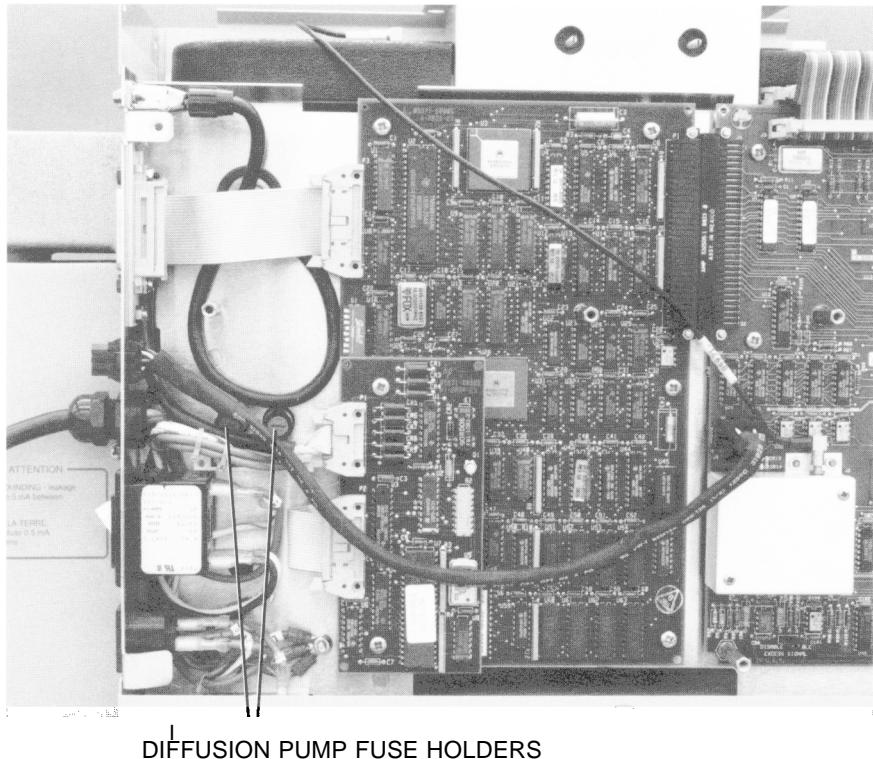


Figure B-35. Diffusion pump fuses



Replacing the Diffusion Pump Fuses B-110

Replacing the Diffusion Pump B-112

Replacing the Diffusion Pump Fuses

If symptoms indicate that one or both of the diffusion pump fuses have failed, use the following procedure to inspect and, if necessary, replace them. Refer to the *Troubleshooting* chapter in the main body of this manual for more information about symptoms of failed diffusion pump fuses.

Materials needed:

Fuses

- 2-amp (2110-0002)
- 4-amp (2110-0055)

Screwdriver

- Pozidriv, #2 (8710-0900)
- small, flat-bladed (8710-1029)

Procedure:

- 1 Shut down the MSD according to the procedure listed in the *Operations* chapter in the main body of this manual. Then, unplug the MSD power cord.
- 2 Remove the MSD cover.
- 3 Remove the electronic safety cover. You will have to disconnect the EI/CI switch wires from the main board.
- 4 Locate the two diffusion pump fuse holders near the rear of the electronics panel (see Figure B-36).
- 5 Use a small, flat-blade screwdriver to rotate each of the fuse holders counterclockwise. The holders are spring-loaded and will pop out.
- 6 Inspect the fuses. Replace a fuse if it has failed. The diffusion pump fuses should be 4-amp fuses if your MSD operates on 110/120 V ac power or 2-amp fuses if your MSD operates on 220/240 V ac power.
- 7 Reinstall the fuse holders.
- 8 Reinstall the electronics safety cover and then the MSD cover.

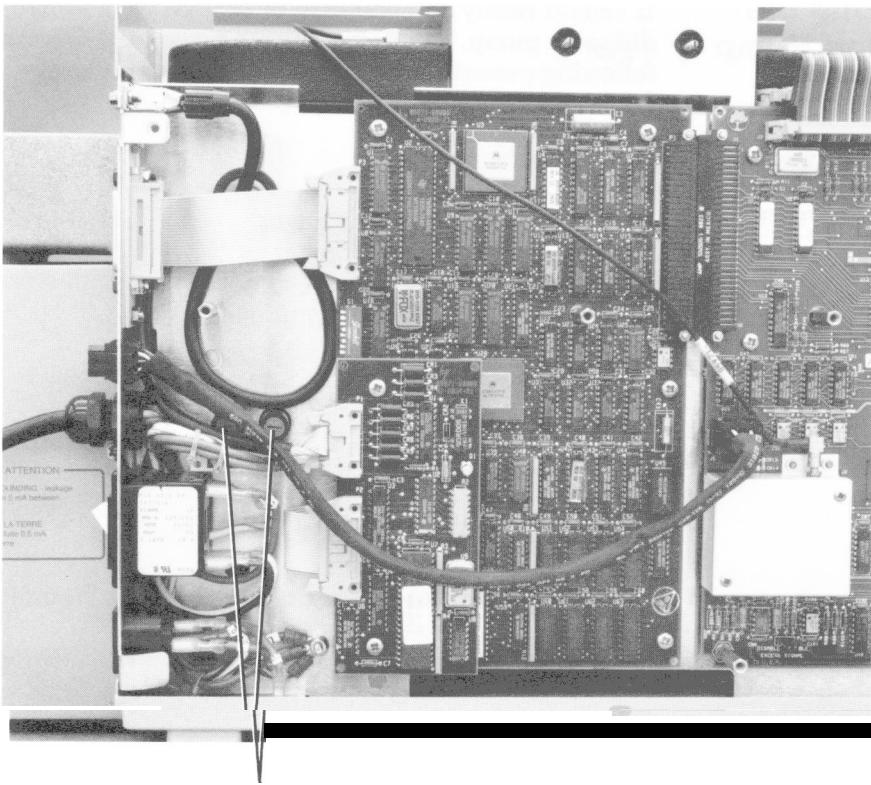


Figure B-36. Replacing the diffusion pump fuses

- 9 Reconnect the MSD power cord.
- 10 Startup and pump down the instrument according to the procedure listed in the *Operation* chapter in the main body of this manual.

Caution Fuses that frequently fail are usually a sign of a significant underlying problem. If the diffusion pump fuses fail repeatedly, contact your Hewlett-Packard Customer Engineer.

Replacing the Diffusion Pump

It should rarely be necessary to replace your MSD's diffusion pump. If it does become necessary, use the following procedure to replace the diffusion pump.

Materials Needed:

Diffusion pump assembly

110/120 V ac (05971-60530)

220/240 V ac (05971-60531)

Diffusion pump fluid (6040-0723)

Screwdriver, Pozidriv #2 (8710-0900)

Procedure:

- 1 Shut down and vent the MSD. Unplug the MSD power cord.
- 2 Remove the diffusion pump cover.
- 3 Unplug the blue connector from the foreline vacuum gauge.
- 4 Remove the small (KF10) clamp that connects the foreline vacuum gauge fitting to the diffusion pump. Remove the fitting.
- 5 Hold the diffusion pump in one hand and with your other hand, remove the large (KF50) clamp that connects the diffusion pump to the vacuum manifold.
- 6 Lower the diffusion pump onto the work surface. The wires from the diffusion pump will still be connected to the MSD.
- 7 Remove the fan from the MSD but do not disconnect its wiring from the power distribution board.
- 8 Reach through the opening where the fan was located, and unplug the diffusion pump wiring connector from the power distribution board.

Note

You have to squeeze in the tabs on the sides of the connector to disengage it.



Figure B-37. Diffusion pump wiring connector

- 9 Withdraw the split grommet from the cutout in the cabinet and remove the diffusion pump wires from the grommet.
- 10 Move the diffusion pump and wires away from the MSD.
- 11 Unpack the new diffusion pump assembly.
- 12 Remove the stack retaining clip by pulling upon one side of the clip. Place the clip on a clean, lint-free cloth.
- 13 Remove the stack pieces one at a time (see Figure B-38). Be careful to note the order in which you remove the pieces. Place the pieces on a clean, lint-free cloth.

Note Some pumps have a one-piece stack which you do not have to disassemble

- 14 Pour one of the pm-measured 20-ml tubes of diffusion pump fluid into the bottom of the diffusion pump. Use this exact amount and do not use any other type of fluid.
- 15 Reinstall the stack, one piece at a time. Install the bottom stack member so that the ejector tube is aligned with the foreline elbow (exhaust tube). If this piece is installed incorrectly, the pump will not function at all.
- 16 Carefully reinstall the stack retaining clip. The clip should be centered and should appear concave when viewed from the top of the diffusion pump.
- 17 Reverse steps 1 through 10 to install the new diffusion pump.
- 18 Startup and pump down the MSD according the appropriate procedure in the *Operation* chapter in the main body of this manual.

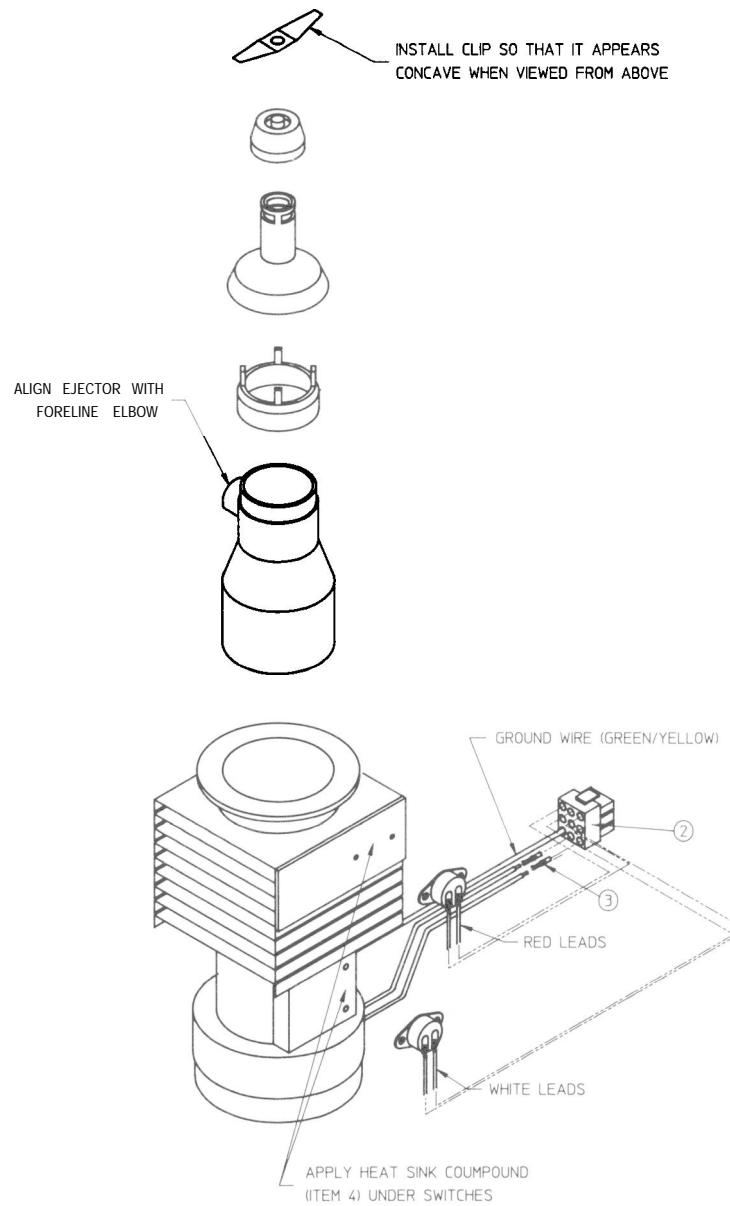


Figure B-38. Removing the diffusion pump stack





Appendix C

GC/IRD/MSD Interface

General Information

The GC/IRD/MSD interface is a longer version of the standard GC/MSD interface. It is used to combine into a single system, the HP 5965A/B Infrared Detector (IRD), HP 5971A MSD, and HP 5890 G-C. The GC/IRD/MSD interface is documented in the installation manual supplied with the interface. If your MSD is equipped with the GC/IRD/MSD interface, we suggest that you keep the installation manual behind the Appendix C tab in this binder so that it is always accessible and does not become lost.



Appendix D

CI Accessory

General Information

The HP G1072A CI Accessory allows the HP 5971A MSD to be operated in the positive chemical ionization mode. The CI accessory consists of a CI ion source, a flow controller, software, and miscellaneous parts. The CI accessory is documented in the *HP G1072A CI Accessory Hardware Manual* which is supplied with the accessory. If your MSD is equipped with the CI accessory, we suggest that you keep the hardware manual behind the Appendix D tab in this binder so that it is always accessible and does not become lost.

Index

This index includes entries for the main body and Appendixes A and B of the *HP 5971A Mass Selective Detector Hardware Manual*. Entries for other manuals supplied with the MSD are not included in this index.

Letter	Page	Letter	Page
A	2	M	22
B	4	N	24
C	5	O	25
D	7	P	26
E	9	Q	29
F	11	R	30
G	13	S	32
H	16	T	35
I	17	U	38
J	19	V	39
K	20	W	40
L	21	X	41

A

Abrasives

use of for cleaning, 6-46

Abundances

causes of inadequate, 5-14

causes of low, 5-17

relative, of air and water peaks, 5-65

Ac power

See also Power requirements

symptoms of fluctuating, 5-44

Ac power cord, 2-44

Accessory, CI, 1-3

Accessory connector

figures showing, 4-41, B-35

functions of, 2-42

Accessory control, 4-30, B-33

grounds, B-37

inputs, B-34

outputs, B-36

voltages, B-37

Adding foreline pump fluid, 6-16

Adjusting the RF coils, B-22

Air and water check, 5-65

Air conditioning requirements, 3-3

Air leaks

See Leaks

ALS controller switch settings, B-51

AMU gain

effect of various settings, 4-33

function of, 4-33

symptoms of incorrect, 5-24

AMU offset
effect of various settings, 4-33
function of, 4-33
symptoms of incorrect, 5-24

Analyzer
figure showing, 2-23
figure showing reinstallation of the, 6-39
figure showing removal of the, 6-37
function of, 2-22
heating of by conductance, 2-20
maintenance, 6-35
major components of, 2-22
parts, 7-8
reinstalling the, 6-38
removing the, 6-36
replacing the, 6-63

Analyzer temperature
See also MS temperature
too low, 5-29

APG remote control card, B-59
block diagram, B-63
cabling, B-65
figure showing, B-61
figure showing connections, 2-39
function of, 2-38
replacing the, B-68
theory of operation, B-60

APG remote control connector, function of, 2-42, 4-40

Argon, use of for leak detection, 5-67

Autotune
for CI, 4-39
function of, 4-36
ions used for, 4-36
symptoms of poor, 5-19

B**Background**

as a symptom of air leaks, 5-11
as a symptom of contamination, 5-12
high, 5-11

BFB tune

function of, 4-37
ions used for, 4-37

C

Calibration valve, B-99
figure showing, 2-19, B-103
function of, 2-18
leaks in the, 5-67, 5-70
location of, 2-18
replacing the, B-102
symptoms of malfunctioning, 5-35, 5-52, 5-61
testing the, B-100

Calibration vial
air trapped in, 6-32, B-104
figure showing, 6-31
refilling the, 6-30
symptoms of an empty, 5-35, 5-52, 5-60
symptoms of over-filled, 5-47, 5-62

Can not achieve constant peak widths, 5-35

Capillary direct column installation
figure showing, 4-7
procedure for, 4-6

Carrier gas
contaminated, 5-72
symptoms of excessive flow, 5-14, 5-17

Checking and replacing the diffusion pump fluid, 6-22, 6-26

Checklist, pre-operation, 4-3

Chemical residue, 6-11

CI accessory, 1-3
manual for, 3-5

CI autotune
function of, 4-39
ions used for, 4-39
reagent gas for, 4-39
tuning compounds, 4-39

CI quicktune, 4-39

Circuit breaker, B-106

Claims, warranty, 1-15

Cleaning

- abrasive, 6-46
- as a source of contamination, 5-73
- supplies needed for maintenance, 6-7
- symptoms of improper, 5-11
- the ion source, 6-41
- ultrasonic, 6-47

Column bleed, 5-72

testing for, 5-72

Columns

See GC columns

Column nut, leaks around the, 5-67, 5-68

Connectors

- figure showing, 2-43
- on the MSD back panel, 2-42
- symptoms of loose, 5-26

Consumables

- needed for maintenance, 6-7
- part numbers, 7-13

Contaminants, table of, 5-71

Contamination, 5-71

- recontamination after cleaning, 6-47
- removing, 5-74
- sources of in the GC, 5-72
- sources of in the MSD, 5-73

Controller cable, A-16

symptoms of a defective, A-36

Conversion between EI and CI operating modes, 3-5

Cooling requirements, 3-3

D Dangerous voltages, 6-9

Data system

function of, 1-4
software, 1-4

Degassing the ion gauge tube

theory of, A-11
procedure for, A-41

Depth, of the MSD, 1-8

Detector

electron multiplier in the, 2-30
figure showing, 2-31
figure showing removal of the, 6-61
figure showing the high voltage lead, 5-38
function of, 2-30
gain of, 2-30
installing a, 6-62
removing the, 6-60
replacing the, 6-59
symptom of loose connections, 5-10, 5-60
symptom of loose output cable, 5-10, 5-35, 5-60
symptoms of malfunctioning, 5-23, 5-37, 5-61, 5-62
voltages applied to, 2-30
x-ray lens in, 2-30

DFTPP tune

function of, 4-37
ions used for, 4-37

Difficulty in the mass filter electronics, 5-36

Difficulty with the detector HV supply, 5-37

Diffusion pump, B-109

checking and replacing the fluid in, 6-22
checking the fluid level, 6-26
disconnecting the wiring, 6-25
figure showing, 2-17
figure showing fuses, B-107

continued

Diffusion pump — continued

- figure showing stack disassembly, 6-27
- figure showing wiring connection, 5-43, B-113
- fluid as a source of contamination, 5-73
- function of, 2-16
- fuses, B-106
- pressure (vacuum) created by, 2-16
- reinstalling, 6-29
- removing the, 6-22
- removing the stack from the, B-115
- replacing the, B-112
- replacing the fuses for the, B-110
- symptoms of a failed fuse, 5-45
- symptoms of a failed heater, 5-45
- symptoms of a low fluid level, 5-39
- symptoms of a disconnected cable, 5-39, 5-42, 5-45
- time required to reach operating temperature, 5-42

Dimensions, of the MSD, 1-8

I)isassembling the ion source, 6-44

Dwell time, 1-7

Dynamic range, 1-6

E

Electrical requirements
See Power requirements

Electron multiplier (EM)

See *also* Detector

effect of various settings, 4-34

symptoms of high voltage on, 5-62

symptoms of low voltage on, 5-15, 5-19

Electronic parts, 7-4

Electronics

figure showing organization of, 2-33

maintenance of the, 6-69

major components of, 2-32

Electronics panel

reinstalling the, B-83

removing the, B-76

Electrostatic discharge, 6-12

Eluent, venting of, 4-12

Emission current, lack of, 5-58

Entrance lens

effect of various settings, 4-32

function of, 4-32

gain, 4-32

offset, 4-32

voltages applied to, 2-26, 4-32

Environment

operating, 1-8

storage, 1-8

Error messages, 5-34

can not achieve constant peak widths, 5-35

difficulty in the mass filter electronics, 5-36

difficulty with the detector HV supply, 5-37

excessive source pressure, 5-47

continued

Error messages — continued

gain and offset .0 and peaks are too wide, 5-52
latched, 5-34
mass spectrometer 1/0 check failure, 5-53
MS does not respond, 5-54
no peaks found, 5-56
serious error occurred during data acquisition, 5-57
the diffusion pump is or was too hot, 5-39
the diffusion pump is too cold, 5-41
the foreline pressure has exceeded 300 mTorr, 5-49
there is no emission current, 5-58
there is not enough signal to begin the tune, 5-60
there was an excessive signal level, 5-62

Excessive source pressure, 5-47, B-104

Exhaust, venting the, 4-3

External devices, interfacing to, B-64

F

Fan

figure showing, 2-17
figure showing wiring connector, 5-7
function of, 2-16
procedure for checking, 5-6
symptom of a bad wiring connection, 5-6
symptoms of a malfunctioning, 5-39

Feedthroughs, 2-10, B-14

Fingerprints, 5-74

Filament relay, B-14

Filaments

emission current value, 4-31
figure showing retaining screws, 6-57
figure showing test points, B-17
function of, 2-25
incorrect alignment of, 5-20
installing a, 6-58
removing a, 6-55
replacing a, 6-54
selection of, 4-31
switching between, 2-34, 4-31
switching off to prolong lifetime, 4-31
symptoms of burned out, 5-58
symptoms of disconnected cable, 5-58
symptoms of poor alignment, 5-15, 5-18
symptoms of shorted, 5-59
testing the, B-15

Flow rate

determining actual, 4-18
limits, 4-18
of GC carrier gas, 4-18
symptoms of excessive, 5-17
table of for various columns, 4-19

Foreline pressure, 2-14

Foreline pump
adding fluid, 6-16
checking the fluid level, 6-14
figure showing, 2-13
figure showing fluid-level window, 6-15
fluid as a source of contamination, 5-74
function of, 2-12
power receptacle for, 2-44
replacing the fluid in, 6-18
symptoms of malfunctions in the, 5-8, 5-51
symptoms of unplugged power cord, 5-8

Foreline trap
function of, 2-12
location of, 2-12
replacing the pellets in, 6-20
symptoms of a saturated, 5-50

Foreline vacuum gauge
figure showing, 2-15, 6-23, 6-34
function of, 2-14
replacing the, 6-33
symptoms of a defective, 5-50
symptoms of unplugged, 5-49

Fuses, B-105
circuit breaker, B-106
diffusion pump, B-106
figure showing diffusion pump fuses, B-107
part numbers, 7-5
power supply, B-106
symptoms of a failed diffusion pump fuse, 5-45

G

Gain and offset = 0 and peaks are too wide, 5-52

Gas chromatography (GC)

sources of contamination in, 5-72

symptoms of poor performance, 5-19

Gauge controller, 1-3, A-1

attaching the controller cable, A-22, A-24

changing the voltage setting, A-45

degas switch, A-16

degassing the ion gauge tube, A-41

figure showing, A-4

figure showing the back panel, A-25

figure showing the front panel, A-17

figure showing voltage selector card and fuse, A-47

fuse

symptoms of failed, A-34

symptoms of a mismatched, A-35

values for various voltage settings, A-45

ground required for safe operation, A-29

hardware description, A-13, A-16

importance of proper grounding, A-24

installation of, A-2 1

ion gauge tube used with, A-14

maintenance of, A-39

manufacturer's manual, A-6

measuring pressure with, A-30

need for, 2-18

operation of the, A-29

ordering parts for, A-50

parts for, A-51

pressure display, A-29

specifications, A-5

replacing the fuse in the, A-48

replacing the ion gauge tube, A-42

symptoms of incorrect voltage setting, A-35

symptoms of low line voltage, A-36

symptoms of malfunctions, A-33

the gauge controller display briefly shows 9.99 + 9 ..., A-36

the gauge controller fuse fails as soon as A-35

the gauge controller power LED does not light A-34

with degas switch on, the degas indicator does not A-37

continued

Gauge controller — continued
theory of operation, A-11
troubleshooting the, A-3 1
voltage selector card, A-47
voltage setting, A-24, A-45
warranty, A-7

GC columns

conditioning of before installation, 4-5
flow rates through, 4-18
installing capillary direct, 4-6
installing with a splitter, 4-10
megabore, 4-4
narrow-bore, 4-4
packed, 4-4
symptoms of broken, 5-49
symptoms of excessive flow through the, 5-14, 5-17
symptoms of incorrect installation, 5-20
types of, 4-4
wide-bore, 4-4

GC/IRD/MSD interface, 1-3

GC/MSD interface

figure showing, 2-21
figure showing contact surface, 5-31
figure showing without insulation, 5-33
function of, 2-20
heater, 2-20
heater control, 2-20
location of, 2-20
maintenance of, 6-64
parts, 7-12
setting temperature during pumpdown, 4-24
symptoms of damaged, 5-30
temperature range, 2-20, 4-20
transfer line, 2-20
typical temperature of, 2-24

GC/MSD interface temperature,
figure showing relationship to MS temperature, 4-21

GC oven

 setting temperature during pumpdown, 4-24
 symptoms of low temperatures in the, 5-14

Ground, importance of, 4-3

Ground-fault loop, symptoms of, 5-10, 5-16, 5-26, 5-52

H

Head pressure, 4-19

Heat dissipation, 1-8

Heater sleeve

figure showing, 5-33

symptoms of incorrectly tightened, 5-32

Heater/sensor assembly

installing a, 6-68

removing the, 6-66

replacing the, 6-65

Height, of the MSD, 1-8

High background, 5-11

High masses, inadequate abundances at, 5-14

High temperatures, sites at which they are present, 6-10

High voltages, sites at which they are present, 6-9

HP-IB interface, B-46

HP-IB/MS address switch, B-47

HP-IB/MS control card, B-41

block diagram, B-45

figure showing, B-43

figure showing connections, 2-39

function of, 2-38

replacing the, B-55

switch settings, B-49

symptoms of a defective, 5-53, 5-55

theory of operation, B-42

troubleshooting

data test, B-53

GC/ALS test, B-54

HP-IB/MS control card test, B-52

initial checklist, B-48

HP-IB/RS232 switch settings, B-50

I

Improper isotope ratios, 5-13

Inadequate abundances at high masses, 5-14

Inconsistent peak widths, 5-16

Incorrect isotope abundances, 5-23

Injection ports, 4-19

- detecting dirty, 5-72
- leaks in the, 5-66

Installation

- initial, 3-4
- manual, 3-3, 3-4
- of the gauge controller, A-21
- steps included in, 3-4

Installing

- See also Reinstalling
- a detector, 6-62
- a filament, 6-58
- a heater/sensor assembly, 6-68
- the diffusion pump, 6-29
- the optional gauge controller, A-21
- the power distribution board, B-82

Interface socket

- figure showing, 5-31
- symptoms of damaged, 5-29

Interfacing to external devices, B-64

I/O check failure, 5-53

I/O connector, function of, 2-42

Ion focus lens

- effects of various settings, 4-32
- function of, 4-32
- voltages applied to, 2-26

Ion gauge tube

- as standard equipment in the MSD, A-3
- connections to the, A-23
- dangerous voltages and temperatures around, 6-30, A-14
- degassing the, A-41
- figure showing, 2-19, A-15
- figure showing theory of, A-12
- function of, 2-14, 2-18
- replacing the, A-42
- retrofitting to older instruments, A-3
- symptoms of a failed, A-36

Ion gauge tube fitting, leaks in the, 5-69

Ion source

- cleaning non-steel parts, 6-48
- cleaning steel parts, 6-46
- cleaning the, 6-41
- disassembling the, 6-44
- excessive pressure in the, 5-47
- figure showing cross-section of, 2-27
- figure showing disassembly of the, 6-45
- figure showing exploded view of the, 7-11
- figure showing removal of the, 6-43
- filaments, 2-25
- function of, 2-25
- lens elements in, 2-25
- parts, 7-10
- reassembling the, 6-50
- reinstalling the, 6-52
- removing the, 6-42
- symptoms of a dirty, 5-15, 5-18, 5-20, 5-23, 5-47
- symptoms of a disconnected, 5-60
- temperature of the, 2-24, 4-20

Ion source pressure, results of excessive, 5-47

Ionization energy, 1-6, 4-30

Isotope

- incorrect abundances, 5-23
- missing, 5-23

Isotope ratios, improper, 5-13

J

Jet separator, 4-4

K

KF flanges (fittings), 2-6
leaks in the, 5-67, 5-69

KF seals, 2-8

L

Latched error messages, 5-34

Leaks

air and water check for, 5-65
in the GC, 5-66
in the MSD, 5-67
isolating the, 5-66
peaks characteristic of, 5-73
symptoms of, 5-19, 5-49, 5-65

Lenses, in the ion source, 2-25

Line voltage, symptoms of low, A-36

Low abundance of m/z 502, 5-17

Low sensitivity, 5-19

M

Main board, B-25
 block diagrams, B-28 — B-32
 figure showing, 2-37, B-27
 functions of, 2-36
 replacing the, B-38
 symptoms of malfunctioning, 5-22, 5-36
 theory of operation, B-26
 voltages generated by, 2-36

Maintenance, 6-1
 analyzer, 6-35
 cleaning non-steel parts, 6-48
 cleaning steel parts, 6-46
 cleaning supplies, 6-7
 consumables for, 6-7
 electronics, 6-69
 general considerations, 6-3
 GC/MSD interface, 6-64
 schedule, 6-5
 tool needed for, 6-6
 vacuum system, 6-13

Malfunctions

 See **Symptoms of MSD problems**

Manual, organization of this, 1-10

Manual tune, 4-38

Manuals

 CI accessory, 1-11
 gauge controller, A-6
 GC/IRD/MSD interface, 1-11
 installation, 3-3, 3-4
 supplied with the MSD, 1-9

Mass assignments incorrect (not m/z 69, 219, 502), 5-22

Mass axis stability, 1-6

Mass filter

- affect of solvents on, 2-28
- figure showing, 2-29
- function of, 2-28
- hyperbolic shape of, 2-28
- maintenance of, 2-28
- parameters, 4-33
- symptoms of malfunctioning, 5-15, 5-16, 5-18, 5-22, 5-23, 5-36
- typical temperature of, 2-24
- voltages applied to, 2-28, 4-33

Mass range, 1-6

Mass resolution, 1-6

Midmass tune

- function of, 4-36
- ions used for, 4-36

Missing isotopes, 5-23

Moving, preparation for, 4-44

MS does not respond, 5-54

MS temperature, 2-24, 4-20

- figure showing relationship to GC/MSD temperature, 4-21
- symptoms of low, 5-21, 5-29

MSD

- analyzer, 2-22
- and GC, figure showing, 1-5
- description of, 1-3
- electronics, 2-32
- locating leaks in the, 5-67
- major components of, 1-3
- options to the, 1-3
- sources of contamination in, 5-73
- symptoms of problems in the, 5-3
- vacuum system, 2-4

N No peaks found, 5-56

 Noise, excessive, 5-10

 NW seals, 2-8

0

On/off switch, 2-44

Operating environment, 1-8

Options, to the MSD, 1-3

Ordering parts, 7-3

Organization

 of the MSD electronics, figure showing, 2-33

 of the MSD hardware, figure showing, 2-3

 of this manual, 1-10

O-ring assemblies, 2-8

 figure showing, 2-9

P

Parallel/remote board, B-67
figure showing connections, 2-39, B-67
function of, 2-38

Parts, 7-1
affected by tuning, 4-27
analyzer, 7-8
cables, 7-4
consumables, 7-13
electronic, 7-4
fuses, 7-5
gauge controller, A-51
GC/MSD interface, 7-12
ion source, 7-10
miscellaneous, 7-15
ordering, 7-3
rebuilt, 7-2
vacuum system, 7-6

Peaks
at m/z 18, 28, and 32, 5-25
none found, 5-56
too wide, 5-52

Peak widths
can not achieve constant, 5-35
inconsistent, 5-16
less than 0.4 amu or greater than 0.6 amu, 5-24

Perfluorotributylamine
See PFTBA

Performance specifications, 1-6

PFTBA, 2-18

Physical specifications, 1-8

Polarity
of the mass filter, 4-33
symptoms of selecting incorrect, 5-18, 5-20

Power distribution board, B-7 1
 block diagram, B-75
 figure showing, 2-41, B-73
 functions of, 2-40
 installing the, B-82
 removing the, B-80
 replacing the, B-76
 symptoms of malfunctioning, 5-6, 5-45
 theory of operation, B-72
 wiring diagram, 5-46

Power requirements, 1-8, 3-3

Power supply, B-85
 crowbar circuit, B-90
 figure showing, 2-41, B-87
 figure showing dc voltage test points, B-89
 figure showing the fuse, B-93
 figure showing the mounting screws, B-97
 functions of, 2-40
 fuse, B-106
 replacing the, B-94
 replacing the fuse, B-92
 symptoms of a defective, 5-54
 terminal strip, B-95
 testing the, B-88
 theory of operation, B-86
 voltages produced by, 2-40, B-86
 voltage ranges, B-89
 wire colors, B-96

Pre-operation checklist, 4-3

Pressure
 actual vs indicated, 2-16
 display on the gauge controller, A-29
 foreline gauge, 4-25
 ion gauge, 4-25
 monitoring, 4-25
 not corrected for helium, A-30
 sudden changes in, 4-25
 symptoms of excessive, 5-14, 5-17, 5-20, 5-47, A-36
 typical, 4-25, A-30

Pressure gauge

See Foreline vacuum gauge

See Ion gauge

Problems

See Symptoms of MSD problems

Pump exhaust, 4-3

Pumpdown

procedure for, 4-23

time required for, 4-23

Pumpdown program, 4-23

exiting before it is complete, 4-24

Pumping speed, 1-7

Q

Quicktune
for CI, 4-39
function of, 4-36

R

- Radiator
 - function of, 2-24
 - thermocouple on, 2-24
 - typical temperature of, 2-24
- Real-time control, 1-4
- Reassembling the ion source, 6-50
- Rebuilt parts, 7-2
- Refilling the calibration vial, 6-30
- Reinstalling
 - See also Installing
 - the diffusion pump, 6-29
 - the electronics panel, B-83
 - the ion source, 6-52
- Relative abundance, of air and water peaks, 5-65
- Removing
 - a filament, 6-55
 - the detector, 6-60
 - the diffusion pump, 6-22
 - the heater/sensor assembly, 6-66
 - the ion source, 6-42
 - the power distribution board, B-80
- Repeatability, causes of poor, 5-26
- Repeller
 - function of, 2-25
 - results of incorrect setting, 4-30
 - symptom of a short to ground, 5-48
 - use of to generate excess source pressure message, 4-30
 - voltage applied to, 4-30

Replacing
a filament, 6-54
the analyzer, 6-63
the calibration valve, B-102
the detector, 6-59
the diffusion pump, B-112
the diffusion pump fuses, B-110
the foreline pump fluid, 6-18
the foreline trap pellets, 6-20
the foreline vacuum gauge, 6-33
the gauge controller fuse, A-48
the heater/sensor interface, 6-65
the ion gauge tube, A-42
the power distribution board, B-76
the power supply fuse, B-92

Resolution, symptom of improperly set, 5-13

Restrictor, 4-14

RF coils
adjusting the, B-22
figure showing adjustment of the, B-23
symptoms of incorrect adjustments, 5-36

S

Safety, 6-8
chemical residue, 6-11
glasses, 6-11
high voltages, 6-9
high temperatures, 6-10

Safety glasses, 6-11

Scan speed, 1-6

seals
KF, 2-8
NW, 2-8
top plate, 2-8

Sensitivity
scan, 1-6
SIM, 1-6

Septum
bleed, 5-72
leaks in the, 5-66

Serial number, of your MSD, 1-12

Serious error occurred during data acquisition, 5-57

Service agreements, 1-16

Shipping clamps, 2-10
installation of, 6-38

Shutdown, 4-42

Signal, insufficient, 5-60

SIM mode, 1-7

Site preparation, 3-3

Size, of the MSD, 1-8

Smart card

See HP-IB/MS control card

Software, data system, 1-4

Solvent delay, symptoms of incorrect setting, 5-57

Solvent peak, effect of, 5-47, 5-62

Source pressure, excessive, 5-47

Specifications

gauge controller, A-5
performance, 1-6
physical, 1-8

Splitter

column installed with a, 4-11
figure showing with megabore column, 4-15
figure showing with wide-bore column, 4-15
installation of, 4-10

Start run signal, B-66

Startup, procedure for, 4-23

Static discharge

See Electrostatic discharge

storage, 4-44

Storage environment, 1-8

Supplies catalog, 7-2

Symptoms of MSD problems, 5-3

error messages, 5-34

can not achieve constant peak widths, 5-35
difficulty in the mass filter electronics, 5-36
difficulty with the detector HV supply, 5-37
excessive source pressure, 5-47
gain and offset = 0 and peaks are too wide, 5-52
mass spectrometer 1/0 check failure, 5-53
MS does not respond, 5-54

continued

Symptoms of MSD problems — continued

error messages — continued

no peaks found, 5-56

serious error occurred during data acquisition, 5-57

the diffusion pump is or was too hot, 5-39

the diffusion pump is too cold, 5-41

the foreline pressure has exceeded 300 mTorr, 5-49

there is no emission current, 5-58

there is not enough signal to begin the tune, 5-60

there was an excessive signal level, 5-62

general symptoms, 5-4

the MSD does not turn on, 5-5

the MSD is on but the fan is not operating, 5-6

the MSD is on but the foreline pump is not operating, 5-8

performance symptoms, 5-9

excessive noise, 5-10

high background, 5-11

improper isotope ratios, 5-13

inadequate abundances at high masses, 5-14

inconsistent peak widths, 5-16

low abundance of m/z 502, 5-17

low sensitivity, 5-19

mass assignments incorrect (not m/z 69, 219, 502), 5-22

missing isotopes or incorrect isotope abundances, 5-23

peak widths less than 0.4 amu or greater than 0.6 amu, 5-24

peaks at m/z 18, 28, and 32, 5-25

poor repeatability, 5-26

pressure symptoms, 5-27

temperature symptoms, 5-28

the analyzer (MS) temperature is too low, 5-29

System ready signal, B-64

T

219 width

correction of, 4-33

symptoms of inappropriate settings, 5-16

Tape, teflon, 6-33

Target tune, function of, 4-37

Technical reference, B-1

materials in, B-2

organization of, B-3

Teflon tape, 6-33

Temperature

See also MS temperature

effect of GC flow on, 4-20

figure showing MS temperature vs GC/MSD temperature, 4-21

figure showing relative temperatures of components, 4-22

high, 6-10

of the ion source, 4-20

symptoms of low MS temperature, 5-21

symptoms related to MSD malfunctions, 5-28

Temperature control, 1-7

Temperature sensors

locations of, 4-20

reading data from, 4-20

Testing the calibration valve, B-100

Testing the filaments, B-15

There is not enough signal to begin tune, 5-60

There was an excessive signal level, 5-62

Thermal equilibrium

importance of, 4-20

time required to reach, 2-24, 4-24

Thermal switches
function of, 2-16
on the diffusion pump, 2-16
symptoms of poor contact, 5-42

Thermocouple amplifier, B-13

Thermocouples
See Temperature sensors

Threshold, problems with, 5-61

TOO COLD switch
function of, 2-16
symptoms of a defective, 5-42
symptoms of poor contact, 5-42

TOO HOT switch
function of, 2-16
symptoms of a malfunctioning, 5-40

Tools, needed for maintenance, 6-6

Top board, B-5
adjusting the RF coils, B-22
block diagram, B-8, B-9
figure showing, 2-35, B-7
functions of, 2-34
replacing the, B-18
symptoms of a malfunction, 5-16, 5-22, 5-36
theory of operation, B-6
voltages generated by, 2-34

Top plate
feedthroughs in, 2-10
figure showing, 2-11
function of, 2-10
seal, 2-8

Top plate seal, leaks in the, 5-67, 5-69

Total ion mode, 1-7

Transfer line, 2-20

Troubleshooting procedures, 5-64

Tuning

- automation of, 4-26
- chemicals required for, 4-35
- figure showing parts affected by, 4-29
- function of, 4-26
- parts affected by, 4-27
- programs for, 4-35
- symptoms of incorrect, 5-23
- types of, 4-26

Tuning compounds, 2-18

Tuning parameters, 4-27

- default values, 4-28
- incorrect initial, 5-35
- settings, 5-35
- table of, 4-28

Tuning programs, list of, 4-35

U

Ultrasonic cleaning, 6-47

Usertune

function of, 4-38

parameter selected by user, 4-38

V

Vacuum fittings, 2-6

Vacuum gauge
foreline, 2-14
ionization 2-14

Vacuum manifold, 2-6
figure showing, 2-7

Vacuum manifold pressure, symptoms of excessive, 5-61

Vacuum seals
See Seals

Vacuum system
function of, 2-4
locations of components, figure showing, 2-5
maintenance of, 6-13
major components of, 2-4
parts, 7-6
pumping speed, 1-7

Vent tube, installation of, 4-12

Venting
of the GC eluent, 4-12
procedure for, 4-42
program, 4-42
through the GC/MSD interface, 4-43

Venting program, exiting before it is complete, 4-42

Voltages, dangerous, 6-9

W

Warranty, 1-13
for the gauge controller, A-7

Warranty claims, 1-15

Weight, of the MSD, 1-8

Width, of the MSD, 1-8

X

X-ray lens

adjustment of voltage applied to the, 4-34
function of, 4-34

